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PROBLEMS IN FEEDING THE ARMED FORCES.*

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The main problems encountered in the proper supply of foodstuffs for the maintenance of defence forces relate to procurement, preservation and storage of foodstuffs and their supply and transport on one hand, evaluation of nutritional requirements of the forces engaged in different kinds of work and designing of rations to serve specific purposes on the other. Apart from these problems which are quite broad in nature, there are others of specific character. This paper is intended to deal with some of the latter with particular reference to (*i*) the eight-men composite pack ration and the scope of its improvement (*ii*) principles guiding the choice of food in relation to environmental factors and (*iii*) some recent developments in food research.

The Eight-men Compo-pack ration

This pack ration is a special one devised for operation when transport is limited and normal cooking and catering arrangements are not practicable.

The pack contains one day's ration for 8 men. The food ingredients in the ration, as detailed in Appendix Table 1, are *biscuits*, *nuts*, (assorted), *ground nuts* (roasted and sugar coated), *milk* (tinned, sweetened as well as unsweetened), *cheese* (tinned), *sugar*, *jam* (tinned), *vegetables* (tinned), *fruit* (tinned), *tea* and *salt*.

The nutrient contents as calculated per ration are approximately 4,200 calories, 107 gms. fat, 91 gms. protein of which 28 gms. are animal protein, 12 mg. iron, 1·2 gm. calcium, 4,700 I.U. of vitamin A, 0·8 mg. vitamin, B_1, 1·5 mg. vitamin B_2, 10 mg. niacin and 43 mg. vitamin C. In order that the levels of B vitamins and vitamin C may be optimum, compound vitamin tablets are issued separately. Usually the supplementation is made when an individual has to live continuously on his ration for 20 days or more.

The importance of each item lies in its specific dietary properties. For instance, biscuits contribute more than 33 per cent. of the total calories, protein, iron and niacin, and 60 per cent. of the vitamin B_1 in the ration. Nuts supply more than 40 per cent. of the fat, 30 per cent. of the protein and 20 per cent. of the iron. Milk and cheese which are the only sources of animal protein supply more than 30 per cent. of the total protein. More than 80 per cent. of the calcium, 60 per cent. of the vitamin B_2 and about 25 per cent. of the vitamin A are also derived from them. Vegetables contribute about 68 per cent. of vitamin A and vitamin C. Vegetables and fruits combined together furnish about 24 per cent. of the iron, 33 per cent. of the niacin and 85 per cent. of the vitamin C.

Though the ration might appear quite adequate on the basis of the calculated nutritive value, this is not, however, the only criterion to indicate its quality. A question may also be asked how far this ration is liked by the troops. Indications are there that this ration requires further modification to suit their taste, especially when it is to be used for a number of days. Some

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ingredients of this ration are not also stable for more than a few months because of certain chemical changes. For example, the biscuit does not retain its freshness and palatability, and becomes rancid and soft within 4—6 months and sometimes much earlier. Groundnut which is fairly rich in fat also develops rancidity and becomes unfit for consumption. If the keeping quality of the biscuit is to be improved, it is necessary to study how this property is influenced by different protein supplements, different types of shortenings at varying levels, moisture, temperature and other constituents. If nuts are to be replaced, protein rich supplements such as gram or peas with lower fat content might be suggested. As usual, they are to be roasted and salted. The biological value of proteins from nuts or gram or peas is relatively poor and it would be desirable from the standpoint of nutrition and palatability to substitute a part of them by an increased level of milk and milk products.

The canned vegetables and fruits which are processed in the country are not yet upto the foreign standard in respect of their storage life, quality, etc. Moreover, detailed information on their nutritional value is lacking.

It is quite probable also that the quantity of sugar and jam as present might render the ration highly sweet and this may be one of the factors why the eight men compo-pack ration is not so popular. This may suggest partial withdrawing of these items from this ration.

The total weight of the entire pack is about 33 lbs. and calorie content per oz. is 64. Nearly one fifth of the weight of the pack is due to materials other than food articles. If it would be possible to get lighter materials for packaging, considerable advantage would be gained from the standpoint of transport.

Recently a ten-man pack and a one-man pack rations have been devised, the composition and nutritive values of which are detailed in Appendix, Tables 2 and 3. Special features of these are as follows :—

In the case of the ten-men pack, the weight per ration is 47·5 oz., the total calorie value is about 3,800 and calorie per oz. of the ration is nearly 80. This ration also contains a sweet preparation from milk proteins, chutney, curried vegetable and less of sugary products.

The one-man pack ration is more concentrated and its weight is 42·2 ozs. calorie content is approximately 4,850 and the calorie per oz. is about 115. This high concentration has been made possible by the incorporation of more energy giving food ingredients like nuts, butter, chocolate, etc. The quantity of animal protein is relatively low and this suggests that the scale is to be used when the feeding period is limited and more energy is required. However, the higher fat content of this ration will make it easily rancid.

Whether or not these pack rations will serve the purpose under all possible operational conditions remains to be seen. The question may now be asked what should be the type of rations under different environmental conditions. Some idea on this point may be obtained from the following section.

Diet in relation to environmental stress

Relevant information on the subject considered very important in the proper rationing for servicemen has been assigned to different climatic regions. Though it has not yet been possible to correlate diet and tolerance to climate on a quantitative basis, certain facts based on recent experiments with human subjects conducted in the U.S.A. and elsewhere may be considered quite illustrative.

Diet in a cold environment

A cold environment has been shown to increase decisively the calorie requirements of man. Its effect upon water requirements is one of depression except in so far as sweating may occur during periods of work of a very severe nature or when arctic clothing is worn.

Diet modifications may definitely affect the tolerance to cold. A high carbohydrate diet is superior in this respect to one that is top-heavy in its proportion of protein. Dietary fat under some conditions improves still further the relatively beneficial effects of carbohydrate food. In conditions of inactivity, high protein foods may exert a temporary favourable effect on cold tolerance for a short period after consumption, but under conditions of normal activity they are of little importance.

There is considerable evidence in support of the belief that decreasing the intervals between the meals, especially if the foods are rich in fat, may increase their favourable effect on the thermal balance in a cold environment. Introducing snacks between regular meals to induce greater calorie consumption may also be beneficial.

Diet in a hot environment

It has been shown that the energy requirements are decreased in a hot climate due to diminished basal expenditure of energy or to a greater efficiency in certain types of muscular work associated with lighter clothing or to a lessened capacity for work and motivation or to all these.

The water and salt requirements are greatly increased when sweating is induced and the requirement increases in proportion to the amount of sweat secreted. The daily requirement of water may increase from 2·5 to 3 litres (4·4 to 5·3 pints) in a temperate climate to 13 litres (22·8 pints) or more during work in a hot environment. For the maintenance of physical fitness water losses in the sweat should be compensated by water ingestion at short interval. The daily salt requirement may be increased from a level of 2 to 5 gms. (1/14 to 1/6 oz.) under non-stress conditions to 15 to 17 gms. ($\frac{1}{2}$ oz.) under conditions of profuse sweating 8 to 10 litres ($26\frac{1}{4}$ to $29\frac{3}{4}$ pints). This large increase is confined to the period of acclimatization and the salt losses in the sweat need not be replaced continuously as in case of water.,

Attempts to increase man's tolerance to heat or to accelerate acclimatization to heat by dietary modification have not been as extensive as the importance of the problem warrants. There is no evidence to suggest at the present moment that any modification of the proportion of protein, carbohydrate and fat in the diet will improve heat tolerance.

Diet at high altitude

This aspect is of particular importance from the stand-point of high altitude flying or high mountain warfare. Due to the slowing down of the digestive processes at high altitude, foods, giving quick energy are shown to be highly necessary. For this reason carbohydrate has to play outstanding role in both pre-and in-flight meals. Well-cooked starches and sugars are recommended as they are readily assimilated and release energy more quickly than proteins and fats. Fats are to be used in limited amounts and so is the case with proteins. Vitamin supplements to an adequate diet have not been shown to be effective in increasing tolerance to anoexia.

Foods containing difficultly digestible carbohydrates, which can go up to the lower end of the intestine with chances of being fermented, should always be excluded from the menu of the flying personnel. For the same reason carbonated food including beer should be avoided.

Recent developments in food research

In the United Kingdom and in the United States of America, a great deal of effort is being concentrated on dehydration of foodstuffs. The method adopted for such purposes during the last war years consisted in passing a current of hot air over the materials and the resulting products were not satisfactory in most cases from the standpoint of reconstitution, texture, palatability and keeping quality. Main causes of deterioration on storage were oxidation browning and staling changes. To obviate these difficulties, further work was subsequently initiated. Recent reports show that high vacuum dehydration technique produces better products. By such method heat sensitive foods can be dried with a minimum of flavour change, protein denaturation, nutrient loss or other adverse effects. Examples of a few products which cannot be made so good by ordinary dehydration procedure may be cited here.

Eggs and egg white have been dehydrated with a slight change in whipping characteristics, and fruit juices such as orange juice have been obtained in the form of crystalline powder without any loss of vitamin C and without acquiring caramelized or apricot like flavour. Another product of interest to the baking industry is the dried gluten. It is important to note that the aceptability of dehydrated foodstuffs largely depends also on how they are reconstituted and prepared.

The other interesting problems under investigation in these countries relate to long storage biscuit, mashed potato of long stability under tropical condition, dried butter, etc. Attempts are also being made to devise insulated containers, in-can-desiccants, and packaging materials for the various processed commodities.

Product's similar to many of these may find place in the Indian compopack ration. For example, dried soup and dried fruit juice might be considered good items for incorporation.

With regard to canning, the technique has been more or less perfected in these countries. But the quality of canned products (tomatoes, potatoes, onion, cauliflower, beans and curried vegetables) produced in India is relative-

ly inferior. The difficulties in quality improvement are mainly due to improper grading of raw materials, and faulty technique adopted in filling and seaming the cans. As has already been mentioned no systematic investigation has been undertaken, to study the nutritional values of canned products on storage under different conditions in this country.

A few other problems of considerable interest may be mentioned as follows :—

(i) Long storage food grains and flour.

The principles underlying storage of these materials for as high a period as five years might be (*a*) packaging or bulk storing in inert atmosphere or (*b*) applying some heat treatment before storage or (*c*) compression in the form of bricks and subsequently storing in appropriate cases. The last treatment will refer to flour only.

(ii) Fortification of army diet with synthetic vitamin A

This new products in the form of acetate or palmitate may simplify the problem of enriching army diet with vitamin A. The esters are fairly stable under various conditions and may be used for the above purposes, if easily available. At the moment the synthetic product has to be imported.

(iii) Pre-cooked, dried rice

Attempts are being made here to develop methods for the preparation of two kinds of processed rice. One of these should be such that it can be cooked within the shortest possible time, whereas the other may be reconstituted in ordinary water. The theoretical basis for the possibility of having such processed rice depends on the fact that the ordinary raw rice contains *β-type* starch which is not soluble in water. Starch in boiled rice is of the *α*-type which is soluble but reverts to the *β-type* again either on keeping as such or on merely drying. This reversion to the *β-type* can be controlled by drying the boiled rice immediately after cooking at an elevated temperate under controlled condition.

Japanese were using a product similar to the second one. Work along the above lines is also worth undertaking in the case of common pulses.

(iv) Canned chapati

If a food item like chapati which is usually taken under ordinary circumstances could be kept for a long time without any change, it might be suggested as a popular item in the composite ration. In this connection it is worth studying the preparation of canned chapati.

(v) Packaging materials

Tin which is used universally as a coating in can making needs to be substituted by some other easily available, lighter and non-toxic materials. Aluminium may be a suitable material for the entire can.

In the field of food packaging, progress is also shown in other countries in the use of thermoplastic materials (polythenes), plastic films (cellophane, plüofilm, alkathene, clarifoil, etc.), metal foil, waxed paper, etc.

TABLE 1

Details of eight-men pack

Articles	Scale per man per diem Ozs.	Number and size of packs	Net weight Lbs.	Net weight ozs.
1. Biscuits (saltish and sweet, equal parts).	12	24×4 oz. packets (4 oz.= 12 biscuits)	6	0
2. Nuts, assorted	1½	1×12 oz. bag ..	0	12
3 Groundnuts, roasted and sugar coated (or peas, roasted and salted).	2 (3)	1×16 oz. bag ..	1	0
4. Milk, tinned, sweetened ..	4	2×1 lb. tins	2	0
5. Milk, tinned	3½	2×14 oz. tins ..	1	12
6. Cheese, tinned	1½	1×12 oz. tin ..	0	12
7. Vegetables, tinned ..	7½	2×30 oz. tins ..	3	12
8. Fruit, tinned	7½	2×30 oz. tins ..	3	12
9. Jam, tinned	6	3×1 lb. tins	3	0
10. Sugar	6	1×3 lb. bag ..	3	0
11. Salt ration	1½	1×10 oz. bag ..	0	10
12. Tea ration	¾	1×6 oz. bag	0	6
	53½	.. ..	26	12
13. Cigarette	Nos. 10	Issued separately ..	Weight of packaging materials: (appro.) 3 lbs. 11½ ozs.	
14. Matches	Box ½			
15. C. V. tablets*	One tablet		Weight of 4 gallon K.O. type tin (approx.) 2 lb. 10 ozs.	
			33 lbs. 1½ ozs	

* One C. V. tablet contains 1 mg. each of thiamine and riboflavin, 10 mg. of niacin and 25 mg. of ascorbic acid.

TABLE 2

Composition of Compo-pack rations

Scale per man per day in ozs.

Commodities	Eight-men Compo-pack	Ten-men Compo-pack	One-man Compo-pack
1. Biscuits	12	14	9
2. Nuts, assorted	1½	3	4
3. Groundnuts, roasted and sugar coated	2	..	..
4. Milk, tinned, sweetened	4	..	..
5. Milk, tinned	3½	5½	..
6. Cheese, tinned	1½	..	..
7. Butter	..	..	2
8. Milk powder, whole	..	..	1
9. Gram roasted	..	..	4
10. Dal, cooked	..	..	6
11. Vegetable, tinned	7½	5½	..
12. Fruit, tinned	7½	6	..
13. Jam, tinned	6	2	2
14. Sugar	6	3	2
15. Chocolate	..	..	4
16. Reori	..	..	4
17. Boiled sweets	..	1	3
18. Rasogollas, tinned	..	6	..
19. Tea ration	½	½	⅓
20. Salt ration	1½	½	5/14
21. Chutney, dried	..	½	½
Total weight ..	53½	47½	42 4/21
Total calories (approx.) ..	4270	3800	4850
Calories per oz. (*) ..	75	80	115

TABLE 3

Comparative nutritive values of the pack rations

(Approximate)

Values per individual ration per day

Nutrients	Eight-men Compo-pack	Ten-men Compo-pack	One-man Compo-pack
Total calories	4270	3800	4850
Fat (gms)	107	125	200
Protein (gms)	91	91	115
Animal protein (gms)	28	24	7
Iron (mg.)	12	14	45
Calcium (gms.)	1·2	0·7	1·0
Vitamin A (I. U.)	4750	3100	2360
Thiamine (mg.)	0·8	0·7	1·7
Riboflavin (mg.)	1·5	1	1·3
Niacin (mg.)	10	8	12
Ascorbic acid (mg.)	43	30	19
Per cent. of calories contributed by :			
Fat	23·0	29·7	37·0
Protein	8·5	9·5	9·4
Carbohydrate	68·5	60·8	53·6
Per cent. of animal protein in total protein	31·0	26·0	6·0

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