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WEANING FOODS AND WEANING FOOD ANALYSIS IN LIBERIA

by

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Summary Recommendations

1. Establish Analytical Laboratory with basic equipment at Dogliotti College of Medicine.
2. Prepare Grant Request for equipment and for future weaning food program so that continuity can be assured.
3. Assemble Liberian Food Tables using available data from the literature and establish future analytical needs by listing widely used foods which are not in the literature.
4. Prepare mixtures according to formulations (Table 5) but such that they would be acceptable to mothers in various areas of the country. Recipes should be low cost, low bulk, palatable and be easy to prepare. (Ancillary studies of food habits, taboos, likes, and dislikes will also be necessary.)
5. Check macronutrient composition of mixtures as prepared in villages paying specific attention to nutrient density of mixtures.
6. Baseline data on children should be collected so that the program can be evaluated.

Background

In the consultant report on Liberia by Dr. G.G. Berggren (1981) one of the recommendations made was for a consultant to visit Liberia to discuss a) Laboratory Facilities and b) Formulations for home prepared weaning mixtures.

In her consultant report, considerable information on previous nutrition surveys in Liberia, the nutrition background and the medium term National Nutrition Plan were presented. None of this information will be given again here but should be read in conjunction with this report.

The itinerary included a broadly based set of meetings and visits and was excellently designed to allow meeting the scope and goals of the consultancy. These were:

1) Explore existing laboratory research and documentation on already identified weaning foods and weaning food components as requested by Ministry of Health of Liberia.

2) Review existing laboratory facilities for carrying out nutrien content analysis of weaning foods and make recommendations for further development of the most appropriate existing facility.

3) Make recommendation on appropriate multimixes which should be tested in the laboratory and could be prepared by mothers at home given time/fuel and other village level constraints.

4) Explore further consultant needs.

Goals:

1) Identify needed laboratory components for nutrient content analysis for laboratory chosen as most appropriate in Liberia.

2) Review and identify appropriate weaning food and technology needed.

3) Make recommendations (if appropriate) about further consulting needs for design and implementation for weaning food program.

Examination of listed objectives

1. Explore existing laboratory research and documentation on already identified weaning foods and weaning food components as requested by Ministry of Health of Liberia.

In Annex 3, the role of the Biochemistry Department in the A.M. Dogliotti College of Medicine is discussed by Drs. Adams and Bediako. This laboratory is identified by this consultant as the facility which should be strengthened to become the center for nutrient analysis for the infant feeding program. This is outlined in a later section.

In Annex 4, an overview of nutrition and the role of weaning foods is discussed by the Nutrition Division of the Ministry of Health. In this document recommendations are given for several weaning mixtures which have been adapted from mixtures developed in Sierra Leone. The protein value of these mixtures has been calculated by the consultant and are shown in Table 1. The importance of an extremely small quantity of fish is demonstrated in this Table. The protein, calories and amino acid data used for calculation of these protein values are shown in Table 2. The distribution of amino acids should be noted in this table where generally, staples are low in lysine and supplements are high in lysine. Mixtures of the two complement each other and approach closer to the desirable pattern. The low level of lysine in sesame seed should also be noted. This indicates that it cannot be a good supplement to staples by itself but should always be incorporated as part of triple mixes since it is an excellent source of sulfur amino acids and can thus improve the supplementary value of both legumes and even some animal proteins.

Table 1

K cal and P cal throughout

Protein-calorie value of recipes recommended for Liberia by Nutrition Department, Ministry of Health (see Annex 4)

Quantities adjusted to equivalent dry food weights from those shown.

(a) Rice·Fish·Oil

Rice 80g, Dry Fish 10g, Palm oil 10g
Protein 11.9g, Kcal 413, Pcal%, = 11.5%
Score 100 (T) NDpCal% = 8.3 U.P. = 11.9g

(b) Rice·Groundnut

Rice 60g, Groundnut (dry) 40g
Protein 13.5, Kcal 439, Pcal % = 12.3%
Score 65(L) NDpCal% = 6.6 U.P. = 8.8g

(c) Rice·Blackeye pea·oil

Rice 60g, Balckeye pea 30g, oil 10g
Protein 11.0g, Kcal 410, Pcal% = 10.7%
Score 91(L) NDpCal% = 7.5

(d) Rice·Groundnut·Fish (modified b)

Rice 60g, Groundnut 35g, Fish (dry) 5g
Protein 15.5g, Kcal 427, Pcal% = 14.5%
Score 82 (T) NDpCal% = 8.4% U.P. = 12.7

(e) Rice·Sesame·Groundnut·Fish (modified in Liberia)

Rice 25g, Sesame 25g, Groundnut 15g, Dry Fish 5g
Protein 12.9, Kcal 330, Pcal% = 15.6%
Score 84(L) NDpCal% 8.9 U.P. = 10.8

For this recipe the fish is given as being optional. Since Rice, Sesame and Groundnut are all low in lysine, fish is the only supplier of lysine to this mixture and if the fish is omitted the mixture is barely acceptable.

Thus: Rice·Sesame·Groundnut

Rice 25g, Sesame 25g, Groundnut 15g
Protein 9.7, Kcal 313, Pcal% = 12.4%
Score 51(L) NDpCal% 5.9 U.P. = 5.5g

This is an excellent example of the importance of an extremely small (5g) of dry fish in improving the protein value of a mixture when all the other components are low in lysine. Milk, egg and soy (if available) would also supply lysine.

<u>Abbreviations</u> T= Threonine L=Lysine. These are calculated as limiting amino acids for scores shown.
U.P.= Utilizable protein i.e. protein of score=100
Pcal%= protein calories as percentage of total calories
NDpCal%- Net Dietary Protein as percentage of total protein.

Table 2 - Selected analytical data for some suitable components of food mixtures.

	per 100g			mg per N			
	Water(g)	Kcal	Prot(g)	Lys	Saa	Thr	Try
A. Low Protein Components							
Banana	77	88	1.5	256	294	213	74
Cassava Flour	9	363	1.1	259	170	165	80
Corn Meal	12	355	9.5	167	217	225	44
Plantain	65	135	1.2	256	294	213	74
Rice	12	365	7.0	226	230	210	85
Sweet Potato	69	121	1.6	214	175	236	107
Taro	70	111	0.5	241	247	225	88
Wheat Flour	12	364	10.3	115	230	153	58
Yam	69	119	1.9	256	170	225	80
B. Vegetable Supplements							
Blackeye pea[1]	11	338	22.5	410	180	250	60
Congo pea[2]	10	345	19.5	490	165	230	60
Butter bean[3]	11	341	19.7	420	190	300	60
Groundnut - dry	7	549	23.2	220	150	170	70
Groundnut - fresh	45	332	15.0	220	150	170	70
Sesame Seed	5	558	17.9	160	311	195	90
Soy bean	10	405	33.9	400	160	240	80
C. Animal Supplements							
Chicken	73	140	19.8	497	239	248	64
Egg	77	140	11.8	437	360	320	93
Fish - dry	10	310	63.0	569	253	286	70
Milk - dry skim	4	350	36.0	453	220	263	82
Milk - dry whole	4	500	25.5	453	220	263	82
FAO/WHO 1973 Requirement Pattern				340	220	250	60

1 = Cowpea = Vigna sp.
2 = Pigeon pea = Cajanus cajan
3 = Lima bean = Phaseolus fungatus

Sources of data: Pellett, Mamarbachi, 1979, pellett and Shadarevian, 1970, FAO, 1964, FAO, 1979. See reference list for full details

Note: any amino acid data for lysine, sulfur amino acids, Threonine and Tryptophan are shown. These are the only amino acids likely to be limited in real diets

The procedure for calculation of protein value is shown in Table 3 where the rice, sesame, groundnut, dried fish mixture is calculated for total calories, total protein, amino acid score, utilizable protein, protein calorie percent (Pcal%) and net dietary protein calories percent (NDpCal%). The example is shown fully worked and should be followed if the protein value of any other food mixtures is needed. Data from Table 2 can be used for these calculations or from any other data sources if the information is not present in Table 2.

Thus the protein value of the mixtures listed by the Ministry of Health are generally good (the rice-groundnut mixture is at the low end) and are above NDpCal% 6-7 which is generally recommended as being the minimum acceptable for the needs of the young child. (Table 4) Limitations may be in bulk and in acceptability (i.e. children may not be able to take sufficient calories of the mixtures to meet their protein needs). This appears to have been done in testing acceptability of these or similar products in Liberia. This is essential and could be undertaken by present staff without special funding.

Table 3 - Protein Scoring and Protein Calorie Values - a Worked Example

Example based on Sierra Leone - Liberia mixture.

A. Protein and Nitrogen

	Quant(g)	per 100g Kcal	Prot(g)	Nitrogen(g)	in mixture Kcal	Prot(g)	N(g)
Rice	25	365	7.0	1.12	91	1.75	0.28
Sesame	25	558	17.9	2.87	140	4.50	0.72
Groundnut	15	549	23.2	3.71	82	3.50	0.56
Dried Fish	5	309	63.0	10.10	15	3.15	0.51
Totals	70g				328	12.95	2.07

Note: Nitrogen value obtained by dividing protein by 6.25.

B. Amino Acid Calculations

	Quant(g)	N	mg/g N Lys	Saa	Thr	Try	mg in mixture Lys	Saa	Thr	Try
Rice	25	0.28	226	229	207	84	63	64	58	24
Sesame	25	0.72	160	311	194	91	115	124	140	66
Groundnut	15	0.56	220	150	170	69	123	84	95	39
Dried Fish	5	0.51	569	253	286	70	290	129	146	36
Totals		2.07					591	501	439	165

Note: mg in mixture is obtained by multiplying N supplied by each component by amino acids (mg/g N). Adding for each amino acid gives total.

C. Calculation for mixture quality

	Total N	Total Amino Acids Lys	Saa	Thr	Try	
Mixture composition	2.07	591	501	439	165	
Divide by 2.07	1.00	286	242	212	80	i.e. mg per g N
FAO/WHO STD		340	220	250	60	mg/g N
Score i.e. Divide by STD and express as percentage		84	110	85	133	Lowest is limiting

Mixture is thus of high quality with a score of 84 and is limited by Lysine. Threonine however, is equally limiting.

Pcal% = = 15.8%

Utilizable Protein (U.P.)= $\frac{12.95 \times 84}{100}$ = 10.9g

NDp Cal% = $\frac{1.25 \times Pcal\% \times Score}{(100 + (0.064 \times Pcal\% \times Score))}$ = 8.9

Table 3 - continued

While the mixture is limited by both lysine and threonine (84 and 85 respectively) the original exponents were of the following poorer scores with the exception of the higher-quality fish.

	Score	Limiting Amino Acid	
Rice	66	Lysine	ie 226/340*
Sesame	47	Lysine	ie 160/340
Groundnut	68	Sulfur Amino Acids	ie 150/220
Dried Fish	100+	None	

*from B above.

Pcal% = Protein calories as percentage total calories. Protein supplies 4 per gm metabolizable energy.
This Pcal% = Protein% x 4 x 100/Total protein x Score/100g.

Utilizable Protein (U.P.) = Total protein x Score/100.

NDpCal% = Net dietary protein as a percentage of total calories. This indicates the effective concentration of utilizable protein calories in relation to the total calories provided. This index was used by Cameron and Mofvander (1976) and pellet and Mamarbachi (1979) in calculating the protein value of mixtures. Its use however, has not been widespread despite certain advantages.

The whole rationale behind scoring systems and their relationship to protein quality as determined in animals and humans has been discussed by Pellet and Young (1981).

Table 4: Protein and Energy Requirements of Children (FAO/WHO 1914)

Age	Weight Kg	Keal	Protein g[1]
<3m	-	120/Kg	2.40/Kg
3 - 6m	-	115/Kg	1.85/Kg
6 - 9 m	-	110/Kg	1.62/Kg
9 - 11m	-	105/Kg	1.44/Kg
<1 Year Average	7.3	820	14
1 - 3 Yrs	13.4	1360	16
4 - 6 Yrs	20.2	1830	20

[1] Protein to be supplied as egg or milk (ie utilizable protein).

2. Laboratories Visited

Biochemistry Laboratory Physiology Laboratory	Dogliotti College of Medicine	University of Liberia
Science Laboratory	College of Science	University of Liberia
Science Laboratories	New College of Science and Technology at Fendell	University of Liberia
Home and Community Development Laboratory	College of Agriculture and Forestry at Fendell	University of Liberia
Soil Analysis Laboratory	Rural Development Institute	Suacoco
Nutrition Laboratory	Agriculture Research Institute	Suacoco

Brief Observations on Laboratories

Dogliotti College of Medicine

The biochemistry and physiology laboratories are poorly equipped with only minimal apparatus for class demonstrations and exercises. While drying ovens, centrifuges, spectrophotometers and flume photometer are useful for food research no basic food analytical equipment is present such as is necessary for nitrogen (Kjeldahl) fat (soxhlet) total food energy (bomb calorimeter) or for fiber. More elaborate apparatus needed in later phases of food research could include fluorimeter, GLC, HPLC, microbiological assay equipment and amino acid analyser. The more sophisticated equipment are far down the road and are quite unnecessary for basic food analytical investigations. A rat room is also available.

College of Science

The biology and science laboratories are minimally equipped with basic equipment such as microscopes, centrifuges, spectrophotometers, TLC, paper chromatography and some food research has been performed. A rat room with home-made cages and metabolic cages was also seen. The facilities at Fendell are truly excellent modern laboratories with fume hoods and all services but they are empty at present and plans for transfer are vague. For the forseeable future, transport (some 20 miles) will be a problem and no plans appear to have been made to equip the laboratories to the standard they deserve.

At present it cannot be recommended that food analytical equipment be installed at Fendell but eventually a food analysis laboratory should be established there for teaching and research.

Home and Community Development Laboratory

At present this is not a laboratory but a demonstration area for food and nutrition. The leader (Mrs. Guwor) has experience with food mixtures and certainly recipe preparation is possible. Installation of a drying oven and balance would allow moisture determinations with estimation of nutrient density. This would be valuable both for the project and for demonstration purposes.

R.D.I. Cuttington University College - A small soils analytical laboratory is present with no facilities for food research.

Agricultural Research Institute, Suacoco.

A basic set of laboratories is functional and are aimed at soil and plant analysis. A macroKjeldahl unit and muffle furnace with fume hood are both relevant to food research and could be made available for occasional analyses. The distance from Monrovia (120 miles) is a major disincentive for collaborative programs. A new Kjeldahl is also on order.

Also at Suacoco there is to be a new laboratory devoted to nutrient analysis for animal feeds. All basic equipment has already arrived but is not yet installed and bench units etc. are also not yet available.

A recent U.S. graduate in animal nutrition (Mr. Koikoi) has only just arrived and will be operating the laboratory. All analytical operatio parallel those for human food analysis and cooperation should be devel- oped. Distance is a problem and the laboratory suffers from frequent power failures.

Recommendations

A basic food analytical facility should be developed at the Dogliotti College of Medicine. Reasons for this are the presence of Drs. Sherman Adams and Badu Bediako who both are closely concerned with nutrition in reaching and research. Dr. Bediako in particular has al- ready had experience in food analysis, food tables and natural toxicant in foods. With basic equipment the laboratories at the Dogliotti colle could develop into an important facility for:

- -Food analysis of nutrients in local food
- -Protein and energy value of weaning foods
- -Demonstration of such techniques to doctors in training
- -Analysis for natural toxicants in foods.

Basic Equipment needed	Estimated Cost
Fume hood (could be locally constructed)	
*Kjeldahl Digestion unit (semi micro)	$480.00
*Kjeldahl Distillation unit	$200.00
*Soxhlet (or Goldfisch) Fat Extraction Unit 250.00/unit	$2,000 for 6 unit s
Crude Fiber Apparatus	$2,000
Muffle Furnace	$1,000
*Associated Glassware and Chemicals	$500.00

*items of high priority

3. Make recommendation on appropriate multimixes which should be tested in the laboratory and could be prepared by mothers at home give time/fuel and other village level constraints.

A paper by Pellett and Mamerbachi (1979) (reproduced in full in Annex 5) examines the rationale behind the home mixing approach and recommends a series of appropriate mixtures. A more complete source for the full background of such mixtures will be found in the book by Cameron and Hofvander (1976). No further elaboration of background will thus be given here.

Table 5, adapted, extended and slightly modified from Table IV in Annex 5, shows appropriate mixtures of staples with supplements (together with extra oil or sugar) to provide about 360 Kcal and 10 g. protein (or 8 g. reference protein) with a NDpCal% between 6 and 7. These quantities thus meet or exceed one third of the daily requirements (i.e. one meal) of a 1 year old child for protein and food energy. Further supplementation of these mixtures with green leaves, fruit or vegetables to convert double or triple mixes to multimixes is also necessary to ensure that needs are also met for minerals and vitamins. The wide acceptance of red palm oil in West Africa is excellent because when used in such mixtures it can ensure adequate carotene (and thus vitamin A) intakes. In many regions of the world vitamin A deficiency compounds the problems of protein-energy malnutrition. Fortunately, this is rare in West Africa.

Table 5 shows pairs of numbers for each intersection of columns ar rows for staple and supplement respectively. For example 65 g. of dry rice, appropriately cooked, when mixed with 20g. (1/3-1/2 an egg) of fresh egg with 10 g. oil or 20 g. sugar will provide about 350 Kcal at an NDpCal% of between 6-7 and will meet about 1/3 of a child's daily protein-energy requirement. The numbers given are minimal and are to } thought of as approximate and not to be considered as rigid. Extra supplements will always increase the protein value but will also increase the cost. The notes to Table 5 are important and indicate possible approximate substitutions of components, i.e. cooked rice for dry rice, fresh fish for dry fish etc. The observations concerning sesame and bulk problems with cassava and legumes are also important.

It is obvious that these recommendations are made for the use of nutrition professionals and must be adapted using local measurements so that the mixtures (double, triple, and multimixes) are acceptable to local people and are not too fluid or bulky.

Proportional recommendations from Table 5 can thus be modified and adapted into large numbers of recipes. However, after possible adaptations by several professionals and then mixed by village mothers, the composition of final recipes may well have changed considerably and a laboratory facility is essential so that recipes at the village level can be tested for nutrient content. If only one analytical technique is possible, use of a drying oven for calculation of dry weight and multiplying this dry weight (g) by a factor of between 4 and 5 (depending on fat/oil content) will give an approximate estimate of the food energy (Kcal) present.

In Table 6 calculations are made showing food energy (Kcal), total protein and utilizable protein per dollar which can be obtained for some selected imported weaning foods and for some home produced mixtures. The difference is considerable. It must however be recognized that the imported products contain extra added minerals and vitamins and that the home mixing costs are those of ingredients alone. Costs of imported products were those observed in a local supermarket (January 1982) while costs of ingredients were those provided by the

Ministry of Health from local (Monrovia) market prices (Annex 6). Similar calculations should be made when mixtures are adapted using locally obtained costs.

Table 5 - Recommended Double mix proportions to give ca 360 Kcal and protein value (ND Cal%) betwen 6 and 7.%

	Wheat Flour	Rice[1]	Maize	Sweet Potato	Yam	Taro	Banana	Plantain	Cassava Flour[2]
Egg[3]	65 25	65 20	65 25	190 35	230 15	200 25	190 40	150 45	55 50
DSM[4]	65 10	65 10	65 10	185 10	225 10	190 10	175 15	165 15	60 15
DWM[5]	55 15	50 15	60 15	120 20	155 15	145 15	150 20	130 20	40 25
Dry Fish[6]	75 5	70 5	75 5	220 10	250 5	230 5	220 10	190 10	75 15
Chicken	70 15	70 15	70 10	200 20	230 10	205 15	195 25	170 25	65 35
Sesame[7]	-	-	-	-	-	-	-	-	-
Soy bean'	65 10	60 10	55 10	175 15	195 10	185 10	160 15	145 15	55 25
Legumes[8] Various	65 20	60 20	65 25	175 30	195 30	185 30	160 30	145 30	- -
Groundnut[9]	65 20	65 20	65 20	175 30	195 30	185 30	160 30	145 30	-

Notes for Table 5

Note: all weights (g) given as edible food portion. To these quanities should be added 10g of oil or 20g sugar. Multimixes can be made by adding green/yellow vegetables or fruit.

1) Quanities for whole rice or pounded rice flour for cooked rice use quantities x 4.

2) For fresh cassava double quantities. Double mixes with cassava are not generally recommended as they will often be too bulky for a young child. Bulk increases greatly with cooking of flour, much less increase occurs with fresh root.

3) Fresh egg from shell

4) Dried Skim milk

5) Dried Whole milk

6) Dry Fish or powder. For fresh fish use quantities x 3.

7) Because Sesame is limited in the same amino acid ie lysine as the staples no complementation can occur. However sesame is high in Sulfur amino acids which are low in legume products and thus can conveniently replace up to half of legumes. Added oil can be reduced when sesame is used.

8) Average for several varieties eg Congo pea, Blackeye pea and Butter bean. Double mixes with cereal and legumes (except soy bean) are too bulky for a young child. Part of legume can be replaced by sesame.

9) Dry groundnut; for fresh, use quantities x 2. Added oil can be reduced when groundnut is used.

The quantities shown for the supplements are minimal (rounded to the nearest five grams). Larger quantities will improve the protein value but will increase the cost. Larger amounts or using more than one supplement (with the amounts of each supplement reduced appropriately) may also be necessary to improve palatibility and acceptibility.

Table 6 Comparative Amounts of Food Energy and Utilizable Protein for Some Commercial Weaning Products and Some Home Mixtures

Product	Quantity	Cost US$	per 10g Protein	per 10g Kcal	Score	per dollar Kcal	per dollar Protein	per dollar U.P.
Commercial								
Cerelac	1000g	4.10	11.0	425	55	1036	26.8	14.7
Farlene	250g	2.30	20.0	390	90	425	21.7	19.6
Cow & Gate Mixed cereal	170g	2.15	13.5	400	80	316	10.7	8.5
Cow & Gate Rice cereal	170g	2.20	7.0	400	66	309	5.4	3.6
Home Mixtures								
Banana: Groundnut	190	0.19	4.9	160	67	1600	49.0	32.8
Sweet Potato: Beans	205	0.23	4.3	197	78	1755	38.3	29.9
Rice Sesame Groundnut Fish	70	0.17	18.4	471	84	1939	75.8	63.6
Rice: Egg	85	0.14	8.3	316	88	1940	50.4	44.3
Rice: Milk (dry)	65	0.09	11.3	396	95	2860	81.6	77.5
Rice: Beans	80	0.09	10.3	355	91	3155	91.6	82.4
Rice:Groundnut	80	0.07	11.7	411	65	4697	133.7	86.9

Note: Home mixture costs are only those of ingredients and do not include preparation waste. Dried whole milk, while not a weaning food mixture, can be very economical to mix with any other food combinations since it supplies 51g of utilizable protein per dollar. Cerelac protein quality is NDU value from rat assay. Prices were a Sinkor (Monrovia) supermarket in January 1982; for the imported producta a Monrovia market costs provided by the Ministry of Health (Annex 6) for the weaning food components.

The Use of Recommended Mixes for Conventional Meals
(Adapted from Cameron and Hofvander 1976)

The following recipes and multimixes are adapted from the proportions shown in Table 5 and owe a great debt to Cameron and Hofvander (1976).

The amounts of ingredients to use in simple mixes are shown first, followed by those suitable for more conventional recipes based on each staple food. The ingredient proportions in the more conventional recipes sometimes differ from those in the double mixes, which were calculated as ideal mixes. A greater variety of ingredients is often used in the recipes and the mix more closely resembles traditional meals. The energy value for each recipe has been calculated and is shown. The protein value of all the mixes and recipes is similar and is adequate for young children, including those exposed to additional stresses, such as infections and infestations. The bulk of the meal has also been considered for its suitability in relation to its energy value.

The quantity for each ingredient in the recipe is given as gram-weight of the edible portion of the food, ready for conversion by the health worker into the local household measure of volume. Costs have been kept as low as possible either by using low cost ingredients or by keeping the quantities of expensive ingredients minimal.

The methods of preparation vary to some degree but the same ingredients, used in the same proportions, will have the same energy and protein value. This presupposes that the different methods do not use quantities of extra oil or fat. Fats or oils, however, are expensive in many communitiies or are hard to find; housewives should be encouraged to use even a little of these ingredients. Red palm oil is an excellent ingredient and adds carotene to the mixture.

It is not possible to give precise instructions about the quantity of food to be given to an individual child for growth and development. This depends on age, the extent of physical activities, appetite and the presence or absence of infections. Table 4 gives requirement levels as a guide.

If the given recipe provides too much food, less of it might be prepared, but the amounts of all the main ingredients must be reduced in the same proportion. If for example, these are halved, the energy and bulk also are halved, but the consistency and the protein value remain the same. Alternatively, the original recipe can be prepared as usual then shared by more than one member of the family.

If, on the other hand, the given recipe is too small, and more food is needed for a meal, the amounts of all the main ingredients should be increased by the same proportion. If they are doubled, the energy value and bulk are twice as much, but, as before, the consistency and protein value are unchanged and still are suitable for the young child. The meals were to provide a child between one and two years of age with about one-third of a day's energy needs and be of suitable protein value. They show how double mixes or multimixes can be adapted for conventional recipes.

NOTE: In all of the recipes for mixes, the most economical amount of supplement is used, but more may be added. All of the recommended multimixes can be made by adding some leafy green, red, or yellow vegetables or tomato to any of the mixes, or by serving fruit after the meal.

The proportions of ingredients sometimes differ from those for double mixes that were calculated as ideal, partly because of the variety of ingredients used, which more closely resemble "family-pot" meals. To each recipe, add water, salt and/or spices, when and if appropriate, in the traditional manner of the area. Remember not to add too much water, because it will overdilute the food, and too much salt or spice may make it unacceptable to some children.

Only the weights of the ingredients are given in most of the recipes. These should be adapted by the health/nutrition worker to more suitable local volumes. In the quantities recommended for milk (when present) lactose intolerance is unlikely to be a problem. Full hygienic consideration must be given to infant food preparation.

RICE

DOUBLE MIXES

ADD: 10g oil or 5g oil and 10g sugar or 20g sugar

TO:	65g rice	and 20g egg
	65g	10g dried skimmed milk
	50g	15g dried whole milk*
	70g	5g dry fish
	20g	15g chicken/lean meat

*or its equivalent

Each mix provides about 350 kcal.
60g rice and 20g legume with 5g oil or 10g sugar provide about the same energy and protein value.

1. Wash the rice and cook in water until soft.
2. Beat with a wooden spoon until creamy.
3. Add supplement and beat into the rice with oil.
4. Feed to the infant with a spoon.

(1) Double mix

Rice	60g
Cowpeas (blackeye)	20g
Onion	10g
Palm oil, red	5g

1. Soak beans, remove and discard skins
2. Grind or pound beans until smooth.
3. Cream until light and fluffy.
4. Add salt, onion, and a little water, if necessary.
5. Fry by spoonsful in oil or fat.
6. Serve with rice (pap).
   (each 400 kcal)

(2) Double mix

Rice	40g
Groundnuts	10g
Cowpeas	20g

1. Roast groundnuts lightly, remove and discard skins, and grind nuts to a smooth paste.
2. Soak cowpeas overnight, remove testa and eyes, and cook gently in water until soft.
3. Add the groundnut paste to cooked cowpeas and mix well.
4. Wash the rice thoroughly. Cook in the usual way.
5. Serve cowpea mixture with rice, beaten smoothly together, if necessary.

(3) Multimix

Rice	50g
Beans	40g
Dry Fish	5g
Onion	30g
Cooking fat or oil	5g

1. Melt the fat and when it is hot, add the sliced onion. Fry a few minutes before adding the dry or fresh fish. When meat is browned, add a little water and seasoning and cook gently until tender.
2. Wash the rice and beans until clean. Cook gently in about twice their volume of water until they are soft. Serve with the stew.

(4) Multimix

Rice	60g
Groundnuts (dry)	20g
Dried fish	5g

1. Add washed rice to the boiling, salted water.
2. Cook for 15 minutes.
3. Add pounded fish and groundnuts.
4. Cook for another 30 minutes.
   (360 kcal)

(5) Multimix

Parboiled rice	40g
Groundnuts	15g
Sesame seed	30g
Red palm oil	5g

1. Clean and wash rice and soak for 1/2 hour.
2. Drain off water and pound rice to flour.
3. Rub and wash sesame seed, remove and sicard husks; parch see slightly and pound it to a paste.
4. Roast groundnuts lightly, discard the skins, and pound nuts to a paste.
5. Mix the rice, sesame seed, and groundnut pasted together in a mortar and add the red palm oil.
6. Dry the resulting flour well before storing it in a tin.
7. Cook 4 heaping Tbspns in 3/4 pt of water with salt, and feed 3 time. per day per infant.

To improve the protein value, add the following whenever available:

	kcal
50g cassava greens	455
or 5g dried fish	450
or 25g egg	510
or 10g skimmed-mild powder (or equivalent)	510

(6) Multimix

Rice	75g
Pigeon peas	25g
Dried milk (whole)	10g + 75ml water
Sesame seed	5g

1. Saok pigeon peas and remove the skins.
2. Wash peas thoroughly, put into freshly salted water, and cook slowly until almost soft.
3. Add thoroughly washed rice and the sesame seed.
4. Continue cooking until rice is soft.
5. Mix well to combine ingredients and serve with the milk as a drink.

(425 kcal)

(7) Multimix

Rice	90g
Groundnuts (shelled)	10g
Dried salt fish	10g
Tomatoes	30g
Onion	10g
Peppers, green	5g

1. Roast groundnuts lightly, remove and discard skins, and pound nuts in a mortar.
2. Cut dried fish into portions, wash in cold water, then soak in hot water for 15 minutes.
3. Cook fish in salted water for approximately 1/2 hour.
4. Add pounded tomatoes and water.
5. Add chopped peppers and sliced onions.
6. Boil gently for 10 minutes, then add well-washed rice.
7. Cook 20 minutes and add groundnuts.
8. Cook a further 10 minutes and serve.

(400 kcal)

(8) Multimix

Rice	60g
Lean meat	15g
Melon seeds	5g
Spinach, edible portion	60g
Tomato	35g
Onion	10g
Palm oil	15g
Fish (Dry)	5g

1. Wash meat, add a little water and salt, and boil until almost tender.
2. Grind the melon seeds.
3. Wash the spinach well and remove the stalk. Shop the leaves.
4. Slice tomatoes and onions.
5. Heat the oil and add tomatoes, onions, and drained meat and fry for a few moments.
6. Add the meat stock and the ground melon seeds. Simmer for 10 minutes.
7. Clean the fish, cut in pieces and add with the chopped leaves to the stew.
8. Add salt to taste and serve with cooked rice.

(520 kcal)

SWEET POTATO

ADD: 10g oil or 5g oil and 10g sugar or 20g sugar

TO:	190g sweet potato	and	35g egg
	185g		10g dried skimmed mild
	120g		20g dried whole milk
	220g		10g Dry fish
	200g		20g chicken/lean meat

Each mix provides about 350 kcal.
175g sweet potato and 30g legume with 5g oil or 10g sugar provide about the same energy and protein value.

(1) Multimix

Sweet potatoes, edible portion	150g
Butter beans	30g
Dry fish	5g
Tomatoes	25g

1. Soak the beans, separately, overnight.
2. Boil in clean water until soft.
3. Mash and sieve the beans and throw away the skins and fibrous parts.
4. Cook tomatoes in a small amount of water. Strain them and add the pult to the beans.
5. Boil together for a few minutes. Add salt to taste.
6. Boil the sweet potatoes in salted water until soft.
7. Serve with the bean and tomato mixture.

(200 kcal)

(2) Multi mix

Sweet potato	60g
Lean meat	15g
Melon seeds	5g
Cassava leaves	120g
Tomato	35g
Onion	30g
Palm oil, red	15g
Fish, smoked dried	10g

1. Wash meat, add a little water and salt and boil until tender.
2. Grind melon seeds, Wash and chop the leaves.
3. Heat plam oil and add sliced tomato and onion.
4. Add drained meat and fry a few minutes
5. Add meat stock and the seeds. Simmer 10 minutes. Add chopped green leaves.
6. Clean the fish, cut into pieces, and add to the stew.
7. Add salt to taste and serve with cooked sweet potato.

(400 kcal)

YAM

DOUBLE MIXES

ADD: 10g oil or 5g oil and 10g sugar or 20g sugar

TO:	230g yam	and 15g egg
	230g	10g dried skimmed milk
	155g	15g dried whole milk
	250g	5g dry fish
	230g	35g chicken/lean meat

Each mix provides about 350 kcal.

(1) Double mix

Yam, edible portion	240g
Powdered fish	10g (1 Tbspn)
Palm oil, red	10g (2 tspn)
Water to cook	
Salt to taste	

1. Put small pieces of peeled and cut-up yam into a pot and just cover with water. Add salt to taste.
2. Bring to a boil and add the powdered fish.
3. Cook gently until yam is soft.
4. Remove any surplus water.
5. Mash yam and beat in the oi.
6. Feed the infant from a spoon.

(320 kcal)

(2) Double mix

Yam, edible portion	150g
Egg (1 small)	30g
Palm oil, red	15g

1. Wash, peel, and slice yam, then wash again.
2. Boil water and salt in a pot.
3. Add yam and egg (in shell) and cook for 15 minutes.
4. When yam is cooked, strain off water and remove egg.
5. Mash yam finely in a bowl, add and mix well.
6. Mold the mixture in a bowl and make hole in center of mixture.
7. Discard egg-shell and upt egg into the hole.
8. Serve.

(240 kcal)

(3) Multimix

Yam, edible portion	60g
Garden egg (eggplant), 2	100g
Okras, 2	30g
Tomato, 1	50g
Powdered fish	10g
Palm oil, red	20g

1. Wash eggplants, okras, and tomato and cut into small cubes.
2. Put in pot, cover with boiling water, and add salt.
3. Bring to a boil again, simmer until tender, then mash finely.
4. Return to pot, add fish, yam cut in cubes, and liquid if necessary.
5. Simmer until yam is soft.
6. Add palm oil and mix well.
6. Serve to toddler.

(370 kcal)

(4) Multimix

Yam	100g
Fish powder	10g
Tomatoes	90g
Palm oil, red	10g
Spinach	100g
Banana	90g

1. Peel, wash, and slice yam, and boil gently with just enough water to cover until almost soft.
2. Add the chopped tomatoes and crayfish powder.
3. Wash and chop the spinach, add it to the pot and simmer gently until all foods are tender.
4. Stir in the palm oil and mix thoroughly before serving.
5. The banana may be served after the meal.

TARO/COCOYAM

DOUBLE MIXES

ADD: 10g oil or 5g oil and 10g sugar or 20g sugar

TO:	200g taro/cocoyam	and 25g egg
	190g	10g dried skimmed milk
	145g	15g dried whole milk
	230g	5g Dried fish
	205g	15g chicken/lean meat

Each mix provides about 350 kcal.

185g taro/cocoyam and 30g legume with 5g oil or 10g sugar provide about the same evergy and protein value.

(1) Double mix

Cocoyam, edible portion	220g
Palm oil	10g
Powdered fish	10g

1. Wash and peel the cocoyam, then wash it again.
2. Cut into small pieces and place in pot.
3. Cover with bone stock or water and add salt.
4. Bring to a boil and add powdered fish.
5. Lower heat and allow to cook until cocoyam is soft.
6. Pour off any surplus stock and mash the cocoyam finely.
7. Add palm oil and mix well.

(360 kcal)

(2) Double mix

Cocoyam, edible portion	195g
Clear palm oil	10g
Lean meat	20g

1. Wash and peel the cocoyam, then wash it again.
2. Cut into small pieces and place in pot.
3. Cover with bone stock or water and add salt.
4. Add chopped meat.
5. Bring to a boil and cook gently until meat is tender.
6. Mash finely with a wooden spoon.
7. Add palm oil and mix well.

(350 kcal)

BANANA

DOUBLE MIXES

ADD: 10g oil or 5g oil and 10g sugar or 20g sugar

TO:	190g banana	and 40g egg
	175g	15g dried skimmed milk
	120g	20g dried whole milk
	220g	10g Dry fish
	195g	25g chicken/lean meat

Each mix provides about 350 kcal.

160g banana and 30g legumes with 5g oil or 10g sugar provide about the same energy and protein value.

Banana does not increase in bulk if boiled or steamed. If ripe, it can be mashed finely and eaten raw.

(1) Double mix could be (140 kcal):

Banana, skinned	60g (1 small banana)
Evaporated milk*(unsweetened)	30g (2 Tbspns)
Sugar	5g (1 tspn)
Salt to taste	

*or 10g dried whole milk plus 2 Tbspns water.

(2) Mutlimix

Banana, Skinned (just ripe)	120g
Groundnuts roasted lightly, skinned, and ground	35g
Skimmed-milk powder	15g

1. Make a paste of the groundnuts and some water.
2. Beat skimmed-milk powder into the rest of the water until smooth.
3. Boil the mixture gently for 1 to 1 1/2 hours, salt to taste.
4. Peel banana, just cover with water in a saucepan, and boil for 30 minutes or until done.
5. Drain off water and mash banana.
6. Serve with the first mixture.

(367 kcal)

(3) Multimix

Banana, skinned	100g
Coconut, Fresh, grated	30g
Egg (1/2, beaten)	20g
Evaporated milk	20g

PLANTAIN

DOUBLE MIXES

ADD: 10g oil or 5g oil and 10g sugar or 20g sugar

TO:	150g plantain	and 45g egg
	165g	15g dried skimmed milk
	110g	dried whole milk
	190g	10 Dry fish
	170g	25g chicken/lean meat

Each mix provides about 350 kcal.

145g plantain and 30 legume with 5g oil or 10g sugar would provide about the same evergy and protein value.

Plantain does not increase in bulk when boiled or steamed.

(1) One double mix could be (164 kcal):

Plantain, edible portion	50g (1/4 - 1/2 plantain)
Fish (no bones)	10g (1 Tbspn fresh)
Oil	10g

1. Cut plantain into small pieces and wrap up in a banana leaf with the fish and a little water. Tie leaf carefully.
2. Steam the food for 2 to 2 1/2 hours.
3. Open the leaves and mash up the cooked plantain and fish with oil before feeding to the infant.

(2) Multimix

Plantain, edible portion	40g
Bambara groundnuts	50g
Dried shrimps	10g
Onion	20g
Peppers and salt to taste	
Palm oil, red	5g

1. Soak beans overnight: change water the next day.
2. Simmer beans until tender (2 1/2 hours).
3. Fry peppers, onion, and shrimps together in the oil.
4. Mash beans and pile on plate.
5. Add shrimp mixture, mashed as necessary.
6. Serve with roasted plantain.

(340 kcal)

CASSAVA FLOUR

DOUBLE MIXES

ADD: 10g oil or 5g oil and 10g sugar or 20g sugar

TO:	55g cassava flour	and 50g egg
	60g	15g dried skimmed milk
	40g	25g dried whole milk
	75g	15g Dry fish
	65g	35g chicken/lean meat

Each mix provides about 350 kcal.

A mix wtih legumes in any proportion would be impractical if the same evergy and protein value were to be achieved.

Cassava flour increases in bulk as it is cooked in water, but the fresh root does not. The following are examples of recipes for mixes using cassava flour.

(1) Multimix

Cassava flour	20g
Butter beans	60g
Leaf	
Beef or Chicken	30g
Fat for frying	10g

1. Boil beans with seasonings until soft.
2. Add cassava flour and continue cooking until it looks like brown porridge.
3. Fry the meat in the fat. Serve foods together.

(390 kcal. Meat can be replaced by equivalent weight of fresh fish or by 10g dry fish).

(2) Multimix

Cassava, edible portion	60g
Meat	40g
Tomatoes	15g
Onion	10g
Red pepper and fermented locust bean to taste	
Dried fish	5g
Palm oil, red	5g

1. Cut meat into small pieces, add about 1 cup water, and boil gently until nearly tender.
2. Pound upon to a fine paste and grind together the tomato, onion, red pepper, and locust bean.
3. Add another cup of water and the oil to the meat, bring to a boil, and add remaining ingredients.
4. Continue cooking for 1/2 hour. Season with salt.
5. Serve with stiff cassava porridge (foofoo).

(440 kcal)

4. Explore further consultant needs.

Recommendations by Berggren (1981) in the original consultant report for further consultant needs were (following my visit):

A. A behavioral scientist, such as a nutrition anthropologist who can work with Liberian counterparts to better define
   - -child-rearing and feeding practices in different parts of Liberia,
   - -traditional dishes and methods of cooking which lend themselves to development of an appropriate weaning diet,
   - -beliefs that affect child and maternal nutrition.

   In addition, this consultant should help to outline the methodology to study acceptability of possible new weaning foods.

B. A specialist in implementation and evaluation of weaning food programs and food supplement programs for pregnant and lactating mothers. If possible, this consultant should also work with the medical school to develop guidelines for the desired training region or regions as requested by the medical school.

Other consultants needed will include specialists in the area of training primary health care workers in nutrition.

These recommendations are still appropriate.

An important consideration which is not completely answered by the use of consultants is the aspect of continuity and application. It is most important that the overall project, i.e., improvement of nutritional status of children by implementation of a program involving the home and village preparation of weaning foods be given a degree of continuity. This can only be obtained by appointment of a project director in Liberia to oversee all stages:

- -Adaptation of appropriate mixtures to meet local food acceptance patterns.
- -Development of laboratory facilities
- -Testing of mixtures as prepared in villages for nutrient content and acceptibility
- -Overall evaluation of the project in improving nutritional status
- -Development of training facilities for the communicators.

Bibliography

Berggren, G.G., 1981, Consultant Report on Liberia, MIT-Harvard International Nutrition Program.

Cameron, M. and Hofvander, Y., 1976, Manual on Feeding Infants and Young Children, PAG Group, United Nations

FAO, 1961, FAO/WHO Seminar on Problems of Food and Nutrition, Scuth of the Sahara: Bukavu Congo, May, 1959, FAO, Rome.

FAO, 1964, Legumes in Human Nutrition, by W.R. Aykroyd and J. Doughty, FAO Nutrition Studies No. 19, FAO, Rome

FAO/WHO, 1974, Handbook on Human Nutritional Requirements, FAO Nutrition Studies No. 28: WHO Monograph Series No. 61, FAO, Rome or WHO, Geneva.

FAO, 1979, Human Nutrition in Tropical Africa by M.C. Latham, FAO Food and Nutrition Series No. 11, Revision 1, FAO, Rome.

Pellett, P.L. and Shadarevian, S, 1970, Food Table - for Use in the Middle East, AUB Press, Beirut, Lebanon.

Pellett, P.L., 1976, Role of Food mixtures in Combatting Childhood Malnutrition, Chapter 16 in Nutrition in the Community, D.S. McLaren Editor, J. Wiley and Sons, London and New York, 1976.

Pellett, P.L. and Mamarbachi, D., 1979, Recommended Proportions of Foods in Home-Made Feeding Mixtures, Ecol. Journal of Nutrition, 7 219-228.

Pellett, P.L. and Young, V., 1981, Nutritional Evaluation of Protein Foods, UNU, Tokyo (Copy donated to Library A.M. Dogliotti School of Medicine).

ANNEX 1

ITINERARY
FOR DR. PETER PELLET'S 2-WEEK VISIT
TO UNIVERSITY OF LIBERIA, BIOCHEMISTRY
LABORATORIES
Under the auspices
of
THE MINISTRY OF HEALTH & SOCIAL WELFARE
AND USAID
JANUARY 18-29, 1982

Mon. Jan.18/'82	Arrival
Tues. Jan. 19/'82	Free
2-4 P.M.	Introductory lecture/discussions on the various aspects of Weaning and Supplementary Foods Conference Room
Wed. Jan. 20/'82 10-12 A.M.	Lecture on the Role of the Laboratory in Weaning and Supplementary Food Program and Research U.L. Conference Room
12-1:30 P.M.	Lunch
2-4:00 P.M.	Visit to Biochemistry Laboratories. Orientation on the current research projec in Food Science in these laboratories Discussions with individual scientists on their present and future research project related to Food Science. U.L.Conference Room
Thursday, Jan. 21/'82 8:30-10:30	Visit to communities West Point/Mambalout
10:30-12:00	Meeting with Officials of MOH, MOA, MOE, U.L., TNINA, and FPAL to discuss the nature and scope of a Weaninc and Supplementary Food Program in Liberia Conference Room
12-2:00 P.M.	Lunch
3:00 P.M.	Meet with the Minister of Health

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Fri., Jan. 22/'82 10-12 A.M.		Visit to Fendell (College of Agriculture and College of Science and Technology Labs.)
12-1:45 P.M.		Lunch
2:00 P.M.		Meet with the Minister of Agriculture
3:15 P.M.		Meet with WHO National Coordinator
Saturday Jan. 23 8:30-1:30		Attend meeting of Liberian Medical-Dental Association at Liberian Institute of Biomedical Research. Present Lecture "Meeting Protein Needs in Children"
1:30 - 3:00		Urban malnutrition - Meet with Officials of USAID
Tues., Jan. 26/'82		Trip to the Agriculture Experimental Station and the Rural Development Institute at Cuttington University College, Suacoco, Bong County.
9:00 A.M.		Departure from the Medical College
Wed. Jan. 27/'82		
9:00A.M.		CARE
10:30		Recording Studio
12:00-1:30 P.M.		Lunch
2:00-4:00 P.M.		Final discussions and Comments involving officials of MOH, MO[illegible] MOE, U.L., FPAL, and TNIMA.
		Conference Room
Thur. Jan. 28/'82	Morning	Free
2:00 P.M.		Meet with the Minister of Heal[illegible] and Presentation of report
Fri. Jan. 29/'82		Departure

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Major Contacts in Liberia

Mrs. Rachel Marshall
Assistant to Minister of Health and Social
Welfare for Coordination

Dr. Dickson D. Redd
Dean, College of Science
University of Liberia

Nancy Nah Ninene
Nutrition Section Director
Ministry of Health
and Social Welfare

Mrs. Guwor
Director, Home and Community Development Program
College of Agriculture at Fendell
University of Liberia

Dr. Z. Sherman Adams Jr.
Physiology Dept. A.M.
Dogliotti College of Medicine

Dr. Bodu Bediako
Biochemistry Department A.M.
Dogliotti, College of Medicine

Mr. N.R. Huff	CARE	Liberia
Dr. S. Robinson	CARE	Liberia
Mr. A. Fosse	AID	Liberia

Dr. H.R. Capener
Director, Rural Development Institute
Cuttington University College Suacoco

Lectures and Appearances in Liberia

Lectures on various aspects of the history, role, application and future of the home mixing approach to combat infantile malnutrition in Liberia were delivered to:

1) the joint nutrition working group at the University of Liberia - two lectures
2) the Liberian Medical and Dental Association meeting at the Liberian Institute for Biomedical Research - Robertstown, Liberia
3) The medical staff, Pediatrics Department, J.F. Kennedy Medical Center, Monrovia

Radio and television interviews together with Dr. Marshall, Dr. Adams and Mrs. Marshall were also recorded at the Radio/Television studios. A fifteen minute radio program and a 30 minute television program were due to be aired during the week of Feb 1st-5th, 1982. The subject of these broadcasts was home mixing of weaning foods.

ANNEX 2

PROTEIN-RICH FOODS

Protein malnutrition is common in many tropical countries, particularly in young children and expectant and nursing women. In view of the existing scarcity in many countries of foods which provide protein and the difficulty of increasing rapidly the production of foods such as meat, milk and legumes, it is necessary to consider other sources of protein not at present widely used, which could be made available. These should have the following characteristics:

(*a*) They should have a high protein content of good biological value and be easily digestible.

(*b*) They should be free from bacterial contamination and nontoxic.

(*c*) They should be acceptable to the extent that the majority of the population is willing to include them in its ordinary diet.

(*d*) It must be possible to keep them in a good state of preservation, under ordinary conditions, until they are consumed.

(*e*) They must be inexpensive. For example, their price per unit content of protein should not exceed that of skim milk powder as sold on the local market.

(*f*) They should preferably be locally produced.

Among the foods which possess some or all of those characteristics are the following: fish flour, groundnut flour, cottonseed flour, sesame flour, sunflowerseed flour, and soy meal. A considerable amount of research on the use of foods of this nature in human nutrition has already been carried out. Of the foods listed, the three following are available in Africa, and could be produced and consumed on a large scale.

Groundnut flour

Two types of groundnut flour may be distinguished, namely, those from which the oil has been extracted by pressure and solvents respectively. Numerous investigations on the use of groundnut flour in human feeding have been made in Africa — in laboratories, hospitals, schools and even among village populations. Large-scale acceptability trials have been undertaken with presscake flours, processed so that the temperature reached does not affect the biological value of the protein. Solvent-extracted flour may be somewhat superior in nutritive value to flour extracted by pressure and this method of processing results in the almost total removal of the oil, which means improved keeping qualities. The WHO Protein Advisory Group has recently concluded that solvent-extracted groundnut flour can be safely used in feeding children, provided that solvents of known characteristics are utilized and controlled.

Groundnut flour produced under good conditions has a digestibility coefficient and a biological value, assessed by observations on children, of 90 and 58 respectively. The limiting amino acids are those of the sulfur group.

The stage has now been reached at which the use of groundnut flour on a large scale in the prevention of protein malnutrition can justifiably be considered. In this connection, it is necessary to determine the optimum and maximum amounts which can be consumed daily by different age groups.

Cottonseed flour

The presence of the toxin gossypol in cottonseed makes the manufacture of cottonseed flour suitable for human consumption difficult. However, it appears that processing methods which remove gossypol are now available. The few trials of feeding with cottonseed flour which have been carried out in Africa suggest that this product can be made nontoxic and is well accepted. Moreover, it has qualities which would promote its use on a commercial scale. Tests on human beings have indicated that its digestibility coefficient is slightly below 90 and its biological value about 60, the limiting amino acids being as in groundnut flour.

Fish flour

Considerable quantities of fish are produced in Africa, possibly of the order of 2 million tons annually. Of this quantity, about 1 million tons are exported as fish meal for use in animal feeding and for various industrial purposes. Much of the fish produced is sold at very low prices. The manufacture of fish flour is to be recommended where the preparation and sale of fish in the fresh form, or after drying and salting or smoking, are not possible. Numerous trials of fish flour in human feeding have already been made or are in progress in Africa. They have been concerned both with " nondeodorized " flour, containing a fair amount of fat, and with " deodorized " flour, which is almost devoid of fat and is relatively tasteless. The type of flour most acceptable to consumers varies from area to area. Fish flour not deprived of fat presents problems with respect to preservation, though indeed certain types of flour with a high fat content (8-9 percent), prepared in Africa, seem to keep well.

Fish flour manufactured under good conditions has a biological value for human beings of about 70 and a digestibility coefficient of about 90 percent. Parallel investigations on the provision of fish flour to children in various African countries have given satisfactory results, indicating that it can help in promoting growth. It should, however, be added that less favorable results have been observed in South Africa. The limiting amino acid is tryptophan.

Use of these foods. In the trials hitherto made, fish flour and groundnut flour have been used as such or mixed in dishes of various kinds, or incorporated in a staple food. The last method is perhaps the one most open to question, since it is intimately concerned with deeply rooted food habits. For example, the addition of fish flour to bread may affect the acceptability of an important staple food. Moreover, the consumption of such a food by a large proportion of the population, including people in good health, is not an economically sound method of procedure, the more so since the relatively small proportion of the " enriching " agent added cannot have any decisive effect on those who are seriously malnourished. On the other hand, when an additional food of high nutritive value can be incorporated in the traditional diet (for example, in soups or sauces), it is more readily accepted even in high amounts and is more likely to reach the people in need. Other preparations based on these products, such as mixed flour for weaning or biscuits which can be distributed in schools, appear equally well accepted. If trials show that preparations of these kinds are valuable and acceptable, attention can be given to their production on a commercial scale, accompanied by suitable educational and advertising campaigns to promote their consumption.

ANNEX 3

ROLE OF BIOCHEMISTRY DEPARTMENT

A.M. DOGLIOTTI COLLEGE OF MEDICINE

The Department of Biochemistry of the A.M. Dogliotti College of Medicine has a short paper on its possible role in a National food and nutrition programme. This short paper is attached and has been circulated, as this follow-up paper intends to briefly re-emphasise the willingness of this College to participate in this programme.

A Food Science Laboratory should have the capacity for food analysis of food components such as proteins, fats, carbohydrates, caloric value, minerals and vitamins. Such a lab. must also be suitable for carrying out simple toxicological analysis (chemical and microbial) of foods. Furthermore such a set up must be suitable for carrying out simple scientific investigations such as chronic toxicity problems due to ingestion of certain foods.

The Medical College already has a full-time Biochemist who did his Ph.D. in a food-related topic, cyanogenic glycosides in Cassava, and who has for the past 3 years gathered much experience in the area of food analysis and simulated foods using vegetable proteins. The college has research animals, spectrophotometers, flame photometers, centrifuges, refrigerators, deep freezers, and certain basic equipments relevant to food research. Specific equipment that will be required (listed below) will supplement what is already available here and together with our highly trained technicians should be able to analyze foods and help to formulate simple mixes for both village and commercial preparations.

Previous Research in Food Science and Nutrition

1. Protein contents of local (Ghana) leafy vegetables, oil seeds and legumes.
2. Preparation of protein concentrates for foods and feeds
3. Preparation of simulated milk products from winged beans, soybeans and Agushie (colocythis citrullis)
4. Preparation of simulated meat products from protein concentrates and isolates from Agushie and winged beans.
5. Poultry feed preparation using isolated leaf proteins.
6. Nutritive values of selected local (Ghana) foods and alcoholic beverages.

Present Research Interest in Food Science and Nutrition in Liberia

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Help to set up and operate appropriate in country analytical lab. to back up a national nutrition programme.

1. Analysis of Liberian food ingredients and prepared foods (emphasis on weaning foods) for building up a food composition table for Liberia.
2. Investigation of toxic principles and protein digestibility of local foods and food ingredients.
3. Endemic goitre and Cassava foods in certain Liberian tribes.
4. Product development of simulated milk and meat products as weaning food supplements.

REQUIREMENTS

EQUIPMENTS:

1. Protein Analysis: macro and semi micro kjeldahl equipments
2. Essential Amino Acid Analysis: Amino Acid Analyser system.

3. Soxhlet apparatus for total fat determination
4. Chemicals
5. Bomb Calorimeter

Product Development

1. Pressure cooker
2. Table top freeze-dryer
3. Lab. scale spray-dryer
4. Laboratory Homogenizer
5. Hand operated grinder

Supporting Personnel

1. One graduate student with a major in Biochemistry
2. One Laboratory Technician

Required Literature

Journal of Agriculture and Food Chemistry

Journal of Science and Food Agriculture

Journal of Food Science

Cereal Chemistry

Protein Advisory Group Bulletin

UNU Food and Nutrition Bulletins

Dr. Badu M.K. Bediako
Department of Biochemistry
AMD College of Medicine
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ANNEX 4

O V E R V I E W OF NUTRITION

Weaning Foods

I. POLICIES:

- Education of Health Workers
- Education of Policy Makers
- Education of Women - It's been found that incidence of malnutrition can be improved by improving level of literacy in women.

- Inclusion of Nutrition Education in various Curriculum.
- Integrated Maternal & Child Health (MCH).
- At-risk - Malnourished children to be followed by weight chart.
- Individual road to health charts.
- Nutrition Education.
- Encourage Breast Feeding - Mothers must be informed of the importance and need to breast feed their children. They must be told:

  1. to feed their children with only breast milk for the first four months after birth and thereafter to complement the breast milk with adequately balanced transitional foods.

  2. that with the additional transition food breast feeding should not stop abruptly, but should be carried on for as long as possible.

  3. that she should breast feed her child and especially even when the child is sick.

- Improve transitional feeding habits (Weaning Foods).

  Factors to consider in selecting the transitional foods to be recommended by nutrition education include:

  a) kinds of food locally available and affordable by the family.
  b) food value with regards to the protein/calorie, or vitamin/mineral content of each food.
  c) Preparation methods of the available food and how each methods affect the nutrition contents of the food.
  d) the time at which the transitional food is given to the child many adversely affect the nutritional status.

II. The Specific concerns of Liberia -

1. That a body be appointed to continue development of the National Nutrition Plan, with a special committee for each of the four main areas in the plan. The functions of this body should include:

   a) Investigate further the available resources for nutrition program, and define clearly what additional resources are needed.

   b) Continue planning and implementation of the program initiatives in working on Nutrition Planning held in Monrovia from 20 - 24 October, 1980. Such as:

      1. Applied research should be emphasized, i.e. formative evaluation of Nutrition Education Materials on-going feedback and evaluation of nutrition program, benefit analysis, and pilot studies to compare effectiveness of different interventions.
      2. Careful estimates should be made of the resources as antihelminthies and Road-to-Health Cards needed to implement the recommendations; otherwise training efforts are wasted when health workers cannot put into practice what they have learned because they don't have the materials.
      3. Petty cash is needed for nutrition demonstrations.
      4. The involvement of participants from the counties in the planning workshop was fruitful and should be a part of further planning and implementation.
      5. Improve nutritional status of pregnant and lactating women.
      6. Improve transitional feeding habits.
      7. Increase over-all nutrition education provided by MCH Services.
      8. Improvement of hygiene and sanitation, especially by improving water and sewage disposal.
      9. Encourage family gardens, to feed the family rather than cash crops.

10. In-service Training for clinic personnel (using community road-to-health cards).

11. All community Development Workers should be supervised at County Level by respective local representatives. i.e. decentralization.

12. Mobilize vacation students in the various counties to conduct literacy program which will be a booster to improving nutrition.

13. Up-grade nutrition training given to medical students

III. Existing Agencies within the country that are already involved in Nutrition Program.

The following is a partial listing of Ministries and Non-governmental Organizations having programs with Nutrition components, or programs affecting nutrition.

1. Ministry of Health and Social Welfare:

a) Family Health Division
   - Preventive Medical Services
   - Empirical Midwives Training Program
   - School Health
   - MCH/FP Services
b) In-service Division
   - Continuing Education Project
c) Health Education Division
d) Social Welfare Bureau
   - Nimba County Rural Child Health Education Package
e) Curran Hospital Nutrition Rehabilitation Center
f) County Community Health Programs
g) Clinics
h) Hospital Out-patient Departments
i) TNIMA School of Nursing.

2. Ministry of Education:

Division of Home Economics/Community Education/Research

- Adults Literacy
- School Health

3. Ministry of Labour, Youth and Sports:

   a) Domestic Section of the Business

   b) Domestic Occupational Training Center

4. Ministry of Agriculture:

   -Home Economic Extension Division

   -Several programs to increases food production.

Demonstration from the Ministry of Agriculture: To obtain sufficiency in food production with improvement in nutrition by introducing a more balanced diet. The following are proposed by the Ministry of Agriculture:

   a) A need for research to be conducted on available food dietary habits and food value at the village level, and prevention should be made for studying and testing foods gathered.

   b) A need for increase production of legumes e.g. pigion peas and other vegetables.

   c) Dry season irrigation of various places to produce more vegetables when out of season.

5. Ministry of Commence, Inductry and Transportation

6. Ministry of Local Government, Rural Development and Urban Reconstruction:

7. Ministry of Action, Development and Programs

8. National Food Assistance Unit:

9. Ministry of Planning and Economic Affairs

10. Non-governmental Organizations:

    MISSIONS:

    Cathclic and Lutheran

    CONCESSIONS:

    Firestone and LAMCO

    Family Planning Association of Liberia (FPAL).

    Federation of Liberian Youth

    Peace Corps/Liberia

Non-governmental Organizations:

Nutritional Rehabilitation Center, Curran Lutheran Hospital, Zorzor Lofa County, Liberia.

Common Family Life Patterns (eating habits)
Diet and Pattern of Food Intake

The staple food of Liberia is rice, supplemented by tubers such as cassava, eddoes (coco yams), sweet potatoes and yams. Rice is eaten mainly in one form (boiled or steamed) in all the regions of the country. Usually there is a sauce (called soup) placed on top of the rice before it is eaten. Rice is eaten at least once daily in most homes but usually twice and as many as three times daily in rice grown areas.

The sauce or soup for rice may consist of clear soup within which a small amount of fish, crawfish, or meat and herbs are cooked and seasoned. Soup may also consist of some typed of greens (cassava leaves, collard greens, sweet potatoes leaves, spinach, etc) and fish or meat cooked in oil and highly seasoned with hot peppers.

Technical Assistance - Weaning Foods

The tubes - cassava, eddoes (coco-yams) sweet potatoes, yams are used along with rice either in the same meal or in different meals. This depends on the food habits of the particular region. Most tubers are considered breakfast or morning foods while rice is always considered the big meal of the day in most regions. The by-products of these foods are also used extensively. Sometimes these foods are preferred to the product itself. Farina, Diabah, Fufu, and Dumboi are made from cassava. Cush-cush, and potatoe bread are made from sweet potatoes.

Corn is used mostly for gruels and paps. Excepts for cornmeal which is widely used in coastal towns, kernal corn is not as widely used as the other starchy foods.

Fish is the most available protein food so it is used throughout the country. Even with refrigerated trucks transporting fish in rural areas, it is still unavailable in many areas. Although it is not as expensive as meat, it is expensive for many rural low income families.

Technical Assistance - Weaning Foods - Continued

Fish ponds gained momentum during the middle 60s, but are only operative in a very few places at present. These people can only offord a amount which is far below the needed requirements for optimum health.

The use of eggs are on the increase and they are sold in the open market as boiled eggs. They are eaten by a fair member of people both children and adults. They too are expensive so that many people cannot afford to buy them.

All meats - beef, poultry, pork, goat, wild meats - are well liked by all Liberians. However, meats of any kind and all kinds are very expensive and scarce. This make it unavailable to many low income groups. For this reason, nutrition education emphasizes the use and consumption of legumes and other plant protein in the diet of low income groups.

Vegetables such as okra, eggplants (garden eggs) and bitterballs, squach and pumkin are used extensively as sauce for rice. Legumes such as green beans are use less extensively. Nutrition Education have been advocating the use of more legumes and nuts as dried beans and peas, groundpeas (peanuts) beniseed, sesame, and deffiseed in the daily diet.

Greens of all kinds-cassava lleaves, sweet potatoes leaves, platto, kellis, any varieties of spinach, collard, cabbage and large variety of wild greens are used extensively in the southwest, contral and western regions.

Local edible oils are palm, kernel, coconut, and groundpea oil. In the regions where greens are used extensibely, oil is consumed in larger quantities than in the sastern and southeastern regions where clear soups of meat, fish, and herbs are preferred.

Condiments, especially hot peppers are used unreservedly in most Liberian food preparations. It is said that many Liberians eat enough hot pepper to provide at least one third of the daily requirements of vitamin C.

Technical Assistance - Weaning foods - Continued

Fruits - oranges, grapefurits, tangerines mangoes, guavas, sour plums water mealons, pawpaw, pineapples are rich in vitamins and plentiful in season. Oranges are more widely eaten than most other fruits. In many sections of tje cpimtru. fruits are considered women and children's foods; therefore fruits are consumed by these category of of people more than men. At any rate, fruits are eaten between meals and they are vary seldom considered a part of the meal. They are looked upon as tie-over foods.

It is culturally accepted and expected that the man of the household gets the choiscost food whether it is the staple or the scarce$. but highly favoured protain, meat fish or other. The men in the household eat together whild the women and children share their food together.

V. Areas of need:

a. Research, knowledge, attitudes, and practices
b. Nutritional analysis of locally grown foods
c. Information on Food Taboos
d. Social & Economical Variables

Technical assistence - Weaning Foods -

e. Methods of preparing available locally produced weaning foods.
f. Training of Trainers (TOT).
g. Continuing Education for Staff Development
h. Consultants

VI. Available resources

a. Staff of the Division of Family Health
b. Nutrition Unit
c. Maternal and Child Health (MCH) Unit
d. Health Education
e. Staff of Various U.N. and other voluntary agencies.

VII. Constraints

a. Constraints in gaining access to foods.
b. Constraints in food production
Subsistence Agriculture
Farm - to Market Roads
Unequal distribution of goods.
Constraints in buying power

Low per Capital Income

Weaning Recipes - 9

VII. 1. Boil soft rice
2. Put beaten cassava leaves onto top of rice
3. Add 1-2 teaspoon red palm oil
4. Steam until done (20-30 minutes)
5. Dish out of pot into baby's pan
6. Cool, feed baby with spoon

VIII. 1. Peal green plantain
2. Dry in fanner in the sun
3. Beat or pound plantain in mortar (specially for baby)
4. Sift plantain
5. Beat or pound one dry bonnie in mortar
6. Sift pounded bonnie
7. Put two small drinking cups of water in pot
8. Add plantain flour, stir and cook until it boils
9. Add bonnie meal (pound bonnie to dust)
10. Cook for 20-½ hour
11. Take out of pot into baby's pan
12. Feed baby with spoon

Recipes for Weaning Foods - 10

Sierra Leone

Anglophone African
Nutrition Conference
May 1981

Recipe of Pap (porridge) with fish

	Prot.	Cal.
4 (2 oz.) tomato tins cooked rice	5.3	260
2 Heaping Spoons (soup) dried fish powder	8.5	30
3 Tsp. palm oil		90
	13.8	380

Prot./Cal % 14.5%

With groundnut (ground peas)

	Prot.	Cal.
3 (2 oz.) tomato tins cooked rice	4.0	200
2 spoons (soup) groundnut paste	9	200
	13.0	400

Prot./Cal. % 13%

With Black eye Beans/peas

	Prot.	Cal.
3 (2 oz.) tomato tins cooked rice	4	200
2 (2 oz.) tomato tins cooked beans pounded	7.3	100
3 tsp. palm oil		90
Prot./Cal. %	11.3	390

Rice, Beniseed, and Ground Peas Mixture:

Ingredients

Rice
Beniseed (sesame) or Keffiseed
Groundpeas
Fish (Optional)

Preparation

1. Rice

Soak country rice 2 hours. Drain off water; spread on fanner or sifter and set in the sun until rice is partially dried. Beat rice in a mortar until fine and sift. Save the fine flour for the mixture.

2. Groundpeas

Clean the beniseed, parch and beat while warm, then sift. Save fine meal for mixture.

4. Fish

Fish is necessary, to increase the protein content. If bonnies (dried herring commonly used in Liberia) are used all scales and hard bones are removed, then dried thoroughly. Fish is then beaten in the mortar and sifted; comes out as a fish flour.

Mixture

5 parts of rice	2½ teaspoon
5 parts of beniseed meal	2½ teaspoon
5 parts of groundpeas meal	1½ teaspoon
1 part fish flour	1 teaspoon

Method

Mix all together and beat a little while in mortar until well mixed.

Cooking

To 1 cup of mixture add 4 cups of cold water slowly until free from lumps. Set on low fire. Add ½ teaspoon salt and let cook slowly for 30 minutes. Add fish meal first before removing from fire. Serve while warm, to a 6-month old baby or older. This mixture is given to the baby in addition to breast milk. Vitamin A is lacking in the food mixture when compared with mother's milk but can be supplied by additio of little raw palm oil or green leafy vegetable, like potato greens, kellis or platto leaves.

COMPERATIVE ANALYSIS OF MOTHER'S MILK AND BABY FOOD MIXTURE RICE, SESAME AND GROUNDPEAS

	Calories	Protein	Fat	Cal	Fe	Vitamin	Thiamine	Ribo flamine	Niacin
		gm	gm	gm	mg	mg	mg	mg	mg
Beniseed) (Sesame)	953	24.5	54.3	924	10	-	.08	325	6.0
Rice	Mixture 180 gms								
Ground Nut									
Human Milk	1000	16.9	54	500	2.0	3000	.6	125	2.6

Weaning Food - 13

* Original recipe was given by Department of Social Welfare and Community Development of Sierra Leone, 1962. Improved preparation methods were done by Nutritionist Nancy Nah of National Food Assistance Unit, Republic of Liberia.

* Comparative Nutrition analysis was done through Sierra Leone by University of London, School of Tropical Medicine.

ANNEX 5

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RECOMMENDED PROPORTIONS OF FOODS IN HOME-MADE FEEDING MIXTURES

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Tabular data are presented on the recommended proportions of staples and supplements for the preparation of home made feeding mixtures. Optimum proportions are presented for 78 combinations originating from 13 staples and six supplements widely consumed on a world wide basis. Calculations were made so as to reach an adequate level of NDpCal percent (6.5–7.0) with the minimum quantity of the more expensive supplement. This follows the procedure of Cameron and Hofvander (1976) in their Manual on feeding infants and young children, however, newer data is used for the protein and amino acid composition of the foods together with the more accurate FAO/WHO (1973) scoring system rather than the no longer acceptable FAO/WHO (1957) procedure. An improved formula for the calculation of NDpCal percent was also used. The new data show, in general, smaller proportions of supplements to reach the same protein-calorie value and would thus be of lower cost.

INTRODUCTION

A major cause of ill health and high mortality in infants and young children is inadequate and/or improper feeding. This remains true despite the fact that general views of causation have changed considerably in recent years, since it is now increasingly recognized that infantile malnutrition may be caused less by food and nutrient deficiency as such and more by many interrelated socio-economic and hygenic factors (Taylor and Taylor, 1976, Pellett, 1976a). Nevertheless, correct selection of acceptable forms of feeding which are also nutritionally sound, economically feasible and relevant to the situation in developing countries can lead to considerable reductions in infant morbidity and mortality. Problems and their resolution, however, differ from age group to age group and from country to country and holistic solutions are probably not possible (McLaren, 1977).

The early discontinuance of breast feeding by mothers in low income groups in urban areas of most developing countries has been a serious concern for some years (Jelliffe, 1971, Jelliffe and Jelliffe, 1975). PAG Statement No. 23 – Promotion of special foods for vulnerable groups (FAO/WHO/UNICEF, 1972) was a reaction to this concern. This statement emphasized the critical importance of breast feeding under the sociocultural and economic conditions that prevail in many developing countries. Infants of more affluent socio-economic groups in industrialized and developing countries, in the absence of breast feeding, suffer no nutritional disadvantage when fed properly-constituted and hygienically-prepared processed commercial formulas. However, the early abandonment of breast feeding by mothers among lower socio-economic groups has often proved to be disastrous to infants. This is particularly true when financial resources are inadequate to purchase sufficient formula and when knowledge of and facilities to follow hygienic practices necessary to feed infants adequately and safely with breast milk replacements are not available. Under such circumstances, and where animal milk and other supplementary protein resources are expensive or in short supply, an important function of the food industry, in close cooperation with governments and physicians, has been the development and marketing of relatively low-cost, nutritionally-equivalent protein foods that can be used to supplement breast feeding.

The development of food mixtures of this type has, had close association with several U.N. Agencies, notably WHO, FAO, UNICEF, and has led to the development of the Protein Advisory Group (PAG). Brief histories exist on the development of protein foods and the involvement of the U.N. Agencies (Kapsiotis, 1969, Van Veen and Van Veen, 1973). In addition, a series of statements and guidelines relevant to food mixtures have been produced by the PAG, and extensive reviews and critiques of the whole field have appeared recently (Milner, 1969; Orr, 1972; Bressani and Elias, 1973; Orr, 1978; Pellett, 1976b, Pellett and Pellett, 1978).

Food mixtures have sometimes been considered as if they were exclusively manufactured products, an alternative approach, advocated by many over a long period and discussed in detail by Cameron and Hofvander (1971, 1976) lies in the home mixing of components so as to produce more balanced mixtures for the feeding of infants and young children. This approach eliminates many of the limitations and dangers inherent in the use of manufactured food mixtures. (Popkin and Latham, 1973).

The supplementary effect between proteins occurs, of course, whether they are mixed by a manufacturer or by the mother immediately prior to the feeding of an infant. While home-made feeding mixtures may be more properly considered the province of infant feeding practice and nutrition education rather than of food science and technology, it is a very relevant approach and is becoming increasingly recommended by the international agencies (Orr, 1978). The concept is, of course, not new and a considerable body of information on appropriate mixtures has been prepared in many local centers on a world wide basis. The manual by Cameron and Hofvander (1971) on feeding infants and young children, now in a second edition (1976), however, puts much of the information together in one place. The manual was designed to give comprehensive information on the preparation of home-made weaning foods so that more efficient use can be made of the locally available staples. The core of the book consists of tables and recipes demonstrating how foods should be mixed together to maximize the protein value. In the tables of the book the amounts of supplementary foods which should be used with various staple foods are shown. Calculations were made so that all the mixtures have a similar protein value which was set at a level suitable for a young child (NDpCal 6–7 percent). The recommended recipes are derived from these tables.

These calculations, however, were made using the FAO (1957) scoring system. A considerable number of predictive errors with the 1957 pattern have been demonstrated (FAO/WHO 1973) and since the manual was published in 1971, a new FAO/WHO (1973) scoring pattern has been adopted. In this new pattern, reference values for the four amino acids most likely to be limiting in real dietaries, lysine, threonine, tryptophan and total sulfur amino acids (SAA = methionine + cystine) have all been changed. Tryptophan and SAA values were reduced while lysine and threonine values were increased. The net result of these changes is that when protein scoring is performed, mixtures are more likely to appear limiting in lysine and threonine and less likely to appear limiting in tryptophan and SAA. The protein scores for the various mixtures would therefore be changed and thus the appropriate quantities of components necessary to give protein values between NDpCal 6–7 percent would also be expected to differ.

The new edition of the manual (1976) still, however, uses the earlier scoring system and has not changed to the newer recommended scoring system despite considerable evidence that the new pattern is superior (FAO/WHO 1973, Kaba and Pellett, 1975, Pellett 1978, Young and Pellett 1978). Possible further criticisms of the calculation procedures followed by Cameron and Hofvander (1971, 1976) pertain to the validity of the amino acid data and to the suitability of equation used to Calories with a NDpCal percent between 6–7 and amino acid scores. For these reasons it was decided to recalculate the proportions of staple and supplementary foods necessary to give 350 Kcalories with a NDpCal percent between 6–7 suitable for feeding to the young child but using best available amino acid data, the newer more valid FAO/WHO (1973) scoring procedure and the improved equation for calculation of NDpCal percent from protein and energy data. It is fully realized that the recommended values given by Cameron and Hofvander (1971, 1976) are not meant to be of the highest accuracy but are produced as guides for the formulation of home made feeding mixtures. Nevertheless it is felt that even for guideline values the recommendations should be calculated from best available data using best available methods.

MATERIALS AND METHODS

Protein, Food Energy and Amino Acid Data

The same values are used by Cameron and Hofvander for both editions of their manual (1971, 1976). The protein and food energy values originated from the food tables of Platt (1962) while the amino acid data (SAA and lysine only) were in practice selected literature values such that they agreed with NPU bioassays performed by Miller and Payne (1961b) using the FAO (1957) scoring pattern. For values not available from the literature estimated values were used as can be seen from the lysine values for the seven items at the bottom of Table I all reading 300 mg/gN. One of the better sets of available data for the amino acid composition of a wide variety of foods is that of FAO (1970) and use of these data have been demonstrated as giving reasonably good estimates of bioassay values (Pelle.., 1978). The energy values used by Cameron and Hofvander are acceptable data and have been retained but protein and amino acid data have been taken from FAO (1970). Most are mean values from multiple reported determinations. These values are shown in Table I. It will be noted that amino acid data are quoted for threonine and tryptophan in addition to SAA and lysine. This is because all four are potentially limiting in mixed dietaries. In practice 16 percent of the values calculated by Cameron and Hofvander would have been limiting by tryptophan rather than SAA or lysine had the values been reported. The possibility of tryptophan limitation was probably disregarded by these authors since it was widely realized by workers in this field that the tryptophan value in the FAO (1957) pattern was unrealistic.

Scoring System

Dietary protein provides the organism with enough material for the synthesis of its own body protein plus other metabolically important nitrogen metabolities, such as peptide hormones and various active amino acid derivatives, such as the neurotransmitters, serotonin, and norepinephrine. All the functions are essential for maintenance of health, but the process of body protein synthesis is usually considered to be quantitatively the most demanding. Daily synthesis may be several times greater than daily protein consumption, thus indicating extensive amino acid reutilization (Young and Scrimshaw, 1977).

Dietary protein needs can be met by nitrogen and sulfur in metabolically available forms, together with a number of the amino acids which the body is not capable of synthesizing. These amino acids are histidine, isoleucine, leucine, lysine, methionine (+ cystine), phenylalanine (+ tyrosine), threonine, tryptophan, and valine.

TABLE I

Food energy, protein and amino acid values used for calculation of the protein value of food mixtures

	Cameron and Hofvander (1976)				This paper					
	Energy	Protein	SAA	Lysine	Energy	Protein	SAA	Lysine	Threonine	Tryptophan
	Cal 100g	g/100g	mg/gN		Cal 100g	g/100g	mg/gN			
Egg	158	13.0	338	369	158	12.4	362	436	320	93
Chicken	139	19.0	219	538	139	20.0	239	497	248	64
Fish	73	17.0	244	538	73	18.8	253	569	286	70
DSM	357	36.0	231	500	357	36.0	220	453	263	82
DWM	500	25.5	231	500	500	25.5	220	453	263	82
Soybean	382	35.0	188	400	382	38.0	162	400	241	80
Wheat flour	350	10.0	194	131	350	9.2	229	113	153	58
Rice	352	7.0	200	156	352	6.7	229	226	207	84
Maize	362	9.5	156	119	362	9.5	217	167	225	44
Millet	365	9.0	175	131	365	9.7	302	214	241	122
Sorghum	353	10.0	169	119	353	10.1	181	126	189	76
Oats	388	12.0	200	169	388	13.0	272	232	207	79
Potato	75	2.0	163	300	75	2.0	118	299	235	103
Sweet potato	114	1.5	163	300	114	1.3	175	214	236	107
Taro	113	2.0	163	300	113	1.8	247	241	25	88
Yam	104	2.0	163	300	104	2.4	172	256	225	80
Plantain	128	1.0	100	300	128	1.0	294	256	213	74
Banana	116	1.0	100	300	116	1.2	294	256	213	74
Cassava flour	342	1.5	100	300	342	1.6	17[illegible]	259	165	81

DSM = Dried skim milk.
DWM = Dried whole milk.

The status of histidine as an essential amino acid for all ages has not been unequivocally demonstrated as yet, and requirement patterns usually only include the other eight amino acids. The remaining amino acids are non-essential or dispensable amino acids, since they can be synthesized from amino nitrogen and carbon-hydrogen-oxygen-containing metabolites. The nutritive value of a protein thus depends primarily on its capacity to satisfy the needs for nitrogen and essential amino acids.

Since egg had been demonstrated as a protein of high biological value, it was suggested as the original reference standard for scoring purposes (Block and Mitchell, 1946). A hypothetical reference protein (FAO, 1957) derived from the human requirement pattern replaced egg protein as the standard in 1957, and the modified term "protein score" was used instead of "chemical score." Since the level of sulfur amino acids was considerably lower in the FAO (1957) reference protein than in egg protein, improved agreement was found between scores and biological determinations of protein quality, and the pattern was used with moderate success for several years. By 1965, however, a considerable number of discrepancies had been found, and the joint FAO/WHO (1965) expert group recommended a new pattern based on the essential amino acids of egg together with a modified method of calculation. The new calculation procedure was cumbrous, and there were a number of theoretical objections to the scoring system advocated; for these reasons, the pattern was not widely adopted, and many workers continued to use the FAO (1957) pattern despite being aware of its shortcomings.

The term "amino acid score" was used in the FAO/WHO (1973) report, which suggested a new pattern based on the more recent evaluation of human amino acid requirements. The method of calculation also returned to using the total nitrogen rather than the total essential amino acids as the basis of comparison.

The reference amino acid patterns used by FAO (1957) and FAO/WHO (1973) in comparison to the whole-egg pattern are shown in Table II.

The strengths and weaknesses of scoring as a means of estimating the protein value of mixtures and diets have been discussed in some detail recently by Pellett (1978) and by Young and Pellett (1978). In summary, the strengths are that the limiting amino acid can be identified by scoring, this not being revealed by a single bioassay. Thus

TABLE II

Some reference scoring patterns for essential amino acids (EAA)

Amino acid	Whole egg	FAO (1957)	FAO/WHO (1973)
Iso	340	270	250
Leu	540	306	440
Lys	440	270	340
Total SAA	355	270	220
Total Arom	580	360	350
Thr	294	180	250
Try	106	90	60
Val	410	270	310
Total EAA's	3,060	2,015	2,215

the proportions necessary for complementary mixtures can be estimated. The procedure is also very simple when amino acid data are available, only a calculating machine is necessary to obtain scores and estimates of protein value. The drawbacks include amino acid availability and digestibility of the protein components, the role of non-specific nitrogen, the presence of toxic materials and the fact of adaptation with the possibility of some recycling of amino acids by animals consuming diets low in certain amino acids (especially lysine). In most instances, however, the potential for problems can easily be recognized and a score can predict the quality of a food or diet with sufficient accuracy for most purposes. The overall relationship between scores and bioassays can be summarized by indicating that general agreement is sufficiently high to confirm the basic validity of the approach but is not yet high enough for absolute predictive purposes. Nevertheless the new FAO/WHO (1973) pattern has been demonstrated as superior to all other available patterns both for predicting the limiting amino acid and the biological protein value (Kaba and Pellett, 1975, Chavez and Pellett, 1976). Since the pattern was derived from the amino acid requirement pattern of children, it is also more suitable for human predictive purposes (FAO/WHO, 1973, Young and Pellett, 1978). From Table II it can be seen that for the four amino acids likely to be limiting in real dietaries, namely, lysine, SAA, threonine and tryptophan, reference values have been increased for lysine and threonine and reduced for SAA and tryptophan. This, of course, has the net result that when protein scoring is performed mixtures are more likely to appear limiting in lysine and threonine and less likely to appear limiting in tryp-

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tophan and SAA. As was indicated earlier, apparent tryptophan limitation was sufficiently common using the FAO (1957) pattern for it to be often ignored. Scoring was thus performed using the FAO/WHO (1973) values for lysine, SAA, threonine and tryptophan (Table II). The amino acid being present in lowest proportion being defined as the limiting amino acid and that value being the amino acid score.

Equation for Calculation of NDpCal percent

The original equation (Miller and Payne, 1961a) for the calculation of NDpCal percent was of the form

$$\text{NDpCal } \% = \frac{P \times S}{100} \frac{(54 - P)}{\left(54 - \frac{400}{S}\right)} \qquad (1)$$

where P is Pcal percent (protein calories as a percentage of toal calories) and S is the protein quality score both expressed as percentages. This equation has been fairly widely used and is reasonably satisfactory for predictive purposes when the protein calorie value (Pcal percent) is low. This equation was used by Cameron and Hofvander (1971; 1976) for their calculations in both editions of their manual. In practice, however, the equations were not routinely used but a graphical solution using a nomograph (Miller and Payne, 1961b) was considered of sufficient accuracy for their purposes. Despite a recognition of the limitation of this equation, it has been used quite recently by Carmel (1976) in a linear programming technique to predict low cost diets of high protein-energy value. Concern has been expressed over the form of the equation by Njaa (1962) and by Carpenter and Anantharaman (1968). To meet some of these criticisms, Payne in a personal communication to Carpenter and Anantharaman (1968) put forward a modified equation:

$$\text{NDpCal } \% = \frac{1.25 \text{ P.S.}}{(100 + 0.064\, PS)} \qquad (2)$$

where P = Pcal percent and S = Score, both expressed as percentages. Other equations have also been proposed and are cited by Pellett (1973).

Comparison between the solutions obtained by the two equations is shown graphically in Figure 1. It will be seen that for low values of Pcal percent (<15 percent), and for low protein quality scores (<60), both equations give similar solutions. Very large differences occur at high levels of Pcal percent, however, such high levels would rarely be met in practical dietaries. Nevertheless, differences do exist especially with high scores (greater than 70) within the practical range of Pcal percent expected in infant dietaries (i.e., less than Pcal = 15 percent). With the new FAO/WHO (1973) scoring system, scores tend to be higher than with the FAO (1957) system, mainly because of the lower value for the SAA reference value. SAA remains the most frequently limiting amino acid. Thus, the differences between the two equations can significantly affect the value for the calculated NDpCal percent. The modified equation by Payne (Eq. 2) was thus used for calculation of NDpCal percent for the various mixtures.

Calculation of Mixture Proportions

Two series of calculations were performed using throughout a small desk-size programmable calculator.† In the first series the amounts of various supplements necessary to raise the protein-calorie value of 100 gram quantities of the 13 staples to an NDpCal percent value about seven percent were calculated. Since the calorie values of the various staples differ considerably ranging from about 1.46 MJ (350 Cals)/100 g for the cereals down to 0.4 MJ (100 Cals)/100 g or below for starchy roots, it would be necessary to increase the quantities of both staple and supplement in order to meet food energy needs. With these larger quantities mixtures could often be too bulky for the young baby to receive its calorie and protein needs. Cameron and Hofvander (1971, 1976) thus also performed calculations where some of the staple food was replaced with oil or sugar or both to reduce bulk. To make allowance for these concentrated but non-protein calories a larger proportion of supplementary food must be used in order to reach the required protein value. Thus for the second series of calculations fat and/or sugar calories were included as follows: Ten grams of oil providing 370 KJ (90 Cals) *or* 20 grams of sugar providing 334 KJ (80 Cals) *or* ten grams of sugar *plus* five grams of oil providing 355 KJ (85 Cals) were considered to be added to all combinations of staple plus supplement. For simplicity a mean value of 355 KJ (85 Cals) was used throughout.

Combinations were tested until the following criteria were met: Total calories (including oil

† Texas Instruments Electronic Slide Rule Calculator Model SR 56.

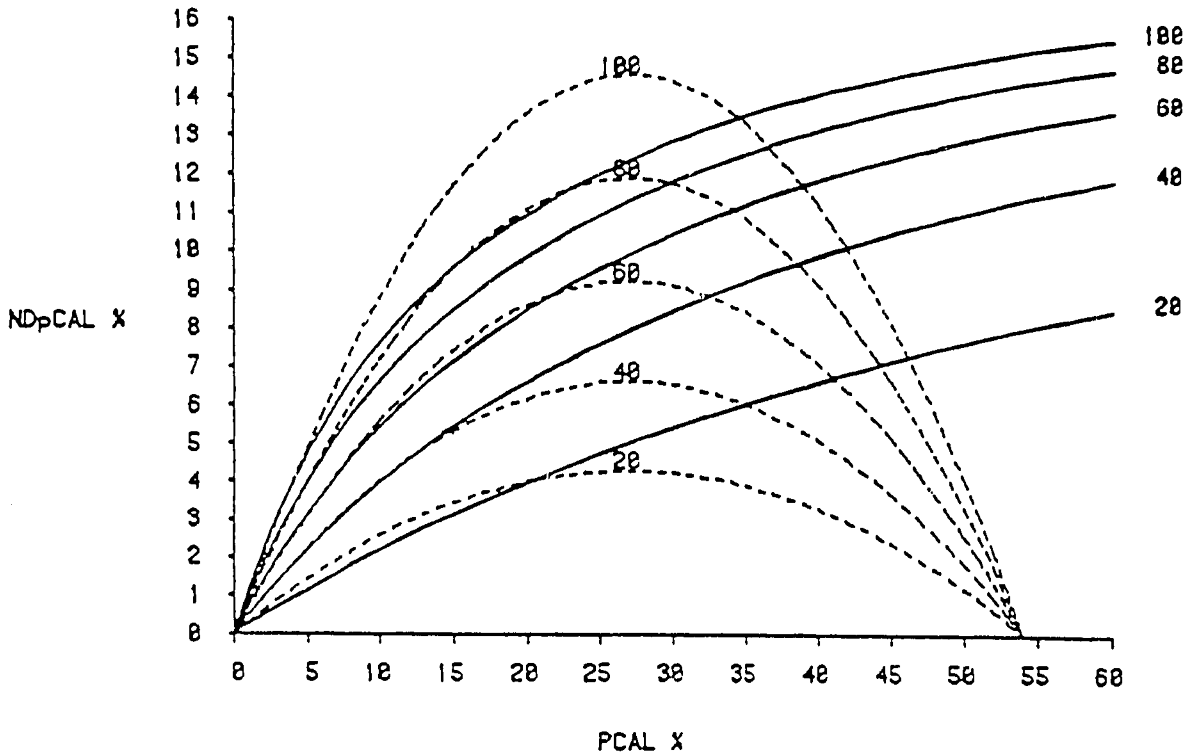

FIGURE 1 Comparison of NDpCal percent values as calculated by the original and by the modified equation. Calculations were performed for protein quality scores 20–100 over the range of 0–60 percent for Pcal percent. — — — — — — — Original Equation. (see text Eq. (1)). ———————— Modified equation (see text Eq. (2)).

and/or sugar) to approximate to 1.46 MJ (350 Cals) NDpCal percent to approximate to 6.5–7.0 percent. Round figures were used throughout with a minimum quantity of 5 g used for supplement quantities. High values for NDpCal percent were of course avoided on the ground of cost, the amounts of more expensive supplements being kept to the minimum.

Further details of calculations will not be given since all procedures for calculation of protein, calories, Pcal percent and protein quality score were absolutely standard. Details of such calculations including worked examples can be found in either edition of Cameron and Hofvander (1971, 1976) *or* in the NAS-NRC report on protein quality evaluation (Young and Pellett, 1978). All the calculations here reported were performed using the new compositional data, the FAO/WHO (1973) scoring pattern and the newer NDpCal percent equation.

RESULTS AND DISCUSSION

The amounts of various supplements necessary to raise 100 gram quantities of staple to a protein calorie value of approximately NDpCal = 7 percent and food energy values are shown in Table III. The latter of course, will vary enormously between staples because of the wide range of food energy in the various staples ranging from about 1.46 MJ (350 Cals)/100 g for the cereals to 0.31 MJ (75 Cals)/100 g for potato. Food energy values also differ with each mixture depending on the amount of supplement used, the variation is greatest with cassava flour where the amounts of supplements used were of necessity large. In comparison to the data given by Cameron and Hofvander (1971) the quantities of supplements used are generally lower despite the mean NDpCal percent being similar, this being mainly a reflection of the higher protein quality scores obtained with using the new FAO/WHO (1973) scoring procedure.

As was indicated earlier the energy values vary enormously and while the proportions used would remain unchanged, the recommended quantities would need adjustment to meet the food energy needs of the young child. Because of bulk, some of these recommended quantities would be too large for a young child's stomach capacity, consequently adjustments have been made by including 0.35 MJ (85 Cals) from sugar and/or oil. The quantities of

TABLE III

Quantities[a] of supplementary foods to be added to 100 g quantities of staples to give a protein value of NDpCal = 7 percent

Supplement \ Staple	Oats	Wheat	Rice	Millet	Sorghum	Maize	Potato	Sweet potato	Yam	Taro cocoyam	Banana	Plantain	Cassava[b] flour
Egg[c]	5	25	15	10	20	20	5	10	5	5	15	15	45
DSM[d]	5	10	5	5	10	5	5	5	5	5	5	5	20
DWM[e]	5	15	10	5	15	10	5	10	5	5	10	10	35
Fresh[f] fish	5	10	10	5	10	5	5	5	5	5	5	10	30
Chicken or lean meat	5	15	10	5	10	10	5	5	5	5	10	10	35
Soybean[g]	5	10	5	5	10	5	5	5	5	5	5	10	30
Food MJ	1.66±0.04	161±0.09	1.56±0.05	1.58±0.03	1.60±0.11	1.55±0.06	0.35±0.04	0.56±0.08	0.48±0.03	0.54±0.05	0.50±0.18	0.63±0.06	1.76±0.22
Energy Cals	402±11	386±23	375±14	380±8	383±2[illegible]	372±20	86±10	139±20	117±9	131±14	120±45	153±16	426±53

[a] All weights (g) given as edible food portions

[b] For fresh cassava root double quantities for cassava flour

[c] Egg weights given since eggs vary in size. A standard egg without shell weighs 50 g

[d] DSM = Dried skim milk

[e] DWM = Dried whole milk. If fresh milk available, 10 g DWM equals 80 ml fresh milk

[f] Fresh fish weights given, dried fish use ⅓ quantities

[g] 10 g Soybean is equivalent to 60 g soybean curd. Most other legumes such as cow pea or kidney bean have poorer supplementary value and must be used in larger quantities. This increases the mixture bulk and may be too large to be practicable. Recommended values for other legumes are thus not shown. If other legumes are used, it is recommended that they be begun in conjunction with other supplements

TABLE IV

Composition[a] of mixtures of staple and supplement to give approximately 1.46 MJ (350 K(cals) with an NDpCal between 6–7 percent[b]: adjusted for bulk

Supplement \ Staple	Oats	Wheat	Rice	Millet	Sorghum	Maize	Potato	Sweet potato	Yam	Taro cocoyam	Banana	Plantain	Cassava flour
Egg	65 10	65 25	65 20	65 20	60 30	65 25	310 15	190 35	230 15	200 25	190 40	150 45	55 50
DSM	65 5	65 15	65 10	65 5	65 10	65 10	290 10	18[illegible] 5	220 5	200 10	175 15	165 15	60 15
DWM	60 5	55 15	50 15	55 10	50 15	60 10	230 15	120 20	155 15	145 15	120 20	110 20	40 25
Fresh fish	70 5	75 15	70 15	70 10	75 15	75 10	320 15	220 25	250 10	230 15	220 25	190 25	75 35
Chicken or lean meat	70 5	70 15	70 15	70 10	70 15	70 10	320 15	200 20	230 10	205 15	195 25	170 25	65 35
Soybean	65 5	65 10	60 10	70 5	65 10	55 10	270 15	175 15	195 10	185 10	160 15	145 15	55 20

[a] All weights (g) given as edible food portions. To these quantities should be added 10 g oil, *or* 5 g oil and 10 g sugar *or* 20 g sugar. Other notes are as in Table III

[b] Mean Kcal 347 ± 12, Mean NDpCal percent 6.6 ± 0.3 (± Standard Deviation)

Triple Mixes

Can be made by reducing the quantity of any of the supplements and replacing with an appropriate amount of any other supplement

Multimixes

Can be made by adding some green leafy vegetable, a little red or yellow vegetable or tomato to any of the mixes or by giving some fruit with or after the meal

staple and supplements have been varied so as not only to meet the criterion of NDpCal percent but also so that each supplies about 1.46 MJ (350 Cals) – approximately one third of a child's daily food energy requirement. The compositions of these double mixes adjusted for least bulk are shown in Table IV. Almost all recommended values have been changed from those recommended by Cameron and Hofvander (1971, 1976). In general, the values in Table IV have higher quantities of staple and lower values of supplement while still supplying about 1.46 MJ (350 Cals) with an NDpCal percent in excess of six percent. These changes would have the effect of reducing the cost while maintaining the protein value. Detailed consideration of these changes would not be productive but some indication must be given as to why the new values are changed. Of the three major changes made, new amino acid data, new scoring procedure and new NDpCal percent equation, probably the most significant is the new scoring system. This would tend to give a higher score with often a different limiting amino acid, hence maximizing the protein calorie value with a lower amount of supplement. Examination of the new protein and amino acid data in comparison to the old (Table I) for sulfur amino acids and for lysine shows in general, somewhat higher values for sulfor amino acids but rather similar values for lysine. The higher values for SAA combined with the lower reference value in the FAO/WHO (1973) pattern make sulfur amino acid limitation far less frequent. 80 percent of the mixtures were apparently limited by SAA when using the FAO (1957) pattern and the older amino acid data, 15 percent by tryptophan and only five percent by lysine. When using the new data and the FAO/WHO (1973) scoring system only 40 percent were limited by SAA, with the remainder almost equally divided between threonine and lysine. No mixtures were apparently limited by tryptophan when using the FAO/WHO (1973) pattern. The scores obtained, despite changes in limiting amino acids, tended to be higher than with the FAO (1957) pattern (mean score 84 ± 1.7 cf 75 ± 1.3) thus producing higher NDpCal percent estimates and therefore allowing some changes in the proportions of components. The recommended changes would, however, have been greater if it had not been for the new NDpCal percent equation which tended to give lower values for NDpCal percent for high scoring mixtures at Pcal percent values below ca. 15 percent. Nevertheless the net result was that the recommended proportions as compared to the Cameron and Hofvander recommendations were in general reduced for supplement and increased for staple, thus giving somewhat more economical mixtures of similar protein value.

As with the manual by Cameron and Hofvander (1971, 1976) these tables are produced as a guide for the mixing of commonly available foods to maximize protein nutritional value at minimum cost. In the manual a whole series of recipes are given, based on the tabular proportions together with wide ranging instructions for the feeding of infants including the mixing of double mixes (two major components only) and multimixes which not only include the staple and supplement but also beans and other components. In the introduction to the manual (Cameron and Hofvander, 1976), the target group of readers was cited as medical personnel, medical assistants, nurses, midwives, nutritionists, dietitians and others in the fields of nutrition, agriculture and community development. It was hoped that these personnel could act as interpreters of the information in the manual, disseminating it in the most practical way at each level until it reached the auxiliaries who work with mothers in rural and urban communities. The purpose of presenting these modified tables is an improvement in accuracy by using the best available data and equations for calculations of the optimum proportions. The Cameron and Hofvander (1976) calculations can be criticized especially for not using the FAO/WHO (1973) scoring system which is now generally accepted as being a considerable improvement over previous scoring systems. Their recommendations could thus be considered as not acceptable by some professionals trained in nutrition. The results presented here are in fact reassuring for these professionals wishing to use the recipes from the manual. The new recommended values being in general higher for the staple and lower for the supplement means that recipes made from the Cameron and Hofvander (1976) recipes will usually be higher than their nominal protein value, and should thus adequately supply the protein-energy needs of the young growing child.

REFERENCES

Block, R. J. and H. H. Mitchell (1946). The correlation of the amino-acid composition of proteins with their nutritive value. *Nutr. Abst. and Revs.* 16, 249–278.

Bressani, R. and L. G. Elias (1973). Development of new highly nutritious food products. In M. Recheigl, Jr. (Ed.), *Man, Food and Nutrition.* CRC Press, Cleveland, Ohio, 251–274.

Cameron, M. and Y. Hofvander (1971). *Manual on Feeding Infants and Young Children for Application in the Developing Areas of the World, with Special Reference to the Home-Made Weaning Foods.* PAG Document No. 1, 14 26, pp. 239. Protein Advisory Group of the U.N. System, United Nations, New York.

Cameron, M. and Y. Hofvander (1976). *Manual on Feeding Infants and Young Children.* Second Edition. Protein-calorie advisory group of the United Nations System. United Nations, New York.

Carmel, J. (1976). The prediction of diets of high energy and protein value by linear programming. *Ecol. Fd. Nutr.* 5, 161–170.

Carpenter, K. J. and K. Anantharaman (1968). The nutritional value of poor proteins fed at high levels. 1. The growth of rats. *Brit. J. Nutr.* 22, 183–197.

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Chavez, J. F. and P. L. Pellett (1976). Protein quality of some representative Latin American diets by rat bioassay. *J. Nutr.* **106**, 792–801.

Fao (1970). *Amino-Acid Content of Foods and Biological Data for Proteins.* FAO, Rome.

FAO (1957). *Protein Requirements.* FAO Nutrition Studies, No. 16, FAO, Rome.

FAO/WHO (1965). *Protein Requirements.* FAO Nutr. meetings rep. ser. No. 37. FAO, Rome.

FAO/WHO (1973). *Energy and Protein Requirements.* Report of a joint FAO/WHO ad hoc expert committee on energy and protein requirements. WHO Tech. Rep. Ser. No. 522 Geneva, FAO, Nutr. Rep. Ser. No. 52 Rome.

FAO/WHO/UNICEF (1972). *Promotion of Special Foods (Infants formula and Processed Protein Foods) for Vulnerable Groups.* Protein Advisory Group. PAG Statement No. 23.

Jelliffe, D. B. (1971). Commerciogenic malnutrition: Time for a dialogue. *Food Technol.* **25**, 55–56.

Jelliffe, D. B. and E. F. P. Jelliffe (1975). Human milk, nutrition and the world resource crisis. *Science*, **188**, 557–561.

Kaba, H. and P. L. Pellett (1975). Prediction of true limiting amino acids using available protein scoring systems. *Ecol. Fd. Nutr.* **4**, 109–116.

Kapsiotis, G. D. (1969). *History and Status of Specific Protein-Rich Foods: FAO/WHO/UNICEFF Protein Food Protein and Products.* In M. Milner, *Protein-Enriched Cereal Foods for World Needs.* The American Association. *J. Cereal Chemists*, 255–265.

McLaren, D. S. (1977). Nutrition planning: the poverty of holism. *Nature*, **267**, 742.

Miller, D. A. and P. R. Payne (1961a). Problems in the prediction of protein values of diets. The influence of protein concentration. *Brit. J. Nutr.* **15**, 11–19.

Miller, D. S. and P. R. Payne (1961b). Problems in the prediction of protein value of diets: The use of food composition tables. *J. Nutr.* **74**, 413–418.

Milner, M. (1969). Protein-enriched cereal foods for world needs. The American Association of Cereal Chemists.

Njaa, L. R. (1962). A note on the method of Miller and Payne for the prediction of protein value. *Brit. J. Nutr.* **16**, 185–190.

Orr, E. (1972). The use of protein-rich foods for the relief of malnutrition in developing countries: an analysis of experience. Report Tropical Institute, No. G 73 iv, 77 pp.

Orr, E. (1978). The contribution of new food mixtures to relief of malnutrition – A second look. *Food and Nutrition*, **3**, 2–10, FAO, Rome.

Pellett, P. L. (1973). Methods of protein evaluation with rats. In Porter, J. W. G. and Rolls, B. A. (Eds.), *Proteins in Human Nutrition.* Chapter 15. Academic Press. London and New York.

Pellett, P. L. (1976a). Nutritional problems of the Arab World. *Ecol. Fd. and Nutr.* **5**, 205.

Pellett, P. L. (1976b). Role of food mixtures in combatting childhood malnutrition. In D. S. McLaren (Ed.), *Nutrition in the Community.* John Wiley and Sons. London, New York, Sydney, Toronto, pp. 185–202.

Pellett, P. L. (1978). Protein quality evaluation revisted. *Food Tech.* **32**, 60–79.

Pellett, P. L. and A. Y. Pellett (1978). Food mixtures for combatting childhood malnutrition. In M. Rechcigl (Ed.), Handbook of Nutrition and Food. CRC Press. West Palm Beach, Florida. In press.

Platt, B. S. (1962). Tables of representative values of foods commonly used in tropical countries. M.R.C. Sp. Rep., Ser. No. 302. London: H.M.S.O.

Popkin, B. M. and M. C. Latham (1973). The limitations and dangers of commerciogenic nutritious foods. *Am. J. Clin. Nutr.* **26**, 1015–1023.

Taylor, C. E. and E. M. Taylor (1976). Multi-factorial causation of malnutrition. In D. S. McLaren (Ed.). Nutrition in the Community. J. Wiley and Sons, London and New York. pp. 75–85.

van Veen, A. G. and van Veen, Scott (1973). Pioneer work on protein foods, *Nutrition Newsletter*, **11**, No. 4, Oct.–Dec.

Young, V. R. and N. S. Scrimshaw (1977). Human protein and amino acid metabolism and requirements in relation to protein quality. In C. E. Bodwell (Ed.), *Evaluation of Proteins for Humans.* AVI Publishing Company, Inc., Westport, Conn., 11–54.

Young, V. R. and P. L. Pellett (1978). Nutrition evaluation of protein foods. (2nd Ed. of NAS–NRC 1100) NAS–NRC. In press.

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ANNEX 6

Local Price List of Foods Used for Weaning in Liberia

Food Item	Quantity	Price (U.S. dollars)
Cereals:		
Rice	8 oz.	$ ¢15
Rice Flour	8 oz.	¢50
Kernel Corn	3 oz.	¢25
Corn Pap Ogee	2½ C 1 big beer bottle	1.00
Corn meal	8 oz.	¢25
Tubers:		
Cassava	1.5 - 2 lbs.	1.00
" farina	8 oz.	¢25
" flour	8 oz.	¢25
" fufu	8 oz.	¢25
Sweet potatoes	1.5-2 lbs.	1.00
" " flour	8 oz.	¢50
Eddoes	1.5-2 lbs.	1.00
Yams	1.5-2 lbs.	2.00
Fruits:		
Plantain	1 lg.	¢16
Plantain flour	8 oz.	¢50
Bananas	1 lg.	¢10
Banana flour	8 oz.	¢50
Pawpaw	1.5-2 lbs.	¢50
Oranges	1	.05
Mangoes	1	¢25

Food Item	Quantity	Price
Vegetables:		
Tomatoes	1 lb.	$ 1.00
Eggplant	1 lb.	1.00
Potatoes greens	8 oz.	.25
Cassava leaves	8 oz.	.25
Platto greens	8 oz.	.25
Pumpkin	8 oz.	.50
Avocado	1	.50
Legumes		
Country peas (pigeon ")	8 oz.	1.00
Dried butter beans	14 oz.	¢50
Pounded Egusi flour	3 oz.	¢50
Black-eye pea	8 oz.	¢50
Sesame (Beniseed)	2 oz.	¢25
Groundpeas (Ground nuts)	8 oz.	¢25
" " flour	8 oz.	1.00
Meat/Fish eggs:		
Eggs Boiled	1	.30
Dried fish Bonnies	1 piece	.10
Pounded fish meal	½ - 1/3 cup	¢40
Dried shrimps	8 oz.	1.00
Fresh fish	1 lb.	¢60
" meat beef	1 lb.	1.50

Food Item	Quantity	Price
Fresh meat		
wild meat	1 lb.	$1.50
Dried meat	1 lb.	2.50
Oils & Fats:		
Palm oil	8 oz.	.35