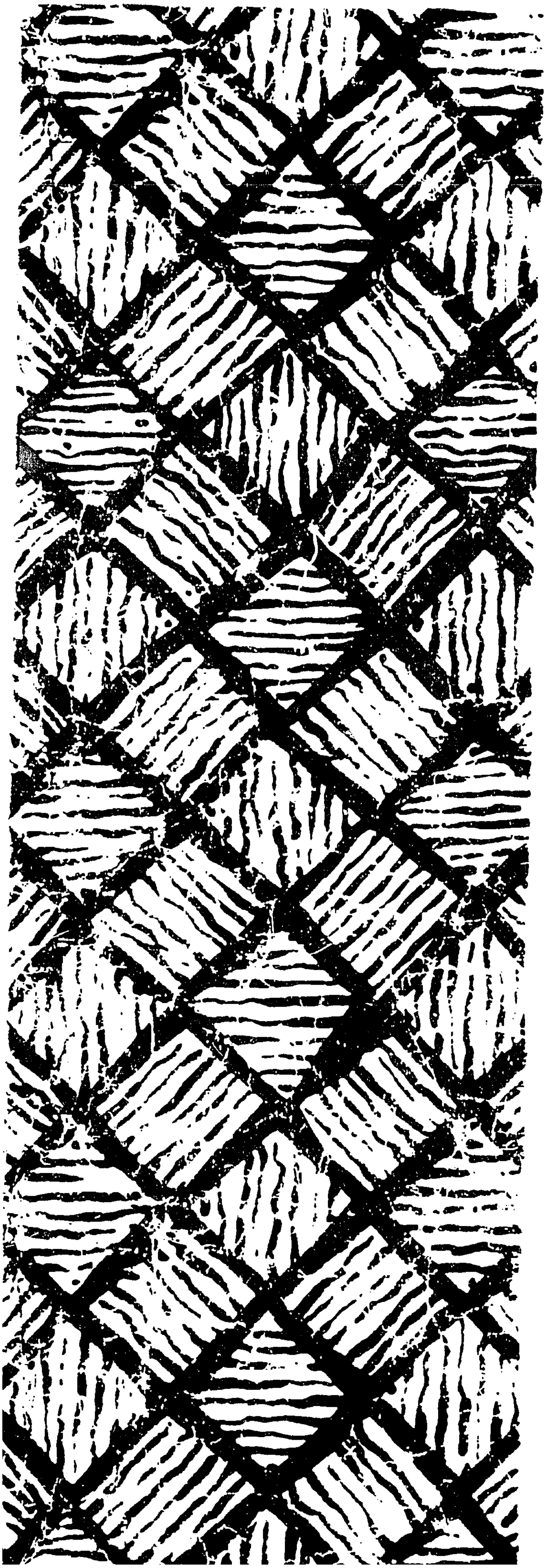


CONTENTS

CONTENTS

"IMPROVING THE VITAMIN A CONTENT OF DIETS"

SLIDE 1

The elimination of vitamin A deficiency in the long-run will depend on people's ability to make correct dietary choices. The focus of this presentation is to provide people with enough information about vitamin A-rich foods to enable them to make these choices.

"IMPORTANCE"

SLIDE 2

Around the world, poor eating habits and lack of a daily supply of nutritious food for mothers and children are factors contributing to the high rate of morbidity and mortality among children. A lack of vitamin A in the diet contributes to childhood deaths and complications from common diseases such as measles, diarrhea and protein-energy malnutrition. Vitamin A is required for proper maintenance and functioning of the immune system, and is essential to ensure the integrity of the respiratory and digestive tract. Vitamin A deficiency is the largest cause of childhood blindness in the developing world. One-half to one million preschool age children develop severe eye disease each year.

"VITAMIN A SOURCES"

SLIDE 3

Where does vitamin A occur and how does it affect the body? Vitamin A occurs widely in nature. Animal foods such as fish, milk, including breast milk, meat, and eggs contain preformed retinol. Plant sources such as dark yellow and orange fruits, carrots, and dark green leafy vegetables contain a precursor to the vitamin A called beta-carotene. Synthetic vitamin A is also available in capsules and liquid concentrates.

"AMOUNTS NEEDED DAILY"

SLIDE 4

To prevent vitamin A deficiency and related illnesses from occurring, foods rich in vitamin A must be consumed regularly. For children under 6 months of age, breastfeeding alone is adequate. For the older infant, small amounts of carrots or spinach or ripe mango are necessary in addition to breast milk. The liver has the capacity to store several months' supply of vitamin A so that the lack of vitamin A-rich foods during some seasons is not a serious problem. To improve the absorption of vitamin A from fruits and vegetables, a moderate amount of fat in the diet is necessary.

"THE PROBLEM IS WIDESPREAD"

SLIDE 5

Globally, more than 124 million children under 5 years of age are at risk of vitamin A deficiency. Based on the results of mortality and morbidity studies, it has been estimated that worldwide, as many as 1.3 to 2.5 million deaths in children in the 6 to 59 months age group could be prevented through vitamin A intervention programs.

"WHAT CAN BE DONE?"

SLIDE 6

What can be done to improve the situation of people most affected by vitamin A deficiency? What solutions exist that are within the capabilities of the population at risk to protect themselves from the detrimental, and often fatal, effects of vitamin A deficiency?

"COMPREHENSIVE PACKAGE: THE GUATEMALA EXAMPLE"

SLIDE 7

In Guatemala, a combination of approaches is being implemented. Each approach is oriented to addressing vitamin A deficiency in a different target population.

"INCREASING VITAMIN A INTAKE: SUPPLEMENTS"

SLIDE 8

There are several ways to increase the vitamin A intake. High-dose supplements containing 200,000 IU of vitamin A have been successfully used to prevent blindness and risk of mortality in high prevalence areas, and to treat cases of xerophthalmia, measles, and PEM. Generally existing delivery systems are used, such as refugee camps, hospitals and clinics for measles, community health workers, and immunization teams. Supplements must be provided at least every 4-6 months; often it is not possible to maintain high coverage rates with vitamin A supplements because of disruptions in supplies (vitamin A must be imported) and a lack of health services outreach. Therefore, supplementation has been called a short-term emergency measure, essential for saving the lives and sight of children in the near-term, but difficult to sustain as a long-term strategy.

"INCREASING VITAMIN A INTAKE: FORTIFICATION"

SLIDE 9

Another method that has proved successful, especially in developed countries, is the fortification of food products. Fortification is an excellent option in countries where a large proportion of high-risk families consume centrally processed foods, where the food industry is advanced, and where a reliable way to monitor and enforce compliance with fortification standards can be assured. However, even in countries with these pre-requisites, recent problems have emerged. For example, problems with vitamin A stability in the fortified products, have highlighted the need for constant monitoring and technical support to achieve successful vitamin A fortification.

"IMPROVING DIETS"

SLIDE 10

Probably the most economical and permanent method of increasing the intake of vitamin A in the long-term, is to increase the consumption of vitamin A-rich foods through better nutritional practices. Implementation of production and preservation activities may be needed in conjunction with nutrition education.

Vitamin A is found in many low- to moderate-cost foods commonly available in most communities throughout the world. The sustained improvements in vitamin A nutrition among populations in many countries can probably be best attributed to improvements in the vitamin A content of their diets.

In areas where food sources of vitamin A are unavailable, expensive, or only available seasonally, simple food preservation and gardening activities can help bridge the gap.

"PROGRAM EXAMPLE: ASSABA/MAURITANIA"

SLIDE 11

Nutrition education programs around the world have contributed to the better health of at-risk women and children. One example is the program supported by World Vision Relief and Development Agency in Assaba region of Mauritania. Dietary improvement is being brought about by promoting production and consumption of vegetables. In combination with primary health care and capsule distribution, the project provided extension education and gardening inputs to 20 villages in the program area. During the first year of the project's implementation, approximately 3,000 women were trained in preparation of weaning foods enriched with vitamin A sources and in growth monitoring, ORT, and hygiene. Carefully developed and pre-tested slide shows and songs helped to spread key messages throughout the program area.

"PROGRAM EXAMPLE: HAITI"

SLIDE 12

Another example of a project that succeeded in making vitamin A-rich foods available all year around can be seen in Haiti.

By utilizing the simple and appropriate technology of solar drying, communities were able to dry vitamin A-rich mangos to be eaten throughout the year and, at the same time, provided additional income for the family.

"FOCUS ON THOSE AT HIGHEST RISK"

SLIDE 13

In order to succeed, a program must focus on those at highest risk. Improving dietary practices is a time-consuming task. Families must be convinced of the need to change their habits. Once high-risk communities and individuals have been identified, the process of program development can focus on the needs and resources available in those communities. For example, in Uganda, in a survey of Kamuli district, these variables were found to be associated with risk of xerophthalmia.

— READ FROM SLIDE —

Such an analysis allows program implementation to be given priority in selected geographic areas, households and age groups.

"THE PROGRAM PROCESS"

SLIDE 14

The chart shows the elements in developing an educational program concerned with dietary interventions. First there is the gathering of data to better understand communities. This data collection is followed by the selection of specific foods and feeding practices to be promoted. Then messages and materials are developed that are appropriate for the different audiences who must be reached. Next, mini-trials are conducted in order to refine the messages and materials so that they are practical, culturally appropriate, and effective. The content of the messages can be similar across target groups, but the choice of words, manner of presentation, and channels or media used for each segment of the population may be different. A detailed plan of action, including training, arrangements for logistics and supplies, and finally, monitoring and evaluation are critical for success.

"GATHERING BASELINE INFORMATION"

SLIDE 15

First, we must gather baseline information regarding the present knowledge, attitudes, and practices of our audience. We ask questions within a certain framework that bears on the goals of the project. The KAP survey (Knowledge, Attitudes, and Practices) provides this information. Some programs have used a combination of methods including group discussions with mothers and opinion leaders, observations, and market surveys. The type of information includes:

— READ FROM SLIDE —

Generally, we define the audience in terms of their knowledge, attitudes, practices, and culture, special interests as they relate to the nutritional intervention we want to propose. What is the audience's understanding of the problem? Do they believe that they have a problem? What are the practices of the population which could have a bearing on vitamin A status? What is the environment in which the change needs to be made, including the mothers' socio-economic status and work constraints? What is the availability of vitamin A-rich foods? What are the consumption and cooking practices? Current perceptions of eye and health problems? Potential media for information dissemination? What other resources or common information exchange methods exist in the community?

"ANALYZING BASELINE INFORMATION"

SLIDE 16

With the baseline information we then make the selection of food consumption practices and varieties of foods to be promoted. Questions that will have to be answered include

— READ FROM SLIDE —

"MESSAGES"

SLIDE 17

Having obtained our baseline and defined our objectives we begin to develop the messages. The key premises in message design are: (1) Content of the message should consider the problem, target audience, resistance points, solution, and necessary action. (2) Design of the message should be developed around single ideas, language, and cultural relevance. (3) The message should be persuasive and believable. (4) The message should be memorable.

"CHOOSING THE MEDIA"

SLIDE 18

Once we have designed the messages, we must decide what types of media would best transmit our messages. In order to determine this we must know how people communicate. Are there folk tales, songs, and drawings that would be appropriate? Can we make use of mass media such as radio and films?

"FIELD TESTING"

SLIDE 19

Pretesting is an important part in the development of materials. It is during this stage in the program that we find out if what we are suggesting and producing is understandable and important to the population at risk. Materials are modified based on the results of the pretesting.

"TRAINING"

SLIDE 20

We will have to train all project personnel in the implementation of the educational objectives. Personnel will have to be trained in the technical content of our interventions, in how to motivate and communicate with target audiences, and in the use of educational support material that will be produced by the project.

"PROMOTING BEHAVIOR CHANGE"

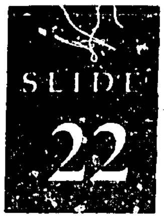
SLIDE 21

The plan of action should reinforce the cycle of behavior change in the target audience. This cycle contains the following stages:

— READ FROM SLIDE —

The project has to set up a complete implementation strategy by scheduling and coordinating activities to reinforce these stages.

"AWARENESS"



Stage 1. Tell about the new idea and stimulate awareness and interest. The first step is to stimulate awareness of the problem and its solution among the audience. The program should aim to make people pause and think, take interest, question, and draw comparisons. The project prepares the ground for the extension workers and gives them a willing audience.

"INSTRUCTION & EXPERIMENTATION"

Stage 2, 3. Instruction/Encourage Trial. The next two phases of the campaign go hand in hand. The families will begin to learn why they need to grow vitamin A-rich vegetables as well as how to prepare and integrate them into their diet. The necessity of eating the vegetables from the garden and perhaps how to prepare them will have to be explained. It may also be necessary to demonstrate methods of preserving vitamin A-rich foods for use when fresh foods are not seasonally available.

"PRACTICE & REPETITION"

Stage 4. Encourage practice. At this time, contact between the program and households will be extremely important. Of all those who hear of the proposed interventions, a certain number will agree to try the new practice for a specified period of time.

"FOLLOW-UP"

Stage 5. Intensive follow-up. Although some of the households will have carried out the trial practice for an agreed amount of time, and tried to introduce the new food into their family diet, there is the possibility here for regression. Some may have a tendency to feel that the new idea is really too much trouble; they may not see any real benefits–yet. Follow-up is important here. Again, close contact with project personnel will be the essential influence, giving personal encouragement, allaying any doubts, answering questions.

"EVALUATION"

SLIDE 26

Stage 6. Evaluation. At this stage, it is time to take stock of our work, to assess our success in terms of the number of people who have accepted the idea and continue to practice it. After evaluation of the educational efforts, the project can proceed using the lessons learned from the evaluation. If we have followed the principles discussed above, the program will succeed in the objective of increasing the consumption of vitamin A-rich foods by the at-risk population.

"SUMMARY"

SLIDE 27

Briefly, we know that poor dietary habits contribute to the high rate of morbidity and mortality of children around the world. The lack of vitamin A contributes to common childhood deaths and complications from diseases such as measles, diarrhea, and respiratory infections. Vitamin A deficiency is the largest cause of blindness in the developing world; one-half to one million preschool-age children develop severe eye disease each year.

There are several ways to increase the amount of vitamin A intake. They include promoting consumption of vitamin A-rich foods, food fortification, and where the need is immediate, distribution of vitamin A supplements.

The process of developing a program to improve diets consists of gathering data so as to better understand the target communities. This is followed by selecting specific foods and feeding practices to be promoted and developing messages, and materials that are appropriate for different audiences that need to be reached. Then, mini-trials are needed to refine the selection of foods, messages and materials so that they are practical and effective. For an efficient program, high-risk communities and families need to be given priority, and program activities should be scheduled to reinforce the cycle of behavior change.

There are many organizations and resources that can help you develop and implement a nutrition improvement education program.

"UNE ALIMENTATION PLUS RICHE EN VITAMINE A"

1

L'elimination de la carence en vitamine A à long-terme dépendra sur la capacité des populations à faire des changements dans leurs choix alimentaires. L'idée maîtresse de cette présentation est de donner assez d'information sur les aliments riches en vitamine A pour les aux populations afin qu'elles puissent faire leurs choix.

"IMPORTANCE DE LA VITAMINE A"

2

Dans le monde entier, les habitudes alimentaires déficientes et la pénurie d'aliments nutritifs pour les mères et les enfants contribuent à des taux élevés de mortalité et de morbidité juvéniles. Le manque de vitamine A dans la ration alimentaire peut être cause de décès et de complications des suites de maladies courantes telles que la rougeole, la diarrhée et la malnutrition protéino-énergétique. La vitamine A est nécessaire pour le bon fonctionnement et l'entretien du système immunitaire et elle est essentielle pour l'intégrité des appareils respiratoire et digestif. La carence vitaminique A est la cause la plus importante de cécité juvénile dans les pays en développement. De 500 000 à un million d'enfants d'âge préscolaire souffrent de maladies oculaires chaque année.

"SOURCES DE VITAMINE A"

3

D'où vient la vitamine A et quelle effet a-t-elle sur l'organisme ? La vitamine A est largement présente dans la nature. Des aliments d'origine animale tels que le poisson, le lait (y compris le lait maternel), la viande et les oeufs contiennent du rétinol préformé. Les aliments d'origine végétale tels que les fruits jaunes foncés et oranges, les carottes et les légumes verts foncés feuillus contiennent un précurseur de la vitamine A appelé bêta-carotène.

"BESOINS JOURNALIERS"

4

Pour prévenir les carences en vitamine A et les maladies qui en découlent, il importe de consommer régulièrement des aliments riches en vitamine A. Pour le enfants de moins de 6 mois, le lait maternel suffit. Chez les enfants plus âgés, il est nécessaire de compléter le lait avec de petites quantités de carottes, de légumes verts foncés ou de mangue mûre. Le foie peut emmagasiner de la vitamine A pour plusieurs mois. Autrement dit la non disponibilité d'aliments riches en vitamine A pendant certaines saisons ne constitue pas un grave problème. Pour améliorer l'assimilation de la vitamine A des fruits et des légumes il est nécessaire d'ajouter des quantités modérées de matière grasse à la ration alimentaire.

"UN PROBLEME REPANDU"

5

Dans le monde, plus de 124 millions d'enfants de moins de 5 ans risquent de souffrir de carences en vitamine A. D'après les résultats d'études de mortalité et de morbidité, on estime que dans le monde entier de 1,3 à 2,5 millions de décès d'enfants de 6 à 59 mois pourraient être prévenus grâce à des interventions de vitamine A. Dans des pays que l'on croyait épargnés, on reconnaît que les carences vitaminiques A constituent de plus en plus un problème grave.

"QUE PEUT-ON FAIRE ?"

6

Que peut-on faire pour améliorer la situation des personnes les plus touchées par les carences en vitamine A ? Quelles sont les solutions à la portée des populations à risque pour les protéger contre les conséquences néfastes et bien souvent fatales des carences vitaminiques A ?

"UNE DEMARCHE GLOBALE : L'EXPERIENCE DU GUATEMALA"

7

Au Guatemala, plusieurs formules sont mises en oeuvre. Chacune vise à attaquer le problème des carences en vitamine A auprès d'une population différente.

"ACCROITRE LA CONSOMMATION DE VITAMINE A : LES COMPLEMENTS"

8

Il existe plusieurs manières d'accroître la consommation de vitamine A. La distribution de compléments contenant 200 000 UI de vitamine A a réussi à prévenir la cécité et le risque de mortalité dans des régions à forte prévalence, et à traiter des cas de xérophtalmie, de rougeole et de malnutrition protéino-énergétique. On utilise en général un système de distribution déjà en place, par exemple camps de réfugiés, hôpitaux et dispensaires contre la rougeole, agents de santé communautaires et équipes de vaccination. Les compléments doivent être distribués au moins tous les 4 à 6 mois. Bien souvent, il n'est pas possible de maintenir des couvertures importantes à cause des perturbations dans les approvisionnements (la vitamine A doit être importée) et du manque de services de santé. C'est pourquoi l'on a dit que la distribution de compléments était une mesure d'urgence de courte durée, essentielle pour sauver la vue et la vie d'enfants à court terme, mais difficile à maintenir comme stratégie à long terme.

"ACCROITRE LA CONSOMMATION DE VITAMINE A : L'ENRICHISSEMENT"

9

L'enrichissement des aliments est une autre méthode qui s'est révélée efficace, tout particulièrement dans les pays industrialisés. Lorsqu'une grande proportion des ménages consomme des aliments qui ont été transformés en un point central, que l'industrie agro-alimentaire est prête et que l'on peut assurer la surveillance et le respect de normes d'enrichissement, l'enrichissement est une excellente option. Cela dit, même dans les pays où ces conditions sont remplies, des problèmes se sont récemment posés sur le plan de la stabilité de la vitamine A dans les produits enrichis, ce qui rend d'autant plus nécessaires une surveillance et un appui technique constants.

"UNE ALIMENTATION MEILLEURE"

10

La consommation accrue d'aliments riches en vitamine A, grâce à de meilleures pratiques alimentaires, est probablement la méthode la plus économique et durable pour augmenter la consommation de vitamine A. Outre l'éducation en nutrition, cela suppose éventuellement des activités de production et de conservation.

La vitamine A est présente dans de nombreux aliments de coût modeste que l'on trouve couramment dans la plupart des communautés du monde entier. Dans de nombreux pays, les améliorations durables de la nutrition en vitamine A peuvent être probablement attribuées à une meilleure ration alimentaire.

Lorsque les sources alimentaires de vitamine A ne sont pas disponibles, qu'elles sont coûteuses ou qu'elles ne sont disponibles que certaines saisons, la conservation des aliments et la culture de potagers peuvent compenser.

"EXEMPLE DE PROGRAMME : ASSABA/MAURITANIE"

11

Les programmes d'éducation en nutrition dans le monde entier ont contribué à améliorer la santé des femmes et des enfants à risque. Nous citerons comme exemple le programme mis en oeuvre par World Vision Relief and Development Agency dans la région d'Assaba en Mauritanie. La promotion de la production et de la consommation de légumes contribue à améliorer la situation alimentaire. Conjointement aux activités de soins de santé primaires et de distribution de capsules, le projet a mis en oeuvre des opérations de vulgarisation et a mis à disposition des fournitures pour la culture de potagers dans 20 villages de la région du programme. Près de 3 000 femmes ont été formées à la préparation d'aliments de sevrage enrichis à la vitamine A, au suivi de la croissance, à la TRO et à l'hygiène durant la première année de mise en oeuvre. Des diaporamas et des chansons élaborés et testés avec soin ont grandement contribué à la diffusion d'importants messages dans toute la région du programme.

"EXEMPLE DE PROGRAMME : HAITI"

12

Haïti constitue un autre exemple de projet qui a réussi à rendre disponibles durant toute l'année des aliments riches en vitamine A. En utilisant la technologie simple et pertinente du séchage solaire, les communautés ont pu conserver des mangues riches en vitamine A pour le reste de l'année tout en produisant un complément de revenu pour les familles.

"UNE ATTENTION PARTICULIERE AUX POPULATIONS LES PLUS EXPOSEES AU RISQUE"

13

Pour réussir, il est essentiel de se concentrer sur les populations qui courent le plus de risques. L'amélioration des pratiques alimentaires prend un certain temps. Il est nécessaire de convaincre les familles qu'elles doivent les modifier. Une fois que l'on a défini les communautés et les individus à risque, les programmes peuvent se concentrer sur les besoins de ces communautés et sur les ressources disponibles.

"LE DEROULEMENT D'UN PROGRAMME"

14

La liste ci-dessus indique les éléments de la mise au point d'un programme d'éducation faisant intervenir des activités sur le plan alimentaire. Tout d'abord, il est nécessaire de recueillir des données pour mieux comprendre les communautés. Ce recueil de données est suivi de la sélection d'aliments et de pratiques alimentaires à promouvoir. Des messages et des supports et ensuite définis pour chaque public visé, puis des mini-essais sont réalisés pour mieux définir les messages et les supports et veiller à ce qu'ils soient pratiques, culturellement pertinents et efficaces. Le contenu des messages peut être comparable dans tous les groupes visés, mais le choix des mots, le type de présentation et les moyens ou les supports utilisés pour chaque groupe de population peuvent changer. La surveillance et l'évaluation pour l'amélioration systématique des méthodes de programme et des supports sont essentielles.

"LE RECUEIL DE DONNEES DE REFERENCE"

15

Tout d'abord, il est nécessaire de recueillir des données de référence qui permettent de faire le point de l'état actuel des connaissances, des attitudes et des pratiques du public visé. Des questions sont posées dans le cadre des objectifs du projet. Une enquête de connaissances, attitudes et pratiques permet d'obtenir ce type d'informations. Certains programmes ont fait appel à une combinaison de méthodes dont les discussions de groupe avec des mères, les leaders d'opinion, les observations et les études de marché.

De manière générale, le public est défini en fonction de ses connaissances, ses attitudes et ses pratiques et de ses intérêts spéciaux quant aux interventions de nutrition proposées. Comment le public perçoit-il le problème ? Pense-t-il qu'il souffre d'un problème ? Quelles sont les pratiques de la population qui pourraient avoir une incidence sur l'état en vitamine A ? Dans quel environnement les changements doivent-ils être apportés (y compris la condition socio-économique des mères et les contraintes de travail) ? Quelle est la disponibilité d'aliments riches en vitamine A ? Quelles sont les pratiques de consommation et de cuisson ? Comment les problèmes oculaires et sanitaires sont-ils perçus ? Quels supports pourraient être envisagés pour la diffusion d'informations ? Quelles autres sources ou méthodes d'échange d'informations y a-t-il dans la communauté ?

"ANALYSE DES INFORMATIONS DE REFERENCE"

16

A partir des informations de référence, un choix est ensuite fait quant aux pratiques d'alimentation et aux aliments à promouvoir. Plusieurs questions devront être posées sur la complémentarité des activités : les aliments suggérés existent-ils en quantité suffisante ? Financièrement, sont-ils à la portée du public ? Y aura-t-il un besoin de production et de préservation alimentaire et d'activités d'entreposage.

"MESSAGES"

17

Après avoir obtenu les renseignements de base et défini les objectifs, les messages doivent être préparés. Les principaux paramètres d'un message sont le contenu (qui doit refléter le problème en cause), le public visé, les points de résistance, la solution et les mesures à prendre. La conception des messages doit reposer sur des idées spécifiques et être pertinente du point de vue linguistique et culturel. Les messages doivent être persuasifs et crédibles. Ils doivent laisser une empreinte dans la mémoire du destinataire.

"LE CHOIX DU SUPPORT"

18

Une fois que les messages ont été conçus, il faut choisir le support le plus approprié pour leur diffusion. Pour cela il faut notamment savoir comment la population visée communique. Y a-t-il des contes, des chansons ou des dessins qui pourraient être appropriés ? Peut-on faire appel aux mass media tels que la radio ou les films ?

"ESSAIS SUR LE TERRAIN"

19

La mise à l'essai préalable est une étape importante de la conception des supports. C'est durant cette phase que l'on peut vérifier si le message visé et le produit proposé sont compréhensibles et importants pour la population à risque. A ce stade, l'on doit être prêt à apporter d'éventuelles modifications selon les résultats des essais.

"FORMATION"

20

Il faut assurer la formation de tout le personnel qui participe à la mise en oeuvre des objectifs d'éducation. La formation doit porter sur le contenu technique des interventions ainsi que sur les modalités de motivation et de communication auprès du public visé. Elle doit également porter sur l'utilisation de supports didactiques qui seront produits dans le cadre du projet. La formation est un bon moyen d'entretenir la motivation du personnel intervenant dans le programme.

"PROMOUVOIR LES CHANGEMENTS DE COMPORTEMENT"

21

La liste ci-dessus est celle des étapes classiques du changement de comportement. Le plan d'action doit renforcer le cycle de modification du comportement au sein du public visé. Une stratégie complète doit être mise en oeuvre dans le cadre du projet en programmant et en coordonnant les activités.

"SENSIBILISATION"

22

1ere étape. Faire part de la nouvelle idée, promouvoir la prise de conscience et susciter l'intérêt.

La première étape consiste à promouvoir la prise de conscience du problème et de la solution au sein du public visé. Le programme doit encourager le public à s'interroger, à s'intéresser, à poser des questions et à faire des comparaisons. Le projet vise à "préparer le terrain" pour les agents de vulgarisation et pour mettre à leur disposition un public disposé à agir.

"INSTRUCTION ET EXPERIMENTATION"

23

2e et 3e étapes. Instruction et expérimentation.

Les deux étapes suivantes vont de pair. Les familles commencent à comprendre pourquoi elles doivent cultiver ou acheter des légumes riches en vitamine A, les préparer et les inclure dans leur ration alimentaire. Il faudra, bien entendu, leur expliquer pourquoi il est nécessaire de manger les légumes du jardin ou du marché et de les préparer. Dans certains cas, il peut être nécessaire de démontrer des méthodes de conservation des aliments riches en vitamine A pour les consommer durant les saisons où ils ne sont pas disponibles.

"PRATIQUE ET REPETITION"

24

4e étape. Encourager la pratique.

A ce stade, les contacts entre les représentants du programme et les ménages sont extrêmement importants. Parmi ceux qui ont entendu parler des interventions proposées, un certain nombre sera disposé à essayer les nouvelles pratiques pendant un certain temps.

"SUIVI"

25

5e étape. Suivi intensif.

Bien que certains ménages auront essayé les pratiques pendant un certain temps et tenté d'adopter de nouveaux aliments dans leur ration alimentaire, il y a un risque de régression. Certains penseront peut-être que les nouvelles idées posent vraiment trop de problèmes et n'en verront pas forcément (encore) l'intérêt. Le suivi est important à ce stade. Là aussi, un contact étroit entre le personnel et la population est essentiel pour influencer, encourager, dissiper les doutes et répondre aux questions.

"EVALUATION"

26

6e étape. Evaluation.

A ce stade il est nécessaire de dresser un bilan, d'évaluer les réussites (c'est-à-dire le nombre de personnes qui ont accepté la nouvelle idée et continuent de la pratiquer). A l'issue de l'évaluation du travail d'éducation, on peut poursuivre la mise en oeuvre du projet en appliquant les enseignements tirés de l'évaluation. Si l'on suit les principes énoncés jusqu'à présent, le programme réussira à accroître la consommation d'aliments riches en vitamine A au sein de la population à risque.

"SYNTHESE"

27

En résumé, nous savons que les pratiques alimentaires déficientes contribuent à accroître les taux de morbidité et de mortalité chez les enfants du monde entier. Le manque de vitamine A peut être cause de décès et de complications des suites de maladies telles que la rougeole, la diarrhée et les infections respiratoires. Les carences vitaminiques A sont la principale cause de cécité dans les pays en développement et de 500 000 à 1 million d'enfants d'âge préscolaire souffrent de maladies oculaires aiguës chaque année.

Il y a plusieurs moyens d'accroître la consommation de vitamine A : promotion de la consommation d'aliments riches en vitamine A, enrichissement des aliments et, lorsque des besoins immédiats le justifient, distribution de compléments vitaminiques A.

L'élaboration d'un programme d'amélioration de la ration alimentaire repose sur le recueil de données afin de mieux comprendre les communautés cibles. On procède ensuite à la sélection d'aliments et de pratiques alimentaires spécifiques que l'on entend promouvoir en mettant au point des messages et des supports se prêtant au public que l'on entend couvrir. Des mini-essais sont ensuite nécessaires pour mieux définir les aliments, les messages et les supports de manière à ce qu'ils soient pratiques et efficaces. Pour que le programme soit particulièrement réussi, il est nécessaire d'accorder la priorité aux familles et aux communautés à haut risque et les activités de programme doivent être programmées de manière à renforcer le cycle de modification du comportement.

Il y a un grand nombre d'organisations et de moyens à votre disposition pour élaborer et mettre en oeuvre un programme d'éducation pour l'amélioration de la nutrition.

"COMO MEJORAR EL CONTENIDO DE VITAMINA A DE LAS DIETAS"

1

La eliminación de la deficiencia de vitamina A a largo plazo dependerá en el cambio de habitudes dieteticas. Esta presentación tiene por objectivo proporcionar informacion sobre alimentos ricos en vitamina A para ayudarles a hacer estas seleciones.

"IMPORTANCIA"

2

En todo el mundo, un mal régimen de alimentación y la carencia de la provisión diaria de alimentos nutritivos para las madres y los niños constituyen factores que contribuyen al alto índice de morbilidad y mortalidad infantil. La falta de vitamina A en la dieta contribuye a la muerte de niños por enfermedades comunes como el sarampión, la diarrea y las infecciones respiratorias. La vitamina A se requiere para un adecuado mantenimiento y funcionamiento del sistema inmunológico y es esencial para asegurar la integridad de las vías respiratorias y digestivas. La deficiencia de vitamina A es la mayor causa de ceguera durante la niñez en el mundo. Anualmente un millón de niños en edad preescolar padece lesiones oculares severas.

"EL PROBLEMA ES GENERAL (EL PROBLEMA ES MUNDIAL)"

3

Este mapa ilustra las zonas del mundo en las que la vitamina A representa un problema de salud importante. En caso de América Latina, observen que Centro América, la zona Andina y Brasil tienen deficiencia de vitamina A.

"¿QUE SE PUEDE HACER? (¿QUE PODEMOS HACER?)"

4

¿Qué podemos hacer para mejorar la situación de la población más afectada por la deficiencia de vitamina A? ¿Dentro de la comunidad, qué alternativas existen para que la población a riesgo se proteja contra los efectos nocivos y a veces fatales de la deficiencia de vitamina A?

El programa en Guatemala es un ejemplo. Se puede observar el papel de cada uno de los acciones.

"PROGRAMA GLOBAL: GUATEMALA (PROGRAMA INTEGRAL: GUATEMALA)"

5

- a nivel nacional
- dirigido a casos de alto riesgo
- dirigido a grupos/areas específicos

"AUMENTO DEL CONSUMO (a)"

6

Existen varias formas de aumentar la cantidad de consumo de vitamina A cuando no se dispone de otras opciones. Para proporcionar rápidamente cantidades terapéuticas de vitamina A a personas seriamente afectadas, se pueden utilizar cápsulas de dosis altas que contengan 200.000 UI de vitamina A. Pero estas cápsulas deben ser únicamente una solución a corto plazo porque se las debe importar y son muy difíciles de distribuir a nivel nacional.

"AUMENTO DEL CONSUMO (b)"

7

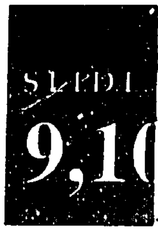
Otro método que ha resultado acertado es la fortificación de alimentos. En aquellos lugares en que una gran proporción de las familias de alto riesgo consume alimentos elaborados, con apoyo de la industria alimentaria, y un sistema de control y vigilancia, la fortificación representa una opción excelente. Pero este método entraña tareas de concientización e implantación a nivel industrial incluyendo la importación de insumos y, en algunas oportunidades, legislación, a fin de ponerla en ejecución con éxito a nivel nacional.

"AUMENTO DEL CONSUMO (c)"

8

El método a largo plazo más económico, natural y adecuado para aumentar el consumo de vitamina A es simplemente el incremento del consumo de alimentos ricos en vitamina A por medio de un mejor régimen de alimentos. La vitamina A se encuentra en muchos alimentos cuyo costo es bajo o moderado, y que normalmente se pueden conseguir en las comunidades de todo el mundo. La combinación de intervenciones permite reducir o eliminar la deficiencia de vitamina A. Las mejoras permanentes en materia de nutrición de vitamina A de los países desarrollados y en vías de desarrollo es probable que puedan atribuirse a las mejoras en el contenido de vitamina A de sus dietas. Sin duda, el mayor consumo de alimentos ricos en vitamina A es beneficioso para la población en general, pero especialmente para las madres y niños que necesitan mantener niveles adecuados para tener buena salud. La educación nutricional puede ayudar a las familias y comunidades a fin de asegurar que los grupos más vulnerables consuman suficiente vitamina A. En aquellas zonas en las que no se dispone de alimentos o hay fuentes de vitamina A pero son caros, la conservación de los alimentos y la horticultura pueden complementarse para llenar el vacío. En esta presentación, se cubrirá información sobre los alimentos ricos en vitamina A y las actividades que pueden ayudar a promover su consumo.

"PROGRAMAS DE EDUCACION NUTRICIONAL (TAILANDIA)"



Los programas de educación nutricional de todo el mundo han contribuido a mejorar la salud de las mujeres y los niños a riesgo. En Tailandia se puede observar un ejemplo excelente de un programa innovador que tuvo éxito en el aumento del consumo de alimentos ricos en vitamina A.

"HAITI"

En Haití se puede observar otro ejemplo de un proyecto que tuvo éxito en facilitar alimentos ricos en vitamina A durante todo el año. Por medio de la utilización de la tecnología sencilla apropiada de secado solar, las comunidades pudieron secar los mangos ricos en vitamina A para comerlos durante todo el año y a la vez proporcionar ingresos adicionales para la familia.

"FUENTES DE ALIMENTOS Y CANTIDADES DIARIAS NECESARIAS"

¿Dónde se produce la vitamina A y cómo afecta al cuerpo? La vitamina A se encuentra ampliamente en la naturaleza. Los alimentos de origen animal tales como el pescado, la leche, incluida la leche materna, la carne y los huevos contienen retinol preformado. Las fuentes vegetales, tales como frutas, zanahorias y verduras de hojas verde oscuro, contienen un precursor de la vitamina A llamado betacaroteno.

Para impedir que se produzca una deficiencia de vitamina A con sus secuelas correspondientes, se debe consumir alimentos ricos en vitamina A en forma diaria. Para los niños menores de 6 meses de edad, sólo basta la alimentación con leche materna. En el caso de lactantes mayores, se necesitan pequeñas cantidades de zanahorias, espinaca, o mangos maduros además de la leche materna. El hígado tiene la capacidad de guardar hasta el equivalente de varios meses de reservas de vitamina A, por lo tanto no hay ningún problema si se consumen grandes cantidades de alimentos ricos en vitamina A. Para mejorar la absorción de la vitamina A de las fuentes vegetales, es necesario contar con una cantidad moderada de grasa o aceite vegetal en los alimentos.

"PROCESOS METABOLICOS"

13

¿Qué es la vitamina A y por qué es importante para la salud de las madres y los niños? ¿Cómo funciona? Este diagrama ilustra los distintos sitios del cuerpo donde se produce el consumo y la utilización de la vitamina A. La vitamina A activa preformada, el retinol, se encuentra únicamente en los alimentos de origen animal, como el hígado, la leche y los huevos. Los pigmentos de caroteno contienen un precursor inactivo que se convierte en vitamina A activa, fundamentalmente en el intestino. Los suplementos orales de vitamina A generalmente vienen en la forma de palmitato de retinol. Con todas las formas de vitamina A, el consumo de grasa es necesario para la absorción. Después de la absorción, el hígado almacena la vitamina A en la forma de ésteres de retinol. Cuando el cuerpo la necesita, se libera la vitamina como un complejo de retinol y proteína, que circula por la sangre y llega a las distintas partes donde se utiliza para funciones tan importantes como la inmunidad, la capacidad de ver en la oscuridad y el mantenimiento de los epitélios. Se usan técnicas de evaluación para medir la vitamina A en los distintos puntos de este trayecto. Estas mediciones se utilizan, a su vez, para determinar el estado de la vitamina A en el cuerpo.

"CONCENTRACION EN LA POBLACION DE MAYOR RIESGO (ENFOQUE DE RIESGO)"

14

Los programas educativos, como los que vimos en Tailandia y Haití, pueden ayudar a la gente a mejorar sus dietas a fin de incorporar más vitamina A. ¿Cómo se elabora un programa que mejora los hábitos alimentarios e incrementa el consumo de alimentos ricos en vitamina A? Mejorar los hábitos de alimentación constituye una tarea que requiere mucho tiempo. Se debe convencer a las familias de la necesidad del cambio. Una parte esencial de la estrategia destinada a mejorar el régimen alimentario es concentrarse en aquellas personas que están a mayor riesgo. Una vez que se identifiquen las comunidades de alto riesgo, el proceso de desarrollo del programa puede concentrarse en las necesidades y los recursos de esas comunidades.

"COMO EMPEZAR?"

15

El desarrollo de un programa educativo para mejorar el consumo de vitamina A consiste en varios pasos. Primero, es necesario recopilar información para entender mejor a las comunidades. Este paso incluye la identificación de las barreras culturales y económicas. A esta recopilación de datos le sigue la selección de los alimentos específicos y los hábitos de alimentación que se promoverán. A continuación, se elaboran mensajes y materiales que se adecúen a las audiencias a las que se intenta llegar. Después se llevan a cabo minipruebas con el fin de perfeccionar los mensajes y los materiales, de manera que sean prácticos, culturalmente adecuados y efectivos. El contenido de los mensajes puede ser parecido para todos los grupos beneficiarios, pero la elección de las palabras, la forma de presentación y los canales o medios de comunicación que se utilicen para cada uno de los segmentos de la población deben ser los apropiados. Por último, evaluamos lo realizado a fin de mejorar nuestros métodos y materiales.

"EL PROCEDIMIENTO DEL PROGRAMA"

16

El cuadro ilustra los elementos del desarrollo de un programa educativo relativo a las intervenciones en el régimen alimentario.

"RECOLECCION DE LA INFORMACION BASICA"

17

Vamos a realizar un análisis breve de cada uno de los pasos. En primer lugar debemos recopilar la información básica sobre los actuales conocimientos, actitudes y prácticas de la población. Formulamos preguntas dentro de un determinado contexto que se basa en los objetivos del proyecto. La encuesta CAP (conocimientos, actitudes y prácticas) proporciona esta información. Definimos al público en términos de sus conocimientos, actitudes y practicas (hábitos, cultura, intereses especiales), en la medida que se relacionan con la intervención nutricional que deseamos proponer. ¿Cómo ve la población al problema? ¿Creen que tienen un problema? ¿Cuáles son los hábitos de la población que podrían tener importancia para la condición de la vitamina A? ¿Cuál es el entorno en que es necesario efectuar el cambio, incluidas la situación socioeconómica y el estilo de vida de las madres? ¿Cuál es la disponibilidad de alimentos ricos en vitamina A? ¿Qué consumo hay y cuáles son las costumbres para la preparación de las comidas? ¿Hay alimentos que se consideran inapropriados para mujeres lactantes y niños pequeños? ¿Cuáles son las percepciones actuales respecto a los problemas oculares y la salud? ¿La percepción actual de la importancia de las cápsulas de vitamina A? ¿Cuáles son los medios potenciales para diseminar información? ¿Qué otros recursos o métodos comunes para el intercambio de información existen en la comunidad? De la información obtenida, será necesario abordar una serie de preguntas.

"ANALISIS DE LA INFORMACION"

18

Con la información básica se realiza la selección de los hábitos de consumo alimentario y las variedades de alimentos a promoverse. Las preguntas que habrá de contestarse sobre las actividades complementarias incluyen los siguientes: ¿Hay suficiente disponibilidad de los alimentos? ¿Están al alcance del público como para que los incorporen en sus dietas? ¿Habrá necesidad de producción de alimentos y actividades de conservación y almacenamiento? ¿Se deberá promover la distribución de cápsulas desde los centros de salud?

"MENSAJES"

19

Después de obtener nuestra información básica y de definir nuestros objetivos, comenzamos a elaborar los mensajes. Las premisas clave de la estructura de los mensajes son: el contenido del mensaje debe considerar el problema, la población beneficiaria, los aspectos de resistencia, la solución y las medidas necesarias. La elaboración de los mensajes debe ser en base a ideas simples, lenguaje sencillo y resonancia cultural. Los mensajes deben ser persuasivos y creíbles. Los mensajes deben ser fáciles de recordar.

"ELECCION DE LOS MEDIOS"

20

Una vez elaborados los mensajes, debemos decidir qué tipos de medios resultarán mejor para transmitirlos al público. Una parte de este paso consiste en saber cómo se comunica la gente. ¿Existen cuentos populares, canciones y dibujos que serían apropiados utilizar? ¿Podemos utilizar los medios masivos de comunicación, como la radio, la televisión y el cine?

"PRUEBAS EN EL CAMPO"

21

Las pruebas previas constituyen una parte importante del desarrollo de los materiales. Durante esta etapa del programa se averigua si lo que estamos sugiriendo y produciendo es comprensible e importante para la población a riesgo. Si es necesario, modificaremos nuestros materiales basándonos en los resultados de estas pruebas previas.

"CAPACITACION"

22

Deberemos capacitar al personal del proyecto para la ejecución de los objetivos educativos. El personal tendrá que capacitarse en el contenido técnico de las intervenciones, así como en la forma de utilizar todos los materiales de apoyo educativo que producirá el proyecto.

"CAMBIOS DE COMPORTAMIENTO"

23

Luego, el proyecto debe establecer una estrategia de ejecución integral por medio de la programación y coordinación de las actividades para controlar el impacto y la vigilancia. Esto se hará en etapas, según se ilustra en la diapositiva, para reforzar el ciclo de cambios en el comportamiento del público beneficiario.

Etapa 1: Identificar el problema, fomentar la toma de conciencia y estimular el interés. El primer paso es concientizar al público sobre el problema y su solución. El programa debe tener por objeto que la gente se detenga a pensar, se interese, pregunte, compare. El proyecto desea preparar el terreno para los agentes de salud y entregarles una población interesada.

Etapa 2 y 3: Educación y promoción. Las dos siguientes etapas de la campaña se dan juntas. Las familias comenzarán a aprender por qué necesitan cultivar vegetales ricos en vitamina A, así como a prepararlos e integrarlos en sus dietas. Se deberá explicar la necesidad de comer vegetales del huerto y la preparación de los mismos. También es probable que sea necesario demostrar los métodos de conservación de alimentos ricos en vitamina A que se utilizarán cuando no se disponga de alimentos frescos fuera de estación.

Etapa 4: Fomentar la práctica. En esta etapa, el contacto entre el programa y la población será de suma importancia. De todas las personas que se enteren de las medidas propuestas, un cierto número convendrá en probar las nuevas prácticas durante un determinado período.

Etapa 5: Seguimiento intensivo. Aunque algunas partes del público hayan probado las prácticas durante el período convenido e intentado incorporar los alimentos nuevos a la dieta familiar, existe la posibilidad de una regresión en esta etapa. Algunos pueden sentirse inclinados a pensar que la idea nueva representa demasiados problemas; es posible que no vean los resultados reales. En esta etapa es muy importante realizar actividades de seguimiento. El estrecho contacto con el personal del proyecto tendrá una influencia fundamental ya que aportará el aliento personal, allanará las dudas y responderá a todas las preguntas.

Etapa 6: Evaluación. Con esta etapa llega la hora de analizar nuestra labor, de evaluar el éxito en términos de la cantidad de gente que ha aceptado la idea y continúa practicándola. Después de la evaluación de los esfuerzos educativos, el proyecto puede proseguir utilizando los resultados obtenidos en la evaluación. Si hemos seguido los principios mencionados antes, el programa tendrá éxito en aumentar el consumo de alimentos ricos en vitamina A por parte de la población a riesgo.

"RESUMEN"

En esta breve reseña hemos aprendido que los hábitos nutricionales deficientes contribuyen a un alto índice de morbilidad y mortalidad infantil en varias regiones del mundo. Esta falta de vitamina A contribuye a las muertes de niños y a las enfermedades comunes, tales como el sarampión, la diarrea y las infecciones respiratorias. La deficiencia de vitamina A es la principal causa de ceguera infantil en el mundo en vías de desarrollo. Todos los años hay un millón de niños en edad preescolar que desarrollan enfermedades oculares graves.

Hay varias formas de aumentar la cantidad de consumo de vitamina A. Las mismas incluyen la promoción del consumo de alimentos ricos en vitamina A, la fortificación de los alimentos y, cuando la necesidad es inmediata, la distribución de cápsulas de vitamina A.

El desarrollo de un programa para mejorar las dietas consiste en la recopilación de información para una mejor comprensión de las comunidades beneficiarias, seguida de una selección de los alimentos específicos y los hábitos alimentarios que se promoverán, con la consabida elaboración de mensajes y materiales que sean apropiados para los distintos públicos a los que es necesario llegar. Luego, son necesarias las minipruebas para perfeccionar la selección de alimentos, los mensajes y los materiales de manera tal que sean prácticos y eficaces.

CREDITS \ CRÉDITS \ CRÉDITOS

"IMPROVING THE VITAMIN A CONTENT OF DIETS" is part of a slide presentation series of the Vitamin A Field Support Project — VITAL — of the Office of Nutrition, Bureau for Research and Development, U.S. Agency for International Development. It is implemented by the International Science and Technology Institute, Inc. (ISTI). This publication was funded under contract No. DAN-5116-C-00-9114-00. Send inquiries, comments, and requests for additional copies to: Robert G. Pratt, Project Director, 1616 N. Fort Myer Drive, Suite 1240, Arlington, VA 22209, U.S.A.

USAID Project Officer:
Dr. Frances R. Davidson

Permission is granted to reproduce this material for distribution. The contents of this presentation are largely based on:

IVACG 1993. *Nutrition Communications in Vitamin A Programs: A Resource Book.* Washington, DC.

VITAL 1991. *Vital Nutrients: Supporting Life, Health and Productivity through Iron, Iodine and Vitamin A Nutrition.* By Tina G. Sanghvi. Rosslyn, VA

FAO/WHO 1988. *Requirements of Vitamin A, Iron, Folate and Vitamin B12.* Report of a Joint FAO/WHO Expert Consultation. Rome.

VITAL 1993. *Solar Drying for Vitamin A.* Mary Linehan et al. Rosslyn, VA.

"UNE ALIMENTATION PLUS RICHE EN VITAMINE A" fait partie d'une série de diaporamas du projet VITAL de l'Office de la Nutrition, Bureau de la Recherche et du Développement, Agence pour le développement international (USAID) et de l'International Science and Technology Institute, Inc. (ISTI). Contrat No. DAN-5116-C-00-9114-00. Pour toute information ou commentaire ou pour recevoir d'autres exemplaires, veuillez adresser votre correspondance à : Robert G. Pratt, Project Director, 1616 N. Fort Myer Drive, Suite 1240, Arlington, VA 22209, U.S.A.

Responsable de projet de USAID:
Dr. Frances R. Davidson

Les informations contenues dans la présente publication peuvent être reproduites et diffusées. Le contenu de cette présentation s'inspire de:

IVACG 1993. *Nutrition Communications in Vitamin A Programs: A Resource Book.* Washington, DC.

VITAL 1991. *Vital Nutrients: Supporting Life, Health and Productivity through Iron, Iodine and Vitamin A Nutrition.* By Tina G. Sanghvi. Rosslyn, VA

FAO/WHO 1988. *Requirements of Vitamin A, Iron, Folate and Vitamin B12.* Report of a Joint FAO/WHO Expert Consultation. Rome.

VITAL 1993. *Solar Drying for Vitamin A.* Mary Linehan et al. Rosslyn, VA.

"COMO MEJORAR EL CONTENIDO DE VITAMINA A DE LAS DIETAS" forma parte de una serie de presentaciones de diapositivas del proyecto VITAL de la Oficina de Nutrición, Dirección de Investigación y Desarrollo, Agencia para el Desarrollo Internacional (USAID) y del International Science and Technology Institute, Inc. (ISTI). Contrato N° DAN-5116-C-00-9114-00. Si desea recibir más información u otros ejemplares, o si quiere enviar sus comentarios, diríjase a: Robert G. Pratt, Project Director, 1616 N. Fort Myer Drive, Suite 1240, Arlington, VA 22209, U.S.A.

Oficial del proyecto de USAID:
Dr. Frances R. Davidson

Se autoriza la reproducción del contenido de esta publicación para su distribución. El contenido de esta presentación se inspira de:

IVACG 1993. *Nutrition Communications in Vitamin A Programs: A Resource Book.* Washington, DC.

VITAL 1991. *Vital Nutrients: Supporting Life, Health and Productivity through Iron, Iodine and Vitamin A Nutrition.* By Tina G. Sanghvi. Rosslyn, VA

FAO/WHO 1988. *Requirements of Vitamin A, Iron, Folate and Vitamin B12.* Report of a Joint FAO/WHO Expert Consultation. Rome.

VITAL 1993. *Solar Drying for Vitamin A.* Mary Linehan et al. Rosslyn, VA.

REVIEWERS \ CONSEILLERS TECHNIQUES \ ASESORES

Jesus Bulux, CESSIAM, Guatemala City

David Calder, A.I.D. Regional Development Office, Suva

Moses Chirambo, Sight Savers Africa Representative, Lilongwe

Nicholas Cohen, WHO/EPI, Geneva

Felicity Cutts, London School of Hygeine, London

Joseph Diallo, Africa Representative for IVACG, Dakar

Nils Daulaire, REACH, Washington D.C.

Rebecca Fields, REACH, Washington D.C.

James Gibson, A.I.D., Washington D.C.

Peter Greaves, UNICEF, New York City

G. Hussey, Children's Hospital, Cape Town

INCAP Sub-Committee on Micronutrients, Guatemala City

M. Klein, Children's Hospital, Cape Town

Robert Northrup, Brown University, Providence

James Olson, Iowa State University, Ames

Vincent Orinda, UNICEF/Namibia, Windhoek

Jon Rohde, UNICEF/SEARO, New Delhi

Victoria Sheffield, International Eye Foundation, Bethesda

Robert Steinglass, REACH, Washington D.C.

Barbara Underwood, National Eye Institute/NIH, Bethesda

John Vince, Faculty of Medicine at University of Papua New Guinea, Borok

Robert Weierbach, REACH, Washington D.C.

Keith West, Dana Center for Preventive Ophthalmology, Baltimore

IMPROVING THE VITAMIN A CONTENT OF DIETS

Introduction

Increasing the consumption of vitamin A-rich foods through promotion of existing local food sources, and where necessary, the production or preservation of such foods - is considered the most sustainable means of controlling vitamin A deficiency. If food habits are to be changed, families must first be motivated and encouraged to find the means to do so. Locally relevant information on why vitamin A is critical, who is most vulnerable, good food sources, how to obtain them, must be communicated effectively. Almost any program of vitamin A improvement, whether it emphasizes supplements, public health measures, or agricultural activities is dependent upon the motivation of families to participate. The purpose of this slide/overhead presentation is to provide a basic set of steps for the development of a program aimed at encouraging families to improve their vitamin A intakes.

The enclosed material can be used as part of a formal training course or an informal refresher/orientation session for field workers, managers or policy makers interested in understanding the various dimensions of an educational/behavior change intervention and by health professionals and para-professionals. Slides or overheads can be made from the charts; photographic material can be added or replaced.

The presentation contains an overview of the vitamin A problem and what can be done about it. Steps in promoting behavior change are reviewed. Examples of programs aimed at improving diets are included.

The contents of this package are:

- **Charts:** Printouts of 27 slides which can be used as hand-outs, overheads or converted to slides for presentations at meetings, training courses or conferences.
- **Text:** Text for each of the slides
- **Manuals & Case Studies:**

  - Social Marketing Vitamin A-Rich Foods in Thailand by Suttilak Smitasiri et al, USAID/INMU.
  - Solar Drying for Vitamin A by Mary Linehan, Katarina Paddack, Mohamed Mansour, USAID/VITAL.
  - The Impact of Home Gardening on Dietary Risk of Inadequate Vitamin A Intake in Guatemala by Nestel et al, USAID/VITAL.

- **Other Publications:**

  - Understanding Infant Feeding Practices: Qualitative Research Methodologies Used in the Weaning Project by Marcia Griffiths, Manoff Group.
  - Carotenoid content of fruits and vegetables: An evaluation of analytic data by Ann Reed Mangels, Phd. et al, U.S. Department of Agriculture.
  - Using Drama for Health Communications: Report from Burkino Faso, Mali and Niger by Peter Gottert, AED, Mothers and Children, Vol. 12, No. 3 at 6
  - Food Sources of vitamin A and provitamin A; Natural food sources of vitamin A and provitamin A; Factors influencing vitamin A intake and programmes to improve vitamin A status; by Harriet V. Kuhnlein, et al, Food and Nutrition Bulletin, vol. 14, no.1, 1992 at 3-33.

CREDITS:

"IMPROVING THE VITAMIN A CONTENT OF DIETS" is part of a slide presentation series of the Vitamin A Field Support Project - VITAL - of the U.S. Agency for International Development and International Science and Technology Institute, Inc. (ISTI). This publication was made possible by support from the Office of Nutrition, Bureau for Research and Development, U.S. Agency for International Development under contract No. DAN-5116-C-00-9114-00. Send inquiries, comments, and requests for additional copies to: Dr. Frances R. Davidson, Deputy Director, USAID Office of Nutrition, Washington D.C. 20521 or OMNI, 1616 N. Fort Myer Drive, Suite 1100, Arlington, VA 22209, U.S.A.

Authors: Benedict Tisa and Tina Sanghvi

USAID Project Officer: Dr. Frances R. Davidson

Translators:
French — Joelle De Laplace
Spanish — Alicia Agnese

Reviewers:

Mary Linehan, VITAL Assistant Director
Mohamed Mansour, VITAL Regional Advisor for Africa
Jose Mora, VITAL Technical Advisor
David Nelson, VITAL Regional Advisor for South America
Penelope Nestel, Consultant
Robert Pratt, VITAL Project Director
Barbara Underwood, National Eye Institute, NIH

Editors:

Karen Canova, Information Program Officer, VITAL
Katarina Paddack, VITAL
Dahlia Hayles, VITAL

USAID / vital slide presentation

Improving the Vitamin A Content of Diets

BEST AVAILABLE COPY

Importance

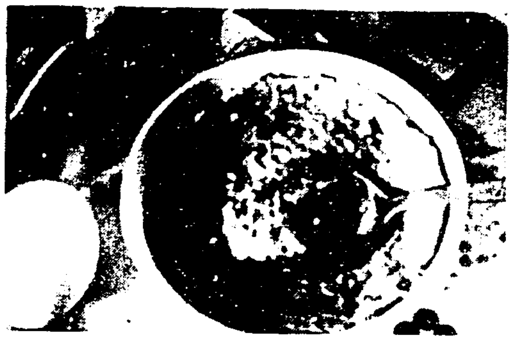
Lack of vitamin A ⟶ blindness, severe diseases, deaths

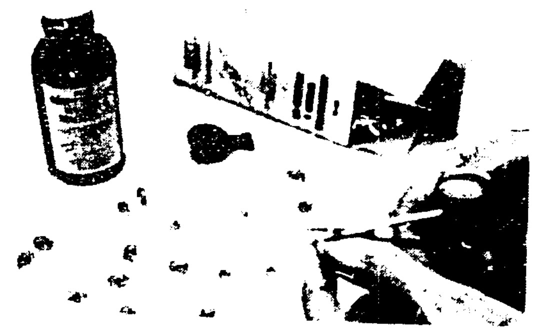
Vitamin A is required for:

- Immune system
- Integrity of the linings of the respiratory/kidney/digestive tracts, eyes

3

Sources of Vitamin A





Daily Needs

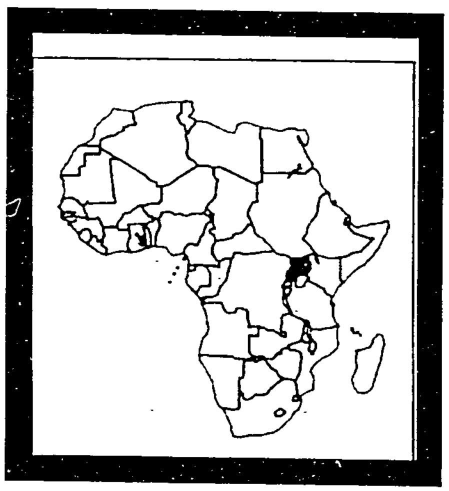
Age Group	RE µg	Food Sources: Carrots	or DGLV	or Mango
● **Children**		**Carrots**	**DGLV**	**Mango**
0-5 months	350	Exclusive Breastfeeding		
6-11 months	350	1/3	1/4 cup	1/4
12-35 months	400	1/2	1/3 cup	1/3
4-6 years	400	3/4	1/2 cup	1/2
● **Pregnant Women**	600	2 1	1 cup	
● **Lactating Women**	850	3	1+1/2 cup	1+1/2

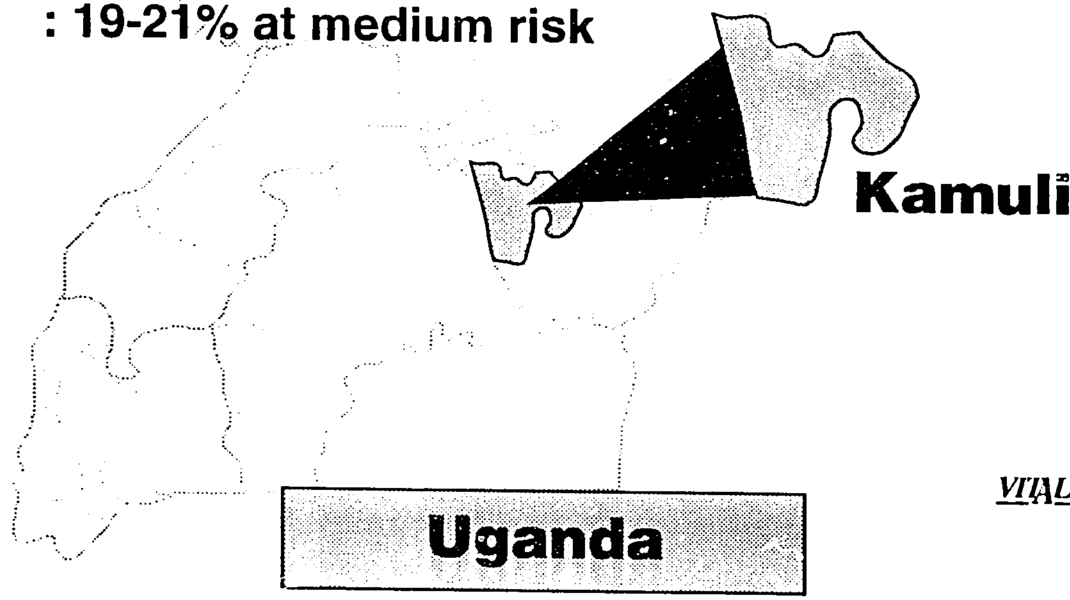
5

The Problem is Widespread

Results of the Kamuli Survey

- Corneal xerosis/ulceration/keratomalacia: 26 x WHO criteria
- Corneal scarring: 35 x WHO criteria
- Vitamin A intakes: 32-41% at high risk
  : 19-21% at medium risk





VITAL

6

What Can Be Done?

- To reach those at high risk
- To ensure that the benefits are permanent

– Supplements – Dietary Improvements – Fortification

7

Comprehensive Package: Guatemala

Nationwide:

- Sugar fortification

Targeted (high risk):

- Supplements in hospitals for measles, PEM
- Supplements in high prevalence communities

Targeted (geographical):

- Gardening and nutrition education in high prevalence communities

Increasing Vitamin A Intake: Supplements

Immediate impact, but.....

- Hard to achieve high coverage and maintain it
- Foreign exhange needed
- Benefits limited to one nutrient

35

Increasing Vitamin A Intake: Fortification

Immediate impact and sustainable if.....

- High risk groups consume processed foods
- Infrastructure exists
- Industry cooperation is forthcoming
- Foreign exchange available

10

Improving Diets

- Education
- Food Production
- Food Preservation

Delayed results, but.....
the benefits are
numerous and
sustainable

VITAL

37

11

Program Example: Assaba/Malawi

Problem:

- **High prevalence of vitamin A deficiency in combination with serious health problems**

Solution:

– Integrated program of gardening, education, vitamin A supplements, primary health care

VITAL

12

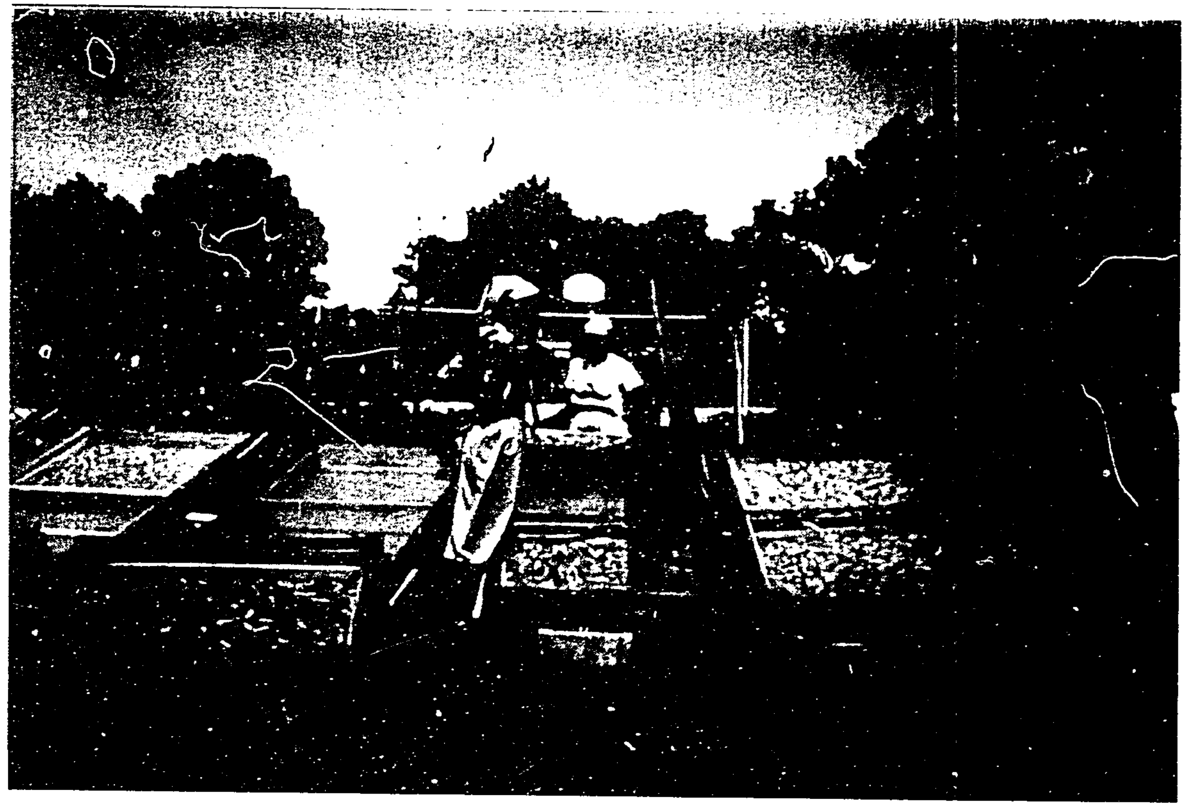
Program Example: Haiti

Problem:

- Un-availability of local vitamin A source throughout the year and extreme poverty

Solution:

- Solar drying of mangos



13

Focus On Those At Highest Risk

- **Population surveys**
- **Risk Factors (geographic, age, other)**
- **Clinic Records**

Risk Factors (Kamuli Survey):

- Geographic: Budiope > Bugabula > Bulamogi > Buzaaya
- Households: Farmer > Non-farmer
- Age groups: 36-72 months > 0-35 months

40

VITAL

14

The Program Process

- Data gathering
- Selection of foods, practices, development of the messages and materials, pre-testing
- Mini-trials and revision
- Detailed plan of action
- Training, community mobilization
- Logistics, materials and supplies
- Monitoring and re-design

41

VITAL

Gathering Baseline Information

- Community's perception of the problem
- Practices related to consuming vitamin A
- Economic capacity to change
- Cultural forces
- Eating habits of women and young children
- Availability and cost of foods
- Opinion leaders
- How information is spread, potential media

16

Analyzing Baseline Information

- What food preparation and feeding practices need to change?
- To whom should the messages be directed?
- What foods and varieties are to be promoted?
- Is there a need for food production/processing activities?
- What messages, methods and materials should be used?
- How can community forces be mobilized?

43

Messages

- Easily understood by target audience
- Propose specific actions
- Contain a single idea
- Give a persuasive reason for taking the proposed action
- Be memorable

Choosing the Media

- Reading material
- Folk tales
- Songs
- Drawings
- Radio
- Slides and films

VITAL

Field Testing

- Messages clear, understandable
- Format appropriate
- Media has capacity to reach target groups
- Feasibility of target audience taking proposed action

46

Training

- Technical content
- How to use educational support material
- Where to find more information/support
- Motivation for achieving program objectives

47

21

Promoting Behavior Change

- Raise awareness and interest
- Provide instruction
- Encourage trial and experimentation
- Encourage repetition and practice
- Help through follow-up and problem solving
- Evaluate audience and program experience

49

Awareness

VITAL

50

23

Instruction and Experimentation

51

VITAL

Practice and Repetition

52

VITAL

Follow-up

Evaluation

VITAL

54

Summary

- Consequences of not preventing vitamin A deficiency
- Options to improve vitamin A nutrition
- Role of nutrition education
- Review of the program design and behavior change processes

vital slide presentation

Une Alimentation Plus Riche en Vitamine A

2

Importance de la Vitamine A

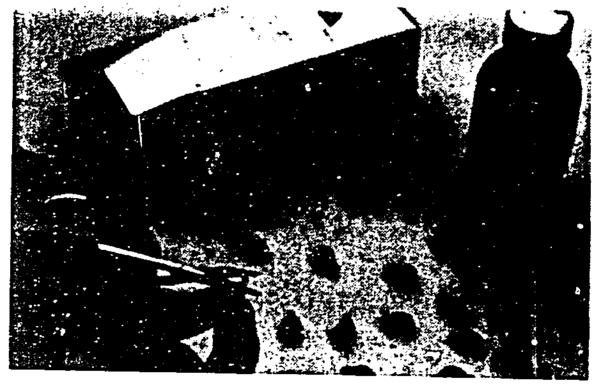
Carences en Vitamine A —— cecite, maladies graves, mortalite

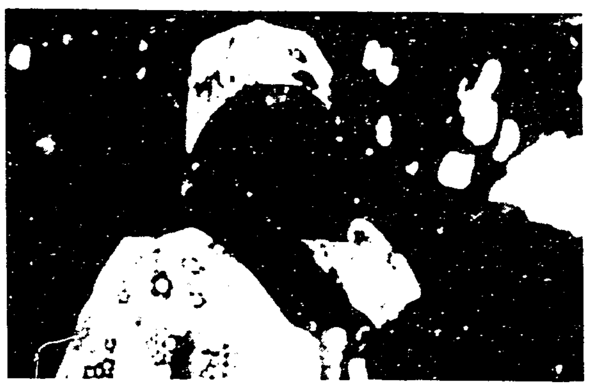
La Vitamine A est necessaire pour:

- le systeme immunitaire
- l'integrite des membranes de l'appareil respiratoire et digestif, des reins, des yeux

3

Sources de Vitamine A





Besoins Journaliers

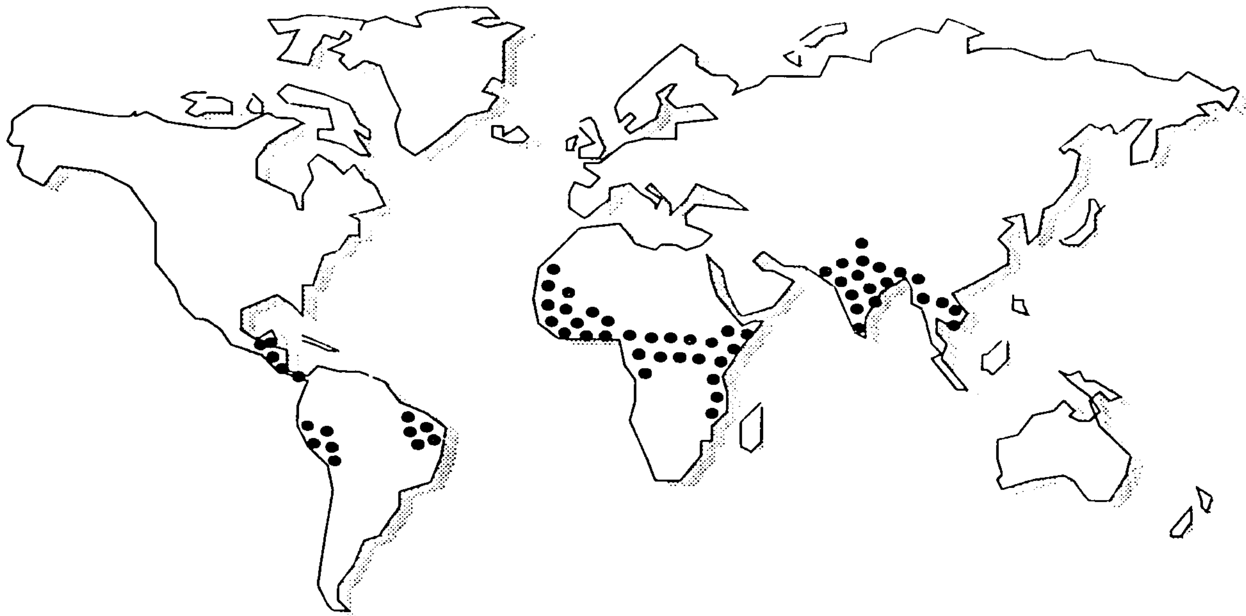
Groupe d'Age	Quantite*	Sources Alimentaires		
● **Enfants**	RE µg	carottes	or légumes verts	or mangue
0 - 5 mois	350	allaitement exclusif		
6 - 11 mois	350	1/3	1/4 tasse	1/4
12 - 35 mois	400	1/2	1/3 tasse	1/3
4 - 6 ans	400	3/4	1/2 tasse	1/2
● **Femmes enceintes**	600	1	1 tasse	1
● **Femmes qui allaitent**	850	3	1,5 tasse	1,5

* Quantité: consommation journalière recommandée par la FAO/OMS, 1988

5

Un Probleme Repandu

Plus de 124 millions d'enfants de moins de cinq ans



Cible Globale: "Une elimination virtuelle de la carence en vitamine A et de ses conséquenses, y inclus la cécité, vers l'an 2000."

60

6

Que Peut-on Faire?

- Parvenir jusqu'aux populations a haut risque
- Veiller a ce que les resultats soient permanents

–Compléments –Enrichissement –Meilleure alimentation

7

Une Demarche Globale: l'Experience du Guatemala

National:

- enrichissement du sucre

Specifique (groupes à haut risque):

- complements dans les hopitaux
- contre la rougeole et la malnutrition proteino-energetique
- complements dans les communautes a forte prevalence

Specifique (géographiquement):

- culture de potagers et education en nutrition

63

8

Accroitre la Consommation de Vitamin A: les Complements

Effet immediat, mais...

- difficile d'assurer une large couverture et de la maintenir
- des devises sont necessaires
- cout annuel : environ 0,40 a 1 dollar par personne
- avantages limites a un nutriment

63

9

Accroitre la Consommation de Vitamine A : l'Enrichissement

Effet immediat et durable si...

- les groupes a haut risque consomment des aliments transformes
- il existe une infrastructure
- l'industrie est disposee a cooperer
- des devises sont disponibles (par exemple, $2 millions/an au Guatemala)

Une Alimentation Meilleure

- Education
- Production alimentaire
- Conservation des aliments

Les resultats ne sont pas immediats, mais... Les avantages sont nombreux et durables

11

Exemple de Programme: Assaba/Mauritania

Probleme:

- forte prevalence des carences vitaminiques A et graves problemes de sante

Solution:

- programme integre de potagers, d'education, de complements vitaminiques A et de soins de sante primaires

12

Exemple de Programme: Haiti

Probleme:
- inexistence de sources locales de vitamine A durant toute l'annee et pauvrete extreme

Solution:
- sechage solaire des mangues

67

13

Une attention particuliere aux populations les plus exposees au risque

- **Enquetes demographiques**
- **Registres des dispensaires**
- **Facteurs de risque (geographiques, age. etc.)**

14

Le Deroulement d'un Programme

- Recueil de donnees
- Selection des aliments et des pratiques, definition de messages et de supports, mises a l'essai
- Mini-essais et revision
- Plan d'action detaille
- Formation, mobilisation de la communaute
- Fournitures, logistique et supports
- Surveillance et reconception

15

Le Recueil de Donnees de Reference

- La perception qu'ont les communautes du probleme
- Les pratiques liees a la vitamine a
- La capacite economique de changement
- Les forces culturelles
- Les habitudes alimentaires des meres et des jeunes enfants
- La disponibilite et le cout des aliments
- Les leaders d'opinion
- Les modalites de diffusion de l'information, les supports envisageables

Analyse des Informations de Reference

- Quelles preparations et pratiques alimentaires devraient etre modifiees ?
- A qui devrait-on adresser les messages ?
- De quels aliments et de quelles varietes devrait-on faire la promotion ?
- Est-il necessaire de mettre en oeuvre des activites de production/transformation alimentaire ?
- Quels messages, methodes et supports devraient etre employes ?
- Comment mobiliser les forces de la communaute ?

17

Messages

- Facilement compris par le public vise
- Proposent des mesures specifiques
- Contiennent une seule idee
- Donnent des raisons convaincantes pour adopter les mesures proposees
- Doivent etre memorisables

Le Choix du Support

- Lecture
- Contes populaires
- Chansons
- Dessins
- Radio
- Diapositives et films

Essais Sur le Terrain

- Messages clairs et comprehensibles
- Format approprie
- Capacite du support a couvrir le public vise
- Faisabilite de la mise en oeuvre (par le public vise) des mesures proposees

Formation

- Contenu technique
- Comment utiliser les supports didactiques ?
- Ou trouver plus d'informations/appui ?
- Motivation pour la realisation des objectifs

75

21

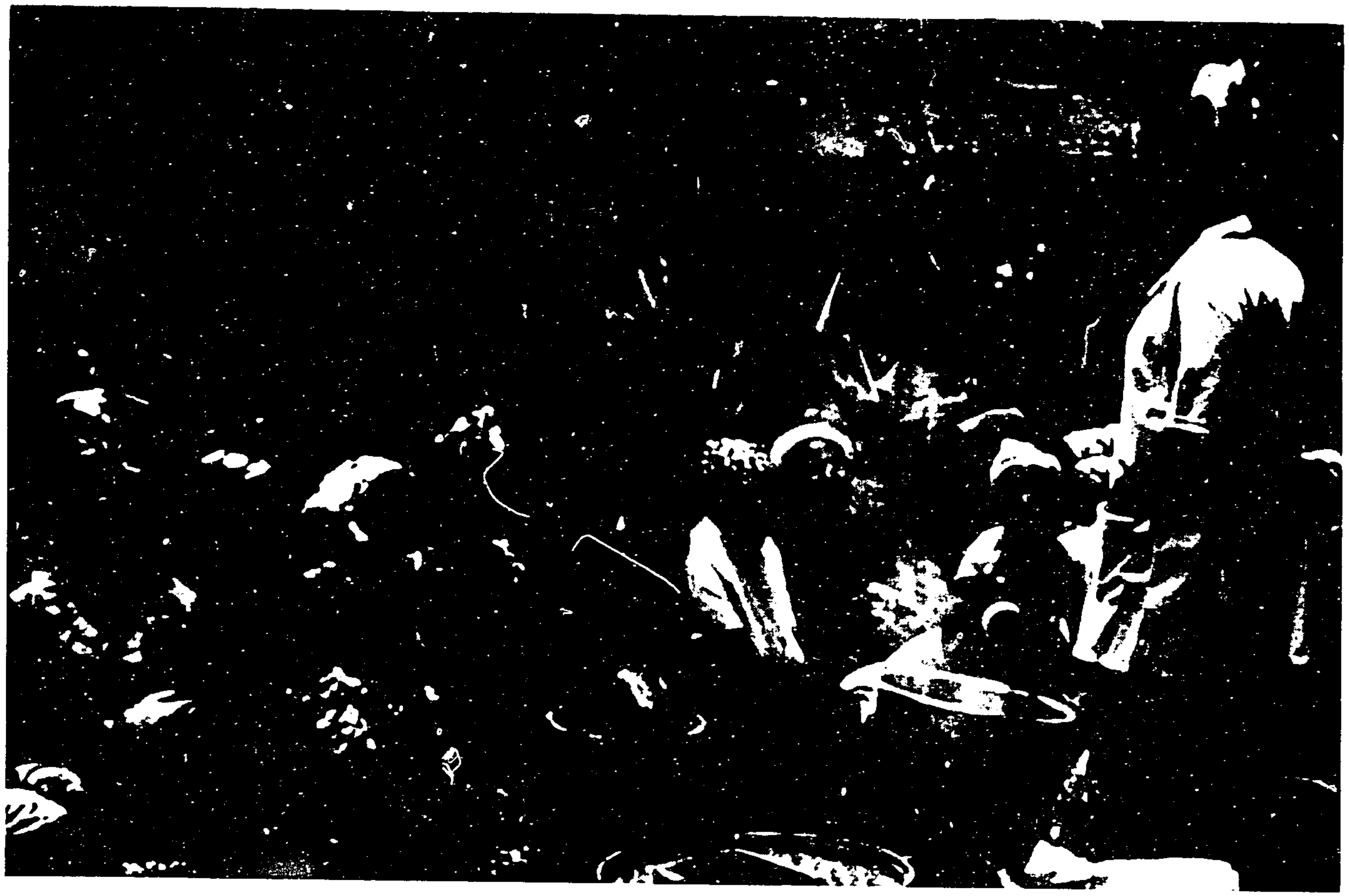
Promouvoir les Changements de Comportement

- Sensibiliser et susciter l'interet
- Instruire
- Encourager les essais et l'experimentation
- Encourager la repetition et la pratique
- Aider au moyen du suivi et de la solution de problemes
- Evaluer le public et l'experience du programme

76

22

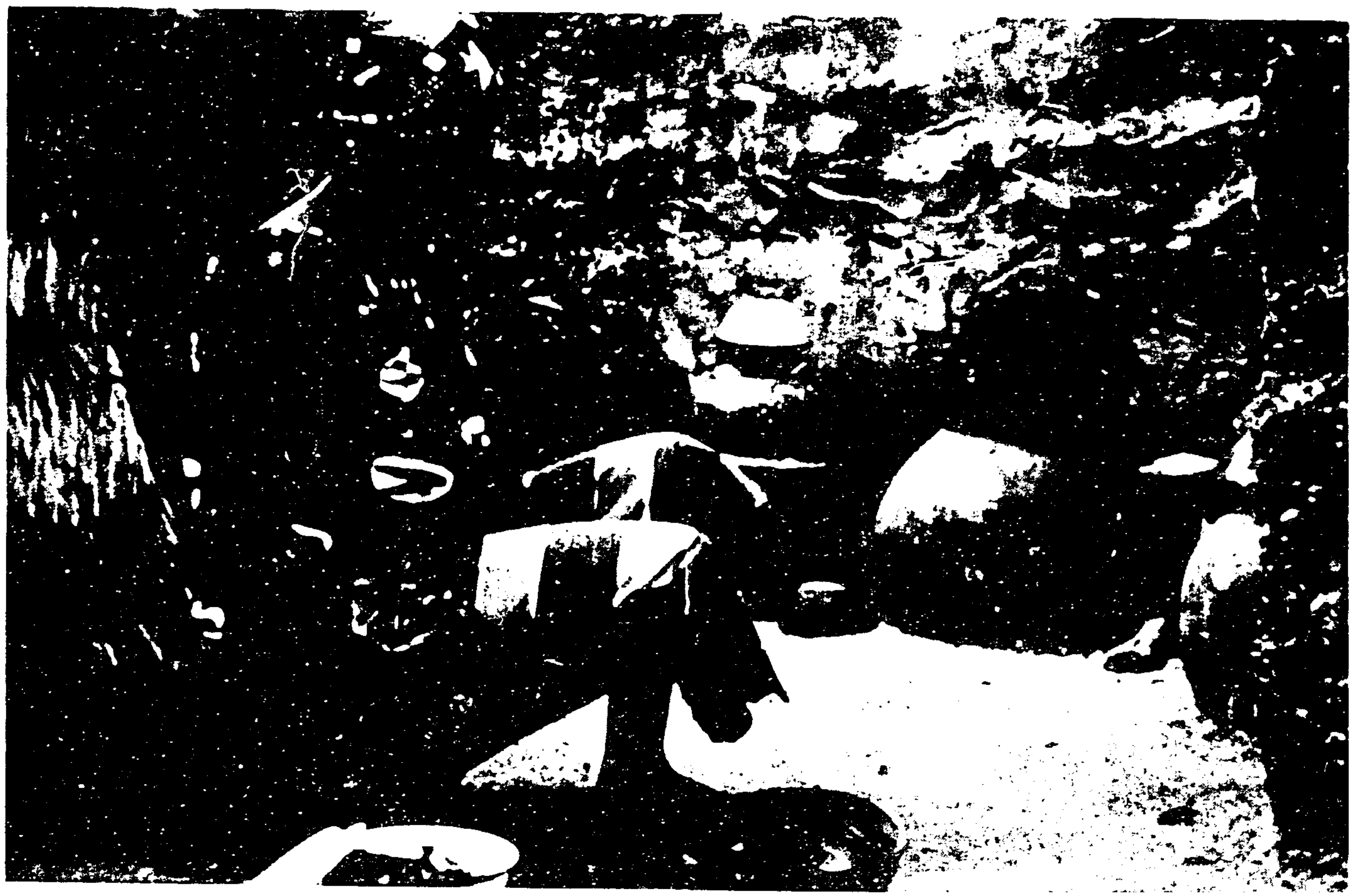
Sensibilisation



23

Instruction et Experimentation

Pratique et Repetition



25

Suivi

60

26

Evaluation

27

Synthese

- Consequences de la non prevention des carences vitaminiques A
- Options pour ameliorer la nutrition en vitamine A
- Role de l'education en nutrition
- Revue de la conception du programme et des processus de modification de comportement

una presentación de diapositivas VITAL

1

Como mejorar el contenido de vitamina A de las dietas

VITAL es un programa de la Oficina de Nutricion, Agencia para el Desarrollo International de los Estados Unidos

Importancia

Carencia de vitamina A → **Muerte, Enfermedades, Ceguera**

La vitamina A se necesita para:

- Sistema de inmunidad
- Integridad del epitelio (conductos respiratorios/digestivos, ojos)

3

El problema es general

● Areas de alta prevalencia

4

¿Que se puede hacer?

- Para llegar a las personas que están a alto riesgo

- Para asegurarse que los beneficios sean permanentes

99

5

Programa global: Guatemala

- **A nivel nacional:**
  Fortificación de azúcar

- **Restringido :**
  (casos de alto riesgo)
  Administración de cápsulas
  en hospitales a casos
  de sarampión, DPC

- **Dirigido a grupos/áreas especificos:**
  Megadosis periódicas,
  educación nutricional,
  horticultura

87

6

Aumento del consumo

A. Suplementos

Repercusion inmediata, pero...

- Dificil de lograr gran cobertura y mantenerla
- Se necesitan divisas
- Los beneficios estan limitados a un solo nutrimento

7

Aumento del consumo

B. Fortificación

Repercusión inmediata, y sostenida si...

- Los grupos de alto riesgo consumen alimentos elaborados
- Existe la infraestructura
- Se logra la cooperacion de la industria
- Se dispone de divisas

8

Aumento del consumo

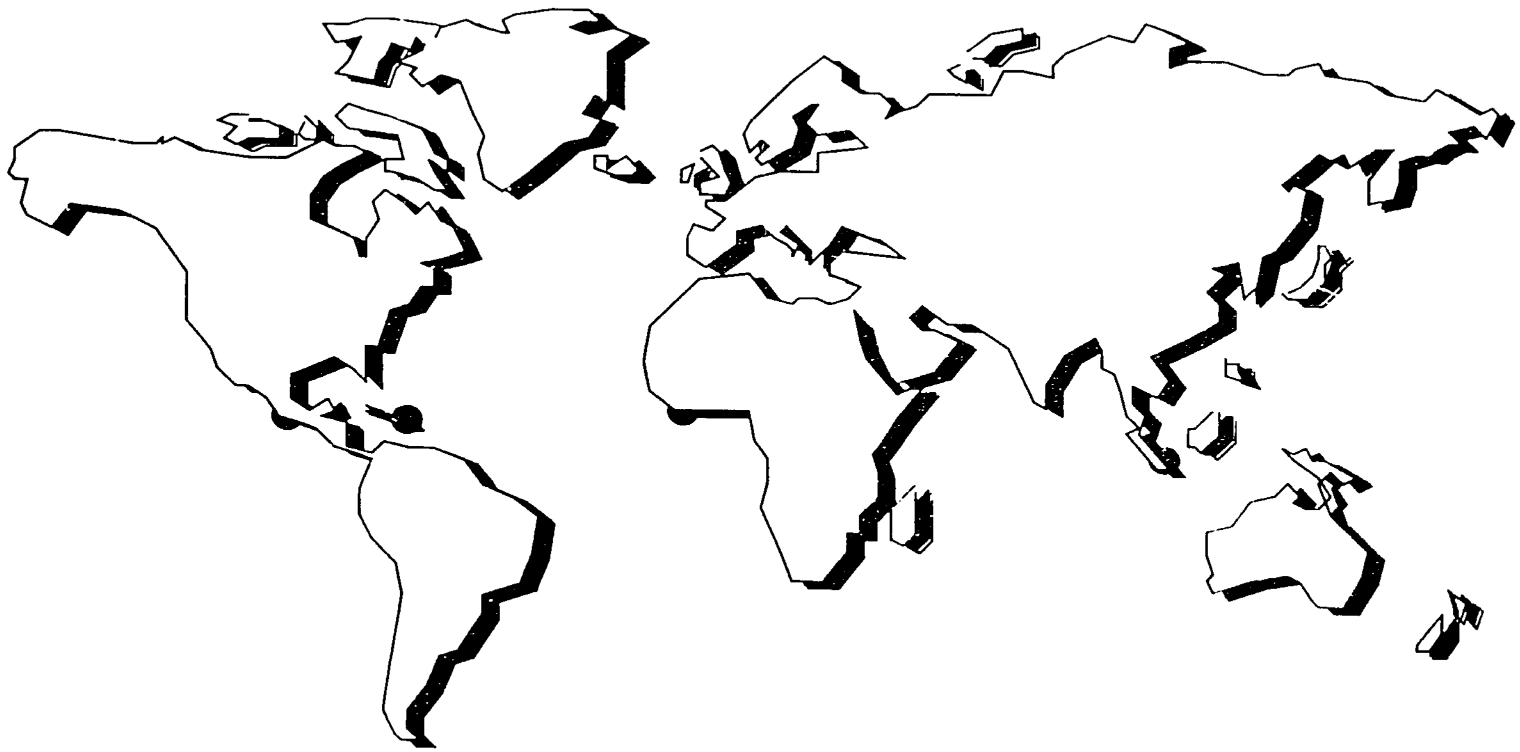
C. El mejoramiento de la dieta

- Educación
- Producción de alimentos
- Conservación de los alimentos

Resultados y acción retardada, pero... los beneficios son numerosos y persistentes

9

Programas de educación nutricional



Guatemala, Haiti, Brasil, Senegal, Mali, Niger , India, Nepal, Tailandia, Philippines, Indonesia

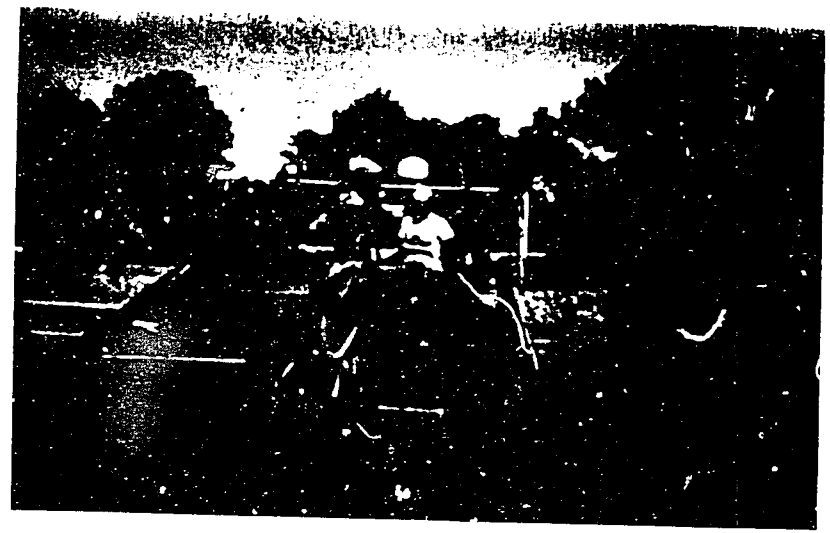
10

Tailandia

- **Problema:** Subutilización de las fuentes disponibles a nivel local
- **Solución:** Producción y consumo de la calabaza hederácea
- **Método:** Extensión agrícola, medios masivos, talleres, educación interpersonal

Haiti

- **Problema:** Carencia de fuentes locales
- **Solucioń:** Secar los mangos al sol
- **Método:** Secadores solares



Fuentes de alimentos y cantidades diarias necesarias

Grupo y Edad	Fuentes		
● Ninos	Zanahoria o	Espinaca o	Mango maduro
0-5 meses	Leche materna exclusivamente		
6-11 meses	1/3	1/4 taza	1/4
12-35 meses	1/2	1/3 taza	1/3
4-6 anos	3/4	1/2 taza	1/2
● Mujeres embarazadas	2	1 taza	1
● Mujeres en lactancia	3	1+1/2 taza	1+1/2

13

Procesos metabólicos

Qué	Ingestion	Absorcion, Metabolismo	Almacena-miento	Transporte	Utilization
Dónde	Boca	Intestino	Higado	Sangre	Tejidos
Formas	• ß Caroteno (alimentos) • Retinol (alimentos) • R. Palmitato (suplementos)	• ß Caroteno ↓ Retinol	• Retinol + ester	• Retinol + complejo proteina	• Retinol

95

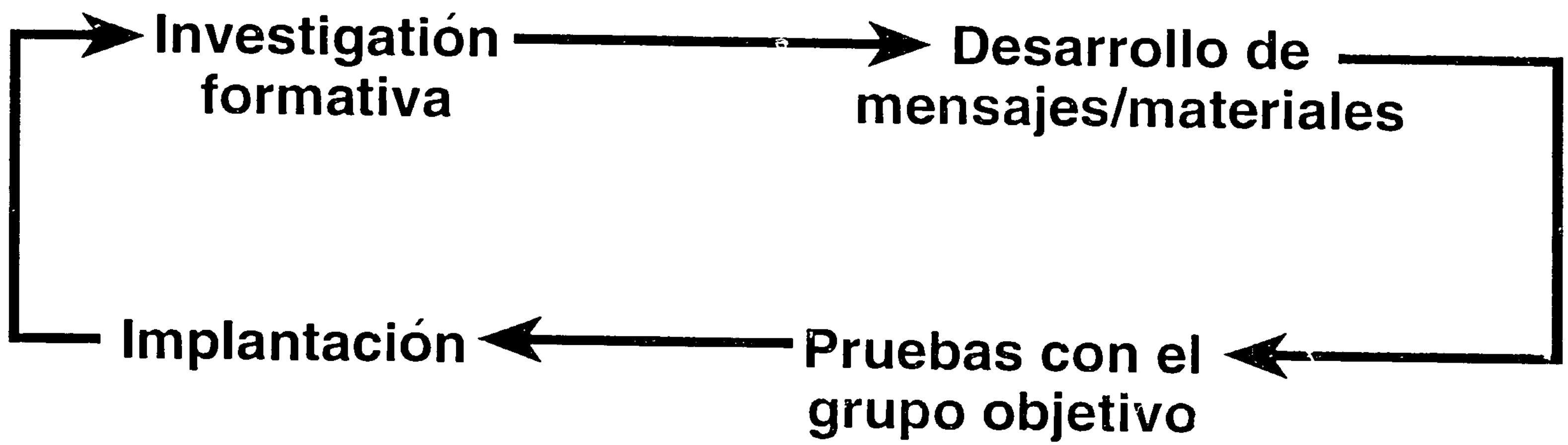
Concentración en aquellas personas que están a mayor riesgo

- **Prevalencia de carencia**
- **Edades**
- **Condiciones**
- **Areas**

15

Cómo empezar

Como?



Qué?

- Importancia
- Fuentes alimentarias locales
- Enriquecer preparaciones para el destete con vitamina A
- Dónde y cuándo conseguir cápsulas
- Técnicas para huertos familiares

El procedimiento del programa

1. Recolección de datos
2. Selección de alimentos, costumbres, desarrollo de mensajes y elaboración de los materiales necesarios
3. Miniensayos y pruebas previas
4. Plan de acción detallado
5. Adiestramiento
6. Materiales y provisiones
7. Control y rediseño

17

Recolección de la información básica

- Toma de conciencia del problema por parte de la comunidad
- Costumbres relativas al consumo de vitamina A
- Capacidad economica de cambio
- Contexto cultural
- Hábitos alimentarios de las mujeres y los niños pequeños
- Disponibilidad y costo de los alimentos
- Las formas de divulgar la información, los medios potenciales

Análisis de la información

- ¿Qué costumbres relativas a la preparación de alimentos y la alimentación es necesario cambiar?
- ¿A quién se deben dirigir los mensajes?
- ¿Qué alimentos y variedades deben promocionarse?
- ¿Existe la necesidad de activadades relativas a la producción y preparación de alimentos?
- ¿Qué mensajes, métodos y materiales deben utilizarse?

19

Mensajes

- Fáciles de entender por parte del público beneficiario
- Propuestas de medidas y acciones específicas
- Contenido de una sola idea
- Proporcionar un motivo persuasivo para la adopción de la medida
- Fáciles de recordar

Elección de los medios

- Material de lectura
- Cuentos populares
- Canciones
- Dibujos
- Radio
- Televisión
- Películas

Pruebas en el campo

- Mensajes claros y comprensibles
- Formato apropiado
- Los medios tienen la capacidad de llegar a los grupos beneficiarios
- Viabilidad de que el público beneficiario adopte las medidas

Capacitacion

- Contenido técnico
- La forma de utilizar el material de apoyo educativo
- Los sitios donde se puede encontrar mayor información y apoyo
- Motivación para la consecución de los objetivos del programa

Cambios de comportamiento

ETAPA 1: Tomar conciencia y despertar el interés

ETAPA 2: Proporcionar instrucción

ETAPA 3: Alentar las pruebas y la experimentación

ETAPA 4: Instar a la repetición y la práctica

ETAPA 5: Ayudar a través del seguimiento y la solución de problemas

ETAPA 6: Evaluar el público y la experiencia del programa

Resumen

- Consecuencias de la deficiencia de vitamina A
- Opciones para mejorar el estado de adecuación de vitamina A
- Papel de la educación nutricional
- Diseño de programas y el proceso de cambios de comportamiento

Marcia Griffiths describes her experience in a number of different countries in developing a qualitative approach to understanding infant weaning practices and designing effective programmes to improve them. The countries included Indonesia, Cameroon, Swaziland, Ecuador, Ghana, and Zaire. The formal RAP guidelines owe a great deal to her experiences in this programme, and particularly to her introduction of the use of focus groups for this purpose. — Eds

7 Understanding Infant Feeding Practices: *Qualitative Research Methodologies Used in The Weaning Project*

By Marcia Griffiths

Marcia Griffiths is president of the Manoff Group, Washington, DC.[1]

A CRITICAL FEATURE of successful public health programmes is that managers know the programme's clientele and tailor policies and activities to meet needs in an acceptable manner. Less successful programmes are often explained with such phrases as "we never anticipated that people's reactions would be . . ." Social science researchers can enhance programme success by offering managers a more succint view of their clientele. However, managers seldom have large budgets for research. This means that effective research which is planned must be completed quickly, below cost, have immediate relevancy for programming, and yield new, useful insights on the clients' perspective. The methodology used in The Weaning Project, to explore and better understand young child feeding practices, met these criteria. It was:

1. Consumer-based, and as open-ended and free of researcher bias as possible;
2. Relevant for programming purposes, particularly the design of communications and training activities;

3. Adaptable to different situations (the same basic protocol was used in six countries);
4. Replicable or manageable by professionals with limited research experience; and
5. Relatively quick and affordable in many development projects. The methodology used in The Weaning Project is the product of nine years of project experience with consumer research, most of it related to the exploration of infant and young child feeding practices.

Historical perspective

In the mid-1970s, in Nicaragua and the Philippines [1] for the design of a weaning food and oral rehydration education program, local researchers were trained to apply basic survey techniques and some open-ended questions with consumers, not too different from the KAP surveys traditionally, and still, done by health educators. Fieldwork took about two months. Evaluations of the resulting educational programs showed their weaknesses were due primarily to the fact that the initial research had been too "researcher-determined" and missed many subtleties needed for message design.

In the late 1970s, research was designed for a nutrition education project in Indonesia [2, 3] in a modified ethnographic style, with open-ended, detailed studies (interviews and observations) in carefully selected communities in the program area. In addition to the ethnography, an innovative step was added: participatory research borrowed from marketing. Mothers were asked to try out potential recommendations to get their reactions to preliminary messages and to solicit their contributions to revising the proposed suggestions for changes in standard practices. This worked well. The resulting educational program was associated with improvements in practices, increased intake of calories and protein, and improved nutritional status among children under 24 months. However, this methodology required nine months of fieldwork and from design through analysis, it took almost a year and a half. The process was guided by a full-time expatriate nutritional anthropologist. Not all programs have that luxury.

Following on this success, the challenge was raised to reduce research time and to incorporate more techniques that would help better understand life-style context: aspirations, desires, fears, attitudes toward child rearing, etc. For work in the early 1980s a component of focused group discussions was added, but the step of the trial of practices and much of the other contextual information gathering, typical of ethnographic research, was eliminated. This work was more like a rapid assessment. In the Dominican

Republic, the process took about two months [4]; in Ecuador, about three months, from planning through analysis [5]; in India [6], about six months before the special step of the trial of recommended practices was added. Again, almost full-time guidance from a nutritional anthropologist was provided. While the resulting programs in the Dominican Republic and Ecuador were relatively successful, there was a feeling among project personnel that the education would have been better if the research plan had allowed for more exploration of the reasons for mothers' practices and particularly their willingness to change.

Based on these experiences and other work in nutritional anthropology [7–9], The Weaning Project developed a protocol for exploring young child feeding practices and refined it in six countries.

The complete protocol was first implemented in Indonesia and Cameroon and included a large amount of foreign technical assistance [10]. Later, in Swaziland, Ecuador and Zaire, the most salient pieces of the multi-step protocol were chosen, modified, and implemented primarily by host country researchers, with periodic technical assistance [11]. After these experiences, there was an opportunity to utilize the protocol in Ghana. Again, based on experience, the protocol was reduced further and this time implemented with only brief orientation from expatriate consultants.

Methodology

Many of the decisions made in designing the methodology and writing the protocol were to allow researchers to go beyond the usual researcher-determined questions about feeding practices and to explore with mothers, in their terms, how they make decisions. To do this, techniques from market research, anthropology, and nutrition assessment were combined to help researchers understand, not only the importance of the different determinants of infant feeding practices, but also the lifestyle context in which infant feeding decisions are made.

The assessment methodology has several characteristics:

1. It is basically qualitative, with some quantitative analyses.
2. It has several steps, each of which builds on the preceding one, so there is limited duplication effort.
3. It is in-depth, to explore the reasons behind everyday practices, beliefs and perceptions.
4. It is rapid, although this depends on what "rapid" means. In the first countries where it was implemented in pilot regions, the process took a year. Now, the time has been reduced to six months for a national assessment.

5. Its implementation requires minimum technical assistance, although it does require a principal investigator with knowledge of qualitative research.

The protocol is divided into four parts, corresponding to the research phases. Each phase has several steps. Not all of the steps need to be done in every situation.

Generalized protocol

STAGE ONE: *PROBLEM IDENTIFICATION*

GOALS

1. Find critical problems impeding proper feeding and care of children;
2. Identify resources to solve problems. (Resources include physical and financial resources as well as outlooks and attitudes.)

METHODS

1. *Literature review.* A complication of relevant information from all previous research. Most of this research is quantitative in nature; therefore, the review serves as a springboard for the design of the qualitative study and as a check on the results ultimately obtained from the qualitative process.
2. *Focused group discussions.* These are extremely open-ended and explore maternal roles, sense of control and confidence, ideas about child rearing, aspirations for children, general feeding practices, and images associated with certain practices.
3. *Ethnography.* This is a community and household exploration of food availability, women's time availability, cultural norms about child feeding, ceremonies, people who influence feeding decisions, the details of food preparation, serving and consumption, childhood morbidity, etc. It usually includes child anthropometry and dietary recall.

COMMENTS

After the Indonesia and Cameroon experiences, stage one was modified:

1. Unless there are persons skilled in focused group discussions with in the country, the discussions are eliminated because it has proved too difficult to train people to get quality information using this technique.
2. The ethnography has been collapsed to in-depth household interviews and observations and some key informant interviews. The extensive questioning on food grown and purchased, on relationships between family members and on ceremonies, was dropped. Although more limited, the work is structured judiciously the households are selected carefully. They include a range of different age children, usually under two years old, and favour children who are growing well or who are undernourished.

Depending on the scope of the work, this initial phase can take up to three months, including planning and training investigators.

STAGE TWO: *ANALYSIS*

GOALS

1. Determine nutritional benefit or harm from current practices;
2. Identify modifications in practices and rationales for them.

METHODS

1. *Case histories.*
2. *Dietary analyses and group feeding histories.*
3. *Tabulations and content analysis of the different topics*, including dietary analysis by geographic area, the age and/or nutritional status of the child, by the amount of time the mother spends with the child, etc.; and
4. *Matrices to compare ideal and real practices* and list major resistances or motivations that may influence a change in the practice.

COMMENTS

This process is done at research headquarters and takes about a month. Most research methodologies end at this point. It is noteworthy that in The Weaning Project, this was not the case.

STAGE THREE: *INTERVENTION OR CONCEPT TESTING*

GOALS

1. Determine what mothers are willing to try and why;
2. Confirm what mothers can do over a brief time period;
3. Retest the successful concepts with even more mothers.

METHODS

1. *Participatory research* where the researcher returns to the homes of mothers who participated in the in-depth interviewing and provides information to these mothers about their children and discusses with them their willingness to try new practices. Then, with some mothers, the researcher actually

asks them to do it — for example, to try to give their children one more meal, or a snack between meals, or to make a different weaning food. The researcher returns to the home to see if the mother has been able to follow the recommendation and if so, exactly what she has done. This step has proved easy to do and analyze once the recommendations have been decided upon. This step is indispensable.

2. *Focused group discussions*: The most successful ideas and practices to emerge from the trials are taken to other communities where focused group discussions are held to get the "top-of-the mind" responses to the new ideas from people who have not participated in the earlier work and to get reactions from health workers and clinic nurses — those responsible for disseminating the new information.

COMMENTS

This phase takes four to six weeks from planning through analysis.

STAGE FOUR: *SYNTHESIS*

GOALS

1. Review all of the information;
2. Synthesize information from the problem identification and concept testing phases;
3. Write a brief for programme designers.

COMMENTS

This report serves as the basic reference for those making strategy decisions and developing the creative work. It is the link so often missing between researchers and programmers. The style in which it is written is abbreviated to assist programmers to find the facts quickly and to understand recommendations about what to do.

The report contains the following sections:

1. The environment or lifestyle of the population;
2. A summary of current infant feeding practices;
3. A list of the most promising practice improvements, the major resistances to change and the possible motivations to stimulate change;
4. A review of potential media — their reach and the frequency with which they are heard or used.

The total time for this type of assessment is about six months.

Sample results

In The Weaning Project new information was abundant. Results common to almost all of the projects include:

1. *The importance of maternal self-confidence in child feeding* [12]. A mother's level of self-esteem and confidence seems to determine the amount to which she is swayed by her child's response to foods. It appears that in general mothers with well nourished children have more self-confidence: they introduce foods when they feel it is right rather than when the child takes them. If they stop breast-feeding early, it is more likely to be because they want to than because of their child's reaction; they are more likely to persist in feeding their child when the child refuses; and they are more willing to try new foods and practices.

2. *The significant role of fathers*. Fathers seem to be playing, or seem willing to have a larger role related to child feeding. This was unexpected. Fathers are often the ones to convince when it comes to the purchase of "special," calorie-dense foods for young children.

3. *Using store owners and food vendors*. These community members hold great potential for disseminating some of the program messages, especially those related to foods. These people are often the most stable and abundant "medium" in the community and, in many instances, are knowledgeable about food-related topics.

4. *Establishing priorities among the different factors in child feeding by the age of the child*. That is, concepts of nutrient density, feeding frequency, and food quantity are difficult for mothers to accept all at once. For them, each component is appropriate for different aged children. The message then must be tailored by the mother's perceptions. For example, for infants four to six months, it is important and acceptable to focus on the consistency of food (decreasing its water content); from seven to 11 months — on feeding frequency and food variety; from 12 to 24 months — on feeding frequency and food quantity.

5. *The early onset of the weaning process*. While this varies by country, in several places there was no period of exclusive breast-feeding. There is an increasingly popular tendency to introduce foods early to "accustom the child to food." A

priority of The Weaning Project has been to address this problem, in part by enhancing women's confidence in their ability to breast-feed their infants.

6. *The worst characteristics of daily feeding pattern occur during and following illness.* If mothers already allow children to determine their own feeding patterns, they will do so even more during illness. If mothers give only a small amount of food regularly, they will further reduce the quantity for an ill child. However, mothers generally continue breast-feeding and do not withhold food because they think they should, but because the child "just won't eat."

The six months that researchers spent to gain these types of insights into weaning problems and solutions was cost effective. The resulting programmes have been successful in achieving improvements in practices and those improvements have improved dietary intake and young children's nutritional status [13, 14].

Endnote

1 The Weaning Project was supported by the Office of Nutrition, Bureau of Science and Technology, USAID, USAID/Jakarta, CARE/Cameroon, USAID/Quito, and UNICEF/Swaziland.

References

1. Manoff International. Radio advertising techniques and nutrition education: a summary of a field experiment in the Philippines and Nicaragua. Final report To the Agency for International Development, The Manoff Group, Washington, DC, 1977.
2. Griffiths M. Nutrition communication and behavior change component, Indonesian Nutrition Development Program. Volume I: Concept testing. Report. The Manoff Group, Washington, DC, 1980.
3. Griffiths M. Using anthropological techniques in program design: successful nutrition education in Indonesia. In: Coriel J, Mull JD eds. Anthropology and primary health care. Boulder, Colorado: Westview Press, 1990.
4. Griffiths M. A nutrition education strategy for the Applied Nutrition Education Project (ANEP), CRS/CARITAS, Dominican Republic. Trip report. Newton, MA: International Nutrition Communication Service, 1984.
5. Griffiths M. Una estrategia para la communicacion nutricional dentro del programa de mejoramiento PAAMI del MSP. Newton, MA: International Nutrition Communication Service, 1984.
6. MODE. Report for a research study on nutrition and health education development, state I. For the Ministry of Human Resources Development, Government of India. Bombay: MODE Services, April 1986.
7. Scrimshaw SCM, Hurtado E. Rapid assessment procedures for nutrition and primary health care: anthropological approaches to improving programme effectiveness. Los Angeles: UCLA Latin American Center, 1987.

8. Van Esterik P. Integrating ethnographic and survey research: a review of the ethnographic component of a study of infant feeding practices in developing countries. Working paper no. 17. New York: The Population Council, 1983.
9. Pelto G. Ethnographic studies of the effects of food availability and infant feeding practices. Food Nutr Bull 1983;6(1):33-43.
10. Griffiths M, Piwoz E. Manual to assess young child feeding practices in Indonesia. Washington, DC: The Manoff Group, 1987.
11. Griffiths M, Piwoz E, Favin M, Del Rosso J. Improving young child feeding during diarrhea: a guide for investigators and program managers. Arlington, Virginia: PRITECH Project, 1988.
12. Griffiths M. How to improve child well-being? First increase mothers' self confidence. Development communication report, no. 70/3. Washington, DC: The Manoff Group, 1990.
13. Hollis C, Seumo E, Mal Bappa A, Griffiths M. Improving young child feeding practices in Cameroon: project overview. Washington, DC: The Manoff Group, 1990.
14. Griffiths M. Improving young child feeding practices in Indonesia: project overview. Washington, DC: The Manoff Group, 1991.

Natural food sources of vitamin A and provitamin A

S. L. Booth, T. Johns, and H. V. Kuhnlein

Overview of natural sources

The new recommended nutrient intakes (RNI) of vitamin A published by FAO/WHO [1] are two-tiered (table 1), with a basal level, corresponding to a recommended intake to prevent deficiency, and a safe level, similar to the recommended dietary allowance (RDA) set for the United States [2], which corresponds to an intake recommended for adequate liver storage of the vitamin [1, 3, 4]. The dietary sources of vitamin A are of two categories: vitamin A, or retinol, also known as preformed vitamin A; and provitamin A, which refers to those carotenoid precursors that are biologically active as retinol.

The parent compound of vitamin A is all-trans retinol, which is an isoprenoid compound found in animal tissue [4–6]. Vitamin A is the generic term for all β-ionine derivatives, excluding the carotenoids. The major storage form, retinyl palmitate, is an ester of a fatty acid chain, 90% of which is stored in the liver. Carotenoids are a class of more than 400 known naturally occurring pigments found in certain fruits, vegetables, oils, and animal foods such as egg yolk and shrimp, of which approximately 50 are known to be biologically active as vitamin A [7, 8]. These carotenoids, of which β-carotene has the highest known vitamin A activity, are converted to vitamin A by oxidative cleavage [9]. Some carotenoids are absorbed intact and then deposited in various body tissues, including fat deposits, skin, shell, milk, and eggs.

Retinol is found exclusively in animal foods, whereas carotenoids are found primarily in plant foods. Their occurrence in animal foods is dietary in origin [6]. It is estimated that the median dietary intake of vitamin A in the United States is composed of approximately 25% provitamin A and 75% preformed vitamin A [3], with dairy products and fortified foods being the major contributing dietary items. In contrast, studies from developing regions suggest that up to 80% of the dietary intake of vitamin A comes from provitamin A food sources [6]. A common observation in the literature is the prohibitive cost of preformed vitamin A food sources for most regions where xerophthalmia is a documented health problem.

The richest known sources of provitamin A are the palm oils. Red palm oil, a common cooking product in west Africa, is usually cited as having the highest concentration of provitamin A activity [10]. However, recent studies indicate that the oil of the buriti palm tree has a tenfold greater concentration of vitamin A activity than red palm oil [11]. The highest levels of preformed vitamin A are found in animal and fish livers and fish oils [12]. Other food sources of the vitamin include the following:

- provitamin A
  - — dark leafy vegetables,
  - — algae,
  - — red and yellow vegetables and tubers,
  - — red and orange fruits, flowers, and juices,
  - — red palm oil;
- preformed vitamin A
  - — milk and milk products,
  - — eggs,
  - — fish and associated oils,
  - — shellfish,
  - — liver and organ meats,
  - — chicken.

These categories are generalizations, because variations between and within species in both provitamin A and preformed vitamin A are very large, as will be discussed in greater detail later.

White roots and tubers and whole grains are considered very low in provitamin A content, and it is often observed that xerophthalmia is more prevalent in rice-consuming areas when vitamin A–rich foods are not introduced early in the weaning stage [13].

The authors are affiliated with the School of Dietetics and Human Nutrition in the Faculty of Agricultural and Environmental Sciences at McGill University, Montreal, Canada.

TABLE 1. Recommended dietary intakes of vitamin A (RE)

	Basal	Safe
Infants	180	350
Children		
1–6 years	200	400
6–15 years	250–350	400–600
Males	300–400	500–600
Females	270–330	500
Pregnancy	+100	+100
Lactation	+180	+350

Source: Ref. 1.

Colour intensity, however, is not necessarily a reliable indicator of biologically active carotenoids. For example, the chlorophyll of green leafy vegetables masks the carotenoid pigmentation, yet as a group these vegetables are considered excellent sources of provitamin A [6]. Moreover, as mechanisms of carotenoid physiology and biochemistry are being clarified, and with the introduction of high performance liquid chromatography (HPLC) for the analysis of the carotenoid profile of these foods, many previous assumptions about natural food sources of provitamin A need to be revised.

Storage of retinol in animal species is not evenly distributed. The richest stores are found in the kidneys and liver [12]. Retinol is also stored in the intestinal walls of fish, in the body fat of eels, and in the eyes of certain species of shrimp. With the exception of fowl, meat products, including beef and pork, do not contain significant quantities of preformed vitamin A.

Published values

The values in tables 2–8 have been compiled to present a sample of the reported vitamin A activity of selected foods from the current food composition literature. In a number of cases, several species are aggregated to demonstrate differences in nutrient content. Foods devoid of or low in vitamin A activity have been included to demonstrate trends in food categories and the use of colour as a general indicator of activity.

For simplicity and consistency, all food items are identified in the tables by their English common names as some of the references do not include scientific names. Because there is wide species-specific variation, the reader is referred to the original references for the scientific names when these are given. A range presented for more than one species is denoted by "diverse species."

The column headed "Description" specifies the part sampled when this information is available, gives other relevant identification of the food items such as colour, and indicates the method of sample preparation.

The units for vitamin A activity have been presented as retinol equivalents (RE) or β-carotene equivalents (CE) per 100 grams of edible portion. Conversion of international units (IU) to RE and calculation of total vitamin A activity (TA) in retinol equivalents will be discussed later. As these nutrient values include original data using various analytical techniques, values converted from IU or RE, and calculation of total vitamin A activity, they should be interpreted with caution.

Difficulties with the published values

Units of expression

Nutrient values of preformed vitamin A and provitamin A can be combined into a single numerical value of vitamin A activity [38]. Originally, the internationally accepted values were IUs [3]. One IU was defined as 0.30 μg of all-trans retinol, or 0.60 μg of all-trans β-carotene. These units are still found in many food composition tables.

In theory, 1 mmole of all-trans β-carotene should cleave to form 2 mmoles of all-trans retinol [39]. The widely accepted central cleavage theory describes the conversion by the cleavage of the central double bond, whereas the more ambiguous excentric cleavage theory proposes that the vitamin A aldehyde, retinal, is formed by cleavage of one or more of the other double bonds in β-carotene. The discrepancies in conversion have also been attributed to factors influencing bioavailability and absorption, which in carotenoids are multiple, including the amount of carotenoid in the diet, interactions with other carotenoids, dietary fat and fibre, nutritional deficiencies of zinc and/or protein, and other disease states [8]. The absorption rate for carotene is 20%–50% of that of retinol, which is estimated at 70%–90%, but absorption of the former is less efficient with increasing levels of intake [4]. Other factors that limit the bioavailability of carotenoids relate to the substrate requirements for absorption. Carotenoids can only be absorbed from a micelle in the presence of bile salts, while retinol can also be absorbed from a micelle in the presence of a non-ionic detergent [40]. Retinol is absorbed by diffusion when present in high doses, but is carrier-mediated at low doses. In contrast, carotenoids are absorbed by passive absorption regardless of the concentration.

Given the strong evidence for lower bioavailability, the values for the biological activity of all-trans β-carotene were revised. On the basis of rat studies, it

TABLE 2. Published values for vitamin A activity in green vegetables, algae, and flowers

	Description	CE	TA	Ref.
Amaranth	leaf, raw	5,400–9,260	900–1,543	14, 15
	leaf & flowers, raw	2,538	423	14
Beet	leaf, raw	2,927	487	14
Burclover	leaf & flowers, raw	5,196	866	14
Cabbage	green, leaf, raw	60	10	16
	red, leaf, raw	18	3	16
Carrot	leaf, raw	7,200	1,200	14
Cassava	leaf, raw	3,000	500	17
Chayote	shoot, raw	1,000	166	18
	shoot, boiled	400	66	18
Chicory	leaf, raw	600–2,160	100–360	16
Chinese leaf	leaf, raw	78	13	16
Cowpea	leaf, raw	4,500	750	18
Dandelion	leaf, raw	7,200–8,200	1,200–1,367	16
Egyptian mallow	leaf, raw	9,000	1,500	14
Flowers (diverse species)	flower, raw	20–3,600	3–353	19
Goosefoot	leaf, raw	5,800	966	14
Jute, potherb	leaf, raw	6,400	1,066	14
Hare's lettuce	leaf, raw	1,430	238	17
Indian mustard	leaf, raw	1,800	300	14
Kale	leaf, raw	900–7,580	150–1,263	16
Lambsquarters	leaf, raw	3,840	640	20
Lettuce	leaf, raw	1,950	325	17
Okra	leaf, raw	730	121	17
Pumpkin	leaf, raw	1,000	166	17
Seaweed (diverse species)	raw	20–1,490	3–248	21
	dried	30–12,500	5–1,083	21
Sweet potato	leaf, raw	1,100–2,700	183–450	21, 22
	leaf, boiled	1,745	291	21
Taro	leaf, raw	5,535	922	21
	leaf, boiled	4,695	783	21
Watercress	leaf, raw	1,200–4,000	200–667	16
Wonderberry	leaf, raw	4,800	800	14
Viper's grass	leaf, raw	1,900–2,200	317–367	14, 16

See text for explanation of abbreviations.

was estimated that the other provitamin A carotenoids have 50% of the growth-promoting activity of β-carotene [40]. This gave rise to units of expression for vitamin A activity called retinol equivalents, or RE. These are now the internationally accepted units for vitamin A activity, and can be summarized as follows:

1 RE = 1 μg all-trans retinol
= 6 μg all-trans β-carotene
= 12 μg other biologically active carotenoids
= 3.33 IU retinol
= 10.0 IU carotene [6]

However, there is still confusion between IU and RE, given the differences in equivalency when converting β-carotene to retinol. Use of RE reduces the contribution of provitamin A to total vitamin A activity compared to the system of IU. The formula for conversion is as follows:

$$RE = \frac{\text{IU retinol}}{3.33} + \frac{\text{IU } \beta\text{-carotene}}{10.0}$$
$$= \mu\text{g retinol}$$
$$= \frac{\mu\text{g } \beta\text{-carotene}}{6} + \frac{\mu\text{g other carotenoids}}{12}$$

(A more thorough presentation of formulae for interconverting units of vitamin A is found in Olson [3].)

Other vitamin A–related compounds exist in dietary sources of preformed A, particularly in fish liver and oils. All-trans dehydroretinol, referred to as vitamin A_2 in the older literature [12], is a vitamin A–

TABLE 3. Published values for vitamin A activity in fruits

	Description	CE	TA	Ref.
Akee	raw	560	93	16
Apple	raw	43	7	16
Apricot	raw	450–3,500	75–583	14, 16
	dried	1,260–6,540	210–1,090	14, 16
Avocado	raw	60–532	10–88	16, 17
Banana	yellow, raw	60–130	10–21	19
	red, raw	90	15	19
Blueberry	raw	60–170	10–28	16
Cashew fruit	raw	760	127	16
Chile pepper	raw	459	77	14
Currant	white, raw	0	0	16
	black, raw	7–200	1–33	16, 23
Guava	raw	80–400	13–67	14, 16
Loquat	raw	1,580	263	14
Mandarin	juice	250	42	16
Mango	ripe, raw	708–2,400	118–400	14, 17, 24
	unripe, raw	60	10	17
	dried	4,400–5,261	733–877	25
Muskmelon	raw	620	103	14
Papaya	raw	300–2,500	50–417	17, 26
Persimmon	raw	3,000	500	14
Plantain	raw	475	79	21
	boiled	345	58	21
Raspberry	juice	60	10	16
Sapote (diverse species)	raw	48–100	8–17	16, 24
Tamarillo	raw	460–2,100	77–350	16, 24
Watermelon	raw	50–350	8–58	16, 17
West Indian cherry	raw	0–240	0–40	16, 23

TABLE 4. Published values for vitamin A activity in plant storage organs and seeds

	Description	CE	TA	Ref.
Bitter gourd	raw	17,040	2,840	27
	cooked	13,260	2,210	27
Carrot	raw	3,890–21,000	648–3,500	14, 16
	dried	36,000–135,000	6,000–22,500	16
	pickled	123–1,063	20–177	14, 28
	juice	2,620	437	16
Cassava	raw	5–35	1–6	16
Finger millet	flour	25	4	17
Maize	yellow, raw	360	60	17
	yellow, dried	125	20	17
	white, dried	0	0	17
Potato	white, raw	2–20	trace-3	16
Rice	parboiled	0	0	17
Summer squash	raw	82	14	14
Sweet potato	white, raw	35	6	21
	yellow, raw	300–4,620	50–770	16, 21
Turnip	yellow, raw	1,620	270	27
	yellow, cooked	1,320	220	27
Winter squash	raw	552	92	14

TABLE 5. Published values for vitamin A activity in plant oils

	CE	TA	Ref.
Buriti palm oil	304,000	50,667	11
Cocount oil	0	0	16
Olive oil	25	4	29
Palm kernel oil	22	4	30
Red palm oil	12,210–87,881	2,035–24,647	30, 31
Seed oil (diverse species)	12–684	2–114	30

TABLE 6. Published values for vitamin A activity in milk, milk products, and eggs

	Description	RE	CE	TA	Ref.
Buffalo milk	whole	64	0	64	16
Chicken egg	whole	260	0	260	32
	white	0	0	0	16
	yolk	870	0	870	32
Cow milk	3.3% butter fat	27–34	14–22	29–38	16
Duck egg	whole	540	1,200	740	16
Ghee	goat milk	236	0	236	33
	cow milk	270	230	308	14
Goat milk	whole	19–71	0	19–71	33
Tabriz cheese	—	0	288	48	14
Teleme cheese	fresh	56	0	56	34
	pickled	48	0	48	34
Yoghurt	plain	23	0	23	32

TABLE 7. Published values for vitamin A activity in fish

	Description	RE	CE	TA	Ref.
Catfish	raw	6–29	0	6–29	12
Cod	raw	8–12	0	8–12	12
	oil	9,009	0	9,009	12
Eel	raw	48–180	0	48–180	12
	smoked	27–180	0	27–180	12
Freshwater fish (diverse species)	oil	9,000–672,000	0	9,000–672,000	12
Halibut	raw	15–47	0	15–47	12
	oil	15,000	0	15,000	12
Loche	flesh	11	0	11	35
	liver	8,690	0	8,690	35
Marine fish (diverse species)	oil	48,048–300,000	0	48,048–300,000	12
Oyster	raw	90–96	0	90–96	12
Requiem shark	liver	143,000	30,000	148,000	14
Skate	raw	3	0	3	12
Sole	raw	trace	0	trace	12
Tigerfish	raw	2,737	0	2,737	14
	pickled	2,668	0	2,668	14
Tuna	raw	80–830	0	80–830	12

TABLE 8. Published values for vitamin A activity in organ meat and other animal products

	Description	RE	CE	TA	Ref.
Beef	flesh, raw	24	5	25	17
	heart, raw	40	10	41	17
	kidney, raw	300	0	300	17
	liver, raw	810	180	840	17
Caribou	flesh, raw	trace	0	trace	35
	flesh, dried	trace	0	trace	35
Chicken	flesh, raw	10–74	0	10–74	14, 16
	heart, raw	9	0	9	16
	liver, raw	6–20	0	6–20	16
Goat	flesh, raw	0	0	0	17
	liver, raw	13,500	2,800	13,967	14
Goose	flesh, raw	44–97	0	44–97	16
	liver, raw	9,880	0	9,880	12
Narwhal	blubber, raw	1,748	0	1,748	36
	blubber, aged	1,004	0	1,004	36
	blubber, boiled	2,193	0	2,193	36
Polar bear	liver, raw	543,543–912,913	0	543,543–912,913	37
Ringed seal	blubber, raw	717	0	717	36
	blubber, boiled	371	0	371	36
	eyes, raw	306	0	306	36
	liver, raw	14,981	0	14,981	36
Sheep	flesh, raw	0–45	0	0–45	16
Turkey	flesh, raw	13	0	13	16

related compound found in freshwater fish flesh and liver-and, to a lesser extent, in some marine fish [40, 41]. This compound is estimated to have 40%–50% of the vitamin A activity of all-trans retinol [42]. Likewise, cis isomers of retinol, which can account for up to 35% of preformed vitamin A measured in fish liver oils, have up to 75% relative activity of all-trans retinol. These discrepancies in vitamin A activity are frequently overlooked in food composition literature, although recent studies are adjusting retinol activity values according to differential biological activity [31, 35]. Isomerization, which will be discussed in greater detail later, is also an important issue in quantifying provitamin A activity in processed forms of plant products but has not yet been given adequate attention in the calculation of units for expressing vitamin A activity.

Analytical techniques

Provitamin A

With recent interest in the possible link between cancer and the intake of carotenoids [43–47], an extensive literature has emerged describing the available methods for analysing carotenoids, particularly those by HPLC. Several thorough reviews exist, with descriptions of the theoretical and practical applications of each method [48–50]. The methods can be summarized as follows:

» biological methods;
» physico-chemical methods
  — phase separation and countercurrent distribution,
  — gas-liquid chromatography,
  — thin-layer chromatography,
  — column chromatography—method of the Association of Official Analytical Chemists (AOAC),
  — HPLC [50].

Bioassays are expensive both in time and money, and lack the precision of the physico-chemical methods that have now replaced them. Of the physico-chemical methods, the two of most significance for this discussion, given their extensive use, are column chromatography and HPLC.

Carotenoid analysis is accomplished by extraction, followed by partial purification, separation according to hydroxyl groups, isolation by chromatography, and then measurement by spectral absorption [51]. The AOAC method for carotene analysis is an open-column chromatography method using a magnesium oxide column, which separates carotenoids from xanthophylls on the basis of polarity, followed by visible absorption spectrophotometry [52]. The first fraction eluted is assumed to be β-carotene.

Recent studies in carotenoid analyses have revealed that assumptions inherent in the AOAC method are incorrect, so that much of the published provitamin A nutrient data overestimates the true value of certain foods [6]. The assumption that all carotenoid activity measured is that of β-carotene can create error, given the lower biological activity of other carotenoids that are eluted in the same fraction [49]. For raw green leafy vegetables, in which the active carotenoids are almost exclusively β-carotene, the assumptions of the AOAC method are still valid [49, 50]. For food items with mixed carotenoid activity, such as squashes and carrots, α-carotene and other carotenes will be measured as β-carotene, though they have less vitamin A activity. For this category of foods, inclusion of a stepwise gradient in the analytical technique is recommended [6]. In fruits, when xanthophylls are esterified their polarity is reduced so they can elute in the same fraction as β-carotene, creating an overestimate of vitamin A activity [51]. The use of a saponification step is recommended for these food items, as it hydrolyses the ester linkage [6, 53]. The saponifiable material is discarded. Plant oils, such as palm oil, also require saponification prior to extraction [49].

Reversed-phase HPLC is rapidly becoming the preferred method for carotenoid analysis, given its flexibility in the identification and quantification of the numerous carotenoids within a single food item. Much of the current literature is a description of evolving methods for the analysis of provitamin A activity in fruits and vegetables [53–59]. While it is argued that HPLC is a superior method [6], the complexity of carotenoids, their isomers, and other chemical substances in foods have so far prevented the development of a single method [51]. Likewise, extraction methods vary with the food substance analysed [57], as does the selection of columns and solvent systems [54], which can create discrepancies in provitamin A values that are not explained by natural sources of variation. Other limiting factors in standardizing analysis of provitamin A activity using HPLC have been reviewed elsewhere [49].

Another major limiting factor for all analytical methods, especially HPLC, is the cost of equipment and solvents, which is prohibitive in most developing regions [49]. A modification of the open column chromatography/visible absorption spectrophotometry method has demonstrated high repeatability and flexibility to adapt to the nature of the food item [60]; this may be a viable alternative for workers in regions that cannot gain access to HPLC.

Preformed vitamin A

Several recent reviews have evaluated the methods available for the analysis of preformed vitamin A in food items [38, 42, 61]. The major categories of methodology can be summarized as follows:

- biological methods;
- physico-chemical methods
  - — spectrophotometric, which includes direct reading and ultraviolet (UV) absorbance,
  - — colorimetric, including the AOAC method,
  - — fluorometric,
  - — chromatographic, including thin-layer and HPLC [61].

Of these, the Carr-Price reaction is the official AOAC procedure for retinol analysis [52]. Retinol (and its esters) produces a blue colour in reaction with antimony trichloride, so the intensity of the coloured product is used to estimate the retinol concentration of the sample. The reproducibility is acceptable, and, as a consequence, this has been the most common procedure used over the past 40 years [38]. Limitations cited for this method include fading blue colour, use of corrosive reagent, inability to differentiate between retinol derivatives, sensitivity of the reagent to moisture, and interference from carotenoids [42]. If carotenoids are not removed by chromatography, corrections must be made for them.

The use of UV absorbance, also known as the Bessey-Lowry method [6], was an accepted procedure for more than 50 years [38]. The absorbance of the extract is read, the retinol is irradiated with UV light, and then the absorbance of the extract is reread. The difference in absorbance is the concentration of retinol in the sample. This method assumes that only retinol is destroyed at this absorbance and therefore, in the absence of a sensitive spectrophotometer, does not differentiate potential interference from various lipids and fat-soluble vitamins that absorb in the same region of the spectrum. Despite this limitation, which led to the use of correction factors to minimize interference from other compounds, it is argued that use of this method from the 1930s to the 1950s to determine retinol content in oils and concentrates produced some of the most reliable data to date [38]. Validation of the UV method using colorimetric analysis of the same samples of polar bear liver was confirmed in one study, with good agreement between the two methods [37]. As previously discussed, saponification is an essential step for conversion to retinol, with the saponifiable portion being discarded [42]. This procedure also frees the ester form from matrices of stabilized vitamin A products.

More recently, HPLC is appearing in the literature as the preferred method of retinol analysis. Chromatography in itself is not a method to measure retinol; instead it is the procedure for separation, with spectrophotometry and fluorometry used for quantification [61]. The advantages of HPLC are numerous, including versatility, high reproducibility, and greater facility to eliminate interfering substances [38].

However, at present, when methodologies using HPLC are evolving rapidly, standardization is difficult to attain. Coefficients of variation between laboratories can exceed 20%, and such a wide margin of variation creates difficulties in the interpretation of nutrient data for vitamin A activity.

Natural sources of variation

Regardless of the analytical method selected for provitamin A and vitamin A determination, error introduced during the collection and preparation of samples can create large discrepancies in the final nutrient values. Sources of sampling and preparation error have been reviewed [62, 63], and it has been shown that much of the variation is attributable to the nature of the foods being analysed [38].

Heterogeneity in nutrient content is a consequence of numerous factors, including soil pH, amount of rainfall, seasonality, genetic diversity, and the stage of maturation. Moreover, the vitamin is not uniformly distributed within the animal or plant tissue, so the accuracy of the nutrient value is determined in part by the portion size and the number of individual units selected for a representative sample. Bureau and Bushway [64] found that the range in provitamin A values for 22 fruits and vegetables sampled was very large and not consistent across seasons or locations. Nutrient data for green leaves analysed in two different seasons also showed inconsistent variation between seasons [65]. It has been demonstrated that time of marketing affected total vitamin A activity in certain fruits [66]. This variation attributable to different cultivars and handling conditions has been confirmed [67]. In a longitudinal study of nutrient composition fluctuations in carrots, the carotene concentration was found to decrease with delayed sowing [68]. Likewise, the β-carotene concentration in sweet potato greens cut only one time demonstrated a significant interaction between cultivar and the time of harvest [69]. Sampling considerations also need to include diurnal variation of β-carotene, which has been documented in leafy vegetables [70].

Preformed vitamin A sources also show large ranges of variation. Retinol concentrations in liver oils among fish species can range more than a thousandfold, and mammalian liver retinol concentrations can differ within species more than two hundredfold [12, 31]. One source of intra-species variation is the age of the animal: young domestic animals have much lower vitamin A liver reserves than their adult counterparts. Age-related differences, however, did not explain the twofold range in preformed vitamin A concentrations in polar bear liver [37]. Dietary differences can also account for differences in retinol concentrations. Yellow fat deposits found in animals may contain large quantities of carotenoids that contribute to the total vitamin A activity [12].

Effects of processing

Carotenoids and retinol are affected by pH, enzymatic activity, light, and oxidation associated with the conjugated double bond system [62]. The chemical changes occurring in carotenoids during processing have been reviewed by Simpson [71]. Fresh plant tissue may contain enzymes that are only activated during, and following, processing [62]. As a consequence of these chemical changes, the preformed vitamin A or provitamin A content of the raw form of a food item may be reduced in food preparation. The most dramatic example of this is found in red palm oil, which in its raw form is considered one of the richest sources of provitamin A [10]. After heating to 200°C for 30 minutes, the β-carotene content becomes negligible.

Numerous reports document changes in the provitamin A content attributed to various forms of cooking [15, 27, 72–76]. Regardless of the method used, dehydration significantly reduces the carotene content in vegetables, which has implications for storage of seasonally available foods [76, 77]. However, others argue that mangoes that are sun-dried and stored up to six months still have adequate vitamin A activity [25].

Changes in provitamin A content have been documented with traditional methods of preparing leafy vegetables and tubers, but the changes vary with the method used. As a general rule, foods boiled in an open container showed the greatest losses. Whereas one study in Bangladesh reported losses of up to 43% in leafy green vegetables following the traditional method of boiling with subsequent frying [15], another study in Indonesia reported negligible losses when sweet potatoes and leafy greens were fried and then boiled [78]. Other authors report either no change or increases in carotene content following certain processing methods [18, 51, 72, 74, 77]. However, values between studies are difficult to compare, given natural sources of variation, different analytical techniques, and an absence of data on the original moisture content.

Sweeney and Marsh [79] reported that processing of fruits and vegetables induced isomerization of β-carotene, resulting in an estimated 15%–20% reduction in vitamin A potency in green leafy vegetables, and 30%–35% in yellow vegetables. The vitamin A activity in the raw form of these foods is predominantly all-trans β-carotene. With the introduction of HPLC, which offers the sensitivity and reproducibility to isolate and quantify stereoisomers, several recent studies have confirmed that cis isomers exist in human serum and in raw fruits and vegetables [80–84].

Moreover, with increased temperature, the presence of light, and catalysts such as acid, isomerization to the cis form increases [72].

The implication of this isomerization is related to the lower biological activity associated with the cis form, which is estimated to have 38%–53% of the potency of the all-trans form [79]. The reports of an increased carotene content following processing may reflect a loss in soluble solids [74] and an associated increase in concentration of cis isomers, which, in terms of vitamin A potency, would be significantly lower than in the raw form. However, a recent study of Indonesian greens demonstrated that the reduction in vitamin A activity due to cis isomer formation during traditional processing did not exceed 10%, whereas the large variation in cis isomer content in raw vegetables selected from different markets accounted for a reduction of vitamin A activity of up to 12% [78]. This suggests that variation attributable to sampling procedures exceeds that associated with processing foods by traditional methods.

The documentation of processing effects on preformed vitamin A sources is less abundant. Losses of up to 40% in fish sources rich in vitamin A have been reported following boiling [85]. In a study examining traditional foods eaten by people of the Dene nations of the Northwest Territories of Canada, processing of animal and fish livers by baking did demonstrate some decrease in total vitamin A activity, but this was not consistent [35]. Pickling of cheeses with a cow and buffalo milk base led to slight losses in total vitamin A activity, but these were attributable to changes in moisture content during the pickling process [34].

Bioavailability and metabolism

Both nutritive and non-nutritive substances in foods affect absorption, and hence availability and metabolism of both preformed vitamin A and provitamin A [86]. Utilization of retinol and β-carotene is improved with both protein and fat intake [8]. Dietary intake of vitamin E and zinc also enhances utilization of preformed vitamin A and provitamin A. Different isomers and related compounds have demonstrable differences in biological activity. Rat studies indicate that excessive intake of preformed vitamin A decreases β-carotene liver stores but increases liver stores of retinol [87]. Excessive intake of either decreases vitamin E status.

The addition of green leafy vegetables to a basal diet of maize and beans increases weight gain in vitamin A–deficient rats, suggesting that provitamin A can have a role in improving vitamin A status [88]. Several metabolic studies involving children document a significant increase in serum vitamin A levels with increased intake of green leafy vegetables [89–92]. This would confirm results from epidemiological studies reporting a negative association between fruit and vegetable intake and xerophthalmia [93–96]. Absorption of β-carotene in the metabolic studies was estimated to range from 61% to 70%. A study by Hussein and El-Tohamy [91] showed that an oral dose of 200,000 IU (21 servings of carrots over a period of 40 days) and an equivalent number of servings of green leafy vegetables were equally effective in raising serum levels after 40 days. Carotene digestibilities (percentage apparent absorption) of 47% and 81% for carrots and spinach respectively were reported following a two-week supplementation study in young males [97]. Lala and Reddy [92] reported increases in serum retinol levels in malnourished children 15 days after treatment with green leafy vegetables. The most dramatic increases were in those children with the lower serum levels at the onset of the study, which confirms the adaptive efficiency of β-carotene absorption. Rains-Mariath et al. [11] demonstrated partial or complete regression of clinical signs of xerophthalmia in 10 of 12 children fed *Mauritia vinifera* Mart. fruit over a period of 20 days.

Two groups [89, 92] noted that respiratory infection and other infectious diseases reduced β-carotene utilization, with lower serum levels being measured during the period of illness. This was confirmed by Hamdy et al. [98], who also reported that provitamin A supplementation did not change serum levels in subjects with parasitic infection. While the strong interrelationships between vitamin A deficiency and various infectious diseases are well documented, the actual mechanisms have yet to be clarified [99].

More recent studies focused on the bioavailability of carotenoids suggest that, within a normal population, large inter-individual variations exist in plasma concentrations of β-carotene [100–102]. In a study of 30 men, a threefold to fourfold inter-individual variation in the efficiency of carotenoid absorption was noted [100]. Eleven days of supplementation with carrots or pure β-carotene resulted in an increase in plasma levels of β-carotene, whereas supplementation with broccoli or tomato juice did not. These authors concluded that plasma carotenoid levels reflected the long-term dietary intake of provitamin A sources. These levels do not appear to fluctuate in plasma levels with the increased intake of a single food item, as demonstrated by low intra-individual variation. Moreover, certain individuals were consistently less efficient in carotenoid absorption than other subjects in the study, which would suggest that plasma levels do not always reflect dietary intake. Significantly higher levels of β-carotene absorption in subjects consuming a high-fat diet than in those on a low-fat diet have been reported [101].

Food composition tables

Accurate food composition data are needed for calculation of the vitamin A intake of a population from

120

dietary surveys and for the selection of foods rich in vitamin A for education programmes. Food composition tables contain crude nutrient values from the chemical analyses of foods, with no allowance for the biological utilization of the item [86], so these values are estimates at best. The limitations of vitamin A and provitamin A nutrient values in existing tables have been reviewed [6], but several issues deserve mention.

The different units for expressing vitamin A activity have created confusion. In the recent USDA Handbook No. 8, vitamin A activity is presented as both RE and IU [103]. FAO tables list values in micrograms of retinol or β-carotene equivalents [14, 21, 104], as do other food composition tables [16, 105], which allows the user to differentiate between preformed vitamin A and provitamin A activity or to calculate total vitamin A activity. Some tables present total vitamin A activity in RE [106]. Other tables are not as flexible or accurate in terms of vitamin A activity [6]. It has been common practice to assume that 1 IU of retinol is equivalent to 1 IU of β-carotene, and then to group the values for vitamin A and provitamin A together [40]. The vitamin A activity values in the Latin American food composition table [107] were recalculated into micrograms of retinol, β-carotene, and other carotenoids [19] based on the FAO table that estimated the distribution of provitamin A and preformed vitamin A in different foods [104]. Similarly, other food composition tables have reconverted original nutrient data from IU to RE using this distribution table [14, 21]. Recalculations were done using data from outdated methods in which many of the original data were analysed in the 1940s and 1950s [6].

The AOAC method for provitamin A determination is not adapted to the complexity of carotenoid profiles in certain foods, so many of the values, particularly those in fruits, are overestimates of the actual vitamin A activity. A comparison of values from USDA Handbook No. 8 [103] with HPLC analysis of the same foods revealed substantial differences in fourteen items, with nine overestimated in the handbook and five underestimated [64]. Discrepancies attributable to outdated methods were also demonstrated in the Thai food composition table [108]. Using 108 dietary records of 24-hour recall, total dietary intakes of macronutrients and micronutrients were calculated from nutrient data from the table and compared with direct chemical analyses of the foods using HPLC. Estimated vitamin A intake in RE as calculated from the table was 243% greater than that calculated from the chemical analyses. The greatest discrepancy occurred in vitamin A values for fruit intake—a 203% estimate. Preformed vitamin A sources (eggs and poultry) were in greater agreement, with the overall modification shifting the percentage contribution of total RE to the retinol sources.

As current food composition tables give little information on the carotenoid profile or the stereoisomers of retinol or carotenoids, assumptions need to be made about the contribution of the food item to the total vitamin A activity. These are not made uniformly across all food tables [56]. For example, original data presented as total carotenes have often been converted to IU by the arbitrary division of one-third part β-carotene and two-thirds parts other carotenoids [23].

Use of appropriate sampling procedures reduces sampling variance, with the nutrient value representing a mean [38]. Caution must be exercised when comparing values from samples with different sampling and handling procedures [63], yet these differences are inherent in food composition tables. As reviewed by Moore [12], reproductive cycle, age, and the species of fish are sources of marked variation in preformed vitamin A activity of fish oils, but these factors are rarely given consideration in the food tables. When nutrient values from locally analysed foods are not available, food composition tables may use values from other regions, which increases the probability of error, given the geographical variation in nutrient content of foods. This has been demonstrated in provitamin A activity values by comparing Turkish with American dried apricots [109]. The Latin American food composition table [107], for example, includes nutrient values from the USDA Handbook No. 8 [110] and FAO publications of 1949 [111]. However, as mentioned in numerous nutrition studies, a complete database for provitamin A and preformed vitamin A values for locally available food items is often lacking [31, 112].

Summary

(1) Vitamin A activity in foods is currently expressed as retinol equivalents (RE). Conversion rates from the carotenoids to retinol adjust for certain factors affecting absorption and utilization, but have yet to address differential vitamin A activity due to isomerization.

(2) HPLC is currently the preferred analytical technique for determination of preformed vitamin A and provitamin A, given the discrepancies in provitamin A values found using earlier techniques.

(3) Natural sources of variation, notably soil pH, rainfall, seasonality, genetic diversity, and stage of maturation, create large ranges in the preformed vitamin A and provitamin A contents of foods consumed in the diet.

(4) Preformed vitamin A and provitamin A contents of foods are reduced during food preparation, although nutrient data are inconsistent among studies. Isomerization of the carotenoids during processing results in lower biological activity, which has im-

portant implications for the promotion of foods rich in provitamin A.

(5) Both absorption and utilization of preformed vitamin A and provitamin A are improved with concurrent dietary intake of fat, protein, vitamin E, and zinc. Other physiological and dietary factors may also influence the efficacy of carotenoid and retinol utilization, but the mechanisms have yet to be clarified. This points to the need for complete food intake data, and possibly for the promotion of additional food items rich in other nutrients, notably fat, to optimize the utilization of preformed and provitamin A in natural food sources.

(6) In their current state, food composition tables contain inconsistencies in preformed vitamin A and provitamin A nutrient values. Differential use of units and conversion rates and reliance on data based on outdated analytical techniques limit their use in the identification of vitamin A-rich foods and the calculation of dietary intake of vitamin A, particularly from carotenoid sources.

References

1. FAO. Requirements of vitamin A, iron, folate and vitamin B_{12}. Report of a joint FAO/WHO expert committee. FAO Food and Nutrition Series, no. 23. Rome: Food and Agriculture Organization, 1988.
2. National Research Council. Recommended dietary allowances. Washington, DC: National Academy Press, 1989.
3. Olson JA. Recommended dietary intakes (RDI) of vitamin A in humans. Am J Clin Nutr 1987;45:704-16.
4. Olson JA. Vitamin A. In: Brown ML et al., eds. Present knowledge in nutrition. 6th ed. Washington, DC: International Life Sciences Institute-Nutrition Foundation, 1990:96-107.
5. Bendich A, Langseth L. Safety of vitamin A. Am J Clin Nutr 1989;49:358-71.
6. Simpson KL, Tsou SCS. Vitamin A and provitamin A composition of foods. In: Bauerfeind JC, ed. Vitamin A deficiency and its control. Orlando, Fla, USA: Academic Press, 1986:461-78.
7. Daun H. The chemistry of carotenoids and their importance in food. Clin Nutr 1988;7(3):97-100.
8. Erdman J. The physiologic chemistry of carotenes in man. Clin Nutr 1988;7(3):101-06.
9. Simpson KL, Chicester CO. Metabolism and nutritional significance of carotenoids. Ann Rev Nutr 1981;1:351-74.
10. Cottrell RC. Introduction: nutritional aspects of palm oil. Am J Clin Nutr 1991;53:989S-1009S.
11. Rains-Mariath JG, Cavalcanti Lima MC, Pacheco Santos LM. Vitamin A activity of buriti (*Mauritia vinifera* Mart.) and its effectiveness in the treatment and prevention of xerophthalmia. Am J Clin Nutr 1989;49:849-53.
12. Moore T. Vitamin A. Amsterdam: Elsevier, 1957.
13. Brown KH, Black RE, Becker S, Nahar S, Sawyer J. Consumption of foods and nutrients by weanlings in rural Bangladesh. Am J Clin Nutr 1982;36:878-89.
14. Polacchi W, McHargue JS, Perloff BP. Food composition tables for the Near East. Rome: Food and Agriculture Organization, 1982.
15. Rahman MM, Wahed MA, Akbar Ali M. Beta-carotene losses during different methods of cooking green leafy vegetables in Bangladesh. J Food Comp Anal 1990;3:47-53.
16. Scherz H, Senser F. Food composition and nutrition tables 1989/90. 4th ed. Stuttgart, Germany: Wissenschaftliche Verlagsgesellschaft, 1989.
17. West CE, Pepping F, Temalilwa C. The composition of foods commonly eaten in East Africa. Wageningen, Netherlands: Wageningen Agricultural University, 1988.
18. Booth S, Bressani R, Johns T. Nutrient content of selected indigenous leafy vegetables consumed by the Kekchi people of Alta Verapaz, Guatemala. J Food Comp Anal (in press).
19. Fleuret A. Dietary and therapeutic uses of fruit in three Taita communities. In: Etkin NL, ed. Plants in indigenous medicine and diet: biobehavioural approaches. Bedford Hills, NY, USA: Redgrave, 1986:151-70.
20. Kuhnlein HV. Nutrient values in indigenous wild plant greens and roots used by the Nuxalk people of Bella Coola, British Columbia. J Food Comp Anal 1990;3:38-46.
21. Leung WW, Butrum RR, Chang FH. Food composition table for use in East Asia. Rome: Food and Agriculture Organization, 1972.
22. Harris RS, Munsell HE. Edible plants of Central America. J Home Econ 1951;42:629-31.
23. Platt BS. Tables of representative values of foods commonly used in tropical countries. Special Report Series, no. 302. London: Medical Research Council, 1962.
24. Homnava A, Rogers W, Eitenmiller RR. Provitamin A activity of specialty fruit marketed in the United States. J Food Comp Anal 1990;3:119-33.
25. Rankins J, Hopkinson S, Diop M. Palatability and nutritional significance of solar dried mangoes for Senegal. Ecol Food Nutr 1989;23:131-40.
26. Imungi JK, Wabule MN. Some chemical characteristics and availability of vitamin A and vitamin C from Kenyan varieties of papayas (Carica papaya L.). Ecol Food Nutr 1990;24:115-20.
27. Nagra SA, Khan S. Vitamin A (β-carotene) losses in Pakistani cooking. J Sci Food Agri 1988;46:249-51.
28. El-Hosseiny SM. Effect of pickling on the nutritive value of food stuff. PhD thesis. Cairo, Egypt: Ain-Shams University, 1976.
29. Heinonen M, Ollilainen V, Linkola E, Varo P, Koivistoinen P. Carotenoids and retinoids in Finnish foods: dietary fats. J Food Comp Anal 1988;1:334-40.
30. Essien AI, Fetuga BL. Beta-carotene content and some characteristics of under-exploited seed oils of forest trees in Nigeria. Food Chem 1989;32:109-16.

31. Pepping F, Vencken CMJ, West CE. Retinol and carotene content of foods consumed in East Africa determined by high performance liquid chromatography. J Sci Food Agri 1988:45:359-71.
32. Ollilainen V, Heinonen M, Linkola E, Varo P, Koivistoinen P. Carotenoids and retinoids in Finnish foods: dairy products and eggs. J Dairy Sci 1989:72:2257-65.
33. Hussein L, Fahmy A, Hussein MZ. Food consumption pattern in North Sinai. Cairo: North Sinai Government, National Institute of Social Sciences, 1990.
34. Buruiana LM, El-Senaity MH. Vitamins A and E of teleme cheese during ripening. Egypt J Dairy Sci 1986:14:55-58.
35. Doolan N. Selected nutrients and PCBs in the food system of the Sahtu (Hareskin) Dene/Metis. MSc thesis. Montreal, Que, Canada: McGill University, 1991.
36. Kuhnlein HV, Soueida R. Use and nutrient composition of traditional Baffin Inuit foods. J Food Comp Anal (in press).
37. Lewis RW, Lentfer JW. The vitamin A content of polar bear liver: range and variability. Comp Biochem Physiol 1967:22:923-26.
38. Thompson JN. Problems of official methods and new techniques for analysis of foods and feeds for vitamin A. J Assoc Off Analyt Chem 1986:69(5):727-38.
39. Olson JA. Provitamin A function of carotenoids: the conversion of beta-carotene into vitamin A. J Nutr 1989;119:105-08.
40. Olson JA. Physiological and metabolic basis of major signs of vitamin A deficiency. In: Bauernfeind JC, ed. Vitamin A deficiency and its control. Orlando, Fla, USA: Academic Press, 1986:19-68.
41. Ball G. Fat-soluble vitamin assays in food analysis: a comprehensive review. New York: Elsevier Science Publishers, 1988.
42. Parrish DB, Moffitt RA, Noel RJ, Thompson JN. Vitamin A. In: Augustin J, Klein BP, Becker D, Venugopal PB, eds. Methods of vitamin assay. New York: John Wiley & Sons, 1985:153-84.
43. Knekt P, Aromaa A, Maatela J et al. Serum vitamin A and subsequent risk of cancer: cancer incidence follow-up of the Finnish mobile clinic health examination survey. Am J Epidem 1990:132(5):857-70.
44. Krinsky NI. The evidence for the role of carotenes in preventive health. Clin Nutr 1988;7(3):107-12.
45. Le Marchand L, Hankin JH, Kolonel LN, Wilkens LR. Vegetable and fruit consumption in relation to prostate cancer risk in Hawaii: a reevaluation of the effect of dietary beta-carotene. Am J Epidem 1991:133(3):215-19.
46. Peto R, Doll R, Buckley JD, Sporn MB. Can dietary beta-carotene materially reduce human cancer rates? Nature 1981:290:201-08.
47. Ziegler RG. Vegetables, fruits, and carotenoids and the risk of cancer. Am J Clin Nutr 1991;53:251S-259S.
48. Davies BH. Carotenoids. In: Goodwin TW, ed. Chemistry and biochemistry of plant pigments. 2nd ed. Vol 2. London: Academic Press, 1976:38-165.
49. Rodriguez-Amaya DB. Critical overview of provitamin A determination in plant foods. J Micronutr Anal 1989;5:191-225.
50. Simpson KL, Tsou SCS, Chicester CO. Carotenes. In: Augustin JA, Klein BP, Becker D, Venugopal PB, eds. Methods of vitamin assay. New York: John Wiley & Sons, 1985:185-220.
51. Lee CY, Simpson KL, Gerber L. Vegetables as a major vitamin A source in our diet. New York's Food Life Sci Bull 1989:126:1-11.
52. AOAC. Official methods of analysis. 14th ed. Arlington, Va, USA: Association of Official Analytical Chemists, 1984.
53. Khachik F, Beecher GR, Whittaker NF. Separation, identification, and quantification of the major carotenoid and chlorophyll constituents in extracts of several green vegetables by liquid chromatography. J Agri Food Chem 1986:34:603-16.
54. Bushway RJ. Separation of carotenoids in fruits and vegetables by high performance liquid chromatography. J Liq Chrom 1985:8(8):1527-47.
55. Bushway RJ. Determination of alpha- and beta-carotene in some raw fruits and vegetables by high-performance liquid chromatography. J Agri Food Chem 1986:34:409-12.
56. Olmedilla B, Granado F, Rojas-Hidalgo E, Blanco I. A rapid separation of ten carotenoids, three retinoids, alpha-tocopherol and d-alpha-tocopherol acetate by high performance liquid chromatography and its application to serum and vegetable samples. J Liq Chrom 1990:13(8):1455-83.
57. Quackenbush FW, Smallidge RL. Nonaqueous reverse phase liquid chromatographic system for separation and quantification of provitamins A. J Assoc Off Analyt Chem 1986:69(5):767-72.
58. Schwartz SJ, Von Elbe JH. High performance liquid chromatography of plant pigments: a review. J Liq Chrom 1982;5(suppl 1):43-73.
59. Simon PW, Wolff X. Carotenes in typical and dark orange carrots. J Agri Food Chem 1987;35:1017-22.
60. Rodriguez-Amaya DB, Kimura M, Godoy HT, Arima HK. Assessment of provitamin A determination by open column chromatography/visible absorption spectrophotometry. J Chrom Sci 1988:26:624-29.
61. Parrish DB. Determination of vitamin A in foods: a review. Crit Rev Food Sci Nutr 1977:9(4):375-94.
62. Elkins ER, Dudek JA. Sampling for vitamin analyses. In: Augustin JA, Klein BP, Becker D, Venugopal PB, eds. Methods of vitamin assay. New York: John Wiley & Sons, 1985.
63. Kuhnlein HV. Food sample collection for nutrient analyses in ethnobiological studies. J Ethnobiol 1986:6(1):19-25.
64. Bureau JL, Bushway RJ. HPLC determination of carotenoids in fruits and vegetables in the United States. J Food Sci 1986:51(1):128-30.
65. Takagi S. Determination of green leaf carotenoids by HPLC. Agri Biol Chem 1985;49(4):1211-13.
66. Johnson CD, Eitenmiller RR, Lillard DA, Rao M. Vitamin A activity of selected fruits. J Am Diet Assoc 1985;85(12):1627-29.
67. Bushway RJ, Yang A, Yamani AM. Comparison of alpha- and beta-carotene content of supermarket versus roadside stand produce. J Food Qual 1986;9:437-43.
68. Nilsson T. Growth and chemical composition of carrots as influenced by the time of sowing and harvest. J Agri 1987;108:459-68.

123

69. Pace RD, Dull GG, Phills BR, Bonsi C, Forrester IT. The effect of topping frequency on nutrient content of sweet potato green tips. J Food Comp Anal 1988; 1:326-33.

70. Pirie NW. Optimal exploitation of leaf carotene. Ecol Food Nutr 1988;22:1-10.

71. Simpson KL. Chemical changes in natural food pigments. In: Finley JW, ed. Chemical changes in food during processing. Westport, Conn, USA: AVI, 1986:409-41.

72. Chandler LA, Schwartz SJ. Isomerization and losses of trans beta-carotene in sweet potatoes as affected by processing treatments. J Agri Food Chem 1988;36:129-33.

73. Chen BH, Han LH. Effects of different cooking methods on the yield of carotenoids in water convolvulus (Ipomoea aquatica). J Food Prot 1990;53(12):1076-78.

74. Imungi JK, Potter NN. Nutrient contents of raw and cooked cowpea leaves. J Food Sci 1983;48:1252-54.

75. Micozzi MS, Beecher GR, Taylor PR, Khachik F. Carotenoid analyses of selected raw and cooked foods associated with a lower risk for cancer. J Nat Cancer Inst 1990;82(4):282-85.

76. Park YW. Effect of freezing, thawing, drying, and cooking on carotene retention in carrots, broccoli and spinach. J Food Sci 1987;52:1022-25.

77. Renquist VH, DeVreeze AC, Evenhuis B. The effect of traditional cooking methods on carotene content in tropical leafy vegetables. Ind Nutr Diet 1978;15:154-58.

78. Van der Pol F, Purnomo SU, Van Rosmalen HA. Trans-cis isomerisation of carotenes and its effect on the vitamin A potency of some common Indonesian foods. Nutr Rep Int 1988;37(4):785-93.

79. Sweeney JP, Marsh AC. Effect of processing on provitamin A in vegetables. J Am Diet Assoc 1971;59:238-43.

80. Chandler LA, Schwartz SJ. HPLC separation of cis-trans carotene isomers in fresh and processed fruits and vegetables. J Food Sci 1987;52(3):669-72.

81. Krinsky NI, Russett MD, Handelman GJ, Snodderly DM. Structural and geometrical isomers of carotenoids in human plasma. J Nutr 1990;120:1654-62.

82. O'Neil C, Schwartz SJ, Catignani GL. Comparison of liquid chromatographic methods for determination of cis-trans isomers of beta-carotene. J Assoc Off Analyt Chem 1991;74(1):36-42.

83. Rushkin WG, Catignani GL, Schwartz SJ. Determination of beta-carotene and its cis isomers in serum. Clin Chem 1990;36(11):1986-89.

84. Schwartz SJ, Patroni-Killam M. Detection of cis-trans isomers by two-dimensional thin-layer and high-performance liquid chromatography. J Agri Food Chem 1985;33:1160-63.

85. Burt J. Fish smoking and drying. New York: Elsevier Science Publishers, 1988.

86. Ferrando R. From analysis to reality: bioavailability in nutrition and toxicology—a misunderstood concept. World Rev Nutr Diet 1987;53:26-68.

87. Blakely SR, Grundel E, Jenkins MY, Mitchell GV. Alterations in beta-carotene and vitamin E status in rats fed beta-carotene and excess vitamin A. Nutr Res 1990;10:1035-44.

88. Bressani R. World needs for improved nutrition and the role of vegetables and legumes. Tainan, Taiwan: Asian Vegetable Research and Development Center, 1983.

89. Charoenkiatkul S, Valyasevi A, Tontisirin K. Dietary approaches to the prevention of vitamin A deficiency. Food Nutr Bull 1985;7(3):72-76.

90. Devadas R, Murthy NK. Biological utilization of beta-carotene from amaranth and leaf protein in preschool children. World Rev Nutr Diet 1978;31:159-61.

91. Hussein L, El-Tohamy M. Effect of supplementation with vitamin A or plant carotenes on plasma retinol levels among young Egyptian males. Int J Vit Nutr Res 1989;59:229-33.

92. Lala VR, Reddy V. Absorption of beta-carotene from green leafy vegetables in undernourished children. Am J Clin Nutr 1970;23(1):110-13.

93. DeSole G, Belay Y, Zegeye B. Vitamin A deficiency in southern Ethiopia. Am J Clin Nutr 1987;45:780-84.

94. Mele L, West KP, Pandji A, Nendrawati H, Tilden RL, Tarwotjo I. Nutritional and household risk factors for xerophthalmia in Aceh, Indonesia: a case-control study. Am J Clin Nutr 1991;53:1460-65.

95. Stanton BF, Clemens JD, Wojtyniak B, Khair T. Risk factors for developing mild nutritional blindness in urban Bangladesh. Am J Dis Child 1986;140:584-88.

96. Tarwotjo I, Sommer A, Soegiharto T, Susanto D, Muhilal. Dietary practices and xerophthalmia among Indonesian children. Am J Clin Nutr 1982;35:574-81.

97. Hussein L, El-Tohamy M. Vitamin A potency of carrot and spinach carotenes in human metabolic studies. Int J Vit Nutr Res 1990;60:229-35.

98. Hamdy BH, Elknokaly F, Gaafer S, Elnaggar B, Hussein L. Effectiveness of periodic oral vitamin A dosage on hypovitaminosis in Egypt. Int J Vit Nutr Res 1982;52:235-40.

99. Chandra RK, Vyas D. Vitamin A, immunocompetence, and infection. Food Nutr Bull 1989;11(3):12-19.

100. Brown ED, Micozzi MS, Craft NE et al. Plasma carotenoids in normal men after a single ingestion of vegetables or purified beta-carotene. Am J Clin Nutr 1989;49:1258-65.

101. Dimitrov NV, Meyer C, Ullrey DE, Chenoweth W, Michelakis A. Bioavailability of beta-carotene in humans. Am J Clin Nutr 1988;48:298-304.

102. Mathews-Roth MM. Plasma concentrations of carotenoids after large doses of beta-carotene. Am J Clin Nutr 1990;52:500-01.

103. Gebhardt SE, Cutrufelli R, Matthews RH. Composition of foods—fruit and fruit juices—raw, processed, prepared. Washington, DC: USDA Human Nutrition Information Service, 1982.

104. Leung TW, Busson F, Jardin C. Food composition table for use in Africa. Rome: Food and Agriculture Organization, 1968.

105. Paul AA, Southgate DAT. McCance and Widdowson's The composition of foods. 4th ed. Amsterdam: Elsevier, 1988.

106. Health and Welfare. Nutrient value of some common foods. Ottawa, Ont, Canada: National Department of

124

Health and Welfare. 1987.

107. Leung TW. Flores M. Table de composición de alimentos para uso en América Latina. Interdepartmental Committee of Nutrition, and Institute of Nutrition of Central America and Panama. Washington, DC: US Government Printing Office, 1961.

108. Speek AJ. Speek-Saichua S. Schreurs WHP. Determination of macronutrient and micronutrient levels in Thai foods: an evaluation of the Thai food composition table. Food Chem 1991:40:251-62.

109. Bolin HR. Composition of commercial U.S. and Turkish dried apricots. J Food Comp Anal 1989:2:37-40.

110. Watt BK. Merrill AL. Composition of foods—raw, processed, prepared. Agricultural Handbook no. 8. Washington, DC: USDA, 1950.

111. FAO. Food composition tables for international use. Rome: Food and Agriculture Organization, 1949.

112. Fleuret A. Dietary and therapeutic uses of fruit in three Taita communities. In: Etkin NL. ed. Plants in indigenous medicine and diet: biobehavioural approaches. Bedford Hills, NY, USA: Redgrave, 1986:151-70.

Editorial introduction

Food sources of vitamin A and provitamin A

Harriet V. Kuhnlein

Hypovitaminosis A is considered one of the major nutritional deficiency diseases affecting populations in developing regions, with 73 countries having been identified as potential endemic areas [1]. Vitamin A deficiency affects multiple physiological systems, but most of the prevalence data are on documented xerophthalmia, the series of ocular diseases associated with a severe deficiency of vitamin A [2]. Problems of deficiency have been documented in Bangladesh [3–5], India [6, 7], Indonesia [8, 9], Nepal [10], the Philippines [8], and Thailand [11]. Data on the prevalence of hypovitaminosis A have only recently become available for other regions of the world, including the African continent [12–15], Latin America [16, 17], and the Mediterranean [1], and suboptimal intakes of the nutrient have been reported among indigenous populations in northern Canada [18].

The prevalence of hypovitaminosis A is not uniformly distributed across regions or within populations. Physiological factors influencing the vitamin A status of an individual have been documented, but the mechanisms are still not clarified [19, 20]. Less emphasis has been given to ecological, economic, and cultural factors that influence the intake of natural food sources of moderate and high vitamin A activity. Consideration of these is essential in the identification of high-risk groups and of temporal factors that create periods of greater risk of deficiency in order to implement successful long-term prevention programmes.

Three major programme strategies have been designed to prevent and control the problem of vitamin A deficiency: periodic oral dosing, fortification, and dietary modification [21]. Prophylaxis programmes evolved with an expanding literature that revealed widespread prevalence of vitamin A deficiency [22]. Whereas initial efforts using high-dose vitamin A supplements were designed to reduce and control xerophthalmia, there is now concern for populations at risk in whom there are not yet the overt clinical signs of the disease [23]. Once clinical signs appear in the form of night blindness and dryness of the conjunctiva, the course of the deficiency is rapid [24].

Poor growth, anaemia, and increased susceptability to infection are now associated with hypovitaminosis A in preschool-aged children [25]. Vitamin A has a well documented role in the human immune responses [19], which has implications for treatment of diarrhoeal diseases and measles [26, 27]. A Guatemalan study also suggests that there is a positive association between vitamin A levels in umbilical cord serum at delivery and birth weight [28].

Administering periodic oral doses of 200,000 international units (IU) of vitamin A to preschool-aged children (with half doses for infants 6–12 months old) and a single dose within one month after delivery to lactating mothers is the most straightforward approach to treating, as well as preventing, xerophthalmia in endemic areas [29]. The underlying principle of this approach is to boost liver stores of retinol. Breast milk provides adequate vitamin A intake in infants exclusively breast-fed for at least the first six months of life [30]. UNICEF-distributed capsules are currently incorporated in prophylaxis programmes, including those in Bangladesh, Brazil, India, the Philippines, and Indonesia [3, 21, 31–33]. A low rate of coverage, failure to target those at risk, failure to sustain coverage, and poor nutritional status and socioeconomic conditions are cited as the major limitations of this strategy. Likewise, while fortification of a food vehicle with vitamin A has demonstrated success in clinical trials [32, 34], unstable economic and political systems have interfered with the sustained implementation of this strategy at the national level [35].

Although periodic oral dosing and food fortification have had documented success and have established their merit in preventing nutritional blindness, they are also considered expensive, temporary solutions. Long-term intervention through dietary modification of the intake of foods rich in provitamin A and vitamin A [21, 22, 35] is more effective. Among the benefits of promoting such natural food sources is that they provide concurrent intake of other nutritive and non-nutritive substances that contribute to the prevention of illness, an example being fruits and vege-

126

tables that are currently inferred to provide protection against certain types of cancer [36]. Another benefit is the avoidance of the potential toxicity associated with the overconsumption of vitamin A supplements [37]. Thorough cost-benefit analyses of the three strategies to prevent and control vitamin A deficiency have yet to be made.

Historical accounts, as reviewed by Sharman [38] and Wolf [39], document that night blindness has been successfully treated with the intake of vitamin A-rich foods. Positive dietary change is a gradual process, initiated by education and choice, which has been given low priority in most vitamin A intervention programmes [4, 33]. Promoting dietary change requires identifying and quantifying natural foods that are rich in vitamin A and provitamin A, in conjunction with foods rich in nutrients that interact with vitamin A uptake and bioavailability [40]. However, as demonstrated by the prevalence of xerophthalmia in regions with abundant food sources of vitamin A [1, 2], the emphasis cannot be limited to identifying and producing the food item. Physiological factors such as protein and zinc status also affect the absorption and metabolism of vitamin A [20]. Dietary fat, fibre intake, and the amount of carotenoid in the diet also influence the utilization of vitamin A. Food availability, cost, and consumption patterns as well as attitudes and beliefs about food and feeding behaviour all need to be defined and incorporated into programmes, as these are often the underlying causes of the deficiency [41].

The two papers that follow are reviews of natural foods with moderate to high vitamin A activity and the factors and programmes that influence improvement of vitamin A status. The first presents published values for the vitamin A activity of a selection of these foods and discusses the current state of food composition data: with the development of new analytical techniques, much of the older data for vitamin A activity needs to be re-evaluated. The second paper discusses factors that influence the dietary intake of foods rich in vitamin A activity. Dietary beliefs and practices are described, with anecdotal information to highlight the differential influence of these beliefs and practices on the intake of vitamin A. This is followed by a discussion of several programmes designed to increase the intake of natural foods rich in vitamin A activity, chosen to highlight strengths and weaknesses of the gardening, nutrition-education, and social-marketing approaches to improving the vitamin A status of the target population.

References

1. McLaren DS. Global occurrence of vitamin A deficiency. In: Bauerfeind JC, ed. Vitamin A deficiency and its control. Orlando, Fla, USA: Academic Press, 1986: 1-18.
2. Gopalan C. Nutrition problems and programmes in South-East Asia. SEARO Regional Health Papers no. 15. New Delhi: World Health Organization, Regional Office for South-East Asia, 1987.
3. Cohen N, Rahman H, Mitra M et al. Impact of massive doses of vitamin A on nutritional blindness in Bangladesh. Am J Clin Nutr 1987;45:970-76.
4. Darnton-Hill I. Vitamin A deficiency in Bangladesh. Health Pol Plan 1988;3(3):205-13.
5. Stanton BF, Clemens JD, Wojtyniak B, Khair T. Risk factors for developing mild nutritional blindness in urban Bangladesh. Am J Dis Child 1986;140:584-88.
6. Pereira SM, Begum A. Vitamin A deficiency in Indian children. World Rev Nutr Diet 1976;24:192-216.
7. Venkataswamy G, Cobby M, Pirie A. Rehabilitation of xerophthalmic children. Trop Geogr Med 1979;31:149-54.
8. Sommer A. Nutritional blindness: xerophthalmia and keratomalacia. New York: Oxford University Press, 1982.
9. Bergen HR, Natadisastra G, Muhilal H, Dedi A, Karyadi D, Olson JA. Vitamin A and vitamin E status of rural preschool children in West Java, Indonesia, and their response to oral doses of vitamin A and of vitamin E. Am J Clin Nutr 1988;48:279-85.
10. West KP, Pokhrel RP, Katz J et al. Efficacy of vitamin A in reducing preschool child mortality in Nepal. Lancet 1991;338:67-71.
11. Bloem MW, Wedel M, Egger RJ et al. Mild vitamin A deficiency and risk of respiratory tract diseases and diarrhea in preschool and school children in northeastern Thailand. Am J Epidem 1990;131(2):332-39.
12. Carlier C, Moulia-Pelat JP, Ceccon JF et al. Prevalence of malnutrition and vitamin A deficiency in the Diourbel, Fatick, and Kaolack regions of Senegal: epidemiological study. Am J Clin Nutr 1991;53:70-73.
13. DeSole G, Belay Y, Zegeye B. Vitamin A deficiency in southern Ethiopia. Am J Clin Nutr 1987;45:780-84.
14. Steinkuller PG. Nutritional blindness in Africa. Soc Sci Med 1983;17(22):1715-21.
15. Tielsch JM, West KP, Katz J et al. Prevalence and severity of xerophthalmia in southern Malawi. Am J Epidem 1986;124:561-68.
16. Shrimpton R. Vitamin A deficiency in Brazil: perspectives for food production oriented interventions. Ecol Food Nutr 1989;23:261-71.
17. Simmons WK. Studies on hypovitaminosis A in Brazil and other Latin American countries. Ecol Food Nutr 1976;5:51-55.
18. Doolan N. Selected nutrients and PCBs in the food system of the Sahtu (Hareskin) Dene/Metis. MSc thesis. Montreal, Que, Canada: McGill University, 1991.
19. Chandra RK, Vyas D. Vitamin A, immunocompetence, and infection. Food Nutr Bull 1989;11(3):12-19.

20. Erdman J. The physiologic chemistry of carotenes in man. Clin Nutr 1988; 7(3):101-06

21. West KP. Sommer A. Delivery of oral doses of vitamin A to prevent vitamin A deficiency and nutritional blindness: a state-of-the-art review. Geneva: UN ACC Subcommittee on Nutrition. 1987.

22. Underwood BA. Vitamin A prophylaxis programs in developing countries: past experiences and future prospects. Nutr Rev 1990;48(7):265-74.

23. IVACG. Guidelines for the development of a simplified dietary assessment to identify groups at risk for inadequate intake of vitamin A. Washington. DC: International Life Sciences Institute. 1989.

24. Solon MA. Control of vitamin A deficiency by education and the public health approach. In: Bauernfeind JC. ed. Vitamin A deficiency and its control. Orlando. Fla. USA: Academic Press. 1986:285-318.

25. Sommer A. New imperatives for an old vitamin (A). J Nutr 1989;119:96-100.

26. Campos F. Flores H. Underwood BA. Effect of an infection on vitamin A status of children as measured by the relative dose response (RDR). Am J Clin Nutr 1987;46:91-94.

27. Sommer A. Katz J. Tarwotjo I. Increased risk of respiratory disease and diarrhea in children with preexisting mild vitamin A deficiency. Am J Clin Nutr 1984;40:1090-95.

28. Neel NR. Alvarez JO. Chronic fetal malnutrition and vitamin A in cord serum. Eur J Clin Nutr 1990;44:207-12.

29. Sommer A. Field guide to the detection and control of xerophthalmia. Geneva: World Health Organization. 1982.

30. FAO. Requirements of vitamin A. iron. folate and vitamin B_{12} deficiency and its control. Orlando. Fla. USA: Academic Press. 1986:285-318. Report of a joint FAO/WHO expert committee. FAO Food and Nutrition Series no. 23. Rome: Food and Agriculture Organization. 1988.

31. Araujo RL. Borges EL. D'Arck J. Silva B. Vieira EC. Failure of massive oral doses of vitamin A to prevent hypovitaminosis. Nutr Rep Internat 1978:18(5):503-13.

32. Solon F. Fernandez TL. Latham MC. Popkin BM. An evaluation of strategies to control vitamin A deficiency in the Philippines. Am J Clin Nutr 1979;32:1445-53.

33. Underwood BA. Underpinning vitamin-A deficiency prevention and control programmes. Food Nutr Bull 1989;11(3):41-42.

34. Arroyave G. Aguilar JR. Flores M. Guzman M. Evaluation of the sugar fortification with vitamin A at the national level. Washington. DC: Pan American Health Organization. 1979.

35. Arroyave G. Alternative strategies with emphasis on food fortification. In: West KP. Sommer A. eds. Delivery of oral doses of vitamin A to prevent vitamin A deficiency and nutritional blindness: a state-of-the-art review. Geneva: UN ACC Sub-committee on Nutrition. 1987:87-91.

36. Ziegler RG. Vegetables. fruits. and carotenoids and the risk of cancer. Am J Clin Nutr 1991;53:251S-259S.

37. Bendich A. Langseth L. Safety of vitamin A. Am J Clin Nutr 1989;49:358-71.

38. Sharman IM. Historical introduction. Proc Nutr Soc 1983;42:1-5.

39. Wolf G. A historical note on the mode of administration of vitamin A for the cure of night blindness. Am J Clin Nutr 1978;31:290-92.

40. Mejia LA. Vitamin A–nutrient interrelationships. In Bauerfeind JC. ed. Vitamin A deficiency and its control. Orlando. Fla. USA: Academic Press. 1986:69-100.

41. Devadas RP. Currently available technologies in India to combat vitamin A malnutrition. In: West KP. Sommer A. eds. Delivery of oral doses of vitamin A to prevent vitamin A deficiency and nutritional blindness: a state-of-the-art review. Geneva: UN ACC Sub-committee on Nutrition. 1987:97-104.

128

Factors influencing vitamin A intake and programmes to improve vitamin A status

T. Johns, S. L. Booth, and H. V. Kuhnlein

Factors influencing the dietary intake of vitamin A

Differential intake of provitamin A and preformed vitamin A can be explained in part by the natural variation in the nutrient content of individual foods. It is also determined by dietary beliefs and practices. In the first part of this paper, the seven general food categories presented in the preceding paper [1] are explored in terms of factors influencing their intake. The discussion of each category is divided into four sections: inclusion in the diet, exclusion from the diet, seasonal factors, and economic factors.

The sections entitled "Inclusion in the diet" provide summaries of documented use of food items rich in vitamin A activity. In some societies, certain foods are prescribed as preventive measures or as treatment for illness [2]. Traditional beliefs and practices in many societies are being modified by the influence of the media and government programmes [3, 4], so that both historical and contemporary factors contribute to actual dietary intake. This extends to methods of food preparation which modify the vitamin A activity estimated in the raw form.

Exclusion of a food item rich in vitamin A activity from the diet can relate to dietary beliefs, although this effect is usually limited to certain sectors of the population. Certain foods are often proscribed from the diet in response to alterations in physiological status, e.g. menstruation, pregnancy and lactation, and illness. Ecological factors such as climate, soil and water, and general environmental integrity all affect the availability of a food item, particularly in regions where transport and storage facilities are not well developed. The availability of time is a determinant of food consumption, particularly time to gather and prepare food. Cross-cultural differences in parental control and dietary beliefs influence the timing of the introduction of foods rich in vitamin A activity during the weaning period, and the quantity ingested [5–8]. This has important implications for the vitamin A status of infants and children, whose liver stores of vitamin A are more rapidly depleted than those of adults and who can eat relatively small quantities of food.

The availability of foods rich in vitamin A activity is often seasonal. For example, in some regions the rainy season is marked by an abundance of wild leafy greens. When liver retinol stores are low or vitamin A status is compromised by disease, seasonal fluctuations can lead to periods of greater risk of hypovitaminosis A.

Dietary intake of foods rich in vitamin A activity is also determined by economic factors. Vitamin A intake is positively correlated with household income level [9]. This correlation is most evident when provitamin A and preformed vitamin A food sources are not readily available [7]. Market value is also linked to issues of social status associated with a given food item.

The literature about food beliefs and practices related to vitamin A intake is multidisciplinary. The sources consulted for this review include the following kinds of materials:

- nutrition surveys in regions where xerophthalmia is endemic,
- evaluations of programmes designed to improve vitamin A status in target populations,
- clinical and case studies of xerophthalmia,
- anthropological studies of dietary practices in various societies,
- general reviews of dietary beliefs and practices,
- studies of traditional medicine that include dietary prescriptions and proscriptions.

(In addition, some of the information from Guatemala and East Africa is based on the personal observations of the authors.)

The available literature has at least four significant limitations for our purposes:

The authors are affiliated with the School of Dietetics and Human Nutrition in the Faculty of Agricultural and Environmental Sciences at McGill University in Montreal, Canada.

129

(1) Nutritional data are often lacking, so that we have had to make assumptions about the potential vitamin A activity of the foods being discussed. This is problematic in light of the wide range of natural variation in vitamin A activity within species of animal and plant foods.

(2) Wild foods, particularly local green leafy vegetables and fruits, are often overlooked in dietary surveys. It is hard to evaluate the dietary intake of provitamin A of children who eat fruit outside the home. As a consequence, the intake of foods rich in vitamin A activity is often underestimated. The same dilemma occurs when other foods are eaten outside the home (e.g., at the kill site for game, or at the market).

(3) Some authors do not include scientific names, or even the common names of foods, in their discussion of dietary practices. It is impossible to differentiate poor from excellent sources of vitamin A within the commonly used categories of "vegetables" and "meat." Likewise, differential dietary practices are observed in different ethnic groups within the same region, or within the same ethnic group in different communities. When authors do not give details on the specific ethnic group and the location of the study, generalizations are often erroneously made.

(4) Anthropological studies cover both reported behaviour and statements of beliefs and attitudes but rarely include reports of direct observations. There are important differences between reported practice, which tends to fit the ideal or norm, and real practice. Furthermore, although the statements of belief may be true, there is not always a direct relation between belief and practice. This is why it is so important not to assume that beliefs and attitudes dictate the way people act, especially in regard to food.

Given the diffuse distribution of literature pertaining to food choice and intake, the references cited should of course not be interpreted as an exhaustive evaluation of all dietary beliefs and practices associated with foods rich in vitamin A activity. The discussion highlights factors that have a documented influence on vitamin A intake, and the differential nature of their influence. Most of the examples cited are very specific and cannot be extrapolated to other populations. This emphasizes the necessity of evaluating the dietary practices of a group targeted for vitamin A intervention programmes before promoting natural food sources rich in vitamin A activity.

Green vegetables, algae, and flowers

Inclusion in the diet

The literature makes ample reference to the dietary use of green leafy vegetables, particularly of gathered wild species.

Leaves of tuber-producing plants are used for sauces, and wild greens make up 80% of the total vegetable intake among certain groups in Tanzania [10–12]. The Bemba and Lamba tribes in the Zambezian woodlands identify 241 edible wild species, and boiling the leaves is the most common method of preparation [13].

Among the Twi-speaking people in Ghana, the leaves of cocoyam are eaten regularly. The consumption of cassava leaves, however, is low; more often they are fed to poultry and other livestock [14]. Gathering is not an organized activity but is practised by both men and women during the course of farm work.

Among the Tswana of Botswana, gathering is a female activity, and the plants within the village are rejected to avoid possible contamination by human or animal faeces [15]. The young plants are eaten fresh or are sun-dried after cooking and then shaped into cakes that can be stored up to three years. The children of this tribe also eat the flowers of certain species of wild plants.

Among the Oto and Twa of Zaire, members of both sexes participate in gathering, which includes the collection of honey, tubers, and caterpillars in addition to green leafy vegetables [16]. In some societies in Zimbabwe, both women and children gather greens that are then eaten in cooked form or are dried for storage in anticipation of drought [17]. Among the Luo of Kenya, leaves are boiled until dry, or the water is discarded, and Magadi soda is sometimes added to soften the leaves [18].

In rural Malaysia, 72 species of edible wild greens have been identified in the diet [19], which contradicts earlier literature claiming that green leafy vegetables are only used for "taste" [20]. Consumption of the flower of the banana by children has also been documented in this region.

Among the Gujarat in India, flowers are eaten to satiety [21]. In northern India, the green leaves of root crops are eaten; in the southern part they are not [22].

In certain regions of Mexico, green leafy vegetables are considered the main source of vitamin A [23]. It has been suggested that variation in preference for different species of wild greens among populations in Oaxaca, Mexico, may reflect differences in availability according to ecological conditions and agricultural practices [24], whereas in Tlaxcala, Mexico, selective weeding encourages growth of preferred species of wild greens [25].

Several indigenous groups in western Canada use the fronds of certain species of algae to gather herring spawn, which are then eaten together [26]. Other species of algae are consumed in various forms, including fermented and dried. The young leaves of species of the celery family are preserved in seal oil by the Inupiaq Eskimos of Alaska and eaten year-round.

130

Dettwyler and Fishman [27] noted that the infusion of papaya leaf was used in at least one village in Mali to treat night blindness in pregnant women. In Java, it has been reported that the majority of women increase their consumption of leafy green vegetables during lactation to increase vitamin intake [28], a reflection of beliefs introduced by the media and government programmes. Among Greek immigrants in the United States, certain species of greens are believed to be health-promoting during pregnancy and post-partum [29].

The only case we have found mentioned of a society in which a green leafy vegetable has high status is that of the Wamiri of Papua New Guinea, who value taro leaves as a feast food [30].

Exclusion from the diet

As a general rule, consumption of green leafy vegetables is not limited by dietary beliefs, but they are underutilized relative to their availability and potential nutrient contribution. As pointed out by Pereira and Begum [22], those dietary restrictions that do exist may be limited to individual species of plants, so other species of greens could be substituted in promoting this category of foods rich in provitamin A.

Among the Yoruba in Nigeria, 57% of pregnant women were reported to avoid a green called "bitter leaf" because it tastes bitter [31]. Three reasons are given why pregnant women in certain regions of the Gambia do not eat enough greens: the greens dilute sauces; they dislike the taste; there is not enough time available for gathering greens [32]. A time constraint was also mentioned in reference to a generally low intake of greens among the Hopi of Arizona [33].

Several programmes under the auspices of Helen Keller International that are promoting the use of provitamin A–rich foods have been hampered by a consistent belief that infants are unable to digest green leafy vegetables [5–8]. Mothers claim that the greens cause indigestion and diarrhoea because the infants' gut is immature. In contrast, older children in these same areas are not restricted in their intake of leafy vegetables as it is assumed that their digestive system is sufficiently mature to digest greens.

Most dietary restrictions on green leafy vegetables are limited to women of child-bearing years. In Java, leaves of sweet potatoes are restricted for young, unmarried girls, as are other species for adolescents of both sexes [28]. In Telegana, India, most foods, including green leafy vegetables, are restricted 3 to 30 days post-partum [34] but are then prescribed during lactation. In Hawaii, there are dietary restrictions for individual species of algae, but they were not detailed by the author [35].

Another concept of dietary restriction is encountered within the humoral classification of foods, the most well-documented being the "hot-cold" classification. The humoral theory of disease is based on the principle that diseases are caused by imbalance, so treatment is designed to restore the balance [36]. Molony [37] reports that a systematic coding system is used in assigning a classification to individual food items. These cultural classifications exhibit intracultural variation and are subject to rapid modification through culture contact and cultural diffusion. Latin American immigrants in the United States generally classify greens as "cold" [38], as do societies in Guatemala [39], China [40], and Malaysia [41]. The implications of a "cold" classification relate to proscription during illness and certain seasons. In Malaysia it is thought that "cold" foods delay recovery from illness and that excess consumption can cause diarrhoea and fever. These foods are avoided during the rainy season, when the individual feels cold, and post-partum. In contrast, the certain species of greens, such as mustard greens, are classified as "hot" and are avoided by pregnant women [41]. Excessive intake of these "hot" species is thought to cause sore throat or fever.

In Zimbabwe [11] and the Philippines [42], there are inadequate plant resources because of deforestation, a shift to an agricultural economy and monocropping, and overpopulation. This leads to a decrease in intake of green leafy vegetables without substitution of other vitamin A sources. In contrast, green leafy vegetables are abundant but are underutilized by populations in Liberia [11], India [22], and Papua New Guinea [43] and among the Quechua in Peru [44] and the Haustec in Mexico [45]. Among nomadic tribes in Afghanistan, green leafy vegetables are eaten by children but are not an important dietary item for adults [46]. Nomads in Iran do not eat them [47]. Likewise, while edible algae are available, they is not eaten by the Seri of Mexico [48].

Members of the Jain religous group in south Rajasthan, India, do not eat wild greens during the rainy season despite their availability, because they believe that preparation/consumption of these greens would result in the religiously undesirable death of worms living on the plants (P. Sundaram, personal communication).

Seasonal patterns

Most accounts of green leafy vegetable intake make reference to seasonal availability and consumption. The diversity of available edible species increases in the rainy season, as, for example, was documented in the Zambezian woodland [13]. In regions of the Gambia, green leaves make an important contribution to total vitamin A intake during the non-mango season, which is between July and November [49]. Among the Sandawe in Tanzania, greens are gathered during the December-to-April rainy season and then dried and stored for later use [12]. Among the Oto and Twa in Zaire, while most species of wild greens are eaten during the rainy season, there is an increased consumption of cassava leaves during the dry season [16]. In societies in which people buy their greens from the market, such as the urban populations in Iraq, there is also an increase in intake of green leafy vegetables during summer months when they are abundant and low in price [50]. This fluctuation in the intake of greens does not occur in the United States [51], nor in the Twi-speaking regions of Ghana [52].

Economic considerations

There are few accounts of green leafy vegetables having an important economic role, although they are often used during periods of food shortages and economic constraints. Reliance on gathered plant sources would allow for greater expenditures on other foods. The Bemba and Lamba tribes are said to have an important retail trade in cassava leaves [13]. In at least one community in Ethiopia where there is no documented xerophthalmia and the average intake of greens among children is three times per week, the production and selling of leafy green vegetables is the responsibility of local prisoners [53]. With extensive urban migration from the rural areas, certain species of greens are becoming important crops in urban markets in Guatemala, Kenya, and Tanzania. Shoots of the ostrich fern, commonly referred to as "fiddleheads," are cooked or frozen for later use by some indigenous groups in Canada [26]. However, they are gaining such popularity as a specialty food among non-indigenous groups that the wild population of this species is being depleted.

Most references to economic issues associated with leafy vegetables refer to social status. In Hyderabad, India [54], Swaziland [55], and the highlands of Mexico [56], while green leafy vegetables are part of the traditional economy, their consumption is associated with poverty. Therefore consumption of wild greens is inversely associated with economic prosperity. In Tanzania, vegetable intake, hence provitamin A intake, may be higher in the "lean" season than after the harvest, which reflects the inferior status associated with these plants [57]. In contrast, in Iran there is higher consumption of green vegetables with increased economic status [58].

Fruits

Inclusion in the diet

In Indonesia, mangoes and papayas are introduced early in the weaning process, with a positive correlation between intake and the absence of xerophthalmia [59]. Among the Malays, fruit is eaten in substantial quantities by pregnant women [19]. Wilson [60] suggests that there is a global dietary belief that promotes the intake of those foods for which there are cravings during pregnancy, fruits being one of the more common food groups. When these cravings are not met, it is generally believed that marks will appear on the newborn that resemble the fruit not consumed.

There are numerous references to the popularity of fruit among children because of its sweet taste and soft texture. As fruits are often classified as food for children, there appears to be little competition with adult members of the household for them. In the Taita Hills of Kenya, where xerophthalmia has not been documented, fruit is eaten as a snack or as a meal replacement, especially by children [61]. In season, children eat fruit on an average of seven or more times per week, while adult women have an average weekly intake of one piece of fruit. Assignment to tasks outside the house allows the children to forage for these fruits, of which 97 species are classified as edible. Not all edible species are actually eaten; different species may be preferred by members of different ethnic groups within the the same ecological region. The concept of fruit as "children's food" is also found among the Mbuti in eastern Zaire [62], in Swaziland [63], and in regions of Mali where treats purchased at markets for children include provitamin A-rich fruits such as mangoes and papayas [27].

Fruit use has apparently not been affected by deforestation in the Condo area of Zimbabwe, where fruit consumption is correlated with a shortage of cultivated resources and is not in synchrony with the fruiting season [3].

Among the Tiruray in the Philippines, immature papaya is used as a vegetable, whereas mature papaya is eaten as a fruit [42]. Differential preference for ripeness in mangoes among Gambian women affects the nutrient intake since provitamin A activity varies with the stage of maturation [32].

The Seri of Mexico have numerous methods of preparing fruit for consumption, as described by Felger and Moser [48], although some species are consumed raw. In a Jivaro community in the Amazonas department of Peru, plantain is usually prepared by boiling or by roasting over coals [64]. At least 17 varieties of bananas and plantain have been documented in the diet, and these fruits are introduced into the diet by one year of age. There are numerous reports of consumption of berries in the form of jam or jelly among indigenous groups in Canada [26]. The Wood Cree eat cranberries raw, stewed, or served with fish and/or meat, or mix them with boiled fish eggs, liver, air bladders, and fat. There is frequent mention of plant foods being eaten with fat or oil, which is a suitable vehicle to increase the absorption of the provitamin A they contain.

In the Condo area of Zimbabwe, fruit is eaten for its perceived nutrient value (61% of those interviewed) and/or taste (52%) [3]. Among the Yoruba in Nigeria, plantain and papaya are perceived as being

132

nutritious for pregnant women by 91% and 59% respectively of women interviewed [31]. In Tamil Nadu in India, green plantain is eaten by some at puberty for a strengthening effect, whereas it is avoided by others because it is believed to have a weakening effect [65].

Exclusion from the diet

In Java, fruits are restricted for young unmarried girls, infants, and adolescents, and also for women during lactation because it is thought that negative effects will be passed through the breast milk to the infant [28]. Among forest-dwelling tribes in Gujarat in India there is also some avoidance of fruits by lactating women for fear of gastrointestinal upset in the child, showing a similar concept of the transfer of the effect of the restricted food from the mother to the infant via the breast milk [21]. Forest fruit is not given to infants in Gujarat for fear of choking the infant. In contrast, older children eat fruit to satiety, although these fruits are proscribed during illness.

Among the Yoruba in Nigeria, papaya is restricted for barren women because sterility is thought to be caused by worms, and papaya and other sweet fruits are considered to be delicacies for worms [66]. Likewise, these fruits are restricted for individuals with helminthic infection. Papayas as well as mangoes are avoided during pregnancy in Tamil Nadu, India, where these fruits are classified as "hot" and thought to have the capacity to induce abortion [67]. This has also been documented among the forest-dwelling tribes in Gujarat [21] and among the Jain religious group in south Rajasthan, India (P. Sundaram, personal communication). In contrast, in Malaysia, papaya is classified as "cold" [41], and its intake is restricted because it is believed to aggravate illnesses classified as "cold," examples being malaria and xerophthalmia [68]. Among different ethnic groups interviewed in the United States, particularly those from northern Mexico, fruits are classified as "cold" and therefore are avoided during menses [38]. Tomatoes are also avoided as they are believed to cause menstrual blood to congeal in the uterus, causing cancer. Chili is classified as a "hot" food in Malaysia and is considered a cause of stomach-ache, diarrhoea, fever, and sweating [41].

Seasonal patterns

Most descriptions of fruit intake make reference to the seasonal availability that creates periods of variable risk of hypovitaminosis A. The increase in provitamin A intake attributable to the mango season in regions of Brazil confounded the evaluation of the impact of a prophylaxis programme in the same region [69]. In the Taita Hills in Kenya, papaya is available year-round, whereas most fruits are limited to the period between March and August [61]. This is a pattern similar to that observed in south-eastern regions of Ghana [14]. Seasonal variation is also evident in the Gambia, where the mango season coincides with the season for red palm oil [32]. In contrast, in the United States consumption of specific raw fruits is seasonal but the availability of canned and dried fruit allows for year-round consumption [51].

Economic considerations

In Java, it has been observed that fruit intake is more frequent among women in higher income groups [28]. Similarly, in Hyderabad, India, tomatoes are considered a prestige food and are eaten more frequently by the wealthier segments of the population [54]. In Iran fruits are consumed in low quantities because of economic restraints [58]. In contrast, children who gather wild fruits in the Taita Hills in Kenya are able to eat these as an alternative to the high-priced commercial snack foods available on the school compounds [61].

Plants with vitamin A stores

Inclusion in the diet

Most roots and tubers are devoid of carotenoid activity, so it is very difficult to identify dietary beliefs and practices in the literature that affect provitamin A intake. Plant storage organs have classically been singled out in nutrition and anthropological studies for their dietary protein and energy contribution to the diet, with little emphasis on their potential contribution to provitamin A intake. In view of these limitations, dietary beliefs and practices related to plant storage organs are probably underrepresented in this literature review.

Plant storage organs are of importance to numerous African societies, and many different methods of preparation are observed [13]. The most common methods of preparation among groups in the Zambezian woodland region are boiling and roasting over an open fire. In the New Guinea highlands, sweet potatoes are the staple food, but "strong" tasting species are not introduced into the diet of children until they are two years old [43]. Species of the squash family are also documented dietary items, but they are seasonal in availability and consumption. In Hyderabad, India, tubers are the least consumed of all plant foods, but of these sweet potatoes are the most popular [54].

In the United States, carrots are ranked as the second largest contributor to total vitamin A intake [70]. Likewise in Ethiopia, in communities where the prevalence of xerophthalmia is low, carrots make an important contribution to vitamin A intake in children [53]. In Egypt, carrots are consumed in pickled form or are boiled and then eaten with potatoes because women argue that the crunchy texture presents

133

difficulties, particularly for children (Wahba, personal communication). In contrast, carrots are usually eaten raw as a treat in Mali [27]. This is problematic for infants, who are often denied this rich provitamin A source because mothers are concerned about possible damage to their teeth from the hard texture of carrots.

A questionnaire identifying dietary beliefs was used in a low-cost housing resettlement in Papua New Guinea [71]. Of the households interviewed, 13% identified sweet potatoes as healthy for children and 12% also identified pumpkins as having health-promoting properties. During lactation, sweet potatoes were perceived as a healthy food (80% of all respondents), with 47% of the respondents stating that, in general, vitamin A–rich tubers were preferable food to plain rice.

Exclusion from the diet

Wild roots and tubers are not widely consumed by the Luo in Kenya, which may be related to availability [18]. They are not eaten at all by nomads in Iraq [47].

Dietary restrictions are ocumented, with emphasis on the classification of these foods as "cold," as previously discussed. In Malaysia, the majority of green and yellow vegetables are classified as "cold," and consequently their intake is restricted because they are believed to aggravate illnesses like malaria and skin infections [68]. This includes the squash family, members of which are classified as "windy" [41]. As "windy" foods are thought to cause aching veins, weak legs and bones and rheumatism, they are generally limited in the diet. A similar classification exists among the Gujarat in India, although pumpkin is classified as "hot," and its consumption is therefore governed by the beliefs relating to "hot" foods. Likewise in Malaysia, tubers, including the sweet potato, are classified as "hot" and are only eaten during the rainy season, at night, or when the body feels cold [41]. As a general rule, "hot" foods are restricted for pregnant women.

Seasonal patterns

In the United States, sweet potatoes, carrots, and other vitamin A–rich vegetables are consumed year-round, with few if any seasonal fluctuations [51]. In contrast, roots and tubers are reported to be seasonal in their availability and intake in Iran and Papua New Guinea [30, 58].

Economic considerations

We encountered little mention in the literature of the economic role plant storage organs may have for those societies consuming them. However, according to FAO food balance sheets, sweet potatoes are classified as a main staple food crop in Burundi, Kenya, Rwanda, Tanzania, and Uganda [72]. In Iran, it has been noted that there is a lower intake of roots and tubers among the low-income groups [58]. Likewise, their consumption is erratic in Ethiopia because of constraints on cash flow [53]. It was found that the large inter-family variation in the intake of plant storage organs was explained in part by the family purchasing priority.

Plant oils

Inclusion in the diet

There is very little literature available on dietary beliefs surrounding the use of plant oils other than the documented use of red palm oil in certain regions of Africa. Given the small quantities that are used in the cooking process, they are particularly difficult to quantify in a dietary survey [73].

Among the Mbuti of eastern Zaire, red palm oil is used for cooking purposes whenever it is available [62]. The Oto and the Twa use palm oil as a base for a sauce in which spiced cassava leaves are added [16]. In those communities in Nigeria and Zambia where red palm oil is consumed regularly in the diet, xerophthalmia is not endemic [74, 75]. In the Yoruba tribe in Ghana and Nigeria, mothers are known to give one teaspoon (5 g) of palm oil as a treatment to infants with measles [76].

As discussed in the preceding paper [1], red palm and buriti palm oil are the richest known sources of provitamin A. While other plant oils have little if any vitamin A activity, their contribution to vitamin A intake is important for the absorption of this nutrient [77]. Therefore, promotion of dietary fat should not be limited to those oils known to be rich in vitamin A activity, although the latter arguably would have the greatest impact on improving dietary vitamin A intake.

Exclusion from the diet

We have found no documented cases of dietary restrictions relating to plant oils, although in several regions, including communities in Zambia [74] and Liberia [11], red palm oil was available but not consumed.

Seasonal patterns

In the Gambia, which has a well documented reliance on red palm oil for cooking purposes, it is seasonal in availability, coinciding with the mango season [32]. During this period between April and June, the average intake of vitamin A and provitamin A is at its peak for the year.

Economic considerations

Red palm oil is expensive in most regions because of the labour-intensive processing required for the final product. As a consequence its dietary use is often limited by price and availability [27, 32]. In India, when dietary fat in the form of ghee is prohibitive in cost, groundnut (peanut) oil is used as an alternative [54].

Milk, milk products, and eggs

Inclusion in the diet

Abrams [78] states that all human cultures include some form of animal protein and fat in the diet. From a survey of 383 cultures represented in the Food Habits Survey of the Human Relations Area Files, of the two classifications of animal produce most commonly consumed, Abrams tabulated 363 societies consuming chicken meat and eggs, and 196 consuming cattle meat and milk.

Reports of egg consumption are few in the literature compared to the numerous dietary restrictions on eggs. In Tamil Nadu, India, eggs are prescribed at the age of menarche, as they are thought to increase fertility [65], although current economic constraints are limiting this belief. In Nigeria, only 14.5% of Yoruba women interviewed considered eggs a healthy food during pregnancy [31]. In Indonesia, eggs are the only preformed vitamin A source consumed significantly more by children who do not show signs of xerophthalmia than by their vitamin A–deficient peers [73]. In China, preservation methods prolong the shelf life of duck or hen eggs without substantially reducing the preformed vitamin A content [79].

There is more documentation of the use of milk, particularly among nomadic groups. In Hyderabad, India, products used for the early supplementation of breast milk include cow milk, buffalo milk, and commercial milk preparations [54]. In this same region, buttermilk is one of the few foods prescribed for adults during diarrhoeal attacks. In Ethiopia, milk makes an important contribution to the intake of preformed vitamin A among children [53]. Both milk and boiled or fried eggs are consumed with more frequency by traditional hunter-gatherer groups in the Philippines than by their peasant counterparts [42].

Among nomadic groups, milk and its by-products have important dietary roles [46, 80]. Among nomads in Uganda, the milk from cows, goats, and sheep is consumed by the women and children who remain in permanent settlements [11]. Milk is made sour by the addition of urine to facilitate storage. The use of sour milk has been documented elsewhere, including Iraq [50]. Milk, yoghurt, and ghee are the only sources of vitamin A for the nomadic tribes in Iraq, and are mixed with bread or whole wheat [47]. Casimir [46] describes in detail the methods of utilizing milk observed among nomads in Afghanistan. Milk is not allowed to boil when heated prior to souring, and this is thought to preserve vitamins. Lactose-intolerant individuals consume fermented products like yoghurt. Among the Masai in Kenya, the traditional diet is cows' milk with maize meal, and milk is consumed fresh or in tea [80]. Milk and butter are principle weaning foods, introduced between 18 and 24 months of age. Yoghurt is also consumed in large quantities among the Masai.

Exclusion from the diet

Dietary restrictions relating to eggs are numerous, particulary for women of child-bearing age. In Tamil Nadu, there is a decrease in consumption of eggs during the third trimester of pregnancy as it is thought that they promote the growth of the foetus, thus creating a diffcult delivery [67]. A similar dietary restriction applies to milk in Hyderabad [54]. Among certain tribes in the Gambia, Uganda, and Tanzania, eggs are restricted for women and girls as they are thought to cause sterility, and among certain groups in Zambia and Zimbabwe, eggs are restricted for children up to seven years old for fear of inducing convulsions [11]. The Masai do not eat eggs under any circumstances, although this pattern has been changing recently among those who are becoming acculturated. Among the Tswana of Botswana, eggs from 13 species of wild birds are eaten by young males and occasionally by adult men, but are restricted for girls and women of child-bearing age [15].

In Iran, eggs are classified as "cold," so they are eaten less during warmer periods, sometimes being replaced by vegetable dishes [58]. A survey of hunter-gatherer societies [81] found restrictions on the consumption of eggs during pregnancy among the Walbiri (an Australian aboriginal society), during lactation among the Inuit, and at menarche among the Hare Indians. Among the Wamira in Papua New Guinea, eggs are restricted for those individuals who have the bird as their lineage totem [30]. Dettwyler and Fishman [27] observed dietary prescription for eggs in two villages in Mali, where eggs were considered good for the foetus and the pregnant woman; but in another village eggs were restricted during pregnancy because they were believed to cause a diffcult delivery. In this latter community, it was also believed that eggs are bad for children because they interfere with physical development. In Honduras, milk and eggs are restricted during gastrointestinal illness to "avoid contamination of the intestinal wound" [82].

With respect to milk intake, Simoons [83] offers three possible explanations as to why "non-milking" areas have emerged: lactose intolerance, a perception of milk as an unpleasant secretion, and a view that it is suitable only for feeding calves. In the Luapala Valley in Zambia, milk and other animal products are not available for consumption because of the presence of the tsetse fly [74]. However, in some regions of Zim-

135

babwe, goat milk is available but not consumed [11]. In some regions of Uganda, it is argued that milk should not be mixed with any other foods, either in a dish or in the stomach, so several hours must pass between the ingestion of milk and other foods. Among the Masai, whole milk is not given to infants because it is thought that fat in the milk forms lumps that can choke the child if it vomits [80].

Seasonal patterns

In the Gambia, milk and eggs are consumed only during the dry season [32]. Among nomadic tribes, milk products are fermented and stored to augment the diet during the dry season, when milk production decreases [46]. This has also been demonstrated among the Sandawe in Tanzania, where cattle struggle to survive during the dry season [12]. Among the Masai, milk availability has seasonal fluctuations according to rainfall and the number of cattle owned by the individual [80]. As permanent settlements are encouraged by the government, there is even more of a decrease in milk production during the dry season.

Economic considerations

The prices of milk, milk products, and eggs have been cited as limiting factors in dietary intake. Eggs and milk are sold instead of being consumed at the local level in the Gambia [32], in Hyderabad, India [54], and in Amazonas, Peru [64]. Among the Fula tribe in the Gambia, milk is often exchanged for grain and housing during the dry season [11].

Fish

Inclusion in the diet

Among the Miskito of Nicaragua, dietary preferences used to determine the intensity and frequency of fishing expeditions [84]. This ethnic group distinguishes high-quality animal flesh, which it terms "meat," from lower quality "flesh," which includes certain shellfish. "Meat" is used to fulfil kinship ties and obligations, and "flesh" is never served at important meals. The Tiruray hunter-gatherers in the Philippines eat numerous freshwater species of fish, whereas those shifting to a peasant lifestyle eat only purchased dried fish [42]. Among the Wamiri of Papua New Guinea, fish are the most stable source of preformed vitamin A [30]. Twenty species of freshwater fish, more than 50 species of saltwater fish, and numerous shellfish are included in the diet.

Methods of preparing fish vary among societies. Only boiled or roasted freshwater fish are consumed in the Luapala Valley in Zambia [74]. As fish are eviscerated prior to preparation in some societies, most, if not all, of the preformed vitamin A is removed. In south-eastern regions of Ghana, fish are prepared by similar methods [14].

In parts of Mali, some women believe that fish oil gives strength to the foetus [27]. Among Chinese in Hong Kong, fish liver oil is used to treat baldness and bronchitis and to prevent coughs and asthma [40].

Exclusion from the diet

Fish, being classified as an animal product, are proscribed for religous reasons among the Brahmin caste in Tamil Nadu, India, [65] and among Buddists in Hong Kong [40]. Likewise, fish are restricted at menarche in Tamil Nadu for non-vegetarian women. This has also been documented in Hyderabad, India [54].

Among the Nootka of western British Columbia, spring salmon, seal, bass, and whale are restricted during lactation and at menarche [81]. Among the Kisarwe in Tanzania, catfish are restricted for women and girls of child-bearing age, with other fish species restricted for this group among the Busoga and the Buganda of Uganda [11].

Although many restrictions relating to fish are reported from Java, including one which associates fish intake with worm infestation in infants, only 20% of mothers interviewed reported knowledge or use of dietary restrictions [28]. In contrast, Kahn [30] gives a detailed description of dietary beliefs that relate to fish species, with some consumed exclusively by the elders of the community, others only by men. These dietary restrictions determine the fishing techniques and scheduling, which is both a female and male activity.

Species-specific dietary restrictions have also been observed among the Miskito of Nicaragua, while other ethnic groups in the region consume fish species rejected by the Miskito [84]. Masai and Sambuni pastoralists in East Africa traditionally express a revulsion towards the consumption of fish.

Seasonal patterns

Among the Sandawe in Tanzania, freshwater fish are caught in April and May and then are eaten in dried form when the rivers dry up [12]. The Wamiri have an elaborate system of procuring fish in accordance with the seasons [30]. River fishing by the women of the community is only practised in the dry season, while shellfish are collected by women and children primarily during the rainy season. Ocean fishing, which is considered a male activity, is year-round.

Economic considerations

The species of fish currently caught by the Miskito of Nicaragua no longer reflect the dietary preferences of the society [84]. With developing commercial markets for different fish, the perception of what is valuable is determined by what can be sold. Likewise, in the Luapala province of Zambia, and among the Kigezi of Uganda, fishing is a successful industry, but not enough fish reach the local level for consumption [11]. Dettwyler and Fishman [27] also found that in parts of Mali fish are often sold for cash to buy other foods or non-food items.

Organ meat and other meat

Inclusion in the diet

The few reports that we encountered that describe the consumption of wild game make no mention of which, if any, organs are eaten. For example, wild game is caught, albeit erratically, in the Papua New Guinea highlands [43], among the Tswana of Botswana (with some fowl species valued only by the elders) [15], in Amazonas, Peru [64], and among the Ache in Paraguay [85]. The viscera, particularly the liver, of chickens and other animals are consumed by groups in Malaysia as a treatment for night blindness [68], among the Tabora of Tanzania [11], and the Tiruray in the Philippines [42].

A review of the foods eaten by groups in the circumpolar area makes numerous references to the popularity of these vitamin A–rich foods, where raw seal liver is prescribed for adults during illness [86]. However, many of the references cited are dated and do not reflect current economic and political pressures that are modifying the intake of traditional foods. The traditional dietary sources of preformed vitamin A in the Inuit diet are very high in vitamin A activity, leading at least one author to speculate that the form of hysteria known as "pibloktoq" is a manifestation of hypervitaminosis A [[illegible]. However, Doolan [88] argues that the current shift to marketed foods among northern native populations results in an inadequate intake of vitamin A.

In some regions of Mali, pregnant women buy and eat grilled chicken and fish in the market because affordable quantities are too small to distribute among the entire household [27]. Liver is eaten in very small quantities, and then only on market day. Children eat liver only with other foods.

Exclusion from the diet

Among the Kisarawe in Tanzania, the consumption of viscera by pregnant women is restricted [11], as is the consumption of wild game among the Yoruba in Nigeria [31]. Landy [87] did not encounter dietary proscriptions among the Inuit, although there is mention of the Copper Inuit's rejecting kidney, considering it food for dogs [86]. Among the Yoruba, chicken meat is proscribed for those diagnosed with sickle cell anaemia as it is believed that fowl bones intensify the aching associated with the disease [66].

Seasonal patterns

Among the Masai in Kenya, meat consumption is seasonal [80]. Two factors determining intake are the number of diseased or dead animals used for consumption and the timing of ceremonies. However, liver flukes, which are endemic in the region can make beef liver, at least, inedible.

Among the Baffin Inuit, consumption of ringed seal liver and other viscera is variable, both seasonally and from year to year [89].

Economic considerations

No discussion of economic value or constraints on the consumption of organ meat was found in the literature.

Summary

(1) The evidence strongly reinforces the significance of both intercultural and intracultural diversity with respect to dietary inclusions and exclusions. The same foods are subject to very different interpretations in different cultural settings. Thus, the selection and consumption of vitamin A–rich foods appears to be highly situation-specific, which points to the need for locally relevant data.

(2) Dietary prescriptions and proscriptions are structured in relation both to normal physiological status and to the prevention and management of illness.

(3) Seasonality in the utilization of vitamin A source foods appears to be significant in many, perhaps the majority, of geographical-cultural settings.

(4) Economic restraints may be significant not only in relation to the relatively more costly preformed vitamin A from animal food sources, but also with respect to provitamin A from plant sources. Specific foods may be prohibitively costly, or they may be avoided because of their association with poverty.

Programmes to increase the consumption of natural food sources of vitamin A and provitamin A

Several reviews of programmes designed to eradicate vitamin A deficiency are available [90–95], including summaries of the activities being implemented or proposed by major international agencies and non-governmental organizations.

While the long-term goal of bringing about sustained dietary change to improve vitamin A intake is proposed for most programmes, few such programmes have been implemented [96]. Programmes that have published evaluations have demonstrated varying levels of success. However, programme strategies and summaries are difficult to obtain, and the operational details rarely appear in publicly accessible literature. Therefore, the programmes described in this section should not be interpreted as an exhaustive list of all of those designed to increase the consumption of natural food sources of vitamin A and provitamin A. Instead, a selection of programmes is used to illustrate the problems encountered. In particular, the gardening and nutrition education approaches to improving dietary intake of provitamin A are stressed, as are alternative approaches that show promise in achieving the goal of sustained dietary change.

Promoting gardening activity

The promotion of community, school, and household gardens, and especially the cultivation of foods rich in provitamin A activity, is currently one of the more common strategies to promote dietary change. This strategy has been reviewed by Brownrigg [97]. It has been one component of current or proposed programmes supported by the ministries of health in Guatemala [98], Brazil [99], and Mali [27], and elsewhere. In most countries, programmes are collaborative with other ministries, international agencies, and local institutions [92]. In Bella Coola, British Columbia, Canada, a traditional plant food garden as a source of vitamin A and several other nutrients was successfully promoted [100]. In Guatemala, promotion of local foods rich in vitamin A activity has involved collaboration at the national and international levels, including the ministries of Health and Education, the United Nations Children's Fund (UNICEF), the International Eye Foundation, the US Agency for International Development (USAID), the Institute of Nutrition of Central America and Panama (INCAP), the National Committee for the Blind and Deaf, and the University of San Carlos, among others [98]. Before regional planning and implementation of the garden projects were undertaken, nutrition and anthropological surveys were conducted at the household and community levels to identify local food sources, food habits relating to provitamin A-rich foods, and marketing behaviours [101].

The collection of preliminary data on dietary intake and attitudes towards health, food, and vitamin A deficiency has been given more importance by certain agencies, and this may help to reverse an otherwise poor record of success among gardening projects [97]. The International Vitamin A Consultative Group (IVACG), for example, has published a simplified approach to the assessment of dietary intake of provitamin A and preformed vitamin A to identify high-risk groups or regions, to identify culturally acceptable foods, and to evaluate programmes designed to increase the intake of foods rich in vitamin A activity [102].

A recent evaluation of food beliefs, food habits, and attitudes towards health in Macina, Mali, confirmed the value of multidisciplinary collaboration in projects designed to eradicate vitamin A deficiency [27]. The evaluation demonstrated that villages in which CARE had gardening and nutrition education projects had a greater comprehension of and receptivity to the concept of preventing vitamin A deficiency by using provitamin A and preformed vitamin A-rich foods. Recommendations were presented for nutrition education, including specific dietary behaviour targeted for change and recommendations for mass media strategies. For example, older women had more time available for gardening, so it was recommended that programmes promoting this activity be directed towards this group.

Factors limiting the success of the gardening approach to increasing the intake of provitamin A include limited access to water, attack by pests, consumption of plants by domestic animals, limited availability of seeds and gardening equipment, and the promotion of inappropriate food items [27, 92, 95]. Shrimpton [99] argues that, in Brazil, the promotion of introduced vegetables that are lower in provitamin A activity than local species has diverted resources, including seeds, fertilizer, and water, from the indigenous foods. With projected increases in the percentage of functionally landless people and those living in poverty, access to land for gardening will also become increasingly difficult [92].

Nutrition education

Nutrition education is often incorporated into gardening projects and is provided at health centres in conjunction with the distribution of vitamin A supplements. In some regions, when a woman becomes pregnant, her previous child who has been being breast-fed is abruptly weaned to a diet devoid of vitamin A [103]. Indonesian mothers may not give their children green leafy vegetables for numerous reasons, including a lack of knowledge of cooking methods. Cases such as these suggest that nutrition education is necessary for the promotion of foods rich in provitamin A.

Using data on maternal attitudes on infant feeding, a rapid education workshop was used in rural Egypt to demonstrate methods of meal selection and preparation (W. Mousa, personal communication). This was a general education project that included some vitamin A-rich foods. While the CARE programme in Mali, previously mentioned, has been favourably evaluated, it was found that a number of constraints, including money, time, and market availability of promoted foods, limited the capacity of women to incorporate their knowledge into meal preparation to increase the use of vitamin A-rich foods [27]. At a nutrition rehabilitation centre in south India, mothers could recite the recommended diet to increase vitamin A intake at the centre during nutrition education sessions; however, few actually incorporated the dietary guidelines into family meal preparation [104].

In contrast, reports from a five-year programme to improve vitamin A status implemented by the Tanzania Food and Nutrition Centre stated that nutrition education through the media was successful [57]. However, funding was limited and active promotion at the community and household levels was not attempted [105]. Local nutrient analyses of indigenous leafy green vegetables, palm oil, and commercial baby formula were incorporated into the programme. Analyses of freshwater fish revealed no traces of contamination with pesticides and heavy metals, and the fish were found to have high levels of preformed vitamin A [106]. Future goals of the programme include expansion of the data base on nutrient values for locally analysed food items, and the introduction of improved techniques for the extraction of red palm oil. These were incorporated into programmes to increase the production and consumption of red palm oil and green leafy vegetables [105].

The promotion of a wide variety of indigenous foods resulted in increased intake of these foods, many of which are rich in preformed vitamin A and provitamin A, and improved serum retinol levels among Canadian Nuxalk women, men, and teenaged girls and boys [100, 107].

Social marketing

Current trends in nutrition communication include the use of social marketing. Social marketing techniques are used to influence the acceptability of social action and to create programmes that elicit desired behaviours [108]. Behavioural changes perceived by the community as beneficial are the target for this approach [109]. Social marketing requires the active involvement of community members and a mixture of communication strategies.

Programmes using social marketing techniques to promote vitamin A intake are being conducted by Helen Keller International in Bangladesh, Indonesia, and the Philippines. The programme in Bangladesh was preceded by an evaluation of factors creating hypovitaminosis A in the region, and the results challenged many of the assumptions found in earlier literature [7, 110]. In an informative review of causality, Rizvi [7] argues that Bangladesh does not have abundant sources of provitamin A, because fruits such as papayas and mangoes are too prohibitive in price and availability for most families. The situation is further hampered by the belief that infants cannot digest greens. It is argued that successful promotion of provitamin A sources should focus on alternative food items that are affordable for poorer sectors of the population, are widely available, and are not prohibited by dietary proscription. Underwood [95] suggested that social marketing techniques that attempt to improve the prestige of local provitamin A sources may be more effective in creating dietary change than promoting horticultural activities.

In the Indonesian project, the use of social marketing techniques through inter-personal and mass-media interaction has had mixed success to date [8]. Although success in reaching the target population through posters, radio, and health personnel was demonstrated, there was poor recall of the messages promoting the consumption of provitamin A–rich foods. However, a preliminary report indicates that consumption of greens has increased among pregnant women and children. This has also been documented in a project in the Philippines, which included a component to increase the use of oil when preparing greens [5].

Social marketing using a decentralized approach has also demonstrated success in promoting the production and intake of the vitamin A–rich ivy gourd grown in household gardens [108]. Most problems encountered within the three-year programme were resolved through cooperation at all levels. When individuals involved in the local programme requested auxiliary information on pest control, fertilizers, and construction of trellises, an expanded education component evolved from the coordination between the agricultural and health sectors of the programme. When agricultural advisers failed to control pests, a local treatment using extracts of leaves was added to the commercial solution and eradicated the infestation. All these auxiliary efforts substantially enhanced the programme's success.

Summary

(1) The few programmes promoting dietary change that have been implemented and evaluated to date indicate that the potential for applying community-based research to the vitamin A deficiency problem is substantial.

(2) Preliminary collection of locally relevant data on dietary intake and attitudes towards health, food, and vitamin A deficiency appears to improve the success of gardening and nutrition education programmes.

(3) Social marketing is a recently introduced concept in nutrition communication that has the potential to create programmes for increasing the intake of natural foods rich in vitamin A activity that are appropriate to the local context.

References

1. Booth SL, Johns T, Kuhnlein HV. Natural food sources of vitamin A and provitamin A. Food Nutr Bull 1992;14(1):6-19.
2. de Garine I. Food and traditional medicine among the Yassa of southern Cameroon. In: Hladik CM, Bahuchet S, de Garine I, eds. Food and nutrition in the African rain forest. Paris: Unesco/MAB, 1990.
3. Campbell BM. The use of wild fruits in Zimbabwe. Econ Botany 1987;41(3):375-85.
4. Folch-Sierra M. Communicating food images: women's consumption patterns and attitudes in a Mexican village. MSc thesis. Montreal, Que, Canada: McGill University, 1986.
5. David FP. An evaluation of the effectiveness of the social marketing program for the prevention and control of vitamin A deficiency in region VI (Western Visayas). A final report submitted to the Department of Health, Region VI, Iloilo City. Iloilo City, Philippines: Social Science Research Institute, 1990.
6. Dettwyler KA. Styles of infant feeding: parental/caretaker control of food consumption in young children. Am Anthropol 1989;91:696-703.
7. Rizvi N. Food beliefs, food use and vitamin A deficiency in children of rural Tangail, Bangladesh. Dhaka, Bangladesh: Helen Keller International, 1988.
8. Sethi A. Social marketing of vitamin A: evaluation of project to promote consumption of vitamin A rich foods & supplements in Western Sumatra—a preliminary report. Jakarta, Indonesia: Helen Keller International, 1989.
9. Perisse J, Polacchi W. Geographical distribution and recent changes in world supply of vitamin A. Food Nutr 1980;6(1):21-27.
10. Fleuret A. The role of wild foliage plants in the diet: a case study from Lushoto, Tanzania. Ecol Food Nutr 1979;8:87-93.
11. May JM, McLellan DL. The ecology of malnutrition in eastern Africa and four countries of West Africa. Vol. 9 of: Studies in medical geography. New York: Hafner, 1970.
12. Newman JL. Dimensions of Sandawe diet. In: Robson JRK, ed. Food, ecology and culture. New York: Gordon and Breach Science Publishers, 1980:27-33.
13. Malaisse F, Parent G. Edible wild vegetable products in the Zambezian woodland area: a nutritional and ecological approach. Ecol Food Nutr 1985;18:43-82.
14. Dei GJS. The dietary habits of a Ghanaian farming community. Ecol Food Nutr 1991;25:29-49.
15. Grivetti LE. Kalahari agro-pastoral-hunter-gatherers: the Tswana example. Ecol Food Nutr 1979;7:235-56.
16. Pagezy H. Coping with uncertainty in food supply among the Oto and the Twa living in the equatorial flooded forest near Lake Tumba, Zaire. In: de Garine I, Harrison GA, eds. Coping with uncertainty in food supply. Oxford, UK: Clarendon Press, 1988:175-209.
17. Zinyama LM, Matiza T, Cambell DJ. The use of wild foods during periods of food shortage in rural Zimbabwe. Ecol Food Nutr 1990;24:251-65.
18. Johns T, Kokwaro JO. Food plants of the Luo of Siaya District, Kenya. Econ Botany 1991;45:103-13.
19. Laderman C. Wives and midwives: childbirth and nutrition in rural Malaysia. Berkeley, Calif, USA: University of California Press, 1983.
20. Wolff RJ. Meanings of food. Trop Geogr Med 1965;1:45-51.
21. Gopaldas T, Gupta A, Saxena K. The phenomenon of Sanskritization in a forest-dwelling tribe of Gurarat, India: nutrient intake and practices in the special groups. Ecol Food Nutr 1983;13:1-8.
22. Pereira SM, Begum A. Vitamin A deficiency in Indian children. World Rev Nutr Diet 1976;24:192-216.
23. Cerqueira MT, McMurry Fry M, Connor WE. The food and nutrient intakes of the Tarahumara Indians of Mexico. Am J Clin Nutr 1979;32:905-15.
24. Messer E. Patterns of "wild" plant consumption in Oaxaca, Mexico. Ecol Food Nutr 1972;1:325-32.
25. Altieri MA, Trujillo J. The agroecology of corn production in Tlaxcala, Mexico. Humn Ecol 1987;15:189-220.
26. Kuhnlein HV, Turner NJ. Traditional plant foods of Canadian indigenous peoples: nutrition, botany and use. Philadelphia, Pa, USA: Gordon and Breach Publishers (in press).
27. Dettwyler KA, Fishman C. Field research in Macina for vitamin A communications: March 5–22, 1990. Washington, DC: Academy for Educational Development, 1990.
28. Hull VJ. Dietary taboos in Java: myths, mysteries, and methodology. In: Manderson L, ed. Shared wealth and symbol: food, culture, and society in Oceania and Southeast Asia. Cambridge, UK: Cambridge University Press, 1986:237-58.
29. Freedman MR, Grivetti LE. Diet patterns of first, second and third generation Greek-American women. Ecol Food Nutr 1984;14:185-204.
30. Kahn M. Always hungry, never greedy. Cambridge, UK: Cambridge University Press, 1986.
31. Ebomoyi E. Nutritional beliefs among rural Nigerian mothers. Ecol Food Nutr 1988;22:43-52.
32. Villard L, Bates CJ. Dietary intake of vitamin A precursors by rural Gambian pregnant and lactating women. Humn Nutr Appl Nutr 1987;41A:135-45.
33. Kuhnlein HV, Calloway DH. Contemporary Hopi food intake patterns. Ecol Food Nutr 1977;6:159-73.
34. Rao HD, Balasubramanian SC. Socio-cultural aspects of infant feeding practices in a Telengana village. Trop Geogr Med 1966;18:353-60.
35. Schonfeld-Leber B. Marine algae as human food in Hawaii, with notes on other Polynesian islands. Ecol Food Nutr 1979;8:47-59.
36. Etkin NL. Multidisciplinary perspectives in the interpretation of plants used in indigenous medicine and diet. In: Etkin NL, ed. Plants in indigenous medicine and diet. Bedford Hills, NY, USA: Redgrave, 1986:2-29.
37. Molony CH. Systematic valence coding of Mexican "hot"–"cold" food. Ecol Food Nutr 1975;4:67-74.
38. Snow LF, Johnson SM. Folklore, food, female reproductive cycle. Ecol Food Nutr 1978;7:41–49.
39. Cosminsky S. Changing food and medical beliefs and

140

practices in a Guatemalan community. Ecol Food Nutr 1975;4:183-91.

40. Koo LC. The use of food to treat and prevent disease in Chinese culture. Soc Sci Med 1984;18:757-66.
41. Manderson L. Traditional food classifications and humoral medical theory in Peninsular Malaysia. Ecol Food Nutr 1981;11:81-93.
42. Schlegel SA, Guthrie HA. Diet and the Tiruray shift from swidden to plow farming. In: Robson JRK, ed. Food, ecology and culture. New York: Gordon and Breach Science Publishers, 1980:9-19.
43. Bailey KY, Whiteman J. Dietary studies in the Chimbu (New Guinea highlands). Trop Geog Med 1963;13:377-88.
44. Mazess RB, Baker PT. Diet of Quechua Indians living at high altitude: Nunoa, Peru. Am J Clin Nutr 1964;15:341-51.
45. Alcorn JB. Haustec noncrop resource management: implications for prehistoric rain forest management. Hum.. Ecol 1981;9:395-417.
46. Casimir MJ. Nutrition and socio-economic strategies in mobile pastoral societies in the Middle East with special reference to West Afghan Pashtuns. In: de Garine I, Harrison GA, eds. Coping with uncertainty in food supply. Oxford, UK: Clarendon Press, 1988:337-59.
47. Al-Ani MR. Diet and dietary habits of nomads in Iraq. Ecol Food Nutr 1980;9:55-58.
48. Felger RS, Moser MB. Seri Indian food plants: desert subsistence without agriculture. Ecol Food Nutr 1976;5:13-27.
49. Bates C. Vitamin A in pregnancy and lactation. Proc Nutr Sci 1983;42:65-79.
50. Shakir A, Demarchi M. Dietary pattern of rural school children in the environment of Baghdad. Trop Geogr Med 1971;23:258-63.
51. Ziegler RG, Wilcox HB, Mason TJ, Bill JS, Virgo PW. Seasonal variation in intake of carotenoids and vegetables and fruits among white men in New Jersey. Am J Clin Nutr 1987;45:107-14.
52. Dei GJS. Hunting and gathering in a Ghanaian rain forest community. Ecol Food Nutr 1989;22:225-43.
53. DeSole G, Belay Y, Zegeye B. Vitamin A deficiency in southern Ethiopia. Am J Clin Nutr 1987;45:780-84.
54. Jyothi KK, Dhakakshayani R, Swaminathan MC, Venkatachalam PS. A study of the socio-economic, diet and nutritional status of a rural community near Hyderabad. Trop Geogr Med 1963;15:403-10.
55. Ogle BM, Grivetti LE. Legacy of the chameleon: edible wild plants in the kingdom of Swaziland, southern Africa—a cultural, ecological, nutritional study. Part III. Cultural and ecological analysis. Ecol Food Nutr 1985;17:31-40.
56. Wilken GC. The ecology of gathering in a Mexican farming region. Econ Botany 1969;24:286-95.
57. Kavishe FP. Malnutrition in Tanzania: a situational analysis in 1990. Dar Es Salaam, Tanzania: Tanzania Food and Nutrition Centre, 1990.
58. Rahmanifar A, Bond JT. Food consumption, iron intake and dietary patterns of urban pregnant women from different socioeconomic populations in central Iran. Ecol Food Nutr 1990;24:97-114.
59. Tarwotjo I, Sommer A, Soegiharto T, Susanto D, Muhilal. Dietary practices and xerophthalmia among Indonesian children. Am J Clin Nutr 1982;35:574-81.
60. Wilson CS. Nutritionally beneficial cultural practices. World Rev Nutr Diet 1985;45:68-96.
61. Fleuret A. Dietary and therapeutic uses of fruit in three Taita communities. In: Etkin NL, ed. Plants in indigenous medicine and diet: biobehavioural approaches. Bedford Hills, NY, USA: Redgrave, 1986:151-70.
62. Hart TB, Hart JA. The ecological basis of hunter-gatherer subsistence in African rain forests: the Mbuti of eastern Zaire. Humn Ecol 1986;14(1):29-55.
63. Ogle BM, Grivetti LE. Legacy of the chameleon: edible wild plants in the kingdom of Swaziland, southern Africa—a cultural, ecological, nutritional study. Part II. Demographics, species availability and dietary use: analysis by ecological zone. Ecol Food Nutr 1985;17:1-30.
64. Berlin EA, Markell EK. An assessment of the nutritional and health status of an Agaruna Jivaro community, Amazonas, Peru. Ecol Food Nutr 1977;6:69-81.
65. Ferro-Luzzi GE. Food avoidances at puberty and menstruation in Tamilnadu. Ecol Food Nutr 1973;2:165-72.
66. Odebiyi AI. Food proscriptions in traditional medicine. J Roy Soc Health 1987;1:34-35.
67. Ferro-Luzzi GE. Food avoidances of pregnant women in Tamilnadu. Ecol Food Nutr 1973;2:259-66.
68. McKay DA. Food, illness, and folk medicine: insights from Ulu Trengganu, West Malaysia. Ecol Food Nutr 1971;1:67-72.
69. Batista M, Mayer-Varela R, Gomes-Texeira S, Simmons WK. A study in the use of oral massive doses of vitamin A. Ecol Food Nutr 1974;3:293-98.
70. Block G, Dresser CM, Hartman AM, Carroll MD. Nutrient sources in the American diet: quantitative data from the NHANES II survey. Am J Epidem 1985;122(1):13-26.
71. Whiteman J. A study of beliefs and attitudes towards food in a New Guinea low-cost housing settlement. Trop Geogr Med 1966;18:157-66.
72. FAO. Traditional food plants: a resource book for promoting the exploitation and consumption of food plants in arid, semi-arid and sub-humid lands of eastern Africa. FAO Food and Nutrition Paper no. 42. Rome: Food and Agriculture Organization, 1988.
73. Sommer A. Nutritional blindness: xerophthalmia and keratomalacia. New York: Oxford University Press, 1982.
74. Awdry PN, Cobb B, Adams PCG. Blindness in the Luapula Valley. Cent Afr J Med 1967;13(9):197-201.
75. Oomen JMV. Xerophthalmia in northern Nigeria. Trop Geogr Med 1971;23:246-49.
76. Dick HM, Goodall HB, Walsh DB. Vitamin A and measles in third world children. Br Med J 1991;302:39.
77. Mejia LA. Vitamin A-nutrient interrelationships. In Bauerfeind JC, ed. Vitamin A deficiency and its control. Orlando, Fla, USA: Academic Press, 1986:69-100.
78. Abrams HL Jr. The preference for animal protein and fat: a cross-cultural study. In: Harris M, Ross EB, eds. Food and evolution. Philadelphia, Pa, USA: Temple University Press, 1987:207-23.

79. Hou HC. Egg preservation in China. Food Nutr Bull 1981;3(2):17-20.
80. Nestel PS. Food intake and growth in the Maasai. Ecol Food Nutr 1989;23:17-30.
81. Spielmann KA. A review: dietary restrictions on hunter-gatherer women and the implications for fertility and infant mortality. Humn Ecol 1989;17(3):321-45.
82. Kendall C, Foote D, Martorell R. Anthropology, communications, and health: the mass media and health practices program in Honduras. Humn Org 1983; 42:353-60.
83. Simoons FJ. The determinants of dairying and milk use in the Old World: ecological, physiological and cultural. Ecol Food Nutr 1973;2:83-90.
84. Neitschmann B. Hunting and fishing focus among the Miskito Indians, eastern Nicaragua. Humn Ecol 1972;1(1):41-67.
85. Hill K, Hawkes K, Hurtado M, Kaplan H. Seasonal variance in the diet of Ache hunter-gatherers in eastern Paraguay. Humn Ecol 1984;12:101-35.
86. Eidlitz K. Food and emergency food in the circumpolar area. Stud Ethnog Upsaliensia XXXII, 1969.
87. Landy D. Pibloktoq (hysteria) and Inuit nutrition: possible implication of hypervitaminosis A. Soc Sci Med 1985;21(2):173-85.
88. Doolan N. Selected nutrients and PCBs in the food system of the Sahtu (Hareskin) Dene/Metis. MSc thesis. Montreal, Que, Canada: McGill University, 1991.
89. Kuhnlein HV, Soueida R. Use and nutrient composition of traditional Baffin Inuit foods. J Food Comp Anal (in press).
90. McKigney JI. Interventions for the prevention of vitamin A deficiency: a summary of experiences. In: Underwood BA, ed. Nutrition intervention strategies in national development. New York: Academic Press, 1983:363-84.
91. Chicester CO. Organizations involved in the eradication of vitamin A deficiency. In: Bauerfeind JC, ed. Vitamin A deficiency and its control. Orlando, Fla, USA: Academic Press, 1986:445-60.
92. Darnton-Hill I. Vitamin A deficiency in Bangladesh. Health Pol Plan 1988;3(3):205-13.
93. Gervais S. Guidelines for IDRC's support to micronutrient deficiency research projects: draft document. Ottawa, Canada: IDRC, 1990.
94. Underwood BA. Underpinning vitamin-A deficiency prevention and control programmes. Food Nutr Bull 1989;11(3):41-42.
95. Underwood BA. Vitamin A prophylaxis programs in developing countries: past experiences and future prospects. Nutr Rev 1990;48(7):265-74.
96. Gopalan C. Combating vitamin A deficiency: need for a revised strategy. In: Gopalan C, ed. Recent trends in nutrition. New Delhi: Oxford University Press (in press).
97. Brownrigg L. Home gardening in international development: what the literature shows. Washington, DC: League for International Food Education, 1985.
98. Bulux J, Moran O, Hernandez AA, Cifuentes D, Lopez CY, Sanchez ME. Guatemala. In: Vitamin A Field Support Project, ed. Taller regional sobre estrategias para mejorar el estado de vitamina A en América Latina y el Caribe. Guatemala, 5-7 June 1990. Report no. TA-3. Arlington, Va, USA: Vitamin A Field Support Project (VITAL), 1990:57-62.
99. Shrimpton R. Vitamin A deficiency in Brazil: perspectives for food production oriented interventions. Ecol Food Nutr 1989;23:261-71.
100. Kuhnlein HV, Moody SA. Evaluation of the Nuxalk food and nutrition program: traditional food used by a native group in Canada. Soc Nutr Educ 1989; 21(3):127-32.
101. Blanks JB, Barrows JM. A proposal for convalescent refeeding and horticultural interventions to improve vitamin A intake in the provinces of Alta Verapaz and Santa Rosa of Guatemala. Vitamin A for Child Survival Project. Country section: Guatemala. Bethesda, Md, USA: International Eye Foundation, 1990.
102. IVACG. Guidelines for the development of a simplified dietary assessment to identify groups at risk for inadequate intake of vitamin A. Washington, DC: International Life Sciences Institute, 1989.
103. McLaren DS. Global occurrence of vitamin A deficiency. In: Bauerfeind JC, ed. Vitamin A deficiency and its control. Orlando, Fla, USA: Academic Press, 1986: 1-18.
104. Venkataswamy G, Cobby M, Pirie A. Rehabilitation of xerophthalmic children. Trop Geogr Med 1979; 31:149-54.
105. Kisanga P. Internal evaluation of the five years 1985–1990. Programme on the Prevention of Vitamin A Deficiency and Xerophthalmia in Tanzania, Monitoring and Evaluation Component. Dar es Salaam: Tanzania Food and Nutrition Centre, 1990.
106. Pepping F, Vencken CMJ, West CE. Retinol and carotene content of foods consumed in East Africa determined by high performance liquid chromatography. J Sci Food Agri 1988;45:359-71.
107. Kuhnlein HV. Final report. Nuxalk Food and Nutrition Program, Health Promotion Control Program. Ottawa: Health and Welfare Canada, 1987.
108. Smitasiri S, Attig GA, Dhanamitta S. Participatory action for nutrition education: social marketing of vitamin A-rich foods in Thailand. Ecol Food Nutr (in press).
109. Young RH. Effective nutrition communication for behaviour change. Report on International Nutrition Planners Forum, Sixth International Conference. Paris, 4-6 Sept 1991. Paris: Unesco, 1991.
110. Pollard R. Social marketing of vitamin A: preparing the communications strategy. Consultant Trip Report no. 2. Dhaka, Bangladesh: Helen Keller International, 1989.

142

Carotenoid content of fruits and vegetables: An evaluation of analytic data

ANN REED MANGELS, PhD, RD; JOANNE M. HOLDEN, MS;
GARY R. BEECHER, PhD; MICHELE R. FORMAN, PhD;
ELAINE LANZA, PhD

ABSTRACT: The test of the association between dietary intake of specific carotenoids and disease incidence requires the availability of accurate and current food composition data for individual carotenoids. To generate a carotenoid database, an artificial intelligence system was developed to evaluate data for carotenoid content of food in five general categories, namely, number of samples, analytic method, sample handling, sampling plan, and analytic quality control. Within these categories, criteria have been created to rate analytic data for β-carotene, α-carotene, lutein, lycopene, and β-cryptoxanthin in fruits and vegetables. These carotenoids are also found in human blood. Following the evaluation of data, acceptable values for each carotenoid in the foods were combined to generate a database of 120 foods. The database includes the food description; median, minimum, and maximum values for the specific carotenoids in each food; the number of acceptable values and their references; and a confidence code, which is an indicator of the reliability of a specific carotenoid value for a food. The carotenoid database can be used to estimate the intake of specific carotenoids in order to examine the association between dietary carotenoids and disease incidence. *J Am Diet Assoc. 1993; 93:284-296.*

J. M. Holden (corresponding author), A. R. Mangels, and G. R. Beecher are with the Beltsville Human Nutrition Research Center, US Department of Agriculture, Beltsville, MD 20705. M. R. Forman and E. Lanza are with the Division of Cancer Prevention and Control, National Cancer Institute, National Institutes of Health, Bethesda, MD 20892.

In numerous epidemiologic studies, an increased intake of fruits and vegetables is associated with a reduced risk of lung and other epithelial cancers (1-10). The odds ratios of lung cancer are higher among subjects with lower (vs higher) intakes of carrots, tomatoes, and dark-green vegetables, which are foods rich in specific carotenoids (4,5,11). Thus, consumption patterns of foods rich in carotenoids, such as lycopene, lutein, and β-carotene, need to be examined with a food composition database of specific carotenoid values. Food composition tables in current use provide data on total vitamin-A activity (eg, reference 12) or total carotenoid content (eg, reference 13) of foods. In the past, carotenoids were viewed primarily as vitamin-A precursors so analytic efforts centered on carotenoids with provitamin-A activity (14).

In addition to lacking data for individual carotenoids, most food composition tables contain carotenoid data generated by procedures similar to the official methods of the Association of Official Analytical Chemists (AOAC). These procedures, as described by Beecher and Khachik (15), quantify total carotenoid rather than individual carotenoids and tend to overestimate total carotenoid content and, subsequently, vitamin-A activity of plant foods (16). Although a few food tables express carotenoid data on a weight basis (micrograms per 100 g), most present carotenoid content of fruits and vegetables as international units, retinol equivalents, or β-carotene equivalents (15). The recent use of high-performance liquid chromatography (HPLC) for the separation and quantification of carotenoids has resulted in an increase in data quantifying the amount of individual carotenoids in foods. The quality of data varies by type and execution of the analytic method, by sample selection and handling, by the number of samples analyzed, and by the presence or absence of quality control procedures.

Fruits and vegetables are rich in carotenoids and are the most important contributors of carotenoids in the typical human diet (17). Multicomponent foods that contain notable amounts of vegetables or fruits may also be good sources of carotenoids; however, few reports of the carotenoid content of mixed dishes are available for foods commonly consumed in the United States. Limited data for dairy products, eggs, fats, and cereals indicate that these foods contain modest levels of carotenoids (17). Meats and fish contain low levels of carotenoids (18,19).

In this article, we describe the development of a carotenoid food composition database that contains values for the five most commonly occurring carotenoids in fruits and vegetables. These carotenoids are also among those found in human plasma. An artificial intelligence system was used to rate existing information on the carotenoid content of foods. The purpose of this article is to describe the components of the evaluation system, to document the carotenoid values of specific foods along with a range of acceptable values, and to indicate the extent to which the data are considered reliable.

143

Categories →	3	2	1	0
Analytic method	Published documentation with validation for foods analyzed, including use of appropriate reference material; with results within acceptable range or 95% to 100% recoveries on similar food and use of other method or laboratory on same sample with agreement within 10%; exemplary processing and saponification of sample and identification and quantification of carotenoid.	Some documentation; incomplete validation studies; including 90% to 110% recoveries on similar foods or use of other method or laboratory on same sample with agreement within 10%; adequate processing and saponification of sample and identification and quantification of carotenoid.	Some documentation; minimal validation; including <8% CV for repeatability or 8% to 20% CV for repeatability along with 80% to 120% recoveries on similar food to sample or use of other method or laboratory on related food with agreement within 10%; minimally acceptable processing and saponification of sample and identification and quantification of carotenoid.	No documentation of method, no reference or inaccessible reference given; nonchromatographic method used; no validation studies or failure to achieve acceptable results with reference material, repeatability (≥20% CV), recovery (<80% or >120%), or comparison method or laboratory; inadequate processing or saponification of sample or identification or quantification of carotenoid.
Analytic quality control	Optimum accuracy and precision of method monitored and indicated explicitly by data.	Documentation of assessment of both accuracy and precision of method; acceptable accuracy and precision	Some description of minimally acceptable accuracy and/or precision.	No documentation of accuracy or precision; unacceptable accuracy and/or precision.
No. of samples	>10; SD, SE, or raw data reported	3 to 10	1 or 2; explicitly stated or not specified	
Sample handling	Complete documentation of procedures, including analysis of edible portion only, validation of homogenization method, details of food preparation, and monitoring of storage and moisture changes.	Pertinent procedures documented, including analysis of edible portion only; procedures seem reasonable but some details not reported.	Limited description of procedures, including evidence of analysis of edible portion only.	Totally inappropriate procedures or no documentation of criteria pertinent to food analyzed.
Sampling plan	Multiple geographic sampling with description of and statistical basis for sampling and sample representative of brands/varieties consumed or commercially used.	At least two geographic regions sampled; sample is representative.	One geographic area sampled; sample is representative of what some eat.	Not described or sample is not representative.

FIG 1. Summary of data-quality criteria. Key: SD = standard deviation; SE = standard error; CV = coefficient of variation.

METHODS

A system was developed for the evaluation of analytic data for levels of five carotenoids in foods: β-carotene, α-carotene, lutein + zeaxanthin, lycopene, and β-cryptoxanthin. This system was based on those previously described for the evaluation of selenium and copper data (20-22), but was modified to accommodate carotenoid data evaluation. Objective evaluation was aided by use of an artificial intelligence system that incorporated standardized questions and decision pathways (23).

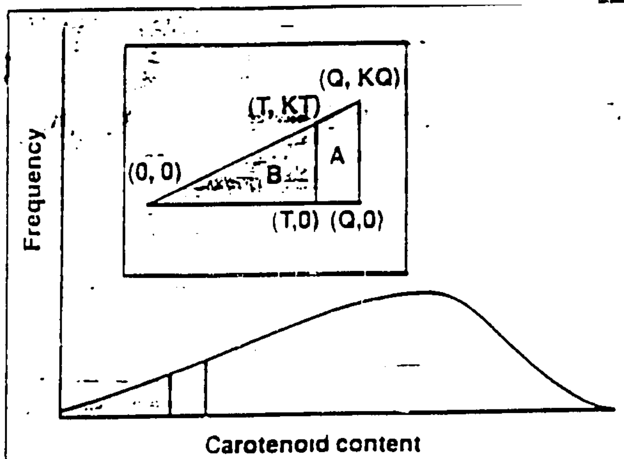
Development of the Evaluation System

Data were evaluated in five general categories: analytic method, analytic quality control, number of samples, sample handling, and sampling plan. These categories represent the major determinants of data quality and inclusion in the database.

Specific criteria were developed for each category; ratings for each ranged from 0 (unacceptable) to 3 (highly acceptable) (Figure 1). Criteria for both analytic method and analytic quality control were developed to address the acceptability of methodology for carotenoid analysis and were based on extensive discussion with experts in carotenoid determination. Within analytic method, we evaluated the steps involved in sample processing; carotenoid separation, identification, and quantification; and validation of the chosen method. Analytic quality control rated both day-to-day accuracy and precision of carotenoid determination. Criteria for number of samples and sample handling were the same as those used for evaluation of selenium (21) and copper (22). Sampling-plan criteria were modified from those used for selenium and copper, based on knowledge of appropriate sampling strategies for food, to incorporate the international nature of the carotenoid database. After the criteria were established, decision trees were developed for each category to simulate the human decision-making process that takes place in data-quality evaluation. (Further details related to data-quality criteria and decision trees can be requested from the authors.)

The category-specific criteria and decision trees were incorporated into artificial intelligence software. The user-friendly system queried for specific information in each category. Questions probed for specific details of steps such as sample processing, saponification, carotenoid identification and quantification, and validation of the analytic method to determine the most appropriate rating. Most questions required a yes or

144



The distribution of possible analytic values for a given component can assume several shapes (eg, normal, skewed). The curve represents the frequency distribution of values for the component of interest. Therefore, the area under the curve is related to the frequency of occurrence of individual values. The quantitation limit (Q) bisects the curve of the distribution.

To quantify trace, it was necessary to determine the point on the x-axis at which the area under the curve from 0 to that point is half the area under the curve from 0 to the quantitation limit. Thus, half the values in this region lie below this point (T).

Although the curve is not linear, it can be approximated, below the quantitation limit, by the hypotenuse of a right triangle (A). The vertical line through the quantitation limit (Q) is the height of the triangle while the base is the distance from 0 to Q on the x-axis. The area of right triangle A is $1/2KQ^2$ when the equation of the line representing the hypotenuse is $y = Kx$ and $x = Q$ = quantitation limit.

To determine a value for point T, or trace, we chose a second triangle (B) so that the area of B was half the area of A. Thus, the area of $B = 1/2(1/2KQ^2) = 1/2KT^2$. Simplifying, $T = 1/(2^{1/2})Q$. Trace can be approximated by 0.71 times the quantitation limit.

FIG 2. Quantitation of "trace" level of a carotenoid.

no response; a few were multiple choice or required a numeric response. Responses were based on information from published or selected internal reports containing carotenoid values for foods. Decision paths were dependent on the user's response so that only pertinent questions were asked. Decisions and scoring limiters were invisible to the user, thus eliminating much of the subjectivity associated with manual evaluation.

Data Compilation

Only those studies that used a chromatographic procedure were evaluated. We reviewed more than 180 articles published from 1971 to 1991, including articles on methodology and composition. When published information was limited, especially regarding method validation and analytic quality control, we contacted authors to obtain additional details. We reviewed 34 responses to 60 queries; 23 of these led to an improvement in the rating in one or more categories. However, there are no assurances that similar improvements would have resulted from the 26 remaining nonrespondents.

Several calculations were performed as needed on published data. Dry-weight values with accompanying moisture values were converted to wet weight and considered for inclusion in the database. Results that were expressed on a dry-weight basis without accompanying moisture values were excluded from the database. Values expressed as carotenal fatty-acid esters were converted to the amount of the individual carotenoid present using a ratio of the molecular weight of the carotenoid to the molecular weight of the carotenal fatty acid ester, multiplied by the amount of the carotenal fatty acid ester.

If a carotenoid was reported as not detected, a value of zero for that carotenoid was assumed. Preliminary assessment of collected data sources indicated that some authors reported a value of "trace." We collaborated with statisticians to quantify "trace" and used a technique adapted during our study. The trace value was estimated as the product of the quantitation limit of the analytic method and a factor, 0.71. The quantitation limit for a specific assay is the lowest point at which the method can quantify the amount of a component in the sample. In practice, the quantitation limit is some multiple of the analytic detection limit. Among analysts that multiple is determined by convention for the specific instrumentation used and component of interest. For HPLC, the quantitation limit is generally defined as 2.5 times the detection limit. If the detection limit (or quantitation limit) was not cited by authors in the same or another reference, we used the convention of 1 μg/100 g for the detection limit. This convention is based upon our review of stated detection limits from acceptable studies (24-27). Figure 2 illustrates the derivation of 0.71 as the multiplier for the quantitation limit.

The procedure used by a number of investigators did not permit separation of lutein and zeaxanthin so we decided to report lutein + zeaxanthin. In the few references where lutein and zeaxanthin were independently measured, their values were summed and reported as lutein + zeaxanthin. Because green vegetables, green fruits, pumpkin, winter squash, and carrots contain essentially no zeaxanthin (28), the values for lutein + zeaxanthin for these foods represent primarily lutein. Peaches and corn contain both lutein and zeaxanthin in varying ratios (24,29).

Data Evaluation

In the evaluation process, we rated each carotenoid value for a food in a specific reference by answering questions in each category posed by the artificial intelligence system. Table 1 provides an example of ratings assigned to various references for β-carotene in winter squash. Next, a Quality Index, an indicator of the overall data quality for a carotenoid value in a food from a single reference or study, was calculated. In general, the mean of the five ratings was designated the Quality Index, as shown in Table 1. When the rating for analytic method was zero or when any three ratings were zero, the Quality Index for that value was set to zero. A Quality Index of one or more indicated an acceptable value and was retained.

Initially, similar foods were grouped into preliminary aggregates. For example, as shown in Table 1, the aggregate titled "squash, winter, cooked, canned, frozen" includes microwaved fresh acorn squash, frozen cooked butternut squash, and unspecified canned winter squash. After all available data were evaluated, acceptable values were reviewed to assess the suitability of the preliminary aggregations. For similar forms of a single food, all acceptable data were grouped together under the general food description. If data were widely divergent and clearly stratified by distinct forms of the food, then the forms of that food were separated into two or more new aggregates. For example, pink and white grapefruit were initially aggre-

BEST AVAILABLE COPY

145

Table 1 [illegible]
Worksheet for β-carotene in winter squash (cooked, canned, frozen)

Description	Reference[a]	Data quality criteria ratings: No. of samples: Actual no.	No. of samples: Rating	Analytic method	Sample handling	Sampling plan	Quality control	Quality[b] Index	β-Carotene value
									μg/100g
Acorn, fresh, microwaved 8 min	o	3	2	2	1	1	1	1.4	490[c]
Frozen, commercial	p	4	2	1	1	1	1	1.2	2,670±6[d]
Butternut, cooked 20 or 40 min	q	4	2	1	1	1	1	1.2	4,570±12
Canned	r	2	1	1	1	1	1	1.0	923
Pressure cooked	s	2	1	1	1	1	1	1.0	2,800
Canned	t	3	2	1	1	0	0	0.8	1,250±180
Frozen, cooked	u	3	2	1	1	2	0	1.2	2,400±570
Frozen, cooked	v	3	2	1	1	2	0	1.2	1,400±600
Acorn, frozen	w	1	1	1	1	1	0	0.8	300
Butternut, frozen, cooked	x	2	1	1	1	2	0	1.0	850±350
Butternut, frozen, cooked	y	3	2	1	1	2	0	1.2	3,600±1,600
Frozen, cooked	z	2	1	0	1	1	1	0[e]	800

Summary: Quality Sum[f] = 10.4; confidence code[g] = A; median[h] = 2,400 μg/100 g; minimum-maximum[h] = 490 to 4,570 μg/100g

[a]Although the data, including ratings, are authentic, the references are coded.
[b]A Quality Index ≥1 is required for data to be considered acceptable.
[c]Mean.
[d]Mean ± standard deviation.
[e]Because of zero rating for analytic method, Quality Index is zero.
[f]The sum of the Quality Indexes for acceptable references; it serves as the basis of the confidence code.
[g]The confidence code is derived from the Quality Sum.
[h]The median, minimum and maximum are based on the acceptable means. In this case, acceptable values are from references o-s, u, v, x, y.

gated as "grapefruit, raw." Lycopene and β-carotene consistently appeared to be markedly higher in pink grapefruit; therefore, pink grapefruit and white grapefruit were listed separately.

However, if the acceptable data for a single food were highly variable but no logical pattern of variance could be identified, the data were retained under the single description. Frequently, both cooked and raw forms of a food were aggregated because insufficient data existed to support their separation. Although season, geographic location, harvest conditions, and many other factors can influence carotenoid levels, the amount of available data per food is insufficient at present to permit aggregation based on these factors. In general, the final aggregation of data was chosen on the basis of approximate similarity of food descriptions within the aggregate.

Table 2
Assignment and meaning of confidence codes

Sum of Quality Indexes	Confidence code	Meaning of confidence code
>6.0	A	The user can have considerable confidence in this value.
3.4 to 6.0	B	The user can have confidence in this value; however, some problems exist regarding the data on which the value is based.
1.0 to <3.4	C	The user can have less confidence in this value because of limited quantity and/or quality of data.

Development of Tables on Individual Carotenoids in Foods

For each aggregate, we calculated the median and mean for each carotenoid. After comparisons of the mean and median for individual aggregates, the median was selected as a measure of central tendency because of the skewed nature of some data. Use of the median tends to reduce the impact of a single observation (30). Some foods had divergent means and medians, which supported the rationale for reporting medians rather than means. For example, for the seven β-cryptoxanthin values for orange juice reported in acceptable studies (14.3, 14.9, 16.4, 23.7, 24.7, 460, and 488.7 μg/100 g), the grand mean is 150 μg/100 g whereas the median is 24 μg/100 g. For the four α-carotene values reported for raw winter squash (0, 0, 23.7, and 935 μg/100 g), the grand mean is 240 μg/100 g whereas the median is 12 μg/100 g. (Zero represents values reported as not detected at a detection limit specified in the acceptable references.)

We used reported values to calculate the median of each carotenoid for an aggregate, with equal weighting of each value. Because 1 μg/100 g is the common detection limit for HPLC determination of carotenoids (24-27), medians with digits to the right of the decimal point were rounded using standard procedures (30). The median was also rounded to reflect the least number of significant digits in any value contributing to the median.

Variability of data (as expressed by minimum and maximum values) and the number and citations of acceptable references were documented for each food aggregate and carotenoid. After all studies were evaluated, and Quality Indexes were assigned, a Quality Sum, that is, the sum of the acceptable Quality Indexes for a food aggregate, was determined. The Quality Sum is an indicator of the relative strength of a data set for a food. Finally, a confidence code was assigned on the

BEST AVAILABLE COPY

a. The consensus of experts in carotenoid analysis is that this food does not contain detectable levels of this carotenoid. Impute the carotenoid level as 0.

b. Carotenoid present in similar food: For imputation purposes, cooked broccoli was used to estimate missing values for asparagus; guava for guava juice; white cabbage for iceberg lettuce; raw peach for raw nectarine; cucumber for okra; orange juice for oranges; green pepper for red pepper; tangerine juice for tangerines; tomato for tomato juice, tomato paste, and tomato sauce; and a mixture of greens (mustard greens, kale, parsley, raw spinach, and cooked spinach) for beet greens, chicory, cress leaf, endive, collard greens, romaine lettuce, and swiss chard. Impute carotenoid using the ratio of the missing carotenoid to β-carotene in similar food multiplied by the β-carotene content of the food with missing carotenoid.

c. Impute using unpublished preliminary data for guava from Nutrient Composition Laboratory, Beltsville Human Nutrition Research Center, Agriculture Research Service, Beltsville, Md.

d. Impute value from similar food with highly similar levels of other carotenoids. For imputation purposes, carotenoid content of cloud berries (29) was used to replace missing values for blueberries, raw broccoli for cooked broccoli, and raw carrots for cooked carrots.

e. Impute based on unpublished preliminary data, 1988, for blueberries from Arthur D. Little, Inc, Cambridge, Mass.

FIG 3. Methods for imputing missing carotenoid data.

basis of the Quality Sum (Table 2).

The confidence code—either "A", "B", or "C"—is an indicator of the relative quality of the data and of the confidence a user can have in each median. Confidence codes of "A", "B", or "C" all indicate that data were acceptable for inclusion in the database of carotenoids in foods. A confidence code of "A" indicates considerable confidence, due either to a few exemplary studies or to a large number of studies of varying quality. Unacceptable data were not included in the database but were archived as a record of their evaluation.

Missing carotenoid values were estimated for some foods using composition data for similar foods. For example, only a limited number of foods are known to contain β-cryptoxanthin; after we consulted experts in the area of carotenoid analysis, if no data were available for the β-cryptoxanthin content of a food and the food was botanically similar to foods not containing β-cryptoxanthin, we imputed a value of 0 for this component. Figure 3 lists the imputation procedures that were used. (Full details of the imputation process are available from the authors.)

RESULTS

Tables 3 and 4 provide information on the carotenoid content of fruits and vegetables, the most important food sources of carotenoids. These tables include a median for each food as well as minimum and maximum values where more than one acceptable study was reported. A confidence code, based on both the quality and quantity of existing data, is associated with each carotenoid value. All values in Tables 3 and 4 derive from analytic data.

Table 5 includes the number of acceptable values and a listing of acceptable references for each entry. These references provide the user with helpful information concerning the source of acceptable values for a food and permit independent review of individual references by interested users.

Imputed data for carotenoids in fruits and vegetables can be found in Table 6. The method by which these values were determined is indicated.

DISCUSSION

The preceding tables represent the most comprehensive estimates of individual carotenoids in fruits and vegetables. These estimates are derived from critically evaluated published and unpublished sources. Users can review the specific criteria to better understand the rating process and the meaning of the confidence codes assigned to the data. Heinonen and others (18,19,27,31,32) have published limited data for meats, grains, dairy products, fats and oils, and other foods that suggest that these foods are relatively poor sources of carotenoids. Information on the carotenoid content of these products in the United States is not available and represents an area for future research.

Results in Tables 3 and 4 present a median based on all acceptable studies. We used minimum and maximum values to illustrate variability of food carotenoid levels because all acceptable citations did not provide standard deviations, which are essential for calculation of variance across studies. Additionally, the limited number of acceptable values for many foods would give little meaning to the concept of a standard deviation or other measure of variability.

Note that the minimum and maximum values for a food are really the minimum and maximum means reported by the sources cited. Unless a study contained only one analytic value for a food, reported values are means of several determinations (range 1 to 60, typically 4 or 5). Therefore, the minimum and maximum values presented in this report do not reflect the full variability that might be observed if we had access to individual values.

We considered various schemes for weighting acceptable values in computation of the median. Weighting based on the number of samples in each study was rejected because this would attach greater significance to the number of samples category than to the other categories that affect data quality. A lack of standard reference materials and quality-control procedures precluded rating based on analytic method or quality control category scores. Weighting based on Quality Index score was also rejected because of the narrow range of Quality Indexes and the resulting lack of resolution. In the future, as the amount of acceptable data increases, a weighting strategy could be devised based on the overall quality of the data, the quality of the sampling plan used, the number of samples, or some other as yet undetermined factor.

Although we believe the carotenoid values in these tables are the best available estimates of carotenoids in fruits and vegetables, there are specific limitations in the quantity and quality of data. For example, 9% of the foods in the carotenoid database had an "A" confidence code compared with 25% and 14% of foods in the selenium (21) and copper (22) databases, respectively, that had confidence codes of "A." The limited quantity of the data is illustrated by the following: 61% of foods

Table 3
Carotenoid content of fruits and vegetables derived from analytic data[a,b]

Aggregate	β-Carotene Median	β-Carotene Min-max	Conf code[c]	α-Carotene Median	α-Carotene Min-max	Conf code	Lutein + zeaxanthin Median	Lutein + zeaxanthin Min-max	Conf code	Lycopene Median	Lycopene Min-max	Conf code
	← μg/100g	→		← μg/100g	→		← μg/100g	→		← μg/100g	→	
Apple, raw	26	12-39	C	0[d]	0-0	C	45	42-48	C	0	0-0	C
Apricot, canned, drained	1,500*	560-19,270	B	0	...	C	2	0-3.5	C	65	...	C
Apricot, dried	17,600*	551-34,630	C	...	...	...	0	...	C	864	...	C
Apricot, raw	3,524	615-6,433	C	0	...	C	0	...	C	5	...	C
Asparagus, raw	449	317-581	C	9	0-17	C	...	...	...	...	...	...
Avocado, raw	34	...	C	...	...	...	320	...	C	...	...	...
Banana, raw	0	0-14	C	0	0-12	B	0	0-3.3	C	0	0-0	C
Basil, not dried	350	266-510	B	...	...	...	...	...	...	...	...	...
Beet greens	2,560	2,181-5,028	B	3	0-14	B	4	...	C	0	...	C
Beet, canned	1	...	C	0	...	C	...	...	...	...	...	...
Bitter melon, raw	50	...	C	...	...	...	...	...	...	...	...	...
Blueberries	...	...	...	0	...	C	...	...	...	...	...	...
Bottle gourd, raw	4	...	C	...	...	...	...	...	...	...	...	...
Broccoli, cooked	1,300	1,000-2,600	A	...	...	...	1,800	530-4,300	A	...	...	...
Broccoli, raw	700	480-1,080	A	1*	0-73	B	1,900	1,300-2,060	C	0	...	C
Brussels sprouts	480	340-1,100	A	6	0-11	C	1,300	320-1,590	A	0	...	C
Cabbage, chinese, bok choy, raw	62	15-110	C	1	...	C	40	...	C	0	...	C
Cabbage, chinese, wild	530	100-970	B	...	...	...	...	...	...	...	...	...
Cabbage, red, raw	15	...	C	1	...	C	26	...	C	0	...	C
Cabbage, white	80*	0-410	A	0	0-1	C	150	0-310	C	0	0-0	C
Cantaloupe, raw	3,000*	1,643-25,496	A	35	9-61	C	0	...	C	0	...	C
Carrot, cooked, canned, frozen	9,800	4,760-26,900	A	3,700	2,200-7,800	A	...	...	...	0	...	C
Carrot, raw	7,900	1,930-14,700	A	3,600	530-8,500	A	260	...	C	0	...	C
Carrot, A+ variety, raw	18,250	...	C	10,650	...	C	...	...	...	0	...	C
Carrot, A+ variety, cooked	25,650	...	C	15,000	...	C	...	...	...	0	...	C
Cashew apple, raw	155	35-225	C	14	8.5-18	C	...	...	...	...	...	...
Cashew apple juice	80	...	C	...	...	...	...	...	...	...	...	...
Cassava leaf	3,000	2,920-3,100	C	...	...	...	...	...	...	...	...	...
Cauliflower	3*	0-430	B	0	0-0	B	33*	0-230	B	0	0-0	C
Celeriac, raw	0	...	C	0	...	C	1	...	C	0	...	C
Celery	710	0-2,900	B	0	0-0	C	3,600	0-7,200	C	0	0-0	C
Chicory leaf, raw	3,430	...	C	...	...	...	...	...	...	...	...	...
Coriander, not dried	2,000	1,692-4,700	C	...	...	...	...	...	...	...	...	...
Corn, yellow	51	3-74	C	50	...	C	780	500-2,300	A	0	...	C
Cranberries, raw	22	...	C	1	...	C	28	...	C	0	...	C
Cress leaf, raw	4,150	...	C	...	...	...	...	...	...	...	...	...
Cucumber pickle	180	...	C	0	...	C	510	...	C	0	...	C
Cucumber, raw	6*	0-130	C	0	0-0.9	C	240	0-470	C	0	0-0	C
Currants, raw	62	25-99	C	0	0-0.9	C	240	47-440	C	0	0-0	C
Dill, not dried	4,500	...	C	0	...	C	6,700	...	C	0	...	C
Eggplant	35	9-87	B	...	...	...	...	...	...	...	...	...
Endive	1,300	960-1,720	C	...	...	...	...	...	...	...	...	...
Fennel leaves	4,440	...	C	...	...	...	...	...	...	...	...	...
Grapefruit, pink, raw	1,310	279-2,343	C	0	...	C	0	...	C	3,362	...	C
Grapefruit, white, raw	14*	2.3-248	B	1*	0.9-8	B	10	...	C	0	...	C
Grapes, raw	33	...	C	1	...	C	72	...	C	0	...	C
Green beans	630	180-810	A	44	39-64	C	740	440-1,100	B	0	...	C
Greens, collard	5,400	5,400-5,510	B	...	...	...	...	...	...	...	...	...
Greens, fiddlehead	1,950	1,640-2,050	B	280	190-331	B	...	...	...	...	...	...
Greens, mustard	2,700	80-7,400	B	...	...	...	9,900	9,400-10,400	C	...	...	...
Guava juice	270	...	C	...	...	...	...	...	...	3,340	...	C
Guava, raw	812	435-1,190	C	...	...	...	...	...	...	5,400	5,340-5,500	C
Jackfruit, raw	23	...	C	...	...	...	...	...	...	...	...	...
Jellies, jams, preserves	16	...	C	1	...	C	6	...	C	0	...	C

Continued on next page

Table 3
Carotenoid content of fruits and vegetables derived from analytic data[a,b] (cont)

Aggregate	β-Carotene Median	β-Carotene Min-max	Conf code[c]	α-Carotene Median	α-Carotene Min-max	Conf code	Lutein + zeaxanthin Median	Lutein + zeaxanthin Min-max	Conf code	Lycopene Median	Lycopene Min-max	Conf code
	← μg/100g →			← μg/100g →			← μg/100g →			← μg/100g →		
Kale	4,700	2,840-14,600	A	...	...	...	21,900	14,700-39,550	B	...	...	...
Kale, chinese	140	55-230	C	...	...	...	...	...	...	...	...	...
Kiwi fruit, raw	43	...	C	0	.	C	180	...	C	0	...	C
Leek, raw	1,000	.	C	0	.	C	1,900	...	C	0	...	C
Lemon, raw	3	...	C	0	...	C	12	...	C	0	...	C
Lettuce, iceberg	480	330-630	C	4	.	C	...	...	...	...	...	...
Lettuce, leaf	1,200	380-1,450	C	1	...	C	1,800	...	C	0	...	C
Lettuce, romaine	1,900	1,200-3,000	B	...	...	...	...	...	...	...	...	...
Lima beans, cooked	...	.	...	0	...	C	...	...	...	...	...	...
Loofah fruit, raw	47	.	C	...	...	...	...	...	...	...	...	...
Mango, raw	1,300	23-3,700	A	0	0-0	C	0	...	C	0	...	C
Mint, not dried	730	.	C	...	...	...	...	...	...	...	...	...
Mushroom	0	0-0	C	0	0-0	C	0	0-0	C	0	0-0	C
Mushroom, chanterelle, raw	1,300		C	1		C	0	.	C	0		C
Nectarine, raw	103	0-0	C	0	0-0	C	.	...	...	...	...	...
Okra, raw	170	54-432	C	28	...	C	...	...	...	...	...	...
Olive, green	280	.	C	0	...	C	510	...	C	0	...	C
Onion, yellow, raw	160	6.9-210	C	0	...	C	16	...	C	0	...	C
Orange juice	7	0-67	A	6	0-49	A	74	0-240	A	0	0-0	B
Orange, raw	39*	0-500	B	20*	0-400	B	14	0-27	C	0	...	C
Papaya, raw	99	38-160	C	0	...	C	...	...	...	0	...	C
Parsley, not dried	5,300	5,040-5,600	C	0	...	C	10,200	...	C	0	.	C
Peach, canned, drained	100	0-625	B	0	0-0.9	C	28	0-33	B	0	0-0	C
Peach, dried	9,256	.	C	...	...	...	188	...	C	0	...	C
Peach, raw	99	40-420	B	1	0-2.9	C	14	9.6-43	B	0	...	C
Pear, raw	17	.	C	0	...	C	110	...	C	0	...	C
Peas, green	350	110-1,300	A	16	0.9-26	C	1,700	1,100-2,400	A	0	...	C
Pepper, green, raw	230	31-276	B	11	0-34	B	700	...	C	0	...	C
Pepper, red	2,200	2,220-2,900	B	60	59-62	C	...	...	...	...	...	...
Pepper, yellow, raw	150		C	92	...	C	770	...	C	0	.	C
Pigeon peas	40		C	.	.	.	...	...	...	.	.	.
Pineapple, canned, drained	18		C	1	.	C	2		C	.		
Plum, raw	430		C		...	.	240	...	C	0	...	C
Potato salad	12		C	2	...	C	...	...	...	0	...	C
Potato, white, cooked	0		C	0	...	C	0	...	C	0	...	C
Potato, white, raw	6	3.2-7.7	C	0	0-0.9	C	36	13-60	C	0	0-0	C
Prune, dried	140	...	C	31	...	C	120	...	C	0	...	C
Pumpkin	3,100	490-20,000	A	3,800	0.9-16,000	A	1,500	630-2,300	C	0	0-0	B
Radish, raw	9	...	C	0	...	C	12	...	C	0		C
Raisins	0	...	C	0	...	C	1	...	C	0	...	C
Raspberries, raw	6	...	C	6	0-13	C	76	...	C	0	...	C
Rhubarb, raw	61	...	C	0	...	C	170	...	C	0	...	C
Roquette, raw	3,460	...	C	...	...	...	...	...	...	...	...	...
Rose hip puree, canned	420	...	C	0	...	C	...	...	...	780	...	C
Rutabaga, raw	1	...	C	0	...	C	0	...	C	0	...	C
Scallion, raw	850	391-1300	C	6	...	C	2,100	...	C	...	...	...
Spinach, cooked, drained	5,500	3,300-9,200	A	...	...	...	12,600	5,000-20,300	A	...	...	...
Spinach, raw	4,100	3,043-6,710	A	0	0-0	B	10,200	4,400-15,940	C	0	...	C
Squash, summer	420	178-670	C	12	...	C	1,200	500-1,800	C	...	...	...
Squash, winter, cooked	2,400	490-4,570	A	12*	0-935	B	38	...	C	...	...	...
Squash, winter, raw	820*	49-5,780	A	12*	0-935	B	38	...	C	...	...	...
Strawberries	9	...	C	2	0-4.5	C	31	...	C	0	...	C
Sweet potato, cooked	8,800	5,620-19,000	A	0	0-0	C	...	...	...	0	0-0	C
Sweet potato, raw	8,900	7,620-16,000	B	0	...	C	...	...	...	0	...	C

Continued on next page

149

Table 3
Carotenoid content of fruits and vegetables derived from analytic data[a,b] (cont)

Aggregate	β-Carotene Median	β-Carotene Min-max	Conf code[c]	α-Carotene Median	α-Carotene Min-max	Conf code	Lutein+zeaxanthin Median	Lutein+zeaxanthin Min-max	Conf code	Lycopene Median	Lycopene Min-max	Conf code
	← μg/100g →			← μg/100g →			← μg/100g →			← μg/100g →		
Swiss chard, raw	3,647	2,725-4,568	C	45	32-58	C	...	...	...	...	...	...
Tangerine, tangelo juice	8[e]	4.5-38	B	5	3-14	B	135	104-166	C	...	...	...
Tangerine, raw	38	...	C	20	...	C	20	...	C	...	...	...
Tomato catsup	5,000[f]	...	C	0[f]	...	C	210[f]		C	9,900[f]	...	...
Tomato juice, canned	900	...	C	...	...		...	...	...	8,580	[illegible]0,000-11,600	B
Tomato paste, canned	1,700	...	C	...	...	C	...	...	...	6,500	5,400-15,000	B
Tomato sauce, canned	1,000	...	C	...	...	...	...	...	...	...	...	...
Tomato, raw	520	115-660	A	...	...	...	100	...	C	3,100	379-4,200	A
Turnip, raw	72	...	C	1	...	C	1	...	C	0		C
Watermelon, raw	230	...	C	1	...	C	14	...	C	4,100	2,300-7,200	B
Yard-long beans, raw	44		C	...	...	...	...	...	...	...	...	...

[a]Missing values for minimum and maximum (min-max) alone indicate that only one acceptable analytic value was found for that carotenoid in that food.
[b]Missing value for median, minimum, maximum, and confidence code indicate that no acceptable analytic values were found for that carotenoid in that food. Refer to Table 6 for imputed values.
[c]Conf code = Confidence code. See Table 2 for explanation of conf codes A, B, and C.
[d]Zeroes represent values reported as not detected at a detection limit specified in the acceptable references.
[e]Mean for acceptable foods more than two times median.
[f]Values based only on data for Finnish catsup containing carrots.

had more than one acceptable reference for β-carotene whereas 20% of foods had more than one acceptable reference for β-cryptoxanthin.

The Quality Indexes of acceptable data range from 1 to 1.8 out of a possible 3. These scores illustrate the idealistic nature of the criteria that were planned to have long-term relevance and to provide guidelines for the development of exemplary methodology and quality control materials for carotenoid determination. A score of 3 in the category of analytic method requires use of a standard reference material, characterized and certified for each carotenoid of interest, or other extensive validation of the chosen method. Because there is currently no standard reference material for carotenoids, it is difficult to achieve a score of 3 in the analytic method category. Given the recommendation of the Committee on the Nutrition Components of Food Labeling to develop additional standard reference materials for use in food analysis (33), we anticipate the development of standard reference materials for carotenoids in the near future.

A lack of published documentation of analytic quality-control procedures was another reason for low Quality Index scores. Analytic quality control is concerned with the day-to-day accuracy and precision of a measurement. Accuracy is monitored by routine analysis of a standard reference material or a secondary reference material developed especially for a study. Precision is usually evaluated by calculating a coefficient of variation of several replicates of the same sample or a quality-control material. Both acceptable precision and accuracy were required for a score of 3 in the analytic quality-control category. Few current studies report any assessment of day-to-day accuracy or precision; a report including both is rare. Limited quality control information makes it difficult to compare the relative quality of analytic data.

Despite the critical evaluation process, the carotenoid values for an aggregate presented in Tables 3 and 4 may or may not represent the carotenoid levels found in a given individual food sample because many factors influence the levels of carotenoids

Table 4
β-Cryptoxanthin content of fruits and vegetables derived from analytic data[a]

Aggregate	Median	Min-max	Conf[b] code
	← μg/100g →		
Apricot, canned, drained	0[c]		C
Apricot, dried	0		C
Apricot, raw	0		C
Cantaloupe, raw	0		C
Cashew apple juice	50	...	C
Grapefruit, pink, raw	0	...	C
Mango, raw	54	...	C
Olive, green	19	...	C
Orange juice	24[d]	14-489	A
Papaya, raw	470	...	C
Peach, canned, drained	47	...	C
Peach, dried	251	...	C
Peach, raw	42	12-71	C
Squash, winter, cooked	0	...	C
Squash, winter, raw	0	...	C
Tangerine, tangelo juice	214	15-304	B

[a]See Table 6 for imputed β-cryptoxanthin values for foods not found in this table.
[b]Conf code = confidence code. See Table 2 for explanation of confidence codes.
[c]Zeroes represent values reported as not detected at a detection limit specified in the acceptable references.
[d]Mean for acceptable foods more than two times median.

150

Table 5
Number of means and acceptable references for carotenoid content of fruits and vegetables

Aggregate/carotenoid[a]	No. of means used	Acceptable references
Apple, raw		
β-car	2	29
α-car	2	29
lut	2	29
lyc	2	29
Apricot, canned, drained		
β-car	3	24, 29, 45
α-car	1	29
lut	2	24, 29
lyc	1	24
β-cryp	1	24
Apricot, dried		
β-car	2	24, 54
lut	1	24
lyc	1	24
β-cryp	1	24
Apricot, raw		
β-car	2	24, 25
α-car	2	24
lut	1	24
lyc	1	24
β-cryp	1	24
Asparagus, raw		
β-car	2	25, 26
α-car	2	25, 26
Avocado, raw		
β-car	1	29
lut	1	29
Banana, raw		
β-car	3	29, A[b]
α-car	3	29, A
lut	3	29, A
lyc	2	A
Basil, not dried		
β-car	5	46
Beet greens		
β-car	5	25, 26, 45, 55
α-car	3	25, 26, 55
Beet, canned		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Bitter melon, raw		
β-car	1	46
Blueberries		
α-car	1	25
Bottle gourd, raw		
β-car	1	46
Broccoli, cooked		
β-car	7	45, 56, A
lut	6	56, A
Broccoli, raw		
β-car	6	25, 26, 29, 45, 55, 57
α-car	4	25, 26, 29, 55
lut	2	29, 57
lyc	1	29
Brussels sprouts		
β-car	9	29, 45, 55, 57, A
α-car	2	29, 55
lut	5	29, 57, A
lyc	1	29
Cabbage, chinese, bok choy, raw		
β-car	2	29, 46
α-car	1	29
lut	1	29
lyc	1	29
Cabbage, chinese, wild		
β-car	4	46
Cabbage, red, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Cabbage, white		
β-car	7	29, 46, 57, 58, A
α-car	2	29, A
lut	3	29, 57, A
lyc	2	29, A
Cantaloupe, raw		
β-car	6	24, 25, 55, A
α-car	2	25, 55
lut	1	24
lyc	1	24
β-cryp	1	24
Carrot, cooked, canned, frozen		
β-car	12	34, 45, 56, 59, A
α-car	12	34, 45, 56, 59, A
lyc	1	34
Carrot, raw		
β-car	14	25, 26, 29, 35, 45, 46, 55, 59, 60, 61, A
α-car	12	25, 26, 29, 35, 45, 55, 59, 61, A
lut	2	29, 35
lyc	1	29
Carrot, A+ variety, raw		
β-car	1	34
α-car	1	34
lyc	1	34
Carrot, A+ variety, cooked		
β-car	1	34
α-car	1	34
lyc	1	34
Cashew apple, raw		
β-car	2	62
α-car	2	62
Cashew apple juice		
β-car	1	62
β-cryp	1	62
Cassava leaf		
β-car	2	63, 64
Cauliflower		
β-car	4	29, 46, A
α-car	3	29, A
lut	3	29, A
lyc	3	29, A
Celeriac, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Celery		
β-car	4	29, 46, A
α-car	2	29, A
lut	2	29, A
lyc	2	29, A
Chicory, leaf, raw		
β-car	1	58
Coriander, not dried		
β-car	3	46, 58
Corn, yellow		
β-car	3	29, 46, 65
α-car	1	29
lut	7	29, A
lyc	1	29
Cranberries, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Cress leaf, raw		
β-car	1	55
Cucumber pickle		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Cucumber, raw		
β-car	3	29, 46, A
α-car	3	29, A
lut	2	29, A
lyc	2	29, A
Currants, raw		
β-car	2	29
α-car	2	29
lut	2	29
lyc	2	29
Dill, not dried		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Eggplant		
β-car	5	46
Endive		
β-car	2	45, 58
Fennel leaves		
β-car	1	46
Grapefruit, pink, raw		
β-car	2	24, 26
α-car	1	26
lut	1	24
lyc	1	24
β-cryp	1	24
Grapefruit, white, raw		
β-car	3	25, 26, 29
α-car	3	25, 26, 29
lut	1	29
lyc	1	29
Grapes, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Green beans		
β-car	7	25, 29, 55, A
α-car	3	25, 29, 55
lut	5	29, A
lyc	1	29
Greens, collard		
β-car	3	45, A
Greens, fiddlehead		
β-car	4	47, 59
α-car	4	47, 59
Greens, mustard		
β-car	4	46, A
lut	2	A
Guava juice		
β-car	1	48
lyc	1	48
Guava, raw		
β-car	2	56
lyc	2	56
Jackfruit, raw		
β-car	1	46
Jellies, jams, preserves		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Kale		
β-car	11	45, 57, 58, 67, 68, A
lut	4	57, A
Kale, chinese		
β-car	2	46
Kiwi fruit, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Leek, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Lemon, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Lettuce, iceberg		
β-car	2	25, A
α-car	1	25
Lettuce, leaf		
β-car	2	29, 58
α-car	1	29
lut	1	29
lyc	1	29
Lettuce, romaine		
β-car	3	A
Lima beans, cooked		
α-car	1	A
Loofah fruit, raw		
β-car	1	46
Mango, raw		
β-car	11	36, 46, 49, A, B[c]
α-car	2	A, B
lut	1	B
lyc	1	B
β-cryp	1	B
Mint, not dried		
β-car	1	46
Mushroom		
β-car	2	29
α-car	2	29
lut	2	29
lyc	2	29

Continued on next page

[illegible] of means and acceptable references for carotenoid content of fruits and vegetables (cont)

Aggregate/carotenoid[a]	No. of means used	Acceptable references
Mushroom, chanterelle, raw		
[illegible]	1	29
[illegible]	1	29
[illegible]	1	29
[illegible]	1	29
Nectarine, raw		
β-car	1	26
α-car	2	25, 26
Okra, raw		
β-car	3	25, 46, 64
[illegible]	1	25
Olive, green		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
β-cryp	1	29
Onion, yellow, raw		
β-car	3	29, 46
α-car	[illegible]	29
lut	[illegible]	29
lyc	[illegible]	29
Orange juice		
β-car	14	29, 37, 38, 69, 70, A
α-car	14	29, 37, 38, 69, 70, A
lut	13	29, 37, 38, 69, A
lyc	3	29, A
β-cryp	7	37, 70
Orange, raw		
β-car	4	25, 29, A
α-car	4	25, 29, A
lut	2	29, A
lyc	1	A
Papaya, raw		
β-car	2	46, 64
α-car	1	A
lyc	1	A
β-cryp	1	A
Parsley, not dried		
β-car	2	29, 58
α-car	1	29
lut	1	29
lyc	1	29
Peach, canned, drained		
β-car	3	24, 29, A
α-car	2	29, A
lut	3	24, 29, A
lyc	2	24, A
β-cryp	1	24
Peach, dried		
β-car	1	24
lut	1	24
lyc	1	24
β-cryp	1	24
Peach, raw		
β-car	4	24, 29, 42, A
α-car	3	25, 29, A
lut	3	24, 29, 42
lyc	1	24
β-cryp	2	24, 42
Pear, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Peas, green		
β-car	10	25, 26, 29, 55, 63, 64, A
α-car	3	25, 29, 55
lut	5	29, A
lyc	1	29
Pepper, green, raw		
β-car	4	25, 26, 29, 55
α-car	4	25, 26, 29, 55
lut	1	29
lyc	1	29
Pepper, red		
β-car	3	29, 45
α-car	2	45
Pepper, yellow, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Pigeon peas		
β-car	1	63
Pineapple, canned, drained		
β-car	1	29
α-car	1	29
lut	1	29
Plum, raw		
β-car	1	29
lut	1	29
lyc	1	29
Potato salad		
β-car	1	71
α-car	1	71
lyc	1	71
Potato, white, cooked		
β-car	1	A
α-car	1	A
lut	1	A
lyc	1	A
Potato, white, raw		
β-car	3	29, 59
α-car	2	29
lut	2	29
lyc	2	29
Prune, dried		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Pumpkin		
β-car	9	29, 34, 45, 64, A
α-car	8	29, 34, 45, A
lut	2	29, A
lyc	3	29, 45
Radish, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Raisins		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Raspberries, raw		
β-car	1	29
α-car	2	25, 29
lut	1	29
lyc	1	29
Rhubarb, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Roquette, raw		
β-car	1	58
Rose hip puree, canned		
β-car	1	71
α-car	1	71
lyc	1	71
Rutabaga, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Scallion, raw		
β-car	2	55, A
α-car	1	55
lut	1	A
Spinach, cooked		
β-car	10	45, A
lut	6	A
Spinach, raw		
β-car	6	25, 26, 29, 45, 57, 68
α-car	3	25, 26, 29
lut	2	29, 57
lyc	1	29
Squash, summer		
β-car	2	25, A
α-car	1	25
lut	2	A
Squash, winter, cooked		
β-car	9	31, 72, A
α-car	6	31, 72, A
lut	4	72, A
β-cryp	1	72
Squash, winter, raw		
β-car	7	26, 45, 46, 55, 67, 72
α-car	4	26, 45, 46, 72
lut	1	72
β-cryp	1	72
Strawberries		
β-car	1	29
α-car	2	25, 29
lut	1	29
lyc	1	29
Sweet potato, cooked		
β-car	13	34, 45, 50, A
α-car	2	34
lyc	2	34
Sweet potato, raw		
β-car	5	25, 26, 34, 45, 50
α-car	2	26, 29
lyc	1	34
Swiss chard, raw		
β-car	2	25, 55
α-car	2	25, 55
Tangerine, tangelo juice		
β-car	3	37, 43, 70
α-car	3	37, 43, 70
lut	2	37, 43
β-cryp	3	37, 43, 70
Tangerine, raw		
β-car	1	29
α-car	1	29
lut	1	29
Tomato catsup, Finnish		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Tomato juice, canned		
β-car	1	A
lyc	4	56, A
Tomato paste, canned		
β-car	1	A
lyc	3	A
Tomato sauce, canned		
β-car	1	A
lyc	2	A
Tomato, raw		
β-car	6	29, 46, 55, 67, 73, A
lut	1	29
lyc	5	29, 73, A
Turnip, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	1	29
Watermelon, raw		
β-car	1	29
α-car	1	29
lut	1	29
lyc	4	29, A
Yard-long beans, raw		
β-car	1	46

[a] β-car = β-carotene; α-car = α-carotene; lut = lutein + zeaxanthin; lyc = lycopene; β-cryp = β-cryptoxanthin.
[b] A = Unpublished data provided by Judy C. Harris, Arthur D. Little, Inc, Cambridge, Mass, under NCI Contract NO1-CN-55442, 1988.
[c] B = Unpublished data provided by Frederick Khachik, Nutrient Composition Laboratory, Beltsville Human Nutrition Research Center, Agriculture Research Service, Beltsville, Md, 1990.

152

Table 6
Imputed values for carotenoids in fruits and vegetables

Aggregate	α-Car	β-Cryp	Lyc	Lut
	μg/100g			
Apple, raw	...	0^{a}	...	...
Apricot, dried	0^{a}			...
Asparagus, raw		0^{a}	0^{a}	640^{b}
Avocado, raw	0^{a}	0^{a}	0^{a}	...
Banana, raw	...	0^{a}	...	...
Beet greens	...	0^{a}	0^{a}	$7,700^{b}$
Beet, canned	...	0^{a}		...
Blueberries*	...	0^{a}	0^{a}	37^{d}
Broccoli, cooked	1^{d}	0^{a}	0^{a}	
Broccoli, raw	...	0^{a}	...	...
Brussels sprouts	...	0^{a}	...	...
Cabbage, chinese, bok choy, raw		0^{a}	...	...
Cabbage, red, raw	...	0^{a}	...	...
Cabbage, white		0^{a}	...	...
Carrot, cooked/canned/frozen		0^{a}	...	260^{d}
Carrot, raw	...	0^{a}	...	...
Cauliflower		0^{a}		
Celery		0^{a}		
Chicory leaf, raw	0^{a}	0^{a}	0^{a}	$10,300^{b}$
Corn, yellow	...	0^{a}	...	...
Cranberries, raw		0^{a}	...	...
Cress leaf, raw	0^{a}	0^{a}	0^{a}	$12,500^{b}$
Cucumber pickle	...	0^{a}	...	...
Cucumber, raw	...	0^{a}	...	...
Currants, raw	...	0^{a}	...	...
Eggplant	0^{a}	0^{a}	0^{a}	0^{a}
Endive	0^{a}	0^{a}	0^{a}	$4,000^{b}$
Grapefruit, white, raw	...	0^{a}	...	...
Grapes, raw	...	0^{a}	...	...
Green beans	...	0^{a}	...	...
Greens, collard	0^{a}	0^{a}	0^{a}	$16,300^{b}$
Greens, mustard	0^{a}	0^{a}	0^{a}	...
Guava juice	23^{b}	0^{a}	...	0^{a}
Guava, raw	70^{c}	0^{a}	...	0^{a}
Jellies, jams, preserves		0^{a}		
Kale	0^{a}	0^{a}	0^{a}	
Kiwi fruit, raw		0^{a}		
Leek, raw		0^{a}		
Lemon, raw	...	0^{a}	...	
Lettuce, iceberg	...	0^{a}	0^{a}	$1,400^{b}$
Lettuce, leaf	...	0^{a}	...	...

Aggregate	α-Car	β-Cryp	Lyc	Lut
	μg/100g			
Lettuce, romaine	0^{a}	0^{a}	0^{a}	$5,700^{b}$
Lima beans, cooked*	...	0^{a}	0^{a}	0^{a}
Mushroom	...	0^{a}	...	...
Nectarine, raw	...	43^{b}	0^{a}	15^{b}
Okra, raw	...	0^{a}	0^{a}	$6,800^{b}$
Onion, yellow, raw	...	0^{a}	...	...
Orange, raw	...	149^{b}	...	...
Parsley, not dried	...	0^{a}	...	...
Peach, dried	0^{a}	...	...	
Pear, raw	...	0^{a}	...	...
Peas, green	...	0^{a}	...	...
Pepper, green, raw	...	0^{a}	...	...
Pepper, red	...	0^{a}	0^{a}	$6,800^{b}$
Pineapple, canned, drained	...	0^{a}	0^{a}	...
Plum, raw	0^{a}	0^{a}	...	...
Potato salad		0^{a}	...	0^{a}
Potato, white, cooked		0^{a}		
Potato, white, raw		0^{a}		
Prune, dried		0^{a}		
Pumpkin	...	0^{a}	...	...
Radish, raw	...	0^{a}	...	...
Raisins	...	0^{a}	...	...
Raspberries, raw	...	0^{a}	...	...
Rhubarb, raw	...	0^{a}	...	...
Rutabaga	...	0^{a}	...	...
Scallion, raw	...	0^{a}	0^{a}	...
Spinach, cooked	0^{a}	0^{a}	0^{a}	...
Spinach, raw	...	0^{a}	...	...
Squash, summer	...	0^{a}	0^{a}	...
Squash, winter, cooked	...	...	0^{a}	...
Sweet potato, cooked	...	0^{a}	...	0^{a}
Sweet potato, raw	...	0^{a}	...	0^{a}
Swiss chard, raw	...	0^{a}	0^{a}	$11,000^{b}$
Tangerine, raw	...	106^{b}	0^{a}	...
Tomato catsup, Finnish	...	0^{a}		...
Tomato juice, canned	...	0^{a}		330^{b}
Tomato paste, canned	...	0^{a}	...	190^{b}
Tomato sauce, canned	...	0^{a}		42^{b}
Tomato, raw	...	0^{a}	...	...
Turnip, raw	...	0^{a}	...	...
Watermelon, raw	...	0^{a}	...	...

a-e Superscripts correspond to imputation method as described in Figure 3.
*For β-carotene, blueberries have an imputed value of 14 μg/100 g using method e in Figure 3 and lima beans have an imputed value of 0 μg/100 g using method a in Figure 3.
Key: α-Car = α-carotene; β-Cryp = β-cryptoxanthin; Lyc = lycopene; Lut = lutein + zeaxanthin.

in foods. These factors include varietal differences (34-41), variable growth and harvesting conditions (40-44), and different postharvest handling and processing (28,41,45-51).

The β-carotene content of cantaloupe illustrates the variable nature of food carotenoid content. Reported values of β-carotene range from 1,640 μg/100 g for cantaloupe purchased in Maine (25) to 25,500 μg/100 g for cantaloupe purchased in Maryland (24). Analytic differences may be partially responsible for this difference but are not likely to be the only cause for this range of values as both studies met established criteria for acceptability of analytic methods. Because of the variable carotenoid content of foods, feeding studies with controlled carotenoid intakes must continue to rely on analysis of foods.

Differences noted in Tables 3 and 4 between the carotenoid content of raw and cooked forms of the same food are more likely attributable to factors other than cooking or processing differences. For example, as Table 3 shows, the median of seven acceptable studies of the β-carotene content of cooked broccoli is 1,300 μg/100 g with a confidence code of "A" whereas the median value of six studies of raw broccoli is 700 μg/100 g with a confidence code of "A." Broccoli is unlikely to actually gain this much β-carotene with cooking. Results for cooked and raw broccoli were often generated by different scientists or laboratories with samples procured in different geographic locations and seasons and, thus, do not represent a controlled study of the effects of cooking. As data with more

153

[illegible]led descriptions of foods become available, aggregations [illegible] be modified to provide more information about the [illegible]tenoid content of specific varieties of foods or the influence [illegible] storage, and processing conditions.

Table 6 provides a listing of imputed carotenoid values for [illegible]ds where no analytic data were reported. Because missing [va]lues are probably the largest cause of errors in nutrient [ca]lculation (52), we decided to impute values rather than leave them as missing. For example, no analytic values were available for the lutein content of collard greens. But because other similar green leafy vegetables, such as mustard greens, kale, and spinach, contain substantial amounts of lutein (Table 3), replacing missing lutein values with a zero would lead to underestimation of the lutein intake of an individual who consumes collard greens. Values were imputed in an attempt to [illegible]de consistent values for users.

[illegible]luation of carotenoid content of fruits and vegetables repr[illegible] an initial step in the development of reliable data on car[illegible]oid content of foods. The evaluation system permitted consistent, objective, and efficient rating of data from numerous references. Quantitative data on the carotenoid content of common foods will be useful for the estimation of dietary carotenoid intake and for the evaluation of the possible effects of carotenoid intake on disease incidence.

IMPLICATIONS

A primary objective for critically evaluating food composition data is the identification of food items for future laboratory analysis. Foods believed to contain notable amounts of a carotenoid, but that had a confidence code of "C" or had no reliable data, are a priority for additional analyses. Information about those foods can be used as the basis for development of a sampling strategy to obtain statistically representative food samples for carotenoid analysis as has been done for selenium (53). Because data on the effects of cooking or processing on individual carotenoids in foods are limited, this is another area for investigation. Foods with highly divergent values for carotenoids are also a priority for further investigation. The evaluation system allows for continual, objective, and consistent updating of the database.

Data-quality indicators, a part of the evaluation system, allow users to make informed decisions about appropriate uses for the data. The inclusion of references for acceptable data also helps the user make decisions about data applications.

This is the third system that has been developed for the evaluation of analytic data for nutrient content of foods (20-22). Although the evaluated components differ, the similarities of the evaluation systems demonstrate the feasibility of multinutrient evaluation systems. This approach could be useful in development of multinutrient food composition tables. In addition, reviewers of manuscripts can use the evaluation categories and the nutrient-specific criteria as guidelines for manuscript quality.

Values for specific carotenoids in foods are necessary to estimate dietary intakes of individual carotenoids in the population. The dietary intake distribution of carotenoids can then be used to examine the relationship between individual and total carotenoid intake and disease incidence. Because lower carotenoid intake has been implicated as a risk factor in certain types of cancer, especially lung cancer, this database could be used to permit greater specificity in examining the relationship between dietary exposure and cancer risk. ■

Partial support by the National Cancer Institute through reimbursable agreement Y01-CN-30609 is acknowledged.

The authors thank Carol S. Davis for creating the tables and figures, Doug Bigwood for computer programming, Frederick Khachik for insightful discussions, and Larry Douglass and Will Potts for statistical advice.

References

1. Byers T, Vena J, Mettlin C, Swanson M, Graham S. Dietary vitamin A and lung cancer risk: an analysis by histologic subtypes. *Am J Epidemiol.* 1984; 120:769-776.
2. Hinds MW, Kolonel LN, Hankin JH, Lee J. Dietary vitamin A, carotene, vitamin C and risk of lung cancer in Hawaii. *Am J Epidemiol.* 1984; 119:227-237.
3. Kvale G, Bjelke E, Gart JJ. Dietary habits and lung cancer risk. *Int J Cancer.* 1983; 31:397-405.
4. Le Marchand L, Yoshizawa CN, Kolonel LN, Hankin JH, Goodman MT. Vegetable consumption and lung cancer risk: a population-based case-control study in Hawaii. *J Natl Cancer Inst.* 1989; 81:1158-1164.
5. Pisani P, Berrino F, Macaluso M, Pastorino U, Crosignani P, Baldasseroni A. Carrots, green vegetables and lung cancer: a case-control study. *Int J Epidemiol.* 1986; 15:463-468.
6. Samet JM, Skipper BJ, Humble CG, Pathak DR. Lung cancer risk and vitamin A consumption in New Mexico. *Am Rev Respir Dis.* 1985; 131:198-202.
7. Shekelle RB, Liu S, Raynor WJ Jr, Lepper M, Maliza C, Rossof AM. Dietary vitamin A and risk of cancer in the Western Electric study. *Lancet.* 1981; 2:1185-1189.
8. Ziegler RG. A review of epidemiologic evidence that carotenoids reduce the risk of cancer. *J Nutr.* 1989; 119:116-122.
9. Ziegler RG, Mason TJ, Stemhagen A, Hoover R, Schoenberg JB, Gridley G, Virgo PW, Fraumeni JR Jr. Carotenoid intake, vegetables, and the risk of lung cancer among white men in New Jersey. *Am J Epidemiol.* 1986; 123:1080-1093.
10. Mackerras D, Buffler PA, Randall DE, Nichaman MZ, Pickle LW, Mason TJ. Carotene intake and the risk of laryngeal cancer in coastal Texas. *Am J Epidemiol.* 1988; 128:980-988.
11. Micozzi MS, Beecher GR, Taylor PR, Khachik F. Carotenoid analyses of selected raw and cooked foods associated with a lower risk for cancer. *J Natl Cancer Inst.* 1990; 82:282-285.
12. Haytowitz DB, Matthews RH. *Composition of Foods: Vegetables and Vegetable Products—Raw, Processed, Prepared.* Washington, DC: US Dept of Agriculture: 1984. Handbook No. 8-11.
13. Souci SW, Fachmann W, Kraut H. *Food Composition and Nutrition Tables 1986/87.* Stuttgart, Germany: Wissenschaftliche Verlagsgesellschaft; 1986.
14. Rodriguez-Amaya DB. Critical review of provitamin A determination in plant foods. *J Micronutr Anal.* 1989; 5:191-225.
15. Beecher GR, Khachik F. Evaluation of vitamin A and carotenoid data in food composition tables. *J Natl Cancer Inst.* 1981; 73:1397-1404.
16. Simpson KL, Chichester CO. Metabolism and nutritional significance of carotenoids. *Ann Rev Nutr.* 1981; 1:351-374.
17. Heinonen M. Food groups as the source of retinoids, carotenoids, and vitamin A in Finland. *Int J Vitam Nutr Res.* 1991; 61:3-9.
18. Ollilainen V, Heinonen M, Linkola E, Varo P, Koivistoinen P. Carotenoids and retinoids in Finnish foods: meat and meat products. *J Food Comp Anal.* 1988; 1:178-188.
19. Ollilainen V, Heinonen M, Linkola E, Varo P, Koivistoinen P. Retinoids and carotenoids in Finnish foods: fish and fish products. *J Food Comp Anal.* 1989; 2:93-103.
20. Holden JM, Schubert A, Wolf WR, Beecher GR. A system for evaluating the quality of published nutrient data: selenium, a test case. *Food Nutr Bull.* 1987; 9(suppl):177-193.
21. Schubert A, Holden JM, Wolf WR. Selenium content of a core group of foods based on a critical evaluation of published analytical data. *J Am Diet Assoc.* 1987; 87:285-296,299.
22. Lurie DG, Holden JM, Schubert A, Wolf WR, Miller-Ihli NJ. The copper content of foods based on a critical evaluation of published analytical data. *J Food Comp Anal.* 1989; 2:298-316.
23. Bigwood DW, Heller SR, Wolf WR, Schubert A, Holden JM. SELEX: an expert system for evaluating published data on selenium in foods. *Anal Chim Acta.* 1987; 200:411-419.
24. Khachik F, Beecher GR, Lusby WR. Separation, identification and quantification of the major carotenoids in extracts of apricots, peaches,

cantaloupe, and pink grapefruit by liquid chromatography. *J Agric Food Chem.* 1989; 37:1465-1473.
25. Bureau JL, Bushway RJ. HPLC determination of carotenoids in fruits and vegetables in the United States. *J Food Sci.* 1986; 51:128-130.
26. Bushway RJ. Determination of α- and β-carotene in some raw fruits and vegetables by high-performance liquid chromatography. *J Agric Food Chem.* 1986; 34:409-412.
27. Heinonen M, Ollilainen V, Linkola E, Varo P, Koivistoinen P. Carotenoids and retinoids in Finnish foods: cereal and bakery products. *Cereal Chem.* 1989; 66:270-272.
28. Khachik F, Beecher GR, Goli MB, Lusby WR. Separation, identification, and quantification of carotenoids in fruits, vegetables and human plasma by high performance liquid chromatography. *Pure Appl Chem.* 1991; 63:71-80.
29. Heinonen MI, Ollilainen V, Linkola EK, Varo PT, Koivistoinen PE. Carotenoids in Finnish foods: vegetables, fruits, and berries. *J Agric Food Chem.* 1989; 37:655-659.
30. Sokal RR, Rohlf FJ. *Biometry.* 2nd ed. New York, NY: WH Freeman and Co; 1981.
31. Ollilainen V, Heinonen M, Linkola E, Varo P, Koivistoinen P. Carotenoids and retinoids in Finnish foods: dairy products and eggs. *J Dairy Sci.* 1989; 72:2257-2265.
32. Heinonen M, Ollilainen V, Linkola E, Varo P, Koivistoinen P. Carotenoids and retinoids in Finnish foods: dietary fats. *J Food Comp Anal.* 1988; 1:334-340.
33. Porter DV, Earl RO, eds. *Nutrition Labeling: Issues and Directions for the 1990s.* Washington, DC: National Academy of Sciences; 1990.
34. Khachik F, Beecher GR. Application of C-45-β-carotene as an internal standard for the quantification of carotenoids in yellow/orange vegetables by liquid chromatography. *J Agric Food Chem.* 1987; 35:732-738.
35. Heinonen MI. Carotenoids and provitamin A activity of carrot *(Daucus carota L.)* cultivars. *J Agric Food Chem.* 1990; 38:609-612.
36. Godoy HT, Rodriguez-Amaya DB. Carotenoid composition of commercial mangoes from Brazil. *Lebensm Wiss Technol.* 1989; 22:100-103.
37. Stewart I. Provitamin A and carotenoid content of citrus juices. *J Agric Food Chem.* 1977; 25:1132-1137.
38. Gross J, Gabai M, Lifshitz A. A comparative study of the carotenoid pigments in juice of Shamouti, Valencia and Washington oranges, three varieties of *Citrus sinensis. Phytochemistry.* 1972; 11:303-308.
39. Arima HK, Rodriguez-Amaya DB. Carotenoid composition and vitamin A value of commercial Brazilian squashes and pumpkins. *J Micronutr Anal.* 1988; 4:177-191.
40. Mercadante AZ, Rodriguez-Amaya DB. Carotenoid composition of a leafy vegetable in relation to some agricultural variables. *J Agric Food Chem.* 1991; 39:1094-1097.
41. Gross J. *Pigments in Vegetables.* New York, NY: Van Nostrand Reinhold; 1991.
42. Gross J. Carotenoid changes in the mesocarp of the redhaven peach during ripening. *Z Pflanzenphysiol.* 1979; 94:461-468.
43. Gross J. Carotenoid changes in the juice of the ripening Dancy tangerine *(Citrus reticulata). Lebensm Wiss Technol.* 1982; 15:36-38.
44. Gross J. *Pigments in Fruits.* London, England: Academic Press; 1987.
45. Sweeney JP, Marsh AC. Effect of processing on provitamin A in vegetables. *J Am Diet Assoc.* 1971; 59:238-243.
46. Speek AJ, Speek-Saichua S, Schreurs WHP. Total carotenoid and β-carotene contents of Thai vegetables and the effect of processing. *Food Chem.* 1988; 27:245-257.
47. Bushway AA, Serreze DV, McGann DF, True RH, Work TM, Bushway RJ. Effect of processing method and storage time on the nutrient composition of fiddlehead greens. *J Food Sci.* 1985; 50:1491-1492.
48. Padula M, Rodriguez-Amaya DB. Changes in individual carotenoids and vitamin C on processing and storage of guava juice. *Acta Alim.* 1987; 16:209-216.
49. Godoy HT, Rodriguez-Amaya DB. Changes in individual carotenoids on processing and storage of mango *(Mangifera indica)* slices and puree. *Int J Food Sci Technol.* 1987; 22:451-460.
50. Chandler LA, Schwartz SJ. Isomerization and losses of trans-β-carotene in sweet potatoes as affected by processing treatments. *J Agric Food Chem.* 1988; 36:129-133.
51. Beecher GR, Khachik F. Analysis of micronutrients in foods. In: Moon TE, Micozzi MS, eds. *Nutrition and Cancer Prevention: Investigating the Role of Micronutrients.* New York, NY: Marcel Dekker, Inc; 1989:103-158.
52. Buzzard IM, Price KS, Warren RA. Considerations for selecting nutrient-calculation software: evaluation of the nutrient database. *Am J Clin Nutr.* 1991; 54:7-9.
53. Holden JM, Gebhardt S, Davis CS, Lurie DM. A nationwide study of the selenium contents and variability in white bread. *J Food Comp Anal.* 1991; 4:183-195.
54. Hsieh YP, Karel M. Rapid extraction and determination of alpha- and beta-carotene in foods. *J Chromatogr.* 1983; 259:515-518.
55. Bushway RJ, Yang A, Yamani AM. Comparison of alpha- and beta-carotene content of supermarket versus roadside stand produce. *J Food Qual.* 1987; 9:437-443.
56. Brown ED, Micozzi MS, Craft NE, Bieri JG, Beecher G, Edwards BK, Rose A, Taylor PR, Smith JC Jr. Plasma carotenoids in normal men after a single ingestion of vegetables or purified β-carotene. *Am J Clin Nutr.* 1989; 49:1258-1265.
57. Khachik F, Beecher GR, Whittaker NF. Separation, identification, and quantification of the major carotenoid and chlorophyll constituents in extracts of several green vegetables by liquid chromatography. *J Agric Food Chem.* 1986; 34:603-616.
58. Ramos DMR, Rodriguez-Amaya DB. Determination of the vitamin A value of common Brazilian leafy vegetables. *J Micronutr Anal.* 1987; 3:147-155.
59. Bushway RJ, Wilson AM. Determination of α- and β-carotene in fruit and vegetables by high performance liquid chromatography. *Can Inst Food Sci Technol.* 1982; 15:165-169.
60. Ogunlesi AT, Lee CY. Effect of thermal processing on the stereoisomerization of major carotenoids and vitamin A value of carrots. *Food Chem.* 1979; 4:311-318.
61. Simon PW, Wolff XY. Carotenes in typical and dark orange carrots. *J Agric Food Chem.* 1987; 35:1017-1022.
62. Cecchi HM, Rodriguez-Amaya DB. Carotenoid composition and vitamin A value of fresh and pasteurized cashew-apple *(Anacardium occidentalis L.)* juice. *J Food Sci. 1981; 46:147-149.*
63. Speek AJ, Temalilwa CR, Schrijver J. Determination of β-carotene content and vitamin A activity of vegetables by high-performance liquid chromatography and spectrophotometry. *Food Chem.* 1986; 19:65-74.
64. Pepping F, Vencken CMJ, West CE. Retinol and carotene content of foods consumed in East Africa by high performance liquid chromatography. *J Sci Food Agric.* 1988; 45:359-371.
65. Lee CY, McCoon PE, LeBowitz JH. Vitamin A value of sweet corn. *J Agric Food Chem.* 1981; 29:1294-1295.
66. Padula M, Rodriguez-Amaya DB. Characteristics of the carotenoids and assessment of the vitamin A value of Brazilian guavas. *Food Chem.* 1986; 20:11-19.
67. Rodriguez-Amaya DB, Kimura M, Godoy HT, Arima HK. Assessment of provitamin A determination by open column chromatography/visible absorption spectrophotometry. *J Chromatogr Sci.* 1988; 26:624-629.
68. Mercadante AZ, Rodriguez-Amaya DB. Comparison of normal-phase and reversed-phase gravity-flow column methods for provitamin A determination. *Chromatographia.* 1989; 28:249-252.
69. Gross J, Gabai M, Lifshitz A. Carotenoids in juice of Shamouti orange. *J Food Sci.* 1971; 36:466-473.
70. Stewart I. High performance liquid chromatographic determination of provitamin A in orange juice. *J Assoc Off Anal Chem.* 1977; 60:132-136.
71. Heinonen M, Ollilainen V, Linkola E, Varo P, Koivistoinen P. Carotenoids and retinoids in Finnish foods: ready-to-eat foods. *J Food Comp Anal.* 1988; 1:221-230.
72. Khachik F, Beecher GR. Separation and identification of carotenoids and carotenol fatty acid esters in some squash products by liquid chromatography. 1. Quantification of carotenoids and related esters by HPLC. *J Agric Food Chem.* 1988; 36:929-937.
73. Zakaria M, Simpson KL, Brown P. Use of reversed phase HPLC analysis for the determination of provitamin A carotenes in tomatoes. *J Chromatogr.* 1979; 176:109-117.

155

Using Drama for Health Communications: Report from Burkina Faso, Mali and Niger

by Peter Gottert

Societies have been communicating important social lessons for generations through proverbs, anecdotes, stories, rituals and dance. Yet projects frequently ignore traditional media in favor of relatively didactic approaches to transferring information. Just as drama and narratives add color, character and humor to daily life, they can also infuse local relevance, creativity and enthusiasm into communication programs.

Working with project counterparts in Africa, the USAID-funded Nutrition Communication Project (NCP) tapped the creative potential of drama and stories to facilitate effective program development and to communicate health concepts directly to rural populations.

Since 1989, NCP has assisted the Ministries of Health in Burkina Faso, Mali and Niger in planning and implementing communication programs in maternal and child nutrition. The overall goal of each program is to reduce malnutrition rates for children under five in the project regions. NCP uses qualitative field research to help identify household behaviors that can be modified with little or no additional financial or other input from outside the family. Much of NCP's effort is centered around fostering new attitudes about the distribution of family resources to improve the diets of women and children. In each program, men are encouraged to play a more active role in their family's nutrition.

Role plays, skits and stories can be used to guide, inspire and implement communication programs. The NCP experience suggest the following:

Role plays make research findings relevant locally

While written research "findings" help identify program objectives, target audiences and ideas for messages, they do not usually convey a multi-dimensional portrait of family or community life. The use of tapes or transcripts of selected focus groups can add an element of empathy to discussions. Role-plays are another way to help project teams see true-to-life models and understand how health and nutrition messages relate to everyday village situations. The spontaneous and dramatic nature of the role play makes it ideal for illustrating potential obstacles to proposed messages.

In Mali, during a strategy workshop, role plays were used for "brainstorming." Participants from government ministries who had read the field research results came to life when asked to use role plays to interpret specific family situations related to food distribution. Role plays provided insights and acted as catalysts for the development of a communication strategy.

Test and strengthen messages through skits

Village-based skits are an effective means of pretesting ideas for messages, exploring and understanding how proposed behaviors relate to traditional customs. Unlike role play, skits are rehearsed beforehand and therefore permit a sharper focus on specific issues. Skits can serve as a final check on unforeseen obstacles and conditions that must be negotiated within a family. A focus group type discussion should follow the presentation of each skit. For example, based on field research a Vitamin A technical team might decide to encourage husbands to

buy 50 francs of liver a week for their wives. By developing a scenario around the idea and staging a village-based skit, the team captures the population's reaction to the proposed behavior as it is being carried out. The population responds directly to what they see, not to a hypothetical "what if."

A story ties messages together

A story with believable characters is more memorable because it places the messages in a culturally appropriate frame of reference. A story can help the project team understand the relationship among individual messages. Some messages cluster and reinforce one another and may represent sequential steps of a larger action. Other messages fall outside a cluster and require a particular communication approach. The story serves as a unifying element of the overall strategy.

In Burkina Faso, actors worked directly from the transcripts of focus groups, to create a dramatic piece *"Deux familles burkinabé sur le chemin de la santé."* Following a pretest and technical revision to firmly root it in Burkina culture, the story became the foundation of a multi-channeled communication program. The story was captured on slides to facilitate its use during training and to help insure high quality images for print materials. Two flipcharts, a poster, a health center handout, literacy booklets and lessons for school children were produced based on the *"Deux familles"* story. Finally, the story was used as a starting point for the creation of a 20 episode radio drama.

Mobilize communities with drama

In addition to being an effective pretest tool, skits performed by village teams for local audiences draw directly on the creative potential of the African people. Members of a community organization can be trained in a week to successfully stage skits based on scenarios developed by a project team. Amateur actors learn the parts more quickly and interchange roles easily when skits are short (3-5 minutes).

In Niger, upon returning from a workshop, five member "Animation" teams immediately began presenting skits to enthusiastic audiences. In the first month the teams presented only skits based on the scenarios developed by the project team. Afterwards they created their own scenarios. Seventy original, innovative skits were developed, which, with rare exceptions, stuck faithfully to the messages.

The village teams took charge of their communities' nutrition education program and communicated directly through humorous and dramatic portrayals of village life. An evaluation of the project showed the skits had direct impact on the audiences and also generated considerable discussion in market places and within families.

Conclusions

Information does not, by itself, translate into widespread adoption of the desired behaviors. People need to see examples of recommended actions within the family and community. Stories and drama offer the flexibility for communicating diverse messages to a variety of audiences. Moreover, they can spur a project team on at critical moments and infuse the overall program with energy and excitement.

Peter Gottert is a program officer for the Nutrition Communications Project.

Single copies of Communications Strategies to Support Infant and Young Child Nutriton *are available for readers in Asia, Africa and Latin America. Contact NCP/Academy for Educational Development, 1255 23rd St., NW, Washington, DC 20037, USA.*

ARROW

(Asia-Pacific Resource and Research Centre for Women)

ARROW is a resource and research organization dedicated to improving the quality of development policies and programs affecting women in the Asia-Pacific region.

ARROW provides information and resource materials to women's organizations and government and non-governmental organizations to re-orient policies and programs to greater sensitivity and responsiveness to women's needs and perspectives. It facilitates the generation and use of new research findings and analyses on policies, programs and organizations and the exchange and dissemination of information through a regional and global network of organizations. The initial emphasis is on women and health.

The Resource Centre collects a range of materials which include books, monographs, journals and newsletters as well as videos, brochures and education materials. The focus is on national development policies and plans on women and development, especially those specific to reproductive health and population; relevant legislation, administrative policies and regulations; current research studies and technical information; program, project and organizational evaluations; and case studies of effective projects and programs.

ARROW is a member of the International Women's Health Documentation Project which includes the Boston Women's Health Book Collective, SOS Corpo (Brazil), ISIS (Chile) and CIDHAL (Mexico). This project grew out of a need to support women's organizations with reliable and accurate information on numerous issues affecting women's health and to incorporate women's perspectives into public policies affecting women's health and population programs. A computerized database encompassing the collections held by five participating institutions has been set up. The database features extensive cross-referencing and searching capabilities and will soon be accessible electronically by all member institutions. ARROW also has access to POPLINE and other databases through electronic mail.

Information Services include literature searches, bibliographies, accession lists of the centre's materials and copies of documents. Statistical information, including indicators of women's health status are also available. Information can be obtained in a printed format or on diskette for a fee. Other services include research and program evaluation, reviews of policies and programmes affecting women's health, highlighting successful programmes in Asia and Pacific and the production of action-oriented regional publications such as information packets, annotated bibliographies, resource kits, news bulletin and research reports on selected issues. Presently ARROW is implementing the Malaysian component of the International Reproductive Rights Research and Action Group's (IRRRAG) global ethnographic study.

Asian-Pacific Resource
& Research Centre for Women
2nd Floor, Block F
Anjung Felda, Jalan Maktab, 54000 Kuala Lumpur
MALAYSIA
Tel: (603) 292-9913 Fax: (603) 292-9958
E-mail: women@arrow.po.my

Statement on natural food sources of vitamin A and provitamin A

IUNS Committee II/6

The International Union of Nutritional Sciences (IUNS) Committee II/6 on Nutrition and Anthropology has developed the following statement on the basis of the two preceding reviews.

Vitamin A deficiency is highly prevalent in developing regions: recent data indicate that the magnitude and severity of the problem are more extensive than originally assessed. Temporary measures to treat and control vitamin A deficiency, notably the periodic massive dosage approach, are still being actively promoted for their value in reducing child mortality [1]. Community trials in India [2], Indonesia [3], and Nepal [1] strongly support the association of vitamin A supplementation and reduced preschool child mortality. Vitamin A supplements have an important role in child survival, particularly in reducing mortality associated with infectious disease. However, the continued use of synthetic vitamin A supplements may be creating a complacency relative to the long-term goals for improved dietary intake of vitamin A-rich foods [4]. The benefits of promoting natural food sources of vitamin A are that change will be more sustainable and economically sound.

Improving vitamin A status through dietary modifications requires accurate food composition data for the identification of vitamin A-rich foods, assessment of dietary intake of vitamin A, and recommendations on cooking processes that minimize losses of preformed vitamin A and provitamin A. The widespread use of high performance liquid chromatography (HPLC) has created an expanding database of nutrient values, including information on isomers associated with the cooking process that reduce the biological availability of vitamin A. However, the food composition data on vitamin A-rich foods are far from complete. In developing regions HPLC is often not a viable analytical technique, and local foods are often analysed using outdated techniques, or nutrient values are extrapolated from analysis of foods from different geographical regions. To date, few food composition tables have been updated to incorporate the expanding data on vitamin A, including identification and quantification of different carotenoids and isomers. Given the large variation in the nutrient content of vitamin A-rich foods and inadequacies in the food composition literature, there has been a shift towards the classification of foods based on their relative contribution to vitamin A intake [5]. By reducing vitamin A activity into a score of low, medium, and high based on retinol equivalents (RE), a simplified dietary analysis can possibly be used in some situations to estimate dietary intake of vitamin A.

Reaching the goal of improving vitamin A status through dietary modifications involves more than an increased intake of vitamin A-rich foods. For example, at least 5 g per day of dietary fat is recommended in a child's diet to optimize the absorption and utilization of preformed vitamin A and provitamin A [6]. Other nutrients that facilitate the utilization of vitamin A include protein, vitamin E, and zinc. The nutrient density of the diet is also an issue in formulating dietary recommendations for groups at risk of developing vitamin A deficiency, notably preschool children. The intake of vitamin A through natural sources may be limited by the quantity and the frequency of food consumption required to meet the individual's requirements not only for vitamin A but also for other nutrients such as protein and energy. Given the well-documented interrelationships between vitamin A status and infectious disease, dietary modifications may be compromised by repeated occurrences of infection. Conversely, increased dietary intake of vitamin A from natural food sources may improve the individual's resistance to infection, although the mechanisms have yet to be clarified. Therefore a dietary approach to the vitamin A deficiency problem needs to incorporate modifications in the intake of other foods when necessary and to promote health measures that reduce infectious diseases.

Ecological, economic, and cultural factors act differentially on the intake of vitamin A-rich foods. Identification of food items rich in vitamin A activity

Food and Nutrition Bulletin, vol. 14, no. 1. © 1992, The United Nations University

158

will not improve a vitamin A deficiency problem if the foods are not available locally or are economically inaccessible. Furthermore, a single food item is subject to very different interpretations in different cultural settings, and inclusion or exclusion of a natural food rich in vitamin A can be determined by beliefs and attitudes dictated by multiple cultural factors such as religion, alterations in physiological status, and gender and age discrimination, to name a few. Moreover, intracultural variation in cultural classifications is considerable. The evidence highlights the need for locally relevant data and the active involvement of community members in the design of programmes for the improvement of vitamin A status through dietary modification. This is supported by the few available evaluations of programmes intended to increase the consumption of natural foods rich in vitamin A activity. It becomes increasingly clear that preliminary local community data on the availability of foods; their economic value; consumption patterns; attitudes, beliefs, and values about food; feeding behaviours; and existing vitamin A deficiency can be used to create locally effective programmes for the prevention of vitamin A deficiency and improved health that will be sustainable over the long term.

Social marketing techniques, nutrition education, and promotion of gardening activity all have potential for modifying dietary practices that affect vitamin A status. The few published examples of programmes that *have* created sustainable dietary modifications to treat and control the problem of vitamin A deficiency indicate that substantial efforts are required in community-based research if the long-term goals of dietary modifications to prevent vitamin A deficiency are to be achieved.

Acknowledgements

We gratefully acknowledge the contributions of Dr. Gretel Pelto and Dr. Richard Young of the Committee on Nutrition and Anthropology, International Union of Nutritional Sciences, for their contributions to the preparation of the preceding committee statement and supporting manuscripts. Special thanks also to Lauren Blum, Dr. C. Gopalan, Dr. Mahshid Lotfi, Dr. P. Pushpamma, Suttilak Smitasiri, and Dr. S. Wahba. Financial support from the Food and Nutrition Programme for Human and Social Development of the United Nations University made this work possible.

Harriet V. Kuhnlein and Isabel Nieves
Cochairpersons, Committee II/6
International Union of Nutritional Sciences

References

1. West KP, Pokhrel RP, Katz J et al. Efficacy of vitamin A in reducing preschool child mortality in Nepal. Lancet 1991;338:67-71.
2. Rahmathullah L, Underwood BA, Thulasiraj RD et al. Reduced mortality among children in Southern India receiving a small weekly dose of vitamin A. New Engl J Med 1990;323:929-35.
3. Sommer A, Tarwotjo I, Djunaedi E et al. Impact of vitamin A supplementation on childhood mortality. Lancet 1986;i:585-88.
4. Gopalan C. Combating vitamin A deficiency: need for a revised strategy. In: Gopalan C, ed. Recent trends in nutrition. New Delhi: Oxford University Press (in press).
5. IVACG. Guidelines for the development of a simplified dietary assessment to identify groups at risk for inadequate intake of vitamin A. Washington, DC: International Life Sciences Institute, 1989.
6. FAO. Requirements of vitamin A, iron, folate and vitamin B_{12}. Report of a joint FAO/WHO expert committee. FAO Food and Nutrition Series, no. 23. Rome: Food and Agricultural Organization, 1988.

159

MINISTERIO DE SALUD PUBLICA (MSP)
ORGANIZACION PANAMERICANA DE LA SALUD (OPS)
INSTITUTO DE NUTRICION DE CENTRO AMERICA Y PANAMA (INCAP)

BORRADOR

RECETAS A BASE DE ALIMENTOS FUENTES DE VITAMINA " A "

Tegucigalpa, M.D.C., Honduras, C.A.
Enero, 1994

RECETAS A BASE DE ALIMENTOS FUENTES DE VITAMINA "A"

Elaborado por: Elsa Victoria López (INCAP/OPS)
Doris Chinchilla (INCAP/OPS)
Geña Mejía (Ministerio Salud Pública)

Revisado por: Hilda Fanny Mejía (INCAP/OPS)
Rossany Auceda (OPS)

Diseño y Dibujos: Esdras Cárcamo

AGRADECIMIENTO

La elaboración del presente recetario fue posible gracias a la valiosa colaboración del personal del Centro de Salud "Ramón Villeda Morales" de la Aldea La Cuesta, perteneciente a la Región Sanitaria Metropolitana del Ministerio de Salud Pública, en la preparación y validación de las recetas.

Asimismo, un especial reconocimiento a la invaluable colaboración de la Sra. Lourdes Méndez, por haber facilitado las condiciones para la realización de las preparaciones; al grupo de voluntarias de salud de la comunidad de La Cuesta y a los alumnos de la Escuela "Felipe Cálix" por haber participado como panelistas durante las pruebas de aceptabilidad de las recetas.

CONTENIDO

INTRODUCCION

En Honduras existe un bajo nivel de consumo de alimentos, especialmente de vegetales como las hortalizas y las frutas, las que son fuente de vitaminas y minerales que el organismo necesita. Este consumo de vegetales es bajo sobre todo en lo que se refiere a las hortalizas y frutas fuentes de vitamina "A". Esto, junto con otros factores, contribuye a que los problemas de deficiencia de esta vitamina sean graves, especialmente en los niños menores de cinco años.

La vitamina "A" es una sustancia que el cuerpo humano requiere para el buen funcionamiento de la vista, para la piel, para el crecimiento y desarrollo de los niños y para protección de algunas enfermedades.

El bajo consumo de esta vitamina en los niños produce una mayor frecuencia de infecciones respiratorias, enfermedades en la piel, problemas en la vista y tardanza en recuperarse de las enfermedades. Estos problemas también pueden presentarse en la población adulta.

Una de las prácticas para proveer a nuestro cuerpo de la cantidad de vitaminas que necesita, es el aumento en el consumo de verduras y frutas. En el caso específico de la vitamina "A", se recomienda consumir verduras y frutas de color verde y amarillo intenso en su interior. Estos vegetales se encuentran en abundancia en la naturaleza sobre todo los de tipo autóctono; sin embargo, su consumo no es frecuente. Por esta razón es menester promover y dar a conocer su valor nutritivo lo mismo que las formas variadas de preparación de estos alimentos.

La vitamina "A" se encuentra también en alimentos de origen animal, como la carne de res, el hígado, las aves de corral, el pescado y mariscos, los huevos, la leche y sus derivados. Pero no todos éstos están al alcance de muchas familias.

En tal sentido, nos unimos al esfuerzo de otras instituciones, que también enfocan acciones de promoción de cultivo y consumo de alimentos fuentes de vitamina "A", presentando este recetario el cual se basa en su mayoría en alimentos autóctonos del país.

Para la preparación de este recetario se llevó a cabo un trabajo que consistió en evaluar con madres y niños escolares la aceptación del sabor de cada una de las recetas, y luego se realizaron análisis de su contenido en vitamina "A". Este análisis fue efectuado en los laboratorios del Instituto de Nutrición de Centroamérica y Panamá (INCAP) en Guatemala.

Las recetas preparadas están basadas en alimentos con alto valor nutritivo, especialmente en vitamina "A", de fácil preparación, en su mayoría disponibles en las comunidades y formando parte de los patrones culturales de alimentación; sin representar un costo alto de producción.

El recetario comprende 13 preparaciones a base de zanahoria, ayote criollo sazón, camote anaranjado, hojas de mostaza, hojas de rábano, hojas de chaya, puntas de las guías de pataste, mango criollo y plátano maduro. Además de su riqueza en esta vitamina estos alimentos nos aportan también otras sustancias nutritivas que el organismo necesita.

Esperamos que el mismo sea de mucha utilidad para las madres en la preparación de sus alimentos y de beneficio para las instituciones que promueven actividades de nutrición y de agricultura. Con esta pequeña aportación, confiamos contribuir a mejorar la dieta de las familias hondureñas.

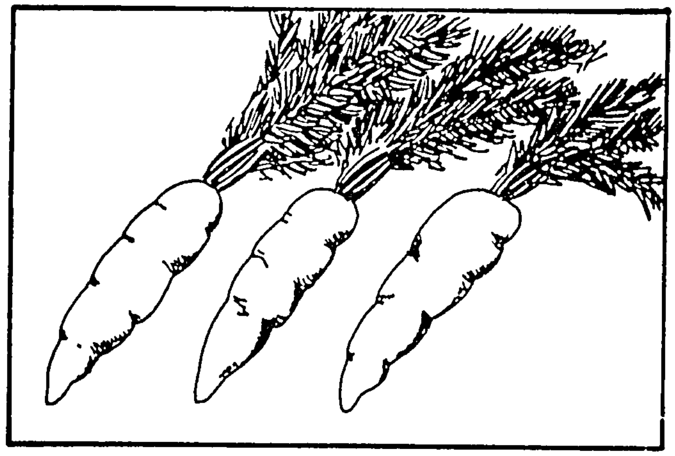
RECETAS CON ALIMENTOS FUENTES DE VITAMINA " A

RECETA No. 1

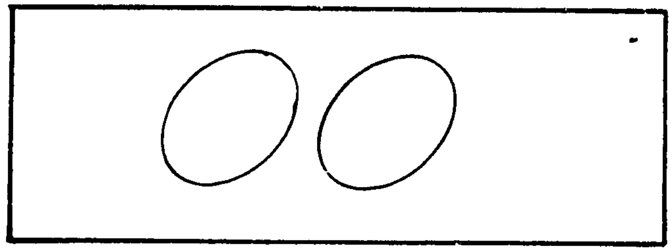
TORTITAS DE ZANAHORIA

INGREDIENTES

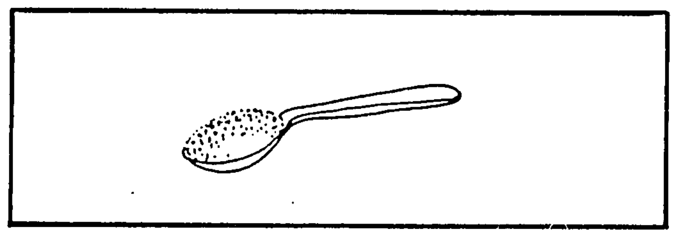
3 . Zanahorias pequeñas.



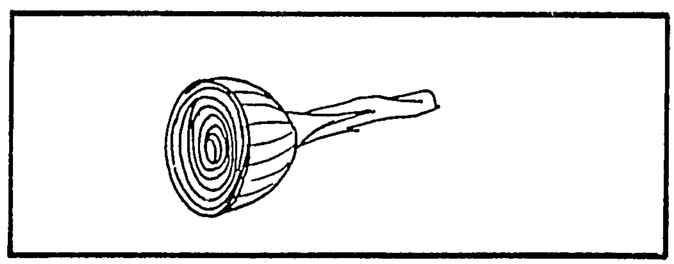
2 Huevos.



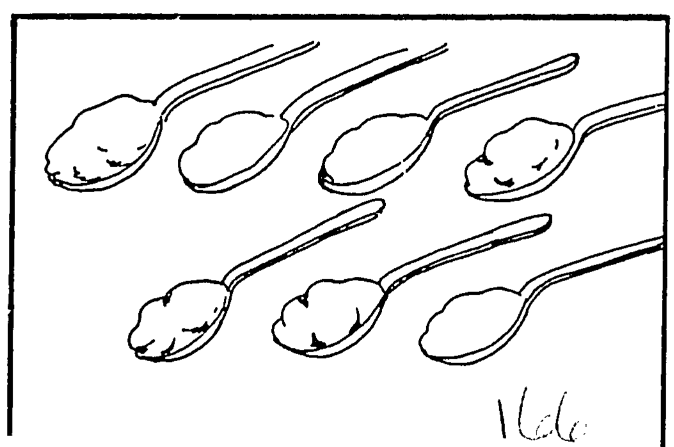
1 Cucharadita de sal.



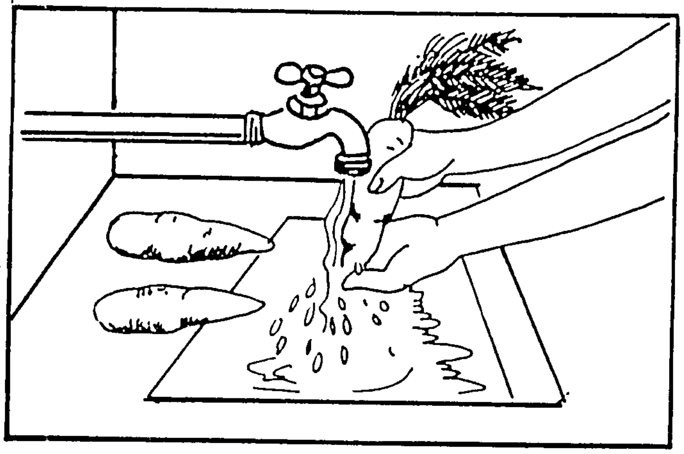
Media cebolla pequeña



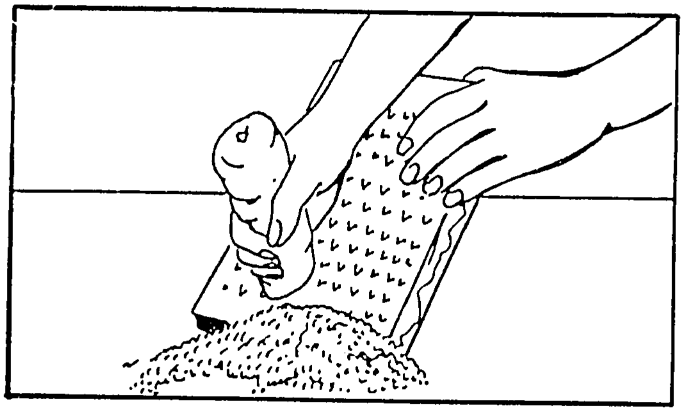
Grasa suficiente para freir
(aproximadamente 7 cucharadas)



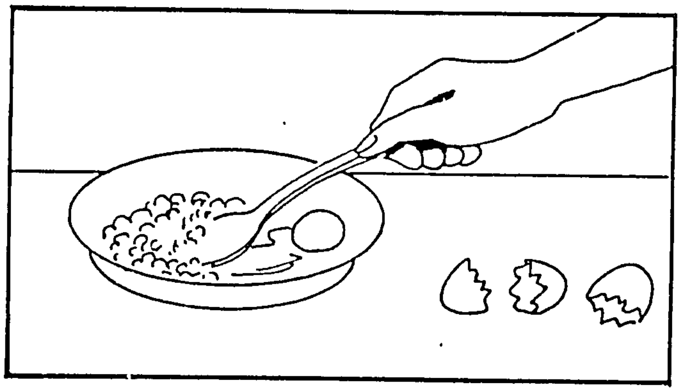
PREPARACION



1. Lavar bien las zanahorias con agua clorada , limpiarlas y dejar que se escurran, (no se pelan, solo se limpia la cáscara con un cuchillo)

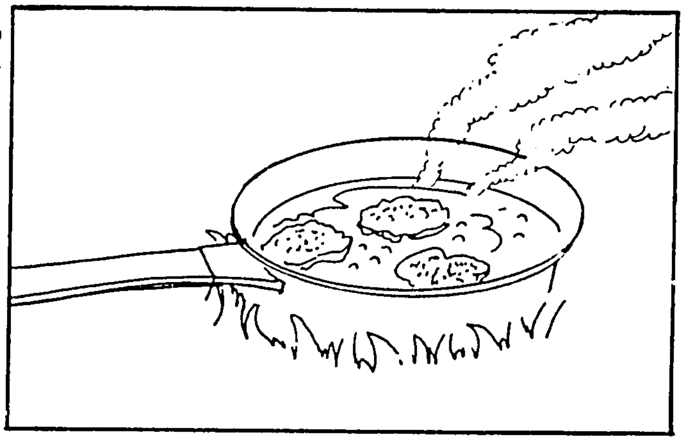


2. Rallarlas con rallador fino



3. Batir los dos huevos a punto de nieve en un plato hondo, agregarles la zanahoria rallada, la cebolla picada, la sal, revolviendo bien.

4. Inmediatamente poner a calentar la manteca o aceite.



5. Al estar caliente la manteca, se va friendo esta mezcla por cucharadas, dándole forma de tortita a cada parte que se va cocinando

6. Dejar que se doren las tortitas por cada lado, sin que se quemen.

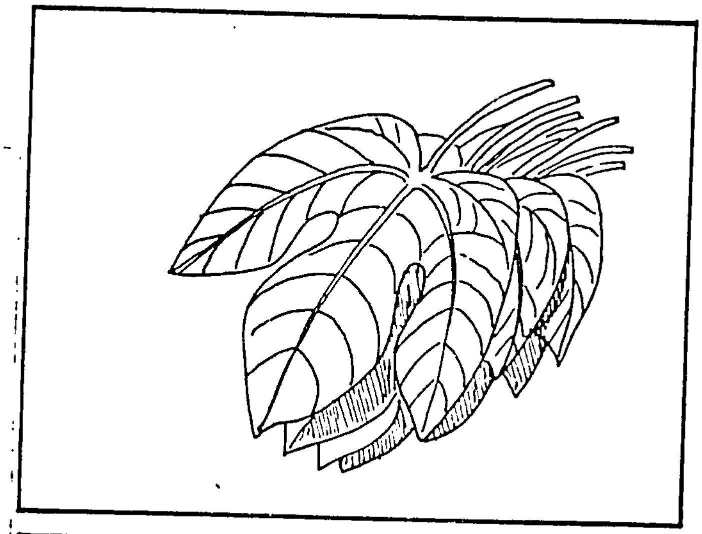
7. Las tortitas que se van friendo se ponen a escurrir antes de servirlas.

NOTA: El costo de la receta es de Lps.3.20. Se obtienen 8 porciones de dos tortitas cada una. La porción cubre la necesidad diaria de Vitamina "A" en niños de 1 a 3 años.

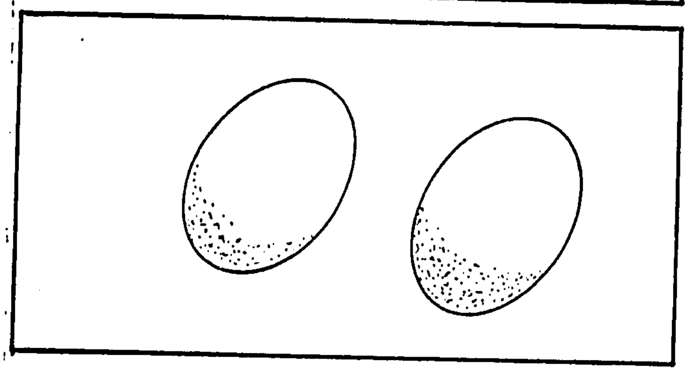
RECETA No. 2

HOJAS DE CHAYA CON HUEVO

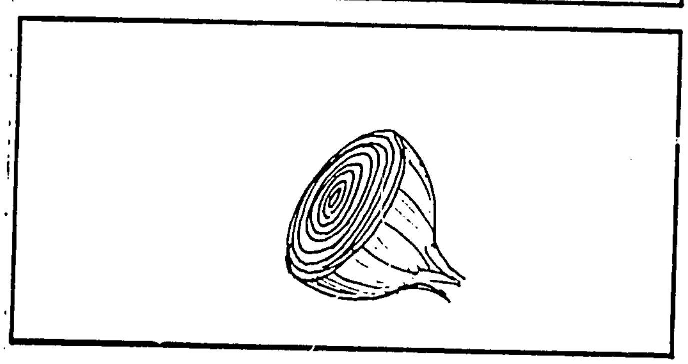
INGREDIENTES:



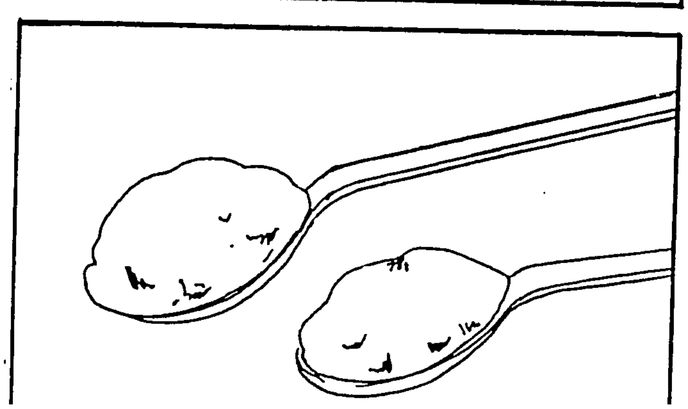
1 manojo de hojas de chaya
(de 15 a 20 hojas no muy sazonas)



2 Huevos.



Media cebolla pequeña

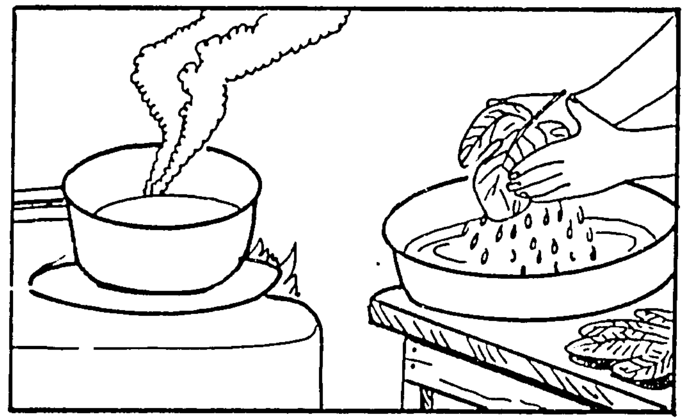


2 Cucharadas de manteca colmadas
Sal al gusto.

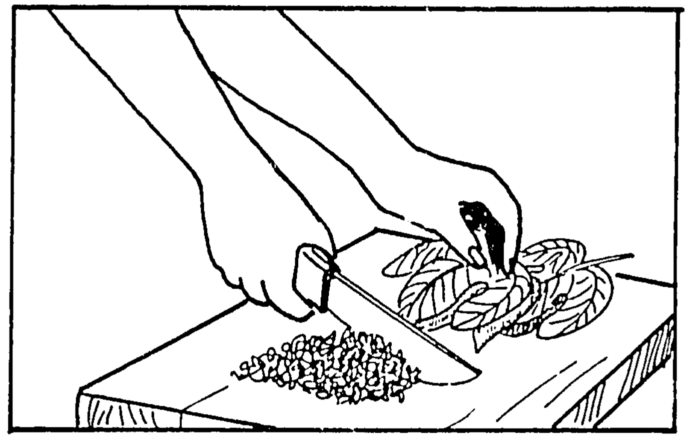
PREPARACION

1. Lavar bien las hojas una por una con agua clorada y ponerlas a cocinar con poca agua.

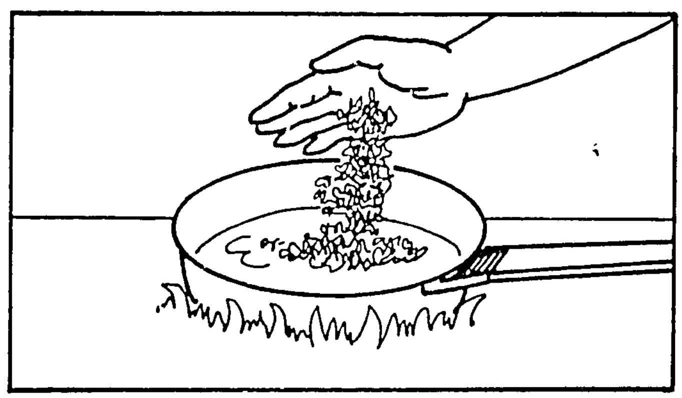
2. Al estar blandas, bajarlas del fuego.



3. Escurrirlas y picarlas bien.

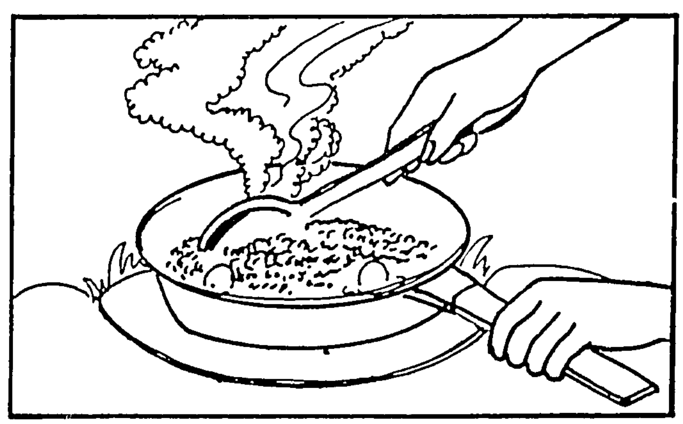


4. Poner a calentar la manteca y agregar las hojas picadas.



5. Agregar los huevos y la sal y mezclar para cocinarlas bien.

6. Al estar suficientemente frita la preparación, sacarla de la freidera y dejarla escurrir.

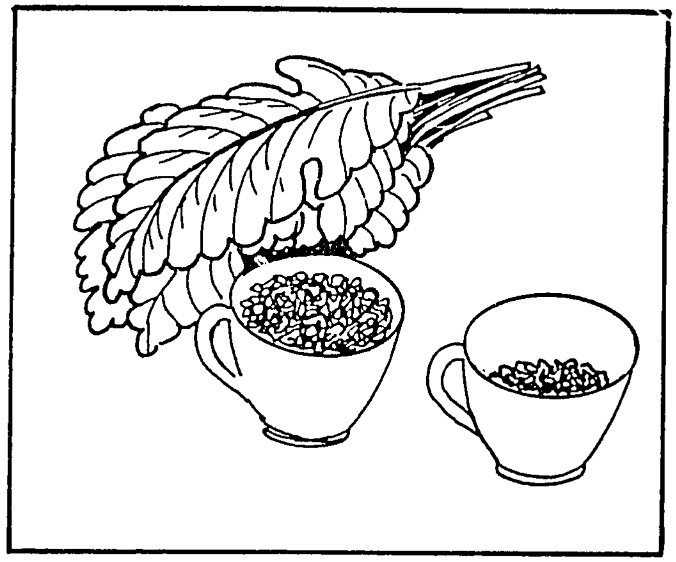


NOTA: El costo de la receta es de Lps.1.55. Se obtienen 4 porciones (3 cucharadas la porción). La porción cubre la necesidad diaria de Vitamina "A" en niños de 1 a 3 años.

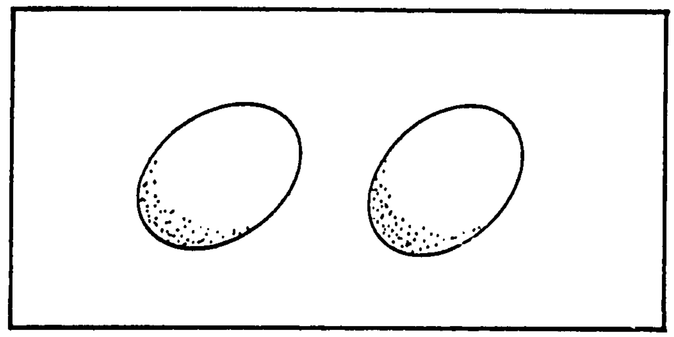
RECETA No. 3

HOJAS DE RABANO CON HUEVO

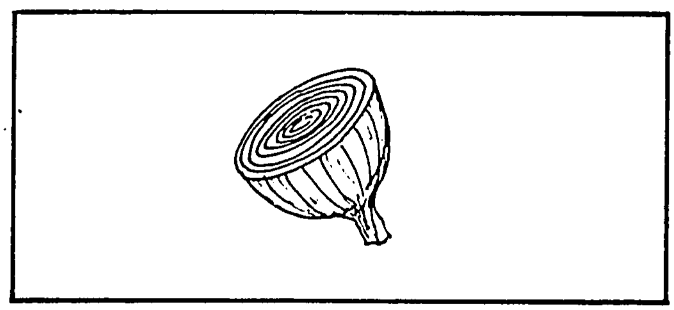
INGREDIENTES



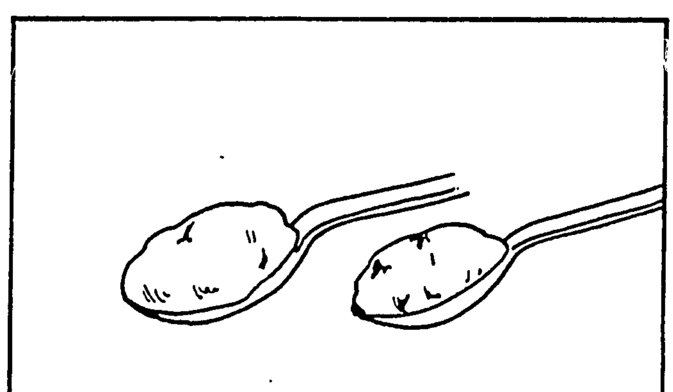
1 Mazo de hojas de rábano frescas (una y media tazas caseras de las hojas picadas)



2 Huevos.



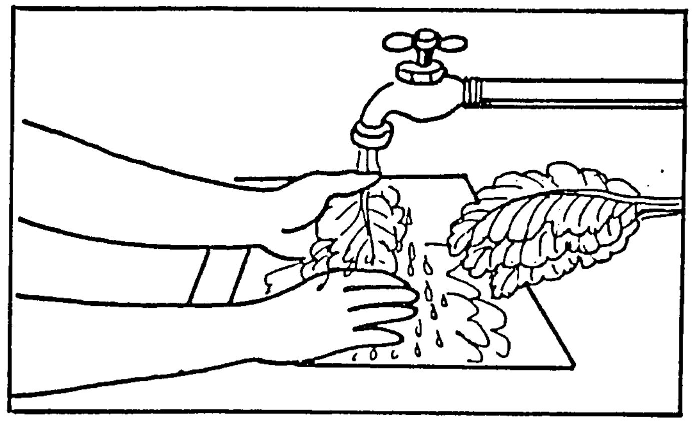
Media cebolla pequeña



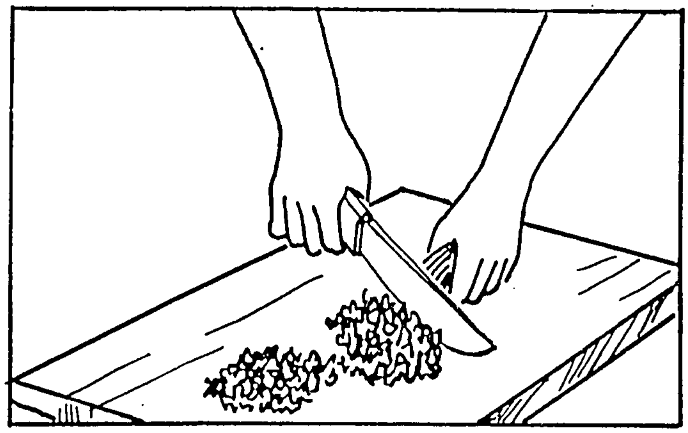
2 Cucharadas de manteca
Sal al gusto.

PREPARACION

1. Limpiar y lavar bien las hojas, una por una con agua clorada.

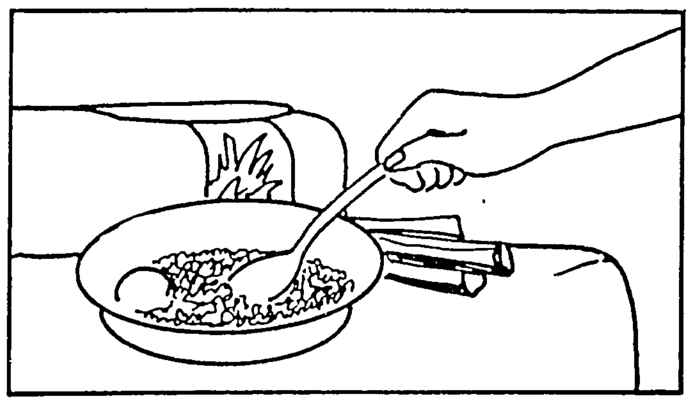


2. Dejarlas escurrir y picarlas finamente.



3. Batir los huevos en un plato hondo y agregar la sal.

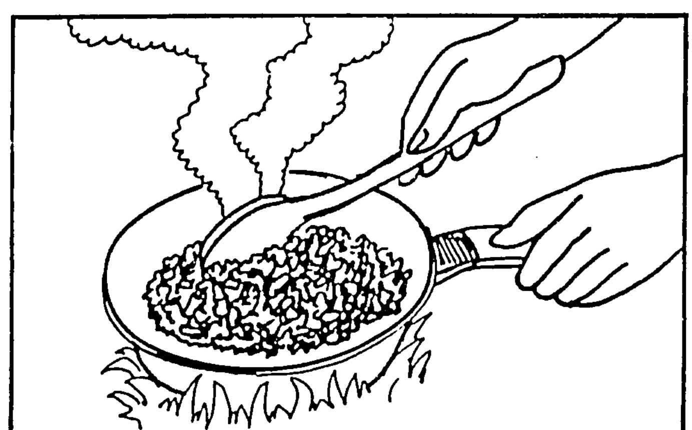
4. Poner a calentar la manteca.



5. Agregar las hojas de rábano y la cebolla picada al huevo y echar a freir en la manteca caliente.

6. Revolver con cucharón o paleta de madera, hasta freir bien la preparación.

7. Bajar del fuego y dejar escurrir antes de servir.

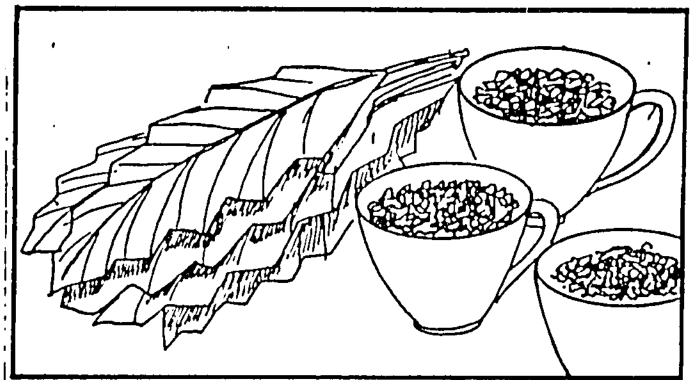


NOTA: El costo de la receta es de Lps.1.80. Se obtienen 4 porciones. La porción cubre cerca de la mitad de la necesidad diaria de Vitamina "A" en niños de 1 a 3 años. Esta receta también se prepara con hojas de mostaza, de acelga o de remolacha.

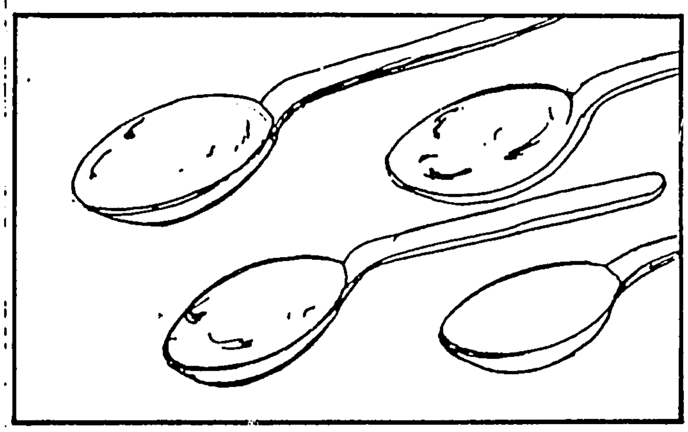
RECETA No. 4

HOJAS DE MOSTAZA SUDADAS

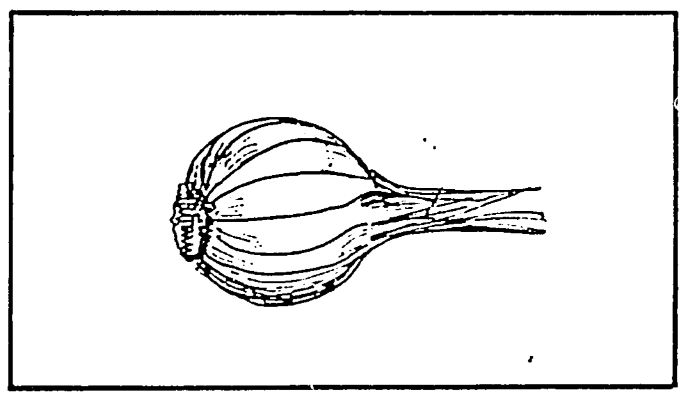
INGREDIENTES:



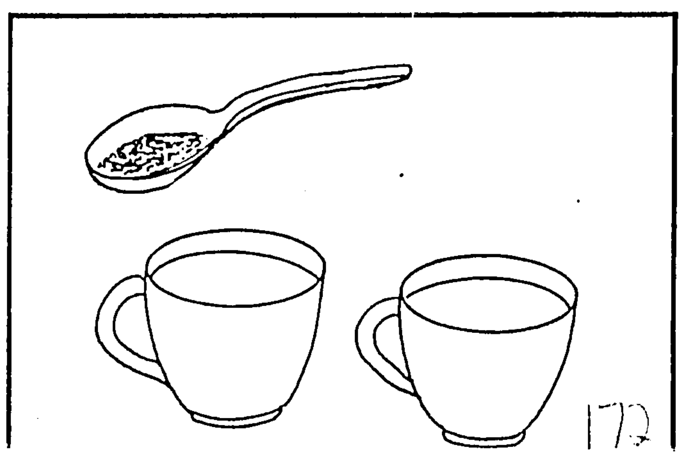
1. Mazo grande de mostaza o 3 tazas caseras de la mostaza ya picada.



4 Cucharadas de mantequilla.



1 Cebolla pequeña.

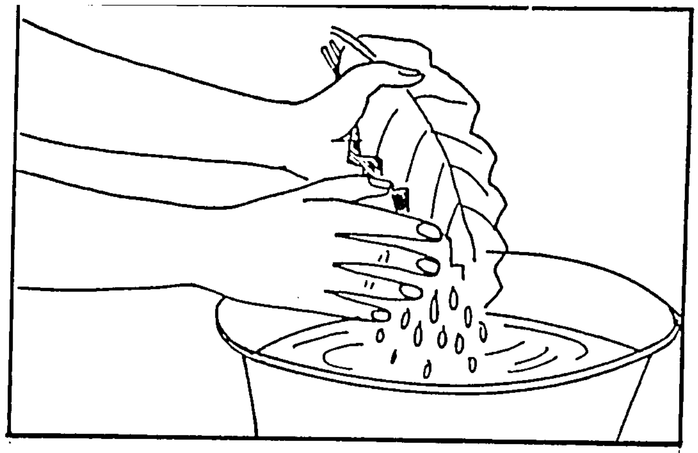


Media cucharadita de sal

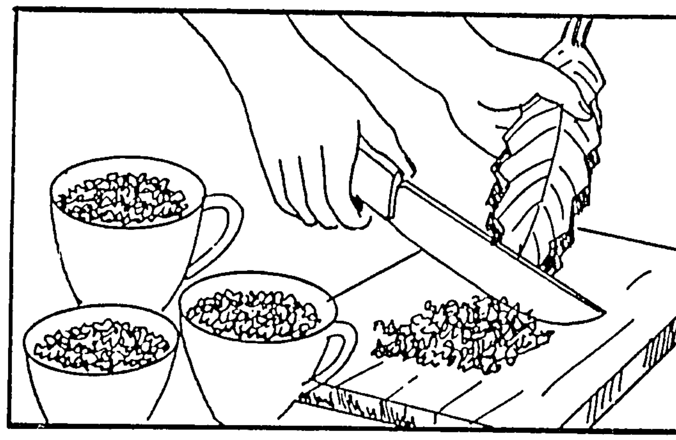
2 Tazas de agua.

PREPARACION

1. Se lava la mostaza hoja por hoja con agua clorada.



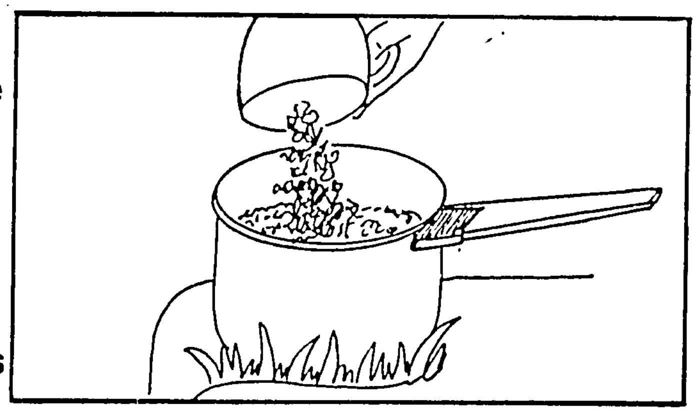
2. Se pican las hojas finamente y se miden las 3 tazas.



3. Se pone a hervir la cantidad de 2 tazas de agua; al estar hirviendo se agrega la mostaza a que se ablande.

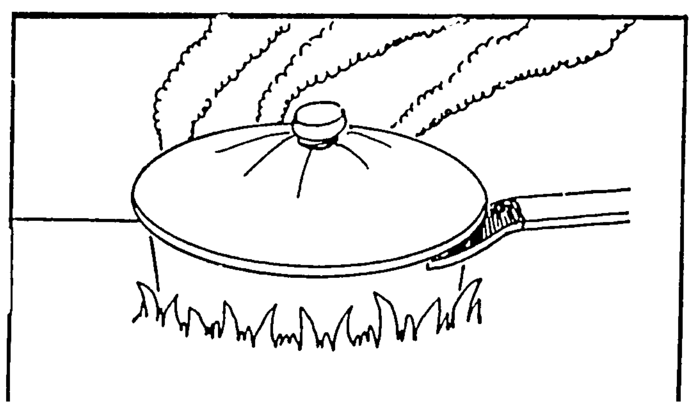
4. Sacar las hojas del recipiente donde hirvieron y ponerlas a escurrir.

5. Ponerlas en una freidera y agregarles la mantequilla, la cebolla picada y la sal.



6. Se tapa la freidera y se deja que las hojas se cocinen un poco más con la mantequilla.

7. Se bajan del fuego y se sirven con el resto de la comida.



NOTA: El costo de la receta es de Lps. 1.80. Se obtienen 4 porciones. La porción cubre la tercera parte de la necesidad diaria de Vitamina "A" en niños de 1 a 3 años. Las hojas de mostaza también se preparan con huevo igual que las hojas de rábano.

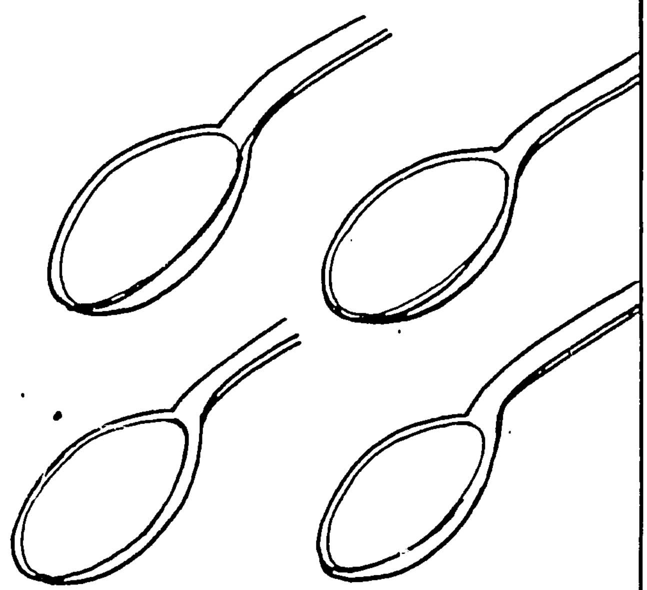
RECETA No. 5

PUNTAS DE GUIAS DE PATASTE SUDADAS

INGREDIENTES

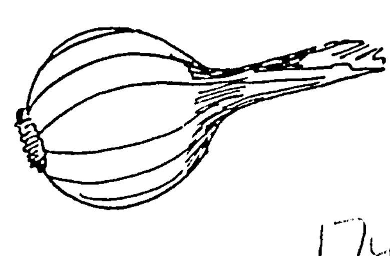
2 Tazas de puntas de pataste tiernas.

4 Cucharadas de mantequilla.

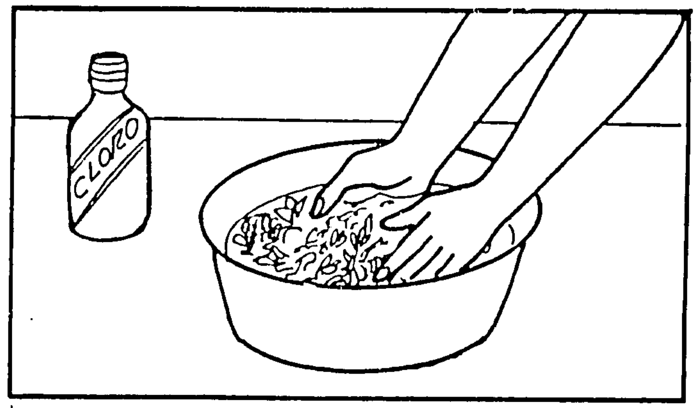


1 Cebolla pequeña

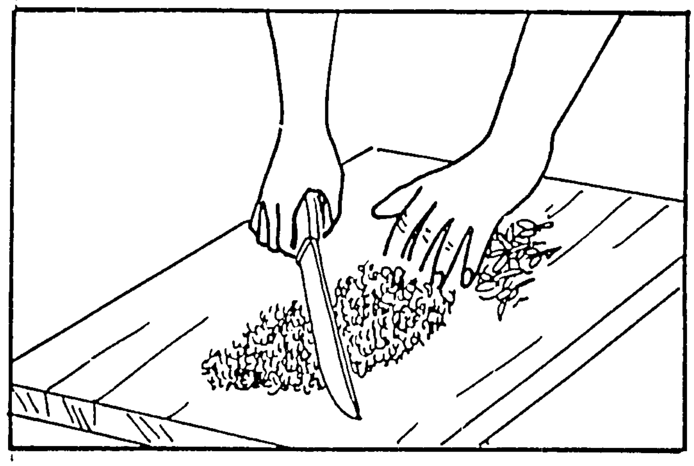
Sal al gusto.



PREPARACION

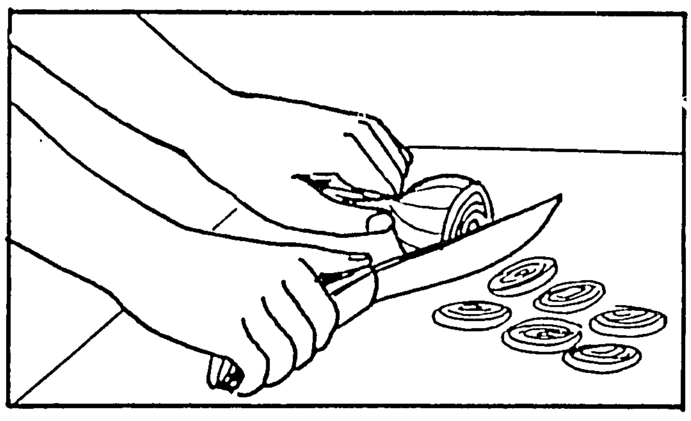


1. Lavar bien con agua clorada las puntas de las guías del pataste.

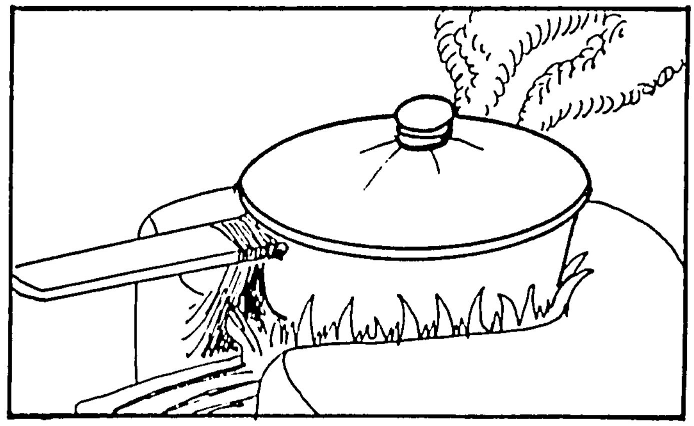


2. Picarlas y ponerlas a cocinar en poca agua a que den solamente un hervor.

3. Bajarlas del fuego, escurrirlas bien



4. Picar finamente la cebolla.



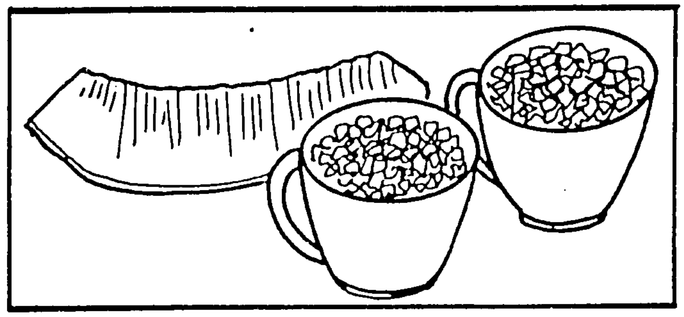
5. Poner las puntas de pataste y la cebolla en una freidera, agregar la mantequilla y dejarlas sudar a fuego lento a que absorban el sabor de la mantequilla.

NOTA: El costo de la receta es de Lps.0.65. Se obtienen 4 porciones. La porción cubre la quinta parte de la necesidad diaria de Vitamina "A" en niños de 1 a 3 años.

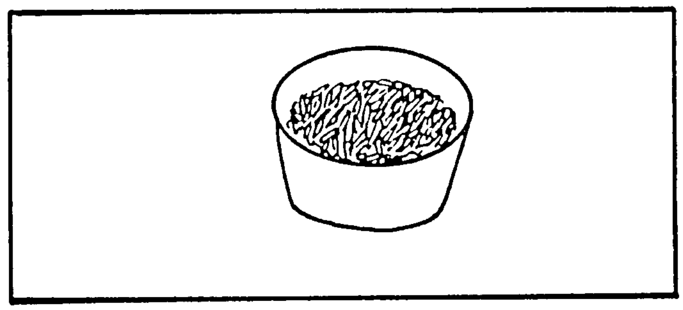
RECETA No. 6

ARROZ CON AYOTE

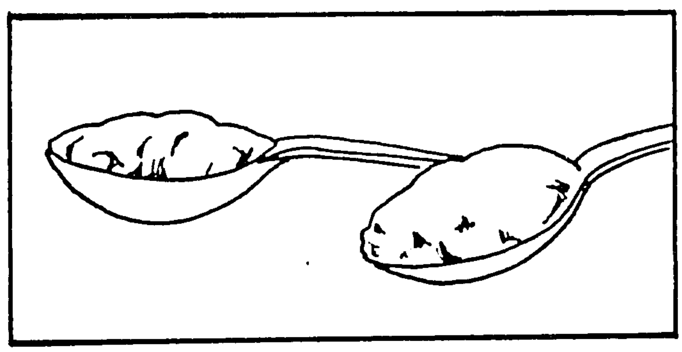
INGREDIENTES:



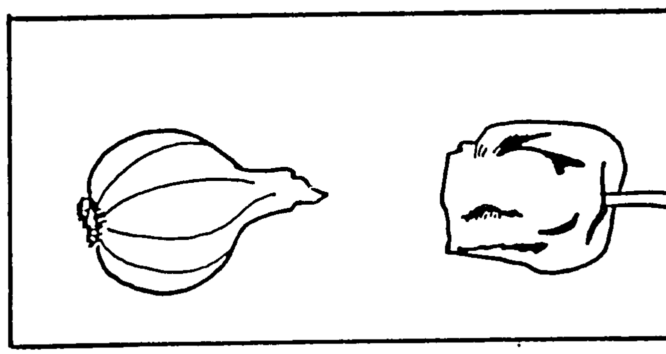
1 Libra de ayote sazón (2 tazas y media partido en cuadritos)



1 Libra de arroz.

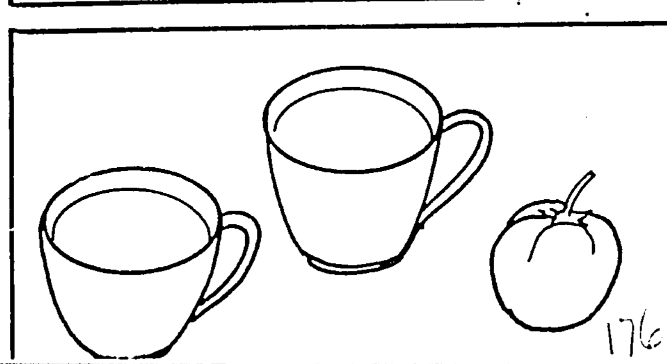


2 Cucharadas de manteca.



1 Cebolla pequeña.

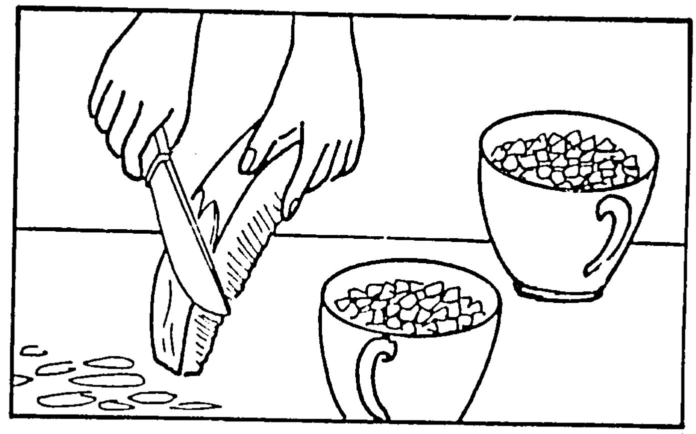
Medio chile dulce pequeño



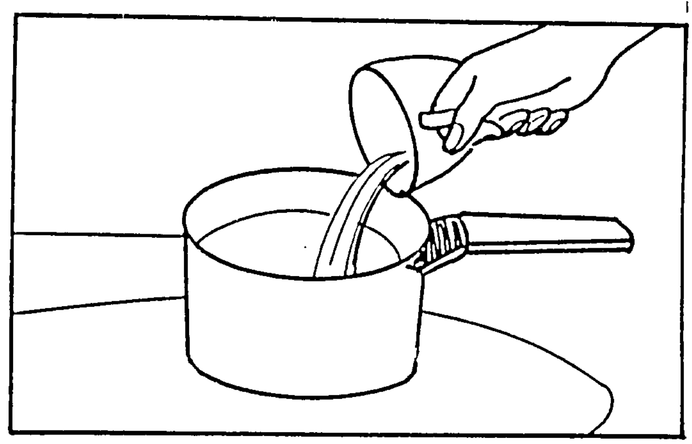
2 Tazas de agua.

1 Tomate pequeno
Sal al gusto.

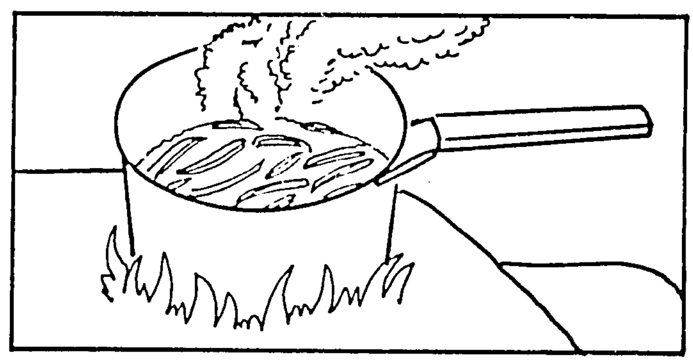
PREPARACION



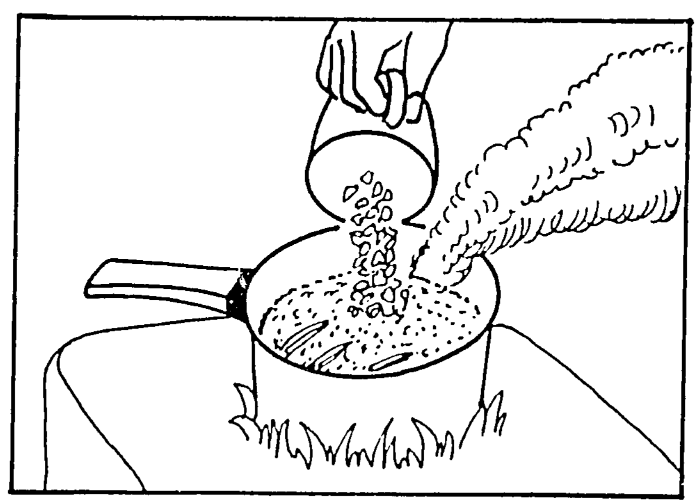
1. Lavar el ayote, pelarlo y partirlo en cuadritos.



2. Partir el chile en tiritas, partir también el tomate y la cebolla y sofreirlos con las 2 cucharadas de manteca.
3. Limpiar el arroz y agregarlo a los condimentos a que se sofría también.
4. Añada el agua hasta cubrir el arroz, también agregue la sal necesaria.



5. Revolver con una paleta de madera o cucharón a que se mezclen todos los ingredientes con el arroz.



6. Revuelva un poco el arroz y luego añada el ayote en cuadritos. Tape el recipiente y deje cocinar hasta que se ablande.
7. Bájelo del fuego y deje enfriar un poco, antes de servir.

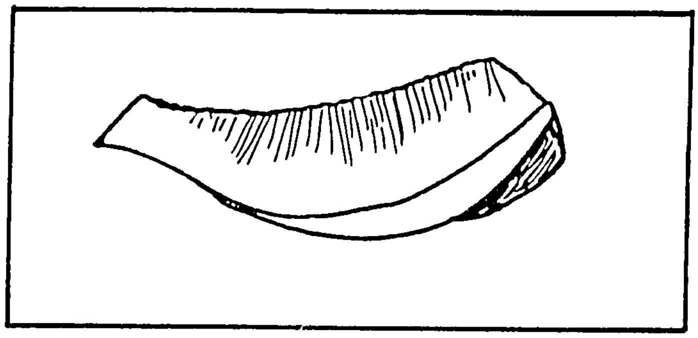
NOTA: El costo de la receta es de Lps.2.80. Se obtienen 8 porciones. La porción cubre la cuarta parte de la necesidad diaria de Vitamina "A" en niños de 1 a 3 años.

RECETA No. 7

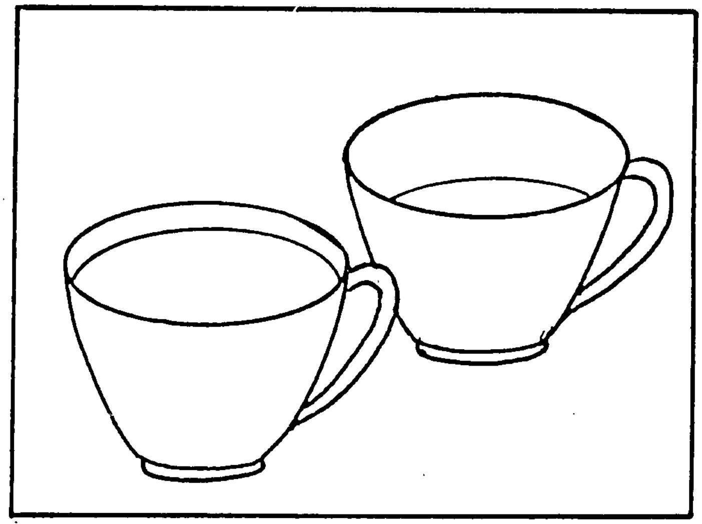
FLAN DE AYOTE

INGREDIENTES

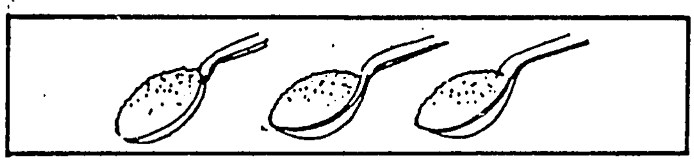
1 Libra de ayote criollo sazón.



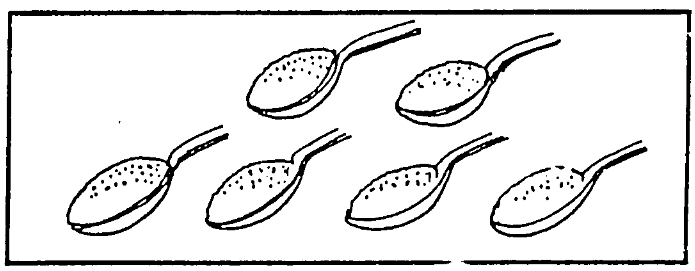
Una y media taza de leche
(tazas caseras)



3 Cucharadas de maicena.

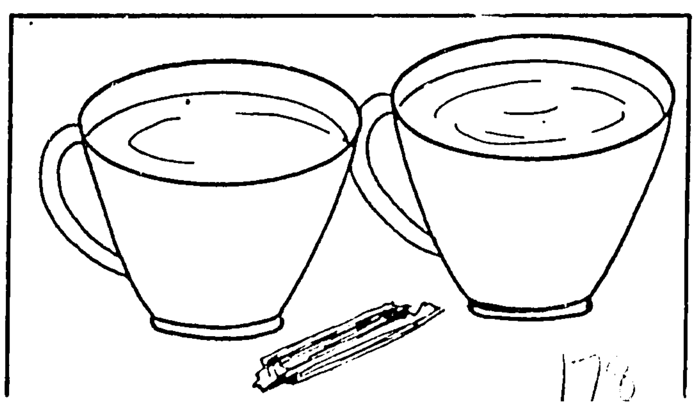


6 Cucharadas de azúcar.

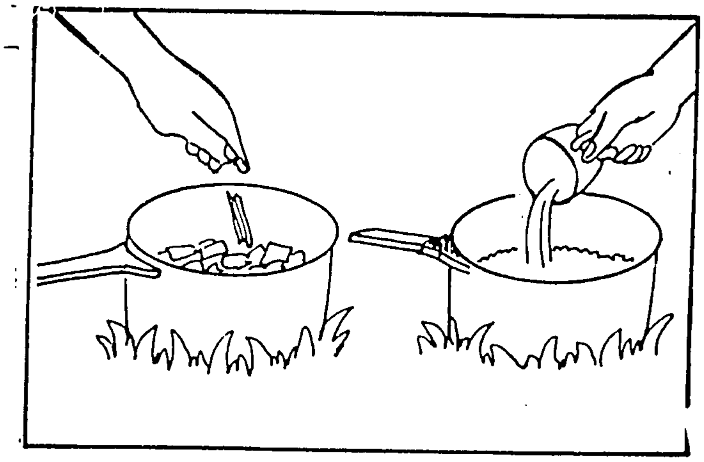


2 Tazas de agua.

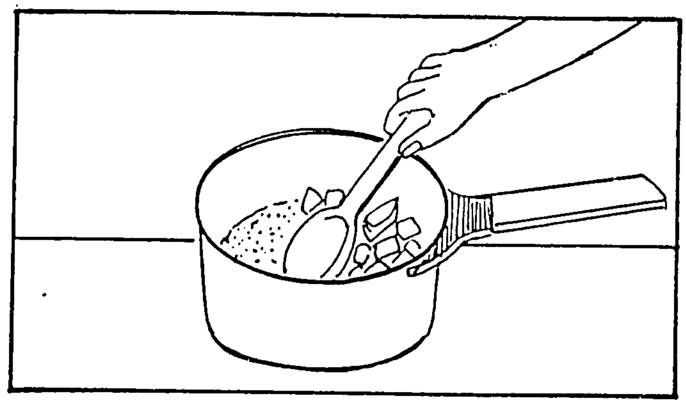
1 Rajita de canela.



PREPARACION

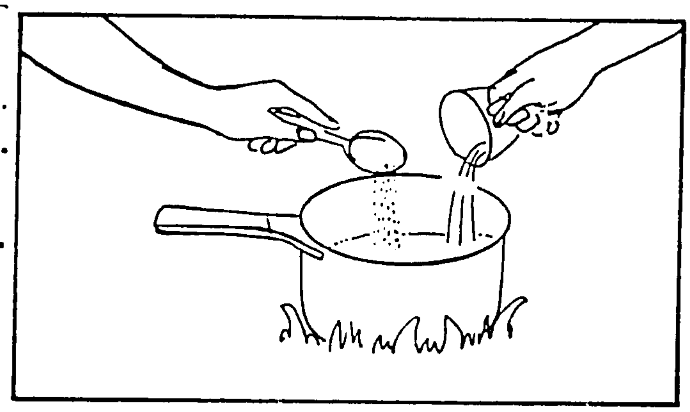


1. Lavar el ayote con agua clorada, pelarlo y ponerlo a cocer con las dos tazas de agua, agregándole una rajita de canela



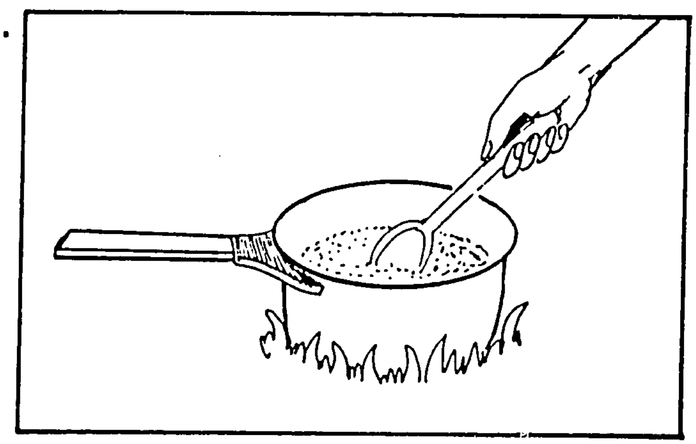
2. Cuando se ablande, bajar del fuego y deshacerlo hasta formar un puré.

3. Disolver la maicena en media taza de leche.



4. Mezclar el puré del ayote con la taza de leche restante y agregar el azúcar.

5. Dejar a que hierva la leche con el puré, sin dejar de mover para que no se ahume o pegue la preparación.



6. Agregar la maicena que se disolvió en la leche y revolver bien.

7. Dejar que se espese, sin dejar de mover, al obtener el espesor deseado se baja del fuego.

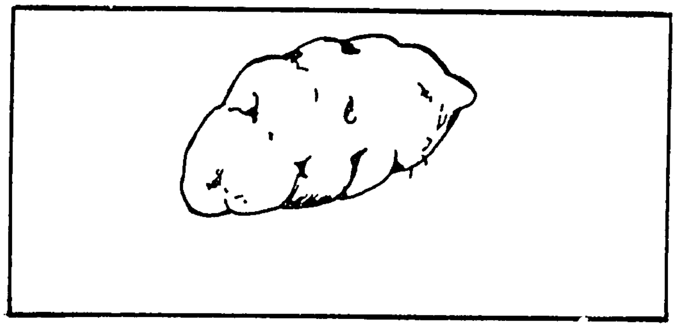
NOTA: El costo de la receta es de Lps.2.50. Se obtienen 5 porciones. La porción cubre la quinta parte de la necesidad diaria de Vitamina "A" en niños de 1 a 3 años.

RECETA No. 8

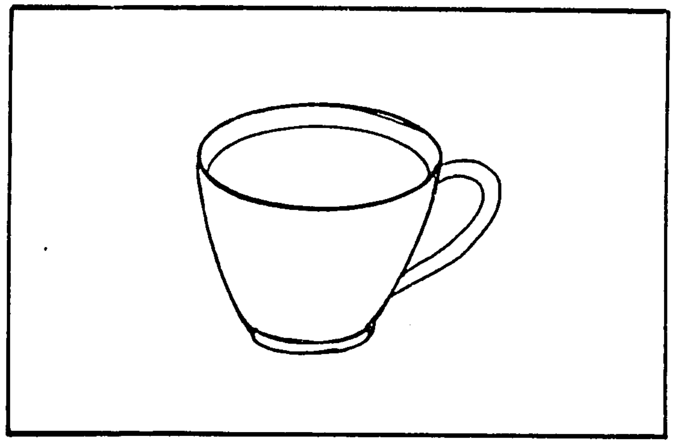
PURE DE CAMOTE

INGREDIENTES:

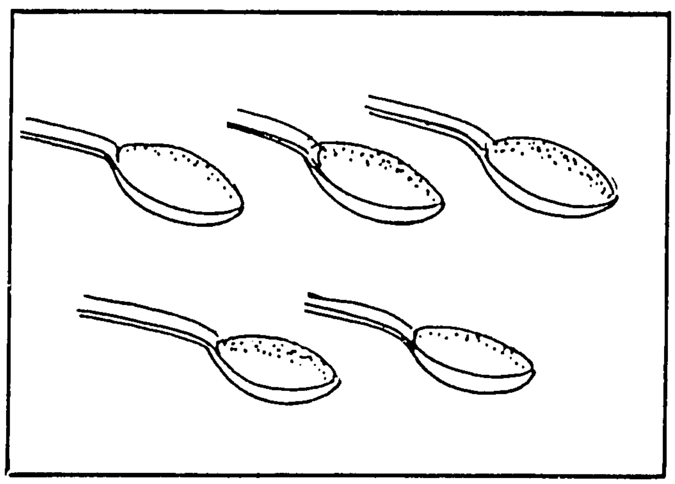
1 Camote anaranjado de más o menos 1 libra.



1 Taza de leche.

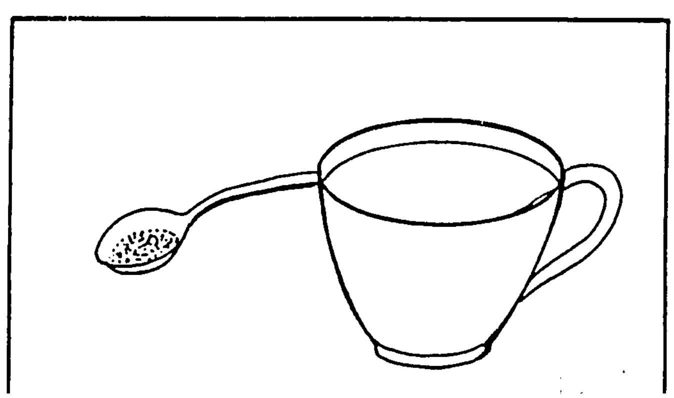


5 Cucharadas de azúcar.



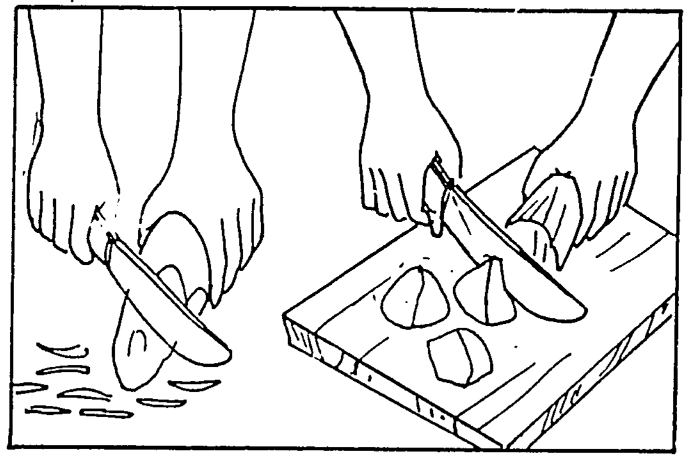
Cuarta cucharadita de canela en polvo

1 Taza de agua.

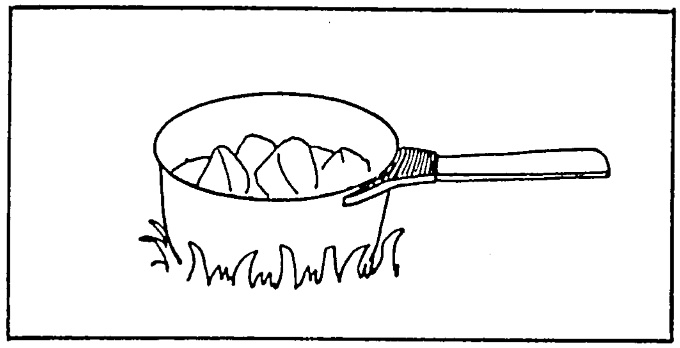


PREPARACION

1. Lavar el camote con agua clorada y pelarlo, partirlo en pedazos no muy pequeños.

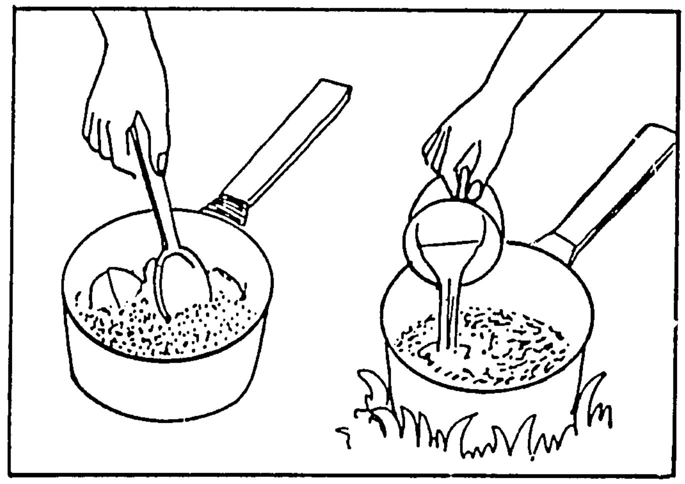


2. Ponerlo a cocinar con la taza de agua; hasta que se ablande

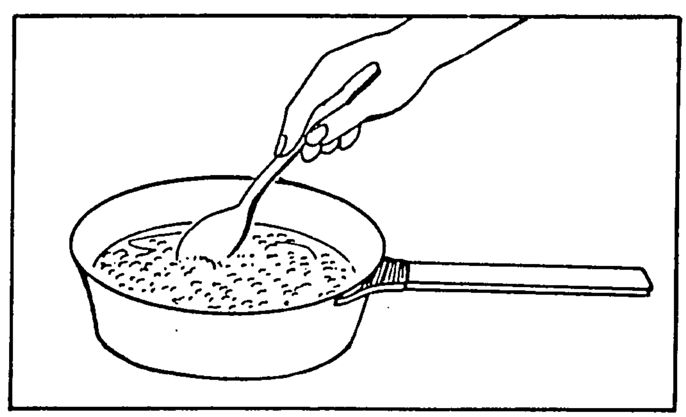


3. Bajarlo del fuego, machacarlo en el mismo recipiente que se cocinó hasta formar un puré.

4 Agregarle la leche y el azúcar y ponerlo a fuego lento a que hierva, sin dejar de moverlo para que no se pegue.



5 Bajarlo del fuego y dejarlo enfriar antes de servirlo.

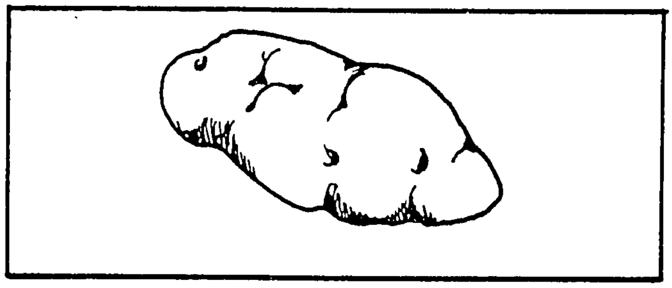


NOTA: El costo de la receta es de Lps.2.00. Se obtienen 10 porciones. La porción cubre la tercera parte de la necesidad diaria de Vitamina "A" en niños de 1 a 3 años.

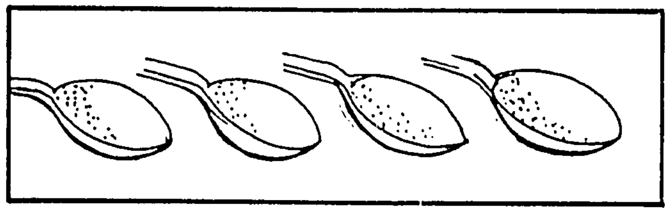
RECETA No. 9

FRITAS DE CAMOTE

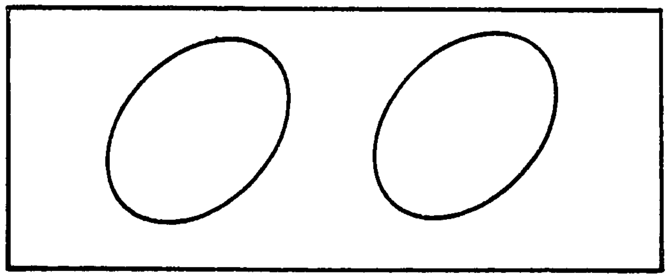
INGREDIENTES:



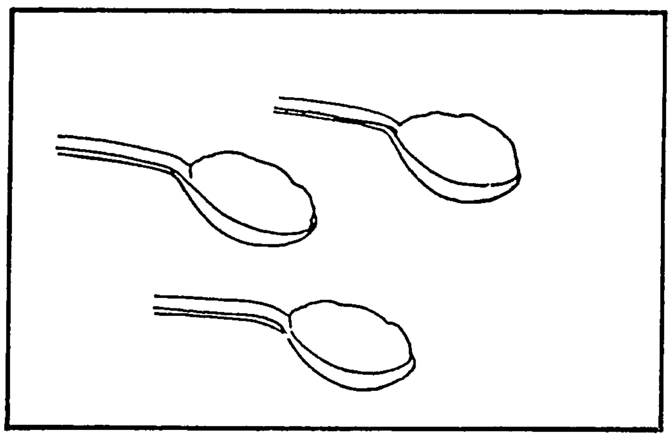
1 Camote anaranjado que pese una libra.



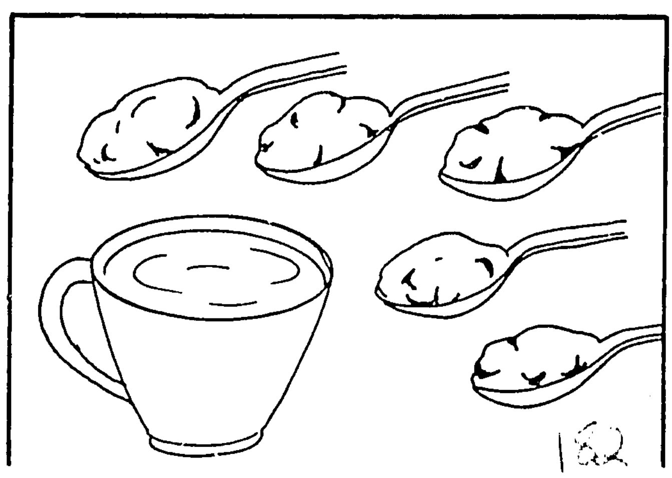
4 Cucharadas de azúcar.



2 Huevos.



3 Cucharadas de harina.



5 Cucharadas de manteca.

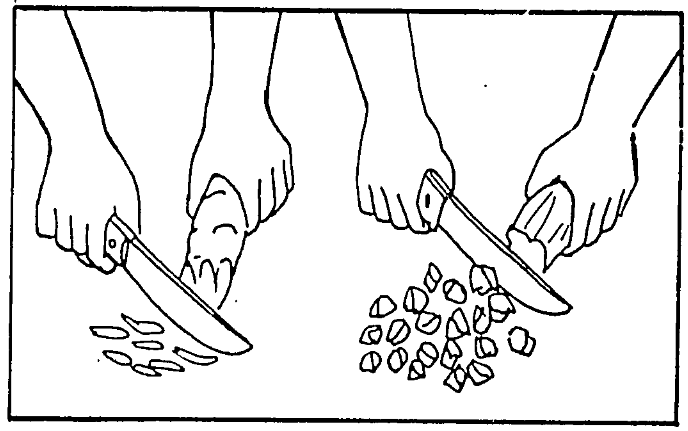
1 Taza de agua.

Sal al gusto

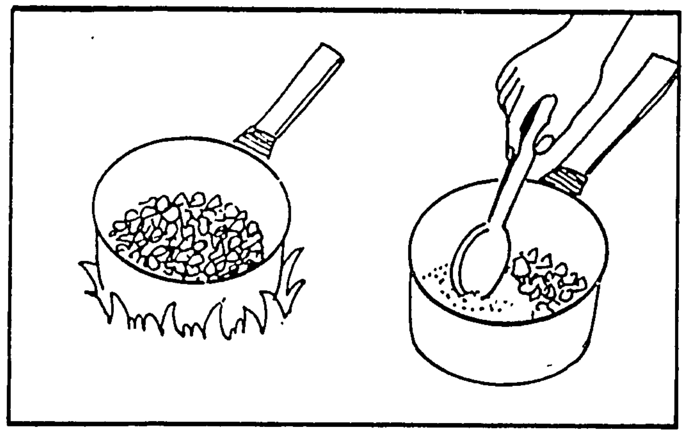
Canela en polvo al gusto.

PREPARACION:

1. Lavar bien los camotes con agua clorada, pelarlos, partirlos y ponerlos a cocinar.

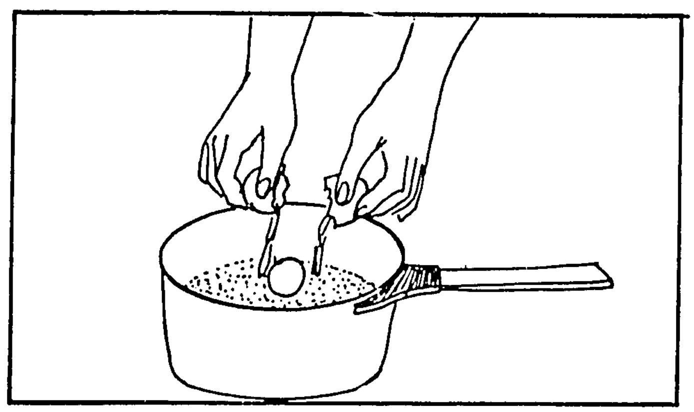


2. Al estar blandos se sacan del fuego, se dejan enfriar y se deshacen o machacan hasta formar un puré.



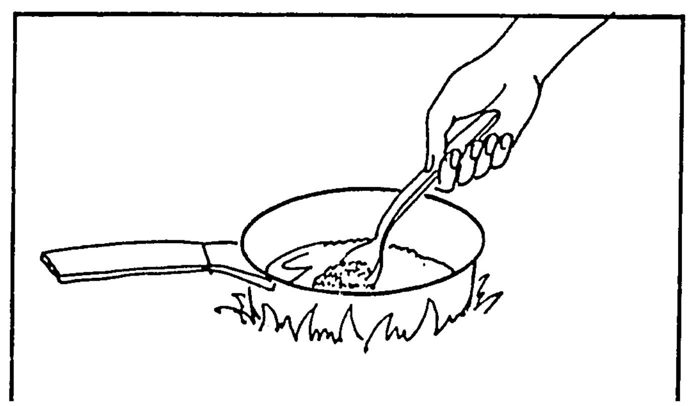
3. Agregarles el azúcar, los huevos, la canela y la sal.

4. Revolver todos los ingredientes con el camote. Agregar la harina solo si se considera necesario para que espese.



5. Poner a calentar la manteca, al estar bien caliente ir friendo la mezcla por cucharadas.

6. Dejar escurrir las fritas y servirlas como postre.



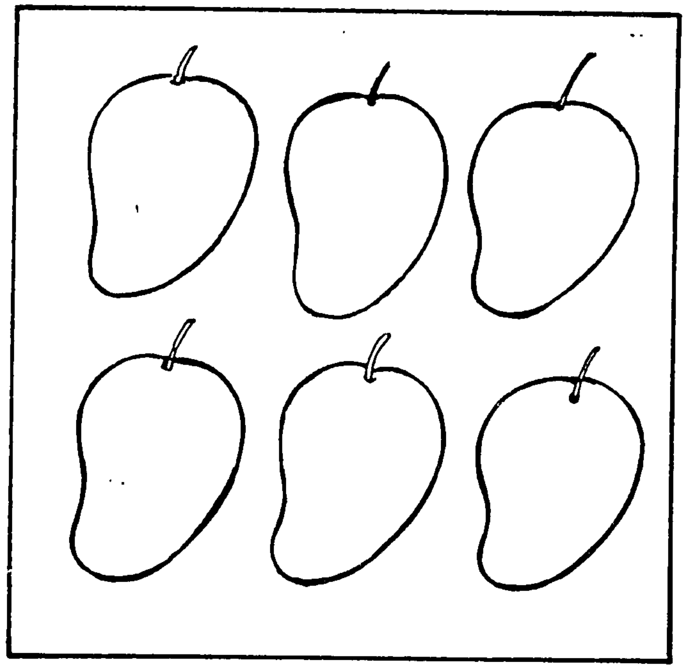
NOTA: El costo de la receta es de Lps.2.85. Se obtienen 7 porciones de tres fritas cada una. La porción cubre la quinta parte de la necesidad diaria de Vitamina "A" en niños de 1 a 3 años.

RECETA No. 10

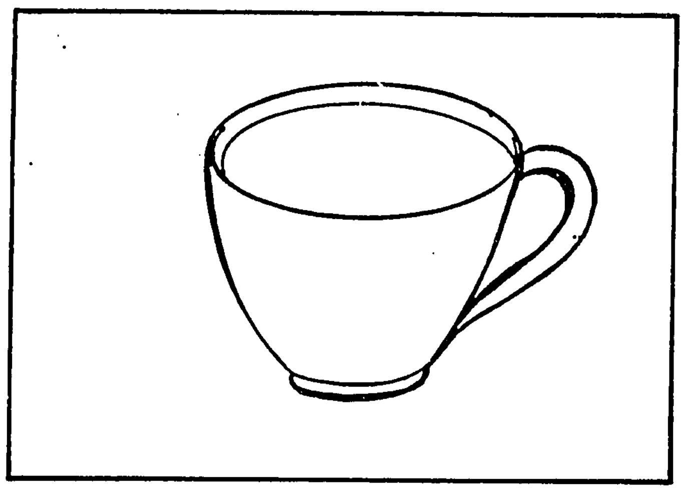
DULCE DE MANGO

INGREDIENTES:

6 Mangos medianos maduros pero firmes.

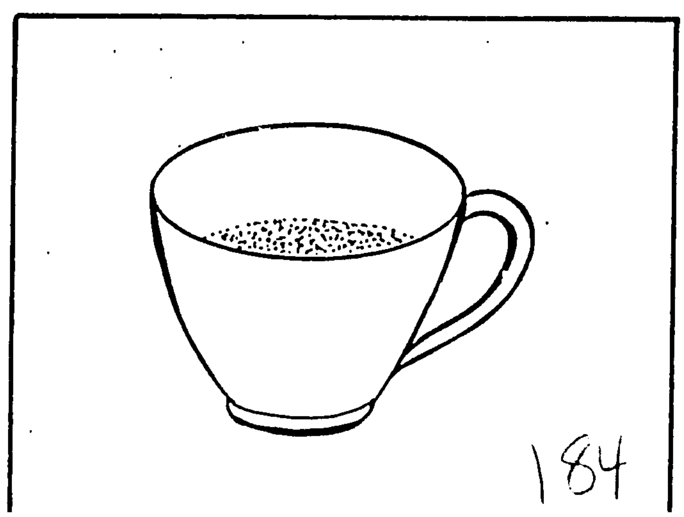


1 Taza de agua.



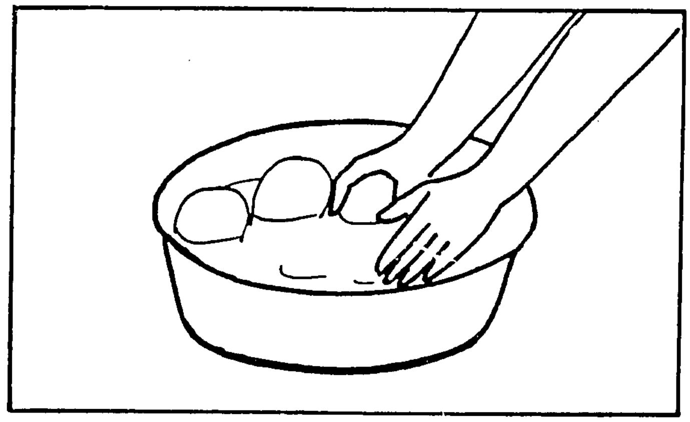
Media taza de azúcar

Canela al gusto

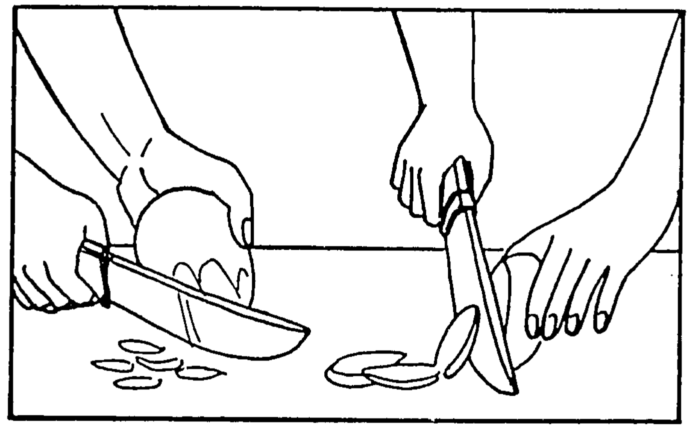


PREPARACION:

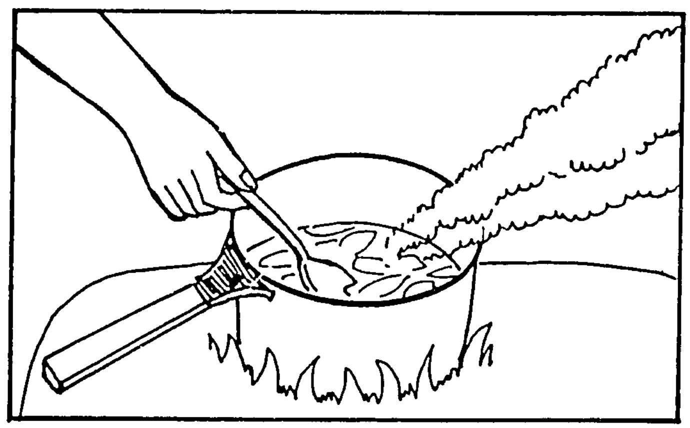
1. Lavar los mangos con agua clorada y pelarlos.



2. Cortarlos en rodajas y eliminar la semilla.

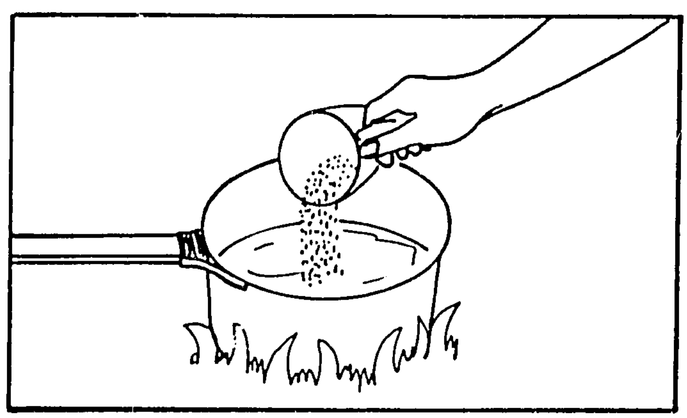


3. En un recipiente poner a hervir el agua, agregar los mangos y dejar que se cocinen, moviendo a que se forme un puré.



4. Luego agregar el azúcar y la canela y dejar cocinar un poco más a que hiervan, esperar a que espesen en el punto deseado.

5. Bajar del fuego y dejar enfriar, antes de servir.

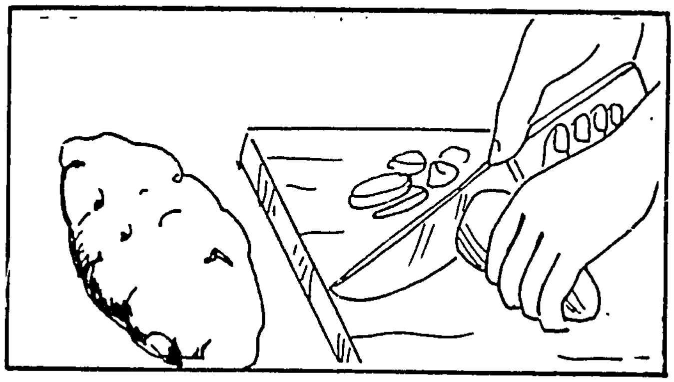


NOTA: El costo de la receta es de Lps.1.15. Se obtienen 4 porciones. La porción cubre la necesidad diaria de Vitamina "A" en niños de 1 a 3 años.

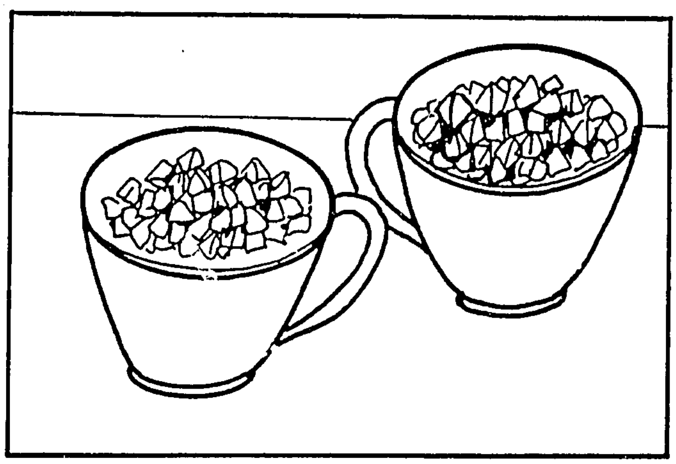
RECETA No. 11

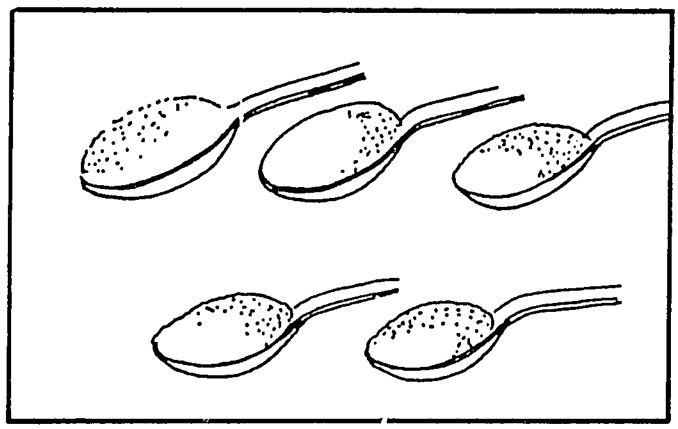
CAMOTE EN MIEL

INGREDIENTES

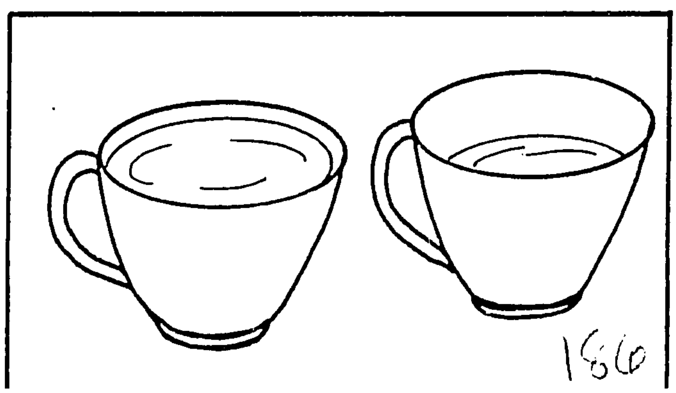


1 Camote anaranjado de más o menos una libra. (2 tazas ya pelado y partido en trocitos)





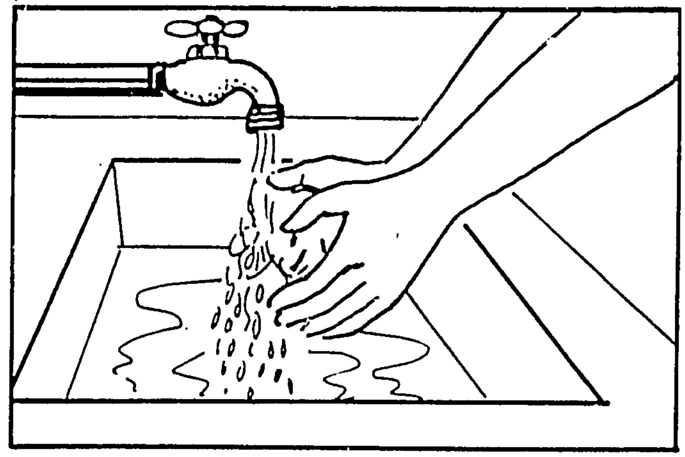
5 Cucharadas de azucar.



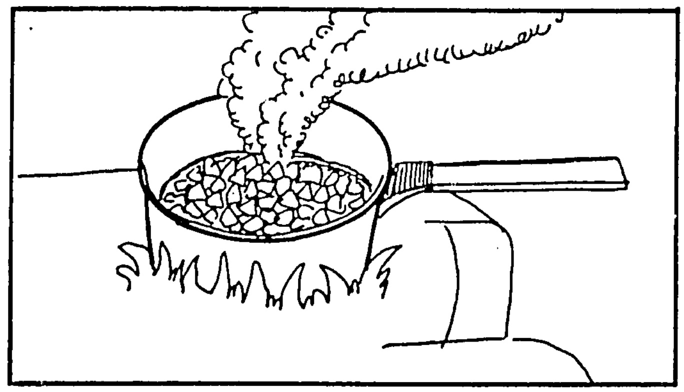
Una y media taza de agua

PREPARACION

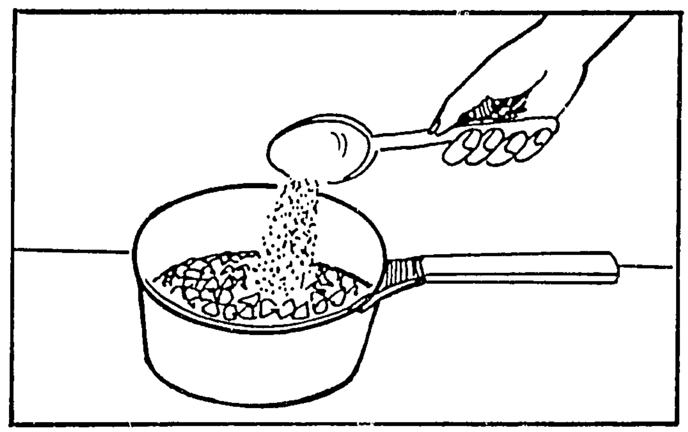
1. Lavar el camote, pelarlo y partirlo en trocitos pequeños.



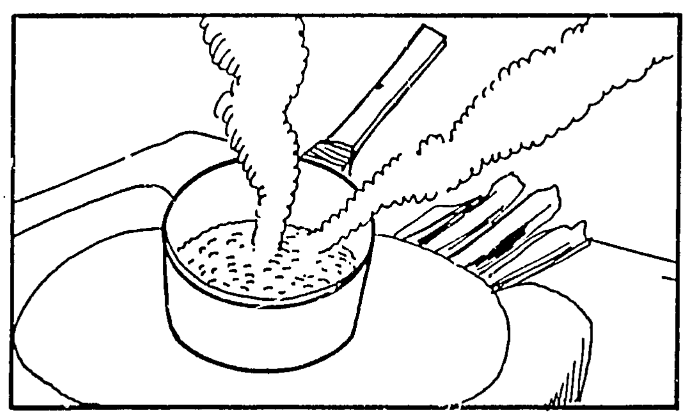
2. Ponerlo a cocinar con la taza y media de agua y dejar que se ablande un poco.



3. Agregarle las 5 cucharadas de azúcar y revolver.



4. Dejar que hierva con el azúcar, hasta que se ablande lo necesario.



NOTA: El costo de la receta es de Lps.1.15. Se obtienen 8 porciones. La porción cubre la tercera parte de la necesidad diaria de Vitamina "A" en niños de 1 a 3 años.

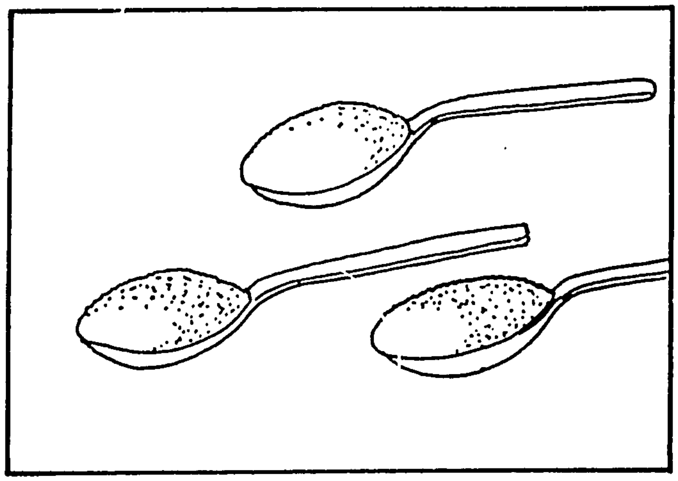
RECETA No. 12

PLATANOS EN GLORIA

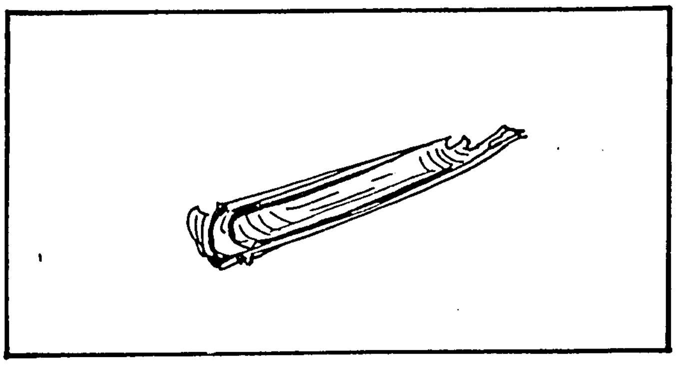
INGREDIENTES

1 Plátano maduro grande.

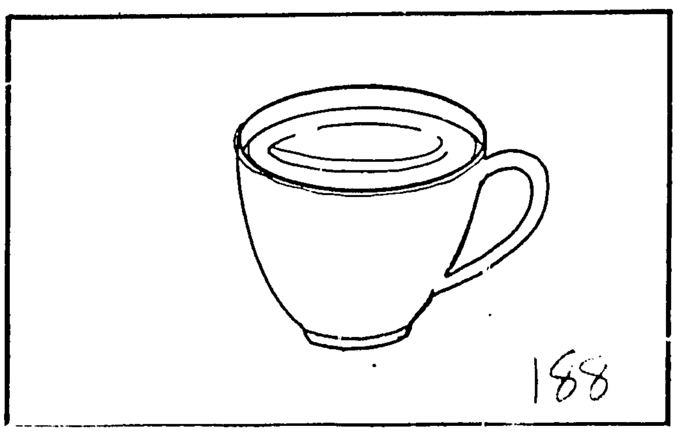
3 Cucharadas de azucar.



1 Rajita de canela.

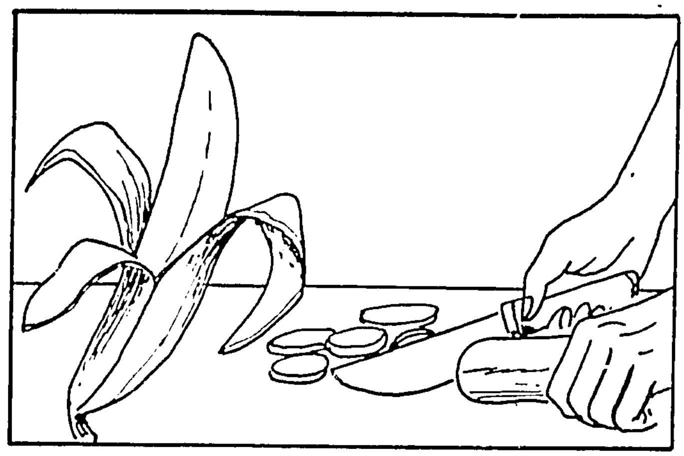


1 Taza de agua.

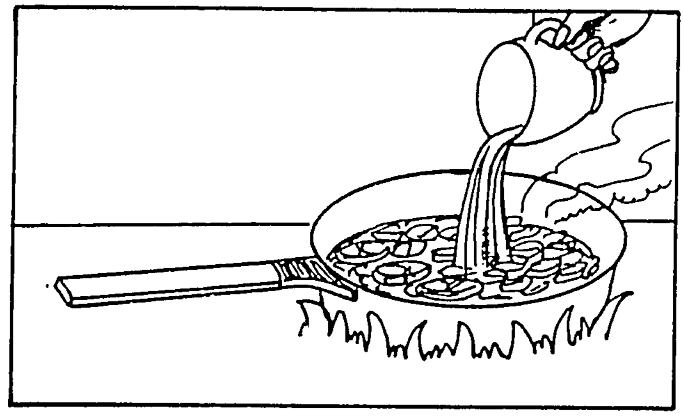


PREPARACION

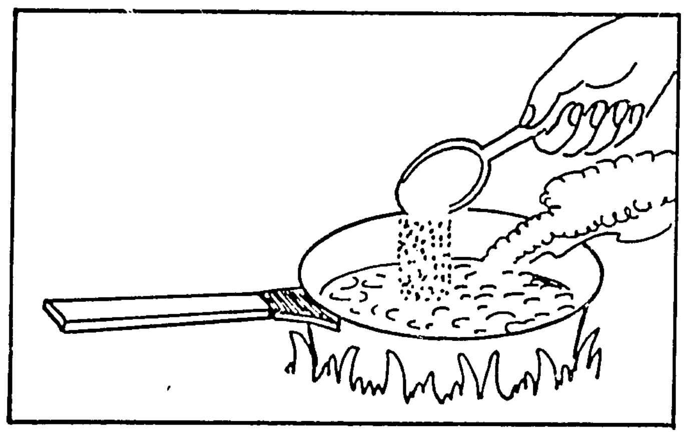
1. Pelar el plátano y partirlo en trocitos.



2. Ponerlo a cocer agregando la taza de agua y la canela.

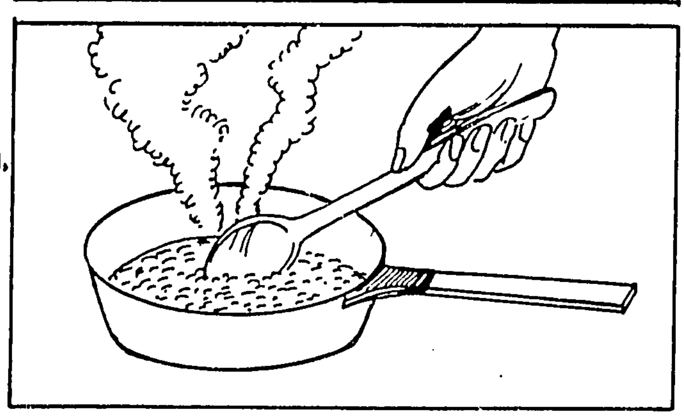


3. Al estar blando, agregarle las 3 cucharadas de azúcar.



4. Revolver y dejar que se ablande bien.

5. Al estar blando bajarlo del fuego.



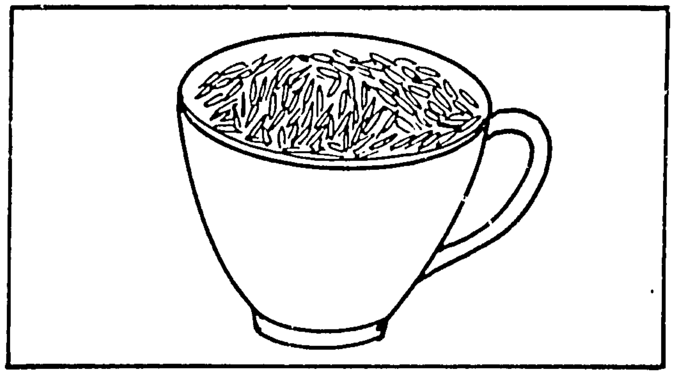
NOTA: El costo de la receta es de Lps.0.70. Se obtienen 4 porciones. La porción cubre la tercera parte de la necesidad diaria de Vitamina "A" en niños de 1 a 3 años.

RECETA No. 13

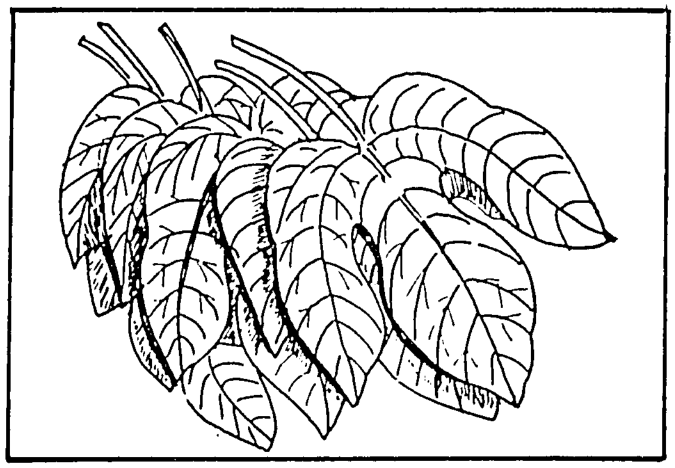
ARROZ CON CHAYA

INGREDIENTES:

1 Taza de arroz
(media libra aproximadamente)

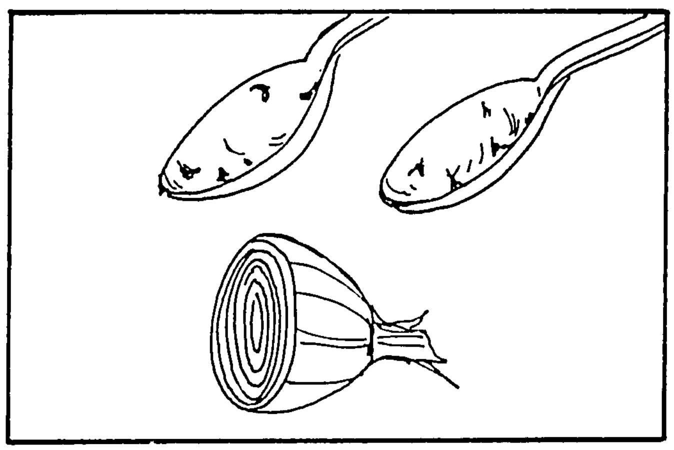


5 Hojas de chaya.



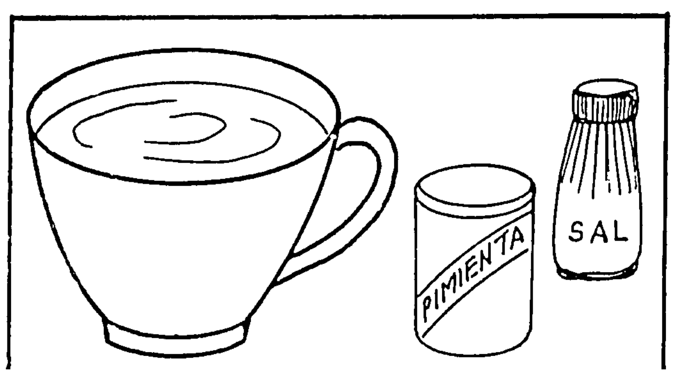
2 . Cucharadas de manteca.

Media cebolla



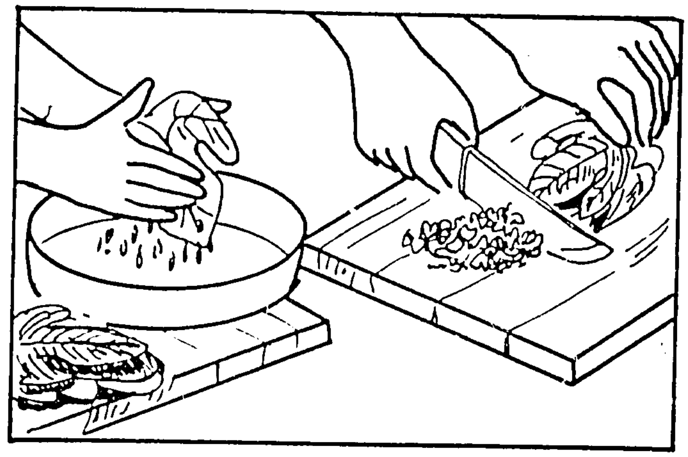
Una y media taza de agua

Sal y pimienta al gusto.

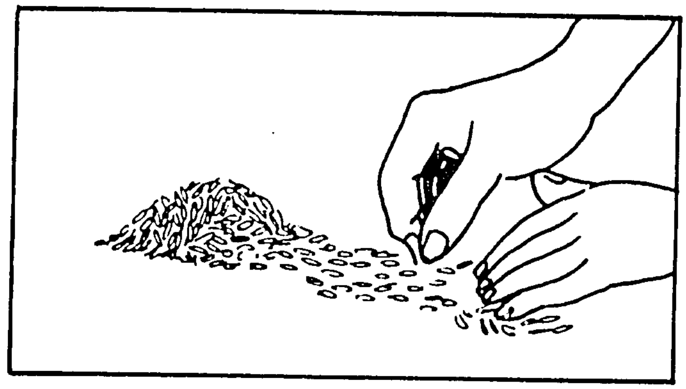


PREPARACION

1. Lavar las hojas de chaya y picarlas bien fino.

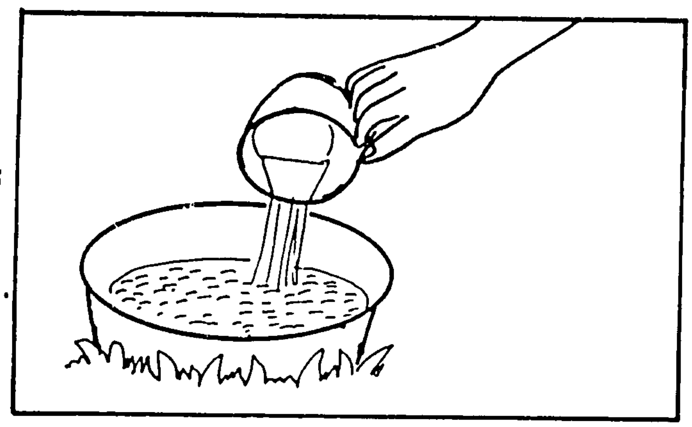


2. Limpiar el arroz.

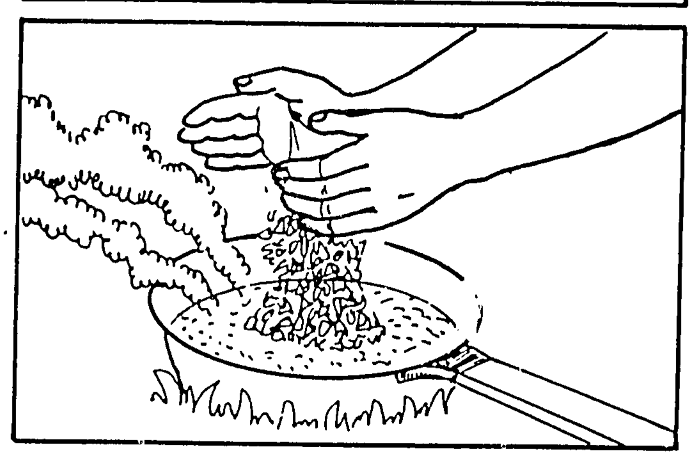


3. Poner a calentar la manteca en una freidera y sofreir en ella el arroz junto con los condimentos.

4. Agregarle el agua, revolviendo bien.



5. Por último agregar la chaya bien picada, tapar la freidera y dejar que se cocine el arroz.



NOTA: El costo de la receta es de Lps.1.30. Se obtienen 6 porciones. La porción cubre la sexta parte de la necesidad diaria de Vitamina "A" en niños de 1 a 3 años.

BIBLIOGRAFIA

1. ICAZA, S.J. Concha Barnoya. Nutricion en la escuela. INCAP y Consejo Nacional de Alimentación y Nutrición. Honduras, C.A 1973.

2. INCAP. Cuantificación de Alfa y Beta carotenos en dietas preparadas en la comunidad de "La Cuesta". Honduras (informe preliminar). Guatemala, C.A., 1993.

3. INCAP. Algunos lineamientos para la evaluación sensorial de aceptabilidad o preferencia de alimentos utilizando una escala de intervalos (documento mimeografiado). Guatemala, 1993.

4. Ministerio de Salud Pública. Departamento de Nutrición. Recetas con alimentos que sembramos en nuestros patios. San José, Costa Rica, C.A. Junio, 1982.

5. Woot. Tsuen Leung y M. Flores. Tabla de composición de Alimentos para uso en América Latina. ICNND e INCAP. (Versión revisada en 1969).