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PROTEIN ENRICHMENT OF FOOD IN DEVELOPING COUNTRIES 1/

by

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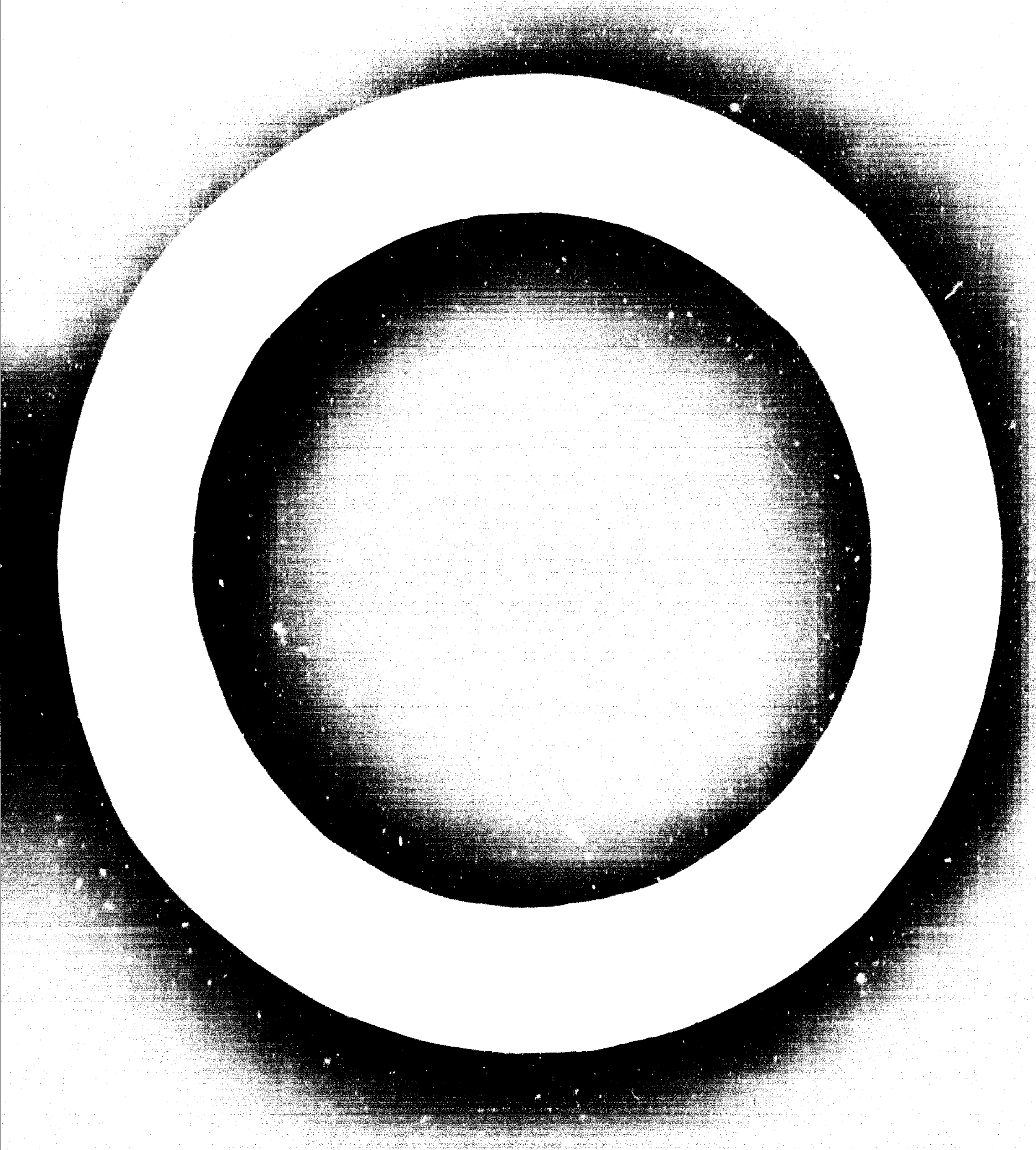


Those who look at the world's food imbalance of today and tomorrow, generally agree that the most important aspect of the world's food shortage is the lack of protein in the diets of the poor and developing countries.

The malnutrition in protein or the deficiency in protein of high biological value concerns mainly some countries in Asia, Africa, as well as the regions in South- and Central America. A discussion of protein nutrition is outside the scope and space of this paper but some short references may be given.

The minimum protein requirement is estimated to be approximately 1.0 gms per kg of body weight of an adult human, this will say 60 - 70 gms daily; in the growing child the minimum requirement for optimum growth may be more than 2 gms per kg of body weight. At least a third of the total protein should be of animal source.

TABLE 1

Staple Foods and Nutritive Value 1/

	Calories		Consumption of			Protein gms/day	
	Requirement/day	Actual Supply %	Cereals kg/year	Tubers and Roots kg/year	Carbohydrate Calories %	Total	Animal Protein
North Africa	2260	97	148	18	75	66	16
West- and Central Africa	2360	103	93	320	74	50	[illegible]
East- and South Africa	2380	101	149	36	73	69	17
South Asia	1970	86	139	10	76	50	7
Central America	2130	90	112	11	71	58	14
Australia and New Zealand	3250	125	89	53	48	94	62
U.S.A.	3110	120	67	49	40	93	66
West Europe	2910	113	111	101	55	83	39

In Table 1, one can recognize the basic diet (staple food) of the different areas in respect of the protein uptake. It can be seen from this table that especially in the regions of West and Central Africa the main diet of the people consists of roots and tubers (e.g. Cassava and Yams), therefore, the protein uptake is insufficient. In South Asia too a deplorable situation of protein deficiency has existed for a long time.

The consequences are mostly found among the poorer population, because foods richer in protein, like meat, eggs, milk, are too expensive, or not at all available. They are compelled to cover their food requirements almost, if not only, by their native starch-containing cereals, legumes, roots and tubers, which are much cheaper.

But very often the economical situation is not the only reason for protein deficiency, for it is found also where protein is available in sufficient amounts. The cause of this malnutrition is to be sought in ignorance.

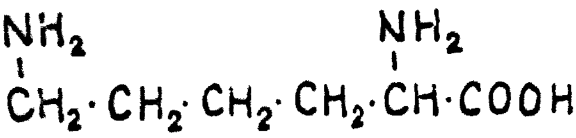
Now allow me to reduce the protein problem to the simplest origins. This introduction and consideration may also help to study more easily the local protein situation and give a better ability to improve protein deficiency.

Human beings are in contrary to plants and many microorganisms dependent on the supply of protein or certain fragments of proteins in the food. These fragments are the amino acids. Today we know about 25 amino acids as basic units of food protein. A certain number of it can be synthesised and converted by our organism. But food must absolutely contain the so-called essential amino acids in a certain minimum amount - 8 for adults, 10 for children.

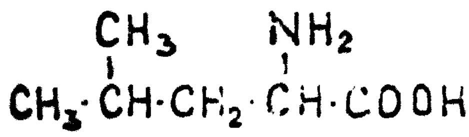
Table 2 see next page

TABLE 2

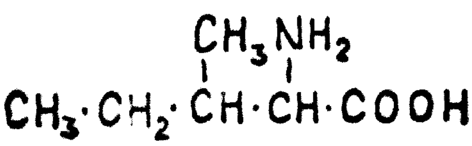
Essential Amino Acids



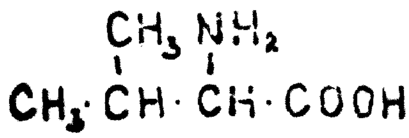
L- Lysine



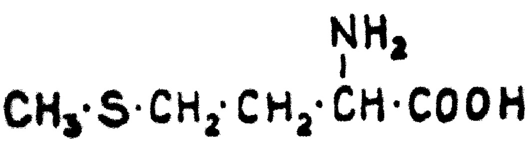
L- Leucine



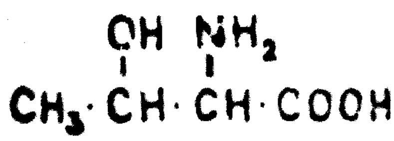
L- Isoleucine



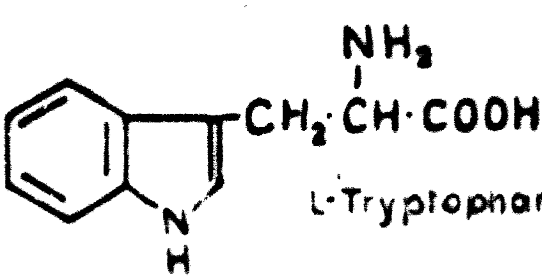
L-Valine



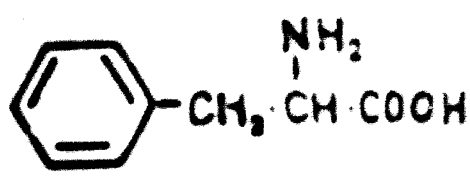
L- Methionine



L-Threonine



L-Tryptophane



L-Phenylalanine

The biological value of the different kinds of proteins is determined by the contents of these essential amino acids.

Table 3 see next page

TABLE 3

Variations in Chemical Scores of Selected Proteins Using Three Different Reference Standards

Food	Based on FAO provisional pattern (a)	Based on human milk essential amino acid pattern (b)	Based on egg essential amino acid pattern (c)	NPU
Milk (cow's)	80	75	60	75
Egg	100	90	100	100
Casein	80	75	60	72
Egg albumin	100	80	90	83
Beef muscle	80	80	80	80
Beef heart	80	80	70	67
Beef liver	85	85	70	65
Beef kidney	80	85	70	77
Pork tenderloin	85	90	80	84
Fish	70	70	75	83
Oats	80	70	70	–
Rye	80	90	90	–
Rice	70	75	75	57
Corn meal	40	40	45	55
Millet	70	60	60	56
Kaollang	70	50	50	56
White flour	50	50	50	52
Wheat germ	60	70	65	67
Wheat gluten	40	40	40	37
Groundnut flour	60	80	70	48
Soy flour	70	85	70	56
Sesame seed	60	50	50	56
Sunflower seed	70	70	70	65
Cottonseed meal	70	95	80	66
Potato	60	85	70	71
Navy bean	50	50	42	47
Peas	60	70	60	44
Sweet potato	80	85	75	72
Spinach	70	100	90	–
Cassava	20	50	40	–

(a) Calculated by comparing the quantity of each essential amino acid per g of total nitrogen with that of the same amino acid in the 1957 FAO reference pattern.

(b) Calculated by comparing the quantity of each essential amino acid per g of total essential amino acids, including tyrosine and cystine, with that of the same amino acid in whole egg.

(c) Calculated by comparing the quantity of each essential amino acid per g of total essential amino acid, including tyrosine and cystine, with that of the same amino acid in human milk.

(d) Sulfur-containing essential amino acids (methionine plus cystine).

Table 3 shows that animal protein is dietetically more valuable than plant protein, e.g. cereal and legume protein. Striking appears the low protein content of Cassava (~ 1.8 per cent). In countries like West and Central Africa the tubers of Cassava, Yams, as well as roots serve as basic diet; there is no deficiency in calories per se. But the low protein content of the tubers and the poor quality of these proteins effect a quantitative and qualitative protein deficiency. For this reason a quantitative protein enrichment of this basic diet is indispensable.

What is the reason that protein of cereals and legumes is not highly valuable (see Table 4)? Today one knows, that these proteins lack certain essential amino acids. Table 4 shows a composition of the limiting essential amino acids in the most important varieties of cereals.

TABLE 4

Limiting Amino Acids in Cereals

Cereal Variety	Limiting Amino Acid No. 1	Limiting Amino Acid No. 2
Wheat (10 - 12 per cent protein)	lysine	threonine
Rice (8 per cent)	lysine	threonine
Maize (9 per cent)	lysine	tryptophane
Millet (10 per cent)	lysine	threonine
Sorghum (10 per cent)	lysine	threonine
Barley (10 per cent)	lysine	threonine

Protein of legumes is characterized by a small contents of methionine. Since in many technical developing countries sufficient amounts of cereals and legumes are available - 70 per cent of the cultivated ground of the earth is used for cereals - the quantitative protein supply is covered there. 1/ This is valid even in case of nutrition with rice, which shows the lowest protein content. The protein supply respectively protein intake covers in case of the above mentioned consumption of rice the daily intake of 1 gm protein per 1 kg of body weight, recommended by FAO. The most acute deficiency in those countries is that in high quality protein! In many regions, there are sufficient quantities of cereal protein, but because of its lack of essential amino acids, it is insufficient in quality. This means, its biological value is low. To be of high quality, this protein requires supplementation with the missing essential amino acids which means to enrich the actual protein. It would be unrealistic to produce more animal protein in the developing countries in order to cover the protein deficiency: The production of satisfactory animal protein in developing countries is an uneconomical process which does not pay because of high loss of transformation by animal feeding.

Other means have to be found to raise protein quality in those countries. Nowadays in principle there are just two possibilities:

1. Enrichment of basic diet as cereals or legumes with pure amino acids,
2. Enrichment of staple foods containing proteins with special supplementary value,
   (a) with animal foods,
   (b) with plant foods.

I. ENRICHMENT WITH AMINO ACIDS 4/

As pointed out, the nutritive value of a dietary protein depends on the pattern or proportions and quantity of essential amino acids which are furnished together with the above protein to the body after absorption by the intestine.

The term "enrichment of protein" will say: protein containing food of lower quality should be revalued, which means to bring it in condition of better "biological protein value". This method has been used in the U.S.A. for many years to enrich feeding-protein with amino acids for poultry nutrition. In order to improve its protein value, methionine is added to legumes which serve as the protein source.

In any case, the way, the know-how, the method and the money for reaching this aim for human nutrition should be adapted to the nutrition and nutrition habits of the concerning developing country.

This means for the practical use: the only success promising method at present, which can guarantee a quick and safe possibility to improve the situation of nutrition with protein containing food of high value is: enriching specifically the staple foods (mostly rich in carbohydrates) with the lacking essential foodstuffs, in this case with protein units.

The ctaple foods of the concerning country are to be chosen as the basis. The means we must add depend on it. The way of adding, that means the technology of enrichment, can differ and depends on several factors.

In many countries the _cereals_ - as corn, rice, wheat, sorghum - are still the main staple foods. As you know, the protein is not complete in biological nutritive sense. The limiting amino acids are lysine and threonine. Corn has still a second limiting amino acids: Tryptophane. These amino acids should be added to cereals in order to improve their protein value.

Theoretical calculations have shown that it would be possible to double the biological value of wheat protein by adding 0.4 gms lysine and 0.3 gms threonine to 100 gms wheat. Within a wheat production of [illegible]00 million tons per year, 25 millions of tons of proteins could be saved. This is as much as the total world production of animal protein.

In countries where _legumes_ are the ctaple food, the amino acid methionine has to be added to the legumes as to peas, soya, peanuts.

It is important to point out that an addition of amino acids as enriching agents only is nutritively effective if the quantitative protein content of the food is sufficient.

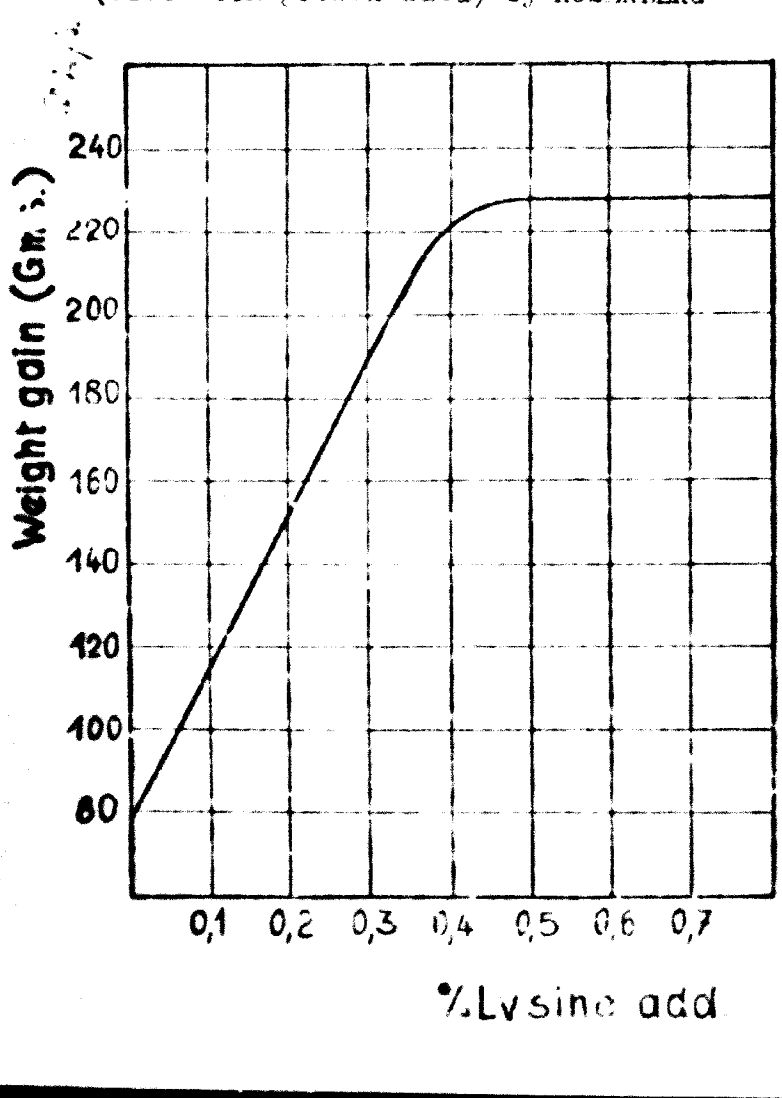
There exists the danger of a destruction of the whole protein metabolism in adding pure amino acids in high quantities; which means that also within an optimal protein supply the utilization of the other amino acids is diminished. This situation or this phenomen is well known as amino acid imbalance.

The chemical analysis gives the first view in determining the optimal amounts of the enriching amino acids in order to avoid amino acid imbalance. The real relations can only be found by biological tests (growth test), alone by this analytical methods the physiological factors - such as digestion and resorption - can be involved.

Here, two examples of this problem: The supplementation of bread protein by the amino acid lysine shows Table 5.

TABLE 5

Growth of Weanling Male Rats on 90 % Bread Diet Supplemented with Graded Levels of Lysine
(five-week growth data) by ROSENBERG

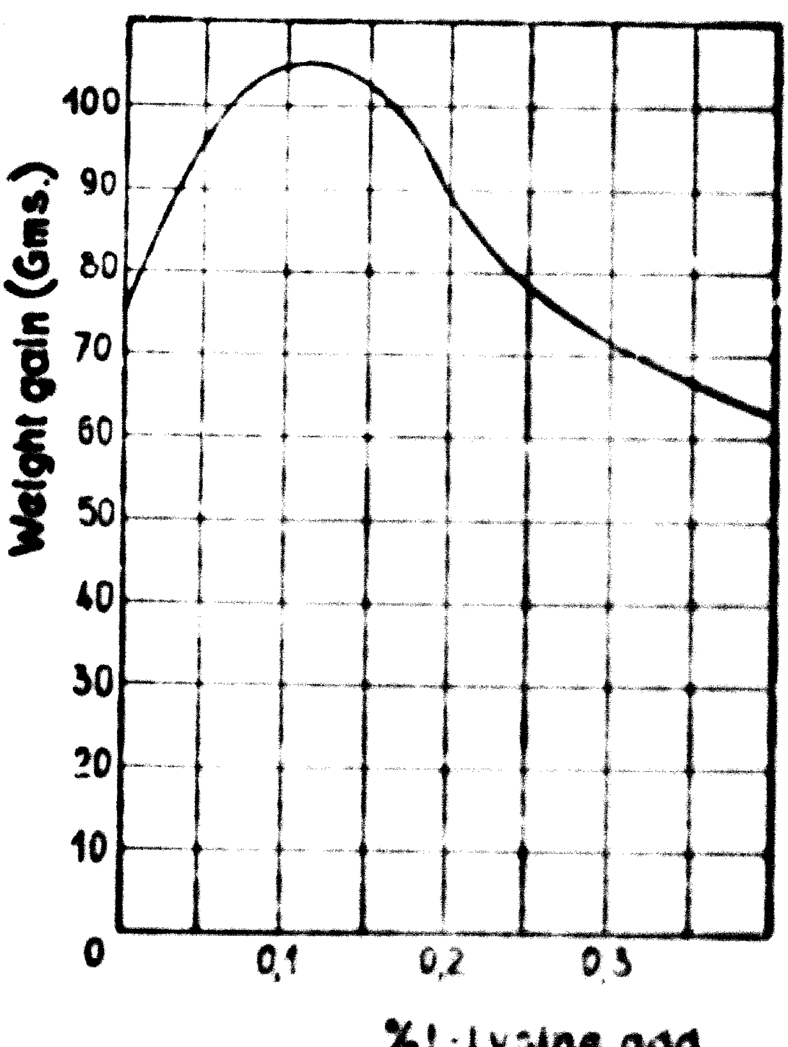


At first the biological value is growing with increasing quantities of the added lysine; but from a definite additive amount no further increase of the biological value can be achieved.

Table 6 gives the results of feeding tests with lysine enriched rice.

TABLE 6

Growth of Weanling Male Rats on Precooked Rice Diet Supplemented with Graded Levels of Lysine (No Threonine added!)



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Here with higher levels of the supplementary lysine a lowering in growth occurs: amino acid imbalance.

Also in the next table (No. 7) you can see in improving peanut protein, that the adding of lysine and threonine gives a lower protein efficiency ratio (PER) than without these amino acids. Both of these amino acids are in optimal amounts in the natural peanut protein.

TABLE 7

Improving of Peanut Protein
(Growth and [illegible])

Methionine	L-lysine	L-threonine	gain/4 weeks	PER a)
%	%	%		
[illegible]	[illegible]	[illegible]	[illegible]	1.[illegible]
[illegible]	0.4	[illegible]	[illegible]	1.[illegible]
[illegible]	[illegible]	0.[illegible]	[illegible]	1.[illegible]
[illegible]	0.4	0.[illegible]	[illegible]	1.[illegible]
0.[illegible]	[illegible]	0.[illegible]	[illegible]	[illegible]

[illegible]

a) PER - Protein Efficiency Ratio = [illegible]

Therefore, [illegible]

[illegible]

I want to show you in Table [illegible] to all cereals.

Production of Amino Acids

Now some notes on the production of the amino acids we need for the fortification of cereals and legumes.

Tables 9 and 10 show two ways to win L-lysine by chemical synthesis [5,6]. In Japan, lysine as well as methionine are synthesized by fermentation [7].

Tendency of Enriching with Amino Acids

As a matter of fact in developing countries, cereals and other foods rich in carbohydrates, represent the main staple food. From the point of view of nutrition and with a view to a certain kind of technique of the protein enrichment, they are considered to be the basis of the protein carriers. The technique of protein enrichment of cereal products can be made by different methods. The method of enrichment has to be adapted to the respective kind of cereal and its state. Whether wheat or rice grains, its milling products (flour) or protein concentrates have to be improved.

Methods of Enriching, Using either Cereal Grains or Processed Cereal Products

The pure nutrients like amino acids are added at very low levels and have therefore no effect on any organoleptic (sensoric) properties of the processed cereal product.

Where cereals are milled into flour or flakes or processed to protein concentrates, the enrichment can be carried out by mixing on a batch basis or on a continuous basis using suitable feeders and mixers. There are in general very simple ways of processing, using the same simple methods exercised for a long time for vitamin enrichment [8].

But enrichment techniques become more difficult when the cereal is consumed in whole grain. This concerns particularly the regions where rice represents the main staple food (basic diet), because of the almost universal custom of washing the

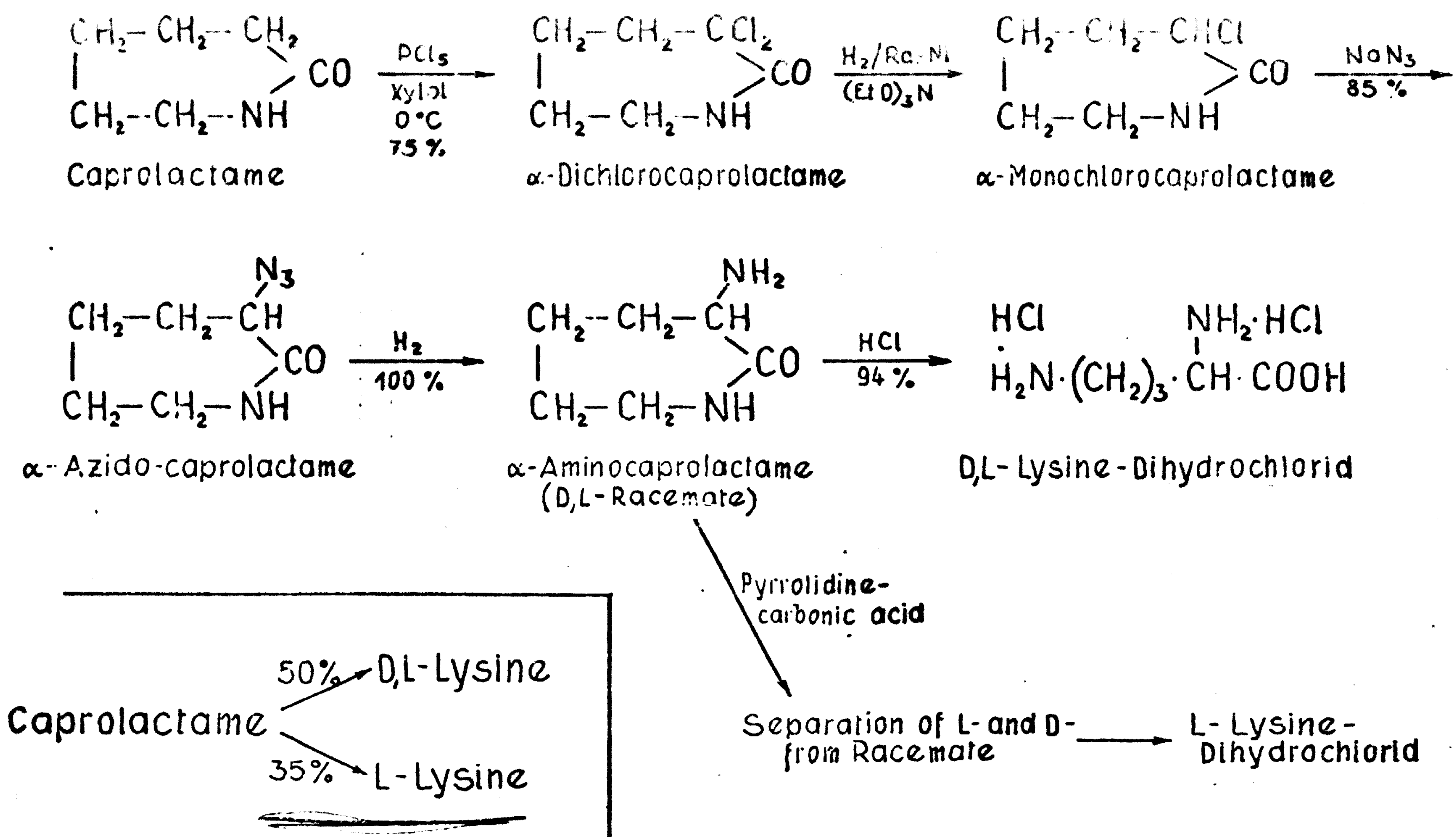


Table 9: Chemical Synthesis of L-Lysine (Basic Material: Caprolactam)

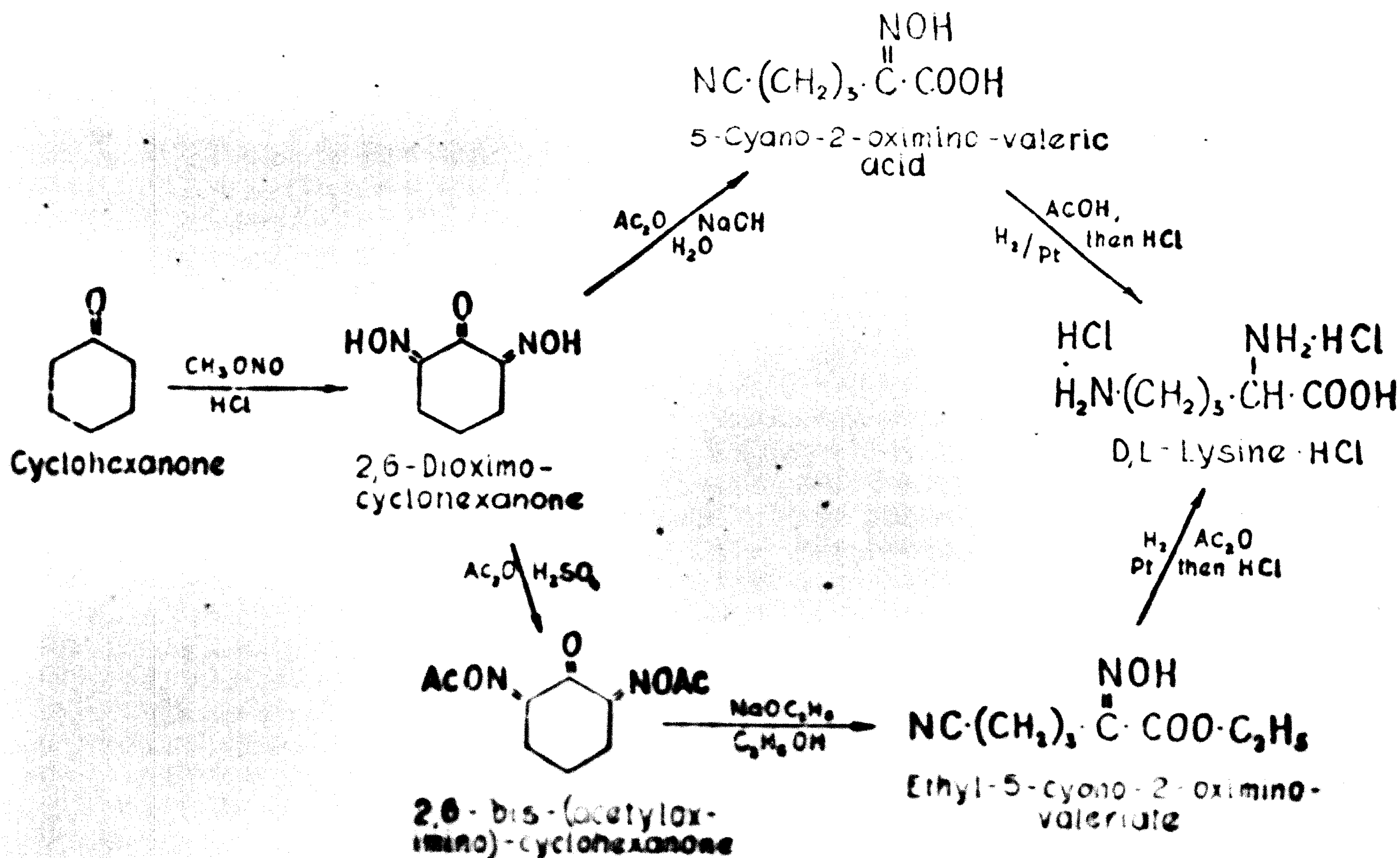


Table 10: Chemical synthesis of L-Lysine (Basic Material Cyclohexanone)

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] "[illegible]"). It depends on the [illegible]. Therefore, [illegible] data [illegible] staple foods [illegible].

Because of the [illegible] and the great [illegible], [illegible] of staple foods [illegible] the protein supply by improving [illegible].

II. [illegible]

(a) [illegible]

[illegible]

[illegible] + [illegible]

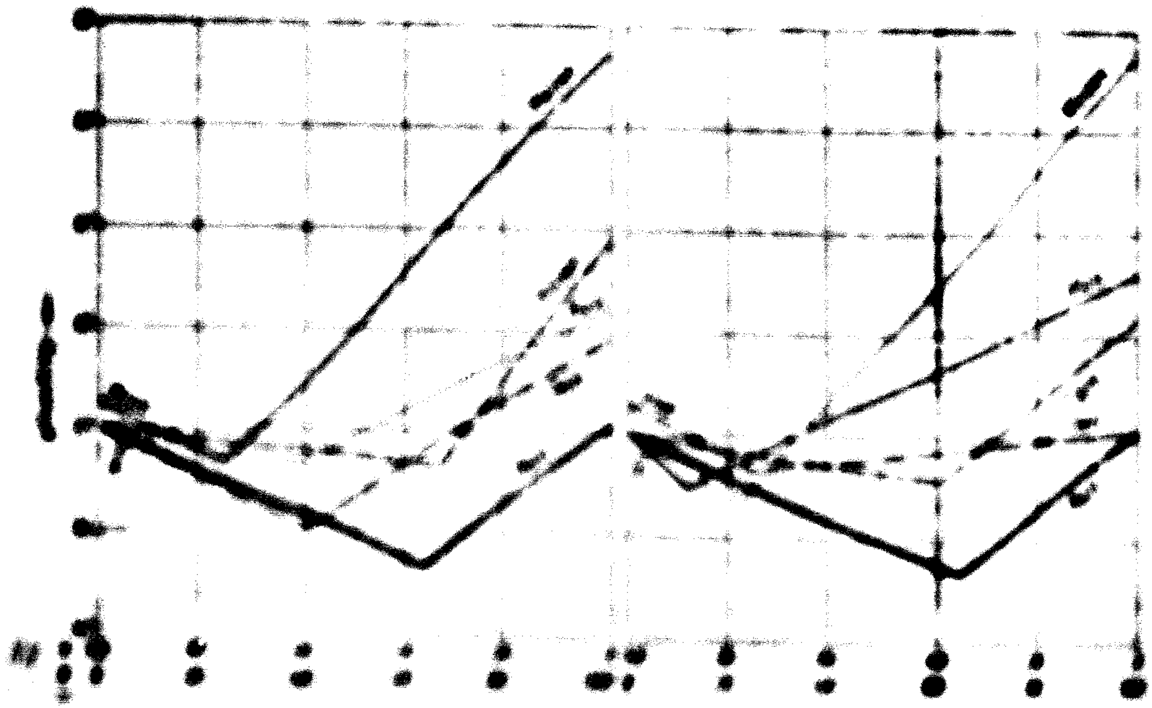
[illegible] + [illegible]

Potatoes + [illegible]

In the next figure [illegible] are shown.

TABLE 11

[illegible]



[illegible]

This shows that animal proteins in suitable mixing ratios result in a significant increase of the biological value of plant proteins.

The enrichment of the cereal and legumes staple foods with animal protein is, of course, only possible if these animal foods are available.

As you know, an increasing production of animal protein in the technically underdeveloped countries is not possible because of the high transformation loss by feeding animals. Nevertheless, it is a wonderful enrichment of the basic cereal and legume foods with animal proteins such as milk powder. Several products have been developed on this basis in different countries with the help of national and international organizations as FAO. Here, a list of these products: See page 19 and 20, Table 12.

The problem of this enrichment is the need of milk powder in developing countries, but it can either not be produced at all, or only in insufficient quantities. These are also the reasons for the fortification with eggs and fish products (fish, dried fish or fish meal).

Therefore, it is necessary to find out ways and means of enriching plant staple foods in these developing countries with protein rich indigenous plant foods.

(b) <u>Enrichment with Plant Protein Foods</u>

The problem concerns not only increase of the agricultural production of the usually grown crops but it also involves the necessity for the

(i) identification of new edible vegetable materials rich in certain essential amino acids suitable for proper supplementation of the low quality proteins of many common food crops.

TABLE 12

Protein Food Mixtures 11/
Addition of Skim Milk Powder

Product	Country	Composition	Protein Content %	Price in US $ per kg
ALIMENT DE SEVRAGE	Senegal	Millet flour, peanut flour, skim milk powder, sugar, Vit. A, D; Ca	20.0	(In 20 kg polyethylene Kraft sacks) 0.25
CSM	U.S.A.	Maize (precooked), defatted soya flour, skim milk powder, $CaCO_3$, vitamins	20.0	(In 50 lb bags) 0.20 - 0.21
CEPLAPRO (in grain form)	U.S.A.	Degerminated maize flour, wheat, defatted soya, skim milk powder, $CaCO_3$, vitamins	18.0 - 20.0	-
SUPRO	East Africa	Maize or barley flour, torula yeast, skim milk powder, salt, condiments	24.0	0.38
PRONUTRO	South Africa	Maize, skim milk powder, peanut, soya, FPC, yeast, wheat germ, Vit. A, B_1, B_2, niacin; sugar, iodized salt	22.0	(In 1 lb bags) 0.62 (In 4 lb bags) 0.46 (In 40 lb bags for institutions) 0.26 (In 40 lb bags for industrial firms) 0.30
PROTONE	U.K., Congo	Maize, skim milk powder, yeast, vitamins, minerals	24.40	(In 50 lb bags, in small quantities) 0.54 (In 50 ton orders) 0.49
ARLAC	Nigeria	Peanut flour, skim milk powder, salts, Vit. B_1, B_2, B_{12}, D	42.0	0.46

TABLE 12 - Continued

Product	Country		Composition	Protein Content %	Price in US $ per kg
ALIMENT DE SEVRAGE	Algeria		Wheat, chick peas, lentils, skim milk powder, sugar, Vit.D	20.0	(Provisional estimate) 0.50
[illegible]	Ethiopia		Teff, peas, chick peas, lentils and skim milk powder	15.0	-
LAC-TONE	India (CFTRI)		Peanut flour, skim milk powder, wheat and barley flour, vitamins, Ca	26.0	-
PERUVITA	Peru	3.1	Quinua and cotton seed flour, skim milk powder, sugar, spices, $CaCO_3$, vitamins A, B_1, B_2	30.0	(In 100 g bags) 0.56 (In 300 g bags) 0.48
		3.2	Same formula with salt instead of sugar	35.0	(In 100 g bags) 0.56

(ii) To realise the possibility of their production in various regions.

(iii) To find the proper and not too complicated technological methods of processing to render them as edible foods with an acceptance as desired by the native people.

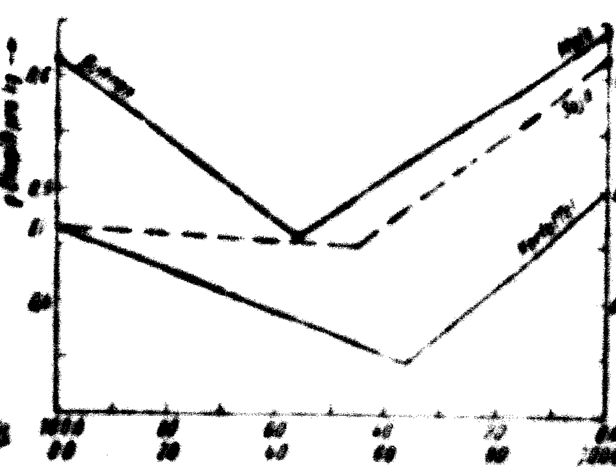
I will try to show you that this way will be possible to verify at least in some important examples and technological possibilities.

To solve this problem, we must at first know the protein composition of the different plant foods. Much work has been done so far in this field, but certainly there is still much left to be done.

But if our aim is to simplify the problem on the amino acid contents of the plant proteins we find some differences (see Table 4). You remember that cereals contain as first limiting amino acid lysine, while legumes have as limiting amino acid methionine. By adding legumes to cereals, a better protein value must be reached. Research work shows results. As you see in Table 13, a mixture of about 40 per cent beans with 60 per cent of corn gives a protein value comparable to the height of egg protein.

TABLE 13

Minimum Requirement of Different Protein Mixtures [10]



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It is interesting, that in Guatemala the poor people take this proportion of beans and corn for their usual diet.

In all countries where cereals and legumes as beans and peas are cultivated, the development of food or rather the education of people to such food mixtures which contain both staple foods, beans as well as corn in a similar proportion, will help to improve the qualitative protein lack.

Feeding experiments with children in Tunesia with a mixture of 1/3 beans and 2/3 corn showed an effective improvement of health.

In Algeria a weaning product was developed on the basis composition from wheat, chick-peas, lentils (name: Aliment de Sevrage, see page 1?, Table 12).

Industrially and economically important for enriching cereals are the oil seeds, mainly peanut, soybean, cotton seed. Here are some examples of such mixtures developed in several countries (the complete composition with all ingredients such as vitamins or milk is not given here).

TABLE 14

Food Mixtures of Cereals and Oil Seeds

Cereal Staple Food		Enriching Oilseed	Name of Product	Country
Corn	+	cotton seed flour	Incaparina	Guatemala
Corn	+	cotton seed flour + defatted soybean flour	Incaparina	Columbia
Corn	+	defatted soybean flour	Incaparina	Mexico
Corn	+	defatted soybean flour	Fortifex	Brazil
Corn	+	peanut soybean	Pronutro	South Africa
Corn pre-cooked	+	defatted soybean flour	CSM	U.S.A.
Corn degermi-nated + wheat	+	defatted soybean	[illegible]	U.S.A.
Wheat (mixed)	+	defatted oilseed flour	Bal-Ahar	India
Barley flour	+	peanut flour	Lac-Tone	India
Millet flour	+	peanut flour	Aliment de Sevrage	Senegal

[illegible]

[illegible]

[illegible]

Product	Country	Composition	Protein Content %	[illegible]
[illegible]	1.1 [illegible]	[illegible]	[illegible]	[illegible]
	1.2 [illegible]	[illegible]	[illegible]	[illegible]
	1.3 [illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	India	[illegible]	[illegible]	[illegible]
[illegible]	India [illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible] with Incaparina 12/

It is interesting to follow the development of such a new product. Let us show this with the example of Incaparina.

This [illegible] protein-rich food product came out after ten years of intensive laboratory research and five years of commercial development in several Latin American countries. Incaparina is the name given by INCAP to vegetable mixtures containing 25 per cent or more of proteins, comparable in quality to those of animal origin. The use has been proved suitable for the feeding of young children as well as for adults. Several formulas, utilizing vegetable protein concentrates derived from cottonseed or soybeans, have been developed and are now in commercial production in several countries. The next table shows the basic Incaparina formula currently in commercial application.

TABLE 16

Basic Formulas and Alternative Modifications [illegible] used in the Preparation of Incaparina

	Formulas		
Ingredients g/100 g	No. 9	No. 14	No. 15
Ground cooked whole corn *	58	58	58
Cottonseed flour	38		19
Soybean flour		38	19
Torula yeast	3	3	3
$CaCO_3$	1	1	1
Vitamin A, I.U.	4500	4500	4500

* Note: Amount of rice, corn or sorghum, or other suitable cereal grains (cooked or [illegible]), may be varied and used separately or together in such a way as to account for 58 g per 100 g of the total product.

This kind of protein-rich food product is utilized in the home in accordance with the cultural pattern of the consumers. It may be readily incorporated in such foods as soups, cookies, drinks, etc. Its principal use in Latin America has been as a popular drink commonly called "Atole".

The biological evaluation and clinical testing with animals and children have proved that the protein content and quality of the mixture approach those of milk!

The following data (Table 17) compare the nutrient content of one glass of Incaparina with that of other common foods:

TABLE 17

Comparison of the Nutritive Value of One Glass of Incaparina with other [illegible] Foods

	Atole of corn masa*	Atole of INCAPA-RINA*	Milk	Meat	Egg	Fresh cheese (whole milk)	Fresh cheese (skim milk)
	1 glass	1 glass	1 glass	1 oz.	1 unit	1 oz.	1 oz.
Calories	86	133	141	36	30	79	38
Protein, g	1.0	6.9	6.9	6.4	5.6	5.2	6.3
Fat, g	0.4	1.0	7.6	0.7	5.5	6.0	0.5
Carbohydrates, g	20.2	25.3	11.3	0.6	0.5	1.0	1.6
Calcium, mg	22	164	374	6	26	235	206
Phosphorus, mg	22	174	168	52	95	112	100
Iron, mg	0.0	2.1	1.0	1.7	1.5	0.4	0.5
Vitamin A, I.U.	0	1125	363	0	90	257	43
Thiamine, mg	0.02	0.55	[illegible]	0.02	0.05	0.01	[illegible]
Riboflavin, mg	0.00	0.28	0.50	0.07	0.20	0.13	[illegible]
Niacin, mg	0.19	1.95	0.10	0.79	0.04	[illegible]	[illegible]

Notes: Values taken from the Food Composition Table for Central America and Panama, Fourth Edition (INCAP Publication E-2[illegible]).

* **One glass** of atole is prepared by dissolving either 2[illegible] g of **Incaparina** or corn masa in one glass of water, boiling the **mixture** for 10 to 15 minutes and sweetening it with 12 g of **sugar**.

Although this product primarily was developed for preventive purposes and has been used to cure serious cases of protein malnutrition, it is not a medicine. It is a food!

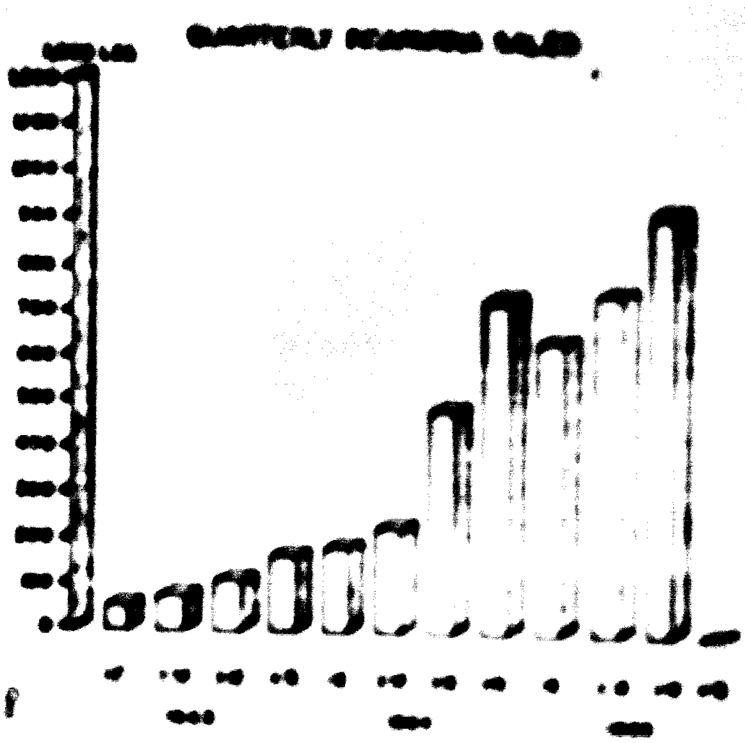
Formula modification (see Table 14) like in this protein-rich product [illegible], are possible for many other protein-rich food products and gives promise for the adoption of further new products to the dietary patterns of other areas of the developing countries where such a protein supplement is needed. This example represents the result of the efforts to develop suitable protein-rich food mixtures since [illegible] at the Institute of Nutrition for Central America and Panama (INCAP) based on maize, cottonseed flour, sorghum and some Torula Yeast + vitamin A as the only ingredients that may have to be imported 1/.

The increase in sales as the result of the wide acceptance of this type of protein-rich food contains a graphic representation from 1963 to 1965:

TABLE 15

Incaparina Sales

1963 - 1965



[illegible]

[illegible]

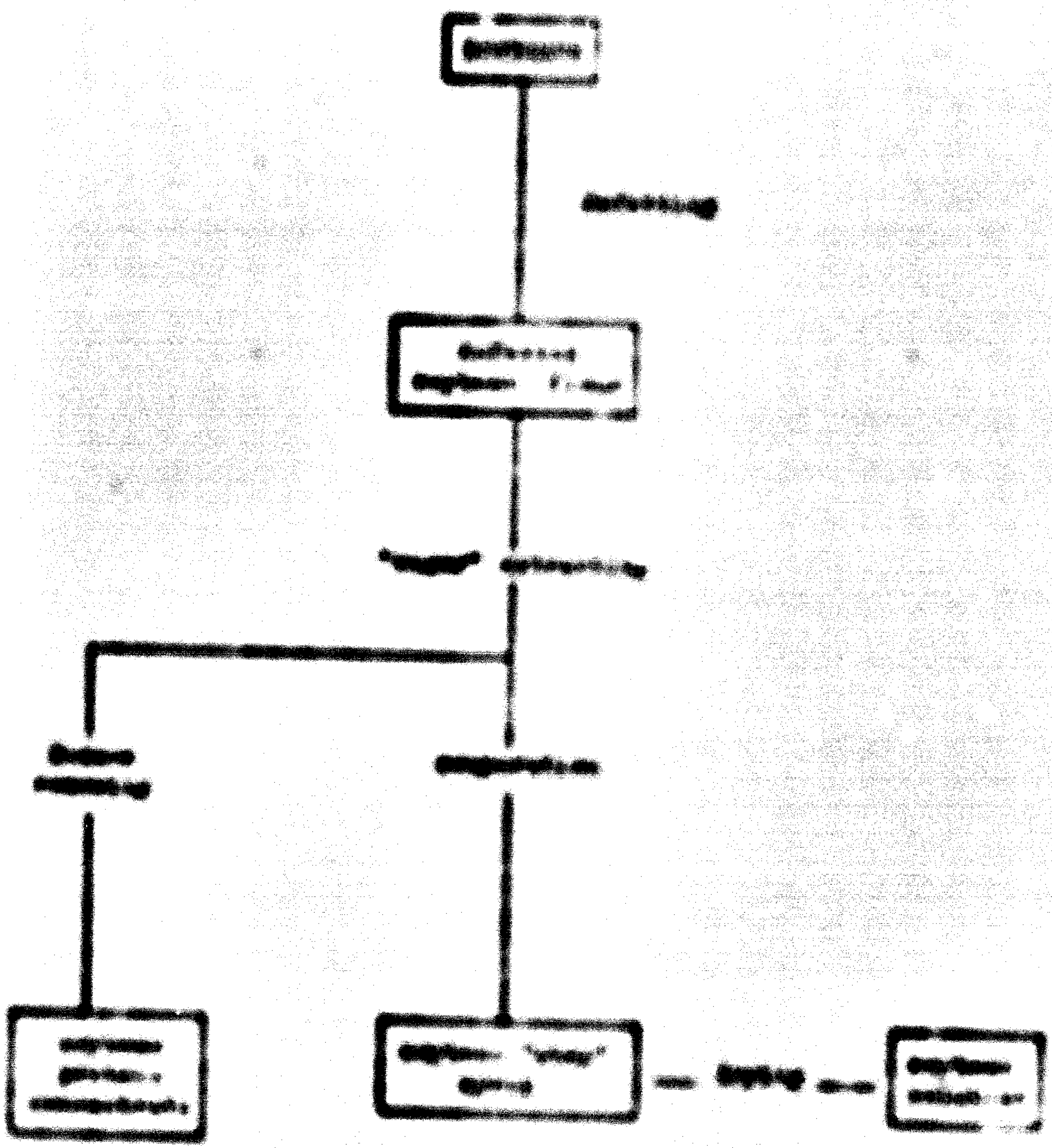
[illegible]

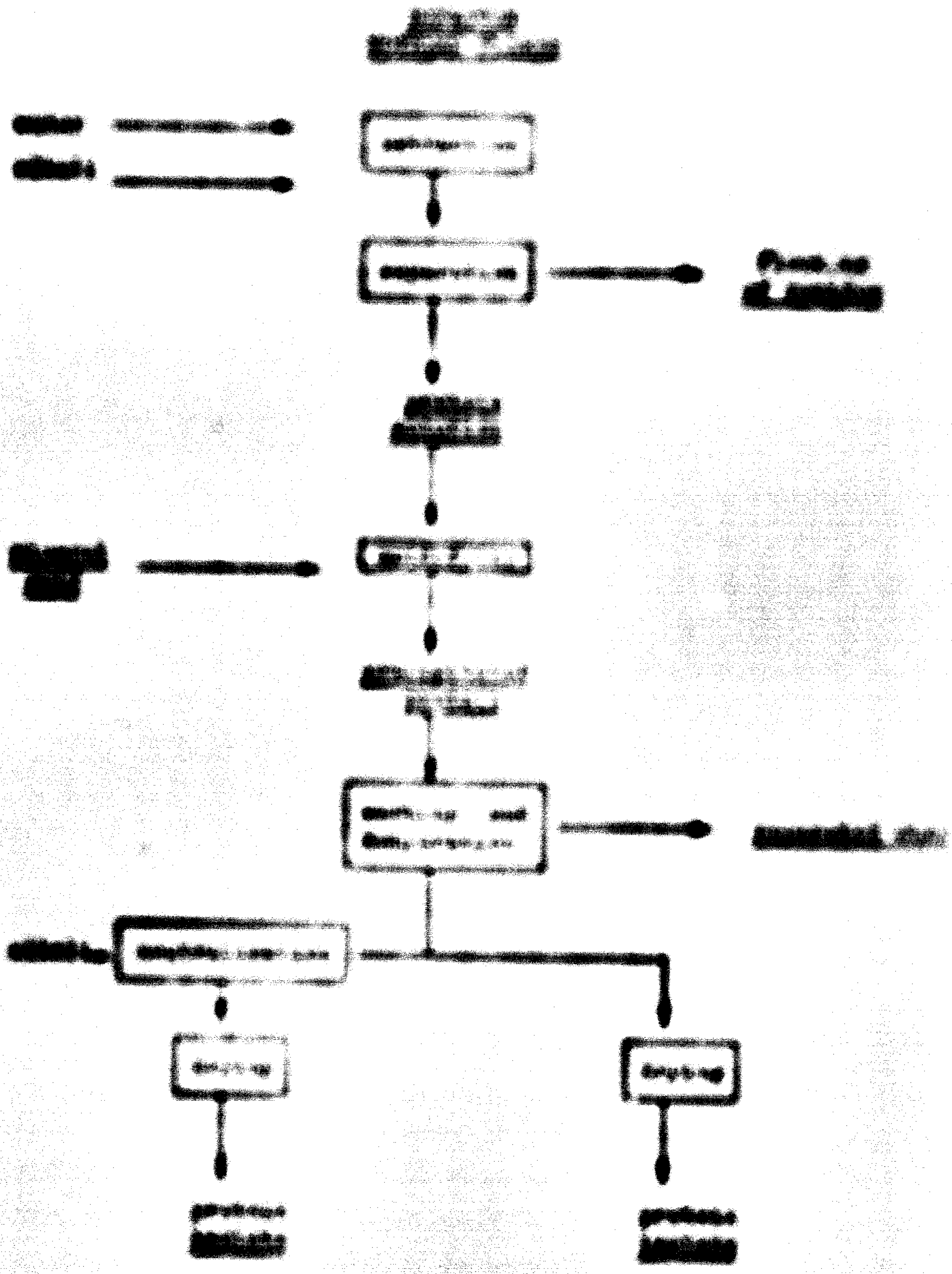
[illegible]

[illegible]

[illegible]

[illegible]





[illegible]

[illegible] [illegible]

[illegible] of protein [illegible] protein [illegible] [illegible] of the oil [illegible] [illegible] per cent [illegible] per cent [illegible] of protein [illegible] Peanut [illegible] of the protein, [illegible] Peanut protein [illegible] [illegible]

The protein efficiency [illegible] of a food [illegible] [illegible] the [illegible] [illegible] the fortified [illegible] per cent [illegible]

[illegible] of [illegible] Africa, [illegible] by peanut protein concentrates.

Peanut [illegible], containing [illegible] per cent of protein, is a [illegible] peanut product; it is commercially manufactured (in U.S.A.) [illegible]

[illegible] [illegible] the oil from the peanuts by [illegible] of the expeller [illegible] the [illegible] to the [illegible] stage used in [illegible] protein from [illegible] are similar to those of protein preparation of [illegible]

1. Preparation of a water-meal mixture and addition of protein dissolving chemicals such as caustic with following extraction with alkali.
2. The protein fraction was prepared by means of screening, filtering and/or centrifuging.
3. The saponified extract is treated with acid (as coagulating chemical) to precipitate the protein as cheese-like curd from water-protein-solution.
4. Separation of the protein curd from the solution, dewatering, washing and drying.

Possibly the most extensive use of peanuts as a food for most people all over the world, especially for developing countries, is in the form of protein. In India much emphasis is put on peanut flour and peanut protein isolates because of the need in high protein foods in that country. Unfortunately those countries where peanuts are most abundant are able to utilize the method of preparation of peanut protein only in a limited way. But the technical way of preparing peanut protein and protein products (described above) is simple and uncomplicated, that there should be given any technical help in producing peanut protein as a food for developing countries.

Recently it has been possible during processing of oil seeds to win protein as well as oil by impulse rendering and to separate oil and protein fractions continuously in a one-way-process. This represents a remarkable progress in oil and protein technology.

Cottonseed Concentrating

Cottonseed represents another important source utilized for human consumption but the development of cottonseed protein concentrate encountered a number of difficulties. In particular the presence of a toxic (phenolic) pigment, called gossypol which is found throughout the plant. By suitable defatting and dehulling cottonseed and by treating it to remove (or reduce) the contents of this toxic factor gossypol to a suitable level (safe), it is possible now to produce a blend product containing [illegible] per cent or more of protein.

However, there are some technical difficulties yet to remove the toxic contents of gossypol. By carefully designed oil extraction processing conditions using special solvent methods, we can obtain an edible cottonseed protein concentrate having a protein contents of about [illegible] per cent and a contents of gossypol of 0.0[illegible] per cent at the most. At present the most technical difficulties in processing of cottonseed is, to reduce the contents of gossypol without any diminution of the nutritive value of the cottonseed protein obtained. It is hoped to procure a cottonseed protein concentrate of sufficiently high quality by employing the new pressure solvent extraction process in near future, which seems of high nutritive value (PER) and free of gossypol.

Considering the advantages and possibilities of the world-wide use of oil seeds as actual and potential protein sources, we should not overlook a serious problem in connection with oil seeds and oil seed proteins in the tropics. The aflatoxin: this means a mycotoxin produced by a mold which grows rapidly on improperly harvested and stored oil seeds and cereals. The aflatoxin problem has arisen with any oil seed protein in the tropics. Any practical programme and solution of this problem will have to comprise applications concerning the nutrition of the developing countries too.

A main problem in respect to produce protein concentrates from oil seeds - free of aflatoxin - is to provide means of preventing the contamination of the crop with fungi or to eliminate the aflatoxin from the processed products.

Nevertheless, preference should be given to the utilization of oil seed protein at all. We need the continuous encouragement

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
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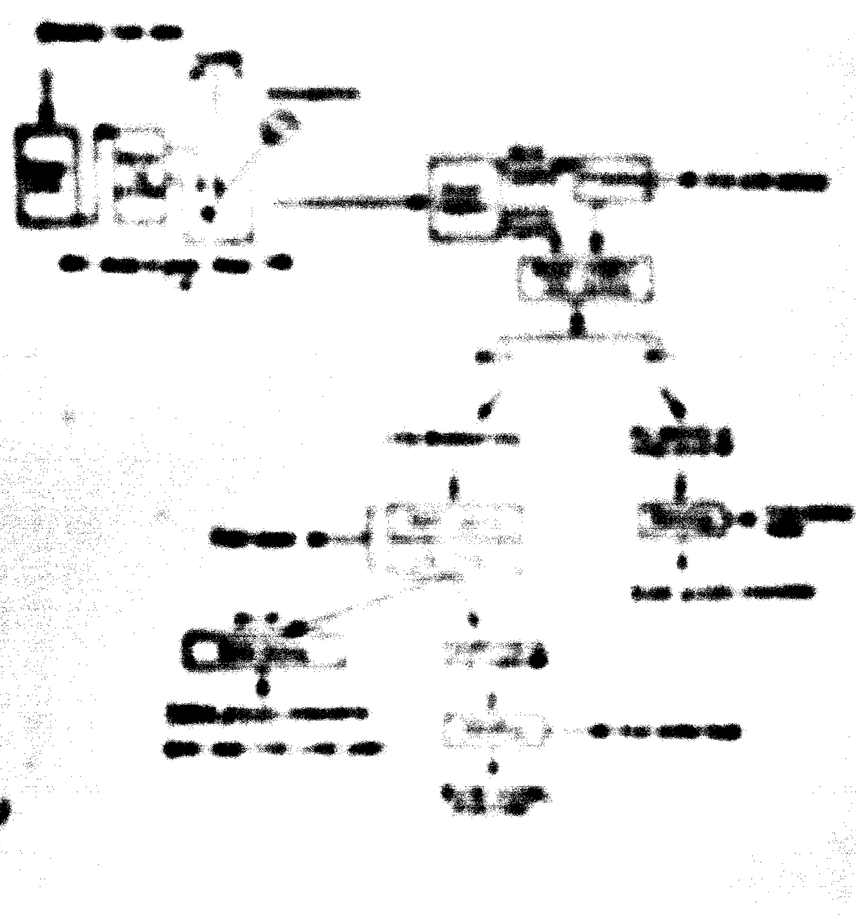

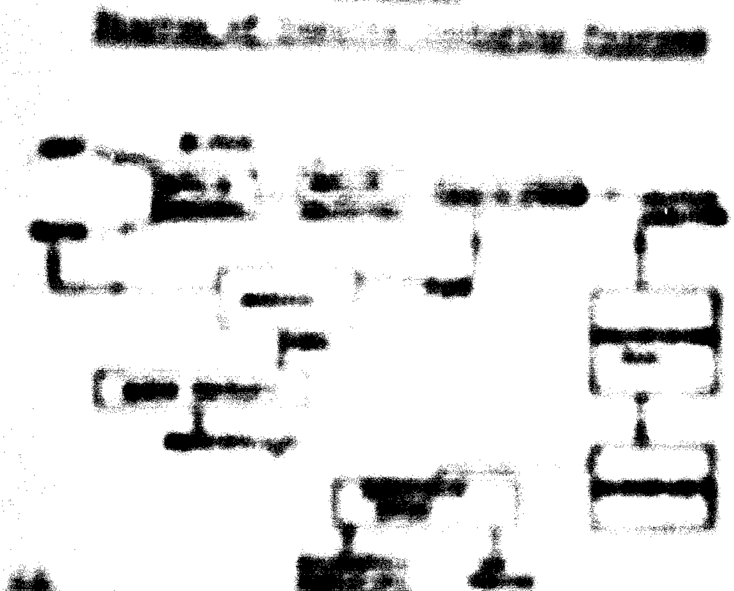

[illegible]

Food Yeast

Yeast [illegible] grown on the [illegible] sources of nitrogen in synthetic [illegible] [illegible] could produce [illegible] [illegible] [illegible] food materials. [illegible] [illegible], food yeast is an important potential source of protein for human nutrition.

Algae

Particularly Chlorella, have found the interest of research workers in Japan, the U.S.A. and elsewhere. To date no substantial commercial production of algae has been attempted, apart from small scale efforts in Japan.

Petroleum Proteins

Recent development activity pursued by several major oil companies in the production of proteins by growing micro-organisms on paraffinic hydrocarbons derived from crude petroleum. These protein products of [illegible] [illegible] [illegible] obtained are now being tested as animal feed.

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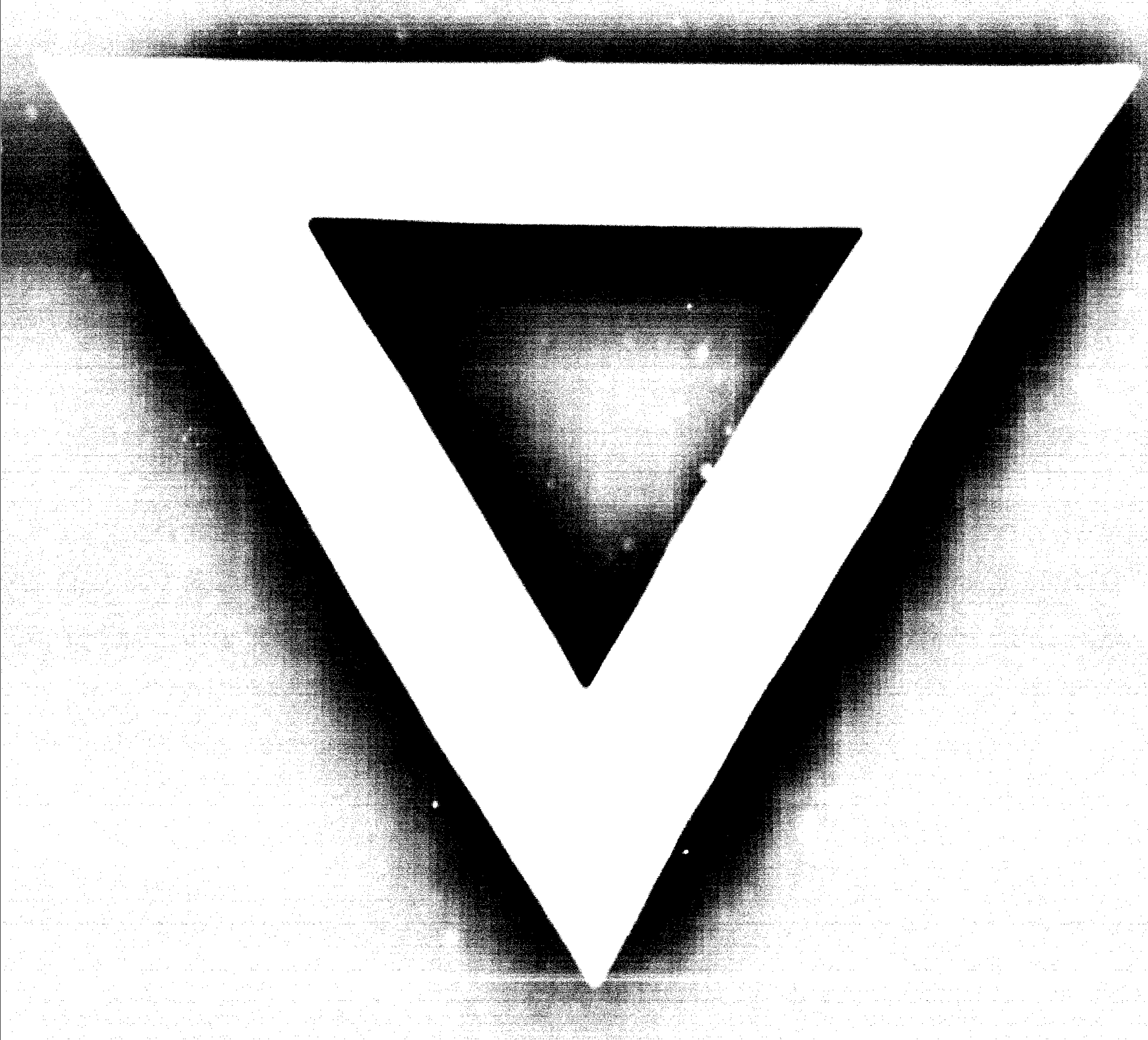

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