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NUTRIENT ANALYSES OF UNCULTIVATED VEGETATION IN BURKINA FASO, WEST AFRICA

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by

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PREFACE

Sub-Saharan Africa is the only region of the world where food production per capita has declined during the past two decades. Approximately 150 million people are malnourished. Hunger and hunger-related diseases are now a serious threat in 27 countries, including Burkina Faso, and there is no doubt that without fundamental changes, food shortages and famine will become more acute during the next decade.

The complex food-deficit problems in Sub-Saharan Africa must be considered, not in terms of short-term solutions, but in a long-term context. Within each country, policies and programs should be designed in such a way that people at all levels of society, particularly women, will actively participate in solving the problems of agricultural development.

How can U.S. Universities help to relieve the current situation and avoid famines in the future? Through research funded by the U.S. Agency for International Development and other international development agencies, U.S. Universities (in particularly the Land Grant Colleges)

in, and do, play a major role in helping to identify and solve agricultural related problems in developing countries.

Although a small institution, Lincoln University is making its contribution to international development. For example, in Burkina Faso, Lincoln University has successfully implemented a major US-AID funded Technical Assistance Project between 1982-85, dealing with food distribution and marketing. In the area of Human Nutrition, Lincoln also has been quite active in Burkina Faso. During 1983, Ms Ardine Kirchhofer, Lincoln's Assistant Professor of Home Economics and Nutrition, carried out a detailed survey of grain consumption and preparation patterns in the rural communities.

This present research project, funded by AID, is concerned with an investigation of the nutrient composition of commonly consumed uncultivated vegetation in Burkina Faso, and their use in meeting the protein needs of the populace. Since very little information currently exists in Burkina Faso on the composition of these uncultivated vegetation, the results of this study will greatly assist in closing the gap in the knowledge of African Food Composition.

Research efforts like this current one by Ms Kirchhofer, when coupled with locally developed food strategies and plans, as well as inputs from the agencies

of international development, surely will make a significant contribution toward the major target of improving human nutrition and eliminating food shortages in Sub-Saharan Africa.

Dr. John Warren, Acting Director, Cooperative Research

Dr. Collin Weir, Director International Programs Office

TABLE OF CONTENTS

ACKNOWLEDGMENTS..... i

PREFACE..... iii

SUMMARY AND CONCLUSIONS..... viii

SECTIONS

I. DESCRIPTION OF BURKINA FASO
- A. Geographic and Demographic..... 1
- B. Dietary Profile of Burkina Faso 2

II. UNCULTIVATED VEGETATION COLLECTION
- A. Selection of Sample Collection Sites..... 7
- B. Vegetation Collection..... 9
- C. Vegetation Drying Procedure..... 11

III. NUTRIENT ANALYSES
- A. Proximate Analyses..... 12
- B. Amino Acid Analyses..... 13

IV. RESULTS AND DISCUSSION
- A. Identification of Samples..... 14
- B. Nutrient Analyses..... 15

V. CONCLUSIONS AND RECOMMENDATIONS..... 21

BIBLIOGRAPHY..... 25

APPENDICES..... 29

SUMMARY AND CONCLUSIONS

Uncultivated vegetation is a major food consumed with the staple grains, millet and sorghum, in rural Burkina Faso, West Africa. Knowledge of the nutrient compositions of this vegetation would provide a basis for evaluating the ability of the diet in meeting the nutritional needs of the population. Nutrient analyses of Burkina's uncultivated vegetation was the goal of this research. Samples of the edible uncultivated vegetation were collected and classified from four distinct agricultural regions of Burina Faso. The samples were oven-dried and transferred to the Lincoln University Human Nutrition Laboratories. Fifty-four samples were analyzed for crude protein (total nitrogen), crude fat (ether extract), moisture and ash. Carbohydrate and energy values were calculated. Forty-four samples were analyzed for twenty amino acids. The results of the proximate analyses on a dry weight basis were 23 percent, 2 percent fat, 11 percent ash, 56 percent carbohydrate and 8 percent moisture. The mean energy value of a 100 gram sample was 270 kcal. The amino acid analyses showed comparable levels of the amino acids as cultivated green vegetation. The limiting amino acid of millet and sorghum, lysine, was limiting in the vegetation samples. When millet or sorghum values of this amino acid are

:ombined, the FAO/WHO recommended level is 85 to 95 percent achieved. Further research is indicated for digestibility and bioavailabilty of the nutrients in order to assess nutritional contribution of these traditional food plants.

SECTIONS

I. DESCRIPTION OF BURKINA FASO

A. Geographic and Demographic

Burkina Faso (formerly Upper Volta) West Africa is located between the Sahara Desert and the Gulf of Guinea. This land locked nation is bordered by Ivory Coast to the southeast, Ghana to the south central, Togo and Benin to the southwest, Niger to the east and Mali to the north.

The soils of Burkina are highly weathered, fragile and considered not suitable for ongoing agriculture.

Long term average rainfall ranges from 500 mm in the northeastern Sahelian zone to 1400 mm in the extreme southwest. Rainfall in the Sahel zone is insufficient for permanent agriculture based on rained crops. The recent drought (1984) caused severe hardships and the northern and eastern regions experienced 25 percent reduction in grain production. Burkina Faso's agricultural growth was zero from 1960 to 1980 and fell 2.0 percent between 1980 and 1983. Famine was declared in the northern sectors of the country in 1983.

The population of Burkina is estimated at 7.9 million and growing at an annual rate of 2.6 percent. The adult literacy rate is 11.4 percent for males and 3.6 percent for females, with one of four primary school-age children

ttending school. The population is 95 percent rural with 79 percent economically dependent on the agricultural sector.

Burkina has more than 60 ethnic groups, dominated by the Mossi, who comprise one-half the total population. The Peul (Fulani) comprise 10 percent of the population. Other groups include the Loki-Dagore (7%), Bobo (7%) and Senaoufo (5.5%). The majority of the population is Animist (65%), while 30 percent follow Islam and five percent are Christian. The rural populations generally speak African languages although French is the official language of the government and the schools.

B. Dietary Profile of Burkina Faso

FAO compiled a review of food consumption surveys covering 1958 through 1976. Burkina Faso is not represented by this review. A participatory observational dietary survey (Kirchhofer, 1983) reported the food habits in several villages in the Koudougou area of the Mossi Plateau. The general pattern of food intake included an early morning, midmorning, midday and evening meal. The pattern was supplemented with generous intakes of foods between the pattern segments. Sorghum and millet were the staple grains of the diet. The grains primarily were ground and boiled into an thick porridge and served as a cake. The grains were used in other preparations, for

example, fried cakes and a beer beverage. Corn and rice were consumed infrequently. Beans were observed as an occasional food eaten with rice. A variety of uncultivated greens, leaves and foliage was prepared by boiling in combination with meat, spices, herbs and cultivated vegetables. The soups and sauces were eaten in combination with the grain cakes. Uncultivated greens were boiled with potash (the residual of soaking burnt millet and/or sorghum stalks in water). Without this addition, most of the uncultivated vegetation was bitter and fibrous.

The meats commonly eaten were guinea-fowl and chicken. Dried fish was added to some soups and sauces. Eggs were not eaten or used in any observed food preparation. Eggs were exchanged or sold at the market. Small field rodents were reportedly used as a meat source, but none were observed. Mango and shea-butter seeds were abundant. These were eaten raw. Uncultivated berries and fruits were eaten, although the variety was extremely limited because the survey was done during the dry season. Some fruits and vegetables were available at the larger markets.

Milk and milk products were not consumed in the area. Children were breast-fed until 2-years of age and no other milk intake was observed. The shea-butter seeds were processed for the oil content. Sweetening was seldom

bserved in food preparation. Honey was used occasionally to sweeten a mixture of grain and water or to sweeten yeast cakes. Carbonated beverages, sweetened fruit drinks and various candies were available in the larger markets, village restaurants and from street vendors.

Cola nuts were chewed by older members of the households. Coffee and tea, not present in the household, were available from vendors and restaurants.

The observational dietary survey showed the following characteristics. The diet was high in complex carbohydrates. Refined carbohydrates were limited. The protein sources, legumes and vegetations, are considered to be complementary in amino acid profiles with the grains. Grains were unrefined and the washing and cooking water was usually consumed in cooking or as animal water. Fruits and vegetables were consumed raw, providing fiber source as well as vital vitamins and minerals. The survey concluded that the diet was 'prudent' although limited in quantity. The overall quantity of food available appeared to be minimal. Infants and children appeared small for their ages, frequently had extended abdomens and displayed little body fat. Adults worked long hours in the fields with minimal food intakes. Pregnant and lactating women appeared to consume the same quantities as non-pregnant and non-lactating women while maintaining similar work loads. In order to determine whether intake met expenditure needs, in-depth studies of quantitative food ingestion and

detailed energy expenditure research would be needed. Special emphasis must be given to the quantity and quality of food consumed outside the household.

A dietary survey of food behaviors in a given region of Burkina Faso is limited in estimating the dietary profile of the nation. Ethnic differences, geographic and economic differences would impact the dietary profile of a population group and vary the food behaviors.

An estimate of food available to nations is presented by FAOs Agricultural Data Bank. Food Balance Sheets provide an estimate of the supply/utilization of primary food and agriculture and fishery commodities. The 1970-81 average for Burkina Faso estimated per capita daily food supply for a population of 6.9 million of 2010 calories, 63.7 grams Protein and 36.1 grams of Fat. At the same time the world food supplies per capita were estimated at 2624 calories, 68.5 grams protein and 63.4 grams fat. Other developing market economies of Africa were estimated at 2229 calories, 55 grams of protein and 42.9 grams of fat (Appendix A).

Another indicator of Dietary Security is the National Research Council's Physical Quality of Life Index (PQLI). Although food supply is omitted from the index, there can be some assumptions made concerning PQLI and nutritional status. The PQLI is based on life expectancy, infant mortality and literacy. Each factor has direct or indirect relationship to food availability. Using a scale of 0-100

(100 being maximum) Burkina Faso had a PQLI of 17 while the average of countries with similar incomes was 48 (NRC, 1977).

Infant mortality rate, as an indicator of national nutritional status, targets the population of greatest risk of food deprivation. The 1985 infant mortality rate per 1,000 births in Burkina Faso was estimated at 203.5 as compared to 91.5 for the average of all developing nations and a world average of 80.8 (PRB, 1986).

II. UNCULTIVATED VEGETATION COLLECTION

A. Selection of Sample Collection Sites

Climate is the chief factor controlling the distribution of vegetation. Temperature and precipitation effect plant growth. In Burkina where temperatures are not limiting, the type of vegetation depends on rainfall. The average rainfall for the country has declined by 25 percent in less than two decades from an average annual rainfall of 910 mm during the 1960's to 667 mm in the early 1980's (Table 1). The decline was more acute in the Southwest Regions where the bulk of the grains are produced, and in the northern Sahel Region where the growth of the Sahara Desert is rampant.

The selection of sites for the collection of uncultivated vegetation was determined by climatic and logistic considerations. Geographically, sites were selected to coincide with the four major climatic and agricultural zones. The northeast is Sahelian in character, with the lowest rainfall and the continuous southward movement of the Sahara Desert. Dori, the principal city of the northeast region, was extremely difficult to reach by car but was accessible by small plane and the villages in the area could then be visited by car.

The Central Plateau (Mossi Plateau) supports half the country's population and is characterized by degradation of the soil due to intensive cultivation and subsequent erosion. Koudougou was selected for it's accessibility

Table 1
Average Rainfall in Burkina Faso
1961-70, 1971-80, 1981-84

Selected Towns	1961-70		1971-80		1981-84		Percent Decline 1961-84
Rainfall	MM	N°DAYS	MM	N°DAYS	MM	N°DAYS	
Sahel Region:							
Dori	590	54	446	45	390	41	34
Ouahigouya	698	62	567	57	486	56	30
Kaya	718	55	684	51	612	42	15
Subtotal average	669	57	566	51	496	46	26
Central Region:							
Ouadadougou	846	75	804	67	643	64	24
Koupela	858	63	772	58	627	51	27
Koudougou	863	72	658	55	636	48	26
Fada	943	77	815	75	727	65	23
Subtotal average	877	72	762	64	658	57	25
Southwest Region:							
Dedougou	951	65	728	61	658	54	31
BoBo	1,180	93	949	85	913	80	23
Banfora	1,228	78	992	68	800	63	35
Gaoua	1,143	98	1,025	92	847	80	26
Subtotal average	1,125	83	923	77	804	69	29
Total average	910	72	767	65	667	58	27

Source: Adapted from SECNA/BF.
Service Meterologique (Moussie, 1985)

from the capital city of Ouagadougou and the numerous surrounding Mossi and Geurunse Villages.

The Eastern Savannah is characterized by grasslands but with scattered trees or shrubs. Fada-Ngourima is a principal city in the region and is accessible by car.

The Southwest region receives the greatest rainfall and is heavily forested. This region produces a surplus of cereals. Bobo Dioulasso, the principal city in the area, was accessible by small plane and offered resources for travel to the rural areas. Figure 1 identifies the thirteen villages in the four regions where uncultivated vegetation samples were collected.

B. Vegetation Collections

In each village, a local language translator and a woman food preparer were enlisted. The edible, uncultivated plants were identified and collected in paper containers. Each container was weighed using a Foley balance. The plant was photographed as it grew. A large portion of the plant, root included when possible, was pressed in a moisture absorbent plant mount. The plant samples were left open in the paper containers to facilitate drying and lessen moisture collection. The samples were transported in the paper containers to the capital city for drying. The pressed samples were identified by the state botanist. The female food preparer

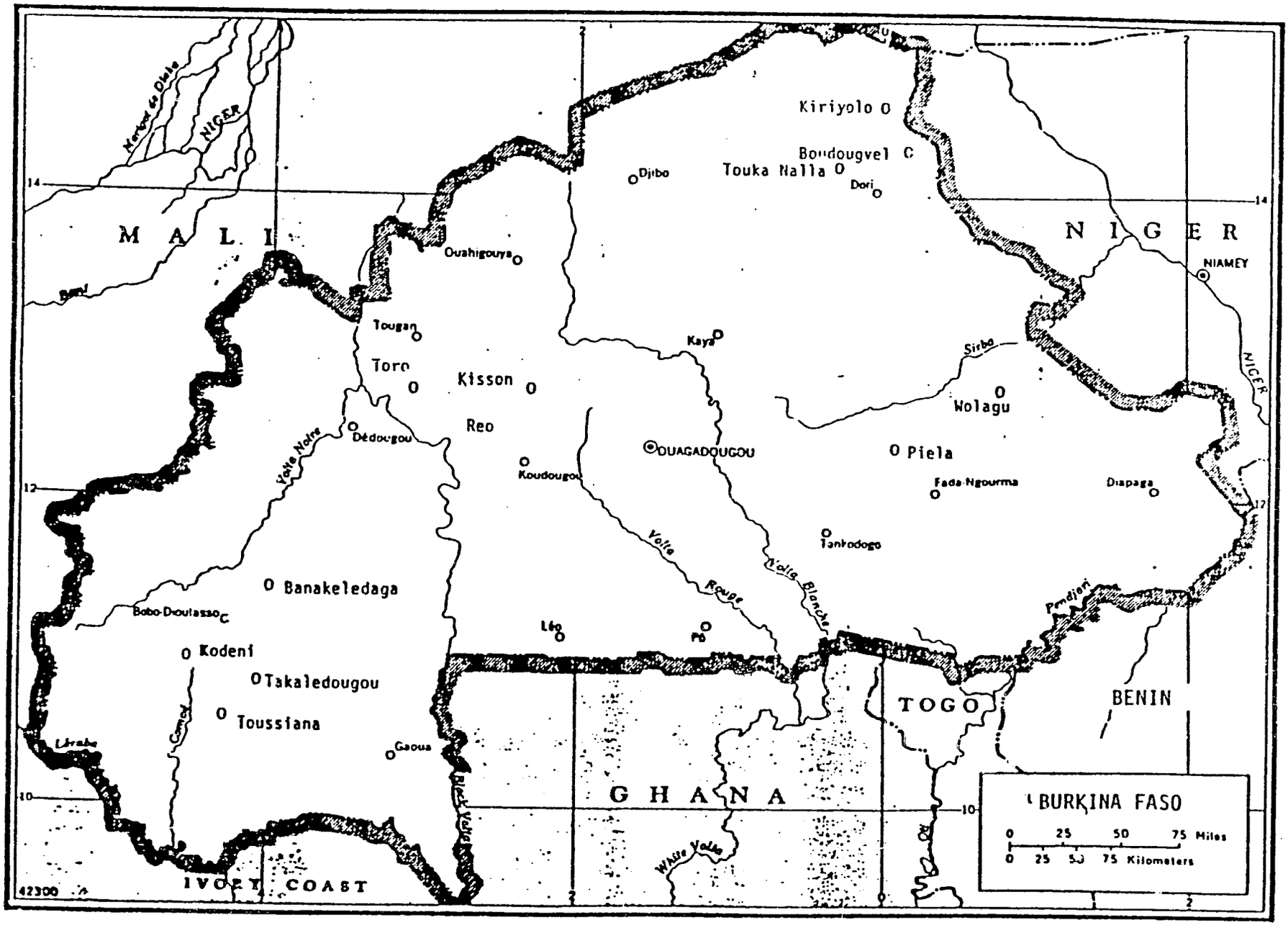

MALI
NIGER
Kiriyolo
Boudougvel
Touka Nalla
Djibo
Dori
NIAMEY
Ouahigouya
Tougan
Toro
Kisson
Reo
Kaya
Sirba
Wolagu
Dédougou
Koudougou
OUAGADOUGOU
Piela
Fada-Ngourma
Diapaga
Tanbodogo
Volta Noire
Volta Rouge
Volta Blanche
Banakeledaga
Bobo-Dioulasso
Kodeni
Takaledougou
Toussiana
Léo
Pô
Gaoua
Comoé
Black Volta
White Volta
Pendjari
TOGO
BENIN
GHANA
IVORY COAST
BURKINA FASO
0 25 50 75 Miles
0 25 50 75 Kilometers
42300

Figure 1

rovided detailed preparation information and local names for each plant sample.

A total of 61 vegetation samples were collected from 13 village sites (Appendix B).

C. Vegetation Drying Procedures

Each sample was weighed in the laboratory of the National Energy Research Center. The samples were washed with 0.1NHCl and returned to paper containers for drying at 90 degrees Celsius until a constant weight was achieved. The samples were removed from the oven and weighed every twelve hours until two consecutive weighings were constant. Sixty-one dried samples were placed in double paper containers and packed for air transport to the Human Nutrition Laboratories of Lincoln University, Jefferson City. The transfer of samples had the inspection and approval of the United States Department of Agriculture.

III. NUTRIENT ANALYSES

The samples were dried in a forced air oven at 60 degrees Celsius for 24 hours then ground in a demi-micro Wiley Mill to pass No.40 sieve. The samples were stored in airtight plastic bottles in the freezer. Seven samples were omitted because the quantity of material was not adequate for complete analysis.

A. Proximate Analyses

Proximate analyses were performed with 54 vegetation samples in the Lincoln University Human Nutrition Laboratories and the Conagra Analytical Laboratory using methods listed in the official methods of AOAC (1980).

Crude Protein. The ground samples were prepared by Block Kjaldahl digest using concentrated sulfuric acid and salt catalyst. Prepared samples were analyzed by an autoanalyzer system using an ammonia-salicylate complex which is read by colorimeter at 660nm.

Crude Fat. Crude fat was determined by extracting 2g of dry sample with ether for 4 hours in a Goldfinch extractor. Ether was then evaporated overnight. The sample was dried to constant weight by heating at 80 degrees Celsius in a vacuum oven for five hours.

Moisture. Moisture was determined by drying two gram samples at 80 degrees Celsius in a vacuum oven for five

hours. Percent moisture was calculated from loss of weight of the sample after drying.

Ash. Ash was determined by heating a porcelain crucible containing a two gram sample at 600 degrees Celsius for two hours. The weight of sample after cooling divided by the total weight times 100 gave the percent ash.

B. Amino Acid Analyses

Amino acid analyses were performed by the Experiment Station Chemistry Laboratories at the University of Missouri (Columbia) by the official methods of the AOAC (1985). Tryptophan analyses was performed by alkaline hydrolyzes in a plastic tube in an autoclave followed by chromatography (Sato, 1984). B-lactoglobulin and lysozyme were used as standards with 82 to 92 percent recovery of the theoretical tryptophan.

IV. RESULTS AND DISCUSSION

A. Identification of Samples

The botanist identified 27 of the 54 samples, and classified these into sixteen species. The remaining samples were unidentifiable from the pressed samples secured during the collection tours. The samples are listed below by number collected, scientific species, family and region(s) of collection. The regions are designated by letter A (Central Plateau), B (Sahel), C (Savannah) and D (Southwest).

NO.	SPECIES	(FAMILY)	REGIONS(S) OF COLLECTION
2	Adansonia digitata	(Bombaceae)	A, C
1	Amaranthus hybridus	(Amaranthaceae)	D
3	Balanites aegyptiaca	(Zyugophyllaceae)	A, B, C
2	Cassia obtusifolia	(Fabaceae)	C, D
1	Celtis integrifolia	(Ulmaceae)	B
2	Ceratotheca sesamoides	(Pedaliaceae)	A, D
1	Cleome gynandra	(Capparidaceae)	C
1	Commelina diffusa	(Commelinaceae)	C
3	Corchorus tridens	(Tiliaceae)	B D
1	Crataeva religiosa	(Capparidaceae)	B
1	Gossypium spp.	(Malvaceae)	D
5	Hibiscus sabdariffa	(Malvaceae)	3A, 2C
1	Leptadenia hastata	(Asclepiadaceae)	B
1	Maerua angolensis	(Capparidaceae)	C
1	Moringa oleifera	(Moringaceae)	D
1	Stylochiton hypogeum	(Araceae)	C
27	Unidentified Samples		
54	TOTAL SAMPLES		

The moisture content of the fresh vegetation samples was 76 percent (mean). The samples with the lower moisture contents were collected in the regions of lowest average rainfall, the Sahel Region and the Savannah Region. Four samples had less that 70 percent moisture, and included the species Balanites aegyptiaca and Maerua angolensis. These species are reported to be common to dry areas occasionally subject to heavy rainfall (Dalziel, 1955). In areas of collection, these plants were referred to as emergency food sources and hunger season plants. Increased use of traditional plant foods that can withstand drought could be promoted as supplements until more adequate food supplies are secured. These samples with low moisture contained 5.5 to 8.5 percent protein on a dry weight analyses.

B. Nutrient Analyses

1. Proximate Analyses

The summary of the proximate analyses of the 54 vegetation samples is shown in Table 2. The individual Sample analyses are presented in Appendix D.

Using the Merrill (1955) factors for vegetation energy, the mean protein content of 22.62 percent dry weight, contributes 20 percent to the mean energy content of 270 kcal per 100 grams of sample. Six of the samples contained a protein content above 30 percent. These samples were

Table 2
Proximate Analyses of Vegetation Samples
(percent dry weight)

	Mean	Std. Dev.	Range
Protein (53)	22.62	6.91	5.99 - 33.67
Fat (44)	2.20	1.88	0.65 - 9.82
Moisture (47)	8.0	3.46	6.57 - 11.08
Ash (47)	11.29	6.98	4.50 - 38.52
Carbohydrate[1] (43)	55.89	20.02	42.81 - 70.87
Energy (KC)[2] (42)	270.33	117.27	177.78 - 315.52

[1]Carbohydrate calculated as the difference between 100 and the sum of the percentages of protein, fat, moisture and ash.

[2]Energy calculated using Merrill's (1955) factors for vegetable kcal per gram: Protein, 2.44; Fat, 8.37 and Carbohydrate, 3.52.

collected in all four regions and included three species: Cassia obtusifolia (Fabaceae), Hisbiscus sabdariffa (Malvaceae) and Moringa oleifera (Moringaceae). Of the high protein species, only the Fabaceae Family is cited for its high protein content. Three of these high protein samples are among the samples that were unidentified at the time of collection.

The mean fat content of the samples, 2.2 percent dry weight contributed 6 percent to the mean energy content of the samples. To appreciate the significance of this expected small content of fat in the vegetation samples, it is necessary to know the proportion of the total caloric

intake that is derived from vegetation in the diet. When the recommendation for the prevention of essential fatty acid deficiency is 10 percent of the total caloric intake, this 6 percent fat contribution could be a significant amount.

The sixteen species identified by the Burkina Faso botanist are represented by one to five samples each; making the nutrient composition limited to a discussion of the individual sample rather than to the species in general. The one species with five samples, Sabdariffa was prepared in Burkina Faso by boiling with 'potash' (the liquid residual made by soaking burnc millet and/or sorghum stalks) to diminish the bitter taste. Analyses of the vegetation after boiling with °potash' would reveal more accurately the quantity of the protein and fat available for human intake. All five samples with high mean protein levels were prepared in a similar manner; Amaranthus hybridus, Cassia obtusifolia, Maerua angolensis, Moringa oleifera and Stylochiton hypogeum. Knowledge of the total leaf constituents would give direction to a more accurate determination of protein availability in the leaf tissue by identification of protein inhibitors as well as enhancers.

2. Amino Acid Analyses

The summary of the amino acid analyses of the vegetation samples is shown in Table 3. The individual

ample analyses are given in Appendix E. The most limiting amino acids are lysine, the sulfur containing amino acids and tryptophan. The nonessential amino acids aspartic and glutamic are present in the greatest quantity. This is characteristic of cultivated green leafy vegetation, also (FAO, 1970).

Table 3
Amino Acid Content of Uncultivated Vegetation of Burkina Faso, Africa (weight/weight percent)

Amino Acid	Mean	Standard Deviation	Range
1. hydroxyproline	0.164	0.088	0.060 - 0.430
2. proline	1.140	0.484	0.210 - 2.860
3. aspartic acid	2.096	0.814	0.630 - 4.440
4. threonine	0.901	0.284	0.210 - 1.430
5. serine			
6. glutamic acid	2.239	0.716	0.590 - 3.550
7. glycine	1.093	0.322	0.230 - 1.710
8. alanine	1.236	0.416	0.270 - 2.220
9. valine	1.086	0.345	0.250 - 1.780
10. isoleucine	0.933	0.299	0.230 - 1.540
11. leucine	1.058	0.548	0.350 - 2.810
12. tyrosine	1.191	0.563	0.260 - 3.330
13. phenylalanine	1.089	0.352	0.220 - 1.810
14. histidine	0.421	0.140	0.080 - 0.700
15. hydroxylysine	0.032	0.017	0.020 - 0.050
16. lysine	0.909	0.336	0.160 - 1.540
17. arginine	1.181	0.450	0.210 - 2.780
18. methionine	0.364	0.131	0.070 - 0.620
19. cystine	0.221	0.686	0.050 - 0.390
20. tryptophan	0.303	0.111	0.060 - 0.580
Total EAA	1.010	0.574	0.221 - 1.089
Total AA	0.880	0.360	0.020 - 4.440

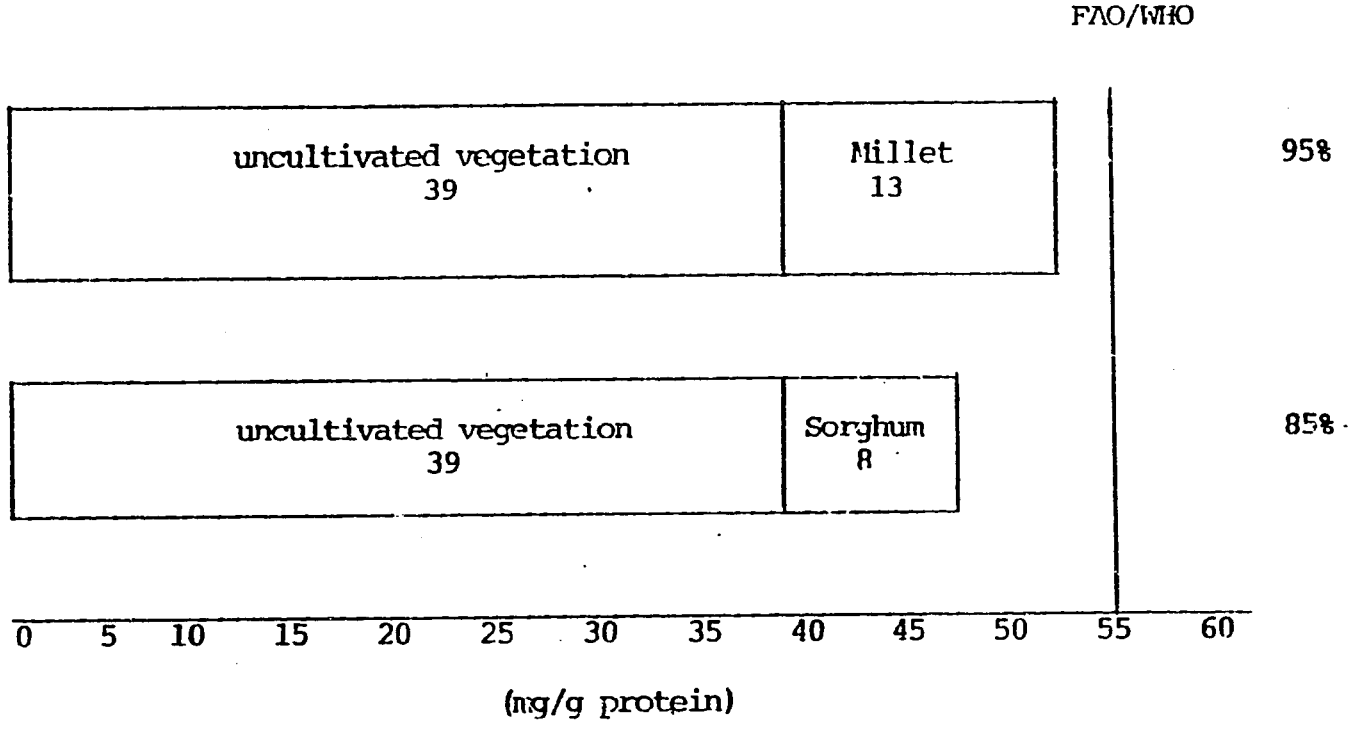
N is 44 except hydroyproline (N=33) and hydroxylysine (N=6)

The limited number of samples per region and per species do not permit comparisons of the amino acid content between regions and between species.

FAO/WHO (1973) developed a reference essential amino acid pattern for world use. The pattern is thought to be a better guide for evaluating protein quality in populations where milk and egg are limited protein sources. The mean amino acid levels of the uncultivated vegetation for leucine, isoleucine, phenylalanine plus tryrosine, and tryptophan are equal to or greater than the FAO/WHO reference pattern. The sample mean for lysine and methionine plus cystine are less than the pattern, confirming the status of these amino acids as limiting in this vegetation. Even though the species are represented by single samples, there is a similarity of the level of each amino acid throughout the samples. These edible plants are noticeably alike across regions and across species.

A review of the essential amino acids of millets and sorghum shows a similar limitation of lysine and the sulfur-containing amino acids (Appendix C). When the vegetation and the grains are consumed together in equal amounts their combined values of lysine achieve 85 to 95 percent of the recommended pattern (Table 4). Their combined values of methionine plus cystine surpass the recommended level. One observed preparation in Burkina

Table 4
Combined Lysine in Uncultivated Vegetation
and Staple Grains



aso was the combining of grain and vegetation in equal proportion with the additions of pepper, onions and herbs. This mixture was formed into balls and steamed. Thus, this combining of grain and vegetation of maximum protein complementation is a current practice within the Burkina Faso dietary pattern.

V. CONCLUSIONS

The chemical analyses for proximate nutrients and amino acids in the dry tissue of uncultivated vegetation provide a limited profile of the plant composition. Such a profile approximates the protein, fat, carbohydrate, ash, moisture and amino acid content of the plant tissue that has been subjected to heat drying and chemical treatment. Nutrient components omitted by such analyses are numerous and include heat volatile organic constituents and heat impaired portions of the protein, fat and carbohydrate.

The use of proximate analyses in the evaluation of the contribution of a food to human maintenance is inappropriate without knowledge of the bioavailability of the nutrients. Animal studies of digestibility and utilization of food nutrients can provide a basis for the determination of human use of food. Human metabolic studies most closely predict the contributions of foods to the nutrient needs of the body.

The nutrient composition of the uncultivated vegetation of this research is based on dry tissue samples of 100 grams. To determine the average amount of vegetation required to yield 100 grams of dry tissue, the following formula was used:

$$\frac{\text{mean collected weight}}{\text{mean dried weight}} = \frac{\text{weight needed}}{\text{100 grams}}$$

The mean collected weight of the samples was 226 grams, with a mean dried weight of 43 grams for a ratio of 5.25. Using this ratio, 525 grams of fresh vegetation are needed to provide 100 grams of dry tissue. This quantity of fresh vegetation would be equivalent to 1.16 pounds in household measure.

Nutrient analyses of the uncultivated vegetation of Burkina Faso provide results that are directional in establishing research areas for the investigation of the contribution of these traditional foods to the nutrient needs of the population. The following conclusions are drawn from this research project.

Nutrient Analyses

1. Dry tissue samples of the uncultivated vegetation of Burkina Faso has a proximate composition characteristic of cultivated green leafy vegetation; the dry tissue remaining from an average of 75.50 percent moisture is 22.62 percent protein, 2.2 percent fat, 11.29 percent ash and 55.89 percent carbohydrate.

2. The dry tissue samples of vegetation have an amino acid profile that is limiting in lysine and methionine plus cystine, but the remaining essential amino acids are equal to or greater than the FAO/WHO recommended values.

The combination of equal quantities of millet or sorghum with an equal quantity of uncultivated vegetation will provide 85 to 95 percent of the limiting amino acid lysine needed to meet the FAO/WHO recommendation; and the combination will surpass the recommended quantity for the limiting amino acids methionine plus cystine.

Future Research

1. Knowledge of the digestibility and bioavailability of the nutrients present in the plants is needed to assess the nutritional contribution of this vegetation to the consuming population.

2. Quantitative measures of the consumption of these traditional foods are needed to assess the contribution to the overall dietary quality.

3. Analyses for nutrient inhibiting constituents of the vegetation are needed to accurately assess the nutrient availability.

4. Production and cultivation feasibility studies are needed to determine the agricultural benefits of the plants.

5. Attitudinal and societal impact studies are needed to evaluate the promotional possibilities for traditional

foods as supplements to the current dietary patterns. This would require detailed and quantitative studies of current consumption of the food plants. Additionally, knowledge of the acceptability of these food plants by the population is essential in predicting impact of promotional policies for the use of these food plants.

6. Studies of governmental policy are needed to assess the priority status and resources available for research into traditional foods and their promotion.

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Appendix A

Burkina Faso Food Availability
(USDA Economic Research Service, July, 1985)

Burkina Basic Food Data

Commodity/year	Actual or forecast production	Begin-ning stocks	Net imports	Nonfeed use	Feed use	Per capita total use	1979-81 Commodity coverage	1979-81 Share of diet
	1,000 tons					Kilos		Percent
Major cereals								
1980/81	1,006	0	65	1,067	4	174	Wheat	1.6
1981/82	1,275	0	106	1,378	3	220	Rice	3.6
1982/83	1,189	0	95	1,282	2	200	Millet and sorghum	56.1
1983/84	1,135	0	179	1,312	2	200	Corn	8.1
1984/85	1,119	0	241	1,358	2	202	Total	69.5
1985/86	1,200	0	--	--	--	--		
1986/87	1,232	--	--	--	--	--		

Import Requirements for Burkina

Commodity/year	Production	Total use: Status quo	Total use: Nutrition-based	Import requirements: Status quo	Import requirements: Nutrition-based	Import requirements: Maximum
	1,000 tons					
Major cereals						
1985/86	1,190	1,419	1,458	229	268	321
1986/87	1,232	1,455	1,496	223	264	327

Financial Indicators for Burkina, Actual and Projected

Year	Exports and other credits	Imports and other debits	Debt service due	international reserves	Foreign exchange available: Total	Foreign exchange available: food imports
	Million dollars					Percent
1980	161	368	17	68	144	27
1981	122	302	15	71	108	22
1982	119	275	17	62	102	19
1983	123	279	14	85	109	22
1984	134	274	36	103	98	NA
1985	141	288	17	103	145	21
1986	148	302	18	103	147	21

Additional Food Needs to Support Consumption for Burkina

Commodity/year	Commercial import capacity: Quantity	Commercial import capacity: Value	Status quo: Quantity	Status quo: Value	Nutrition-based: Quantity	Nutrition-based: Value
	1,000 tons	Millions $	1,000 tons	Millions $	1,000 tons	Million $
Cereal equivalent Consumption						
1985/86	69	12	160	29	199	36
1986/87	73	13	150	26	191	33

Appendix B

Identification of uncultivated vegetation samples collected in Burkina Faso, July/August 1984.

Regional Location	Local language/ Name	Scientific Classification
Central Plateau		
Kisson		
1	More'/Bitto	Hibiscus sabdariffa
2	" /Berinse	*
3	" /Tue'ga	*
4	" /Zible'	*
5	" /Pogni-Naaba	*
6	" /Bulivato	*
Peo		
7	" /Tue'ga	*
8	" /Tuega	*
Tougan		
9	Jula/Da	Hibiscus sabdariffa
10	" /Sobo	*
11	" /Sere	*
12	" /Lamo	*
13	More'/Pogni-Naaba	*
14	Jula/Bandougou	Ceratotheca semamioides
15	Jula/Tarba	*
Toro		
16	Bwamu/Ke're	*
17	" /Nyika-ke're	*
18	" /Nye'nu	*
19	" /Kansi Yoveni	*
20	" /Bodih0	Balanitus aegyptioca
21	" /Konoo	*
	Jula/Batugu	
22	Bwamu/Fwari	*
	Jula/Sobon	
23	Bwamu/Donkovah	*
	Jula/Bumbu	
24	Bwamu/Tovabovo	*
25	Bwamu/Tovanni	*
	Jula/Bebere	
26	Bwamu/Vani	Hibiscus subdariffa
	Jula/Da	

Sahel		
Boudougvel		
27	*/Tanni	Balanites algyptiaca
28	Tulani/Nduloohi	Leptadema nastata
29	" /Footo	Stylochiton hypogaeus
Kiriyolo		
30	*/Hiso	*
31	Fulani/Foko	Corchorus olitorius
32	" /Laalo	Adansonia digitata
33	" /Duroobe	*
Touka Nalla		
34	Fulani/Bootere	*
35	" /Lelehi	Cratera religisu sieber
36	" /Nganki	Celtis integrifdia
Eastern Savannah		
Piela		
37	Gowimantche/Ferue	*
38	" /Follenfongu	Commelia diffusa
Wolagu		
39	Gowimantche/Tokaaru	Adansonia digitata
40	" /Jollougou	Maeruda angolensis
41	" /Kpangpama	Cassia Toro
42	" /Kpanpaabu	Balamites aegyptiaca
Southwest		
Kodeni		
43	Bobo/Sogodo Dafing/Sounri Jula/Kikiri More/Nakarika	Cassia obtusifolia
44	Dafing/Da Jula/Da More/Bitto	Hibiscus subdariffs
45	Jula/Dadjan More'/Beringa	Hibuscus canabinus
46	Jula/Sir	
47	Bobo/Ngnansigi Dafing/Gumbi Jula/Wenwen	Cleome gynandra
Banakeledaga		
48	Bobo/Dongone Jula/Folongo More'/Bulvancka	Corchorus tridens
49	Bobo/Lapien Jula/Bandugou More/Bundou	Ceratotheca Semamoides
50	Jula/boronboubou	Amaranthus hybridus
51	Jula/Ardjanayira	Morenga oleifera

Toussiana 52	Toussian/Tiekege Niameire	Gossyifrium
53	Jula/Torida-Jula/Sobon	Cochorus
Takaledougou 54	*	*

*unidentified

Appendix C

Proximate Analyses: Millets and Sorghum
Adopted from Food Composition Table for use in Africa
USDHEW/FAO 1968

Terms and Symbols Used.

1. Figures in parentheses denote approximate number of analyses, and the values below indicate the range values. When no range values are reported, a dash is used.

2. Trace denotes the amount present in small.

3. Blank means no values reported, or data are questionable and omitted.

Appendix C
Millets and Sorghums
Food Composition Table for Use in Africa
USDHEW/FAO, 1968

Food and Description	Food Energy	Moisture	Protein	Fat	Carbohydrate total (incl. fiber)	Ash
CEREALS AND GRAIN PRODUCTS	Calories	Percent	Grams	Grams	Grams	Grams
Millets:						
Bulrush (Pennisetum typhoides; P. typhoideum):						
Whole-grain:						
Dried.....	341	12.0 (21)	10.4 (20)	4.0	71.6	2.0 (19)
Germinated.....		4.4-21.1 5.1 (2)	6.9-15.6	.0-6.3		.3-5.1
Flour, roasted 75% extraction.....	333	16.0 (1)	5.9 (1)	3.5 (1)	71.3	3.3 (1)
Kodo millet, bastard millet; ditch millet; haraka millet; native millet (paspalum commersonii), whole-grain						
Unhulled.....	335	9.6 (2)	5.4 (2)	2.0 (2)	79.0	4.0 (2)
Hulled.....	352	8.8-10.5 11.7 (1)	5.7-6.0 6.5 (1)	1.3-2.6 2.1 (1)	78.4	3.6-4.3 1.3 (1)

Appendix C continued

Food and Description	Food Energy	Moisture	Protein	Fat	Carbo-hydrate total (incl. fiber)	Ash
CEREALS AND GRAIN PRODUCTS	Calo-ries	Percent	Grams	Grams	Grams	Grams
Ragimillet; African millet: finger millet; tolabun dagusa; bula; tamba bolu; korkan; wimbi (Eleusine coracana):						
Whole-grain:						
Red.....	328	11.3	7.5	1.4	76.5	3.3
		(12)	(12)	(12)		(12)
		9.8-12.6	5.7-9.0	1.1-1.7		2.4-4.7
White.....	345	10.5	9.9	4.5	72.0	3.1
		(8)	(8)	(8)		(8)
		9.1-11.2	7.2-11.3	1.3-7.7		2.0-5.0
Unspecified.....	329	10.9	7.4	1.3	77.7	2.7?
		(15)	(15)	(16)		(15)
		7.0-16.6	4.9-10.5	.9-2.0		2.0-3.6
Meal.....	336	12.8	5.6	1.4	76.8	3.4
		(2)	(2)	(2)		(2)
		12.7-13.0	5.2-6.1	.8-2.0		3.3-3.6
Meal, made from germinated grain.....		9.1	5.9			3.3
		(1)	(1)			(1)

Appendix C continued

Food and Description	Food Energy	Moisture	Protein	Fat	Carbo-hydrate total (incl. fiber)	Ash
CEREALS AND GRAIN PRODUCTS	Calories	Percent	Grams	Grams	Grams	Grams
Sanyo millet (Pennisetum pyenostachyum); Whole-grain.....	349	10.4 (27) 7.0-13.2	9.6 (27) 7.6-12.7	4.0 (26) 2.0-4.8	74.4	1.6 (27) 1.2-2.2
Meal.....	378	8.8 (2) 8.6-9.0	7.6 (2) 7.2-8.1	2.0 (1)	80.1	1.5 (1)
Couscous, doughy paste made from: Fresh millet.....	227	40.0 (2) ---	5.7 (2) ---	1.0 (2) ---	52.4	.9 (2) ---
Semoliana.....	320	16.0 (3) ---	6.7 (3) ---	1.7 (3) ---	74.6	1.0 (3) ---
Spiked millet (Pennisetum spicatum), whole meal.....	377	8.5 (3) 7.9-9.6	9.7 (3) 9.6-10.0	5.7 (3) 4.3-6.6	74.2	1.9 (3) 1.7-2.3

Appendix C continued

Food and Description	Food Energy	Moisture	Protein	Fat	Carbo-hydrate total (incl. fiber)	Ash
CEREALS AND GRAIN PRODUCTS	Calo-ries	Percent	Grams	Grams	Grams	Grams
Unclassified millets, Pennisetum species						
Whole-grain.....	346	10.8 (14) 7.1-14.1	8.9 (13) 6.1-11.3	3.7 (12) .9-5.5	74.9	1.7 (13) 1.2-2.5
Meal.....	387	8.6 (6) 5.8-10.2	9.3 (6) 8.3-10.0	4.2 (6) 1.8-6.6	76.3	1.6 (6) 1.0-2.3
Bran.....	325	18.0 (1)	11.0 (1)	7.6 (1)	53.4	10.0 (1)
Flour made from 80% millet and 20% defatted peanuts....	387	6.7 (1)	16.8 (1)	2.3 (1)	72.8	1.4 (1)
Couscous, doughy paste made from millet and maize....	348	13.7	8.2	1.2	74.1	2.87

Appendix C continued

Food and Description	Food Energy	Moisture	Protein	Fat	Carbo-hydrate total (incl. fiber)	Ash
CEREALS AND GRAIN PRODUCTS	Calo-ries	Percent	Grams	Grams	Grams	Grams
Sorghum, spp.; guinea-corn; kaffir-corn (Sorghum spp.):						
Whole-grain:						
Brown.....	342	9.5 (12) 8.5-11.7	10.3 (12) 8.1-11.7	2.9 (12) 2.2-5.0	74.4	2.9 (12) 1.8-4.5
Red.....	339	11.5 (13) 4.9-16.4	9.8 (15) 7.8-14.2	3.1 (13) 2.1-3.8	73.6	2.0 (12) 1.5-2.7
White.....	342	11.0 (29) 8.9-16.4	9.8 (29) 7.9-12.5	3.2 (29) 2.205.2	74.0	2.0 (28) 1.3-3.3
Yellow.....	353	9.4 (1)	8.7 (1)	3.9 (1)	76.6	1.4 (1)
Others, unspecified.	347	9.8 (132) 4.6-18.0	11.1 (134) 7.3-18.9	3.2 (129) .1-5.8	74.1	1.8 (130) 1.1-3.8
Average of all varieties.....	345	10.1 (187) 4.6-18.0	10.7 (189) 7.3018.9	3.2 (184) .1-5.8	74.1	1.9 (183) 1.1-4.1

Appendix C continued

Food and Description	Food Energy	Moisture	Protein	Fat	Carbo-hydrate total (incl. fiber)	Ash
CEREALS AND GRAIN PRODUCTS	Calo-ries	Percent	Grams	Grams	Grams	Grams
Germinated.....		11.5 (2) —				
Sprouted, malted....	335	11.4 (3) 10.7-12.3	10.2 (3) 9.2-12.1	1.6 (2) 1.4-1.7	75.4	1.4 (2) 1.3-1.4
Meal, unsifted or home pounded.....	343	10.8 (15) 9.8-12.4	9.5 (8) 8.6-10.4	2.8 (8) 2.5-3.7	75.5	1.4 (8) 1.3-2.6
Meal, stamped and winnowed.....	369	11.9 (63) 11.1-1.4	10.0 (45) 7.2-14.4	2.6 (45) 1.7-3.7	74.4	1.2 (45) .6-2.1
Sorghum products:						
Bran.....	341	11.7 (1)	15.4 (1)	4.7 (1)	65.1	3.1 (1)

Appendix C continued

Food and Description	Food Energy	Moisture	Protein	Fat	Carbo-hydrate total (incl. fiber)	Ash
CEREALS AND GRAIN PRODUCTS	Calo-ries	Percent	Grams	Grams	Grams	Grams
Couscous, doughy paste, made from sorghum:						
Uncooked.....	238	4.27 (3)	6.3 (3)	1.5 (3)	48.6	.9 (3)
Cooked.....	232	43.4 (3)	6.0 (3)	.8 (3)	48.9	.9 (3)
Malt.....	366	11.6 (6) 11.0-12.0	10.9 (6) 9.5-11.7	2.4 (6) 2.102.6	73.3	1.8 (6) 1.302.6
Porridge, soured, prepared from stamped, sifted grain...	85	79.6 (1)	2.7 (1)	.5 (1)	17.0	.2 (1)

Appendix C continued

Food and Description	Food Energy	Moisture	Protein	Fat	Carbo-hydrate total (incl. fiber)	Ash
CEREALS AND GRAIN PRODUCTS	Calo-ries	Percent	Grams	Grams	Grams	Grams
Sorghum products:						
Semolina, made from						
Unspecified sorghum.....	326	21.8 (2)	7.8 (2)	2.0 (2)	67.3	1.1 (2)
Yellow sorghum.....	356	14.4 (1)	8.2 (1)	1.6 (1)	75.2	.6 (1)

Appendix D

Proximate Analyses of Vegetation Samples from Burkina Faso, West Africa (percent)

Sample No.	Protein	Fat	Moisture	Ash	Energy	CHO (1)
Mossi Plateau						
1	21.07	2.72	8.34	6.77	292.30	61.10
2	18.78	5.24	8.20	4.50	315.52	63.28
3	23.57	2.85	10.46	11.28	266.43	51.84
4	25.10	...	....	.....	.....	.....
5	19.38	2.21	8.76	20.37	241.71	49.28
6	25.27	7.34	9.26	13.90	281.00	44.23
7	12.60	1.80	10.63	8.38	283.54	66.59
8	12.61	2.35	10.59	9.08	283.81	65.37
9	26.29	3.39	8.60	6.53	289.55	55.19
10	25.48	1.04	9.88	13.55	249.55	50.05
11	27.81	2.56	9.51	13.77	254.75	46.35
12	27.34	2.09	....	.....	.....	.....
13	25.31	0.65	9.51	12.56	252.73	51.97
14	18.91	0.65	6.57	38.52	177.78	35.35
15	18.20	1.46	8.99	5.15	292.96	66.20
16	31.33	3.37	9.64	11.85	261.05	43.81
17	26.55	3.59	10.45	13.60	258.37	45.81
18	29.62	3.84	14.36	11.08	251.14	41.10
19	12.91	3.55	10.48	11.34	281.55	61.72
20	15.22	0.94	9.31	13.43	263.13	61.10
21	26.27	1.39	9.09	13.39	253.73	49.86
22	23.48	1.78	10.22	11.52	261.40	53.00
23	18.99	2.03	10.14	7.40	282.67	61.44
24	31.34	2.13	10.03	13.83	246.63	42.67
25	29.28	1.19	10.48	8.27	262.69	50.78
26	23.08	2.78	9.27	6.18	289.11	58.69
Sahel						
27	18.87	1.79	10.26	9.96	272.08	59.12
28	16.80	.....	9.32	20.46	.....	.....
29	29.56	.....	....	.....	.....	.....
30	32.17	.....	10.04	18.10	.....	.....
31	26.73	.....	9.82	16.69	.....	.....
32	17.60	.....	.....	.....	.....	.....
33	.....	.....	.....	.....	.....	.....
34	5.99	1.47	9.61	12.06	279.93	70.87
35	24.66	2.98	8.55	11.65	271.32	52.16
36	14.61	2.66	10.28	18.4[illegible]	250.69	54.00
Savannah						
37	25.65	1.57	9.10	15.36	248.23	48.32
38	26.11	1.94	8.76	17.78	242.06	45.41
39	12.01	4.59	9.55	9.24	298.38	64.61
40	28.90	1.50	9.79	12.15	253.22	47.66
41	26.58	2.55	8.98	14.42	255.67	47.47
42	19.47	1.32	8.66	15.34	255.65	55.21

Appendix D (cont'd)

Proximate Analyses of Vegetation Samples from Burkina Faso, West Africa (percent)

Sample No.	Protein	Fat	Moisture	Ash	Energy	CHO[1]
Southwest						
43	31.43	4.20	8.37	10.52	274.21	45.48
44	25.03	1.43	9.15	7.05	277.22	57.34
45	33.67	1.76	8.77	6.89	271.49	48.91
46	16.00	.....	.....	.....	.....	
47	23.81	.....	.....	.....	.....	
48	25.79	1.49	9.91	12.99	253.26	49.82
49	22.42	0.88	8.37	22.06	227.25	46.27
50	28.31		9.17	20.81	.....	.....
51	32.65	4.02	8.27	10.35	.....	44.71
52	14.90	1.84	9.06	8.76	285.38	65.44
53	23.61	1.14	9.78	9.85	265.71	55.62
54	22.44	3.34	8.43	19.57	247.71	46.22

(1) Carbohydrate calculated as the difference between 100 and the sum of the percentage of protein, fat, moisture and ash.
(2) Energy calculated using Merril (1955) factors for vegetable calories: Protein, 2.44; Fat, 8.37; carbohydrate, 3.52

Appendix E

Amino Acid Analyses of Uncultivated Vegetation
(weight/weight percent)

Amino Acid	Sample Number 1	2	3	5	6	7	8
Hydroxyproline	----	0.08	----	0.07	0.09	0.09	0.09
Proline	0.88	0.86	1.10	0.89	1.24	0.54	0.58
Aspartic Acid	1.68	1.64	2.40	1.65	2.23	1.06	1.09
Threonine	0.91	0.89	1.03	0.88	1.15	0.53	0.55
Serine	0.76	0.78	0195	0.72	1.06	0.51	0.52
Glutamic Acid	2.12	2.05	2.50	2.05	2.87	1.22	1.25
Glycine	1.00	0.97	1.19	0.99	1.37	0.60	0.63
Alanine	1.14	1.07	1.40	1.17	1.57	0.68	0.72
Valine	1.04	0.94	1.18	1.02	1.39	0.62	0.64
Isoleucine	0.88	0.77	1.05	0.87	1.18	0.58	0.58
Leucine	1.69	1.61	1.94	1.61	2.23	0.96	0.98
Tyrosine	1.02	1.10	1.56	0.86	1.52	0.61	0.60
Phenyalanine	1.01	0.96	1.21	1.00	1.42	0.61	0.59
Histidine	0.46	0.42	0.44	0.34	0.54	0.25	0.25
Hydroxylsine	----	----	----	----	----	----	----
Lysine	1.04	0.98	1.08	0.68	1.24	0.58	0.58
Arginne	1.55	1.06	1.30	1.03	1.37	0.64	0.65
Cystine	0.20	0.20	0.21	0.18	0.23	0.12	0.12
Methionine	0.42	0.39	0.44	0.35	0.48	0.21	0.22
Tryptophan	0.27	0.28	0.35	0.29	0.35	0.17	0.18
Total	18.07	17.05	17.71	24.47	10.76	10.58	10.82

Appendix E continued

Amino Acid Analyses of Uncultivated Vegetation
(weight/weight percent)

Amino Acid	Sample Number 9	10	11	13	14	15
Hydroxyproline	----	0.10	----	0.19	----	0.23
Proline	1.28	1.27	1.30	1.11	1.03	0.84
Aspartic Acid	2.50	2.16	2.38	2.10	2.04	1.60
Threonine	1.33	1.11	1.22	1.09	0.99	0.69
Serine	1.03	1.02	1.07	0.93	.087	0.70
Glutamic Acid	3.11	2.78	3.06	2.61	2.37	1.60
Glycine	1.47	1.32	1.46	1.22	1.11	0.78
Alanine	1.59	1.46	1.63	1.41	1.24	0.90
Valine1.50	1.50	1.34	1.63	1.16	1.12	0.87
Isoleucine	1.29	1.12	1.37	1.08	1.03	0.78
Leucine	2.45	2.16	2.54	1.98	1.78	1.28
Tyrosine	1.35	1.49	1.47	0.95	0.87	0.87
Phenyalanine	1.48	1.38	1.65	1.22	1.15	0.88
Histidine	0.69	0.51	0.60	0.41	0.37	0.33
Hydroxylsine	----	----	----	----	----	----
Lysine	1.50	1.18	1.32	0.86	0.55	0.73
Arginne	1.59	1.35	1.45	1.32	1.08	0.88
Cystine	0.26	0.24	0.29	0.21	0.17	0.16
Methionine	0.55	0.51	0.59	0.47	0.38	0.25
Tryptophan	0.39	0.38	0.36	0.37	0.33	0.23
Total	25.36	22.88	25.50	20.69	18.48	14.60

Appendix E continued

Amino Acid Analyses of Uncultivated Vegetation
(weight/weight percent)

Amino Acid	Sample Number 16	17	18	19.	20	21
Hydroxyproline	0.09	0.20	0.14	----	0.39	0.11
Proline	1.53	1.11	1.39	0.56	0.76	1.19
Aspartic Acid	2.78	2.41	2.43	1.00	1.05	2.48
Threonine	1.43	1.06	1.17	0.47	0.51	1.16
Serine	1.25	1.06	1.20	.047	0.53	0.99
Glutamic Acid	3.47	1.94	2.82	1.27	1.20	2.79
Glycine	1.71	1.22	1.43	0.60	0.74	1.33
Alanine	1.90	1.59	2.07	0.66	0.75	1.50
Valine	1.78	1.37	1.48	0.61	0.61	1.40
Isoleucine	1.51	1.18	1.26	0.53	0.54	1.25
Leucine	2.81	2.03	2.29	.094	0.86	2.12
Tyrosine	1.90	2.13	2.14	1.36	0.68	1.18
Phenyalanine	1.81	1.16	1.37	0.58	0.64	1.36
Histidine	0.66	0.44	0.48	0.21	0.23	0.45
Hydroxylsine	----	----	0.04	----	----	----
Lysine	1.54	1.38	1.52	0.47	0.57	0.67
Arginne	1.67	0.86	1.10	0.59	0.59	1.26
Cystine	0.30	0.21	0.30	0.15	0.25	0.21
Methionine	0.62	0.45	0.61	0.23	0.19	0.48
Tryptophan	0.58	0.27	0.35	0.17	0.15	0.41
Total	29.34	22.36	25.85	10.87	11.24	22.35

Appendix H continued

Amino Acid Analyses of Uncultivated Vegetation
(weight/weight percent)

Amino Acid	Sample Number 22	23	24	25	26	27
Hydroxyproline	0.21	0.13	0.17	0.12	0.09	0.26
Proline	1.10	0.81	1.25	0.93	1.04	1.78
Aspartic Acid	2.06	1.57	2.44	1.98	1.96	1.75
Threonine	1.06	0.77	0.99	0.90	1.04	0.50
Serin	0.97	0.72	1.04	0.93	0.87	0.58
Glutamic Acid	2.60	1.80	2.91	2.19	2.52	1.46
Glycine	1.23	0.89	1.51	1.06	1.16	0.71
Alanine	1.42	1.04	1.60	1.23	1.30	0.71
Valine	1.26	0.94	1.50	1.04	1.15	0.63
Isoleucine	1.07	0.84	1.25	0.87	0.98	0.54
Leucine	2.03	1.47	2.12	1.47	1.93	0.88
Tyrosine	1.14	0.90	1.03	3.33	1.20	0.85
Phenyalanine	1.31	0.96	1.48	1.05	1.15	0.62
Histidine	0.47	0.32	0.54	0.41	0.51	0.27
Hydroxylsine	----	----	0.05	0.02	----	----
Lysine	0.73	0.62	1.28	0.72	1.10	0.66
Arginne	1.07	0.18	1.48	1.05	1.22	0.78
Cystine	0.20	0.18	0.29	0.31	0.24	0.23
Methionine	0.42	0.34	0.40	0.36	0.48	0.20
Tryptophan	0.41	0.26	0.33	0.30	0.29	0.24
Total	20.77	15.42	23.66	20.27	20.23	13.65

Appendix E continued

Amino Acid Analyses of Uncultivated Vegetation
(weight/weight percent)

Amino Acid	Sample Number 30	34	35	36	37	38
Hydroxyproline	0.15	----	0.25	0.23	----	0.27
Proline	2.33	0.21	1.10	1.16	2.86	1.12
Aspartic Acid	2.46	0.63	1.72	1.16	2.04	3.28
Threonine	1.19	0.21	0.88	0.50	0.99	1.03
Serine	1.12	0.23	0.88	0.50	0.94	0.99
Glutamic Acid	3.55	0.59	1.97	1.29	2.43	2.46
Glycine	1.28	0.23	1.08	0.67	1.17	1.30
Alanine	2.22	0.27	1.10	0.65	1.36	1.28
Valine	1.36	0.25	1.04	0.66	1.20	1.19
Isoleucine	1.07	0.23	0.81	0.54	0.99	0.98
Leucine	1.86	0.35	1.55	0.95	1.84	1.73
Tyrosine	1.93	0.26	1.36	0.52	1.13	1.47
Phenyalanine	1.31	0.22	1.04	0.24	1.22	1.15
Histidine	0.49	0.08	0.44	0.24	0.45	0.42
Hydroxylsine	----	----	----	0.49	----	----
Lysine	1.33	0.16	1.03	0.49	0.80	0.99
Arginne	1.69	0.21	0131	0.58	1.29	1.18
Cystine	0.30	0.05	0.33	0.15	0.21	0.24
Methionine	0.48	0.07	0.34	0.18	0.35	0.39
Tryptophan	----	0.06	0.31	0.13	0.45	0.45
Total	26.22	4.31	18.83	11.27	21.72	21.92

Appendix E (cont'd)

Amino Acid Analyses of Uncultivated Vegetation
(weight/weight percent)

	Sample Number					
Amino Acid	39	40	41	42	43	44
Hydroxyproline	0.09	0.12	——	0.43	0.19	0.11
Proline	0.54	0.89	1.70	0.60	1.34	1.04
Aspartic Acid	1.31	2.29	2.95	0.83	4.44	3.62
Threonine	0.49	0.87	1.08	0.34	1.24	0.88
Serine	0.46	0.90	1.01	0.42	1.21	0.84
Glutamic Acid	1.20	2.16	2.55	0.99	2.92	2.19
Glycine	0.59	1.08	1.24	0.54	1.44	0.96
Alanine	0.70	1.15	1.41	0.49	1.55	1.15
Valine	0.60	1.10	1.30	0.41	1.48	0.98
Isoleucine	0.55	0.91	1.07	0.35	1.22	0.84
Leucine	0.93	1.52	1.96	0.59	2.24	1.50
Tyrosine	0.55	2.24	1.24	0.44	1.34	0.98
Phenyalanine	0.60	1.12	1.34	0.42	1.56	1.10
Histidine	0.24	0.44	0.52	0.20	0.62	0.57
Hydroxylsine	——	0.03	——	0.20	——	——
Lysine	0.59	0.83	1.11	0.51	1.27	1.02
Arginne	0.63	1.15	1.51	2.78	1.65	1.37
Cystine	0.11	0.33	0.27	0.12	0.29	0.24
Methionine	0.20	0.32	0.43	0.14	0.49	0.37
Tryptophan	0.18	0.30	0.45	0.11	0.53	0.27
Total	10.56	19.75	23.41	10.73	27.02	20.03

Appendix E continued

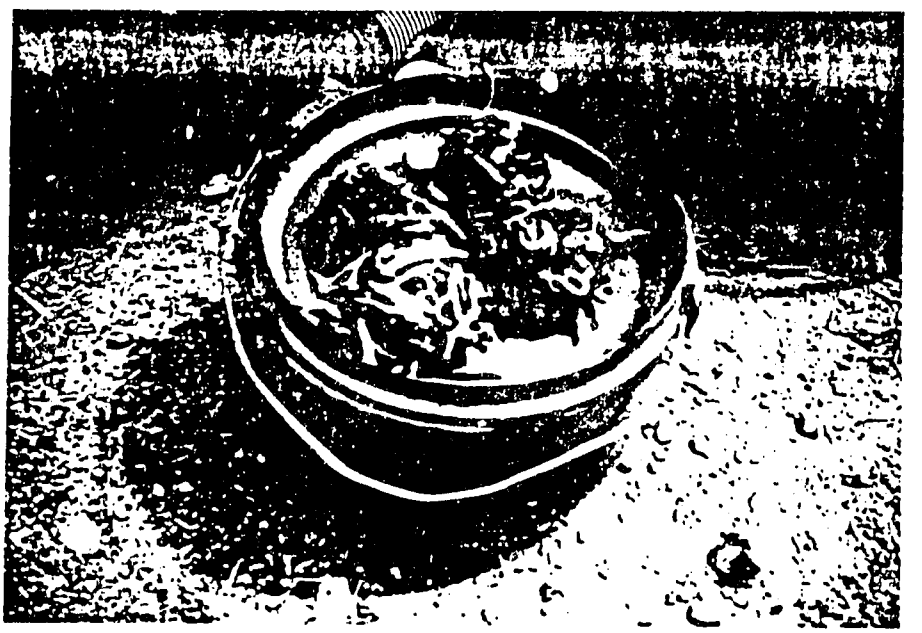
Amino Acid Analyses of Uncultivated Vegetation
(weight/weight percent)

Amino Acid	Sample Number 45	48	49	51	52	53
Hydroxyproline	0.06	0.24	----	0.10	0.19	----
Proline	1.65	1.74	1.04	1.28	0.63	1.77
Aspartic Acid	4.43	2.84	2.25	2.49	1.74	2.17
Threonine	1.16	0.98	0.99	1.20	0.56	0.92
Serine	1.00	0.93	0.91	1.19	0.50	0.88
Glutamic Acid	2.74	2.59	2.39	3.46	1.43	2.31
Glycine	1.23	1.21	1.15	1.49	.067	1.15
Alanine	1.49	1.44	1.28	1.71	0.79	1.35
Valine	1.36	1.24	1.18	1.41	0.68	1.16
Isoleucine	1.05	1.05	1.11	1.54	0.58	0.96
Leucine	1.88	1.83	1.18	2.14	1.04	1.79
Tyrosine	1.26	1.03	0.81	1.17	0.63	1.03
Phenyalanine	1.49	1.19	1.17	1.44	0.69	1.18
Histidine	0.70	0.44	0.38	0.60	0.32	0.41
Hydroxylsine	----	----	----	----	----	----
Lysine	1.36	0.86	0.62	1.26	0.66	0.78
Arginne	2.07	1.36	1.12	1.52	0.70	1.17
Cystine	0.25	0.23	0.20	0.39	0.14	0.19
Methionine	0.46	0.35	0.33	0.47	0.24	0.36
Tryptophan	0.38	0.33	0.33	0.40	0.15	0.34
Total	25.82	21.88	19.07	25.26	12.34	19.92

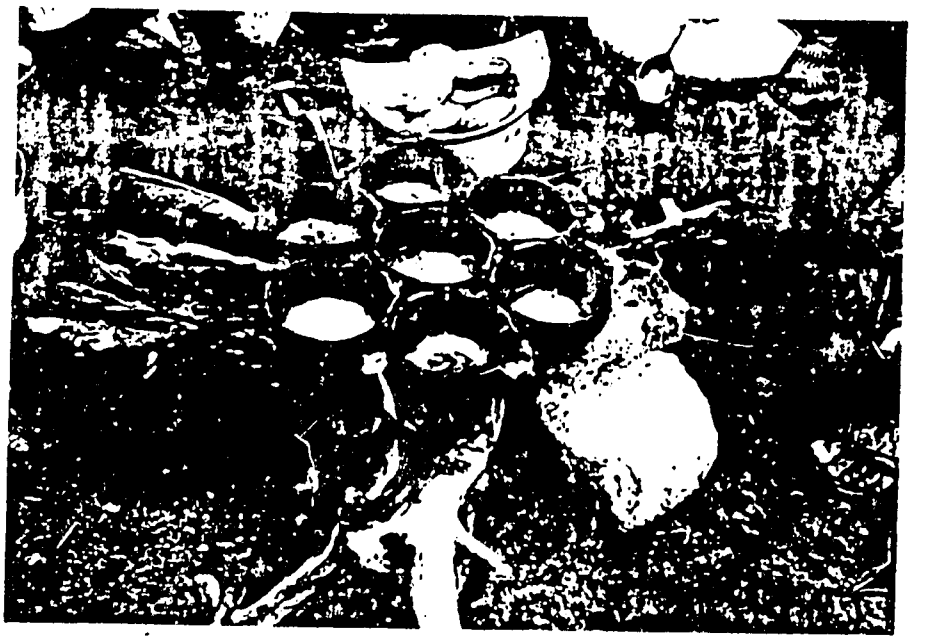
Appendix E continued

Amino Acid Analyses of Uncultivated Vegetation
(weight/weight percent)

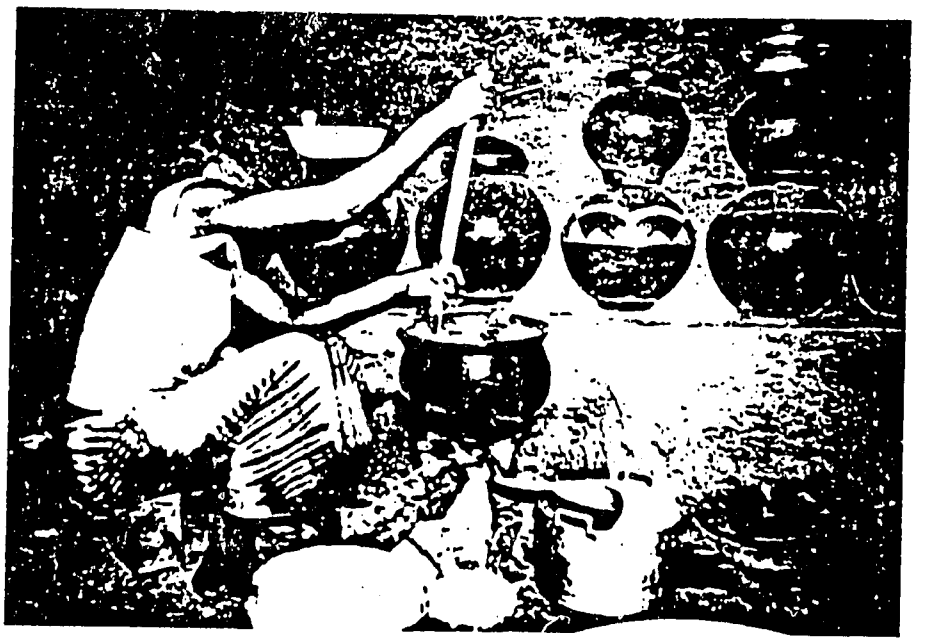
Amino Acid	Sample Number 54
Hydroxyproline	0.13
Proline	0.79
Aspartic Acid	1.59
Threonine	0.72
Serine	0.76
Glutamic Acid	2.72
Glycine	0.92
Alanine	1.25
Valine	0.95
Isoleucine	0.78
Leucine	1.31
Tyrosine	0.91
Phenyalanine	0.97
Histidine	0.37
Hydroxylsine	——
Lysine	0.76
Arginne	0.88
Cystine	0.21
Methionine	0.32
Tryptophan	——
Total	16.34



Grain and local vegetation are combined and seasoned with pepper and onions. The mixture is pressed into balls and steamed, providing a complementary protein source.



Millet and sorghum are used to make hot fried pan bread for sale in the market.



A cookhouse (kitchen) in rural Burkina Faso contains an open fire, storage jars and water cannisters for daily meal preparation.

Winnowing is a traditional means to separate the chaff from grain.

Granaries on the Mossi Plateau attest to the seasonality of the grain supply.

The majestic Baobab Tree (Adonsonia digitata) provides bark, roots, fruit, pith, seeds, shoots and leaves for food sources.

"Bebere" an uncultivated vegetation was collected in the Central Plateau for use in soups and sauces.