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THE APPLICATION OF FOOD TECHNOLOGY IN OVERCOMING MALNUTRITION IN INDIA

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DIET surveys conducted in different parts of India have shown that the diets consumed by a large section of the people contain negligible amounts of protective foods such as milk, egg, meat and fish and are deficient in proteins, certain vitamins and minerals. A small section of the population do not get enough food to eat (1-3). Nutrition surveys have shown the wide-spread incidence of deficiency diseases among the low-income groups of the population. The incidence of protein malnutrition and vitamin A and riboflavin deficiencies is high among weaned infants and young children and of anaemias due to deficiencies of iron, folic acid and vitamin B_{12} are fairly common among expectant and nursing mothers (3, 4).

Data regarding the *per capita* food production in 1954-55 and of the expected production in 1965-66 together with the estimated *per capita* food requirements are given in Table I. It is evident that the estimated production of milk, meat and fish in 1965-66 falls short of the requirements. The production of animal foods requires more land and is less economical than the production of vegetable protein foods (5). It will therefore be difficult to increase their production to any appreciable extent as the present *per capita* land available in the country is highly inadequate for this purpose. In view of this, the shortage of protein-rich and protective foods can be made up only by increasing the production of plant proteins.

It is possible to make better use of available food resources in several ways through the application of food science and technology. Some of these include (*i*) conservation and better utilisation of available food supplies (*ii*) augmentation of the supplies of energy yielding foods, (*iii*) development of low-cost protective foods based on protein-rich foods of vegetable origin and fortified with essential vitamins and minerals for use in feeding infants and as supplements to the diets of weaned infants, children and expectant and nursing mothers. A brief survey of the progress made in the application of food science and technology in solving problems of nutrition in India is presented in this paper.

Conservation and better utilisation of available food supplies

The developments in this field are briefly outlined below:

Prevention of Losses of Foodgrains in Storage

Surveys in commercial godowns have shown that the annual losses of foodgrains stored in godowns in India as a result of insect infestation are about 5 million tons (6). Simple and effective methods for the fumigation of foodgrains in warehouses using a mixture of ethylene dibromide and methyl bromide have been developed. Impregnation of jute bags with insecticides has been found to prevent insect infestation of foodgrains stored in jute bags. Adoption of the above techniques in warehouses and godowns has been found to prevent effectively losses of foodgrains in storage (6).

Preservation and Processing of Fruits and Vegetables

Optimum cold storage conditions for the preservation of several fruits and vegetables have been worked out (7). Treatment of fruits and vegetable with wax emulsions containing fungicides and growth regulators has been reported to extend their storage lives two to four fold both at room temperature and under refrigerated storage conditions (7). Improvements have been effected, in the methods for the processing of several fruits, in various forms such as canned fruits, squash, juice concentrates, fruit juice powders, jams, jellies etc. and in the dehydration of fruits and vegetables (8).

Preservation and Processing of Meat and Fish

Freezing of fish on a commercial scale is being carried out to a limited extent in coastal areas. Improvements relating to the following processes have been published (*i*) salting and curing of fish (*ii*) drying of fish and (*iii*) canning of fish. A process for the production of fish flour from oil sardine has been developed. Reference to this product will be made in a later section. Improve-

ments in the processes for the preparation of canned and dehydrated meat and meat-based soups have been reported (9).

Preservation and Processing of Milk

Milk is a highly perishable food. Experience in India and several other countries has shown that adequate facilities for processing of milk into different products are essential for increasing milk production. The different processed milk products consumed in India are infant and invalid foods, dried milk—full-fat and skimmed, condensed, and evaporated milk, butter and ghee, cheese and casein. The estimated requirements of some dairy products by 1966 are as follows: Milk powder, (full-fat), 5,000 tons; Milk powder, Skimmed, 20,000 tons; Infant and invalid foods, 6,000 tons; Cheese, 1,500 tons and condensed milk 6,000 tons. Steps are being taken by the government to achieve the above production targets. The problem of production of infant foods has been dealt with in a later section.

Augmentation of the supplies of energy yielding foods

In view of the shortage in the supply of cereals, it has been found necessary to augment cereal supplies by the use of improved processing techniques and also by the use of subsidiary foods such as roots and tubers and oil-seed meals. Investigations carried out at C.F.T.R.I. have shown that roots and tubers such as tapioca, sweet potato and potato, which yield about 2-3 times as much calories as cereals, can be used as partial substitutes for cereals (10). A blend (75: 8: 17) of wheat flour, groundnut flour and tapioca flour (known as *Paushtic atta*) possesses nutritive value comparable to that of wheat flour as judged by experiments on children (10). Macaroni type of products prepared from blends of tapioca flour, groundnut flour and wheat semolina, can be used as partial substitutes for cereals (10). Improvements have been effected in the process of parboiling of paddy. Since parboiling helps to retain more B vitamins and to give a higher yield of head rice, large scale adoption of this process will help to increase the present rice supplies to an appreciable extent (11). Recent investigations at C.F.T.R.I. have shown that solvent extraction of oil-seed cakes, rice bran and cotton-seed will help to increase the present oil supplies by about 50 per cent and will thus add substantially to our oil resources (12).

Development of low-cost processed protective foods for feeding infants and for supplementing the diets of vulnerable section of the population

In view of the acute shortage in the supply of protein-rich and protective foods in several developing countries, efforts have been made by research workers in different countries and some U.N. agencies towards the utilisation of plant proteins such as oil-seeds, oil-seed meals and legumes and also fish in child-feeding (13-14). Since milk is a good source of not only proteins but also of calcium, vitamin A and several B vitamins, it is essential to fortify the protein foods of vegetable origin with the nutrients commonly lacking in poor diets. The cost of fortification has been found to be very low.

Infant Foods

Cow's milk is used widely for feeding infants in many countries. In India, buffalo milk is also used to a limited extent for feeding infants particularly in the states of Punjab, Gujarat and Maharastra. India has been importing, till recently, infant milk foods from other countries. A process for the production of infant food from buffalo milk, which is available in surplus in certain regions, was developed at C.F.T.R.I., Mysore (15). Infant food is now being manufactured according to this process on a large scale by the Kaira Co-operative Milk Producers' Union, Anand.

A large volume of work has been carried out in India and other countries on the produetion of milk substitutes based on oil-seed meals (16). Milk substitutes prepared in dry form will have the advantage of compactness, ease of transportation and good keeping quality. Spray dried milk substitutes based on soyabean are at present being commercially manufactured in America (17) and also in Indonesia with FAO and UNICEF aid (18). Methods have been developed at C.F.T.R.I., Mysore for the preparation of infant foods from (*i*) blends of soyabean and groundnut milks, (*ii*) groundnut protein isolate, dextri-maltose, vegetable fat, and skim milk powder and (*iii*) coconut honey, groundnut protein isolate, dextri-maltose, vegetable fat and skim milk powder (19-21). Data regarding their chemical composition are given in Table II. Large scale production of these products will help to overcome to a considerable extent the shortage of milk and milk foods in the country.

Protein Foods for Weaned Infants and Young Children

Several types of protein foods suitable for supplementing the diets of weaned children have been developed by several workers. These include (*i*) a blend (4: 1) of parched Bengal gram flour and skim milk powder, (*ii*) Indian multipurpose food formula C, a 3: 1: 1 blend of groundnut flour, Bengal gram flour and skim milk powder fortified with calcium salt and certain vitamins, (*iii*) Nutro biscuit from a blend of wheat flour and groundnut flour fortified with calcium salts and vitamins, (*iv*) Balanced Malt Food, a blend of sorghum or ragi malt, groundnut flour, Bengal gram flour and skim milk powder fortified with calcium salts and vitamins, (*v*) Enriched tapioca and wheat macaroni from a blend of tapioca, wheat, groundnut and Bengal gram flours fortified with calcium salts and certain vitamins and (*vi*) Roller dried flakes based on blends of wheat flour, groundnut flour and Bengal gram flour. Data regarding the nutritive value of these foods are given in Table II. Feeding trials with weaned infants and young children (Table III) have shown that incorporation of these foods in their diets brings about a marked improvement in their growth, general health and nutritional status and they are readily acceptable to the children (22-27).

Protein Foods suitable for the Treatment of Protein in Malnutrition in Children

Recent investigation have shown that a blend (52: 48) of groundnut protein isolate and skim milk powder or a spray dried protein food (Table II), based on groundnut protein isolate, dextri-maltose, and skim milk powder

(containing about 36 per cent protein) is almost as effective as skim milk powder in the treatment of protein malnutrition in children (28, 29). The cost of these foods will be less than that of skim milk powder when compared on the basis of their protein contents. Use of such blends will help to extend three fold the available meagre supplies of skim milk powder in the country.

Protein Foods for School Children and Expectant and Nursing Mothers

Protein foods (Indian multipurpose food and similar products) based on blends of groundnut flour, Bengal gram flour and coconut flour and fortified with calcium salts and certain vitamins have been found to be excellent supplements (Table IV) to the diets of children (30, 31). A protein food based on a 2:1:1 blend of groundnut flour, Bengal gram flour and fish flour and fortified with calcium salts when incorporated daily at a level of 40g. per child, brought about a highly significant improvement (Table IV) in the growth and nutritional status of the children (32). These foods can also be used as supplements to the diets of expectant and nursing mothers.

Organisation and development of essential food industries

The need for large scale production of protein foods for use as a supplement to the diets of weaned infants and other vulnerable sections of the population has been stressed by the U.N. agencies, such as FAO, WHO and UNICEF (33, 34). In fact, these organisations have been helping various governments in the production of protein supplements by providing equipment and technical help (18, 35). Two plants for the production of edible groundnut flour (production capacity 10 tons/day) have recently been installed with UNICEF aid in Bombay and Coimbatore. These will go into production shortly. The entire output will be used by the government for the production of protein supplements for weaned infants and young children. At present, a private firm in Madras state is manufacturing Indian multipurpose food on a large scale (5 tons/day) according to the process developed at C.F.T.R.I., Mysore. A greater part of this production is being used by the Madras state as a supplement in the lunch provided to school children. Some other states in India have also plans for the production and use of Indian multipurpose food in school lunch programmes. It has been reported that a product (known as INCAPARINA), based on sorghum, corn and cotton-seed flours and fortified with food yeast, calcium salts and vitamin A, is being manufactured and used successfully on a large scale for feeding young children in Gautemala (13). It is to be hoped that rapid advances will be made in the near future in the application of available knowledge of food technology for overcoming malnutrition and for improving the diet and nutrition of the vulnerable sections of the population.

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TABLE I

Estimated production of foodstuffs as compared with requirements for a balanced diet (ounces/*per capita*)

Foodstuffs	Requirements for a balanced diet*	Estimates of production†	
		1955/56	1955/66
Cereals	14	14.7	17.4‡
Pulses	3	2.6	3.5
Green leafy vegetables	4	2.6	4.0
Root vegetables	3		
Other vegetables	3		
Fruits	3	1.0	1.2
Milk	10	4.5	6.0
Sugar and jaggery	2	1.6	2.0
Oils and fats	2	0.4	0.6
Fish and meat	3	0.4	0.6
Eggs	one		

* Recommendations of the Nutrition Advisory Committee of the Indian Council of Medical Research (1944).

† Ministry of Food and Agriculture.

‡ Without making allowances for grains required as seed and for losses in storage.

TABLE II

Chemical composition* of processed infant and protein foods fortified with essential minerals and vitamins (values/100g.)

Sl. No.	Foods	Protein (N×6.25) (g)	Fat (g)	Carbo-hydrates (g)	Cal-cium (g)	Phos-phorus (g)	Iron (mg)	Thia-mine (mg)	Ribo-flavin (mg)	Nicoti-nic acid (mg)	Vitamin A I.U.	Vitamin D I.U.	Calories
	Infant Food based on:												
1.	Soya and groundnut ...	24.7	18.6	51.5	1.05	1.13	7.2	0.85	1.23	8.2	2120	400	472
2.	Groundnut protein isolate and skim milk powder ...	26.2	18.4	47.3	0.95	0.73	4.0	0.90	1.50	6.0	1500	400	460
3.	Coconut honey, groundnut protein isolate and skim milk powder ...	26.0	18.2	46.8	1.10	0.80	4.0	0.62	1.33	6.2	1500	400	455
4.	Milk food (from buffalo milk) ...	26.6	18.5	46.5	1.04	0.92	4.0	0.52	1.46	1.2	1360	400	459
	Processed Protein Foods:												
5.	Indian multipurpose food (Formula A) ...	41.9	8.5	35.8	0.67	0.82	5.1	1.03	3.00	14.0	3000	300	387
6.	Indian multipurpose food (Formula C) ...	40.6	7.0	39.0	0.80	0.86	4.2	1.11	2.80	10.4	2400	240	381
7.	Protein food containing coconut meal ...	36.5	7.5	39.4	0.88	0.65	5.5	1.82	3.11	10.5	3000	300	382
8.	Balanced malt food ...	31.9	4.9	48.0	0.58	0.55	6.7	1.50	3.00	8.5	3000	300	364
9.	Nutro Biscuits ...	16.5	16.7	62.5	0.22	0.20	1.2	1.10	2.50	34.0	1520	700	466
10.	Enriched tapioca macaroni	18.0	2.1	71.1	0.49	0.42	3.2	0.68	0.70	5.6	1500	100	347
11.	Spray dried protein food based on groundnut protein isolate and skim milk powder ...	35.2	1.8	53.7	1.42	0.98	6.5	0.94	1.53	6.2	1500	400	372
12.	Fish flour from oil sardine	84.2	0.12	2.0	3.77	2.26	8.8	2.40	3.65	16.5	5000	500	346
13.	Protein food containing fish flour ...	51.6	5.3	25.3	1.80	1.51	8.2	1.51	2.10	9.9	3000	300	355
14.	Skim milk powder ...	35.6	1.0	52.0	1.30	1.03	0.6	0.33	1.96	1.1	...	...	359

* The moisture content of the different foods varied from 4—8.5%.

TABLE III

Mean increases in height and weight of young children receiving different protein supplements

Experiment No.	Duration of experiment (months)	Diet	No. of children per group	Age (years)	Increase in Height (cm)	Increase in Weight (kg)
I	3	Rice diet (control) ...	23 boys	1¼—2½	0.82	0.34
		Rice diet + 4 : 1 blend of groundnut flour and skim milk powder ...	23 ,,	1¼—2½	1.40	1.02
		Rice diet (control) ...	23 girls	1¼—2½	0.70	0.32
		Rice diet + 4 : 1 blend of groundnut flour and skim milk powder ...	23 ,,	1¼—2½	1.20	0.98
II	9	Rice diet (control) ...	8 boys	9/12—2½	4.30	0.74
		Rice diet + Multipurpose food (formula C) ...	8 ,,	9/12—2½	6.38	1.95
		Rice diet + Malt food ...	8 ,,	9/12—2½	5.46	1.91
		Rice diet (control) ...	10 girls	9/12—2½	3.51	1.02
		Rice diet + Multipurpose food (formula C) ...	10 ,,	9/12—2½	6.17	2.34
		Rice diet + Malt food ...	10 ,,	9/12—2½	6.18	2.29
III	6	Rice diet (Control) ...	16 boys	8/12—3	3.86	0.92
		Rice diet + Enriched tapioca macaroni ...	16 ,,	8/12—3	5.21	2.08
		Rice diet (Control) ...	17 girls	8/12—3	3.56	0.85
		Rice diet + Enriched tapioca macaroni ...	17 ,,	8/12—3	4.95	2.02

TABLE IV

Mean increases in height and weight of school children receiving different protein supplements

Experiment No.	Duration of experiment (months)	Diet	No. of children per group	Age (years)	Increase in Height (cm)	Increase in Weight (kg)
I	6	Rice diet (control) ...	26 boys	5—11	1.83	0.54
		Rice diet + Fortified groundnut flour ...	26 ,,	5—11	2.79	1.29
II	5	Rice diet (control) ...	23 girls	4—12	1.32	0.45
		Rice diet + Multipurpose food ...	23 ,,	4—12	2.44	1.19
III	8	Rice diet (control) ...	20 boys	5—12	3.22	0.57
		Rice diet + Protein food containing coconut meal ...	20 ,,	5—12	4.09	1.50
VI	6	Rice diet (control) ...	29 boys	4—12	1.78	0.98
		Rice diet + Protein food containing fish flour ...	29 ,,	4—12	3.17	1.99

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