Reprinted from ECONOMIC BOTANY, Vol. 17, No. 3, July-September, 1963

Amino Acid Profile of Manioc Leaf Protein in Relation to Nutritive Value

DAVID J. ROGERS AND MAX MILNER[1]

Introduction

Emphasis since World War II on the need for providing more dietary protein to populations in tropical and subtropical areas has frequently included reference to increased use of locally available vegetable protein resources, as well as expanded use of edible fish meals (11, 14). This follows from the probability that countries in such areas may be unable to develop adequate production of animal proteins. It is also evident that, although vegetable proteins generally have a lower order of nutritive value than those of animal origin, satisfactory protein nutrition may be achieved with proteins of vegetable origin. Even infants and young children may benefit from vegetable proteins, if amino acid deficiencies of individual foods are supplemented in a mixed diet. An extensive nutritional evaluation of this problem has led to the formulation and nutritional testing of several protein-rich food mixtures, based largely on unused vegetable protein resources available in the tropics and subtropics, and consisting principally of processed oil seed residues from soybean, peanut, cottonseed and sesame seed (1, 2, 19).

The potentials of leaves as high protein sources for human nutrition did not become evident in scientific circles until quite recently, although the use of foliage foods is rather ancient. Irvine (12) indicated the frequency of use of foliage from numerous plants in tropical West Africa. Alfalfa and certain grass species, as a protein-rich foliage for animal food, have, of course, been known for many years. However, a significant potential for leaf protein did not develop until the introduction of technology, such as that of Pirie and others (16, 17), to separate the protein from nutritionally unavailable or deleterious materials in the leaf. Pirie's work has now been supplemented with studies relating to the nutritive value of protein isolated from the leaves of various species (3, 19).

One of the earliest indications that manioc (*Manihot esculenta* Crantz) leaves might have nutritive value as a protein source was the work of Echandi (8). This study was primarily directed at finding a substitute for alfalfa in countries where alfalfa cannot be produced and is not concerned with human nutrition. Further indications of the possible value of manioc foliage in human nutrition comes again from West Africa, particularly the Congo, where the leaves of the cultivars of *M. esculenta* are regularly used in the diet as a boiled vegetable (13). Also, in the Amazonian parts of Brazil, a favored dish is "pato de tucupí" or duck in a sauce of manioc leaves.[2]

As a part of systematic studies on the cultivars of *M. esculenta* in Jamaica, analysis of the foliage of a number of cultivars was made. Values for crude protein (total N x 6.25) reported by Rogers (18) indicated that, at least potentially, the leaves are worthy of further investigation. Other studies exist on the protein content and amino acid profile of manioc leaves (10) and roots (7).

The purpose of this study was to obtain more precise information on the amino acid profile of fresh manioc leaves carefully collected as to cultivar identification and handled prior to analysis in a manner which would minimize biochemical changes. Other objectives were to determine the range of amino acid values in different cultivars,

[1] The New York Botanical Garden, Bronx Park, New York 58, and United Nations Children's Fund (UNICEF), United Nations, New York, respectively. Paper submitted for publication January 18, 1963.

[2] *Tucupí* is a word usually reserved for the pungent sauce prepared by boiling down of the juice from the roots of manioc. Its use to include the foliage may be a variation or may be an incorrect application of the word.

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(PRINTED IN U.S.A.)

Cassava Leaf Protein

Crude protein content of the leaf of cultivars of* Manihot esculenta *is very high. There are no analyses of nutritionally essential amino acids, but certain evidence indicates that cassava leaf may be of value in protein-rich diets.

DAVID J. ROGERS
Curator of Economic Botany
The New York Botanical Garden

Introduction

One of the more outstanding nutritional needs of people in the tropics is for higher protein levels in the diet. It is interesting to note that in certain areas of tropical Africa, where cassava *(Manihot esculenta)* is one of the most abundant crops, the young foliage of cassava plants is commonly used as a vegetable in the native diets.

If the cultivars used in Africa contain approximately the same quantities of crude leaf protein as those of the Jamaican cultivars, there may be major significance to correlate the distribution of the habit of eating the foliage of *M. esculenta* among the natives in Africa with the occurrence and absensce of the protein deficiency disease "kwashiorkor" (Trowell, 2). I have been unable to obtain information on the distribution of the areas in Africa where the foliage is used as a vegetable or of the presence or absence of "kwashiorkor" in such areas. In a feeding experiment with milk cattle in Costa Rica, Echandi (1) demonstrated that a mixture of dried yuca (cassava) leaves with wheat bran, rice, and cotton seed cake provided a diet nearly comparable with a similar mixture in which dehydrated alfalfa replaced yuca. On a cost basis, the pulverized cassava leaf meal was superior to the alfalfa in Costa Rica, where alfalfa leaf meal is an expensive import.

Methods

In the course of my studies* of the variation within the species *M. esculenta,* a cooperative endeavor with the Agricultural Chemistry Section of the Jamaican Department of Agriculture was established to analyze several constituents of the cultivars growing in Jamaica. Cuttings of plants from many areas of Jamaica (see tables below) were grown in two experiment stations, one the Bodles Experiment Station near Old Harbor, Jamaica, and the other the Grove Place Experiment Station, Mile Gully, Jamaica. At Bodles the cultivars were grown under irrigation in a plastic marine clay. At Grove Place no irrigation was employed, and the soil is a friable "red earth." Samples were taken from mature or nearly mature plants (11 to 12 months). Leaves of varying size, from just mature to small and under-developed at the stem apex, were included in the sample for each plant. Petioles are not included. The protein analyses given in the following table are the results of this study.

* Supported in part by National Science Foundation Grant #G-1309.

Discussion

No knowledge is yet available as to whether cassava protein is "nutritionally complete," but the fact that the percentages of crude protein are very high (comparing favorably with alfalfa) indicates that there is some chance that the leaf protein of cassava will be of significance for protein-rich diets. Quantitative and qualitative studies of amino acid composition of the leaf protein are needed

Another matter of importance for further investigation is the age of the plants when samples are taken. The foliage of the mature cassava plant is usually a

March 9, 1964

Dr. Horace D. Graham
Department of Biology
University of Puerto Rico
Mayaguez, Puerto Rico

Dear Dr. Graham:

I am pleased to have your letter of the 3rd requesting cooperative endeavor on the analysis of amino acids. I would be very pleased to be able to give this cooperation, but the acid analyses were not done with our own facilities.

I was working at the time on a joint effort with UNICEF, and UNICEF paid for the analyses to be made by a private research organization, The Food and Drug Research Laboratories of Maspeth, Long Island.

I would suggest very strongly that if you wish to pursue this work you address a letter to Dr. Max Milner, UNICEF, United Nations, New York, who would be in a position to advise you on this work.

I enclose a reprint of the paper on our analyses.

Sincerely yours

David J. Rogers
Curator of Quantitative Taxonomy

DJR:MDF
Enclosure

UNIVERSITY OF PUERTO RICO AT MAYAGUEZ
COLLEGE OF ARTS AND SCIENCES
MAYAGUEZ, P. R.

BIOLOGY DEPARTMENT

March 3, 1964

Dr. David J. Rogers
New York Botanical Garden
Bronx Park
New York 58, N.Y.

Dear Dr. Rogers:

I have been reading with much interest your work on the protein of Manioc Leaf. I am interested in the protein content of the leaves of certain tropical plants and would like to have amino acid patterns of some of them. However, my laboratory lacks the facilities you used and I am wondering if you would be interested in a co-operative effort. I am growing some of these plants now under various treatments. I could send samples to you for analysis and thus we could establish a joint project. Here, in the tropics, quite a few "leaves" are eaten, especially by the lower socio-economic groups and nutritional schemes could probably be facilitated, if the amino acid pattern of these leaves are known. I will be willing to collect and grow any leafy plant of interest to you, if you decide that the venture will be worthwhile.

I look forward to your early reply and wish you success in your work.

Yours respectfully,

Horace D. Graham

Horace D. Graham
(Associate Prof. of
Biology)

HDG/nv

MERCK INSTITUTE
FOR
THERAPEUTIC RESEARCH

RAHWAY, N. J.

G. E. HOWE, PH. D.
DIRECTOR OF NUTRITION

February 14, 1964

Mrs. Daisy Yen Wu
United Nations Children's Fund
Room 1873
United Nations, New York

Dear Mrs. Wu:

In accordance with my conversation with Drs. Milner and Tepley I am returning the unused portion of the lyophilized manioc leaf which you sent me. The quantities returned are seven pouches of the Brazilian leaves and nine plus pouches of the Jamaican product.

Following is the information which we have obtained in our experiments with this material:

1. Effect of Cooking

A comparison was made with manioc leaf which had been heated for one hour on the steam bath.+ Four rats were used on each diet. After five days the animals which received the uncooked manioc had lost 4-1/2 grams while those which had ingested the cooked material had lost an average of seven grams each.

2. Toxicity

In order to check whether the manioc leaf was toxic or unacceptable to the rats five per cent whole egg protein was added to a manioc diet supplying ten per cent protein. Rats receiving this diet gained 12 grams in seven days. This result indicates that manioc leaf itself is nontoxic.

+ Three ml of water/gram of manioc leaf.

3. Experiments with Amino Acid Mixes

The essential amino acids were divided into two groups each with glutamic acid and used separately with manioc leaf. Mixture A consisted of L-leucine 14.3%, DL-threonine 17.8%, L-arginine HCl 3.6%, DL-phenylalanine 12.5%, L-histidine HCl.H_2O 7.2% and glutamic acid 53.5%. Mixture B consisted of DL-isoleucine 17.8%, L-lysine monohydrochloride 17.8%, DL-methionine 10.7%, DL-valine 25.0%, DL-tryptophan 3.6% and L-glutamic acid 46.5%. These mixes were added at levels of 5.4% and 6.1% respectively to a diet containing manioc leaf contributing 10% protein. Again four rats were used per diet. After five days those animals receiving amino acid mix A had lost 0.9 grams while those receiving mix B lost 2.0 grams. When the diets were mixed and fed an additional five days, animals in group 1 gained 18 grams while those in group 2 gained 17.5 grams. From these data it may be concluded that at least one essential amino acid from each group is unavailable in the manioc leaf.

I hope this information will be of some use to Dr. King in his examination of the product.

With very best regards,

Sincerely yours,

E. E. Howe

E. E. Howe

EEH:reh

Dear Doctor: Milner

I would appreciate receiving a reprint of your paper Amino Acid Profile of Manioc leaf Protein in Relation to nutritive value

Published in Econ Bot 17; 211, 1963

Kindly accept my thanks for this courtesy.

Dr Leo J Schermeister
Dept Pharmacognosy

COLLEGE OF PHARMACY
North Dakota State University
Fargo, North Dakota

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CABLE MEALFOMIL

11 Chatham Road 4/F
Kowloon - Hong Kong
September 27, 1963

Dr. David J. Rogers
The New York Botanical Garden
Bronx Park
New York 58, New York

Dear Dr. Rogers:

If available will you please send a reprint of the article authored by you and Dr. Milner, "Amino Acid Profile of Manioc Leaf Protein in Relation to Nutritive Value"?

The application of your investigation will undoubtably offer a means to helping relieve malnutrition where this problem is most serious.

Sincerely,

Don Schmidt

Donald Schmidt

DS/wl

ans 10/1/63

sent 9/30/63

I should very much appreciate receiving a reprint of your article (s):

Amino Acid Profile of Manioc Leaf Protein
in Relation to Nutritive Value

from: ECONOMIC BOTANY
Volume 17 Number 3
July-September 1963

Yours sincerely,

[signature]

Chief, Fruit and Vegetable Crops Section
~~Crop Production and Improvement Branch~~
Plant Production and Protection Division

PL-8/E
R/1059 2M

Dear Sir:

I would appreciate a reprint of your publication entitled

Amino Acid Profile of Manioc Leaf Protein

in Relation to Nutritive Value

Thank you

Very truly yours, Dr. Edward E. Anderson

Arthur D. Little, Inc.
Acorn Park
Cambridge 40, Mass.

sent 9/20/63

ADL 313

Dear Sir:

I would appreciate another reprint of your publication entitled

Amino Acid Profile of Manioc Leaf

Protein in Relation to Nutritive Value

sent 9/25/63

Thank you

Very truly yours, Dr. E. E. Anderson

Arthur D. Little, Inc.
Acorn Park
Cambridge 40, Mass.

ADL 313

Department of Biology
College of Agriculture and Mechanic Arts
University of Puerto Rico
Mayaquez, Puerto Rico
September 11th, 1963

Dr. David J. Rogers
New York Botanical Gardens
Bronx Park 58, New York, N.Y.

Dear Dr. Rogers,

I would deeply appreciate receiving a reprint of your article entitled "'Amino Acid Profile of Manioc Leaf Protein in Relation to Nutritive Value" as published in Economic Botany Volume 17 # 3, July-Sept. 1963 p. 211. Any other articles on the topic will also be appreciated.

Yours respectfully,
HORACE D. GRAHAM
(Professor of Biology)

sent 9/13/63

Telephone / Telegrams } Harpenden 4671 (10 lines)

Railway Station: Harpenden (Central)

ROTHAMSTED EXPERIMENTAL STATION

(LAWES AGRICULTURAL TRUST)

Director: F. C. BAWDEN, M.A., F.R.S.

Head of Biochemistry Department
N. W. PIRIE

PLEASE ADDRESS YOUR REPLY
TO THE WRITER BY NAME

HARPENDEN
HERTS.

2-9-63

Dear Dr Rogers,

I would appreciate a reprint of your article 'Amino acid profile of manioc leaf-protein in relation to nutritive value', which appeared in Economic Botany July-Sept. 1963 17 p211.

I enclose a reprint of some work on the extraction of protein from tropical leaves, which was carried out during a visit to Ghana. Though cassava (manioc) leaves have a high N content, it would ~~[illegible]~~ appear that the protein is very hard to extract - & further, what does come out is of low quality. This was rather a disappointment, owing to the vast quantities of cassava, both wild & cultivated, in W. Africa generally. A few additional experiments, not reported in this paper, were carried out - they were mainly of a nature designed to extract the protein - and concerned mainly of extraction with a variety of buffers. The results was no better than those reported.

Yours sincerely

Marjorie Byers

(M. BYERS)

DR. GEORGE H. PETERSON
DEPARTMENT OF BIOLOGICAL SCIENCES
CALIFORNIA STATE COLLEGE AT HAYWARD
25800 HILLARY ROAD
HAYWARD, CALIFORNIA

Dear Sir:

The following publication is requested: "Amino Acid Profile of Manioc Leaf Protein in Relation to Nutritive Value" Econ. Bot. 17: 211 (1963)

Sincerely yours,

sent

George H. Peterson

Rutgers – The State University
Agricultural Experiment Station

New Brunswick, New Jersey August 8, 1963

Dear Sir:

If available, I would appreciate receiving a copy of Amino Acid profile of manioc leaf protein in relation to nutritive value. (Econ. Bot. 17:211, 1963)

~~Copies of other papers on this or similar subjects would also be welcomed.~~

Very truly yours,

sent

Dr. Hans Fisher

College of Physicians & Surgeons of Columbia University | New York 32, N.Y.

INSTITUTE OF NUTRITION SCIENCES

562 West 168th Street

LOrraine 8-6162-63

August 29, 1963

Dr. David J. Rogers
New York Botanical Gardens
Bronx 58, New York City

Dear Dr. Rogers:

I was very much pleased to receive from the hands of Dr. Max Milner a reprint of your joint publication on manioc leaf protein. This has been read with deep interest, as you would know. May I congratulate you on putting a lot of information into such few pages. I am interested that you find, as did my friends in Indonesia, difficulties in getting the rats to eat enough of the leaf preparation to satisfy your tests. I think this rat refu~~eling~~sal needs some further work. Possibly amino acid supplementation is the approach.

With best wishes, I am

Cordially,

Elmer L. Severinghaus

Elmer L. Severinghaus, M.D.
Associate Director

ELS:aj

MEMORANDUM FOR THE RECORD

18 April, 1963

MM/ma

Max Milner

Report by 'phone from Dr. Eugene Howe, Merck Institute

1. They have confirmed Oser's observation that rats will not eat enough manioc leaf powder to maintain their body weight.

2. Heat treatment by boiling did not improve the acceptability to rats.

3. In a 10% protein manioc ration, replacement of 5% of the manioc protein with equivalent amount of whole egg protein caused the rats to eat the mixture and gain quite well.

4. Dr. Howe tentatively interprets these results to mean that some of the essential amino acids of manioc leaf are not available, i.e. the manioc leaf material is not adequately digested. This seems to confirm other work with Pirie's materials. He indicates also that there is probably nothing toxic in the manioc leaf powder.

5. They will try supplementation with amino acids singly and in combination to determine which are involved.

6. The Saridele requisitioned from Indonesia for these tests showed a P.E.R. of 1.46. In 28 days the saridele group gained 46 grams and two casein groups 74 to 79 grams.

7. Fish flour FFH-1 (Halifax ?) showed P.E.R. 3.1 and 28 day gain of 134g. relative to PER 2.5 and 77 grams for a casein control.

8. Repeat feeding of sesame flour showed PER of 0.9
Addition of 2% FFH1 to sesame yielded PER 1.95
" " 4% " " " " " 2.5

9. In a recent test the Quintero fish flour sample gave PER 2.34, although growth was better than on casein. 2% of Quintero product boosted sesame to PER 1.67, and 4% to 2.02.

10. Dr. Howe has run out of sesame flour and needs more. Can we oblige?

c.c. Messrs. D.R. Sabin/D. Wu/L.J. Teply/L.E. Allen/C. Hunnikin/H.J. Humphrey
Dr. D. Rogers

June 20, 1962

Ing. Agron. Milton de Albuquerque
Instituto Agronomico do Norte
Belem, Para, Brazil

Dear Milton:

Enclosed you will find the analysis made on the foliage of mandioca collected in 1960. I am sorry it has taken so long to have these analyses made. Apparently, there were many problems in the analyses that had to be overcome.

Although the tables indicate that the essential amino acid content of the foliage of Manihot is surprisingly good and well balanced for nutritional purposes, you will see that because of the content of Prussic acid that animal feeding trials that were made were not successful. We feel that the animals lost weight when fed a diet of leaf extract of mandioca because of the cyanide content of the foliage. It was not possible to entirely extract the cyanide without destroying the amino acids.

I am sorry that we were not able to demonstrate positively that mandioca leaves are valuable food materials. Perhaps we will be able to find some technique to remove the cyanide and leave the biological value in the plants. This, however, is something that will have to wait for future work.

Thank you very kindly for all your assistance, and I look forward to seeing you again some time shortly.

Very sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF
Enclosure

July 7, 1960

Senor Milton de Albuquerque
Instituto Agronomico do Norte
Belem, Para, Brasil

Dear Milton:

I have finally returned to The New York Botanical Garden after a most successful stay there in Belem. I am indded grateful to you for all the fine work which preceded my visit in your collections of mandioca. I am sure that I can express the gratitude of UNICEF for your help in making our endeavor successful.

I am tremendously impressed with the studies that you have made, and I hope that in some way I may contribute to the continued work which you are doing. Please be assured that if you have any need for information or for assistance with this particular project, I will do my best to help.

I trust that I shall have the opportunity to visit you again within a year.

Sincerely yours

DJR:MDF

June 20, 1962

Mr. D. C. Webster
Crop Agronomy Division
Ministry of Agriculture and Lands
Hope, Kingston, Jamaica

Dear Don:

At long last we have gotten the analysis of the protein from the cassava leaves that we made two years ago. It is amazing how much time can pass with so little accomplished. The copies of the analysis that are enclosed are for your information. We have not yet published any information on this but hope to do so soon.

We were quite excited at the levels of amino acids found in the foliage, but unfortunately there is some difficulty in the utilization of the leaves in animal food because of the cyanide content. You will be able to see the effects of the trials of rat feeding and the fact that rats consistently lost weight when fed a diet of the leaf extract. I did not take these to be the final answer on the utilization of cassava leaves, but at least for the time being the project has been shelved by UNICEF. Some day perhaps we will be able to pick up again on this.

I am still at work trying to make up a classification system for the genus Manihot and to fit the cultivated species into this classification. I should be able to complete this work within a year and hope to finally have some sort of useful publication. I have now completed the field work in South America and feel that I finally know something about the total variations in the species. I hope that this will be of some use eventually.

In the meantime, how goes it at the Crop Agronomy Division? Have you had any results of the trials with cassava? It would be interesting to know which of the varieties that we had there are turning out to be the most useful.

With all good wishes, I am,

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF
Enclosure

August 11, 1960

Mr. D. C. Webster
Crop Agronomy Division
Ministry of Agriculture and Lands
Hope, Kingston, Jamaica

Dear Don:

Would you be so kind as to let me have a short description of the soils at Bodles. I should have some description to go with my specimens, which would give the soild type, pH, etc.

Each time I come, I intend to get this information, but always forget it.

The leaf material is presently being analyzed, but I have had no reports of the analyses yet. As soon as I get any definite results, I'll send you a copy of them.

Things are moving along here. I have spoken to the people of Special Funds, the United Nations, and they seem quite receptive to the idea of supporting more work there at the Ministry. I've also written to Miller, telling him how to proceed to get assistance, and I hope he is working on an application.

Thanks for your assistance on the above request--it has no immediate rush need, so do it when you have an extra minute. Are there any of those?

Cordially,

David J. Rogers
Curator of Economic Botany

November 20, 1961

Dr. Max Milner
UNICEF
United Nations
New York

Dear Max:

Thanks a lot for sending back the review of MacGillivray's paper. I have forwarded to him the comments made by Dr. Bruce Nicol and hope that the author will modify accordingly.

I have a very faint and guilty feeling that I was supposed to have made arrangements or contacted you some time sooner about the amino acids from Manihot. As you know, I am expecting to take off again around the first of January for two months in Bolivia and Peru. If there is anything that we need to do beforehand, please let me know, and I will see what we can arrange in the time left.

Sincerely yours

David J. Rogers
Editor, ECONOMIC BOTANY

DJR:MDF

YN:DT

30 October 1961

ESSENTIAL AMINO ACID AND CYANIDE CONTENTS OF MANIOC LEAF SAMPLES

Sample No.	Lysine	Cystine	Methionine	C.&M.	Tryptophane	Threonine	Cyanide ppm (Wet basis)	FAO Score
J.316	5.94	1.24	1.79	3.03	1.50	5.01	34	
J.318	-	-	1.39	-	1.69	4.71	39	
J.315	6.65	1.56	1.56	3.12	1.45	4.91	39	
J.312	7.73	1.41	1.65	3.06	1.37	5.14	43	
J.313	6.18	1.35	1.78	3.13	1.29	4.76	47	
J.314	7.46	1.31	1.51	2.82	1.28	4.70	73	
J.317	8.24	1.09	1.79	2.88	1.53	5.20	48	
J.319	7.83	1.29	1.44	2.73	1.40	5.01	39	
J.320	7.86	1.04	1.74	2.78	1.62	4.80	33	
J.321	6.00	1.39	1.84	3.23	1.59	4.96	65	
AVERAGE	7.1	1.3	1.65	2.98	1.47	4.92	46.0	
B.322	6.29	1.47	2.00	3.47	1.56	4.74	47	
B.323	5.60	1.45	1.54	2.99	2.03	4.71	46	
B.324	7.81	0.74	1.64	2.38	1.96	4.72	77	
B.325	7.82	0.96	1.68	2.64	1.94	4.50	48	
B.326	-	0.79	1.68	2.47	2.50	4.83	74	
B.327	6.10	1.09	1.91	3.00	1.85	4.69	80	
B.328	5.91	0.93	1.51	2.44	2.20	4.66	43	
B.329	6.07	1.02	1.54	2.56	2.18	4.85	60	
B.330	5.71	0.98	1.86	2.84	2.19	4.49	42	
B.331	4.78	0.97	1.73	2.70	2.33	5.08	48	
AVERAGE	6.23	1.04	1.71	2.75	2.07	4.73	56.5	

ANNEX A

FOOD AND DRUG RESEARCH LABORATORIES, Inc.
Maurice Avenue at 58th Street
Maspeth 78, New York City

May 2, 1961

Dr. Max Milner
United Nations Children's Fund
New York 17, N.Y.

Dear Dr. Milner

... We enclose the first six sets of amino acid profiles recently obtained with our automated system. As you can see, the values are a good deal more self-consistent than those included in our earlier tentative report (dated December 28, 1960).

We have satisfactorily overcome the need for preliminary freeze-drying of the samples in order to ensure uniformity in sampling for nitrogen and amino acid assays. Nitrogen content is simply determined by analysis of the hydrolyzate of the frozen sample prepared for amino acid assay.

At present our arginine and tryptophan analyses must be done microbiologically, and we anticipate that these will be run near the end of this work. All samples run thus far have shown the presence of an unidentified amino acid in substantial quantity. This is referred to as "Unknown A" in the tabulation, although we have reason to believe that it is actually ornithine. We are carrying out experiments to confirm its identity and perhaps determine its level. Also present in a few samples is another unknown material, referred to as "B", which might correspond to hydroxyproline. We intend to verify this also, if possible.

The assays are proceeding rather smoothly right now and we hope that no unforeseen events occur to slow our progress.

Very truly yours,

FOOD and DRUG RESEARCH LABORATORIES, Inc.

Chemist

Dr. Robert D. Kross:ab
encl.

/...

Ref Bloch + Bolling - AA comp of proteins + foods.

Amino Acid Profiles of Manioc Leaves[1]

Determination	Jamaica 315	Brazil 323	Brazil 327	Brazil 328	Brazil 329	Brazil 331
	Collection Number					
	per cent (16 gm Nitrogen basis)					
Alanine	6.11	6.60	6.51	5.98	6.37	6.16
Arginine	to follow					
Aspartic Acid	10.20	9.81	9.95	9.10	9.48	9.50
Cystine	1.56	1.45	1.09	0.93	1.02	0.97
Glutamic Acid	11.83	10.14	10.83	11.00	10.80	10.13
Glycine	5.25	5.45	5.30	5.27	5.10	5.42
Histidine	3.28	3.01	2.14	2.97	3.22	3.40
Isoleucine	4.95	4.78	4.91	6.31	4.54	4.70
Leucine	9.32	8.81	9.15	8.55	8.72	8.86
Lysine	6.65	5.60	6.10	5.91	6.07	4.78
Methionine	1.56	1.54	1.91	1.51	1.54	1.73
Phenylalanine	6.39	6.65	4.95	6.06	5.45	5.89
Proline	—	5.48	4.91	4.97	6.40	4.91
Serine	5.24	4.44	5.35	4.65	5.05	4.52
Threonine	4.91	4.71	4.69	4.66	4.85	5.08
Tryptophan	to follow					
Tyrosine	4.82	3.96	4.14	3.75	3.68	4.21
Valine	5.89	5.48	5.83	5.65	5.46	5.55
Unknown A	present	present	present	present	present	present
Unknown B		present			present	
Tot	87.96	87.91	87.76	87.27	87.75	85.81

[1] Moore, S., Spackman, D. H., and Stein, W. H., Anal. Chem., 30, 1185 (1958).

TELEPHONE PLAZA 4-1234

CABLE ADDRESS UNICEF

UNICEF

UNITED NATIONS CHILDREN'S FUND • FONDS DES NATIONS UNIES POUR L'ENFANCE

UNITED NATIONS, NEW YORK

MM/ma

11 January, 1961

Dr. Robert D. Kross
Food and Drug Research Laboratories, Inc.,
Maurice Avenue at 58th Street
Maspeth 78, New York City

Dear Doctor Kross:

We presume that because of the uncertainty associated with some of the amino acid values for the manioc leaves, you hope to repeat these analyses with your automatic system when it is completed. We shall consider the values you submitted only as tentative until that time. Certainly one would be very happy to have assurance that lysine values as high as 7.4% and methionine as high as 6.2% were indeed valid. Additional information might also be useful in rationalizing the great variability between samples in certain of the essential amino acids as indicated in your tentative report.

We do not seem to recall that we objected to freeze drying of these samples for analytical purposes. As a matter of fact we had hoped originally that Dr. Rogers might have found the facilities in Jamaica and Brazil to accomplish this prior to shipment. We do recall discussion concerning air drying, and it was possible damage to the amino acids, particularly lysine, by this procedure that worried us. We have no objection of course to freeze drying this material for analytical purposes. As a matter of fact, if your final results continue to be encouraging, we may wish rat feeding trials carried out, in which case the manioc material to be used may need to be dried in this way.

Yours sincerely,

Max Milner
Senior Food Technologist
Food Conservation Division

c.c. D.J. Rogers ✓

Food and Drug Research Laboratories
INCORPORATED

Maurice Avenue at 58th Street
Maspeth 78, New York City
Telephone TWining 4-0800
Cable: Foodlabs, New York

December 28, 1960

Dr. Max Milner
United Nations Children's Fund
New York 17, N. Y.

Dear Dr. Milner:

Following your request to Dr. Morgareidge for an interim report on the amino acid profiles we are enclosing a compilation of the more reliable analytical data we have accumulated thusfar. We believe Dr. Morgareidge has apprised you of the uncertainty associated with these figures owing to some rather spurious assay values we have recently obtained. We are now in the process of converting to a new, more fully automated system and hope to concomitantly eliminate any possible sources of error.

An additional cause of variation, peculiar to these samples alone, is the necessity for working with frozen, inhomogeneous leaves. It is extremely difficult to maintain the same relative quantities of veins to leafy portions when sampling for moisture, nitrogen and amino acid analyses. An ideal solution to this problem would be the freeze-drying and homogenization of a large sample, adequate for the three analytical tests, and we understand that this was proposed initially, but was not acceptable to you. Does this position still hold?

In reference to the enclosed tabulation of figures, no results are available yet for cystine, tryptophane, histidine, and arginine. These involve procedures separate from that for the main body of amino acids, and will be run simultaneously near the completion of this work.

We trust these data will be of value to you.

Very truly yours,

FOOD and DRUG RESEARCH LABORATORIES, Inc.

Chemist

Dr. Robert D. Kross: ab
encl.

Food and Drug Research Laboratories
INCORPORATED

Maurice Avenue at 58th Street
Maspeth 78, New York City
Telephone: TWining 4-0800
Cable: Foodlabs, New York

Preliminary
REPORT

Submitted to United Nations Children's Fund
United Nations
New York 17, N. Y.

Date December 28, 1960

Laboratory No. 80914

Sample Frozen manioc leaves

Marking See table on following page

Examination Requested Determination of amino acid content of manioc leaves.

RESULTS

See following page

FOOD AND DRUG RESEARCH LABORATORIES, INC.
Robert N. Ross
Chemist

ab

Amino Acid Profiles of Manioc Leaves (Tentative)[1]

Determination	Collection Number: Jamaica 313	Jamaica 315	Brazil 324	Brazil 326	Brazil 329	Brazil 330	Brazil 331
	- - - - per cent (16g Nitrogen basis) - - - -						
Aspartic Acid	5.56	4.03	5.35	5.60	4.27	6.76	6.91
Threonine	3.29	3.16	3.44	3.09	3.12	4.01	3.86
Serine	3.20	4.22	3.09	3.87	3.27	4.06	3.74
Glutamic Acid	7.76	6.92	5.80	6.15	6.21		8.06
Proline		0.99	3.43	1.03	4.73		2.94
Glycine	3.51	4.56	4.07	4.65	4.28	5.35	5.04
Alanine	4.23	4.95	5.89	4.24	4.31	5.97	4.60
Valine	3.51	4.97	5.98	2.69	2.75	3.12	4.19
Methionine	2.69	6.20	3.44	3.02	2.92	3.46	1.37
Allo-isoleucine	1.25	1.55	0.33	0.84	1.29	0.73	1.28
Isoleucine	5.86	4.62	4.00	5.25	1.94	5.15	3.92
Leucine	7.74	11.55	7.23	9.06	8.11	8.47	8.96
Phenylalanine	7.74	5.09	6.36	3.88	2.66	5.28	5.43
Tyrosine	5.14	7.39	4.98	3.54	2.08	3.72	2.68
Lysine[2]	7.24	6.31			5.25	4.27	3.54

	Jamaica 312	Jamaica 314	Collection Number: Jamaica 316	Jamaica 317	Jamaica 318	Brazil 327	Brazil 328
	- - - - per cent (16g Nitrogen basis) - - - -						
Lysine[2]	7.40	5.47	5.93	3.85	4.81	5.55	6.85

[1] Moore, S., Spackman, D. H., and Stein, W. H., Anal. Chem., 30, 1185 (1958)

[2] Enzymatically, with L-Lysine decarboxylase.

TELEPHONE PLAZA 4-1234

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Protein

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UNITED NATIONS CHILDREN'S FUND · FONDS DES NATIONS UNIES POUR L'ENFANCE

UNITED NATIONS, NEW YORK

MM/ma

25 August, 1960

Dr.David J. Rogers
Curator of Economic Botany
The New York Botanical Gardens
New York 58, N.Y.

Dear Dave:

The enclosed preliminary report was received this morning.

The Food and Drug Research Laboratory informs me by 'phone that results on cyanide analyses will be available soon. The amino acid values will of course take a longer time.

We are having this preliminary material reproduced for the Protein Advisory Group meeting.

With kind regards.

Yours sincerely,

Max

Max Milner
Senior Food Technologist
Food Conservation Division

Enc:

25 AUG 1960

REPORT

DETERMINATION OF PROXIMATE ANALYSES AND CALCULATION OF CALORIC VALUES OF MANIOC LEAVES

Submitted to United Nations Children's Fund
New York 17, New York

Date August 23, 1960

Laboratory No. 80914

Kenneth Morgareidge
Assistant Director

Food and Drug Research Laboratories
INCORPORATED

Maurice Avenue at 58th Street
Maspeth 78, New York City

Introduction

This constitutes the first of three reports on the analysis of frozen manioc leaves. The samples were received July 18, 1960 by hand from Dr. David J. Rogers, and are described in detail in Table 1.

Experimental

The frozen samples, upon receipt, were stored under dry ice. Representative portions of each sample were transferred to 8-ounce jars, from which the necessary analytical samples could be withdrawn. The analyses were performed according to the 1955 edition of the Official Methods of Analysis of the Association of Official Agricultural Chemists. Carbohydrate values were obtained by subtracting the sum of the protein, moisture, fat, ash and crude fiber percentages from 100. Caloric values were based on caloric equivalents per gram of 9, 4 and 4 for fat, carbohydrate and protein, respectively.

Results

Tables 2 and 3 summarize the results of the proximate analyses of these samples. Table 2 presents the values on an "as received" basis, which are recalculated to a dry basis in Table 3.

Table 1

Manioc Leaf Samples ~~Received for Analysis~~

Laboratory Number	Collection number (D. J. Rogers)	Station Number (at Bodles)
Jamaica, Bodles Experiment Station		
80914 a (in duplicate)	312	C8
b ditto	313	1
c ditto	314	34
d ditto	315	39
e ditto	316	49 and 49, 56
f ditto	317	55 and 55, 56
g ditto	318	28
h ditto	319	51
i ditto	320	44
j ditto	321	11

(continued following page)

Table 1 (continued)

Manioc Samples Received for Analysis

Laboratory Number		Collection No. (Rogers)	Local Name	Origin
		Brasil, Instituto Agronomico do Norte, Belem, Para		
80914	k	322	Pretinha	Mun. Portel, Belem, Para
	l	323	Cachimbo	Rio Uapes, Rio Negro, Amazonas
	m	324	Pai Lourenco	Mun. Portel, Belem, Para
	n	325	Mamluca	Mun. Cameta, Para
	o	326	Abaete	Mun. Cameta, Para
	p	327	Xingu	Rio Pixuna Cupari, Tapajos
	q	328	Uapichuna (Wapchuna)	Regiao Uapes, Rio Negro, Amazonas
	r	329	Niplo	Oiapogue (indios Galibis)
	s	330	Amazonas	Pernambuco (Nordeste)
	t	331	Paica	Maioba-Sao Luis Maranhao

Table 2

Proximate Analysis of Manioc Leaves[1]

Laboratory Number	Moisture	Protein	Ether Extract[2]	Ash	Crude Fiber	Carbo-hydrates	Calories
	per cent						per 100 gm
80914 a	79.29	6.41	1.17	1.72	1.48	9.93	75.9
b *313*	80.50	5.69	.77	1.47	1.34	10.23	70.6
c *314*	80.05	4.58	1.40	1.70	1.84	10.43	72.64
d *315*	79.86	3.73	1.20	2.23	1.90	11.08	70.04
e *316*	79.10	5.36	2.67	1.56	1.57	9.74	84.43
f *317*	79.60	4.82	2.03	2.04	1.87	9.64	76.11
g *318*	79.15	5.10	1.75	1.89	1.47	10.64	78.7
h *319*	79.83	6.54	1.92	1.88	1.66	8.17	76.1
i *320*	76.72	4.81	1.38	2.03	1.92	13.77	86.7
j *321*	78.17	6.50	1.59	1.69	1.40	10.65	82.9
k *322*	69.83	5.37	3.36	1.57	1.37	18.50	125.7
l *323*	67.01	10.74	2.82	1.56	1.36	16.51	134.4
m *324*	71.35	7.39	2.05	1.73	1.36	16.12	112.5
n *325*	69.00	6.08	2.47	1.44	1.25	19.76	125.6
o *326*	73.78	6.36	2.00	1.56	1.78	14.52	101.5
p *327*	71.25	10.01	1.91	1.77	1.32	13.74	112.2
q *328*	74.82	6.60	3.35	1.40	1.55	12.28	105.7
r *329*	72.13	7.74	4.16	1.44	1.11	13.42	122.1
s *330*	70.57	9.31	3.68	2.01	1.28	13.15	123.0
t *331*	72.58	8.80	4.18	1.81	1.40	11.23	117.7

[1] "As received" basis.

[2] Considered as fat for the calculation of caloric values.

Table 3

Proximate Analysis of Manioc Leaves[1]

	Laboratory Number	Protein	Ether Extract[2]	Ash	Crude Fiber	Carbo-hydrates	Calories
		- - - - -	- - - - -	-per cent-	- - - - -	- - - - -	per 100 gm
312	80914a	30.95	5.65	8.31	7.15	47.95	366.5
313	b	29.18	3.95	7.54	6.87	52.46	362.1
314	c	22.96	7.02	8.52	9.22	52.28	364.1
315	d	18.52	5.96	11.07	9.43	55.01	347.8
316	e	25.65	12.78	7.46	7.51	46.60	404.0
317	f	23.63	9.95	10.00	9.17	47.25	373.1
318	g	24.46	8.39	9.06	7.05	51.03	377.5
319	h	32.42	9.52	9.32	8.23	40.51	377.4
320	i	20.66	5.93	8.72	8.25	59.15	372.6
321	j	29.78	7.28	7.74	6.41	48.79	379.8
322	k	17.80	11.14	5.20	4.54	61.32	416.7
323	l	32.56	8.55	4.73	4.12	51.43	412.9
324	m	25.79	7.16	6.04	4.75	56.27	392.7
325	n	19.61	7.97	4.65	4.03	63.74	405.1
326	o	24.26	7.63	5.95	6.79	55.38	387.2
327	p	34.82	6.64	6.16	4.59	47.79	390.2
328	q	26.21	13.30	5.56	6.16	48.77	419.6
329	r	27.77	14.93	5.17	3.98	48.15	438.1
330	s	31.63	12.50	6.83	4.35	44.68	417.7
331	t	32.09	15.24	6.60	5.11	40.96	429.4

1 "Dry" basis.

2 Considered as fat for the calculation of caloric values.

CR.13 (4-59)

ROUTING SLIP

Comments for the record should not be written on this slip. REFERRAL SHEET PT.108 should be used instead.

TO: Dr. David J. Rogers

	APPROVAL		YOUR INFORMATION
	MAY WE CONFER?		AS REQUESTED
	YOUR SIGNATURE		FOR ACTION
	NOTE AND FILE		REPLY FOR MY SIGNATURE
	NOTE AND RETURN		PREPARE DRAFT
	YOUR COMMENTS		ATTACH RELATED PAPERS

DATE: 9 Sept.'60

FROM: M. Milner

Food and Drug Research Laboratories
INCORPORATED

Maurice Avenue at 58th Street
Maspeth 78, New York City
Telephone: TWining 4-0800
Cable: Foodlabs, New York

REPORT

Submitted to United Nations Children's Fund
United Nations
New York 17, New York

Date September 7, 1960

Laboratory No. 80914 a-t

Sample Frozen manioc leaves

Marking See following pages

Examination Requested Cyanide analysis of frozen manioc leaves.

RESULTS

See following pages

FOOD AND DRUG RESEARCH LABORATORIES, INC.

Kenneth Morgareidge

Assistant Director

mrs

Sample Identification		Cyanide[1]
Laboratory No.	Description	ppm
80914 a (in duplicate)	Jamaica, Bodles Experiment Station, Collection number (D.J. Rogers) 312, Station Number (at Bodles) C8	43
80914 b (in duplicate)	Jamaica, Bodles Experiment Station, Collection number (D.J. Rogers) 313, Station Number (at Bodles) 1	47
80914 c (in duplicate)	Jamaica, Bodles Experiment Station, Collection number (D.J. Rogers) 314, Station Number (at Bodles) 34	73
80914 d (in duplicate)	Jamaica, Bodles Experiment Station, Collection number (D.J. Rogers), 315, Station Number (at Bodles) 39	39
80914 e (in duplicate)	Jamaica, Bodles Experiment Station, Collection number (D.J. Rogers), 316, Station Number (at Bodles) 49 and 49, 56	34
80914 f (in duplicate)	Jamaica, Bodles Experiment Station, Collection number (D.J. Rogers), 317, Station Number (at Bodles) 55 and 55, 56	48
80914 g (in duplicate)	Jamaica, Bodles Experiment Station, Collection number (D.J. Rogers), 318, Station Number (at Bodles) 28	39
80914 h (in duplicate)	Jamaica, Bodles Experiment Station, Collection number (D.J. Rogers), 319, Station Number (at Bodles) 51	39
80914 i (in duplicate)	Jamaica, Bodles Experiment Station, Collection number (D.J. Rogers), 320, Station Number (at Bodles) 44	33
80914 j (in duplicate)	Jamaica, Bodles Experiment Station, Collection number (D.J. Rogers), 321, Station Number (at Bodles) 11	65
80914 k	Brazil, Instituto Agronomico do Norte, Belem, Para, Collection No. (Rogers) 322, Local Name Pretinha, Origin Mun. Portel, Belem, Para	47

(continued on following page)

Sample Identification		Cyanide[1]
Laboratory No.	Description	ppm
80914 l	Brazil, Instituto Agronomico do Norte, Belem, Para, Collection No. (Rogers) 323, Local Name Cachimbo, Origin Rio Uapes, Rio Negro, Amazonas	46
80914 m	Brazil, Instituto Agronomico do Norte, Belem, Para, Collection No. (Rogers) 324, Local Name Pai Lourenco, Origin Mun. Portel, Belem, Para	77
80914 n	Brazil, Instituto Agronomico do Norte, Belem, Para, Collection No. (Rogers) 325, Local Name Mamluca, Origin Mun. Cameta, Para	48
80914 o	Brazil, Instituto Agronomico do Norte, Belem, Para, Collection No. (Rogers) 326, Local Name Abaete, Origin Mun. Cameta, Para	74
80914 p	Brazil, Instituto Agronomico do Norte, Belem, Para, Collection No. (Rogers) 327, Local Name Xingu, Origin Rio Pixuna Cupari, Tapajos	80
80914 q	Brazil, Instituto Agronomico do Norte, Belem, Para, Collection No. (Rogers) 328, Local Name Uapichuna (Wapchuna) Origin Regiao Uapes, Rio Negro, Amazonas	43
80914 r	Brazil, Instituto Agronomico do Norte, Belem, Para, Collection No. (Rogers) 329, Local Name Niple, Origin Oiapogue (indios Galibis)	60
80914 s	Brazil, Instituto Agronomico do Norte, Belem, Para, Collection No. (Rogers) 330, Local Name Amazonas, Origin Pernambuco (Nordeste)	42
80914 t	Brazil, Instituto Agronomico do Norte, Belem, Para, Collection No. (Rogers) 331, Local Name Paica, Origin Maioba-Sao Luis Maranhao	48

[1] As cyanide, by autolytic cleavage of cyanide-glucoside bond with phaseolunatase enzyme; in which the frozen sample is placed in 25 ml of H_2O, incubated at 37° C. for 24 hours, and then acidified to 1N H_2SO_4 and re-incubated for another 24 hours. The contents are then transferred to a reaction chain and the cyanide

Footnote continued

[1] is collected in 0.1 N NaOH, and determined by the method of J. Epstein (Anal. Chem. 19, 272 (1947)) as modified by G. E. Boxer and J. C. Richards, Arch. Biochem. and Biophys. 30, 372 (1951).

Table 1

Manioc Leaf Samples

Jamaica, Bodles Experiment Station

Laboratory Number	Collection Number (D. J. Rogers)	Station Number (at Bodles)
80914 a (in duplicate)	312	C8
b "	313	1
c "	314	34
d "	315	39
e "	316	49 and 49, 56
f "	317	55 and 55, 56
g "	318	28
h "	319	51
i "	320	44
j "	321	11

Table 2

Manioc Leaf Samples

Brazil, Instituto Agronomico do Norte, Belem, Para

Laboratory Number	Collection No. (Rogers)	Local Name	Origin
80914 k	322	Pretinha	Mun. Portel, Belem, Para
l	323	Cachimbo	Rio Uapes, Rio Negro, Amazonas
m	324	Pai Lourenco	Mun. Portel, Belem, Para
n	325	Mamluca	Mun. Cameta, Para
o	326	Abaete	Mun. Cameta, Para
p	327	Xingu	Rio Pixuna Cupari, Tapajos
q	328	Uapichuna (Wapchuna)	Regiao Uapes, Rio Negro, Amazonas
r	329	Niple	Oiapogue (indios Galibis)
s	330	Amazonas	Pernambuco (Nordeste)
t	331	Paica	Maioba-Sao Luis Maranhao

Table 3

Proximate Analysis of Manioc Leaves

Sample Number		Moisture	Protein	Ether Extract	Ash	Crude Fiber	Carbohydrates	Calories	Cyanide ppm. wet
		percent						per 100 gm.	
Jamaican Samples									
312*	frozen	79.29	6.41	1.17	1.72	1.48	9.93	75.9	43
	dried		30.95	5.65	8.31	7.15	47.95	366.5	
313	frozen	80.50	5.69	.77	1.47	1.34	10.23	70.6	47
	dried		29.18	3.95	7.54	6.87	52.46	362.1	
314	frozen	80.05	4.58	1.40	1.70	1.84	10.43	72.64	73
	dried		22.96	7.02	8.52	9.22	52.28	364.1	
315	frozen	79.86	3.73	1.20	2.23	1.90	11.08	70.04	39
	dried		18.52	5.96	11.07	9.43	55.01	347.8	
316	frozen	79.10	5.36	2.67	1.56	1.57	9.74	84.43	34
	dried		25.65	12.78	7.46	7.51	46.60	404.0	
317	frozen	79.60	4.82	2.03	2.04	1.87	9.64	76.11	48
	dried		23.63	9.95	10.00	9.17	47.25	373.1	
318	frozen	79.15	5.10	1.75	1.89	1.47	10.64	78.7	39
	dried		24.46	8.39	9.06	7.05	51.03	377.5	
319	frozen	79.83	6.54	1.92	1.88	1.66	8.17	76.1	39
	dried		32.42	9.52	9.32	8.32	40.51	377.4	
320	frozen	76.72	4.81	1.38	2.03	1.92	13.77	86.7	33
	dried		20.66	5.93	8.72	8.25	59.15	372.6	
321	frozen	78.17	6.50	1.59	1.69	1.40	10.65	82.9	65
	dried		29.78	7.28	7.74	6.41	48.79	379.8	
Brazilian Samples									
322	frozen	69.83	5.37	3.36	1.57	1.37	18.50	125.7	47
	dried		17.80	11.14	5.20	4.54	61.32	416.7	

Table 3 continued

323	frozen	67.01	10.74	2.82	1.56	1.36	16.51	134.4	46
	dried		32.56	8.55	4.73	4.12	51.43	412.9	
324	frozen	71.35	7.39	2.05	1.73	1.36	16.12	112.5	77
	dried		25.79	7.16	6.04	4.75	56.27	392.7	
325	frozen	69.00	6.08	2.47	1.44	1.25	19.76	125.6	48
	dried		19.61	7.97	4.65	4.03	63.74	405.1	
326	frozen	73.78	6.36	2.00	1.56	1.78	14.52	101.5	74
	dried		24.26	7.63	5.95	6.79	55.38	387.2	
327	frozen	71.25	10.01	1.91	1.77	1.32	13.74	112.2	80
	dried		34.82	6.64	6.16	4.59	47.79	390.2	
328	frozen	74.82	6.60	3.35	1.40	1.55	12.28	105.7	43
	dried		26.21	13.30	5.56	6.16	48.77	419.6	
329	frozen	72.13	7.74	4.16	1.44	1.11	13.42	122.1	60
	dried		27.77	14.93	5.17	3.98	48.15	438.1	
330	frozen	70.57	9.31	3.68	2.01	1.28	13.15	123.0	42
	dried		31.63	12.50	6.83	4.35	44.68	417.7	
331	frozen	72.58	8.80	4.18	1.81	1.40	11.23	117.7	48
	dried		32.09	15.24	6.60	5.11	40.96	429.4	

1/ Considered as fat for the calculation of caloric values.

* These are the collection numbers of the specimens. A documenting herbarium specimen for each number, collected by David J. Rogers, is deposited in the Herbarium of The New York Botanical Garden, Bronx Park, New York.

July 29, 1960

Dear Max:

Enclosed are two copies of a rather informal report on my activities. I thought that this might serve until we get the results of the analyses, at which time a more formal presentation might be made. I welcome your suggestions and criticisms on both this report and the idea of the formal presentation later.

Would you have any objections to my forwarding copies of this report to Waterlo? I'd also like to send something to the steamship company, the customs brokers, to the Dept. of Agriculture in Jamaica, and the Institute in Belem--not necessarily the same report, but judicious samplings which are pertinent to each. I await your approval.

Sincerely,

David J. Rogers
Curator of Economic Botany

Dr. Max Milner
UNICEF
United Nations, NY.

Encl.

REPORT TO UNICEF

July 28, 1960

PROJECT

Collection of manioc leaves for analyses

PERSONNEL

David J. Rogers, The New York Botanical Garden

PURPOSES

1. To determine the value of the foliage of *Manihot esculenta* as a source of protein for dietary supplements.

2. To obtain information on the economics of production of *M. esculenta* foliage.

3. To establish the possibility of collaboration in institutions and laboratories of the countries visited.

PROCEDURES

Collections of Foliage of *Manihot esculenta*

Twenty known varieties of both bitter and sweet *M. esculenta* were sampled in Jamaica and Brazil. Varieties are maintained as living collections in "museum" plots, available for continuing studies.

In Jamaica, the varieties are maintained by the Ministry of Agriculture and Lands, at the Bodles Experiment Station, Old Harbor, Jamaica. Mr. D. C. Webster, Crop Agronomy Division, Ministry of Agriculture and Lands, Hope Gardens, Kingston, Jamaica, is the officer in charge of collections at Bodles.

The varieties collected were chosen on the following bases, the criteria listed in descending order of importance:

1. Percent of crude protein according to previous analyses
2. Productivity of foliage
3. General acceptability of the variety in present Jamaican usage

The Jamaican varieties sampled are:

Collection number (D. J. Rogers)	Station number (at Bodles)
312	C8
313	1
314	34
315	39
316	49
317	55
318	28
319	51
320	44
321	11

Approximately ten pounds of foliage of each variety were collected, packed in dry ice, and returned to the U. S. via air freight. These collections are documented by herbarium specimens in the *M. esculenta* collections of David J. Rogers at The New York Botanical Garden, Bronx Park, New York 58. All references to the leaf samples for analysis or to the herbarium specimens should be to the collection number, i. e., Rogers 312, 313, etc.

In Brazil the varieties are maintained by the Instituto Agronomico do Norte, Belém, Pará, Brazil. The officer in charge of the collections is Sr. Milton Albuquerque, Secção de Melhoramente do Inst. Agron. do Norte.

As no previous data on crude protein content of the foliage of the varieties had been collected, the criteria for collections for sampling were:

1. Productivity of foliage

2. General acceptability of the variety in present Amazonian usage

The varieties came originally (with two exceptions) from various parts of the Amazon basin. They are:

Collection No. (Rogers)	Local Name	Origin
322	Pretinha	Mun. Portel, Belém, Pará
323	Cachimbo	Rio Uapés, Rio Negro, Amazonas
324	Pai Lourenço	Mun. Portel, Belém, Pará
325	Mameluca	Mun. Cametá, Pará
326	Abaeté	Mun. Cametá, Pará
327	Xingú	Rio Pixuna Cupari, Tapajós
328	Uapichuna (Wapchuna)	Região Uapés, Rio Negro, Amazonas
329	Niplê	Oiapoque (índios Galibis)
330	Amazonas	Pernambuco (Nordeste)
331	Paicá	Maioba-São Luiz Maranhão

No dry ice was available in Belém, and alternate procedures had to be used. Approximately five pounds of each variety were collected, packed in plastic bags, and within two hours of collection were placed in the frozen food locker aboard the motorship Spenser of the Lamport-Holt Steamship Company. The agent of Lamport Holt in New York is the Booth Steamship Co., Ltd., 17 Battery Place, New York.

Receipt and Storage of Specimens in New York

Upon arrival in New York, the Jamaican specimens were cleared through customs, examined by Plant Quarantine officers, and placed in dry ice chests at The New York Botanical Garden. Personnel at The New York Botanical Garden handled all arrangements for receipt of the Jamaican material. Considerable expense was involved because the shipment arrived after 5 P.M., though scheduled for 4 P.M., and overtime was charged.

The specimens from Brazil arrived in New York on July 5. I cleared these through customs and quarantine personally. Much credit is due, however, to H. W. St. John and Co., customs brokers, whose assistance made it possible to remove the specimens from the ship and have them stored in the laboratory of The New York Botanical Garden still completely frozen.

It is a pleasure to report that there was no charge made by either Lamport-Holt or Booth for transporting material. Furthermore, arrangements for discharging the material, examination of the material by Plant Quarantine Personnel and release by Customs officials were efficiently handled at no cost by H. W. St. John Co., 18 Pearl Street, New York 4, N. Y. We are most appreciative of their fine efforts in expediting the removal of the material without thawing from ship to safe storage.

The specimens were kept in dry ice storage at The New York Botanical Garden until their delivery to the Food and Drug Research Laboratories on July 18. Considerable dry ice was required to keep the specimens in good condition.

ECONOMICS OF PRODUCTION

Jamaica

The Jamaican Department of Agriculture has long been interested in cassava, and notes on variety introduction, trials, fertilizer experiments have been made in the annual reports of the Department almost since the Department was eatablished. All these notes, however, deal with the root product, and none with the foliage.

The most recent endeavors by the Department of Agriculture in Jamaica have been made as a cooperative endeavor with me. The major goal of these endeavors has been to produce an adequate classification of the cultivars, but analyses of roots for starch content and foliage for crude protein have been made as adjuncts to this project.

As in most areas, the greatest quantity of cassava, as the crop is known locally, is produced in small holdings. Therefore, it is difficult to get figures of actual acreage of cassava raised as a root crop. Most country districts of Jamaica are suitable for the plants. The greatest concentration of the plants, however, is found in the southwestern part, in the parishes of Clarendon, St. Elizabeth, and Westmoreland.

In Jamaica the foliage is not used. Only one or two isolated reports of the use of the leaves of cassava as a vegetable have been noted.

Using rather crude estimates and methods I obtained the following data:

1. Leaf yield--fresh leaves. Based on the specimen plants in the experimental plot, rather than on field-grown plants, the following amounts of foliage are produced:

A. Ten pounds of leaf obtained from an average of ten plants.

B. Plants usually planted on 3 1/2' x 3 1/2' centers, ideally giving 3-4,000 plants per acre.

C. One pound of fresh leaf per plant, 3-4,000 pounds per acre.

2. Variance

A. Variety #1 (Rogers 313) at Bodles Experiment Station gave ten pounds of leaf per plant, 30,000 pounds of leaf per acre.

The following estimate of production costs in Jamaica is based on the experience of Mr. D. C. Webster, Food Crop Agronomist, Ministry of Agriculture and Lands, Hope Gardens.

1. On a large scale (10+ acres) including

A. Cost of land preparation, using tractor

B. Cost of planting material

C. Cost of planting, maintaining (two weedings) and reaping

Total £100 (exchange: 1 pound for $2.80) per acre

2. On a small scale (1-2 acres), add £20 per acre for hand labor.

These figures include no fertilizer, sprays, etc.

Brazil

I was unable to obtain reliable figures for costs of production in Belém. Although considerable study of the agricultural problems has been made at the Instituto Agronomico do Norte, no economic studies have been included in their work. No reliable statistics are available from other sources. There is little likelihood that figures established at the Institute could be applied to local agricultural practices because of the nature of the local culture of mandioca plants.

I did find that there is some use of the foliage in foods, but in a rather special way. A product using the leaves, called "maniçoba," is prepared on festive occasions, but not as a regular daily part of the diet. Many different materials go with the foliage in preparation of this dish (meats, spices, etc.) and there seems no exact requirement, other than considerable boiling of the leaves (about two days). No details of the preparation of this dish were noted.

Perhaps a rural sociologist or an agricultural economist could collect important data on this subject to learn what significance there is in the use of mandioca (or macachera, as the sweet varieties are known) leaves in the daily routine of the people. Certainly this use should be examined along with other information in the same manner as that done by Jones in Africa.

POSSIBLE COLLABORATION FOR FURTHER STUDIES

Jamaica

At the moment, there is no active work on the foliage of <u>Manihot esculenta</u> in Jamaica. However, the two institutions ~~are~~ most likely to become involved are: The Department (or school) of Medicine, University College of the West Indies, and The Ministry of Agriculture and Lands, Department of Crop Agronomy, both institutions in Kingston.

At U.C.W.I., the group interested in leaf proteins as dietary supplements is headed by Drs. Waterlo and Cruickshank. Waterlo is the active worker and has been working on protein supplements for kwashiorkor patients for some time. His most recent work (with Pirie extracted, dried and powdered leaf protein) shows promising results as a substitute for dried milk in infant diets. Their results have been so good that Dr. Waterlo and Dr. Cruickshank have applied to the Jamaican NRC (or equivalent organization) for funds to purchase a Pirie extractor and have been successful to the extent that £5,000 have been granted, with the understanding that additional funds will be sought from other sources.

As I understand the situation, the following activities, listed in order of precedence, are planned:

1. Set up a Pirie extraction device in Jamaica
2. Use leaf protein of any source

3. Determine the problems of utilization of these extracts to overcome protein deficiencies.

4. Determine which source of leaf protein is most valuable, economical, and available.

Parenthetically, it should be said that Waterlo and Cruikshank (on the advice of Pirie) feel that protein from any leaf is nearly the same as from any other; therefore, at the moment the source of leaf protein is a matter of secondary importance.

The group at U.C.W.I. proposes eventually to work on the problem of the most practical, as well as the most desirable, source of leaf protein. Their work should, in my estimation, definitely be encouraged, and perhaps the studies of amino acids ~~leaf protein from~~ present in manioc leaf protein would speed or supplement solution of the whole problem.

The second institution of importance in Jamaica is the Ministry of Agriculture and Lands, whose director is Mr. Hugh Miller. For many years the Department of Agriculture (as it was formerly known) has been interested in the improvement of cassava as a root crop. The latest endeavor (begun in 1953) is a cooperative one, working with me to establish a practical classification of the cultivars. They have been very cooperative, and have expended considerable funds in this work. Though most of the work has been of an agronomic nature, their department of plant chemistry has made a number of analyses of the roots (starch, glucose, fiber) and the foliage (crude protein).

Their staff is competent and will, I am sure, be able to handle any level of work required.

At the moment, they are engaged in an extensive variety trial project, and the foliage from this trial will be available for further study of leaf protein.

It seems to me that this is one of the best possible combinations for continuing research in this important field. Nutritional studies at U.C.W.I., using materials of known origin carefully tended by the Ministry of Agriculture, could be very important in this respect. There is already close liaison between the two organizations, and staff members from both sit on an interdisciplinary advisory committee.

Brazil

For reasons which are beyond the scope of my ability to advise on, there is little hope that work at this stage could be accomplished in the part of Brazil I visited. Granted that my visit was short and that my contacts were limited, ~~but~~ I do not feel that anything could be accomplished in this part of the program which cannot be accomplished in Jamaica.

I refer specifically to the analytical and nutritional aspects of the problem in the preceding paragraph. For purposes of the agronomic studies and screening for best varieties of mandioca for production of leaf protein, the Instituto Agronomico do Norte is well suited.

CONCLUSION

In conclusion I wish to state my gratitude to UNICEF for the fine way in which the arrangements have been handled. It is particularly gratifying to know that the program has been well conceived and the importance of collaboration all the way from the taxonomic botanical aspects through the critical analyses to the eventual practical applications has been recognized. Certainly the procedures established have been most practical and worthwhile.

c.c. Dr. David Rogers
" L.J. Teply
Mr. H.J. Humphrey
" L.E. Allen
Mrs. D. Wu
Miss E. Brown

File: Testing-Food & Drug
Leaf Protein
Jo's Manioc file.

MM/ma

20 July, 1960

Dr. Benjamin Oser
Food & Drug Research Laboratories, Inc.,
Maurice Avenue at 58th Street
Maspeth 78
New York.

Dear Doctor Oser:

This will confirm the agreement reached by telephone on Friday last between you, Mr. Weinberg and Mr. Harold Humphrey of our group with reference to charges for analyzing 20 samples of fresh manioc leaf. The analytical schedule is outlined in my letter to you dated 16 May 1960, and involves specifically sections a, b and c of item 3. The 20 fresh samples will be analyzed for:

(a) Proximate analysis (moisture, total nitrogen, ether extract, crude fiber and ash by AOAC procedures).

(b) Amino acid profile - a total of 11 amino acids including the 8 essential amino acids plus arginine, histidine and cystine, using chromatographic procedure of Moore, Spackman and Stein, Anal. Chem. 30:1185-1190 (1958).

(c) Total hydrocyanic acid.

It is understood that the complete schedule as indicated will cost $4,600.00. A purchase request for this amount will reach you shortly.

By the time you receive this letter, Dr. David Rogers of the New York Botanical Gardens, who personally collected these samples in Jamaica and Brazil, will have called at your laboratory and turned the samples over to your Mr. Weinberg. We presume that analyses will be undertaken without delay and that unused portions of the 20 samples will be maintained in the same frozen condition as delivered to you by Dr. Rogers, until the analyses are completed and checked. It may well be that after completion of the analytical program we will wish to consider animal feeding trials with the balance of this material. Accordingly it should be maintained in a frozen condition until we have discussed this matter with you following completion of the analysis.

Your cooperation in this matter is appreciated. With kind regards.

Yours sincerely,

Max Milner
Senior Food Technologist
Food Conservation Division

file: leaf protein
testing newproducts

26 May 1960

Dr. Alvin Ostaschever
ANALYTICA Corporation
118 East 28th Street
New York 16, New York

Dear Dr. Ostaschever:

In an effort to evaluate manioc leaves as a potential source of dietary protein, we are presently considering a program of testing as outlined below.

1. About 10 samples of manioc leaves will be collected in the field at each of two different locations (Jamaica and Brazil) and either lyophilised or frozen immediately, depending on whether lyophilization facilities are available at collecting points. Individual sample size would correspond to approximately one pound of dry solids. Dry samples obtained by lyophilization would be packed in moisture-proof material for shipment to the U.S. by air. Frozen samples will be packaged with dry ice for shipment by air express.

2. Upon arrival at the laboratory or testing station in the U.S., the samples will be analyzed as soon as possible. Frozen samples will be kept in the freezer until all tests are completed and eventual questionable values rechecked.

3. The following analyses are to be performed:
   a. Moisture, total nitrogen, ether extract, crude fibre, and ash;
   b. 8 essential amino acids plus arginine, histidine and cystine, by chromatographic procedure;
   c. Hydrocyanic acid (HCN), total, upon acidification;
   d. Eventually, pending the outcome of the above tests, animal feeding experiments and vitamin assays.

We would like to receive your comments on this plan, and, if arrangements may be made to have you carry out this program, to receive from you a quotation for this work based on 20 individual samples, excluding costs of collection of leaves, freezing or drying, and transportation. Quotations should be broken down by individual analytical items.

We look forward to your early reply.

Sincerely yours,

Max Milner
Senior Food Technologist

MM/sw
cc: Dr. Rogers ✓
Dr. Severinghaus

File: Testing FDRL
Leaf protein

16 May 1960

Food and Drug Research Laboratories
Maurice Avenue at 58th Street
Maspeth 78
New York

Dear Sirs:

In an effort to evaluate manioc leaves as a potential source of dietary protein, we are presently considering a program of testing as outlined below:

1. About 10 samples of manioc leaves will be collected in the field at each of two different locations (Jamaica and Brazil) and either lyophilized or frozen immediately, depending on whether lyophilization facilities are available at collecting points. Individual sample size would correspond to approximately one pound of dry solids. Dry samples obtained by lyophilization would be packed in moisture-proof material for shipment to the U.S. by air. Frozen sample will be packaged with dry ice for shipment by air express.

2. Upon arrival at the laboratory or testing station in the U.S., the samples will be analyzed as soon as possible. Frozen samples will be kept in the freezer until all tests are completed and eventual questionable values rechecked.

3. The following analyses are to be performed:
   a. Moisture, total nitrogen, ether extract, crude fibre, and ash;
   b. 8 essential amino acids plus arginine, histidine and cystine, by chromatographic procedure;
   c. Hydrocyanic acid (HCN), total, upon acidification;
   d. Eventually, pending the outcome of the above tests, animal feeding experiments and vitamin assays.

We would like to receive your comments on this plan, and, if arrangements may be made to have you carry out this program, to receive from you a quotation for this work based on 20 individual samples, excluding costs of collection of leaves, freezing or drying, and transportation. Quotations should be broken down by individual analytical items.

We will look forward to your early reply.

Sincerely yours,

Max Milner
Senior Food Technologist

MM/sw
cc: Dr. Rogers ✓
Dr. Severinghaus

File: leaf protein
testing new products

16 May 1960

Evans Research & Development Corporation
250 East 43rd Street
New York 17
New York

Dear Sirs:

In an effort to evaluate manioc leaves as a potential source of dietary protein, we are presently considering a program of testing as outlined below:

1. About 10 samples of manioc leaves will be collected in the field at each of two different locations (Jamaica and Brazil) and either lyophilized or frozen immediately, depending on whether lyophilization facilities are available at collecting points. Individual sample size would correspond to approximately one pound of dry solids. Dry samples obtained by lyophilization would be packed in moisture-proof material for shipment to the U.S. by air. Frozen samples will be packaged with dry ice for shipment by air express.

2. Upon arrival at the laboratory or testing station in the U.S., the samples will be analysed as soon as possible. Frozen samples will be kept in the freezer until all tests are completed and eventual questionable values rechecked.

3. The following analyses are to be performed:
   a. Moisture, total nitrogen, ether extract, crude fibre, and ash;
   b. 8 essential amino acids plus arginine, histidine and cystine, by chromatographic procedure;
   c. Hydrocyanic acid (HCN), total, upon acidification;
   d. Eventually, pending the outcome of the above tests, animal feeding experiments and vitamin assays.

We would like to receive your comments on this plan, and, if arrangements may be made to have you carry out this program, to receive from you a quotation for this work based on 20 individual samples, excluding costs of collection of leaves, freezing or drying, and transportation. Quotations should be broken down by individual analytical items.

We look forward to your early reply.

Sincerely yours,

Max Milner
Senior Food Technologist

MM/sw
cc: Dr. Rogers ✓
Dr. Severinghaus

File: Testing New Products
Leaf Protein

16 May 1960

Arthur D. Little, Inc.
30 Memorial Drive
Cambridge 39
Massachusetts

Dear Sirs:

In an effort to evaluate manioc leaves as a potential source of dietary protein, we are presently considering a program of testing as outlined below:

1. About 10 samples of manioc leaves will be collected in the field at each of two different locations (Jamaica and Brazil) and either lyophilized or frozen immediately, depending on whether lyophilization facilities are available at collecting points. Individual sample size would correspond to approximately one pound of dry solids. Dry samples obtained by lyophilization would be packed in moisture-proof material for shipment to the U.S. by air. Frozen samples will be packaged with dry ice for shipment by air express.
2. Upon arrival at the laboratory or testing station in the U.S., the samples will be analyzed as soon as possible. Frozen samples will be kept in the freezer until all tests are completed and eventual questionable values rechecked.
3. The following analyses are to be performed:
   a. Moisture, total nitrogen, ether extract, crude fibre, and ash;
   b. 8 essential amino acids plus arginine, histidine and cystine, by chromatographic procedure;
   c. Hydrocyanic acid (HCN), total, upon acidification;
   d. Eventually, pending the outcome of the above tests, animal feeding experiments and vitamin assays.

We would like to receive your comments on this plan, and, if arrangements may be made to have you carry out this program, to receive from you a quotation for this work based on 20 individual samples, excluding costs of collection of leaves, freezing or drying, and transportation. Quotations should be broken down by individual analytical items.

We look forward to your early reply.

Sincerely yours,

Max Milner
Senior Food Technologist

MM/sw
cc: Dr. Rogers ✓
Dr. Severinghaus

file: Testing New Products
Leaf protein

16 May 1960

Oxford Laboratories
Analytical Division
961 Woodside Road
Redwood City, California

Dear Sirs:

In an effort to evaluate manioc leaves as a potential source of dietary protein, we are presently considering a program of testing as outlined below:

1. About 10 samples of manioc leaves will be collected in the field at each of two different locations (Jamaica and Brazil) and either lyophilized or frozen immediately, depending on whether lyophilization facilities are available at collecting points. Individual sample size would correspond to approximately one pound of dry solids. Dry samples obtained by lyophilization would be packed in moisture-proof material for shipment to the U.S. by air. Frozen samples will be packaged with dry ice for shipment by air express.

2. Upon arrival at the laboratory or testing station in the U.S., the samples will be analyzed as soon as possible. Frozen samples will be kept in the freezer until all tests are completed and eventual questionable values rechecked.

3. The following analyses are to be performed:
   a. Moisture, total nitrogen, ether extract, crude fibre, and ash;
   b. 8 essential amino acids plus arginine, histidine and cystine, by chromatographic procedure;
   c. Hydrocyanic acid (HCN), total, upon acidification;
   d. Eventually, pending the outcome of the above tests, animal feeding experiments and vitamin assays.

We would like to receive your comments on this plan, and, if arrangements may be made to have you carry out this program, to receive from you a quotation for this work based on 20 individual samples, excluding costs of collection of leaves, freezing or drying, and transportation. Quotations should be broken down by individual analytical items.

We look forward to your early reply.

Sincerely yours,

Max Milner
Senior Food Technologist

MM/sw
cc: Dr. Rogers ✓
Dr. Severinghaus

Testing: WARF
Leaf Protein

MM/sw/60 16 May 1960

Wisconsin Alumni Research Foundation
506 North Walnut Street
Madison 5
Wisconsin

Dear Sirs:

In an effort to evaluate manioc leaves as a potential source of dietary protein, we are presently considering a program of testing as outlined below:

1. About 10 samples of manioc leaves will be collected in the field at each of two different locations (Jamaica and Brazil) and either lyophilized or frozen immediately, depending on whether lyophilization facilities are available at collecting points. Individual sample size would correspond to approximately one pound of dry solids. Dry samples obtained by lyophilization would be packed in moisture-proof material for shipment to the U.S. by air. Frozen samples will be packaged with dry ice for shipment by air express.

2. Upon arrival at the laboratory or testing station in the U.S., the samples will be analyzed as soon as possible. Frozen samples will be kept in the freezer until all tests are completed and eventual questionable values rechecked.

3. The following analyses are to be performed:
   a. Moisture, total nitrogen, ether extract, crude fibre, and ash;
   b. Eight essential amino acids plus arginine, histidine and cystine, by chromatographic procedure;
   c. Hydrocyanic acid (HCN), total, upon acidification;
   d. Eventually, pending the outcome of the above tests, animal feeding experiments and vitamin assays.

We would like to receive your comments on this plan, and, if arrangements may be made to have you carry out this program, to receive from you a quotation for this work based on 20 individual samples, excluding costs of collection of leaves, freezing or drying, and transportation. Quotations should be broken down by individual analytical items.

/...

We will look forward to your early reply.

Yours truly,

Max Milner
Senior Food Technologist

cc: : Dr. Rogers
Dr. Severinghaus

May 16, 1960

Mr. Donald R. Sabin
Coordinator, Food Conservation
UNICEF
United Nations, New York

Dear Mr. Sabin:

With reference to your letter of May 11, 1960, concerning the study of manioc leaf samples from Jamaica and Brazil, I wish to advise you that the instructions and agreements contained in this letter are perfectly satisfactory to me.

I am proceeding to gather the necessary information for the sampling procedures with the aid of Dr. Milner and Mr. Odlum, who, I understand, has contacted several research laboratories.

I understand further that it may be of importance to go to Rio in the event that the Brazilian authorities are interested.

Thank you for your assistance and kind cooperation.

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF

TELEPHONE PLAZA 4-1234

CABLE ADDRESS UNICEF

UNICEF

UNITED NATIONS CHILDREN'S FUND · FONDS DES NATIONS UNIES POUR L'ENFANCE

UNITED NATIONS, NEW YORK

DRS/ja

11 May 1960

Dr. David J. Rogers
Curator of Economic Botany
New York Botanical Gardens
The Bronx 58, N.Y.

Dear Dr. Rogers,

Study of Manioc Leaf Samples from Jamaica and Brazil

This is with reference to your recent visits to this office and our discussions on the above subject.

The purpose of this letter is to confirm the agreement we reached, namely that you would undertake on behalf of UNICEF the collection of different varieties of manioc leaf from each of the above countries for a preliminary examination of its amino acid content in relation to its possible use as a protein supplement in diets.

A Travel Authorization is being issued to you for travel to Jamaica and Brazil for this purpose on or about 1 June 1960, which will permit you to spend about 15 days in each country, where you will select approximately one pound (dry weight) of up to 10 different specifically identified varieties of manioc leaf from each area and arrange their shipment to the United States. The various analyses involved (determination of composition, proximate analysis, amino acid values etc.,) will be made at a laboratory to be determined.

Upon your return, we will appreciate your obtaining similar samples of indigenous varieties from other countries through your contacts with reputable scientists. We will also appreciate your providing us as much information as possible concerning the economic aspects of manioc leaft utilization in various parts of the world including time and frequency of harvest, tonnage of protein leaf per acre, cost of harvesting and processing of the leaf for food, and whether leaves can be harvested if the root is to be permitted to mature. It is understood that the information gained in this study will be covered in a report to UNICEF.

UNICEF will sustain the expenses involved in this study, namely your round trip air fare New York/Jamaica/Belem/New York, rental of car in Jamaica and Brazil for 25 days at $15 per day. You will receive a "per diem" of $15 for the days you are in travel status. Costs of air express shipment of the samples to the USA will be covered by UNICEF.

/...

Furthermore, we have requested our representative in Rio de Janeiro, Mrs. Gertrude Lutz, to find out whether the Brazilian Authorities would wish you to go to Rio during your visit in June, or whether they would be satisfied to have you call on them during your contemplated visit to Rio and Sao Paulo in September/October. Should the Government of Brazil request your visit to Rio in June, UNICEF will cover the additional transportation costs involved.

Please confirm that these arrangements are satisfactory to you.

Wishing you a successful trip,

Sincerely yours,

Donald R. Sabin

Donald R. Sabin
Coordinator, Food Conservation

cc. Dr. E.L. Severinghaus, NY
Mr. R. Moltu

Agenda Item No. 1(g)

Nutrition Document R.10/Add.46
PAG (WHO/FAO/UNICEF)
March 1962 Meeting - Rome

NOT FOR PUBLICATION

Distribution restricted pending decision at PAG meeting

LEAF PROTEIN

Tests on Manioc Leaves from Jamaica and Brazil

The final amino acid assay results on manioc leaf samples collected ... in Jamaica and Brazil are given in Annex A.

Previously reported proximate analyses and cyanide determination results on those samples can be summarized as follows:

	Jamaica Samples	Brazil Samples
% moisture	76 - 85	67 - 74
% protein	3.7 - 6.5	5.3 - 10.7
% ether extract	18 - 2.6	1.9 - 4.1
% ash	1.4 - 2.0	1.4 - 2.0
% crude fiber	1.3 - 1.9	1.1 - 1.5
% carbohydrates	8.1 - 13.7	11.2 - 19.7
cyanide, ppm	33 - 73	42 - 80

Methods of Analysis

Cyanide - As cyanide, by autolytic cleavage of cyanide-glucoside bond with phaseolunatase enzyme; in which the frozen sample is placed in 25 ml of water, incubated at 37oC for 24 hours, and then acidified to 1N N_2SO_4 and reincubated for another 24 hours. The contents are then transferred to a reaction chain and the cyanide is collected in 0.1 N NaOH, and determined by the method of J. Epstein (Anal. Chem. 19, 272 (1947) as modified by G.E. Boxer and J.C. Richards, Arch Biochem, and Biophys. 30, 372 (1951).

Amino Acids - Moore, S., Spackman, D.H., and Stein, W.H., Anal. Chem., 30, 1185 (1958).

Arginine - Barton-Wright, E.C., "The Microbiological Assay of the Vitamin B-Complex and Amino Acids", Pitman Publishing Corporation, New York, N.Y., (1952), page 135.

Tryptophane - Ibid, using A.I.B. method of hydrolysis.

/...

The samples which had been in frozen storage were lyophilized and composited (Jamaica and Brazil samples kept separate) for rat protein evaluation. In a preliminary feeding trial, 4 rats with 15% manioc protein (66% manioc leaf-dry basis) in the diet, lost weight (18g) gradually over two weeks. Control rats on casein and on casein with sodium cyanide added at a level equivalent to that found in the manioc leaf diet grew normally. In a subsequent test, rats lost 14 to 22 grams the first week on a diet with manioc leaf providing 10% protein.

UNICEF believes that further attempts to obtain PER values on these samples may not be warranted; the views of PAG are requested.

Leaf Protein Processing

A pilot plant (1 ton per day capacity) designed by Dr. N.W. Pirie, Rothamsted, has been set up in Jamaica by the Government and preliminary processing trials are being carried out. There is interest in exploring the possibilities of using sugar cane tips, among other sources, as raw material. The Nuffield Foundation has provided a grant to further the studies.

Dr. Pirie has also developed a small "village" mill which can be powered by a donkey. The fresh curd produced is intended to be consumed rather soon after production; the exact storage characteristics of these curd preparations are not known. One of these small mills has been delivered to Professor Kane, National Botanical Gardens, Lucknow, and it is planned to provide one or more for trials in the Caribbean.

The Andre Mayer Fellowship (FAO) holder, Mr. Khown Foet Tjen, from Indonesia, has completed his year studying leaf protein concentrates with Dr. N. W. Pirie, Rothamsted Experimental Station, England, and Dr. A.A. Woodham, Rowett Research Institute, Scotland.

L.J. Teply/dt
6 March 1962

./ANNEX A

Table 1

Manioc Samples Received for Analysis

Laboratory No.		Jamaica, Bodles Experiment Station	
		Collection Number (D. J. Rogers)	Station Number (at Bodles)
30914 a	(in duplicate)	312	C8
b	ditto	313	1
c	ditto	314	34
d	ditto	315	39
e	ditto	316	49 and 49, 56
f	ditto	317	55 and 55, 56
g	ditto	318	28
h	ditto	319	51
i	ditto	320	44
j	ditto	321	11

(Continued on following page)

/...

Table 1 (Concluded)

Manioc Samples Received for Analysis

Laboratory No.	Brazil, Instituto Agronomico do Norte, Belem, Para Collection No. (Rogers)	Local Name	Origin
80914 k	322	Pretinha	Mun. Portel, Belem, Para
l	323	Cachimbo	Rio Uapes, Rio Negro, Amazonas
m	324	Pai Lourenco	Mun. Portel, Belem, Para
n	325	Mamluca	Mun. Cameta, Para
o	326	Abaete	Mun. Cameta, Para
p	327	Xingu	Rio Pixuna Cupari, Tapajos
q	328	Uapichuna (Wapchuna)	Regiao Uapes, Rio Negro, Amazonas
r	329	Niple	Oiapogue (indios Galibis)
s	330	Amazonas	Pernambuco (Nordeste)
t	331	Paica	Maioba-Sao Luis Maranhao

/...

Table 2

Cyanide Analysis of Manioc Leaves

Laboratory No.	Cyanide
	ppm
(Jamaica)	
80914 a	43
b	47
c	73
d	39
e	34
f	48
g	39
h	39
i	33
j	65
(Brazil)	
80914 k	47
l	46
m	77
n	48
o	74
p	80
q	43
r	60
s	42
t	48

/...

Annex A to R.10/Add.46

Table 3

Amino Acid Profiles of Manioc Leaves

Determination	Collection Number — Jamaica — 312	313	314	315	316	317	318	319	320	321	
	per cent (16 gm Nitrogen Basis)										
Alanine	6.01	6.18	6.17	6.11	5.66	6.03	5.68	5.86	5.77	6.39	5.98
Arginine	5.48	5.70	5.28	5.20	4.29	5.49	5.04	5.53	4.00	6.80	5.28
Aspartic Acid	10.27	10.22	9.79	10.20	10.64	10.72	10.10	9.80	10.12	9.49	10.14
Cystine	1.41	1.35	1.31	1.56	1.24	1.09	1.99	1.29	1.04	1.39	1.37
Glutamic Acid	10.26	10.50	10.10	11.83	10.43	10.08	10.10	9.50	10.07	9.37	10.22
Glycine	5.42	5.44	5.95	5.25	5.66	4.29	5.76	5.58	5.28	5.32	5.39
Histidine	2.04	1.95	2.42	3.28	2.05	2.14	2.30	1.66	3.05	1.44	2.23
Isoleucine	4.86	5.23	4.95	4.95	5.08	5.12	4.92	5.26	4.91	4.85	5.01
Leucine	8.76	8.98	8.88	9.32	7.66	9.18	8.66	8.95	8.82	9.67	8.89
Lysine	7.73	6.18	7.46	6.65	5.94	8.24	8.14	7.83	7.86	6.00	7.20
Methionine	1.65	1.78	1.51	1.56	1.79	1.79	1.39	1.44	1.74	1.84	1.65
Phenylalanine	5.95	5.68	5.06	6.39	5.85	6.23	5.79	5.79	5.25	6.23	5.82
Proline	4.82	4.47	4.23	4.55	4.67	4.27	6.14	4.33	4.12	4.38	4.64
Serine	4.74	5.11	5.81	5.24	4.80	4.93	4.96	5.32	5.52	5.12	5.16
Threonine	5.14	4.76	4.70	4.91	5.01	5.20	4.71	5.01	4.80	4.96	4.92
Tryptophane	1.37	1.29	1.28	1.45	1.50	1.53	1.69	1.40	1.62	1.59	1.47
Tyrosine	4.22	3.98	4.04	4.82	4.30	3.86	4.25	4.11	3.74	4.47	4.18
Valine	5.70	5.30	5.46	5.89	5.99	5.46	5.65	5.83	6.22	5.82	5.73

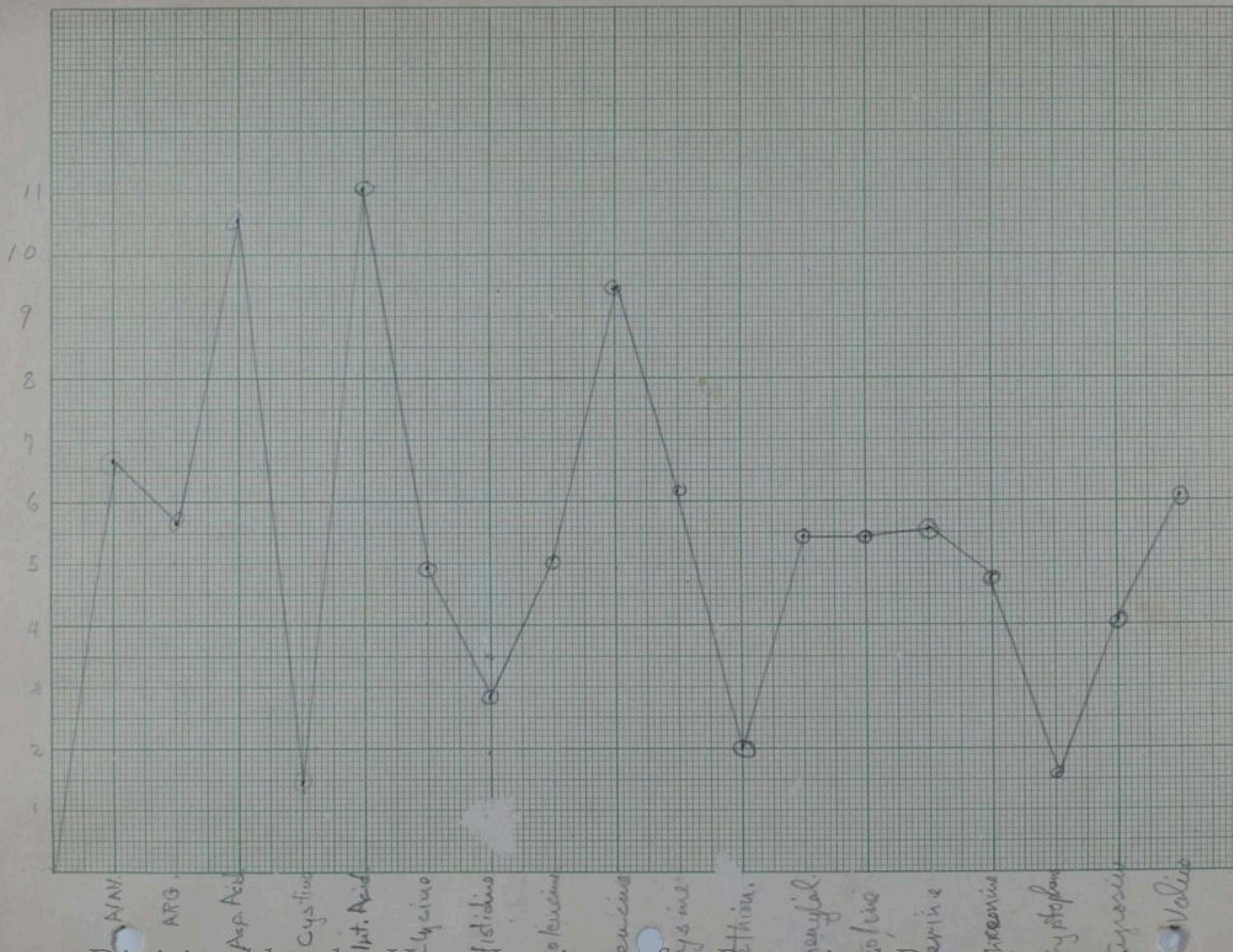
/...

L.J. Teply
8 March 1962

Table 4

Amino Acid Profiles of Manioc Leaves

Determination	Collection Number										
	Brazil										
	322	323	324	325	326	327	328	329	330	331	
	per cent (16 gm Nitrogen Basis)										
Alanine	6.66	6.60	6.20	6.32	5.88	6.51	5.98	6.37	5.22	6.16	6.19
Arginine	5.69	6.00	6.10	6.56	7.35	6.67	5.80	5.70	5.30	6.00	6.12
Aspartic Acid	10.53	9.81	9.45	9.69	9.33	9.95	9.10	9.48	9.44	9.50	9.63
Cystine	1.47	1.45	0.74	0.96	0.79	1.09	0.93	1.02	0.98	0.97	1.04
Glutamic Acid	11.02	10.14	8.80	8.95	10.13	10.83	11.00	10.80	9.42	10.13	10.12
Glycine	4.94	5.45	5.13	5.43	5.58	5.30	5.27	5.10	5.58	5.42	5.32
Histidine	2.87	3.01	1.48	1.79	2.65	2.14	2.97	3.22	2.02	3.40	2.56
Isoleucine	5.06	4.78	4.34	4.49	4.64	4.91	6.31	4.54	4.64	4.70	4.84
Leucine	9.47	8.81	8.33	8.73	9.29	9.15	8.55	8.72	8.57	8.86	8.85
Lysine	6.29	5.60	7.81	7.82	7.25	6.10	5.91	6.07	5.71	4.78	6.33
Methionine	2.00	1.54	1.64	1.68	1.68	1.91	1.51	1.54	1.86	1.73	1.71
Phenylalanine	5.48	6.65	5.07	5.34	5.11	4.95	6.06	5.45	5.29	5.89	5.53
Proline	5.44	5.48	5.13	5.12	6.22	4.91	4.97	6.40	5.43	4.91	5.40
Serine	5.56	4.44	3.76	3.58	4.50	5.35	4.65	5.05	4.51	4.52	4.60
Threonine	4.74	4.71	4.72	4.50	4.83	4.69	4.66	4.85	4.49	5.08	4.73
Tryptophane	1.56	2.03	1.96	1.94	2.50	1.85	2.20	2.18	2.19	2.33	2.07
Tyrosine	4.08	3.96	3.79	4.00	4.00	4.14	3.75	3.68	3.71	4.21	3.93
Valine	6.09	5.48	5.34	5.56	5.40	5.83	5.65	5.46	5.46	5.55	5.58


11
10
9
8
7
6
5
4
3
2
1
ALAN.
ARG.
Asp. Acid
Cystine
Glut. Acid
Glycine
Histidine
Isoleucine
Leucine
Lysine
Methion.
Phenylal.
Proline
Serine
Threonine
Tryptophan
Tyrosine
Valine

30 June 1961, Volume 133, Number 3470 **SCIENCE**

CURRENT PROBLEMS IN RESEARCH

Protein Malnutrition in Young Children

Malnutrition is still a major factor in the high morbidity and mortality in underdeveloped areas.

Nevin S. Scrimshaw and Moisés Béhar

It is disconcerting to discover that even today in many parts of the world half of the children born in low-income groups die before they are five years of age and that a significant proportion of these deaths are attributable directly or indirectly to malnutrition. It is now evident that most deaths from protein malnutrition occur after weaning, and that the mortality of children from one to four years old in a country is the best index of the seriousness of protein malnutrition (*1*). For example, the mortality of children one to four years of age in the United States and in most countries of Western Europe is now around 1 per 1000, while in most technically underdeveloped countries the proportion varies from 10 to 45 per 1000.

Careful investigation was made of a series of individual deaths of children in four rural Guatemalan towns in which the mortality of the 1- to 4-year age group was 50.3 per 1000. It was found that nearly two-fifths died from the deficiency disease kwashiorkor, and that the remaining deaths were nearly equally attributable to infectious diarrhea and to systemic infections very few of which would have been fatal if the children had been well nourished (*2*).

The widespread occurrence of kwashiorkor is shown in Fig. 1, but its seriousness is better indicated by the data in Table 1, which shows the mortality of children from one to four years of age in representative countries where kwashiorkor is rare or unknown as contrasted with deaths occurring in countries where kwashiorkor is common.

Another form of severe malnutrition in children, which is often fatal, is marasmus. This disease develops when the child is deprived not only of adequate protein but also of calories and other nutrients. For both physiological and cultural reasons, marasmus is more common in children below one year of age, while kwashiorkor is more prevalent in children during the second and third years.

Research on the problem of protein malnutrition in children is now being actively carried on throughout the world, and this article attempts to define the present status of our knowledge in a still dynamic and rapidly progressing field (*3*).

Clinical Characteristics

Protein deficiency in growing children cannot be described as a single clinical syndrome because it is usually associated with some degree of calorie inadequacy. The relative magnitude of this deficiency and of deficiencies of other nutrients determines the resulting clinical picture (*4*). The clinical spectrum of severe protein deficiency ranges from deficiency accompanied by an adequate or even excessive caloric intake to that accompanied by a lack of calories so great that this lack becomes the limiting factor and few signs and symptoms of protein deficiency are apparent. The principal reason why investigators cannot fully agree on the line of demarcation between kwashiorkor and marasmus is the difficulty of establishing limits within this continuous spectrum, which is illustrated diagrammatically in Fig. 2. Cases combining characteristics of both are frequently identified as "marasmic kwashiorkor" (*5*).

The clinical picture depends greatly on the relative degree or intensity of protein and calorie deficiencies. If consideration is limited to the advanced states of each, the main clinical signs and symptoms of the kwashiorkor type are pitting edema (which is a *sine qua non* of the diagnosis), a variable degree of dermatosis characterized by hyperkeratosis, hyperpigmentation, and desquamation, which are illustrated in Fig. 3.

The hair shows three types of alteration: its implantation is affected, so that it falls out spontaneously or can be painlessly removed with little effort. It becomes dry, thin, and brittle, and curly hair tends to straighten. The color is also usually altered. When periods of malnutrition alternate with periods of relatively adequate dietary intake, depigmented bands appear in the hair. The name "flag sign" has been applied to this phenomenon, which is illustrated in Fig. 4. Changes paralleling those in the hair may also be observed in the nails.

Psychic changes always occur to some extent, with a mixture of apathy and irritability prevailing. Anorexia and diarrhea are also very common. Even when clinical diarrhea is not present, the stool volume is greater than in normal children, a finding characteristic of malabsorption syndrome. Muscular hypotonicity is also frequently observed.

Dr. Scrimshaw is the director of the Institute of Nutrition of Central America and Panama (INCAP), Guatemala. Dr. Béhar is assistant director.

The Presentation of Leaf Protein on the Table

BY J. E. MORRISON, B.Sc. and N. W. PIRIE, M.A., F.R.S.

Rothamsted Experimental Station, Harpenden

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N. W. PIRIE, F.R.S.

PROTEIN FROM LEAVES

THE rapid increase in the population of the world, has created critical nutrition problems, especially in small underdeveloped countries. In such areas lack of industrialisation is generally associated with low incomes, sometimes with inadequate land space, and always with low productivity. As a result of these factors, neither the importation of high grade protein foods such as meat, eggs and milk nor their local production is a feasible solution to the nutritional needs of underdeveloped areas.

The problem has stimulated intensive research into the use of more abundant vegetable products, as substitutes for short-supply animal protein, in the diet of human beings. These efforts have met with considerable success. Meals for Millions Foundation Inc. of Los Angeles, California, produces a **Multi-Purpose Food** based chiefly on soy-beans. The Indian adaptation is based on the plentiful peanut crop. A United Kingdom Firm, British Glues & Chemicals Ltd., has developed the so-called IPP (Impulse Process Protein) process for the extraction of vegetable protein from both oil seeds and grasses. Both peanuts and lucerne have been processed in pilot plant experiments.

At Rothamstead Experiment Station in Britain, sustained work on the extraction of leaf protein has resulted in its production in bulk. Under the supervision of Mr. N. W. Pirie, F.R.S., head of the Biochemistry Dept., the extraction technique has been developed to the point where large quantities of protein material, of a uniformly high nutritive value, are now being produced on pilot machinery.

In January/February of this year Mr. Pirie came to Jamaica at the invitation of the Scientific Research Committee. He set up a programme for work in Jamaica on extraction of leaf protein. He also suggested sources of raw material and conducted a training course in extraction technique.

It was indicated in preliminary extraction tests and analyses made by Mr. Pirie at the U.C.W.I., on a laboratory scale, during a previous visit in 1957, that several types of vegetable material in Jamaica are sources of high quality protein. Success in producing enough leaf protein, to overcome the present nutrition problem with which Jamaicans are faced, will depend largely on its availability in a wide variety of leaves. If suitable protein sources are found in uncultivated plants and commercial crops whose leafy parts are discarded, great possibilities will be opened up. Success with soybeans and peanuts would not make such a significant contribution to Jamaica's needs. Even if these crops can be grown successfully in large quantities not only would land have to be found for them, but labour and other costs would make production relatively expensive.

NEW SOURCES OF FOOD

N. W. PIRIE

Rothamsted Experimental Station, Harpenden

Eliminating wastefulness and increasing the yield from traditional sources of food will diminish the problem of feeding the world's growing population. But present and foreseeable needs are so great that every reasonable new source must also be exploited.

In 1951 we gave the title "Four Thousand Million Mouths" to a book of essays explaining how various aspects of existing knowledge could be used to meet the needs of the world's population, as we foresaw it, "within the lifetime of some of our children". Many reviewers of that book scoffed at it as alarmist and said that the usual laws would operate and stabilise the population at a much lower figure. The facts have proved the contrary and conservative official estimates now suggest that we may reach 4000 million in twenty to thirty years. Furthermore, mainly through the sustained and vigorous efforts of FAO, there is general recognition of the inadequacy of present-day food supplies; half the people in the world are now underfed. Although world food production by the end of this century is likely to be more ample than it is today—perhaps three times the bulk and of improved quality—present and foreseeable needs are so great that every reasonable source should be tapped.

Two factors may diminish the world's need for food. War between powerful nations, with nuclear or biological weapons, would kill a large part of the population. The immediate result would probably be famine because communications would collapse and crops would be destroyed, but it is conceivable that after this phase there would be a period resembling to some extent the 18th century, with abundant nearly empty land waiting for development. Few will be foolish enough to use this as a justification for modern weapons. The second factor—contraception—introduces an immense uncertainty into any forecast of world population. It seems fairly safe to assume that when concupiscence can be dissociated from fecundity the birth-rate will fall, but it is not absolutely certain. If large families are wanted, for their own sake, our job is to try to feed them rather than to say that families must be limited because we cannot be bothered to produce the necessary food. If, on the other hand, people prefer small families and more space, it is our job to do the necessary research to ensure that the consequences of sexual activity are not in doubt. A third factor tending to upset predictions about population is sometimes mentioned—but probably only as a joke. This is that people may start living in artificial satellites or on other planets. They may, but the probability that any significant number will be doing this in the time for which useful predictions can be made is negligible. So, bearing all these factors in mind, the prudent course is to make plans for abundant food.

Food supplies can be increased in three ways: we can do more skilfully or more vigorously something we are already doing; various forms of waste can be avoided; radically new sources and techniques can be introduced. These approaches to the problem are complementary and not always clearly distinguishable from one another, but the classification is convenient and the possibilities will be considered in that order.

WASTED SUNSHINE

Photosynthesis is the primary source of our food, and agriculture is a technique for increasing its effectiveness. The process depends on sunlight and there is little prospect of doing anything to increase or control that. But we can increase the area over which sunlight is used and the proportion of the year for which it is used. These are the two factors that have been mainly responsible for making food available for the expansion in population during the past few centuries; they are now nearing their limit and not much virgin land remains that can be brought into cultivation by conventional means. There is, however, still scope in those parts of the world subject to wide temperature variations (so inaptly called the Temperate Zone) for improving frost-hardy varieties of plants so that more of the spring sunshine may be used. Farmers do not sufficiently clearly realise that any illuminated surface without a complete green cover is wasting its time.

The tropical rain forests are the most extensive under-exploited areas still remaining, but they are generally written off as unproductive. That only means that they are not suited to conventional crops farmed by methods that are best described as "agricultural mining" and that not enough work has been done on finding uses for the type of plant that grows, or could grow, there exuberantly. As in the highly productive areas of Europe, productivity can only be maintained by a generous use of fertilisers. If we take nutrients steadily out of a piece of land, we must put them back wherever the land is, and, as our need increases, this will be done. Given water, warmth, and light, only knowledge and enthusiasm are needed for productive agriculture to start (cf. Holdridge, 1959).

Water and fertilisers are essential catalysts of photosynthesis; they control the area of leaf that will be exposed to sunlight. This is generally recognised so that irrigation and fertiliser production have a prominent place in the policies of the international organisations. Skilled attention is needed to maintain an optimal environment for photosynthesis. This means that drainage as well as irrigation should be attended to, and research on actual fertiliser needs should replace the casual or traditional applications

REPRINTED FROM ENGINEERING

Protein from Leaves by Bulk Extraction

Edible protein may be extracted from leaves by first bruising the plant cells in a pulper and then applying pressure. A process employing a hammer mill and a cam-operated press has yielded 75 per cent of leaf protein content.

M. N. G. Davys and N. W. Pirie

Rothamsted Experimental Station, Harpenden

ADVANTAGES that may be expected from the development of practical methods for separating protein on a large scale from various types of leaf have been discussed elsewhere by Pirie[1, 2]. Methods have been described by Morrison and Pirie[3, 4] for preserving and purifying the protein and for incorporating it into foods in a manner that most people find acceptable. Duckworth, Hepburn[5] and Woodham[6] have published experiments on pigs, rats and chickens showing that the protein is not only palatable but nutritionally valuable. This article deals only with the process of extracting protein from leaves and with the reasons governing the selection of certain types of machine for the purpose.

Ideally, juice would be separated from fibre in one operation. The ideal is readily achieved in the laboratory and many people have claimed success on a large scale with 3-roll sugar cane rolls or screw expellers modified in various ways. An extensive series of tests on units such as these in 1940-42 resulted in the conclusion that for continuous large-scale operation they would not be satisfactory. Obviously, improvements in design may sometime invalidate this conclusion and we are working on the design of a batch-type machine to make juice from 100 to 300 lb lots of leaf in one operation. But at present we regard pulping the leaf and pressing out the juice from the pulp as essentially different operations that may conveniently be performed in different machines.

BRUISING

Significant amounts of protein cannot be pressed out from undamaged leaf cells. But it is not necessary to cut open every cell to obtain satisfactory liberation. Thorough bruising is sufficient; furthermore very fine grinding is extravagant and increases the problems of juice separation at a later stage. This bruising is as effectively done by rubbing the leaves against each other as by rubbing them against the surfaces of the machine, but the soggy and dough-like consistency of a mass of properly pulped leaf makes it imperative to keep the mixture open; hence slow moving machinery in which bars are forced through a compacted mass are unpromising. Three other important factors influencing pulper design may be mentioned. Power consumption must be kept low, not only for economy but also because much of the protein coagulates on the fibre if the temperature of the pulp rises above 50° C. This limits the power consumption to 50 h.p. for a ton per hour grinding rate; in practice we can run at a half or one-third of that power consumption. The machine must be able to cope with occasional stones, sticks and bits of metal for these, especially the first, will unavoidably be present in an agricultural product collected on a large scale. Finally the machine must not clog either from overloading or from the accumulation of the more resistant pieces of fibre in the charge. The last factor has the greatest effect on design.

The trials made in 1940-42 showed that high-speed fixed-hammer or swing-hammer mills meet all these requirements except the last. A dozen different makes were tested and in each the screens or bars that keep the charge in the working volume until pulping is satisfactory blinded over with fibre after a few minutes running. This difficulty was easily overcome by pulping in the presence of so much water that the product became mobile enough to flow out of the machine. But water supplies are not always ample in places where leaf protein might be made and it is inconvenient to handle very large volumes of dilute leaf extract. Apparently this is the method that has recently been adopted by British Glues and Chemicals Limited. (ENGNG. 1959.[7]) Our alternative solution was to design a pulper that cannot clog but discharges whatever is put into it whether pulping is complete or not. The setting of such a machine must be controllable so that in spite of variations in texture the crop emerges properly pulped.

In 1948 a Christy and Norris "Coir Sifter" was installed after slight modification and, in the light of experience, it was extensively modified. This machine has already been described briefly by Pirie[2] and illustrated by Raymond and Tilley.[8] An improved machine was made in 1953 and last year Christy and Norris supplied another; its performance is good enough to justify more detailed description.

BUILT-IN FLEXIBILITY

Twenty-eight beater arms are carried on a horizontal hub inside a steel drum 3 ft long and 3 ft in diameter. One third of the drum casing is hinged so as to allow the inside to be cleaned and the disposition of the beaters to be changed. Two men can easily lift the swinging section and fasten it as shown in Fig. 1. The first pair of beaters is bolted to the hub so that there is only 0·5 in clearance from the end of the drum, these have a 30° set so as to suck the charge into the pulper. The other beaters are carried in sockets in the hub. Experience shows that the gap between the tracks of the tips of adjacent beaters must not exceed 1·5 in or a wall of pulp will build up in the gap and then collapse and cause uneven running. Experience also shows that the beater ends should not be more than ¾ in thick in a direction parallel to the axis, or lumps of fibre remain wedged between the beater ends and the case of the drum and cause heavy running. To satisfy these requirements, while still using a standard design of hub, the beater ends are U shaped thus doubling their effective number. Some of these U's have their faces parallel to the direction of motion and so simply beat the charge without moving it forwards, one face of the others is twisted by 10° about a radius of the pulper and so move the charge along. By varying the ratio of these two types of beater ends, which are interchangeable in all positions on the hub after the first, the time of passage through the pulper and so the amount of work done on the charge can be varied. These three types of beater are shown in Fig. 2 in position on the hub; spares are also shown lying on the ground under the pulper. Further control over the amount of work done on the charge is given by eight pairs of ⅜ in diameter pins that can be screwed through the casing of the drum into the gaps between the beaters. One set can be seen at the bottom of the casing in Fig. 2, the other set is diametrically opposite.

Material to be pulped is fed axially through an opening 14 in wide and 6 in high by a belt running at 6 ft per sec and passing round a 2 in diameter roller set as near to the end of the pulper as possible. Pulp emerges tangentially at the other end through an opening 9½ in wide. The depth of this opening (measured along the circumference of the pulper casing) and the direction of the stream are controlled by a set of steel slats ¼ in thick and 1½ in wide bolted to studs on the outside of the pulper casing. An opening 7½ in deep is suitable for most materials.

Leaves vary greatly in texture: sugar beet and pea haulm pulp very easily, mature grasses and cereals are harsh. For the former the pulper is fitted with 8 or 10 pairs of the propelling type of beater and rung at only 424 r.p.m. (tip speed 3,950 ft per min), for the latter the number of propelling beaters is reduced to two or three pairs, the speed increased to the maximum 955 r.p.m. (tip speed 8,870 ft per min) and the pins are screwed through the casing so as to protrude ½ in into the pulper and break up the flow of material. If the texture of the pulp is unsatisfactory, the pins can be readjusted while the pulper is running; a change of beaters, or of driving pulleys, takes 10 minutes. The pulper is driven by a 25 h.p. 3-phase electric motor and the pulp output varies with the texture of the crop from 2 to 3 tons per hour to ½ ton per hour. In our experience with British crops, no leaf from which it is possible to extract by this technique useful amounts of protein will require more power for pulping than this, but some tropical crops, sugar cane tops for example, may need a larger motor.

Leaves also vary in moistness. When the water content exceeds 85 per cent, as with pea haulm, very early cuts of cereals, or clover, nothing is gained by adding water during the initial pulping; it is preferable to pass the fibre, after pressing, back through the pulper and make a second extract with added water. With more mature leaves water should be added during pulping so as to get a pulp containing about 85 per cent water. Fig. 1 shows the

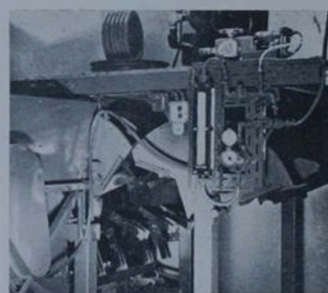

Fig. 1 Hammer-mill pulper, designed for accessibility. The drum is shown open. Control equipment is used for adding water and alkali.

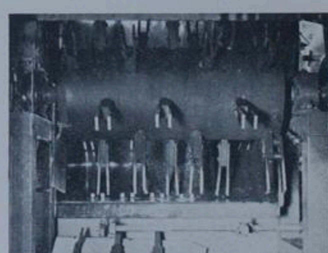

Fig. 2 Work done on the charge is regulated by varying the number and type of hammers and studs. Hammer types are shown in foreground; a row of studs is installed in the drum.

Some suggestions on the initiation of work on the use of leaf protein as a human food.

N. W. Pirie

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Sustained work on the production of leaf protein in bulk has been going on since 1948. Several publications, which are listed in an appendix, describe the background to the project and give in outline the techniques used. Reprints of several of these papers are still available so that there is no need to go over the ground again. The object of this note is to explain what will be needed when a unit for producing and studying leaf protein is set up elsewhere.

There are three essential stages in the work. Each could be undertaken independently in the first instance and this is probably a wise procedure for they involve different types of experimenter and different levels of expenditure. These three are intended to answer the questions:- What would leaf protein be made from; how would it be made; and how would it be used?

1. Since 1942 we have been studying the extractability of protein from the plants readily available at Rothamsted and several accounts of the work have been published (E. M. Crook, Biochem. J., 40, 197, 1946; E. M. Crook & M. Holden, Biochem. J., 43, 181, 1948). On the basis of this we can now judge fairly accurately whether protein will be extractable and we have a group of about thirty species with which extraction is satisfactory. No comparable studies have been published from tropical and subtropical regions but I was able to make a very superficial study of some Jamaican leaves and my colleague, Miss M. Byers, has made a more extended study of Ghanaian leaves; the latter is available as a mimeographed paper and will in time be published. Ten to twenty satisfactory species were found.

This type of work needs only the equipment found generally in biochemistry or agricultural chemistry laboratories; a mincer, centrifuge, balance and facilities for doing nitrogen determinations. Samples of fresh leaf weighing 1 - 4 lb. are used. The techniques are given in the papers quoted but I would be very pleased to demonstrate them to anyone who wishes to survey a new region. Once the technique has been learnt one full-time scientist could produce in a year enough information to show what would be available, or should be grown, to put into the large-scale machinery. This is an essential first step for it is safe to assume that if protein cannot be extracted in the laboratory it will not be extracted on a large-scale and laboratory work is the cheaper of the two.

Work of this type has, in any event, a general scientific interest and I would strongly urge the authorities in any country that is even beginning to discuss large-scale extraction, to take the steps necessary to start this background laboratory work immediately.

2. The basic machine in our unit is a pulper. The essence of this is that it cannot be choked; whatever goes in one end comes out the other whether it is properly pulped or not. By varying the arrangement of beater arms in it, and its speed, the amount of work done on the crop can be controlled so that, with skill, pulping is always optimal. With average material it handles 1 ton an hour and takes 25 HP. In some ways it would be convenient to have a smaller machine but experience shows that it is too difficult to feed anything smaller without a pre-pulper of some sort so, for simplicity, it seems best to use a large machine and, if need be, not run it for very long at a time. Three machines have been made for me by Messrs. Christy & Norris of Chelmsford and the first two were extensively modified in use so that I am now satisfied with the basic design. With its electric motor it will cost £700 - £1,000., depending on how completely the existing drawings are used in making further units.

Pulp flies out of this machine on to a press. It is best to arrange for the pressing to go on continuously because there is rapid coagulation of protein on to the fibre if the pulp is allowed to lie; presses that have to be filled and emptied by hand are therefore not recommended. I have had two continuous presses made; the second (Weedon Engng. Co. Ltd., 480, Dunstable Road, Luton) appears to be satisfactory. It is driven by a 2 HP motor and costs £450.; another like it would be cheaper. There are various other possible presses and screw expellers on the market but I have not tested them for this particular application and do not think that there is one as cheap as this.

The juice, carrying the protein that has been extracted, goes through a simple strainer that can be made locally and steam is then injected into it to coagulate the protein at 70 - 80°C. If in an hour the pulper and press handle 500 kg. there will be about 400 kg. of juice from lush leaves and that will need 40 kg. of steam at most. The steaming unit is simple and costs £5. but the cost of the steam raising plant depends on local conditions. It is not satisfactory to heat the juice in a cauldron over a flame or by immersion heaters.

On a large scale or for continuous working the protein is collected in a filter press and those on the market are satisfactory. If it is only proposed to process a ton or so of leaf at intervals, cloth filter stockings about 2 metres long and 12 - 16 centimetres in diameter are perfectly adequate. Filtration is so rapid that 6 - 8 will handle the protein from a ton of leaf in a few hours and a hard cake can be made by pressing the stockings under weights or, better, with a loaded beam. The costs of this phase of the process can therefore be very low. When the protein is intended for use as a human food it should be washed and this process demands an efficient stirrer (commercially available at about £60.) and a suitable tank holding 200 - 500 litres. It is an advantage, with most leaf species, to add enough hydrochloric acid to get to pH 4 at this stage; the cost of acid is negligible but the advisability of adding acid rules out galvanised iron as a material for the tank. The protein is then collected in stockings as before.

For most purposes this pressed cake is the final product. It contains about 60% of water and has little flavour when fresh or when kept at -10°C. It is perishable to about the same extent as cheese - that is to say, in a few days at room temperature th flavour changes and moulds begin to grow. These changes are not harmful but during the early stages of work with leaf protein it is probably wise to use a relatively unflavoured product. The product freeze-dries satisfactorily and it can be air-dried if mixed with meal or flour, but if simply dried in air or by heat it becomes inconveniently hard and granular. It can also be canned. For many reasons I suggest that, in the first stages of work at any rate, it would be best to accept this as a perishable commodity and use it as it is made.

If a new batch of leaf is only processed every second day, so that the protein can be processed and the plant cleaned between runs, the plant can be run by a part-time expert and 1 - 2 intelligent but not highly trained helpers. This is on the assumption that the crop is grown, harvested and delivered by others. The labour and expense of getting the crop cannot of course be predicted without a knowledge of local conditions and of the species used. The two extremes are a water weed which is a pest that is being collected in any event, and a crop grown under irrigation specially for protein production.

The special equipment necessary for setting up a unit able to turn out a few hundred pounds of protein a week will therefore cost less than £2,000. If suitable arrangements are made for housing and running the unit I would probably be able to lend the two main items - the pulper and press. Local funds would then only have to meet the costs of transport, labour crop production and steam. Where labour is expensive, or when continuous production is envisaged, it would be necessary to get some sort of elevator to feed the pulper, but in the first phase of the work this can be done by hand.

There are obvious advantages in having one machine to do both pulping and pressing. Attempts have been made at Rothamsted and elsewhere to do this with screw expellers but they seem to have failed; the machinery is expensive and

July 25, 1960

Dr. Kenneth Morgareidge
Food and Drug Research Laboratories
Maurice Avenue and 58th Street
Maspeth, Queens, Long Island, N. Y.

Dear Dr. Morgareidge:

Enclosed is a list of the collections of Manihot esculenta for analysis according to directions from Dr. Milner. It is essential that the specimens be identified by the collection number which appears in the left hand column of the enclosed list.

We look forward to the results of the analyses.

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF
Enclosure

Expenses and Expenditures

1. Hotels

Jamaica	$67.20
Brazil	172.55
Puerto Rico	16.00

2. Car rentals, taxi, truck and incidental travel expenses

Jamaica--car rental	100.00
gas and oil expenses	18.00
Taxi, Belem	165.00
Trucks, cars, New York	30.00
Tolls, New York	4.00
Excess baggage charge--New York to Jamaica (amount over that allowed)	7.65
Jet surcharge, San Juan--New York	8.00
Charge for travelers checks	7.00
Passport renewal	5.00
Passport photos	2.85
Anti-malarial drugs	3.00
Limosine services	19.69

3. Expenses of collections

Photo equipment (portable background, materials and labor	12.79
Photo supplies (film and developing)	24.62
Color comparison fan	6.00
Shipping charges: Jamaica-New York via BOAC	47.60
Dry Ice, Jamaica	19.50
Cablegram: Jamaica-New York	7.12
Packaging materials, Jamaica	5.04
Packaging materials, Brazil	7.70
Expenses charged by The New York Botanical Garden, Jamaican materials	160.50
Dry ice, New York	80.00

4. Incidental expenses

Tips, payment to laborers for assistance, living costs	103.27

TOTAL	1,100.00

August 1, 1960

Mr. Rolv Moltu
Finance Officer, UNICEF
United Nations, New York

Dear Mr. Moltu:

Enclosed is the final report on expenditures and attached vouchers in connection with my portion of the studies of leaf protein from manioc (Manihot esculenta). I could not make the report earlier, as some expenditures were outstanding until last week. Some of the expenses are, of course, not covered by vouchers.

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF
Enclosures

October 10, 1960

Dr. N. W. Pirie
Rothamsted Experimental Station
Harpenden, Herts
England

Dear Dr. Pirie:

Many thanks for the reprints which you have given us.

I wonder if we could assist your program to some extent by having a well publicized dinner, either at the U.N. or at some other such institution where we feed selected "influential" individuals a meal prepared according to the recipes given in the little reprint from "Nutrition."

If this idea has any appeal to you, we might have a trial run or two giving whatever cooks we use a chance to get the recipes down into their own skills inasmuch as the preparation of food is more of an art than a science. We would, of course, need some of your protein preparation for this purpose.

This is just an idea. If it has appeal to you, then perhaps we would work out details for carrying it out.

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF

ROTHAMSTED EXPERIMENTAL STATION, HARPENDEN, HERTS, ENGLAND.

Director: F. C. BAWDEN, M.A., F.R.S.

REF.

Telegrams:
HARPENDEN 4671

16th October 1960

Dear Dr Rogers,

I was very pleased to get your letter and hear that you are willing to make some cookery trials and a demónstration. We will send off some protein as soon a we have finished some new preparations and at the same time I will send you a few colour prints of our cooking attempts.

The material that I will send you will have been freeze dried so as to keep the texture soft. Nevertheless one of the common troubles is a slight grittiness. This can be overcome by sufficiently thorough running in a food mixer; it is just a matter of running it for so long enough that the initial paste is smooth to the tongue before going on with the cooking.

I wish I were likely to be back in New York soon to help with the presentation but this is not at the moment likely. After seeing you I had a pleasant and useful talk with Dr Nicholson about the various places where the next stage ofthe work might go on. We discussed Turrialba and he suggested that I consult Hutchinson who was there recently. This I have done but Hutchinson advises against that laboratory and I have passed this advice on to Dr Nicholson and now await his reaction. In the meantime I have started tentative inquiries at the Imperial College of Tropical Agriculture in Trinidad. As I think I told you, I visited that laboratory in February and stirred up a certain amount of interest. It is at the moment undergoing some reorganisation as a result of being amalgamated with the University College in Kingston (Jamaica) so I am not sure who the right person to approach is. I mention all this because it is on Dr Nicholson's actions and the reactions in Trinidad that my next visit to USA depend.

We sent some protein to Professor Emmett Holt (Dept of Pediatrics, NY School of Medicine 550 First Avenue NY 16) one or two weeks ago. It may not have arrived yet. He intended to use it in some feeding experiments on infants but he may have tried some himself as well. Before you start any work on the protein it might be well to get into touch with him in case he has any advice to offer.

I look forward to hearing how you get on and repeat my invitation to visit us when you are next in Britain.

Yours sincerely

N. W. Pirie

N W Pirie

October 20, 1960

Dr. N. W. Pirie
Rothamsted Experimental Station
Harpenden, Herts, England

Dear Dr. Pirie:

Thank you for your letter of October 16. I plan to contact Dr. Max Milner to see if he is interested in going along with our cookery trials and demonstration. I am sure he will be interested in this.

I will also keep in mind that you have sent material to Dr. Emmett Holt. He may very well be interested in this project.

We look forward to the receipt of the materials.

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF

vulnerable and the protein made, because of the intense rubbing in an expeller, contains much more fibre than that made in a pulper, that does a controlled amount of disintegration, and a press that simply presses. We are working on a batch type machine that we hope will handle 50-200 kg. lots of leaf every half hour but have not yet got this fully satisfactory; when we succeed it will naturally be the obvious machine on which work should start but this will certainly take some months and may take a year or more.

3. Work on the incorporation of leaf protein into the diet of a community need not be postponed until a production unit has been installed. Air transport, or some form of refrigerated surface transport, makes it easy to send protein made at Rothamsted, in 5 - 50 kg. lots to most parts of the world and it is probable that what we are making regularly is of higher quality than what would at first be made on a new unit working on new types of leaf. With supplies from here, trials could start immediately.

We have already considerable experience in incorporating protein into various predominantly vegetable dishes and also into what may loosely be called "cocktail snacks" in which the protein is encased in a batter or macaroni type casing. This type of presentation is not altogether unrealistic, bearing in mind that the protein is concentrated so that only 10 - 15 g. of pressed cake is eaten at a time. This means that only 5 - 10 of these "snacks" should be eaten at a time. As a preliminary to work on presentation in the local type of food, it might therefore be well for whoever is going to undertake the work to come here for a few weeks and learn what we have achieved. It would be better still if someone with experience of a range of the world's cooking techniques could come to Rothamsted for a longer period and go into the matter thoroughly, for presentation is the main problem that remains to be solved. It is probable that a salary for someone to do this could be arranged. This would also have the advantage of teaching us more about the problems that would be met in other parts of the world.

The nutritional problems are essentially aesthetic. We already know from the amino acid analyses and from feeding experiments on pigs, rats, and chickens that the protein is better than most proteins of vegetable origin and, for pigs, as good as, or a little better than, fish meal. One experiment on this is already published (R. S. Barber, R. Braude and K. G. Mitchell, Proc. Nut. Soc., 18, iii, 1959) and another is under way. But the protein has little flavour when fresh, and a broccoli-like flavour when old, and the green colour is unusual. Hence the need for some finesse in presentation. Many people, and I among them, have eaten it both in large amounts at one time and in smaller amounts regularly without digestive disturbance or other ill effect, but others find either the idea, or the appearance, or the flavour (in these matters it is difficult to disentangle reactions) unattractive. A few rules can, however, be stated: it probably goes better with salty, spiced or fish-flavoured mixtures than with those that are sweet and it should not be subjected to prolonged cooking. But there are great local variations in matters of this kind.

This note is only intended to explain what is involved in starting work on leaf protein along the lines that we follow; obviously there are other modes of approach. Whatever course is followed we will give all possible advice and help in ordering equipment, installing it, and getting it running.

Appendix

Many different aspects of work on leaf protein are dealt with in these papers. The titles indicate fairly clearly the general nature of each and, because they were written for widely different groups of readers, there is considerable repetition. There is also a brief section on leaf protein in each volume of the "Report of the Rothamsted Experimental Station".

Direct use of leaf protein in human nutrition. Chem. & Ind., 61, 45. (1942)

Green leaves as a source of proteins and other nutrients. (1942) Nature 149, 251

Some practical aspects of leaf protein manufacture. (1942) Food Manufacture, 17, 283.

Leaf protein. (1947) Food Manufacture, 22, 493.

The circumvention of waste. (1951) In "Four Thousand Million Mouths". Oxford University Press.

Large-scale production of edible protein from fresh leaves. (1952). Ann. Rep. Rothamsted Exp.Sta. 173-181.

Protein production from green leaves. (1952) World Crops, 4, 374.

The efficient use of sunlight for food production. (1953) Chem. & Ind. 442.

Proteins. (1955) In "Modern methods of plant analysis", 4, 23. Springer, Heidelberg.

Biochemical engineering. (1955) Society of Biological Chemists, India : Souvenir. pp. 122-127.

Power from leaves. (1956) Proc. UNESCO Symposium on "Wind and solar energy". 216.

Unexploited technological possibilities of making food for man and animals. (1956) Proc. Nut. Soc. 15, 154-160.

The large-scale production of leaf protein. (1956) Biochem. J. 63, 33-34.

Leaf protein as a human food. (1957) Food Manufacture. 32, 416-419. Reprinted in Nutrition, 12, 3-8. (1958).

Unconventional production of foodstuffs. (1958) In "The biological productivity of Britain". Institute of Biology.

The unconventional production of foodstuffs. (1958) Penguin Science News, 49, 17 - 38.

The use of higher plants for storing solar energy. (1958) Trans. Conf. on Use of Solar Energy - The Scientific Basis. Tucson, Arizona, 4, 115-121.

Biochemical engineering. (1957) Research, 10, 29-34.

Leaves as a source of human food. (1958) The Vegan, 10, 7-9.

World hunger as a biochemical problem. (1958) J. Roy. Soc. Arts, 104, 511-528.

The large-scale separation of fluids from fibrous pulps. (1959) J. Biochem. Microbiol. Tech. and Engng. 1, 13-25.

Leaf proteins. (1959) Annual Review of Plant Physiology, 10, 33-52.

Malthus 1959 - Farmer and biochemist versus engineer and doctor. (1959) Proc. Manchester Lit. and Phil. Soc. 101.

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DEP.: New York		1	6	60	12 M							
ARR.: Kingston, Jamaica		1	6	60	1900							
STOPOVER:	OFFICIAL ☐ PERSONAL ☐											
DEP.: Kingston, Jamaica		13	6	60	12:30							
ARR.: Belém, Brazil		14	6	60	6:15							
STOPOVER:	OFFICIAL ☐ PERSONAL ☐											
DEP.: Belém, Brazil		26	6	60	1:00							
ARR.: San Juan, Puerto Rico		26	6	60	7:00							
STOPOVER:	OFFICIAL ☐ PERSONAL ☐											
DEP.: San Juan, P.R.		28	6	60	1430							
ARR.: N.Y., N.Y.		28	6	60	1745							
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2. TO: Dr. David J. Rogers (NAME OF TRAVELLER) — FCD Consultant (TITLE AND GRADE) — (N. Y.) (OFFICIAL DUTY STATION)

Home Tele: Owens 3-0597 (Hartsdale, N. Y.)

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3. PURPOSE OF TRAVEL: To collect specimens of native plants for exam. re protein utilization in diets

4. TRAVEL BEGINNING: 1 June 1960
TRAVEL ENDING: 30 June 1960

5. TRAVEL ADVANCES AUTHORIZED FOR PAYMENT BY U. N. OFFICES UP TO A TOTAL OF $

6. TRAVEL ADVANCE REQUESTED PRIOR TO DEPARTURE $1,100.-

7. NATIONALITY OF TRAVELLER: U. S. A.

8. PASSPORT NO.: 260086

9. TYPE OF VISA HELD: - -

10. LAISSEZ-PASSER REQUESTED: YES ☐ NO ☐

11. ITINERARY: New York/Jamaica/Belem/New York, via air, Tourist - Wherever no Tourist available, F.C. is authorized.

12. SPECIAL INSTRUCTIONS: To be charged to programme account* ref UNICEF PR-GC/01-79.

15 Kilos of Excess Baggage authorized on Tourist travel

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	54648	New York rt	Baracas	BOAC	6/1	$461.80	
		THOS. COOK & SON XO for	excess baggage up				
		to fifteen kilos (following original routing)					NO VALUE N. Y.
TRANSPORTATION $350.00							

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12.00	TERMINAL
500.00	~~xxxxx~~ Est.Cost of Air Express to NY of Samples
450.	SUBSISTENCE 30 days @ $15.
55.	EXCESS BAGGAGE 15 Kilos on Tourist portion
375.	MISCELLANEOUS Local Car Rental, est. at $15. per day for 25 days
$1,742.00	◄ ESTIMATED TOTAL

19. STANDARDS OF ACCOMMODATION 17 May 1960. ENT; r/t air tourist class NY/Jamaica/Belem/NY $521.85. Note item #11 & 12. 1st class travel authorized wherw no Tourist class is available. plus 15 Kilo's excess baggage on the tourist portion. er

20. ALLOTMENT ACCOUNT NO. PR-GC/01-79*

HB [signature]

CERTIFYING OFFICER

12 May 1960 (DATE) New York (PLACE)

21. OFFICE OF THE CONTROLLER OBLIGATION STAMP

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UNDER AGREEMENT DATED 20 JAN. 1953 BETWEEN UNITED NATIONS & THOS. COOK & SON, INC.

TO: THOS. COOK & SON, INC.

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DATE

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Mr. David ROGERS — May 31, 1960 195

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(SIGNATURE DU CAISSIER)

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Mr. Montague. — Bronx Pk. N.Y.

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AIR EXPRESS INTERNATIONAL

PER

IF THIS ORDER DOES NOT CORRESPOND WITH YOUR RECORDS ADVISE US BY TELEPHONE AT ONCE

BANK OF LONDON & SOUTH AMERICA LTD.
BELÉM

№ 3162

Data: 18 / 6 / 1960

Vendeu-nos David J. Rogers

cambiais no Mercado de Taxa Livre no valor total

de $ 120.00 a Cr$/800 Cr$ 1.200,00

Menos:- Cr$
Cr$
Cr$ Cr$
Cr$ 1.2000

([illegible])

Feita por   Gerente

JAMAICA

MINISTRY OF AGRICULTURE AND LANDS

DUPLICATE

CERTIFICATE No. 398

PHYTOSANITARY CERTIFICATE

PLANT PROTECTION SERVICE

THIS IS TO CERTIFY that the ~~plants~~, parts of plants, or plant products described below, or representative samples of them, were thoroughly examined on 9th June 1960 19........by Arthur G. Naylor an authorised officer of the Plant Protection Service and were found to the best of his knowledge to be substantially free from injurious diseases and pests, and that the consignment is believed to conform with the current phytosanitary regulations of the importing country both as stated in the additional declaration hereon and otherwise.

Fumigation or disinfection treatment (if any):—

Date.. Treatment..

Duration of exposure.. Chemical and..

Concentration..

Additional Declaration..

....

....

(Stamp of Service) MINISTRY OF AGRICULTURE AND LANDS · JAMAICA · PLANT PROTECTION SERVICE

Signed A. G. Naylor

Official Status Actg Chief Plant Prot Officer

Date 9/6/60 19....

DESCRIPTION OF CONSIGNMENT

Name and address of exporter Ministry of Agric + Lands Hope

Name and address of consignee New York Botanic Gardens N Y USA

No. and description of packages, weight Two

Distinguishing marks Address

Origin (Grown at*) Bodles - Old Harbour

Means of conveyance Plane

Point of entry in Importing Country New York

Quantity and name of produce Two packages of Cassava material

....

....

Botanical name Manihot esculenta

* State precise location.

This certificate is issued from information found or believed to be correct and no liability attaches to the Ministry or any of its officers in respect of this certificate.

3221—[illegible]

THE NEW YORK BOTANICAL GARDEN STATEMENT OF ACCOUNT

INVOICE DATE		AMOUNT OF INVOICE	AMOUNT	ACCOUNT NO.
5/6/60	x	$ 30.00		102

UNICEF Grant

DETACH THIS STATEMENT BEFORE DEPOSITING CHECK

May 6, 1960

Memo to: Mr. Kolkebeck

From: D.J. Rogers

I would like to have a $30.00 cash advance on the UNICEF Grant to pay for photographic materials. The money will be refunded when the grant has been cleared, which should be the last week in this month.

David J. Rogers

July 8, 1960

Mr. Hugh Miller
Director, Department of Agriculture
Hope Gardens
Kingston, Jamaica

Dear Hugh:

I want first of all to thank you and the other staff members there who so ably assisted me in my most recent endeavor with cassava.

I am very eager to help you in your efforts to obtain funds from Special Funds, and to that end I have already had a talk with the Agricultural Consultant to Special Funds, Dr. G. Edward Nicholson. Dr. Nicholson tells me that you are in a very favorable position and that one of the best possible sources of information for you for your continuing activities with Special Funds would be through Dr. Arthur Lewis who, as I understand, is the Principal of the U.C.W.I. Dr. Lewis used to be right hand man to Mr. Hoffman, the Director of Special Funds. He will therefore be knowledgeable concerning Special Funds activities and methods of operation.

They are quite receptive to the granting of funds to you, and you should make your case as strong as possible by consulting with Arthur Lewis. If you find any difficulties there which you cannot overcome, I would be glad to help in any way that I can. Once again, let me thank you for your assistance in my endeavors, not only for this time but in the past. It has certainly been a pleasure to work with you.

Sincerely

David J. Rogers
Curator of Economic Botany

DJR:MDF

July 8, 1960

Mr. D. C. Webster
Crop Agronomy Division
Ministry of Agriculture
Hope Gardens, Kingston, Jamaica

Dear Don:

I finally have completed my peregrinations, and I think successfully. The specimens which we sent from Bodles arrived in good shape and are now awaiting the decision as to which laboratory will do the protein analyses.

Believe me, I had more problems by far in getting the material off from Belem than we had in getting the material from your home. You have no idea how much better off Jamaica is than is the Amazon region of Brazil. I finally ended up by sending my specimens back in the frozen meat locker of a ship which regularly travels between Belem and New York. Fortunately, these specimens have arrived in good shape.

It really was a pleasure to see you and to work with you, and I trust that our future plans for cassava will materialize in the not too distant future. I shall keep you informed of these activities. I shall also send you a copy of the analysis made on the leaves so that you can get some notion of what has happened.

I asked the people in Puerto Rico to send Bell the citrus sport which they have there. I would be happy to know from Bell when and if this material arrives. Please give him and others there in the Crop Agronomy Division my regards. Let me hear from you at your convenience.

Sincerely

DJR:MDF

July 8, 1960

Dr. Carlos G. Moscoso
Agricultural Experiment Station
Rio Piedras, Puerto Rico

Dear Carlos:

I certainly do appreciate the fine efforts that you made in my behalf during my stay there. It was a pleasure to meet you personally and to know of the fine activities which are in progress there. By comparison with all the other areas which I have visited, your activities stand head and shoulders above those which I have seen. I trust that we shall have an opportunity in the near future to visit again.

Please let me know if there is any way in which I can help your activities along. If you have futher interesting materials to report on, ECONOMIC BOTANY will be most honored to have the chance to publish them.

Please give my regards to your wife and to the others at the station.

Most sincerely

DJR:MDF

July 8, 1960

Dr. Hans Ph. Huffnagel
FAO Agricultural Economist
Caixa Postal 298
Belem, Para, Brasil

Dear Hans:

Your application for membership in the Soc iety for Economic Botany has been duly filed. You should be hearing shortly from Dr. Richard Klein, the Chairman of the Membership Committee. We are very pleased to have you with us in the Society and look forward to your activities. Let me say again that the Society is only as strong as its members make it. Your recommendations and suggestions for activities will be warmly received.

It was a shame that we had no more opportunity to converse during my stay in Belem. There are many questions that I would like to have asked, but I had no opportunity to do so. However, the few days that we did have were certainly pleasant ones, and I certainly appreciate your endeavors and your wife's in helping to make my stay pleasant. We certainly hope that your projected trip to New York materializes, and once again be assured that we would like to have you come for a visit to our house during that period.

I have written to Jeff Gray. In the event that one of the letters does not reach either you or him, give him my best regards and thanks for his co-operation.

I have received the copy of the paper which you so kindly had typed for me on the study of mandioca. This is much appreciated.

Most sincerely

David J. Rogers
Curator of Economic Botany

DJR:MDF

July 7, 1960

Mr. Geoggrey G. Gray
Chief, FAO/UNESCO Mission to the Amazon
Caixa Postal 298
Belem Do Para, Brasil

Dear Jeff:

I finally have an opportunity to thank you for all of your help to me while I was there in Belem. My live material arrived safely here in New York and is now in good hands. The ship arrived, and I had no trouble in getting the material off. Fortunately, it had remained frozen the whole way, and in large part this is due to your suggestions and help.

I wish also to express my gratitude to you and your wife for making life more pleasant in Belem. Chances are good that if I had not met you I would not have had a chance to meet the Bartletts.

I intend to write to the Chief of the FAO Mission, Dr. Glesinger, to encourage him to allow you to make a report in ECONOMIC BOTANY on the tremendous surveys of the Amazon forest. The more I think about it, the more important this type of information seems to me to be. Certainly the experiences which you have had over the long years in Amazonia are so much more valuable than those "quick and dirty" reports of specialists like myself who come for two weeks and know all the answers.

Let me again express my sincerest thanks to you and your wife for your fine help.

Most sincerely

DJR:MDF

July 7, 1960

Dr. Joao Murca Pires
Instituto Agronomico do Norte
Belem, Para, Brasil

Dear Murca:

This letter of course will not reach you before you take off for your journey with Bassett Maguire. However, I trust that you will have it there in your office when you return. I trust that your trip will be a successful one, as I am sure it will be with yours and Dr. Egler's assistance.

Let me thank you for the tremendous kindnesses and assistance shown to me during my visit there. Without your assistance it would have been impossible to have accomplished the mission upon which I set forth. All of the material which you sent off on the ship arrived safely here in New York and is now in the laboratories of The New York Botanical Garden.

If there is any possible way in which I can assist you in your endeavors, I would be most pleased to do so. Please give my best regards to Milton.

Sincerely yours

DJR:MDF

Customs Form 6043-A
TREASURY DEPARTMENT
18.2, 21.9, C. M.; 21.8, 21.9, C. R.
April 1958

BUREAU OF CUSTOMS

No. ....

TICKET FOR GOODS CARTED OR LIGHTERED

Port ... N.Y. ..., ... (Date)

Transferred under ... Custom Form 7529 ... (WHB, IT, TE, GO, etc.) No. ....

From ... Spencer ... (Vessel, warehouse, etc.) Arrival date ... 7-3-67

At ... Pier 1 Brooklyn ... (Pier, address, etc.) For shipment to ... New York Botanical Garden ... (Warehouse, vessel, etc.)

MARKS AND NUMBERS	DESCRIPTION	CONDITION, ETC.
New York Botanical Gardens Bronx 58 NY	1 Frozen Mountain Escalator	Hold for Plant Quarantine or Mr. Peter A.Q.
Total packages	No. 0	

C. H. License No. ... [illegible] ... City No. .... Truck or lighter No. ... 18217 M ...

Delivered to cartman or lighterman in good condition unless otherwise noted.

Hr. 1 P. ... (Date) ... [illegible signature] (Inspector or warehouse officer)

Signature ... David Rogers ... (Cartman or lighterman)

Received from cartman or lighterman in apparent good condition unless otherwise noted.

Hr. ......, ... (Date) .... (Inspector or warehouse officer)

Signature .... (Warehouse proprietor)

U. S. GOVERNMENT PRINTING OFFICE: 1958—O-462124

ESTADOS UNIDOS DO BRASIL

Ministério da Agricultura
Departamento Nacional da Produção Vegetal
Divisão de Defesa Sanitária Vegetal

INSPETORIA REGIONAL DE DEFESA SANITARIA VEGETAL DE Belém, Pará

CERTIFICADO FITOSSANITÁRIO

Pflanzenschutzzeugnis der Internationalen Pflanzenschutzkonvention 1951 Pflanzenschutzdienst

Certificat Phytosanitaire de la Convention International pour la Protection des Végétaux 1951 Service de la Protection des Végétaux

Phytosanitary Certificate of the Internacional Plant Protection Convention 1951 Plant Protection Service

N.º 317

CERTIFICO
Es wird hiermit bescheinigt,
Il est certifié
This is to certify

que os vegetais, partes de vegetal ou produtos vegetais abaixo descritos, ou suas amostras representativas fôram cuidadosamente examinados em

dass die unten beschriebenen Pflanzen, Pflanzenteile oder pflanzlichen Erzeugnisse, insgesamt oder durch Entnahme charakteristischer Durchschnittsproben, am

que les végétaux, parties de végétaux ou produits végétaux décrits ci-dessous ont été minutieusement examinés, en totalité ou sur échantillon représentatif le

that the plants, parts of plants or plant products described below or representative samples of them were thoroughly examined on

Data 20 de Junho de 1960 **por (nome)** Geraldo Meira Freire Couceiro
(Datum) *durch (name)*
(Date) par (nom)
(Date) by (name)

técnico autorizado da Divisão de Defesa Sanitária Vegetal do Ministério da Agricultura do Brasil e foram no melhor do seu conhecimento encontrados praticamente livres de doenças e pragas nocivas; e, que a partida está de acôrdo com a legislação fitossanitária vigente do pais importador, tanto no que concerne á declaração adicional abaixo, como á outras exigências

einen bevollmächtigten Beamten des brasilianischen Pflanzenschutzdienstes gründlich untersucht und nach seiner besten Kenntnis praktisch frei von gefährlichen Krankheiten und Schädlingen befunden wurden; und dass angenommen wird, dass die Sendung den bestehenden Pflanzenschutzvorschriften des Einfuhrlandes, wie in der nachstehenden zusätzlichen Erklärung oder anderweit angegeben, genügt.

agent autorisé du Service De La Protection Des Végétaux du Brésil et sont, à sa connaissance, jugés pratiquement indemnes d'ennemis et maladies dangereux des cultures; et que l'envoi est estimé conforme aux réglementations phytosanitaires actuellement en vigueur dans le pays importateur, ainsi qu'il est spécifié dans la déclaration supplémentaire ci-après ou par ailleurs.

an authorized officer of the Plant Protection Service of Brasil and were found to the best of his knowledge to be substantially free from injurious diseases and pests; and that the consignment is believed to conform with the currente phytosanitary regulations of the importing country both as stated in the additional declaration hereon and otherwise

---

Fumigação ou Desinfeção (se exigido pelo país importador):
Begasung oder Desinfektionsbehandlung (wenn vom Einfuhrland gefordert):
Fumigation ou désinfection (á remplir sur la demande du pays importateur):
Fumigation or disinfection treatment (if required by importing country):

(Data .... **Tratamento** ....
Datum: *Behandlung*
Date Traitement
Date Treatment

Duração da exposição .... **Produto químico utilizado e concentração** ....
Dauer der Behandlung *Chemikalie und Konzentration*
Durée du traitement Produit chimique utilisé et concentration
Duration of exposure Chemical and concentration

Declaração adicional ....
Zusätzliche Erklärung
Déclaration supplémentaire
Additional declaration

Belém, 20 de Junho de 1960

(Carimbo do Serviço)
(Dienstsiegel)
(Cachet du Service)
(Stamp of the Service)

[signature]
(assinatura)
(Unterschrift)
(Signature)
(Signature)

Agronômo Classe "J"
(Cargo)
(Dienstbezeichnung)
(Fonction)
(Rank)

Descrição da partida
Beschreibung der Sendung
Description de l'envoi
Description of the consignment

Nome e endereço do exportador ... Institute Agronemico do Norte
Name und Adresse des Exporteurs:
Nom, prénom et adresse de l'expediteur
Name and address of exporter

Nome e endereço do consignatário .. Dr. David Rogers, New York Botanical Garden.
Name und Adresse des Empfängers
Nom, prénom et adresse du destinataire
Name and address of consignee

Número e descrição dos volumes ...... 1 caixa
Zahl und Beschreibung der Stücke; Gewicht
Nombre et nature des colis
Number and description of packages

Marcas ....
Unterscheidungsmerkmale
Marque des colis
Distinguishing marks

Origem (se exigida pelo país importador) .... Estado do Pará - B R A S I L
Ursprung (Wenn vom Einfuhrland verlangt):
Provenance (sur la demande du pays importateur)
Origin (if required by importing country)

Meio de transporte .... Via marítima (Navio SPENCER)
Transportmittel:
Moyen de transport
Means of conveyance

Ponto de entrada .... New York - U.S.A.
Grenzübertrittsort:
Poin d'entrée
Point of entry

Quantidade e nome do produto ...... 40-50 quilos de mandioca
Menge und Name des Erzeugnisses
Contenu de l'envoi
Quantity and name of product

Nome botanico (se exigido pelo país importador) MANIHOT ESCULENTA
Botanischer Name (Wenn vom Einfuhrland verlangt)
Nom botanique (sur la demande du pays importateur)
Botanical name (if required by importing country)

Jamaica -

Leaf yield: Fresh leaves

1. 10# of leaf from ~~...~~ 8-12 plants
2. # of plants per acre
   planted on 3½ x 3½ ft centers =
   3-4,000 plants/acre
3. figuring 1# leaf/plant, 3-4,000# leaf/acre

Variances

Var. #1 (in Bodles) gave 10x the amt. of foliage of Var #56 + #49.
∴ ideally 10x the above given figure for leaf/acre.

Production costs for Jamaica

1. On a large scale, including 10+ acres
   cost of land preparation - using tractor
   planting material
   planting, maintaining (weeding twice) reaping
   — £100. per acre
2. On a small scale - 1 acre, add £20.00/acre for hand labor

- These figures do not include cost of fertilizer, sprays, etc.

Analytical Results of Forty-eight Samples of Cassava Tubers

Analyses were made by the Agricultural Chemist at Hope November 1958. on material from the Museum plot at Bodles.

Sample	% Starch Original Material	% Starch Moisture Free Mat.	Sample	% Starch Original Material	% Starch Moisture Free Mat.
44	17.6	77.4	38	23.8	77.3
12	17.5	75.4	22	18.7	77.3
35	25.9	79.6	14	29.5	80.1
69	24.8	81.2	2	9.9	63.4
7	13.1	70.7	3	9.7	68.4
33	18.9	78.4	39	25.1	79.9
62	10.6	69.4	1	11.6	63.0
48	21.8	77.4	28	21.4	77.4
30	15.3	73.3	46	27.8	82.3
13	28.1	83.1	34	11.9	69.3
53	18.7	77.2	57	19.6	77.0
18	14.3	72.0	78	19.9	78.3
31	20.5	76.6	58	15.6	73.6
8	12.6	69.7	50	14.9	71.0
52	8.2	62.1	11	28.2	79.3
42	7.3	63.4	43	16.4	73.0
41	18.0	77.0	54	13.4	71.1
51	9.2	69.0	56	21.0	74.0
27	19.5	75.9	49	14.2	73.7
47	8.7	65.0	17	19.2	75.8
25	12.9	71.2	20	20.5	75.3
45	17.2	76.0	70	15.4	75.1
16	16.7	74.9	59	23.2	78.0
55	16.2	74.0	72	10.4	66.8

NOTA INFORMATIVA

Estación Experimental Agrícola
Universidad de Puerto Rico
Río Piedras, Puerto Rico

Número 5
Junio 27, 1960

DISTINGUIDO VISITANTE OFRECE CHARLA A TECNICOS DE LA ESTACION EXPERIMENTAL AGRICOLA, RIO PIEDRAS

El señor David J. Rogers, Editor de la revista Economic Botany, visitará la Estación Experimental Agrícola el martes próximo, 28 de junio del año en curso.

Ese día, el distinguido visitante ofrecerá una conferencia al personal técnico de la institución, a las 9 de la mañana, en su Salón de Asambleas, sobre el tema: "El Campo de la Botánica Económica, sus Nuevos Aspectos y el Trabajo que Lleva a Cabo el Jardín Botánico de Nueva York en estas Disciplinas".

A tal efecto, la Dirección de la Estación Experimental Agrícola invita a dicho acto al personal de la agencia y a todas aquellas otras personas interesadas en este tema.

ESTACION EXPERIMENTAL AGRICOLA
Universidad de Puerto Rico
Río Piedras, Puerto Rico

Circular

24 de junio de 1960

AL PERSONAL TECNICO

Compañeros:

El señor David J. Rogers, Editor de la Revista "Economic Botany," nos visitará el martes próximo 28 de junio.

Ese mismo día nuestro distinguido visitante dará una conferencia a las 9:00 de la mañana en nuestro Salón de Asambleas, sobre el tema "El Campo de la Botánica Económica, sus Nuevos Aspectos y el Trabajo que Lleva a Cabo el Jardín Botánico de Nueva York en estas Disciplinas."

Por la presente se autoriza a los miembros del personal técnico destacado en Río Piedras a que asistan a esta conferencia.

Cordialmente,

B. G. Capó
B. G. Capó
Director Asociado

UNIVERSITY OF PUERTO RICO
AGRICULTURAL EXPERIMENT STATION
SEED FARMS DIVISION
RIO PIEDRAS, P. R.

May 26, 1960

Dr. David J. Rogers
Managing Editor
Economic Botany
New York Botanical Garden
Bronx Park, N. Y. 58, N. Y.

Through the Director's Office

Dear doctor Rogers:

I received your letter of May 19, 1960, and I am pleased to hear that you are contemplating a stop over in Puerto Rico on your way back from South America.

I tried to make arrangements for you to stay at our University Guest House, but unfortunately, their accommodations have all been spoken for in advance for the first of July.

However, if you will give me an idea of the type of Hotel accommodations you prefer and the approximate date of your arrival, I shall be glad to make reservations for you at one of the better San Juan Hotels. Rates range from $10.00 to $15.00 and up daily for a single room with bath.

If you will let me know your flight number and arrival date I shall try to meet your plane, if you can arrange to arrive during the day or early evening.

I should like to have an idea of your particular interests at our Experiment Station in order to arrange interviews with key personnel and also to set up a tentative trip schedule in case you would be interested in seeing some of our Substations and points of interest around the island.

If your schedule is not too crowded, would you consider the possibility of giving a short talk or lecture for the technicians at our Experiment Station?

I shall be looking forward with pleasure to meeting you, and rest assured that we shall do everything possible to make your stay in Puerto Rico enjoyable.

Sincerely yours,

Carlos G. Moscoso

Carlos G. Moscoso, Head
Seed Farms Division

cc: Mr. Arturo Roque, Director
Mr. Enrique Molinary, Editor

May 19, 1960

Dr. Carlos G. Moscosco
Agricultural Experiment Station
Rio Piedras, Puerto Rico

Dear Dr. Moscosco:

I am tentatively planning to stop in Puerto Rico on the way back from Belem about the first of July and would like to have an opportunity to meet you and to see some of the experimental work there.

I will probably have only two days in Puerto Rico before I must return here, and I wonder if I might impose upon your good nature to arrange for some sort of housing accommodations and to let me know what sort of transportation is available. I trust that this is not too much of an imposition, and I certainly do hope to meet you then.

I shall be more specific on theexact dates and times after the middle of June; but if these dates are not convenient to you, can you please get a reply to me here before the first of June.

Sincerely yours

David J. Rogers
Managing Editor
ECONOMIC BOTANY

DJR:MDF

Dr. Nelson Chaves - Recife -
Dutra de Oliviera - Sao Paulo -

Evans - lab, N.Y.C.

deCastro - toxicity factor in [CN] ?

{ Cruickshank - Jamaica - (U.C.W.I) - rat testing.
{ Waterlow

Belém - Jamaica - June 1-30

⇐ Material?
Local testing

Protein Analysis

Budget requirements

Jamaica trip –
" labor

Rockefeller Inst. costs of analyses

LJT/mt/267/60 31 May 1960

Memorandum for the Record

When I was in Beirut Dr. Cicely Williams told me about her use of cassava leaves in Malaya. She reported that the leaves were used quite extensively and the cassava bushes produced leaves indefinitely, as the plants were cut back they branched out. Apparently the varieties Dr. Williams observed in Malaya do not offer toxicity problems and Dr. Williams recommends cooking the leaves for a minimum time with a small amount of oil in a covered vessel. For feeding to infants the cooked material was put through a sieve.

cc - Dr. W.H. Sebrell, Jr.
Dr. E.L. Severinghaus
Dr. P. Gyorgy
Dr. D.J. Rogers
Mr. H. Humphrey

MEMORANDUM FOR THE RECORD 9 May 60

HJH/ma

H.J. Humphrey

This will confirm my advices today as to Birds Eye experience in shipping samples long distances packed with dry ice. By distance I am referring here to Trans-Atlantic shipments, as well as Trans-Continental. They follow a rule of ½ to 3/4 of a pound of dry ice per hour of transportation. This is of course for shipments consisting of up to 10 or 12 lbs of product. If the transportation is to take 20 hours then it would be between 10 and 15 lbs of dry ice. The dry ice should be distributed between the top and bottom of the packages, and there should be sufficient i.e. plenty of insulation.

Likewise I repeat again, that whoever is to receive the shipment should be advised by cable so that the shipment will not stand around too long at destination.

HJH

c.c. Mr. D.R. Sabin
Dr. M. Milner
" D.J. Rogers ✓

DELEGACIA REGIONAL DA CRIANÇA

Address: PRAÇA BATISTA CAMPOS, No. 172

Delegado: DR. SALOMÃO MOISÉS LEVY

DJ Rogers D.J.
NY Botanical Gdn
Bronx 58

Columbia University

SCHOOL OF PUBLIC HEALTH AND ADMINISTRATIVE MEDICINE
OF THE
FACULTY OF MEDICINE
600 WEST 168TH STREET, NEW YORK 32, N. Y.

INSTITUTE OF NUTRITION SCIENCES

May 16, 1960

Dear Eric:

Paul has told me of your concern about our sending Dr. Rogers to Jamaica to collect manioc leaves for analysis. One of the reasons for selecting Dr. Rogers and sending him to Jamaica is the fact that since 1954 he has been working in cooperation with Dr. D.C. Webster of the Crop Agronomy Division, Jamaican Agriculture Department on the manioc project in Jamaica. Dr. Rogers plans to be in Jamaica for about two weeks early in June and expects to visit you and discuss the whole matter. In the meantime you might want to see Dr. Webster concerning Dr. Rogers acceptability. There is still time to cancel his trip if Dr. Webster feels it to be objectionable. I can assure you that we have no intentions of trying to move into Jamaica without consulting you.

There is considerable interest in manioc leaves in Brazil and Indonesia and we intend to promote this interest into studies which will determine whether different varieties of manioc leaves may offer any practical protein food possibilities. We would like to know the amino acid composition of Jamaican manioc leaves of known variety for comparison with leaves of known variety from other parts of the world. We think it essential that there be no question of origin, maturity, growing conditions, etc. and we feel that Dr. Rogers can eliminate any doubt on these points by making collections himswlf.

I am of course delighted to see signs of interest on your part in work on manioc leaves. I hope you and Waterlow will push ahead on it as rapidly as possible. You may remember that we corresponded about this previously, but I had assumed that you had little interest in it. We would be much interested to know exactly what you plan to do with manioc leaves and when you expect the work to be completed.

Sincerely,

W. H. Sebrell, Jr., M.D.

Dr. Eric Cruikshank
University of West Indies
Kingston, Jamaica

May 5, 1960

Dr. Rubens Rodrigues Lima, Director
Instituto Agronomico do Norte
Belem, Para, Brazil

Dear Dr. Lima:

Enclosed please find a letter of introduction from Dr. Maguire. As you are no doubt aware, there is considerable interest in the possible use of the foliage of various cultivars of Manihot because of the high protein content of this foliage.

The United National International Children's Emergency Fund (UNICEF) has asked me to proceed with a study of the types of amino acids which are present in the proteins. It is important that these analyses be made to determine whether amino acids, which are significant for the nutrition of man and animal, are present.

I would be very pleased if it would be possible to collect a small number of leaves from several of the varieties of Manihot which you have at your Experiment Station. I would also like to make documentary herbarium specimens of each of the varieties from which the leaf samples are taken.

I plan to be in Belem about the middle of June. The exact date has not yet been fixed, but I would say that perhaps June 15 is close to the time when I will arrive. I plan to be there in Belem for ten or twelve days, taking the samples and talking with you and various members of your staff on other fascinating possibilities in the study of the cultivated mandioca.

Very sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF
Enclosure

April 29, 1960

Dr. Rubens Rodrigues Lima, Director
Instituto Agronomico do Norte
Belem, Para, BRAZIL

Dear Dr. Lima:

This will introduce Dr. David J. Rogers, Curator of Economic Botany at this institution.

Dr. Rogers is engaged in nutritional studies related to the genus Manihot on the behalf of UNICEF (United Nations International Childrens' Emergency Fund).

He is visiting Belem and the Instituto to consult the extensive cultivars of Manihot that you have in your experimental farm. I have assured Dr. Rogers that you would welcome his visit and would be very pleased to lend him the facilities of the Instituto in this matter.

Please accept for yourself and the Senhora our best personal regards.

Sincerely,

Bassett Maguire, Head Curator
Coordinator of Tropical Research

BM:gg

LJT/mt/196

26 April 1960

Dr. Elmer L. Severinghaus
School of Public Health and
Administrative Medicine
600 West 168th St.,
New York 32, N. Y.

Dear Elmer:

... Enclosed is a report on fermentation of cassava which may be of some interest to you.

Sincerely yours,

L. J. Teply, Chief
Expanded Aid to Nutrition

Encl.

cc - Dr. David Rogers
Botanical Gardens

have the exceptionally high R.Q. of 6·0 after a 4-hr. soaking, with a decrease to 1·8 after 8 hr., and a further decrease with increasing time[2,3]. Allerup[6] showed, however, that it takes approximately 18 hr. for peas to complete their imbibition of water. Thus it may be suggested that non-respiratory gaseous output during wetting accounted for the high apparent R.Q. values reported after 4 and 8 hr.

These experiments suggest certain precautions for studies of respiration of intact seeds and similar biological material. Examination of the literature suggested that this unrecognized non-respiratory gas output in many instances led to mistakenly high apparent R.Q. values before water imbibition had been completed.

ALAN H. HABER
NANCY HARRINGTON*

Biology Division,
Oak Ridge National Laboratory†,
Oak Ridge, Tennessee.

* Biology student trainee from Winthrop College, Rock Hill, South Carolina.

† Operated by Union Carbide Corporation for the United States Atomic Energy Commission.

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A Two-Stage Fermentation of Cassava

ONE of the staple foods of the people of the rain forest belt of West Africa is gari, a starchy food prepared from the root of the cassava plant (*Manihot utilissima*). The traditional preparation of gari[1] consists briefly of the following stages: both the corky outer peel and the thick cortex are removed; the body of the root is grated by hand on home-made raspers; the greater part of the juice is removed from the pulp by primitive pressing; the pulp is left in bags for 72-96 hr. before it is fried. During this time fermentation occurs; hand-made raffia fabrics are used for 'sifting'. A certain amount of fibre and ungrated ends of the roots are removed here. The pulp is afterwards heated in large iron pans over an open fire with or without the addition of palm oil.

We have recently been investigating the microbiology of the traditional preparation to determine the conditions needed for mechanized production of this foodstuff in Nigeria.

It is well known that the cassava root contains a cyanogenic glucoside which renders it poisonous if eaten fresh, and that during the traditional methods there is a holding stage during which this glucoside decomposes with liberation of gaseous hydrocyanic acid and after which the material is safe to eat.

The presence of hydrocyanic acid in cassava roots was first recorded by Boutron Chalard in 1836[2]; but it was found that the acid is not present in cassava roots in its free state but in the form of a glucoside[3]. This was later found to be identical with the glucoside present in the beans of *Phaseolus lunatus*, phaseolunatin[4]. The precise nature of the process by which the glucoside is broken down, and what, if any, other changes occur during the holding stage, which lasts three or four days, is not clearly stated. It has been suggested that the glucoside is hydrolysed by the same mixture of enzymes as is present in the beans of *Phaseolus lunatus*[4]. In a more recent publication[5] Oyenuga and Amazigo refer to the glucoside as "linamarin" and to the enzyme responsible for its hydrolysis as "linase".

We have succeeded in preparing partially purified cyanogenic glucoside from the pressed juice of cassava roots, using the cortex and the inner flesh, from which the starch and other suspended matter were removed by centrifuging followed by filter pressing. This juice was found to contain 0·0045 per cent hydrocyanic acid, that is, its glucoside content is of the same order as that of the cortex of bitter cassava. The material was free from protein and may therefore be regarded as uncontaminated with any plant enzyme. This material is very unstable and undergoes spontaneous hydrolysis at pH's less than 7. During its isolation the glucoside was stabilized with potassium hydroxide and the sugars were removed with Fehling's solution until all reactions for sugars were negative. The compound was then purified by crystallization from alcohol. The purified glucoside hydrolysed spontaneously after acidification, liberating hydrocyanic acid and glucose.

Further, we have consistently isolated two organisms from grated cassava during the holding stage of the traditional preparation of gari: (*a*) A member of the genus *Corynebacterium* characterized by the production of yellow colonies on nutrient agar, and the fermentation of starch with the production of acid only. This organism does not appear to be recognized in Bergey's "Manual of Determinative Bacteriology", and the specific name of *Corynebacterium manihot* is suggested for it. (*b*) The fungus *Geotricum candida*.

The *Corynebacterium* was found in increasing numbers during the first 48 hr. of the fermentation, and was then replaced by the *Geotricum*, which by the third or fourth day was the predominant organism.

We therefore suggest that the process of detoxification of cassava root that occurs in the preparation of gari should be regarded as a two-stage fermentation. In the first stage the *Corynebacterium* attacks the starch of the root with the production of various organic acids, and the lowering of the pH causes spontaneous hydrolysis of the cyanogenic glucoside with liberation of gaseous hydrocyanic acid. When sufficient organic acids, including lactic acid, have been produced, conditions become favourable for the growth of the *Geotricum*, and this then proliferates, producing a variety of aldehydes and esters. These last products appear to be responsible for the characteristic taste and aroma of the gari.

Acting on the two-stage fermentation hypothesis, we have prepared gari in 24 hr. using as starters a mixture of pure cultures of the two organisms mentioned above, and this product has been tested by feeding it to volunteers. They were unable to tell the difference between the gari produced in 24 hr. by the use of the pure culture starter and the traditional product produced by 4 days holding. We have also found it possible to shorten the fermentation to 24 hr. by using as a starter pressing water from the first stage in the preparation of the roots which had been kept at room temperature for 4 days, and which, on examination, was found to contain enormous numbers of both the *Corynebacterium* and the *Geotricum*. A description of this starter technique has been published in a report on improved methods of preparing gari circulated by the Federal Ministry of Commerce and Industry, and the method is being adopted by some co-operative societies.

Further work on the chemistry of the cyanogenetic glucoside is in progress and will be published elsewhere. A full account of the new species of *Corynebacterium* is in preparation and will be submitted for publication elsewhere.

We wish to thank Mr. K. R. Butlin, National Chemical Laboratory, Teddington, for kindly checking the characteristics of the two organisms.

PATRICK COLLARD

Department of Bacteriology,
University College,
Ibadan.

SIMON LEVI

Federal Institute of Industrial Research,
Ministry of Commerce and Industry,
Lagos. Dec. 23.

[1] [illegible] and [illegible], "Valeurs Coloniales", No. [illegible] (October 1950), quoted in R.T.I., [illegible], 22 (1952).
[2] R.T.I., 1, 12 (1953).
[3] Dunstan, Henry and Auld, Proc. Roy. Soc., B, 78, 152 (1906).
[4] [illegible] and [illegible], West African J. Biol. Chem., 1, 10 (1957).

AGRICULTURAL SCIENCE

Spraying of Barley with 2,4-Dichlorophenoxyacetic Acid

DR. H. INGVARD PETERSEN has discovered differences in the translocation of the plant growth regulator herbicides applied to cereal plants of different ages[1]. His autoradiographs show that whereas radioactive 2,4-dichlorophenoxyacetic acid applied to barley at the one- to three-leaf stage is readily translocated to all parts of the plant, including, presumably, the growing point, application to successively older plants results in progressively less translocation. This plant growth regulator herbicide applied to the fifth and sixth leaves of a five- to six-leaf plant appears to be translocated to a very limited extent indeed.

I note with interest Dr. Petersen's conclusion that this may account for the fact that cereals do not develop deformed heads after treatment with 2,4-dichlorophenoxyacetic acid at the five- to six-leaf stage, whereas treatment at earlier stages leads to interference with the pattern of differentiation of the spikelet primordia and deformed heads. Hitherto it had been thought that the leaf and spikelet primordia are sensitive to damage by the plant growth regulator herbicides when first initiated but become progressively resistant as their development proceeds. In view of Dr. Petersen's alternative explanation, it is worth while to examine more closely the evidence for this latter concept.

Fig. 1 shows photomicrographs of the growing point and developing spike of barley sprayed with 2,4-dichlorophenoxyacetic acid at a series of stages between one and six leaves. The apices were dissected and photographed some days after treatment.

Plant 1 was sprayed when the ultimate leaf initial was appearing, that is, just before transition to the reproductive stage. The plant had one expanded leaf and the second was emerging. The small arrow points to the developing leaf primordium which can be seen to be a 'ring' of tissue completely encircling the stem. This is the aberrant type of cell differentiation which gives rise to the 'tubular leaf' abnormality. (Normally, growth of a leaf primordium is restricted to one side of the stem and the leaf margins are free, not fused as in the 'tubular leaf'.)

Plant 2 was sprayed when transition to the reproductive phase had just taken place and the lower spikelet primordia were in the early phase of development, characteristically the 'double ridge' stage, but were not organized further. As may be seen, these lower primordia are grossly aberrant (arrow). They would give rise to the 'opposite spikelets' or 'whorled spikelets' abnormality or may be abortive. It should be noticed, however, that the ultimate leaf is apparently developing quite normally and from experience it is known that it will give rise to a normal leaf. It is suggested that by the time of the treatment it had already developed to a stage when it was no longer susceptible to damage by the synthetic growth regulator.

Plant 3 shows the effect of spraying when subsequent spikelet primordia were at the very early phase of development but when the lower, first formed, spikelet primordia had progressed somewhat. Clearly, the subsequent spikelet primordia are severely affected (arrow) but the lower ones are developing quite normally. It is suggested that these lower spikelets had progressed beyond the sensitive phase when the growth regulator was applied. Lack of translocation can scarcely account for the lack of

Fig. 1. Photomicrographs of the growing point and developing spike of barley plants sprayed with the equivalent of [illegible] lb. per acre of 2,4-dichlorophenoxyacetic acid. Plant 1 was sprayed when the growing point was vegetative and had the second leaf just visible. Plants 2, 3, 4, 5 and 6 were sprayed at a succession of stages during the reproductive phase. The most advanced, plant 6, had five to six leaves when sprayed

April 28, 1960

Mr. D. C. Webster
Food Crops Specialist
Crop Agronomy Division
Ministry of Agriculture and Lands
Hope, Kingston 6
Jamaica, W. I.

Dear Mr. Webster:

I should know by now that, when dealing with such agencies as UNICEF, the first stated plans are never the ones which eventually mature. The situation certainly has been modified since I last wrote you on the 15th. Now I plan to be in Jamaica on or about the first of June and will stay for 10 or 12 days.

This being the case, I do not wish to delay your harvesting or further upset your plans for varietal tests. May I suggest, however, that since I will not need great quantities of leaf material the varieties which are now in the museum plot be allowed to remain and that you go ahead with your variety trials at your convenience. In the event that you decide to harvest the variety trials before my arrival, I would very much appreciate it if you could make observations of the following nature (be assured that the observations are only approximations and do not have to be quantitative):

1. Approximately how much total foliage is produced by each of the varieties at the stage when harvesting for roots.

2. The approximate differences between each of the varieties in the variety trials on the amount of foliage produced.

You can see, of course, what I am aiming for. We want to know which varieties yield the highest total quantity of foliage at root maturity. When I come down in June, I will probably see if we can estimate the economy of foliage production.

The method of preparation of samples is still open, inasmuch as the UNICEF people have decided that we should run only amino acid analyses and not collect sufficient materials for additional rat-feeding nutritional studies. I am glad that they have chosen to do it this way because I feel that the nutritional studies would be much more appropriately made after we know the type and amounts of amino acids present in the proteins.

I am sorry for this modification, but I am sure you are well aware of the intricacies of planning in such organizations as UNICEF, and I cannot apologize for them. At any rate, I am fairly certain that I will be there on or about the first of June, and I look forward to seeing you then.

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF

Crop Agronomy Division,
Ministry of Agriculture & Lands,
Hope, Kingston 6,
JAMAICA, W.I.

21st April, 1960.

Our Ref: 41/1821/60

Dr. David J. Rogers,
Curator of Economic Botany,
The New York Botanical Garden,
New York 58,
New York.

Dear Dr. Rogers,

This acknowledges receipt of your letter dated 15th April, 1960. I am glad that you will be able to return early in May and am looking forward to your visit. We will delay reaping of both the museum plot and variety trials until you are here.

We have located a unit for freeze-drying in the Department of Bacteriology at the University College of the West Indies but it is reported as not working satisfactorily. I have not been able to discuss details about it or even whether it would be available for your use, but hope to investigate these aspects during the week-end. I would suggest that you come prepared for both situations - either to prepare samples here or prepare them for despatch to the United States of America.

Hoping to see you soon,

I am,

Yours faithfully,

D. C. Webster
D. C. Webster
Food Crops Specialist.

DCW/emg

April 15, 1960

Mr. D. C. Webster
Crop Agronomy Division
Ministry of Agriculture and Lands
Hope, Kingston 6, Jamaica, W. I.

Dear Mr. Webster:

I am very pleased to hear from you and to know that you have gone ahead with the variety trials of the cultivars.

I hope that it will be no great difficulty to you to postpone the harvesting of the present planting until after the first week in May. I plan now to be in Kingston on the second or third of May and will be there for at least one week collecting foliage for the amino acid analyses. If it is not difficult for you to postpone the harvesting, it would certainly be of great assistance to me.

I would like to ask your assistance in advance of my arrival to locate, if possible, an apparatus either within the Department of Agriculture or perhaps in the University College of the West Indies for freeze-drying. Because of the fragility of the protein materials, it is advantageous to prepare samples using the freeze-drying technique. If such an apparatus is somewhere available there, it will facilitate the preparation of the samples for the analyses. If you could make one or two phone calls to find whether or not such an apparatus is available, I will appreciate it. If we do not locate a freeze-drying apparatus in Jamaica which can be used, we will have to make special provisions for sending the fresh material back here where such equipment is available.

My work will be sponsored by the United Nations International Children's Emergency Fund (UNICEF). They are quite interested in the possibilities of the nutritional aspects of cassava foliage.

I trust that my request for a delay of harvesting and for information on the freeze-drying equipment will not be too burdensome to you. I look forward to seeing you again, and I shall call you upon arrival. If you have other activities on the 2nd or 3rd of May, please do not feel it necessary to cancel your regular appointments.

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF

CROP AGRONOMY DIVISION,
MINISTRY OF AGRICULTURE & LANDS,
HOPE, KINGSTON 6,
JAMAICA, W.I.

6th April, 1960.

Our Ref: H1/1264/60

David J. Rodgers, Esq., Ph.D.,
Curator of Economic Botany,
The New York Botanical Garden,
New York 58,
New York.

Dear Dr. Rodgers,

Your letter dated 14th March, 1960, addressed to the Director of Agriculture has been referred to this office for direct reply.

We are very glad to see that you are still interested in Cassava and it will be a pleasure to co-operate with you in further studies on this crop.

The museum plot of your 49 cultivars has been maintained at Bodles as well as a variety trial of the cultivars. Our plans are to reap and repeat these in April/May this year. If you are interested in the foliage at this mature stage arrangements could be made to collect samples before reaping. If, on the other hand, you prefer more succulent foliage and further samples as growth progresses, a special plot could be set out for you. We cannot at this stage decide whether additional funds will be necessary until we know such details as the amount of foliage of each variety necessary for one sample, the conditions under which these must be collected and prepared for despatch to you, and whether it would be necessary to set out special plots for your purposes.

Please let us know early whether you are interested in the present mature foliage and how much of each cultivar you would require as well as instructions for packaging and mailing. Information on the details mentioned in paragraph (3) would also be appreciated.

Yours faithfully,

D. C. Webster
Food Crops Specialist.

DCW/emg

April 6, 1960

Dr. Max Milner
UNICEF
United Nations, N. Y.

Dear Dr. Milner:

It was certainly a pleasure to meet and speak to you and to the other men there. I recall Dr. Teply's name, but I am not sure that I have the other gentlemen correctly identified. I would appreciate it if you could give me a thumb nail sketch of each man so that I can better remember his endeavors.

I would like to try to summarize our meeting, both for my own benefit and to see if this checks with your recollections. First, the problem of nomenclature is still one which you wish to check as there may be a possibility of some previous work in your office.

Second, your systematic investigation of suitable proteins for nutrition includes studies of not only known protein sonrces but also possible other plant materials whihh may be utilized by appropriate processing.

Third, you are quite interested in the cassava leaf protein and will be watching the developments which we are now following with Dr. Sebrel.

Fourth, you would be pleased to see in operation at The New York Botanical Garden a program for gathering information on protein rich plant sources and would be willing to endorse such a program.

I think that this summarizes our discussion. I will be happy to note your corrections, if any, of this summary.

As you know, a verbal endorsement of a program is fine; but when it comes to mentioning this in a request for funds for such an endeavor, it will be necessary to have some formal statement of this interest. I wonder if you would be willing to give us a formal endorsement if and when I prepare an outline of our intended endeavors. If you will, on behalf of UNICEF, I feel sure that this support will be in large measure the difference between failure and success of our proposal.

I plan in the near future to set up a program outline which would state our goals and give you some notion of that for which we would like support. I am enclosing herewith a draft of a proposal for our information retrieval program. This draft has not been directed to any agency as yet, but I trust that we will soon be able to propose this to Rockefeller or other agencies capable of supporting it.

Once again it was a pleasure to have met you, and I look forward to some fruitful co-operation between us.

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF
Enclosure

March 15, 1960

Dr. Elmer L. Severinghaus
Institute of Nutrition Sciences
Columbia University
600 West 168th Street
New York 32, N. Y.

Dear Dr. Severinghaus:

Yesterday we sent you a copy of a letter which I wrote to the Director of Agriculture in Jamaica. This was a mere indication of the fact that we are proceeding to get together information for the needed funds for this project.

We have been somewhat delayed in the Rockefeller Institute because the people we need to contact there are out of town and will not be available until next week.

We are going ahead as fast as possible.

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF

March 14, 1960

Director, Department of Agriculture
Hope Gardens
Kingston, Jamaica

Dear Sir:

Once again I would like to ask your participation in furtherance of studies of cassava which you and your staff have so greatly aided in the past. Because of new evidence, nutritional studies on these plants have become of much greater significance. In our co-operative studies begun in 1954, we were primarily interested in the numbers of varieties of cassava in Jamaica. After several years' study the collections at Bodles seemed to represent at least a major portion of the actual number of varieties found there. The fine work of your scientists in the Department of Agricultural Chemistry shed some light upon the possibilities of the protein of the foliage as an excellent source of vegetable protein. Results of these studies are summarized to some extent in the enclosed reprint.

The Institute of Nutrition Sciences of the School of Public Health at Columbia University has a tremendous interest in tropical nutrition problems. Having seen the evidence as presented in the enclosed reprint, the department finds the possibilities of further studies quite interesting. The Directors of the Institute, Dr. Sebrel and Dr. Severinghaus, have proposed that further analyses of the amino acid content of the varieties now collected and growing on your stations would be of great value. They are willing to support these studies both from the standpoint of the necessary labor and time which would be required of you and your staff for assistance in this program. We propose to have the chemical analyses of the selected samples of cassava made at the Rockefeller Institute in New York City.

I will be pleased to hear if you are interested in further co-operative studies, this time with some recompense to you for your fine co-operation. Briefly, the studies that I would like to make on the cassava plants are as follows: (1) collections of specimens from the field at Bodles (and perhaps at Grove Place); (2) analysis of the amino acids in the foliage of these collected materials.

As you are probably aware, there are several amino acids of high importance to human and animal nutrition. These may or may not be present in the proteins of the cassava plants. Until accurate analyses of the amino acid content of the cassava protein are made, it is rather difficult to progress to further studies on their nutritional significance. We would hope, therefore, to make precise analyses of the amino acids of the varieties now growing at the stations mentioned above; and if these analyses show sufficiently high percentage of the needed amino acids, then I am sure that further nutritional studies will be forthcoming.

With this background in mind, I would be pleased to know (1) the present state of those varieties which we had in cultivation at Bodles; (2) are they now available to be sampled for their foliage? (3) what funds would you need to assist for approximately one week's work on the part of two or three laborers? (4) what funds would you need for maintenance of the plot, both to bring it into good condition for collecting of material and for maintenance of the plot in the event that the analyses offer interesting enough results to continue the work? I am, as you can see, quite interested that you not be overburdened financially in the assistance which you have to have for the continuation of the growth of the plants for these analyses. I ask these questions in broad terms so that you can give me a general estimate of labor and other necessary costs to you.

We would like to have this information as soon as it is possible in order that we may prepare a budget for the carrying out of this work. Looking forward to your early reply, I am,

Sincerely yours

David J. Rogers
Curator of Economic Botany
(formerly of Allegheny College,
Meadville, Pennsylvania)

DJR:MDF
Enclosure

CC-Severinghaus

Columbia University
SCHOOL OF PUBLIC HEALTH AND ADMINISTRATIVE MEDICINE
OF THE
FACULTY OF MEDICINE
600 WEST 168TH STREET, NEW YORK 32, N. Y.

WA 3-2500

INSTITUTE OF NUTRITION SCIENCES

8065
7562

February 5, 1960

Dear Dr. Rogers:

Thank you for your letter of January 29th and for returning the manuscript on cassava. Last Winter after our conversation Dr. Sebrell wrote to Dr. Cruikshank about studies in this field. The reply came back from Dr. Waterlow which said in essence:

"You will see that our problem up to now has been one of manpower, rather than of money. Neither Cruikshank nor I have the staff to embark on such a project ourselves, except for the testing in human beings, which is what we are primarily interested in. If you could give us any advice on the scientific lines which this work should follow, we would be very grateful. Then we would be able to see whether, in order to follow those lines, more money is needed than the government of Jamaica can supply. If this were the case, we could make an application to you, as you have so kindly suggested."

Klein?

Dr. Sebrell has been in touch with Waterlow on other matters but nothing further has come of this project. If you think there is some possibility of reopening it, I shall be glad to hear from you.

Sincerely yours,

Elmer L. Severinghaus

Elmer L. Severinghaus, M.D.
Professor
Public Health Nutrition

Dr. David J. Rogers
Curator of Economic Botany
New York Botanical Gardens
Bronx Park
New York 58, N. Y.

ELS:aj

PROTEIN FOR LATIN AMERICA

Submitted by Dr. J. de Castro

Toxicity Problem?

1.0 PRELIMINARY CONSIDERATIONS REGARDING NEED FOR THE PROGRAM

1.1 General Aspects of the Problem in Latin America

ASCOFAM (World Association for Struggle Against Hunger), through its Administrative Council, has conceived several projects for the coming period, among them being one to obtain proteins in sufficient quantities to take care of the nutritional needs of the people of Latin America.

Surveys of living conditions carried out recently in various Latin American countries have revealed the fact that this continent constitutes one of the great world areas of undernourishment and hunger. This comes as something of a shock, because the rest of the world has always considered Latin America a land of abundance, an area possessing great natural riches.

The intensity with which hunger assails the American Continent varies from one region to another, different groups of factors being responsible in each. Everywhere, however, diets are insufficient, incomplete and unbalanced. And one of the most serious defects of these diets is a shortage of proteins capable of supplying the amino acids indispensable for growth and vital equilibrium. This protein deficiency is quite accentuated, clearly revealing the limited consumption of foods rich in proteins of animal origin such as meat, fish, milk, cheese and eggs.

Average consumption of these products of animal origin is in fact among the lowest in the world, far below a desirable minimum. Annual consumption of meat is less than 30 kilos per inhabitant; and consumption of milk, in many regions of Latin America, is practically nil - less than 8 liters.

This low protein consumption is revealed in evident signs of deficiency. It may in fact be stated that protein deficiency is the most intense, most widespread and most serious of all the forms of hunger that afflict this continent.

The first expression of this deficiency in a biological sense is retarded growth and low stature of a majority of individuals at various ages. Other results are reduced organic resistance to infectious diseases and to fatigue, which in turn lead to lowered working capacity and therefore lowered productivity. In more serious cases of protein deficiency we find typical alimentary dystrophies such as hunger edema and kwashiorkor; these diseases, to which children are particularly subject are quite widespread in certain areas of Latin America. A report published by the FAO (Food and Agriculture Organization of the United Nations) and WHO (World Health Organization), based on a survey of various Latin American countries, points out that this region, along with black Africa and the Far East, is one of the prime victims of kwashiorkor.

/2

The shortage of proteins in Latin America has its roots in the social and economic structure of the region, but it could be attenuated in a short time through plans making proteins available at accessible prices. Because such proteins exist in abundance in Latin America, in various plants of the region if not of animal, then of vegetable origin.

During a certain period it was thought that only animal proteins were capable of furnishing all the amino acids needed by human beings. Observations in various countries, however, as well as laboratory experiments, have demonstrated that it is possible to take care of these needs in large part by an appropriate combination of certain foods of vegetable origin. New perspectives have thus opened for solution of the protein problem in countries too poor to be able to consume enough animal products.

It is well known that plants contain a quantity of proteins that varies greatly from one species to another, or even according to the season. Certain plants contain, in their leaves, seeds or roots, a proportion of proteins that is very high indeed. The nutritive value of these proteins, meanwhile, varies greatly; if some can be utilized normally for human food (beans, peas), others, particularly the proteins from leaves, are not easily assimilated by the human organism.

Scientists have recently developed ways of extracting vegetable proteins for human food, especially the proteins of herbs and leaves which are normally used only for pasturage. Present scientific knowledge has already made it possible to transform these plants into industrialized food products that can perfectly well be eaten by men.

A plan of "Proteins for Latin America" should be based precisely on those most recent developments of science. We are already familiar in this region with many plants that are rich in proteins; some of these proteins are complete, that is, capable of supplying all the amino acids essential to the human organism. The Brazil nut, for example, produced in considerable quantities by a tree native to the Amazonbasin, possesses a protein whose composition in amino acids is comparable to that of meat.

Manioc or cassava, from whose roots a meal is prepared that is the basic food of a large part of Central and South America, can also provide a meal, made from its dried branches and leaves, with a higher average protein content than that made from the roots. Other plants might be cited, such as the peanut, the soy bean, the cashew nut, cotton seed, sesame, and many others.

With such an abundance of plants that could be used as sources of proteins, it is incredible that this region of the world should continue to suffer from a serious and chronic shortage of these nutritive principles.

1.2 The Specific Case of Brazil

During the last few years, economic development has come on rapidly in Brazil. Everyone feels that the country must break through the barrier of backwardness, and fulfill the just aspirations of the people for a better life.

In spite of the growth, in physical terms, of agricultural production for the internal market at a rate faster than that of population growth, a state of dissatisfaction persists as regards the quantities of certain essential foods made

/3

available to the public. This deficiency arises because production is still carried on in terms of the country's former dietary structure, which can no longer take care of the needs of a working class with growing purchasing power; and because the supply system is antiquated and incomplete, without adequate installations for storage and distribution.

On the other hand the present agricultural structure of the country, marked by one of the highest indexes of property concentration in the world, has led to excessive increases in the cost of land. In fact, the price of land has risen faster than that of any other utility. It has also made difficult the introduction of new agricultural techniques. For these reasons ASCOFAM in Brazil has taken its place among those who recognize the imperious need of an agrarian reform that would increase productivity and permit expansion of the internal market through greater purchasing power of the rural populations.

Adequate planning for an effective solution of the Brazilian food problem, taken as a whole, will thus have to be based on structural reforms of a far reaching nature. Old food habits must be changed and new ones rationally established. The agrarian system must be reorganized and levels of productivity raised. There must be a radical transformation in the systems and methods used for stocking and transporting merchandise and for supplying the consuming centers. And everything must be done to stimulate the industrialization and semi-industrialization of food products.

Before a program of such scope could be put into effect, exhaustive research would be required, as well as the mobilization of public opinion and of capital. Meanwhile something simpler might be carried out, an emergency program designed to take care of the most pressing dietary deficiencies.

The FAO estimates that human consumption of proteins in Brazil is on the order of 54 grams a day per inhabitant, 17 being of animal origin. The deficiency is quite marked, since each person should have 70 to 80 grams of protein per day, 30 to 40 being of animal origin. The above figures are a general average for the country; there are population groups above or below the average - in direct proportion to their greater or lesser income.

Information is lacking as to distribution of national income by social groups; figures are available, however, for the various geographic areas of the country. Per capita income for the whole country is estimated at about 12,000 cruzeiros (1956) annually. On this basis, there are various regions that fall below the average: the western Northeast, with 3,400 cruzeiros; the eastern Northeast with 5,300; the eastern South with 5,500; and the West-Central with 8,500. Only three regions are above the average: the North with 14,600 cruzeiros, the Southeast with 18,100, and the South with 12,900 - but even here there are many low-income areas. Income in the states of Maranhão and Piauí, in the western Northeast, is hardly more than a quarter of the national average, while in the eastern Northeast and eastern South it is less than half.

It is easy to judge from these figures how great the protein deficit must be among the less privileged groups, particularly in the low-income areas. And since proteins of animal origin are higher in price, and since the national average is already very low, the deficiency of such proteins in the population groups mentioned must be very nearly complete.

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And in fact, protein deficiencies have been observed in various regions of Brazil, particularly among groups with the least purchasing power. Investigations carried out in 1953 by the FAO and WHO in five Brazilian cities (Belem, Recife, Belo Horizonte, Porto Alegre and Rio de Janeiro), among children of one to five years interned in hospitals or living in poor neighborhoods, brought to light many cases of multiple-deficiency dystrophies, including some with the full clinical picture of kwashiorkor. Although rare in Belem and Porto Alegre, these conditions were common in Recife, Belo Horizonte and Rio de Janeiro. At that time it was estimated that in certain parts of Brazil perhaps a third of the children were suffering from protein deficiency and were thus predisposed to disease. In 1957, health examinations of 18-year-olds called to military service revealed signs of various protein deficiencies in 48% of the conscripts. Even in the Federal District, one of the country's more privileged economic areas, deaths of children between one and four due to gastro-intestinal disturbances were in 1958 some 30% of total mortality in the age group - a very significant index of inadequate diet.

For these reasons it seems highly advisable to put into effect an emergency plan to promote the production of proteins, particularly those that are more cheaply and easily obtained - vegetable proteins.

2.0 BALANCE OF INDUSTRIAL FACTORS

2.1 Availability of Raw Materials

As is well known, the preponderant sources of proteins in the habitual Brazilian diet are cereals and legumes (beans). The former provide proteins in small quantities relative to volume/calories; the latter contain appreciable quantities, but of a relatively low biological value.

But these are not the only sources of vegetable proteins. Rich in proteins of high biological value, and available on a greater or lesser scale, are: soy beans (Soja max (L) Piper); peanuts (Arachis hypogoea L); Brazil nuts (Bertholetia excelsa HBK); cashew nuts (Anacardium occidental L). There are also: babassu nuts (Orbigaya speciosa (Mart) B. Rodrigues); coconuts (Cocos nucifera L); cottonseed (Gossypium hirsutum L); molasses (derived from sugar cane - Saccharum officinarum L); and leaves of the cassava (Manihot spp), which could supply large additional quantities of proteins.

Farinaceous products of high protein concentration may be obtained from the vegetables indicated.Also,pure proteins might be extracted from them, if use were made of technological processes now available. Such products could be used for human food or as food for animals - since stockraising in Brazil also has to struggle against a shortage of proteins, particularly for feeding birds and smaller animals.

In order that protein-supplying foods may not be subtracted from those already available in the country - a mere transfer from sources already insufficient - the raw materials for carrying out the Brazilian plan should be obtained by making industrial use of what is now wasted, or by increasing primary production itself.

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If advantage is taken of the proteins from oleaginous fruits, the result will be additional production of vegetable fats and oils. Industrially speaking, in fact, those constitute the primary product, while the resulting cakes or brans - the sources of proteins - are considered by-products. This represents a favorable factor for industrialization of these proteins, since their raw material is a by-product and should therefore be available at favorable prices. The plan for production of proteins, meanwhile, should take into account the situation of the national and world market for vegetable oils, that is, the prospect of an increasing shortage. This will be true if present ideas prevail, to the effect that excessive consumption of animal fats leads to an undesirable concentration of cholesterol in the blood, in which case a movement to substitute vegetable oils may be expected as the idea becomes more widespread.

Brazil possesses a considerable industrial development in this field, with 333 producing establishments and some 17,000 workers. Almost 400 thousand tons of vegetable oils and fats are produced annually, worth more than 19 billion cruzeiros - not counting factories devoted exclusively to refining of oils for food. These establishments are in a position to take care of a greater demand, since most of them run at less than capacity.

As among the oleaginous fruits that exirt in Brazil, it seems to us that those most appropriate for industrialization on a large scale - whether on account of present capacity and availability, whether because of low cost (see following item) and satisfactory protein content - are cottonseed, peanuts, babassu nuts, and soy beans.

As to taking advantage of other raw materials, such as stalks and leaves of cassava or sugar-cane molasses, there is no tradition in the country, and their industrial production will depend on adaptation of existing factories or installation of new ones.

Upon the initiative of the Sugar and Alcohol Institute, in cooperation with the government of Pernambuco and the Office of Northeast Development, steps are being taken to install at Cabo a factory that will make use of a by-product of sugar manufacture, the molasses of the Presidente Vargas Central Distillery. The principal purpose is production of stock feeds.

As to production of meal from cassava tops, the protein content is some 20%, and it is obtained by simple drying and grinding. Production could be very large in Brazil, as the plant is grown everywhere for its roots, either the bitter cassava (Manihot esculenta) grown for meal and starch, or the sweet cassava (Manihot sipi), which is eaten like potatoes. These two plants constitute the country's fifth largest crop, and cover an area of 1,100,000 hectares. Use of the leaves for human food, although known since colonial times, is restricted to a few regional dishes. They are eaten in the Northeast, boiled and mashed, under the name of manicoba.

In view of the fact that one hectare under cultivation produces about 30 tons of stems and leaves (containing 1800 kg of proteins), national production may be estimated at 33 million tons, less the amount necessary for replanting (3 tons per hectare).

To some extent, of course, the producer himself makes use of the stems and leaves for animal feed. However, the great industrial establishments that process the roots, particularly those in the South (São Paulo, Santa Catarina and

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Rio Grande do Sul), as well as the installations, now idle, belonging to the Executive Commission for Manioc in the state of Rio de Janeiro, should be mobilized to make a start toward utilizing the stems and leaves of the plant. Steps should also be taken to install factories in the great manioc producing centers of Bahia (highest producing state), Minas Gerais and Pernambuco (4th and 5th producers), where processes for extracting meal from the root are still primitive, and carried out in small rural shops of low production.

Meal produced industrially amounts to 30% of the green stems and leaves employed, and contains 20% of proteins. Thus the industrialization of a fifth (20%) of the stems and leaves currently grown would mean 1.8 million tons of meal containing 360 thousand tons of pure protein. Such a quantity will not seem excessive if we remember that the meal can be used in mixtures intended for human food, and can also be applied toward satisfying the great demand for products rich in proteins for use in balanced animal rations. Such feeds are particularly needed for the chicken industry, which has grown tremendously, on a rational and intensive basis, in recent years.

2.1.1 Favorable prices

Satisfactory supplies of raw materials already exist and are perfectly available, or can be obtained through additional planting, but this is not the only circumstance favorable to establishment of a protein industry. Another important and related factor has to do with the prices at which the raw material can be secured for industrial use.

Considering the problem from the angle of already available materials (one of the alternatives of the present program), we show in the following table, in 1958 cruzeiros, prices of certain pressed cakes of interest to the protein program, and prices of the basic product at the source.

Prices of Raw Materials in 1958 (cruzeiros)

	Farm product at source	Price of pressed cake in industry	
	(t)	per 1000 kg	per 1000 kg of prt cost
Cottonseed	14,900	2,200	4,400
Peanuts with shells	6,300	2,700	5,300
Babassu nuts	11,500	1,900	8,300
Cashew nuts	4,000	-	-
Brazil nuts with shell	14,200	-	-
Coconuts with shell	3,100	3,000	16,900
Soy beans	4,300	3,600	7,500

The prices of cashew nut as received by the producer and also of the resulting oil, are quite low as compared to the others. This is because production is entirely unorganized; the only demand is on the part of one or two factories in Ceara, which by the side of other items produce a food oil for a limited local

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market. National production is some 2500 tons, concentrated in the states of Ceará and Pernambuco (8(,> of the total), but ecological conditions in the East and Northeast are extremely favorable to large-scale production, and there are local plans in some places (Ceará) to stimulate planting. The low price of the cake and even of the oil results from the fact that it is a by-product of the production of cashew nuts for food.

Coconut, from which copra is made and coconut oil extracted, although the cake brings good prices, is not so useful for large-scale use because the protein content is only 20% as compared to 40% with other oleaginous cakes. The cake produced in Brazil at present results from extraction of "coconut milk", a product much used in cooking. The small production of cake has been taken over in part by the baking industry in the form of meal, has been used in part as animal feed.

In a general way, therefore, prices of raw materials represent a stimulus and a promise of adequate profits in the protein industry.

2.1.2. Hypothesis of Existing Supply of Raw Materials

If we accept the principle that production of proteins should make use, first of all, of material that now goes to waste or of new primary production, we will do well to examine the current situation of the various products we have been considering as possible sources of raw materials, so as to familiarize ourselves with the levels of production and judge how much effort we will have to make.

For this purpose we have constructed the following table, which gives a balance of the 1957 and 1958 output of certain crops and the protein equivalents.

Production of raw materials for industrialization of proteins

	Area cultivated (1000 hectares)		Production (1000 t)				
						Equivalent in proteins	
	1957	1958	1957	1958	%	1957	1958
Oleaginous							
Cotton fiber)	)2771	)2707	392	381	-	-	-
Cotton seed)	)	)	784	762	25	196.0	190.5
Peanuts with shell	169	228	192	308	18	34.6	55.4
Babassu nuts	...	...	87	94	7	6.1	6.7
Cashew nuts	...	...	3	2	20	0.6	0.4
Brazil nut with shell	(1)	(1)	37	39	8	3.0	3.1
Coconut with shell	66	68	160(2)	181(3)	3	4.8	5.4
Soy bean (dry)	97	107	122	131	36	43.9	47.2
Total	...	...	-	-	-	289.0	308.7
Non-oleaginous							
Manioc (tops)	1193	1227		30,000	5		1200

(1) About 550,000 producing trees. (2) Equivalent to 48,000 tons of copra.
(3) Equivalent to 54,300 tons of copra.

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Thus, in terms of proteins, national production of the oleaginous vegetables cited in this study came in 1957 and 1958 to about 300 thousand tons, of which 193 thousand, or 64%, were derived from cotton seed.

For purposes of increasing protein production immediately, use of cotton is not to be recommended, as this would lead to over-production of fiber. The acceptable and accessible course is to promote cultivation of peanuts and soy beans, stimulate more extensive harvest of native Brazil nuts and babassu nuts, and encourage certain tendencies toward broader culture of cashew nuts. Coconuts should be abandoned for this purpose on account of the low protein content of the cake. The products thus chosen contributed in 1958 with a production of 113 thousand tons of proteins, or 574 thousand tons in primary form. Out of this production in 1958, about half must have been used as animal feed in the form of babassu nut and soy bean cake.

The plan for production of proteins should be based, first of all on primary production, since it is a plan for intensifying both production and consumption. If this thesis is accepted, agricultural production must be stimulated up to the point necessary for the industrialization of proteins. It must be kept in mind, however, that parallel to the obtaining of proteins through the vegetables noted above, the plan also proposes to obtain them through industrialization of manioc tops, which implies making available to the market quantities so far unused. As soon as production from stalks and leaves of manioc is begun, it will immediately be possible to withdraw for human consumption an equal quantity of pressed-out cake of peanuts, babassu nuts and soy beans, materials now being used for animal feed. The proteins involved may be estimated at 60 to 70 tons, 80% from peanuts.

The following table shows how much production of raw materials would be necessary to obtain 180 thousand tons of pure proteins from the selected plants. A column has been included to provide an estimate of the resulting oil, placing of which on the consumer market, national or foreign, must be considered. Estimates of production are based on the 1958 relation among the various products.

Raw Material Production Necessary for the Protein Plan

RAW MATERIAL	In thousands of tons					
	PRODUCTION	Proteins			Oil	
		% content	Amount	% of total	% content	Amount
Peanuts with shell	492	18	88.4	49.1	34	167.0
Babassu nuts (1)	150	7	10.7	5.9	67	100.0
Cashew nuts	3	20	0.6	0.4	47	1.4
Brazil nuts (1)	62	8	4.9	2.7	34	21.0
Dry soy beans	209	36	74.4	41.9	22	46.0
TOTAL	916		180.0	100.0		335.4

(1) Native products that are merely picked, not planted, and therefore without great possibilities of expansion.

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Present production of proteins from this group of plants, amounting to almost 90 thousand tons, is more than 90% represented by peanuts and soy beans, with 49% and 42% respectively. Babassu nuts contribute 6%, Brazil nuts 3%, and cashew nuts only 0.4%. If the same proportions are maintained in the plan to intensify production to the point of obtaining 180 thousand tons of proteins, the figures will have to be increased to the amounts shown in the first column of the preceding table. This means, in general, about 270% of 1958 production, something that could be achieved with a proper campaign in one or two years, particularly as regards peanuts and soy beans, with which two crops a year are possible. It should be noted that this hypothesis makes a simple expansion of agriculture the instrument for supply of the protein industry.

At present these products are heavily concentrated in certain areas of the country. Thus Sao Paulo produces more than 80% of the peanuts, Rio Grande do Sul a little less than 90% of the soy beans, Maranhao about 85% of the babassu, Ceara and Pernambuco more than 95% of the cashew nuts, and the Amazon 100% of the Brazil nuts. Aside from babassu and Brazil nuts, where systematic culture apparently cannot compete with native production, all these plants can be raised in other parts of the country. After all, they are tropical products, and experiments already made have shown what regions are ecologically most appropriate for them. Thus the plan for increasing production of raw materials will have to be based largely on products that can be systematically cultivated and that have a short vegetative cycle, contrary to the case of extractive products.

Thus the estimated figures in the preceding table, based on the proportional distribution of present Brazilian production of these items, will have to be revised when specific projects are prepared, when areas of cultivation are selected and location of plants decided on. Substantial increases in production of babassu and Brazil nuts will clearly be difficult, and cultivated products will have to be increased accordingly. This possibility should not be forgotten, as well as the possibility, according to the location chosen for the industry, of substituting one source of protein for another. For this purpose specific studies of costs and adaptability of plants to growing conditions will be necessary.

As regards the oil, about 335 thousand tons will be produced as a result of the protein industrialization plan indicated, and its appearance on the consumer market is a problem that will have to be faced.

As is known, Brazilian consumption of fats (48 grams per day per inhabitant, equivalent to 432 calories) is below the recommended level; it should be from 60 to 70 grams, equivalent to 600 calories. Increase of Brazilian consumption to recommended levels would mean absorption of 250 thousand tons more of vegetable oils and fats annually (10 grams more per inhabitant per day). However, this still would not take up all the oils resulting from the protein industrialization plan. There would be about 100 thousand tons left over, and this must be sold abroad. The fact must be faced immediately, because a parallel solution to this problem will lead to lowering the cost of raw material (pressed-out cake) and thus to obtaining of proteins at more reasonable prices.

2.2 Capital to be Mobilized

Let us admit, for the sake of argument, that an industrial program for 50 thousand tons of proteins per year would require an investment somewhere between 100 and 120 million cruzeiros. This amount would be represented in part by the foreign currency required to cover certain types of tools and equipment not produced in Brazil.

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The following table suggesting percentual composition of the investment is merely a preliminary projection, and subject to ratification following studies that really belong in the realm of industrial engineering (and following further study of the problems of the raw material and technological process to be used, exact location of factory, etc.):

	% of investment (+)
Land	8
Buildings	17
Tools and equipment	
- in foreign exchange	40
- in cruzeiros	20
Installations	10
Mounting, etc.	5
	100

(+) Only a part equivalent to 48 million cruzeiros would involve spending of exchange.

3.0 THE INDUSTRIAL PROGRAM FOR PROTEINS

3.1 Hypothesis of New Production

It would be perfectly possible to launch the present industrial program on a broader basis - to cover, for example, a production of 180 thousand tons of proteins per year, as mentioned later. In item 2.1, indeed, we have defended an undertaking on this scale.

Nevertheless, there are certain circumstances and factors that must be remembered, including conditions of the market; so let us think in terms of a limited program to begin with, for example, 50 thousand tons per year.

A definite decision as to the size of the factory will of course depend on complementary investigations, which will take into consideration, among other things, the profit-making potentialities of the enterprise.

The following table sets out the basis normally accepted by nutritionists for determining the production of proteins necessary to take care of those groups of the population which, because of age or special biological status, stand most in need of proteins - the so-called "vulnerable groups" (item 4.2). We have taken these groups for the year 1960 together with the amount of proteins per capita recommended daily, and have estimated the amount of proteins necessary to take care of only 1/3 of the quantities recommended.

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VULNERABLE GROUPS AND THEIR PROTEIN NEEDS

Vulnerable groups		Protein per day recommended (gr)	Estimated population 1960	Proteins to take care of 1/3 recommended quantity (t)	
				per day	per year
Pregnant w.		90	2,400,000	72.0	26,300
Nursing mothers		100	1,400,000	46.2	16,900
Infants		30	1,200,000	12.0	4,400
Pre-school ch.		40 (1)	1,200,000	156.0	56,900
School ch.	(total (2)	70	13,000,000	299.0	74,800 (3)
	(enrolled		7,500,000	172.5	13,100 (3)
Total	(general (5)		30,000,000	585.2	179,300
	(partial (6)		24,500,000	458.7	147,600

Nursing mothers: up to 6th month. Infant: 7 to 12 months. Pre-school children: 1 to 6 years. School children: 7 to 14 years. Notes: (1) Average for group. (2) All children 7 to 14. (3) For 250 school days. (4) Probable enrollment 1960. (5) Including all school children. (6) Including only those enrolled.

According to the calculations shown in the above table, if we are to provide the vulnerable groups with 1/3 of the quantities of proteins recommended by nutritionists, we must produce about 180 thousand tons of pure proteins per year, or in terms of a 40% concentrate, 450 thousand tons of such concentrate. In order to judge the significance of this figure, we need only recall that it represents about 70% of present production of cake and bran in factories making vegetable oils, production that in 1958 amounted to some 630 thousand tons worth 1.5 million cruzeiros (at 2400 cruzeiros a ton).

If we propose to launch an undertaking to produce 50 thousand tons of proteins per year - that is, about 28% of the theoretical needs estimated in the preceding table - we must face certain factors on a national plane that discourage the enterpriser, including cost of the investment itself.

3.2 Choice of Location

The problems that will arise as the plan is put into execution, meanwhile, can be more easily faced if it is limited, at the beginning, to taking care of the vulnerable groups of the region where the greatest deficiencies exist, that is, the Brazilian Northeast. In this case the protein needed would be only 46 thousand tons (instead of 180 thousand for the whole country) and the resulting oil would drop to a little more than 85 thousand tons. The northeast also offers favorable conditions for developing production of raw materials such as peanuts and soy beans: there is a tradition of peanut growing in the Agreste and Brejo

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regions of Paraíba, in the Sertaneja region of Alagoas, in the Central region of Sergipe, and in the Litoral, Recôncavo and Feira de Santana regions of Bahia; and there is a tradition of soy bean culture in the Sertão Central of Pernambuco. The Northeast is already the great Brazilian producer of babassu and cashew nuts. And the region itself could absorb a good part of the resulting oil, since consumption is low and importation considerable (about 17,000 tons in 1958).

3.3 The Technological Process to be Used

The company British Glues and Chemicals, Limited, owner of the process recently patented in Great Britain for producing practically pure proteins - the so-called "IPP" - Impulse Process Protein - has offered ASCOFAM rights to use the equipment it may acquire without payment of royalties, provided the product is used in assistance programs, and provided the factory functions as a pilot project for experimentation, on an industrial scale, with various raw materials. The English process extracts the proteins physically, by vibration, using alkaline water under pressure and obtaining products with a high rate of protein concentration, even when working with raw materials containing a minimum of proteins-common grass, for instance, which contains only 8% protein when dry. The final product is obtained after only a few minutes of work by the equipment, without solvents, and analyses show high indices of protein concentration, never less than 80%, with excellent purity and integrity as regards composition of the original amino acids.

4.0 MARKET PERSPECTIVES

4.1 The Potential Market

Protein shortages pointed out in this document indicate the existence of a broad potential market, which however is limited for the moment by low purchasing power of most of the needy populations and little production of good vegetable proteins at low cost. It is to be hoped, however, that the coming years will bring continued increases in the purchasing power of populations presently in need, which by a parallel and spontaneous process will lead to a greater demand for proteins. Furthermore, the execution of a plan which, along with the present project of supplying additional proteins to more vulnerable groups, promotes and publicizes the crying need for greater consumption of proteins, so as to eradicate at least the most serious forms of deficiency, will have the effect of stimulating a greater demand for proteins among those of better income who suffer from protein shortages, and thus hasten intensification of general demand.

Studies carried out by the Work Group have determined the advisability of beginning production of proteins in quantities sufficient to take care of the needs of those vulnerable groups presently being aided by government or para-government organizations, whether they supply protective foods free of charge in keeping with their assistance plans or promote supply of low-cost foods to specific groups.

Once an initial market is assured through these institutions, expansion of production should take place by compulsory use in mixtures, as determined by law on the basis of appropriate technical studies. A movement in this sense will have to be promoted by ASCOFAM. It will be similar to the one in the United States for enriching flour with vitamins, except that in Brazil it is a question of proteins.

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Attention is called at this point to the fact that well-organized protein associations, where proper account is taken of the constituent amino acids involved, may result in a product of greater biological value than the sum of their parts. A case in point is the protein of corn, which is considered of low biological value; when it is associated with the protein of milk, however, the resulting product is of exceptional nutritive value, superior even to milk protein taken alone.

Pressure in this direction should also be exerted through government measures to rationalize meals for groups directly or indirectly under public control. This includes the armed forces, as well as schools and hospitals maintained or subsidized by them; also other organs of nutritional assistance such as SAPS (Social Security Food Service) and SESI (Social Service for Industry), which supply meals to large numbers of associates or beneficiaries. The rational preparation of such meals with industrialized vegetable proteins will in many cases permit economies in animal proteins, or provide good vegetable proteins for meals in which the protein ratio is too low.

This market alone could absorb a protein production on the order of 133 thousand tons per year, if the following figures are accepted:

Hypothetical Size of Market

Market elements	Estimated meals monthly	Coefficient adopted (%)	Capacity of protein absorption (tons per year)
School children	50,000,000	40	24,000
Social Security, etc.	70,000,000	70	58,800
Armed forces	25,000,000	80	24,000
Hospitals	20,000,000	50	12,000
Other	20,000,000	60	14,400
Total	185,000,000	-	133,200

(%) Coefficient in grams, proteins per meal

Finally, the commercial market itself should be considered, because it too will be greatly benefited as the general plan develops. The commercial market will be in a position to put part of the production obtained into the hands of the economically more favored classes - which do not yet use sufficient quantities of vegetable proteins, either through ignorance of their properties or because of their present scarcity.

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4.2 Vulnerable groups

Execution of the ASCOFAM protein plan will have to begin with the consumer market represented by the government organs which care for those groups most vulnerable to protein deficiencies - pregnant and nursing mothers, infants, pre-school and school children. At present the plan of assistance to these groups is based on US surplus dry milk, imported for cost of freight only by the National Food Commission (CNA - Comissão Nacional de Alimentação), National School Lunch Program (CNME - Campanha Nacional de Merenda Escolar), and UNICEF (FISI - Fundo Internacional de Socorro à Infância), which have drawn up the plans and execute them through the local network of national institutions (Brazilian Legion of Assistance, National Children's Department, Special Public Health Service, and others), or through regional institutions or state or municipal governments with which they have entered into agreement.

In 1958 these plans took care of about 460 thousand pregnant and nursing mothers, infants and pre-school children, 167 thousand through the National Food Commission and 293 thousand through UNICEF. The National School Lunch Program, for its part, took care of about a million primary school children. The group of pregnant and nursing mothers and infants received 60 grams of dry milk per day, while pre-school and school children received 40. Thus, consumption of dry milk that year amounted to a little more than 16,000 tons, which at the price of 7,000 cruzeiros (freight only) meant 110 million cruzeiros. Inasmuch as the type of milk distributed contains 35.6 o/o proteins, it will be seen that present plans, with 21.4 grams of protein per day, provide for 71 o/o of the needs of infants, 24 o/o of the needs of pregnant women, and 21 o/o of the needs of nursing mothers, while 14.2 grams of protein per day provides for 21 o/o of the needs of pre-school children and 20 o/o of the needs of school children.

According to broad estimates prepared by the National Food Commission, the groups most vulnerable to protein deficiency in Brazil will reach the following levels in 1960: 2,400,000 pregnant women, 1,400,000 nursing mothers, 1,200,000 infants and 12,000,000 pre-school children - 17 million persons in all. This total does not include children of school age (7 to 14 years), about 13 million, of whom 7 1/2 million will be enrolled in primary school. The total is thus about 30 million, if all children of school age are counted.

Limited by lack of available financial resources and by absence of local organizations for distribution, present plans take care of only a small part of the most vulnerable groups: 8 o/o of pregnant and nursing mothers and infants, 1.5 o/o of pre-school children and 20 o/o of primary students. Aid presently being given under plans of the National Food Commission and UNICEF need to be broadened in the sense of embracing a larger number of persons with limited financial resources, while the National School Lunch Program also proposes to increase the individual protein ration so as to take care of 1/3 of the student's daily needs.

There is no good means of judging what portion of these vulnerable groups - whether because of low family income or because of existing states of protein deficiency - ought to be taken care of under present plans. With the exception of the National School Lunch Program, which plans an increase of 20 o/o, these plans face rigorous limitations and have no expansion plans for 1960.

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It is thus of the very essence of the plan "Proteins for Latin America" to call the attention of governments to the situation of protein deficiency assailing a large part of the population; and by utilizing all appropriate means and measures to eradicate the evil, it should promote ampliation of existing plans and should establish adequate plans to bring greater quantities of proteins wherever they may be necessary.

CONCLUSIONS

On the basis of the facts brought out in this report, and in view of the upsurge of economic development now taking place in Latin America, particularly in Brazil, there is no longer any excuse for delaying a solution of one of the area's most serious problems, that is, the problem of raising indices of protein consumption.

Magnificent recent technological advances, permitting extraction of pure proteins and concentrates from products of vegetable origin, place such a solution within reach of countries of limited economic development. Up until now the practically prohibitive price of animal protein has been an almost impassable obstacle to raising levels of protein consumption. A more practicable line of attack had to be found, and has now been provided by the scientific developments referred to.

The present project represents a pilot experiment on the part of Brazil, but it may well serve as an example and a stimulus to solution of the problem in other Latin American countries. It will be carried out by initiative and under the supervision of ASCOFAM in collaboration with the Brazilian government, and very possibly as part of the plan of a World Campaign Against Hunger now being developed by the United Nations.

As a preliminary step, the leadership of ASCOFAM has already made contact with Brazilian financial groups, which have shown great interest in the project, that is, in the installation of new Brazilian industries strategically located with relation to raw materials and consumer markets.

Meanwhile, ASCOFAM has obtained authorization from the English company British Glues and Chemicals Co. to install in Brazil the equipment necessary for extraction of proteins through the "impulse process". The Brazilian government is prepared to give all assistance, both financial and technical, toward carrying out this undertaking.

ASCOFAM is also in contact with international groups interested in the same problem, in particular a group of Canadians who have shown great interest in collaborating on execution of the plan.

With these resources assured, ASCOFAM is now proceeding to the second phase of the program, which consists in drawing up specific projects for the execution of each of the points brought out in the present report.

There have also been discussions and exchanges of viewpoints with UNICEF, which is very much interested in production of proteins to take care of the needs of children in underdeveloped regions. This is felt to be particularly important

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in view of the relative scarcity of dry milk, now that US and Canadian surplus supplies are being reduced.

In general terms, such are the fundamental aspects of this project called "Proteins for Latin America".

Although we have not yet come down to details and definitive formulations on the material here studied, certain additional problems of a financial nature should now be taken up, quite aside from the questions concerning industrialization of proteins so far raised. These may be summarized as follows:

a) Who will be the enterpriser, that is, who will be entrusted with the task of carrying out the industrial undertaking? One possibility is that the state itself, through appropriate organs, might make the investment and operate the industry. Or the state could merely supply the stimulus (exchange facilities for importation of equipment, freedom from import duties, reduction of internal taxes and, above all, guarantee of markets), leaving the undertaking itself to private initiative. Under present Brazilian conditions as regards consumer goods industries, the second alternative should be preferred.

b) Another of the final points to be worked out is the cost in foreign exchange of the industrial program, and what the accompanying difficulties and repercussions will be. In similar cases, problems arising in our balance of payments are being handled through application of Decree 42,820, which regulates entry of foreign equipment, without exchange coverage, as share capital of the foreign investor. In the present case, with the part of the investment in foreign exchange representing some 40 o/o of the total (although British Glues, which proposes to collaborate with ASCOFAM by providing technical assistance and use of the technological process, shows no interest in making the investment directly) this form of cooperation would be the most practicable. Under the terms of Decree 42,820, assuming that some foreign industrial group were prepared to take part in the undertaking, this could be worked out in the following way:

1) Investment, foreign participation, representing the equivalent of Cr 48 million (conversion of foreign currency, corresponding to equipment transferred from abroad, at free exchange, for acquisition of shares);

2) Investment in cruzeiros on the order of Cr 72 million, which would be covered by participation of Brazilian enterprisers. Eventually, the foreign group itself, referred to above, if it wished to increase the margin of participation in the social capital of the enterprise, could transfer dollars from abroad to convert them into cruzeiros and acquire shares in the company;

3) Part of the investment in national currency, in case the enterprise is located in the Northeast as discussed, would be partially covered by state financing, although for private purposes, through the SUDENE.

Botanists who can collect samples of Manihot

1. India - Dr. A. Abraham,
Prof + Head, Dept of Bty.
Travancore Univ.
Trivandrum, South India.

2. Brazil Belem - Dr. Joao Murca Pires
Insto Agronomico do Norte
Belem, Para, Brasil

3. Brazil São Paulo - Dr. Alcides R. Teixeira
Director, Instituto de Botanica
Caixa Postal 4005
Sao Paulo, Brazil.

4. Africa?

For processing of foliage for samples see UNICEF public for suggestions of labs, etc.
Also be sure to get voucher specimens of the plants used.

Project -
Economics of the harvest
Production/acre (tonnage)
Produc. time - months -
Freq of planting + harvesting
Cost of harvesting (labor) + processing -

AGvanVeen:bam
Typed 12 April 1960
cc: Dr. David J. Rogers, Curator of Economic Botany, The New Yrk Botanical Garden
Dr. Autret
Dr. Kapsiotis
Registry

NU - 13/1
Leaf Protein

APR. 1 4 1960

Dear Max,

Here are some comments on your Memorandum for the Record of 6 April concerning Cassava Leaf Protein. I am sending you and also Dr. Rogers a copy of my pre-war publication on Cassava Leaves. Young Cassava leaves have saved the lives of many people in Indonesia during the war. Most leaf proteins, however, deteriorate during drying. You may know that Erie has found a method of preventing the deterioration of biological value by mixing leaf protein concentrates with dehydrated cereal flours.

It is quite true that large protein resources exist in fresh leaves, but one should keep one thing in mind, and that is that if one wants a good crop of Cassava tubers, one should not rob the plant of its young leaves; in other words, particularly in a poor soil, we cannot have both a rich crop of tubers and of young leaves.

Of course, our Plant Production Division could probably provide the common names of many legumes in most areas where they are grown.

Hoping that these notes are of some use to you,

Yours sincerely,

A.G. van Veen
Chief, Food Processing
and Preparation Branch
Nutrition Division

Dr. Max Milner
Senior Food Technologist
Food Conservation Division
UNICEF
United Nations
New York

Note: The information in this bulletin should not be used for any public purpose without special permission

FAO/WHO/UNICEF High-Protein Food* Programme

News Bulletin No. 1

October, 1957

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*It is recognized that the expression "high-protein food" is not altogether satisfactory, since the basic aim of the programme is to make available foods or combinations of foods, which effectively supplement local diets. It is the quality of the protein provided by the supplement, rather than its total protein content, which is important. Further, a food which cannot be called a high protein food may be a good supplement if consumed in sufficient amounts. The term "high-protein food" is used for purposes of brevity.

Table of Contents

Section 1

Summary of purposes of News Bulletin

A number of the groups working in the High-Protein Food Programme have expressed a need for some medium of intercommunication which would be more rapid than conventional publication. Further, there is a continuing need to advise all cooperating groups as to the activities under way in FAO, WHO and UNICEF so that advantage can be taken of any information, products or services which would be useful in their programme.

Please note Section 7 where we are soliciting your ideas for the content of future issues of this bulletin.

Section 2

Description of FAO/WHO/UNICEF High-Protein Food Programme

The historical development of the FAO/WHO/UNICEF High-Protein Food Programme need not be described here since many of those who will receive this bulletin participated personally in its development. It should suffice to state that many individuals, national groups, as well as the international agencies, have given serious attention to the problems of protein malnutrition and practical methods for its prevention over a number of years.

From the standpoint of the international agencies there were two international conferences concerned with this subject which are of particular interest. One of these was convened in Jamaica in 1953 - "Protein Malnutrition-Proceedings of a Conference sponsored jointly by Food and Agriculture Organization of the United Nations (FAO), World Health Organization (WHO), Josiah Macy Jr. Foundation, New York". The second conference was convened at Princeton in 1955 and resulted in a rather detailed outline of the practical measures which the international agencies might sponsor - "Human Protein Requirements and Their Fulfilment in Practice", sponsored jointly by FAO, WHO and Josiah Macy Jr. Foundation, New York. The latter document is recommended reading for all who have particular interest in this area since it contains most of the background as well as most of the guidelines presently followed in the High-Protein Food Programme. It should also be noted that joint FAO/WHO Regional Nutrition Meetings in South and East Asia and in Latin America have considered these problems in recent years.

However, it may be useful to sketch briefly some of the more important aspects of the programme as it has developed. The content of the present programme has been guided in an important way by the Protein Advisory

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Group established by WHO with representation from FAO and UNICEF. It has been meeting twice yearly since April, 1956. The original functions of this group were to advise on the safety and nutritional value of the products to be included in the programme. However, as the programme has developed this group has broadened its activities to include many related aspects.

Increased production and consumption of milk has been a keystone of the approach of international agencies, as well as many national and local groups, in efforts to combat protein malnutrition in children. FAO is specially concerned with developing milk production. UNICEF's long range feeding and milk conservation programmes carried out under the technical guidance of FAO are designed to foster the use of both imported and indigenous milk to the maximum extent possible. However, it has become clear that sources of protein rich foods in addition to milk are necessary. There are many countries where milk cannot be produced, or where there is little hope in the immediate future of producing it in sufficient quantities. In some places there are strong local beliefs that cow's milk is not suitable for infants and young children. Inadequacies in transport and storage facilities, not to mention economics, further limit the range of practical usefulness of milk in many areas of great need.

Seven criteria have been accepted by FAO, WHO and UNICEF to select additional resources of high protein foods which may be useful, namely:

a) They must be already available locally or be capable of local production.

b) They must be within the economic means of the particular population group to either produce or buy.

c) They must be easily transportable and have a long storage life without refrigeration under conditions of heat and humidity.

d) They must be completely free of any toxic or other deleterious effects.

e) They must have characteristics of taste, odor or physical properties which would make them acceptable food products,

f) They must have nutritional values such that they would be expected to be effective protein supplements, and

g) They must be products not already being used maximally as human food.

On the basis of these criteria, six products have been selected for study. These are: fish flour, soybean products, peanut flour, sesame flour cottonseed flour and coconut. Many others may be added to this list but have

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been eliminated, for the time being, either because their nutritional properties are not well known, because the amount of the raw material is too small on a world basis, or because a satisfactory and economical process is not yet available.

Fish Flour

Fresh fish is available in many of the underdeveloped areas and there is no doubt that the production of fresh fish could be expanded very substantial However, lack of transport and refrigerated storage presents wider distribution and use of this valuable protein food. Usual methods of preservation such as canning or freezing are too expensive for the groups of greatest nutritional vulnerability. Smoking and drying offer some possibilities but fish so processe do not have a long storage life under tropical conditions. Recently, several processes have been developed by which either fresh fish, or dehydrated fish meal, can be defatted, deodorized and finished as an almost tasteless, odorless, nearly white "flour". The deodorization step can be omitted for groups which prefer a fishy taste in their foods. These fish flours retain the high biological value of the starting material, they are very stable to storage, and can be incorporated into bread, other cereal products or into soups or stews with excellent acceptability of the resultant food. Since these flours contain 70-80 per cent protein, relatively small amounts are needed to supplement children's diets. It is estimated that fish flour can be produced at a price which would at least be competitive with milk on a proteih basis. The UNICEF/FAO assisted pilot plant in Chile should be in operation this year or early in 1958.

Soybean products

Soybean products are of special interest since properly prepared soy products have a biological value closer to animal proteins than any other commonly used vegetable protein. Furthermore, among the various products to be studied, only soy has been prepared as an acceptable liquid food for infants. The UNICEF/FAO soybean extract plant in Indonesia has had its first trial production runs and should be in full operation shortly.

Oilseed products

Peanuts, sesame, cottonseed and coconut are also of particular interes since ordinarily they are processed for their oil, and the protein-rich presscakes which are by-products of the oil production are used mainly for animal feed or for fertilizer. If it is ecohomic to use these materials as animal feed or fertilizers, it certainly should be economic to use them as human food if carefully controlled processing would in fact produce a food suitable for human consumption. Millions of tons of these presscakes are produced annually, much o: it in underdeveloped countries, yet very little is used as human food.

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Need for research and development

If even a portion of this production could be diverted to human use, a substantial contribution might be made. However, relatively little is known about these presscake proteins as human food, although in one form or another most of them have been used in human dietaries to some extent. There is a large amount of literature on the nutritional values of these presscake proteins as determined by chemical analyses and animal studies. Unfortunately, many of the data are difficult to interpret since these proteins are known to suffer nutritional damage if excessive heat is used in processing and the precise conditions of production are usually not stated.

These and many other factors made it clear that a considerable amount of research and development would be necessary to evaluate fully the usefulness of these high protein foods as supplements to various types of human diets. A grant of $250,000 from the Rockefeller Foundation in April 1956 made it possible to start the necessary research, using the $100,000 allocated by UNICEF to procure the food products needed. With these resources a co-ordinated plan of research and testing is being developed by FAO, WHO and UNICEF. Even though this programme has a world wide target there are no illusions that it will alleviate all of the protein malnutrition in the world. It is simply one approach which may make some contribution to an extensive and difficult problem.

The Committee on Protein Malnutrition with which FAO, WHO and UNICEF are closely associated, has been organized under the auspices of the National Research Council (US) to administer the research grant from the Rockefeller Foundation. Approximately $210,000 of these funds have been committed to support the research of 19 research groups in 11 different countries. Approximately half of the special UNICEF allocation has been used or committed to provide the food products and certain essential analytical data.

Principles in research

Several principles have been applied in designing the research programme (see Princeton Conference report):

a) Any food product to be studied must be well identified and reproducible. It must be produced by a process the complete details of which are known. Thus it is hoped that facts accumulated about a product can develop into a systematic body of knowledge which can be interpreted and extrapolated to assist in solving local problems in many different areas of the world without repetition of all of the experimental and developmental work.

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b) The product must be produced by an open process which is commercially feasible, and which could be duplicated in underdeveloped areas. Obviously it is of little value to study a product produced by an elegant laboratory method which could not be used in underdeveloped areas, nor is it of much value to study a food produced by a "secret" process which could not be used freely in the areas of need.

c) The food must be characterized as to chemical composition, biological value and shown to be completely safe prior to testing in human subjects. Studies of biological value and safety should be conducted in more than one species of animals except where similar products have already been relatively well studied in these respects.

d) The food must have a protein and amino acid content such that it would be predicted to be a useful protein supplement to one or more types of "poor" diets in underdeveloped areas.

e) Predictions made as above, must be confirmed by actual tests in human subjects. While a considerable body of knowledge is accumulating on the protein and amino acid requirements of various age groups, from which it may be possible to predict the value of protein supplements, there is at this moment no substitute for the direct test.

f) The product should offer special possibilities as a practical supplement for infants, pre-school children and mothers.

g) The product should have good storage properties to enable distribution to take place under difficult conditions.

Initial objective

The initial objective of the programme is to locate at least one source for each type of high protein product and to produce a batch under carefully defined conditions, following the principles enumerated above. This lot of material would be carefully studied as to composition, biological value and safety in animal studies and biological value in man. As soon as the true nutritional value and safety of the food is known, and assuming satisfactory values, then it would be made available as widely as possible to research groups in underdeveloped areas, and elsewhere, to study as to its ability to prevent or cure protein malnutrition when used as supplements to various types of local diets. In many instances it may be desirable to use combinations of these foods as supplements depending on local circumstances and the nutritional value of the foods.

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The next objective might then be to establish a facility in the country concerned to manufacture the product for local consumption. UNICEF aid may be required at this stage. The programme is already at this stage with two of the products, namely, fish flour and saridele (soybean extract).

While the initial approach is being built around single, standardized, reproducible products this, of course, does not rule out the later inclusion of products with improved biological values or with special physical or physiological properties designed to meet special needs. However, knowledge accumulated in the initial studies should speed materially the practical use of these newer products. Indeed it seems quite likely that the best protein supplements may be found to be not single protein foods but combinations of foods. The ability of proteins to supplement one another is well known. Also, the principles outlined above do not rule out the study and use of well known, commonly used foods which may be a normal part of diets in certain areas.

Section 3

List of grantees cooperating in programme

The following is a list of groups cooperating in the programme with financial support from the Rockefeller Foundation funds. These groups are listed in the order in which their applications were received.

1) Principal Investigator: Dr. Nevin S. Scrimshaw, Regional Advisor in Nutrition (Pan American Sanitary Bureau) and Director, Institute of Nutrition of Central America and Panama (INCAP), Carretera Roosevelt, Zona 11, Guatemala, C.A.

   Title: "Chemical, Microbiological, and Biological Evaluation of Protein Mixtures of Local Origin for Human Feeding".

   Research Plans: Mixtures of locally available foods resembling the local tortilla are being tested in animal experiments, in normal children, and in children with kwashiorkor. Clinical improvement, biochemical changes, growth, and nitrogen balance are used to evaluate the mixtures.

   The mixtures are based on corn masa, supplemented with sesame flour, cottonseed flour, yeast and leaf meal. Results with the vegetable protein mixtures are compared to results with milk proteins.

2) Principal Investigator: Dr. James B. Allison, Rutgers University, Bureau of Biological Research, New Brunswick, New Jersey.

   Titles: i) Determination of the Nutritive Value and Safety of Fish Flour
   ii) Determination and Nutritive Value and Safety of Cottonseed Flour.

   Research Plans: i) Defatted and deodorized fish flour prepared by the Dabsch process was compared to non-deodorized fish meal and to casein in rat experiments lasting one year. The nutritional value and safety of these fish products were assessed by growth, blood studies, organ and histopathological examinations at intervals during the year. In addition, tests of biological value by a nitrogen repletion method in dogs were done. These studies are essentially complete. The rat studies revealed no evidence of toxic effects and a nutritional value indistinguishable from casein. The dog experiments indicate a biological value for the defatted and deodorized fish flour equivalent to that of lactalbumen (these studies in dogs are not yet complete). Also studies are being done in rats using the non-deodorized fish flour after twelve months storage.

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2. ii) A cottonseed flour designed for human consumption produced by an expeller process will be evaluated for nutritional value and safety in two-month and six-month rat growth studies which will include one reproductive cycle.

3. Principal Investigator: Dr. L. Emmett Holt, Jr., New York University-Bellevue Medical Centre, Department of Pediatrics, College of Medicine, 550 First Avenue, New York 16, N.Y.

   Title: Testing of Nutrient Value of Vegetable Foods

   Research Plans: Premature infants are being used to assess the nutritive value of various vegetable proteins and of mixtures based on these proteins. The normality of growth when the vegetable proteins are compared to a standard formula based on milk, physiological tolerance and serum protein changes are the primary criteria of value. Nitrogen balance is also done in some instances.

4. Principal Invesitgator: Dr. R.F.A. Dean, Director, Medical Research Council Group for Research in Infantile Malnutrition, Mulago Hospital, Kampala, Uganda, Africa.

   Title: "Research in the Utilisation of Indigenous Foods Rich in Protein for the Prevention and Treatment of Malnutrition".

   Research Plans: Biscuits prepared from groundnuts, wheat flour, maize flour, edible oil and sugar, with or without supplements of skim milk or fish flour are being studied as to their nutritive value and acceptability in growth studies using school children and pre-school children, as well as in infants recovering from kwashiorkor. In the latter instance, balance studies will be done to show the utilization of the protein and other constituents in the biscuit. Animal and other experiments will be done to assess any changes in nutrient quality due to baking.

5. Principal Investigator: Dr. John F. Brock, University of Cape Town, Wernher & Beit Medical Laboratories, Department of Medicine, Cape Town, Union of South Africa.

   Title: "Search for Milk Substitute in the Treatment of Kwashiorkor and in the Prevention of Infantile Protein Malnutrition".

   Research Plans: Locally available, high-protein vegetable and fish additives will be studied as supplements to maize meal in:
   1) the convalescent phase of kwashiorkor and 2) for the initiation of cure of kwashiorkor; clinical results will be controlled by biochemical and nitrogen balance tests.

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6. Principal Investigators: Dr. Bruce M. Nicol, Adviser on Nutrition to the Federal Medical Department and Mr. P.G. Phillips, West African Institute for Trypanosomiasis, Kaduna, Northern Nigeria, Nigeria, Africa.

Titles: i) Peanut Flour as a Supplement to Traditional Nigerian Diets in Infants, Growing Children and Adults; ii) Human Digestibility Trials with Groundnut Flour of Low Fat Content.

Research Plans: i) Under Dr. Nicol's direction, the nutritional value of a protein supplement of low fat peanut flour, and a mixture of this flour with dried skim milk will be studied as a supplement to traditional Nigerian diets in normal children and in children with kwashiorkor. Clinical recovery growth, and biochemical changes will be used to determine the value of the mixtures.

ii) Under the general direction of Dr. Nicol, Mr. Phillips will determine the biological value of low fat peanut flours in adults using nitrogen balance techniques.

7. Principal Investigator: Dr. Raymond Jacquot, Laboratoire de Biochemie de la Nutrition du Centre National de la Recherche Scientifique, Bellevue, Paris, Seine-et-Oise, France.

Title: "Study of the Composition, Nutritive Value and Safety of Flours made from Groundnuts".

Research Plans: Low fat groundnut flours produced by expeller processes in French West Africa, in England, and in the United States, will be analyzed to determine their proximate composition, amino acid content, biological value and safety. Two-month and six-month rat growth and safety studies including one reproductive cycle will be done.

8. Principal Investigator: Dr. Robert Kaye, Driscoll Foundation Children's Hospital, P.O. Box 6038, Corpus Christi, Texas.

Title: "Study of Utilization of Plant Proteins in Human Infants".

Research Plans: The acceptability and protein values of vegetable proteins such as sesame, peanut, and cottonseed flours will be studied in infants, approximately two-six months in age by clinical observations, growth, biochemical and nitrogen balance techniques.

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9. Principal Investigator: Dr. A.E. Bender, Research Department, Bovril Ltd., P.O. Box No. 107, 148/166 Old Street, London, E.C.1. England.

Title: "Determinations of Biological Value of Protein Foods by the Carcass-Nitrogen Method."

Research Plans: The technique indicated above will be used to determine the biological value on experimental rats of high protein foods produced for testing in the WHO/FAO/UNICEF programme. In a few instances, the biological value of protein mixtures and amino acid analyses by chromatographic techniques also will be done.

10. Principal Investigators: Dr. Jean Senecal, Professeur Agrege des Facultes de Medecin, Service de Pediatrie, Hôpital le Dantec, Dakar, French West Africa; Medecin Lt. Col. Aretas, O.R.A.N.A., B.P. 2089, Dakar, French West Africa.

Title: "Low Fat Peanut Flour as a Nutritional Supplement to the Normal African Diet".

Research Plans: i) Under the direction of Dr. Senecal, millet flour, with or without supplements of peanut flour and fish flour, will be compared to milk proteins as to acceptability and value in the treatment of mild and advanced kwashiorkor. Clinical response, growth and biochemical changes will be the primary criteria used. Growth studies in school age children are planned using the most effective mixtures.

ii) Under the direction of Col. Aretas, the mixtures found to be effective in Dr. Senecal's studies will be subjected to controlled field acceptability studies designed to measure the general acceptance of the products and to define techniques which would be useful in their widespread practical promotion.

11. Principal Investigator: Dr. E. De Maeyer, Institut pour la Recherche Scientifique en Afrique Centrale, Lwiro, (Katana), D.S. Bukavu, Belgian Congo

Title: "Nitrogen Metabolism in Healthy and Malnourished Children, with Special Reference to the Use of Different Sources of Protein in the Diet".

Research Plans: The biological value of high protein materials such as peanut flour, cottonseed flour and fish flour will be studied using nitrogen balance and other techniques in healthy and malnourished children between the ages of 3 and 6 years. These represent a continuation of the studies Dr. De Maeyer has been conducting with milk proteins, soya flour and peanut-bean mixtures.

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12. Principal Investigator: Dr. Tamotsu Sano, Dept. of Pediatrics, Tohoku University Medical School, 85, Kitayobancho, Sendai, Japan.

Title: "Studies on Child Feeding (Miso, Natto and control unfermented soya bean)as protein-rich diet, especially for infants after the post-weaning period".

Research Plan: Studies in animals and in children will be made to determine whether there is any change in the nutritive values of soya protein when it is subjected to fermentation as in the production of Miso and Natto.

13. Principal Investigator: Dr. C.G. Pandit, Director, Indian Council of Medical Research, Flat Nos. C-11-14 & 16, Post Box No. 494, Medical Enclave, New Delhi, and cooperating institutions.

The project will be carried out by:

a) Nutrition Research Laboratories - Dr. V.N. Patwardhan, Director, Coonoor, South India.

b) Upgraded Department of Pediatrics, Dr. S.T. Achar, Professor of Pediatrics, Government General Hospital, Madras, South India.

c) Department of Nutrition, Government of Bombay, Haffkine Institute, Dr. M.V. Radhakrishna Rao, in-charge, Parel, Bombay.

d) All-India Institute of Hygiene and Public Health, Dr. N. Jungalwalla, Director, 110 Chittaranjan Avenue, Calcutta.

e) School of Tropical Medicine, Dr. R.N. Chaudhuri, Director, Central Avenue, Calcutta.

f) Central Food Technological Research Institute, Dr. V. Subrahmanyan, Director, Cheluvamba Mansion, V.V. Mohalla, P.O., Mysore, South India.

Title of Project: "Chemical and Biological Evaluation of Locally Available Protein-Rich Foods for the Prevention of Protein Malnutrition in the Country".

Research Plan: Analytical, animal, clinical and field studies of locally-available high protein food mixtures will be made. Study will include investigation of the technology involved in producing these foods.

Three different foods will be studied - i) Bengal gram-skim milk mixture, ii) groundnut flour-Bengal gram mixture and iii) groundnut flour-Bengal gram-sesame flour mixture.

Section 4

List of other cooperating laboratories

The following individuals and groups are cooperating in certain aspects of the programme without special financial support.

1) England - Dr. B.S. Platt and associates, Applied Nutrition Unit, London. All of the products presently included in the programme are being studied by the Miller-Bender rat biological value method, fingernail growth test and certain animal growth studies.

2) Switzerland - Dr. K. Durrenmatt and associates, AFICO S.A., (Nestle Laboratories), La Tour de Peilz, Switzerland. This group is studying all of the peanut products for methionine, tryptophan and lysine availability as judged by the method of Mauron (an in vitro enzymatic digestion speed of release test) by biological value determinations in rats and for the products showing the highest and lowest probable nutritional values, a complete amino acid spectrum will be obtained.

3) Peru - Dr. R. Bradfield and Dr. Carlos Collazos, Inst. of Nutrition, Lima. This group is testing in animals, various mixtures of locally available high-protein food or foods which could be produced locally. It is planned that the best of these various products will be subjected to clinical trials.

4) Philippines - Dr. C.R. Pascual and associates, Institute of Nutrition, are cooperating by providing supplies of a special isolated coconut protein product which will be subjected to various tests.

5) United States -

i) Dr. A. Altschul and Dr. V. Frampton, Southern Utilization Research and Development Division, U.S. Department of Agriculture, New Orleans, Louisiana.
The various peanut products, cottonseed flour and sesame flour are being studied as to composition, lysine content (by Moore and Stein and the dinitrofluorinebenzine methods) other basic amino acids, content of various carbohydrates, nitrogen solubility and dilute alkali, gossypol content and related studies.

ii) Dr. E.E. Howe, Nutrition Laboratories, Merck & Co., Rahway, New Jersey. Cottonseed flour is being studied in animal growth experiments to relate the amino acid content of the protein to actual growth and growth which would be predicted from the known amino acid requirements of the rat. Further amino acid supplements will be used to further define the problem.

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iii) Dr. Gladys Emerson and associates, Department of Home Economics, University of California, Los Angles 24, California.
Cottonseed flour and peanut flour (PF-4) are being studied using an approach similar to that outlined above. In addition some work on recipe development will be undertaken.

iv) Dr. Barnett Sure, Head, Department of Agricultural Chemistry, University of Arkansas, Fayetteville, Arkansas.
Defatted and deodorized fish flours are being studied for their ability to supplement various types of cereals and for their nutritive value as a sole source of protein in rats.

v) Dr. Paul Gyorgy, Department of Pediatrics, Hospital of the University of Pennsylvania, Philadelphia, Penn.
Animal studies to compare the nutritive value of unfermented versus fermented soya products. Also planned, soya "milk" produced in Indonesia will be studied in normal infants.

vi) Dr. N.W. Flodin, Technical Manager, Lysine Division, E. I. du Pont de Nemours & Co. Inc., Wilmington, Delaware.
Various peanut flours, cottonseed flour and sesame will be analysed to determine their essential amino acid content by Moore & Stein procedures. In addition, high-protein food mixtures shown to be effective in the prevention or treatment of kwashiorkor will be analysed for amino acid content by chromatographic procedures and will be studied in animal experiments to see whether their protein values can be improved by amino acid supplements.

A number of industrial establishments and commercial laboratories are cooperating voluntarily or under special contractual arrangements. Some of these are identified in Section 6, others will be described in later issues of this bulletin. Special mention should be made of the Food Research Laboratories, Inc., Long Island City 1, N.Y. (Dr. B. Oser and Dr. K. Morgareidge) which has a special contractual arrangement with UNICEF to provide analytical data on many of the products.

Section 5

List of documents available

The following documents can be supplied. If you desire a copy please check in the box indicated and return to: James M. Hundley, FAO Nutrition Adviser to UNICEF, Room 1?71, United Nations, New York 17, N.Y.

1. ☐ WHO Protein Advisory Group's Proposed Statement of Basic Principles, 4 pages.
   A brief outline of recommended principles with some recommendations pertaining to specific types of products.

2. ☐ Procedure for Testing a New Processed Food (Check List), 2 pages.
   An outline of the types of information which should be obtained on each high-protein food.

3. ☐ Note on Protein Supplements for Children, prepared by FAO Nutrition Division, 31 pages.
   Fish flour, soybean products, peanut presscake flour, peanut milk, cottonseed presscake flour and sunflower seed presscake flour are discussed as to their nutritive value in animals and in man. Some information on processing methods and problems and in some instances potential toxicity are discussed.

4. ☐ Soy as a Food for Children by J.F. Muller, Ph.D., 11 pages, including bibliography. (R.1/Add.6)
   A general discussion of processing methods, composition and nutritive value.

5. ☐ Review of Literature on the Nutrition Value of Soy Milk by Harry W. Miller, M.D., (Nut. Pan. R.1/Add.4), 17 pages including 69 references.
   A review of the clinical literature as well as certain personal experiences in using soy milk particularly for the feeding of infants.

6. ☐ Soybean Milk and Saridele, (Nut. Pan. R.1), 13 pages. A note prepared by the Nutrition Division of FAO, including 15 references.
   A description of the composition and biological value of soya milk in animals and infants. Some of the preliminary studies with soya milk in Indonesia are included.

7. ☐ Fermented Protein-Rich Foods by A. G. van Veen, Nutrition Division, FAO, 15 pages, including 19 references.
   A collection of available information on various types of fermented products such as soya, soya sauce, groundnut and coconut presscake and fermented milk products. Insofar as information is available methods of manufacture, composition, nutritive value and methods of use are included.

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8. ☐ Notes on Fish Flour for Human Consumption (Nut. Pan. R.8) prepared by the Nutrition Division of FAO, 15 pages.
The document consists largely of a review of the analytical and biological value studies made on fish flours, defatted and deodorized by various methods.

9. ☐ FAO's Work with Edible Meals, FAO No. 56/6/4103, 6 pages.
A review of different types of fish flour for human consumption, methods for production, practical use of edible fish meals and related considerations.

10. ☐ The Determination of the Nutritive Value and Safety of Fish Flour by J.B. Allison and associates (Nut. Pan. R.8/Add.5), 6 pages plus 11 tables.
Studies in rats and dogs of the nutritive value and safety of non-deodorized fish flour produced in Chile versus the same material further processed to be deodorized by the Dabsch process.

11. ☐ Notes on Fish Meal and Fish Flour studied by Dr. Allison and associates, (Nut. Pan. R.8/Add.2), 3 pages, relating the production, history, analytical and biological value determinations on the products used by Dr. Allison.

12. ☐ Peanut Flour prepared by Nutrition Division of FAO, 21 pages, including 37 references. A literature review as to composition, biological value, effects of processing, supplementary value to cereal diets, toxicity problems and special methods of using peanut flour. (Nut. Pan. R.3)

13. ☐ Sesame Protein by Dr. Richard J. Block, (Nut. Pan. R.6), 19 pages, plus 374 references. A comprehensive review of available literature including historical, agronomic, genetic, processing and nutritional aspects.

14. ☐ Sesame Seed Flour prepared by the Nutrition Division of FAO, (Nut. Pan. R.5), 5 pages plus 12 references. Composition and the supplementary values of sesame proteins are reviewed.

15. ☐ Cottonseed Flour by F. H. Thurber, (Nut. Pan. R.4), 41 pages including 78 references and 8 tables.
A review of available literature on the composition, processing method and problems, toxicity problems related to gossypol as well as the nutritive values in animals and man.

Name ....

Address ....

....

Section 6

List of products available

Each product would be supplied with a description of all known facts with respect to manufacturing conditions, composition, biological value, etc.

1. Reference Protein:

   A specially prepared low temperature spray-dried, non-fat dry milk powder which is being used as a reference protein in clinical experiments being conducted by a number of cooperating groups. The product is available in sealed #10 cans.

2. Cottonseed Flour:

   A product prepared especially for human consumptioh using specifications approved by the WHO Protein Advisory Group.

3. Peanut Flour:

   Six different lots of peanut flour - four produced in the U.S., one in England and one in French West Africa are available. Although each of these was produced under conditions to make it suitable as human food, the complete analytical values and animal studies are just becoming available. These different lots were produced using various types of equipment and different processing conditions to provide a variety of products as to colour, peanut taste, as well as information on possible effects of processing on nutritive value.

We do not have on hand at this moment certain products which we expect to be available within the next few months. These are low fat sesame flours, dried soya "milk" and fish flour, both non-deodorized and deodorized.

Section 7

Ideas for future issues

The basic idea behind this bulletin is to provide information which will be of use to you. This first issue is undoubtedly overly long since it represents an accumulation of material over a period of 1-1½ years. Future issues should be briefer.

Your ideas as to types of things which you would like to see included would be welcomed by us. Your frank comment as to the value of such a news bulletin will also be welcome.

A considerable amount of effort is required to produce such a communication and we have no desire to do it unless a definite purpose will be served.

James M. Hundley
October 18, 1957.

P. Maheshwari
New Delhi

Note: The information in this bulletin should not be used for any public purpose without special permission

FAO/WHO/UNICEF Protein-Rich Foods Programme

News Bulletin No. 2*

July 1959

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* A number of the groups working in the Protein-Rich Foods Programme have expressed a need for some medium of intercommunication which would be more rapid than conventional publication. Further, there is a continuing need to advise all cooperating groups as to the activities under way in FAO, WHO and UNICEF so that advantage can be taken of any information, products or services which would be useful in their programme.

Your ideas as to types of things which you would like to see included would be welcomed by us. Your frank comment as to the value of such a news bulletin will also be welcome.

C. E. French
July 1959

UNITED NATIONS

ECONOMIC AND SOCIAL COUNCIL

DISTR.
GENERAL

E/ICEF/389
27 July 1959

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Executive Board

Progress Report by the Executive Director on Results Achieved in FAO/WHO/UNICEF Protein-Rich Foods Programme

59-18108

Reprinted from PLANT PHYSIOLOGY, Vol. 35, No. 1, January, 1960, pages 68–71.
(PRINTED IN U.S.A.)

ON THE NATURE OF GLUTAMIC ACID DECARBOXYLASE IN WHEAT EMBRYOS [1, 2]

YU-YEN CHENG, PEKKA LINKO AND MAX MILNER

DEPARTMENT OF FLOUR AND FEED MILLING INDUSTRIES, KANSAS STATE UNIVERSITY, MANHATTAN

The presence of glutamic acid decarboxylase in wheat germ has been shown recently (3, 9, 14). This enzyme is readily activated in dry embryos by wetting (12). A strong carboxylase activity appears simultaneously (10). Hence it became important to obtain more information about the source of this carbon dioxide evolution, which is a unique characteristic of wetted wheat germ (13). Schales et al (16) reported that phenol inhibits squash pyruvic acid decarboxylase whereas glutamic acid decarboxylase activity remains largely unchanged. This prompted a study of the effect of various chemicals on these two enzyme systems in wheat embryos in order to elucidate the role of glutamic acid in the carbon dioxide evolution initiated by the increased moisture content. In this connection a study was also undertaken to determine the mechanism and kinetics of the decarboxylation of glutamate by wheat germ.

MATERIALS AND METHODS

The materials and the manometric techniques used were essentially the same as have been described earlier (3). One-sidearm vessels were used. Although the retention of carbon dioxide by the buffer (pH 5.8) is negligible, the results were corrected for retention of carbon dioxide. Values for CO_2 evolution were determined with a standard error of 1.4 %.

Initial reaction velocities for glutamic acid decarboxylase in 50 mg of wheat embryos, employing concentrations of 0.5, 0.4, 0.2, 0.1, 0.05, 0.025, 0.01 and 0.005 molar, were determined graphically by two methods: I) plotting the observed velocities x/t (μl CO_2/5 min) versus time and extrapolating to the value $t = O$ (manometer stopcock closing time was taken as zero time), and also to the value $t = -5$ min (time of tipping of the substrate solution); and II) plotting the velocities x/t versus x and extrapolating to the value $x = O$, as suggested by Schales et al (15)[3].

The Michaelis-Menten constants (K_m) and the maximal reaction velocities (V_{max}) were obtained by the usual graphic methods from a double reciprocal plot of the relation between the reaction rate and glutamate concentration.

The activation energies were determined for the temperature interval, 21° to 30° C using the conventional graphic adaptation of the Arrhenius equation.

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[1] Received April 10, 1959.

[2] Contribution No. 315, Department of Flour and Feed Milling Industries, Kansas Agricultural Experiment Station, Manhattan. Part of the work reported here was taken from a thesis of Miss Yu-Yen Cheng submitted to the Graduate Faculty of Kansas State University in partial fulfillment of the requirements for the degree of Master of Science. The work was supported by grants from the Rockefeller Foundation and Cargill, Inc.

[3] The practice of closing the stopcocks and initiating the trial 5 minutes after tipping-in of the substrate solution was adopted as standard procedure in this work for the reason that only a part of the immediate pressure change produced when dry germ is wetted is due to enzymatic carbon dioxide evolution. Other factors which affect the pressure change significantly, but only during the first 3 or 4 minutes after wetting, include colloidal swelling of the germ and the release of carbon dioxide from fixed sources of this gas (e.g. bicarbonate). The relative amounts of pressure change contributed by these factors during the first five minutes are as follows: enzymatic decarboxylation 10 %, swelling 37 %, and non-enzymatic carbon dioxide release, 53 %.

No. 250 - 11 May 1960
(For use of UNICEF staff only)

UNICEF STAFF NEWS

3223. Composition of the 1961 Executive Board

Of the ten Board members whose term of office expires at the end of 1960, the following eight were re-elected by the Economic and Social Council on 21 April:

Brazil
China
El Salvador
France
Poland
Tunisia
Union of Soviet Socialist Republics
United States of America

The additional two members elected were Afghanistan and Japan (replacing India and the Philippines). India decided not to be a candidate for re-election, withdrawing in favour of Afghanistan.

The unsuccessful candidates, in addition to the Philippines, were Cuba and the United Arab Republic.

As a result of the election the composition of the Executive Board for 1961 will be as follows (in alphabetical order):

Afghanistan
Australia
Belgium
Brazil
Bulgaria
Chile
China
Dominican Republic
Ecuador
El Salvador
France
Germany, Fed.Rep. of
Greece
Indonesia
Iran
Italy
Japan
Mexico
New Zealand
Pakistan
Poland
Sweden
Switzerland
Tunisia
Turkey
Union of Soviet Socialist Republics
United Kingdom
United States of America
Vietnam, Republic of
Yugoslavia

3224. Government contributions for 1960

Word has been received that Sarawak, which has already paid Malayan $10,000 ($3,267) for 1960, has decided to restore the level of its contribution to Malayan $25,000 ($8,167) as given in 1958.

Libya has paid $3,500 as its contribution for 1959; as accounts for that year are closed, it will be listed in 1960.

/...

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
CROPS RESEARCH DIVISION
BELTSVILLE, MARYLAND

September 22, 1959

Dr. David J. Rogers
New York Botanical Garden
Bronx Park
New York 58, N. Y.

Dear Dave:

I was much interested in your recent article concerning the protein in the leaves of Cassava.

A number of years ago, we made the determinations on protein for a number of cultivars of Cassava. Our determinations did not range as widely as yours, but on the other hand, we had very many fewer samples analyzed. Most of those we did, showed protein at about 20% of dry weight. There are several papers in Volumes 14 and 15 of Food Research for 1949 and 1950 which have analyses of leaves of Cassava. On pages 432 and 433 of Volume 15, you will find 7 analyses in one place.

With my regards, I am,

Sincerely,

Louis

Louis O. Williams, Botanist
Plant Introduction Section
New Crops Research Branch