STUDIES ON A 'BALANCED FOOD'

Part I. Processing and Related Aspects

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Summary

The method employed in processing a 'balanced food' composed of oilcake proteins is described.

The conditions under which simultaneous mutual supplementation of amino acids from a mixture of vegetable proteins could be effectively achieved were indicated in an earlier communication.[1] The data presented there showed that a protein mixture composed of groundnut, sesame and soyabean cake flours, in the proportion of 3 : 1 : 1, possessed the highest biological value (72·5). This composition was therefore selected as the protein base for the balanced food.

During recent years, supplementary foods based on oilcake proteins as possible sources of dietary proteins have formed the subject of intensive research. Groundnut cake by itself was found useful in some cases.[2–4] Pulses[5] did not supplement effectively diets composed largely of tapioca due presumably to the low biological value of these proteins.[6] Kuppuswamy *et al.*[7] did not find groundnut flour at 10% level to be a useful supplement to a poor rice diet. Partial replacement (25–50%) of the rice in a rice diet by tapioca and other similar tuber flours was found beneficial.[8–13] Various other types of tonic foods and synthetic cereals were found to improve the quality of poor rice diets.[14–25]

The studies reported in this paper were initiated long before many of the papers referred to above were published.[26, 27] Besides, a systematic study involving the selection of a protein base by biological value determinations and evaluation of the nutritive value of the food by practically all the known methods including human feeding trials was still necessary. Only by adopting such a procedure it would be possible to evolve a food which could afford protection against the protein malnutrition prevalent in the country.

Composition and method of preparing the food.—The oilcakes available in the market are not suitable for use in food meant for human consumption. These cakes are made under wholly unhygienic conditions and contain a fair percentage of stones and dirt. No attempt is made to remove the unhealthy and fungus attacked seeds prior to crushing. Further, the deshelled groundnut used in the expeller still contains a high amount of shells and the outer red skin is never removed. Thus the market cake is fit only for use as a fertiliser, though in this country it is also used as a cattle feed.

The oilseeds, therefore, had to be specially processed taking care to exclude completely stones, dirt, bad seeds, and, in the case of groundnut, the shell and the outer red skin. Only then would it be possible to obtain a cake fiour that could be used in the supplementary food. In the case of sesame, the white variety was used. The expeller cakes were subjected to solvent extraction so as to obtain the cake flours nearly free from oil. Soyabean was decorticated, debittered[28] and autoclaved to destroy the proteolytic and growth inhibitors. The dried product was powdered and solvent extracted.

The shape of the supolementary food would be a major factor influencing its acceptability. In view of many Indian homes using vermicelli (popularly known as *sevai* in South India) in one form or another, it was decided to make the food in that form which, when broken to small uniform bits would also, to a certain extent, resemble rice. But it was found that vermicelli made with the mixed cake flours and tapioca added as the carbohydrate component of the food did not yield a hard material that would stand handling and subsequent cooking. In order, therefore, to improve the quality of the food from the points of view of acceptance and nutritive value and strength of the vermicelli, and after carrying out some trials with different materials, wheat flour to the extent of 10% was added. This improved the quality of the dough and yielded harder grains with better cooking quality. Incorporation of wheat flour also helped to improve the taste and palatability of the food. The following composition of the different constituents was finally chosen.

Groundnut cake flour	30%
Sesame cake flour	10%
Soya flour—defatted	10%
Wheat flour	10%
Tapioca (powder)	35%
Yeast	2%
Common salt and condiments*	3%

Gelatinisation.—In making vermicelli from the dough generally the mixed flour is gelatinised so as to facilitate the formation of uniform threads. In order to avoid gelatinising the entire flour it was felt that trials could be conducted to determine the optimum percentage of the flour which on gelatinisation would result in the production of uniform threads of vermicelli. It was found that gelatinisation of 30% of the mixed flour yielded satisfactory results.

Gelatinisation consisted of heating the flour with the requisite quantity of water at 70° to 80° C. with constant and intimate mixing for about 15 to 20 minutes when the characteristic gelatinous texture could be noticed. The gelatinised portion was then mixed with the rest of the flour and the dough pre-

* The condiments consisted of carrot powder, onion extract, chillie powder and some pulses such as tur dhal.

pared in the usual manner was passed through a vermicelli machine. The threads were dried in the sun or in an oven at 40° to 50° C. through which a current of air was blown. When dry, the threads were broken to small bits as uniformly as possible and stored in suitable containers.

The food analysed to the following composition. The composition of American multi-purpose food is also given in the same table for comparision.

TABLE I

Chemical composition of the 'Balanced Food'

	American Multi-purpose Food	Balanced food A	Balanced food B
Moisture		3·1	3·1
Protein % (N × 6·25) ..	42·3	34·8	35·0
Mineral matter		5·9	5·8
Crude fibre		2·5	2·5
Carbohydrate		53·6	53·6
Calcium mgm. %	470·0	353·0	473·2
Phosphorus mgm. %	440·9	453·1	450·0
Iron mgm. %	7·1	5·3	7·1
Thiamine (B_1) mgm %	0·7	0·22	0·76
Riboflavin (B_2) mgm. %	1·18	0·25	1·2
Nicotinic acid mgm. %	7·05	7·14	7·2
Vitamin A and carotene I.U. % ..	2940·0	140·5	3001·0

The above results show that the 'balanced food' without enrichment with minerals and vitamins may not satisfactorily answer the needs of a supplementary food. Though the protein content is lower than the American food, it is not desirable to increase the protein content as a greater proportion of oilcake flours would adversely affect the colour and taste of the food. It is, however, possible to add synthetic vitamins and minerals to bring these to the same level as in the American food. Accordingly a fortified† balanced food was prepared incorporating synthetic vitamins (A, B_1 and B_2) and minerals (calcium and iron). In the

† At the time of mixing the different flours calcium lactate and iron citrate, at 4·1 gm. and 41 mgm. respectively, per pound of the flour were added in a finely powdered condition. Vitamins A, B_1 and B_2 were added as an emulsified solution at the time of making the dough. Vitamin A concentrate (Roche) at 12,875 i.u. per pound of flour was dissolved in a small quantity of groundnut oil with Tween 80 and was emulsified with aqueous solutions of Vitamin B_1 (2·5 mgm./lb. of flour) and Vitamin B_2 (4·5 mgm./lb. of flour) using a Waring Blender. Thus a thorough and uniform mixing of these constituents was ensured.

case of the fortified product, yeast (2%) was replaced by condiments. The chemical composition of the fortified food is also given in Table I.

In most of the studies conducted to evaluate the nutritive value of the food, both the compositions (enriched and non-enriched) were employed. The object was to determine the extent to which the non-enriched food would be useful. For, in times of emergency, the supplies of synthetic vitamins might not be available thereby necessitating the use of the non-enriched food.

Although in the original composition tapioca was added, it is now felt that this material need not be used. When people find a ready-made food in the market, they often get suspicious. If, on the other hand, the specially processed oilcake flours, enriched with vitamins and minerals, are distributed to the people, they could mix other types of flour with it. Thus, it is possible to make *chappati*, *puri*, *ompudi*, *bajji*, and other preparations. Mixed with rice flour, vermicelli could also be made. Many homes have the vermicelli machine and know the best method of obtaining vermicelli. Under certain emergencies, such as flood, it is no doubt advisable to make the vermicelli food.

Cooking qualities of the food.—The vermicelli bits could be cooked in the same way as rice. It was found that frying the material for a short period (about five minutes) with a small quantity of oil imparted a characteristic flavour and a desirable taste to the cooked product.

It is well known that excess of water in cooking rice would necessitate decanting *kanji* (gruel) containing useful amounts of vitamins and minerals. The same type of losses would also result in cooking the food with excess of water. Trials conducted in this direction showed that the total loss of nutrients increased with increasing amounts of water.

TABLE II

(*a*) *Extent of loss of food as indicated by total solids in* kanji

Weight of raw food (gm.)	Quantity of water c.c.	Ratio of food to water	Weight of cooked food (gm.)	Volume of *kanji* c.c.	Total solids present in *kanji* (gm.)	Percentage of food lost in *kanji*
30	120	1 : 4	80	15	1·1	3·6
30	180	1 : 6	76	85	2·9	9·6
30	240	1 : 8	80	150	4·5	15·0

But it was found that the product cooked with six times the weight of water (as that of the dry food) was the best from the point of view of appearance and acceptability of the cooked food. In spite of some loss of nutrients, it was considered desirable to use six times the weight of water. It was also felt that the *kanji* thus obtained could be used as a drink in place of water (as is actually the case particularly with the labour classes).

(b) Loss of nutrients as influenced by increased proportions of water used in cooking

1. Minerals and nitrogen

Ratio of food to water	Total in raw food mgm.	Total in cooked food mgm.	Drained in *kanji* mgm.	% loss in *kanji*	Percentage unrecovered
		Phosphorus			
1 : 4	127·86	115·0	9·1	7·1	3·0
1 : 6	127·86	110·3	15·0	11·7	2·1
1 : 8	127·86	107·5	17·8	13·8	2·0
		Calcium			
1 : 4	140·2	130·2	8·0	9·7	1·5
1 : 6	140·2	119·6	17·8	12·7	2·0
1 : 8	140·2	116·0	21·5	15·3	2·1
		Iron			
1 : 4	2·0	1·8	0·15	7·5	2·2
1 : 6	2·0	1·7	0·26	13·2	2·0
1 : 8	2·0	1·6	0·32	16·2	2·0
		Nitrogen			
1 : 4	1580·0	1494·7	47·4	3·0	2·5
1 : 6	1580·0	1475·2	73·2	4·6	2·0
1 : 8	1580·0	1345·8	199·5	12·6	2·2

2. Vitamins

Ratio of food to water	Total in raw food	Total in cooked food	Drained in *kanji*	% loss in *kanji*	% loss during cooking
		Thiamine			
1 : 4	153·0 mgm.	105·3 mgm.	30·61 mgm.	20·0	11·1
1 : 6	153·0 ,,	73·19 ,,	64·22 ,,	42·0	10·2
1 : 8	153·0 ,,	61·53 ,,	80·0 ,,	52·3	7·5
		Riboflavin			
1 : 4	328·3 mgm.	236·38 mgm.	67·37 mgm.	19·0	9·01
1 : 6	328·3 ,,	185·82 ,,	115·89 ,,	35·3	8·1
1 : 8	328·3 ,,	141·83 ,,	152·0 ,,	46·3	10·5
		Nicotinic acid			
1 : 4	2087·0 mgm.	1638·3 mgm.	298·44 mgm.	14·3	7·2
1 : 6	2087·0 ,,	1463·0 ,,	515·49 ,,	24·7	5·2
1 : 8	2087·0 ,,	1302·29 ,,	653·23 ,,	31·3	6·3
		Vitamin A			
1 : 4	1612·0 I.U.	1259·3 I.U.	198·27 I.U.	12·3	9·6
1 : 6	1612·0 ,,	1147·8 ,,	295·0 ,,	18·3	10·5
1 : 8	1612·0 ,,	1118·75 ,,	356·2 ,,	22·1	8·5

The cost of the food.—Expeller merchants all over India, generally obtain a fair amount of profit which would normally be considerably in excess of the cost of cake. Even with the extra cost towards cleaning the oilseeds, the oil sold would more than cover the price paid for the oilseed as well as the working and establishment charges. In any event, the cake flours could certainly be obtained without any cost if the manufacturer of the ' balanced food ' also puts up an expeller unit. It is, however, advisable to go in for a solvent extraction plant in which case the yield of oil would be higher than with an expeller. Further, the cake produced would contain only traces of fat and would thus help in improving the keeping quality of the food.

Soyabean oil is not used in India. It is not difficult to explore the possibilities of exporting this oil.

The cost of the ' balanced food ' under these conditions would be comparatively low and a daily supplement of 2 oz. calculated to meet a third of the total daily requirements of proteins, vitamins, and minerals would be within the reach of everyone including the poorest. It may also be reasonably hoped that the food in question would bestow substantial benefits on the class of population showing symptoms of protein malnutrition and deficiencies due to inadequate vitamin and mineral intake.

Supplementary foods of the above type do not come under the category of the usual supplementary foods. Although it is not desirable to feed the population of any country with such materials, the special conditions now prevailing demand the use of oilcake or other good quality proteins in order to safeguard the health of the people.

Certain unfavourable criticisms have been advanced against the use of soyabean.[23] Proceeding on the basis of biological value, it may be seen that few vegetable proteins could come up to the quality of soyabean protein. If it is desired to overcome the protein malnutrition prevalent in the country, there is little doubt that the protein supplement should be of high quality. Quantity can never make up quality. Groundnut cake flour by itself or mixed with other low-quality oilseed proteins could make up bulk, but would not contribute to the needs of the human body.

While it is reasonable to expect people to have prejudices and sentimental objections in the matter of using a supplementary food composed of oilseed cake flours, it is wholly unjustifiable to ban the use of soyabean which contains about 40% proteins of a biological value of about 76 (the autoclaved product). Further, soyabean could be cultivated with comparative ease. It is high time that scientists of this country realise the value of this legume and recommend its cultivation on an extensive scale. Any attempt at overcoming the protein malnutrition with a low cost supplementary food would be attended with success only if India could produce soyabean or other such equally protein rich *cum* high protein quality crops.

The studies on nutritive value of the food are reported in the subsequent papers under this series.

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