BIOCHEMICAL AND PHYSIOLOGICAL BASIS OF SERVICE RATIONS FOR TROPICAL CLIMATE

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ABSTRACT

The paper describes the various theoretical considerations which form the basis of formulating service rations for various situations in tropical climates. It has been mentioned that the main problem related to provisioning of bulk rations consists in the selection of right type of food materials, and in this connection, a discussion has been made of the studies being undertaken at Defence Science Laboratory on the nutritive values of oil dehydrogenated serum cholesterol and phospholipid levels of service personnel and on the development of precooked dehydrated food-stuffs.

The need of having a more varied and more appetising pack ration has also been stressed in this paper.

Lastly, the fundamental basis of determining the size of the food components as well as the water components of the survival rations for the navy and airforce has also been explained.

Introduction

One of the essential duties of planners of military expeditions is to equip every service personnel with materials and equipments for combating any adverse situation and one of the prime requirements under these conditions is to supply ration so as to keep them fighting in fit conditions. This is true not only in the case of provisioning of bulk rations when lines of communications and normal cooking facilities are well established, but is also true in the case of emergency landings with a view to assault of enemy territories, or when a man succeeds in reaching a boat or a life saving raft after his ship has been sunk by enemy action or when his aeroplane is compelled to land in the sea or desert. The difficulties associated with the provisioning of bulk rations are not much but these are enormous in case of supply of rations in the last mentioned situations. Had there been plenty of storage space and weight in the plane or the raft carrying these personnel, the selection of the ration would have provided very few problems, but in any craft equipped to carry survivors, the accommodation is necessarily very limited and consequently the ration need be as compact and light as possible. Besides these most obvious factors of weight and volume, many more considerations determine the design of various types of operational rations, the ideal solution being a compromise between the criteria offered by logistics, food technology and the science of human nutrition. However the machinery of the body and its alterations in a variety of survival conditions on a given dietary regime must receive primary consideration, serving as the guide to manufacture of the ration and to the efforts to supply it to men in the field. An attempt will therefore be made to deal with some of these factors especially the biochemical and the physiological principles determining the design of the operational rations in various situations.

Effects of Tropical Climate on Nutritive Requirements

A tropical climate, particularly when the heat-load of solar radiation is super-imposed upon a high environmental temperature, induces moderate to considerable changes in the nutritive requirements of men. The basic informations relative to nutrition in tropical climates which will undoubtedly be answered before any proper planning of feeding of service personnel can be undertaken are:

(*a*) Does exposure to tropical climates alter the quantity or the kinds of nutrients required to maintain optimal physiological functioning?

(*b*) Do the quantity and the quality of nutrients consumed influence the processes of adaptation of hot climate, or in any way alter the processes of recuperation following exposure to heat stress?

(*c*) Is it possible to prevent the deterioration resulting from exposure to hot climates by including in the diet any special nutrients?

The answers to these questions are not easily available in the light of rather limited present-day knowledge of human nutrition. The experiments on human subjects indicate that the effects of climatic stress on nutritive requirements are limited primarily to food energy, water and some of the nutrients lost to the body through sweat[1]. Energy requirement is slightly decreased in a hot climate as compared with a temperate climate though it is associated with the wearing of lighter clothing, a lesser capacity for work and less motivation.

The last question, *i.e.*, whether it is possible to increase man's tolerance to heat or to accelerate man's acclimatization to heat by dietary modifications say, by varying the ratio of carbohydrates, protein and fat or by inclusion of any other specific nutrient, has not yet been answered. As a matter of fact attempts have not been made as extensive as these should have been. Mention may be made that there has been some belief that vitamin C in heavy doses may prevent or delay heat prostation, but even this could not be substantiated by well controlled experiments.

Thus there is scarcity of informations on each of these basic problems, and these call for more work so as to be able to apply them for making service ration.

Service Rations

In formulating service rations for tropical climate, it would be a policy to make it, in such a way that in addition to meeting the daily physiological demands of the body, a sufficient margin is left in order that troops can build up adequate nutritional reserve so that they would be able to stand the stress of training, field service duties and disease/injuries.

Service feeding situations may be broadly classified into three groups:

(*a*) Situations where bulk ration may be used.

(*b*) Situations where pack rations are required, and

(*c*) Situations where feeding is based on the minimum survival requirement.

Bulk Rations

Bulk rations are generally used in garrison units or in other camps where facilities exist for cooking and preparation of the food in the field. Provisioning of this ration does not provide much difficulties, as most of the ingredients are fresh which need only be cooked for which adequate facilities are usually provided. Major problems associated with provisioning of food for tropical climate can be classified under three broad heads:

(1) Fixation of calorific level of the ration.

(2) Choice of foods; *e.g.*, the type of dietary fat, introduction of precooked dehydrated foodstuffs etc.

(3) Preservation and packaging of foods.

An account of the work being carried out at this Loboratory on the first head has already been given by Malhotra[2]. A short account would be given now of the theories and facts on the remaining two heads and a brief reference would also be made of the work being carried out here in these particular subjects.

Problems related to the Choice of Foods

(*a*) *Question of dietary fat of the service personnel*

Since 1951 oil hydrogenated is being used as the sole source of fat in the service rations, and though there have been frequent complaints from some quarters about its use, in absence of any definite scientific evidence pointing towards the harmful biological effects of hydrogenated oil[3], no action has been taken so far to withdraw it from the service rations. However, in recent times evidences are becoming increasingly available implicating hydrogenated oils in producing hyper-cholesterolemia [4,5]. Further it has been alleged that coronary heart diseases are manifestations of essential fatty acid deficiency caused by a diet containing very little of fatty acids like linoleic and linolenic acids[6]. In view of the importance of this subject it was decided to examine this problem more critically.

As a first step towards studying the effects of oil hydrogenated in the human organism it was thought worth-while to study the levels of serum cholesterol and phospholipids in army personnel[7]. The results of the study are indicated in Table 1.

TABLE I

Serum Cholesterol and Phospholipids in normal Service Personnel

Group	Normal Subjects					
	No. of subjects	Total Chol. (mg. %)	Free Chol. (mg. %)	Ester. Chol. (mg. %)	Lipid Phos. (mg. %)	Total Chol. Lipid Phos. Ratio
20—30	25	177·28±3·87	52·12±1·86	125·16±3·23	9·34±0·38	18·97±0·92
31—40	25	194·96±7·42	62·28±2·98	132·68±5·2	10·92±0·34	18·12±0·80
41—50	25	208·48±6·80	63·16±2·2	145·32±5·07	10·74±0·29	19·55±0·54
51—60	25	215·36±8·17	62·64±2·03	152·72±6·69	11·09±0·25	19·08±0·53

It can be seen that the total serum cholesterol for the various age groups irrespective of dietary habits, were 177, 195, 209 and 215 mg. per cent. The increase in cholesterol with age was almost entirely in the ester portion. These values, it may be noted were slightly higher than those reported by other workers for Indians.

The results also stand to confirm the current predominant theories regarding the effect of diet and body weight on serum cholesterol. When the total cholesterol values were averaged according to dietary habit, the results for the various age-groups are as follows:

TABLE II

Serum cholesterol in vegetarians and non-vegetarians

Age group	A. VEGETARIANS: Number of subjects	Mean weight of group, lb.	TOTAL CHOLESTEROL Range	TOTAL CHOLESTEROL Mean ±S.D. mg. per cent.	B. NON-VEGETARIANS: Number of subjects	Mean weight of group, lb.	TOTAL CHOLESTEROL Range	TOTAL CHOLESTEROL Mean ±S.D. mg. per cent.	Average after adjustment to the weight of veg.	Difference between A & B
20—30	10	146·7	120-180	161·6±4·88	15	145·7	170-215	189·2±3·18	191	Significant
31—40	10	133·3	120-90	163·3±7·87	15	159	173-265	218·47±6·11	176	Not-significant.
41—50	10	150·2	145-202	181·5±5·78	15	159·9	200-300	226·4±7·91	210	Significant
51—60	10	155·1	154-210	178·5±5·69	15	162·1	196-286	239·9±8·47	228	Significant

It can be seen that when the values were adjusted for differences in weight, the vegetarians had significantly lower total cholesterol levels for all age groups except for the 31 to 40 yr. age group. When all the vegetarians were compared with all of the non-vegetarians, the average total cholesterol levels were 170 and 219 mg. per cent respectively (i.e., 16 per cent higher in the non-vegetarian group).

In this connection we were also interested to find out whether it is possible to establish any threshold figures for serum cholesterol beyond which hypercholesterolemia should be considered pathological. With this in view we examined the levels of serum cholesterol and phospholipids in 40 patients of coronary disease. The means with S.E. for total, free and esterified cholesterol and lipid phosphorus contents for the coronary and the normal cases of the various age groups studied are given in Table III[8].

TABLE III

Cholesterol and Phospholipid Levels in Normal Subjects and in Patients with Coronary Heart Disease

Group	No. of subjects	Total Chol. (mg. %)	Free Chol. (mg. %)	Ester. Chol. (mg. %)	Lipid Phos. (mg. %)	Total Chol. Lipid Phos. Ratio
20—30	5	250±10·39 (41·24±6·6)	67·6±3·43 (29·74±8·1)	182·4±7·35 (45·74±7·0)	10·04±0·34 (7·52·±5·7)	25·17±1·86
31—40	10	258·2±7·79 (33·04±6·5)	72·0±4·45 (15·6±9·0)	186·2±6·38 (40·3±7·3)	11·04±0·25 (1·1±3·9)	23·41±0·55
41—50	10	270±6·8 (24·8±5·4)	75·2±3·57 (19·1±7·0)	194·8±5·53 (34·1±6·0)	11·20±0·15 (4·3±3·2)	24·1±0·33
51—60	10	286·4±7·09 (33·0±6·0)	79·4±4·47 (26·8±8·2)	207±4·49 (35·6±6·6)	11·35±0·03 (2·3±2·2)	25·22±1·62
61—70	5	305±5·74	88·2±5·47	217·4±6·7	11·5±0·1	26·48±0·37

The values which are not in brackets are the mean values and the standard error.

The figures in the brackets show the percentage increase, with standard error, over the value observed in normal subjects of the same age.

The table indicates that the average total cholesterol in the coronary cases is significantly higher than that for the normals in all the age groups and this increase is between 30 to 40 per cent of the normals. Assuming that the distribution of cholesterol in both the groups are normal, the following table is prepared showing the cholesterol content of healthy and coronary cases on the basis of one tail region for 95 per cent probability level.

TABLE IV

Age	Normal Subjects	Patients with coronary disease
20—30	205	211
31—40	218	256
41—50	235	263
51—60	250	284

From this table it can be seen that for the age group 20—30, we may consider people with less than 205 mg. per cent cholesterol content as normal and those having more than 211 mg. per cent as pathological. Those having cholesterol content between 205 and 211 mg. may be considered as doubtful cases. Similarly for the age group 31—40, people having cholesterol content less than 218 mg. per cent may be taken to be normal and those having more than 256 as abnormal, whereas people having cholesterol content between 218 and 256 mg. per cent as borderline case and so on.

It is admitted that solution of a vital issue like determination of the threshold values of serum cholesterol cannot be achieved by studies on such extremely small number of subjects. It may be possible only as a result of study on thousands of subjects drawn from different socio-economic groups of Indian subjects belonging to various ethnic derivation, and some more work is going to be undertaken in this line.

Lastly, studies have also been undertaken to determine the effects of oil hydrogenated, milk ghee and some vegetable oils like groundnut and mustard oils on levels of serum cholesterol. It is hoped that this study, when completed will indicate whether hydrogenated oil as it is supplied now, does meet the demands of the body with respect to essential fatty acids or there is necessity of replacing it wholly or partially with some other oil or fat containing more of these acids.

(b) *Introduction of Precooked Dehydrated foodstuffs in Service rations*

Another specific problem on which serious consideration is already being given is to develop methods of production of ready-to-eat precooked dehydrated foodstuffs, *i.e.*, foodstuffs which would require very little time for reconstitution and making them ready for eating. The use of dehydrated foodstuffs for feeding military personnel stationed at various theatres of war has been an accepted principle in almost all countries from very early times. In India, too during the last war there were about 200 dehydrated factories running all over the country to meet the demands of the service personnel. But soon after the cessation of hostilities nearly all of them have been closed down. Dehydrated foods prepared at that time were never popular among Indian troops, and it was realised that in order to make dehydrated foodstuffs acceptable to our troops, more research on the techniques of dehydration were absolutely necessary.

A variety of precooked dehydrated rice and pulses has been prepared at by a modification of the usual air-drying method of dehydration. The cooking time of these products is much less (hardly 3—7 min.) as compared to that of the unprocessed foodstuffs. It is hoped that the introduction of the foodstuffs will greatly simplify the difficulties of provisioning in the field.

Attempts are also being made to standardise methods for production of precooked dehydrated foods by the fat-vacuum method of dehydration. This technique affords an excellent method of production of precooked vegetables, quality being much better than that obtained by the hot-air drying method. The cooking time of these processed vegetables is even less than that of the foodstuffs prepared by the hot air drying method.

It must be mentioned here that one of the main reasons for complaints about the unpopularity of dishes prepared from processed foods, especially from the dehydrated products is the faulty methods used for reconstitution and cooking. If they are taken on an expedition the cook must know their limitations and learn before hand how best to use them. Great importance must also be attached to the problem of making our Service personnel accustomed to the use of these dehydrated foodstuffs. This introduction period must start during the peace time and at least once in a week, some sort of dehydrated foodstuffs must be issued to the Service personnel.

However the problem confronting us now is to get a regular supply of these precooked dehydrated foodstuffs. At the present time there is no industrial organisations in India manufacturing these foodstuffs, specially because these have got no place in the dietary of our civilians. Perhaps our Ministry can take the lead in setting up an Experimental Factory having several units, each concerned with production of one type of processed food and capable of producing this item so as to meet the demand of the Services.

Problems on Preservation and Packaging of Foodstuffs

The most important problem which can be listed under this head is that of the preservation of whole wheat flour (atta), specially in high humid areas, where this becomes unfit for human consumption within a very short time. Attempts are therefore being made to increase its storage life.

One approach has been made to store whole wheat flour in the form of blocks by compression. The results of the storage trial in the case of blocks indicate that the rate of deterioration was more in the case of the compressed samples than the uncompressed ones, and thus there was economy in the storage space. So far as extension of the storage period is concerned no advantage was obtained. It was, however, observed that by this technique it had been possible to protect the material from the attack of insects for a very long time.

Packaged Rations

Packaged rations are usually used where operational conditions do not allow a soldier to be fed according to the standard ration scales or when troops are stationed far from their home bases where normal cooking facilities do not exist.

The only type of packaged ration authorized for issue to the Indian armed forces is the 8 men composite pack ration. Operational conditions have however necessitated the changeover of this ration to 10-men pack and 1-man pack, the former meant to be used for a maximum period of six weeks continuously, and the latter for 48 hours. These two packs have already been proposed, but have not as yet, been tried on a large scale and trials are to be commenced shortly. Table V gives details of the three packs mentioned above.

Based on the experience of the 8-men pack, and on a perusal of the items comprising the two proposed packs, it may be said that the main defects in all these packs are:

(*a*) Unpalatable nature of the majority of the items,

(*b*) Lack of variety,

(*c*) Inadequacy of animal proteins.

An alternative pack has therefore been suggested which contains items to which our troops are accustomed in their every day life. Table VI shows the proposed scale of ration. It is possible to make three or four menus out of this scale which could be offered to troops by rotation.

TABLE V
Pack Rations

Commodity	Composite (10 men) pack Ration Scale per man per diem	'Individual' pack Ration Scale per man per diem	Composite (8 men) pack Ration Scale per man per diem
	oz	oz	oz
Biscuits—sweet	8	8	12
Biscuits—saltish	12	12	..
Sugar	3	3	6
Vegetable—tinned	5½ (2 varieties)	..	7½
Sweets—boiled	1	1	..
Groundnuts Candy Bar/Skimmed Milk Toffee	2	2	..
Milk—tinned	5·3/5	..	3½ (evap)
Achar	1	..	..
Tea	½	½	¾
Salt—evaporated	2/5	..	1¼
Skimmed milk—powder	..	2	..
Matches	½ box	1 box	½ box
Cigarettes Nos	10	10	10
Multi Vitamin tablets (A & D) Nos ..	..	..	..
Multi Vitamin tablets (B & C) Nos ..	1	..	..
Water sterilizing tablets Nos.	..	4	..
Taste remover tablets Nos.	..	4	..
Tin opener (per pack)	1	1	..
Gram—roasted and salted	..	..	5¼
Milk—tinned, sweetened	..	..	4
Jam—tinned	..	..	6
Cheese—tinned	..	..	1½
Fruit—tinned	..	..	7½
	lb oz	lb oz	lb oz
Weight of rations	26 2½	1 13-4/5	27·8
Weight of container	3 6	0 7	2·5
Total Weight ..	29 8½	2 4-4/5	30·3 *30 4-4/5
Total Calories per day ..	3505	3349	4150

TABLE VI

Ten Men Composite Pack Ration

Item	Quantity (oz)
Biscuit—	
Sweet	8
Saltish	8
Canned rice*	10
Butter—tinned	1
Jam—tinned	2
Milk—tinned†	6
Sugar	3
Canned vegetable curry/canned dal ‡	6
Canned fish/canned meat curry	6
Canned fruit	6
Groundnut candy bar	2
Dried fruits	1
Milk Toffee	1
Tea	½
Accessories—	
Wt. of the Food materials	51 oz.
Nutritive value	4213 Cal/day.

* To be issued on alternate days, when the quantity of biscuits would be halved.

† Should be preferably sweetened condensed milk.

‡ Should be issued on alternate days only in the case of non-vegetarians.

Vegetable curry of at least four varieties should be made in combination of at least two of the following vegetables—potatoes, peas, beans, lady's finger, brinjal, tomatoes, onions, cauliflower.

Dal cooked and tinned should be of at least four varieties so that these may be given by rotation.

The main difficulties associated with the development of pack ration having the necessary properties like (1) acceptibility (2) nutritional adequacy (3) storage stability and (4) military utility, consists in the procurement of right types of ingredients from indigenous industries. As normal practice in the country consists in consuming foodstuffs directly from the lines of cultivation without relying too much on the industries for processed foodstuffs, food industries of our countries are not well developed. Even some of the common items like canned fish, canned curried meat etc. whose methods of production have been well established in foreign countries are not available in India. Of late, the position has improved much, and it is hoped that very soon it will be possible to procure all the items from indigenous sources which would be acceptable to the palate of our troops.

A specific problem connected with the design of pack ration is that of development of longer keeping chapaties. As can be seen from table V biscuit, which is not an item of every day use to our troops forms the main bulk of the ration. It has been thought that substitution of biscuit with chapati, to which our troops are familiar, would very much increase the acceptability of the ration. The difficulties associated with preservation of chapaties for longer period are however quite considerable as they become unfit for consumption within 24—48 hours of preparation either due to loss of moisture at lower humidities when they become dry, brittle and unpalatable or become moldy when the environmental humidity is quite high. By employing special packaging conditions and use of preservative it has been possible to extend the life of chapaties to six months in a high state of microbiological purity and in apparently good edible conditions.

Survival Rations

Survival rations require in practice, rations for two main situations. The first situation arises when the casualty takes place in the desert or in a sea or similar area where no water is available. The main task in this situation is to supply the man with an adequate supply of drinking water and a ration which will conserve his body protein to the maximum extent. The ration would also be such as to spare the destruction of body water to the maximum extent and it would produce when metabolized minimum quantities of acetone, aceto-acetic acid and *B*-hydroxy butyric acid, as excess of these products can bring about enhanced loss of body water because of their heavy solute load upon the kidney. The second situation arises when the accident takes place in regions where the need is not so much for drinking water, which can be found, but for a ration which will support a high level of external work involving high efficiency.

Survival ration for the IAF in desert areas or for the Shipwrecked personnel

In view of the limitations of the carrying capacity of the aircraft or the life raft, it is not possible to supply the survival ration, which has to be stored before hand in the aircraft or the life boat, at that calorific level which can maintain calorific balance and prevent physiological deterioration of the body, and as a general rule there is loss of weight with all emergency rations. In a man there is no change in bodily function when 3 per cent of the body weight is lost through dehydration and breakdown of the body tissue. He remains reasonably capable and efficient, though feeling discomfort with a further loss of 5 per cent of body weight. Finally a deficit of 10 per cent is disabling and one of 20 per cent lethal. In designing survival rations attempts are therefore made to keep the extent of this weight loss within 10 per cent of total body weight.

Keeping this in view, the final decision on the calorific level of the emergency ration is made on the basis of the probable time for which it may be required to be used. To mention a specific case, in the case of IAF, irrespective of the site of the casualty, assuming that it takes place inside Indian territory, airman is sure to come across human habitation and hence to receive food and shelter, or be rescued, within a period of 5 days and as such it is needless to design a ration supplying food for more than this period of 5 days and 450 cal/day would be adequate to meet this requirement. Similarly in the case of personnel of Indian Navy, it may be assumed that rescue would be forthcoming within 5 days (provided the casualty takes within 1500 miles of Indian shores as in Bay of Bengal, Arabian Sea or in Indian Ocean), consequently naval survival ration may be required to be used for a period of maximum five days and a ration supplying 450 cal/man/day would be enough for this purpose.

It may be argued that if the requirement of the survival ration is only for 5 days there would be no need to provide food at all, except for the sake of morale, as in the absence of food during this period life would be maintained by the energy supplied by the breakdown of body tissue and there would not be any gross change in the cellular and the extra-cellular structures of the body. But in reality this is not so, as unless food is supplied there would be loss of appreciable amounts of body water as the tissue breakdown products consisting mostly of nitrogenous materials together with some phosphate and sulphates requires water for their excretion. A minimum urine volume only occurs when there is a minimum amount of mineral and nitrogenous substance to be excreted. Thus even if there is no gross change in the structure of the body in absence of food for a short time it is always advantageous to have small amounts of food under these conditions[9].

It has also become quite clear in recent times that because of the limitation in the storage space and carrying capacity in the aircraft or the life saving raft in sea, caloric density of the ration is not as vital as the antiketogenic and the body protein-sparing powers. The earlier thesis was that fat should form the bulk of the survival ration. This was based on the fact that fat being the most concentrated source of energy among all the nutrients, it would confer high caloric density of the pack. The second argument in favour of fat rich survival ration was that fat, when metabolized in the body would produce, as compared to protein and carbohydrates, nearly double the amount of water, and thus would contribute to the water economy of the survivor. A study instituted to test this hypothesis clearly indicated that the survival performances are better on a low fat or carbohydrate rich ration, and it has become customary to avoid fat, as far as possible, in designing emergency ration[10].

In another recent experiment the hypothesis put to test was that under condition of semistarvation survival, the addition of protein to a protein free ration has got no beneficial effects in sparing the breakdown of body protein; this on the contrary increases the minimal water requirements. The results of this investigation, conducted by Quinn [11] et al indicated that added protein does not improve nitrogen balance but it serves under the condition, only as a source of energy. It was the protein fed group which exhibited a great loss of water, lost largely at the expense of the extracellular water due to increased excretion of protein metabolites. Also ketonuria was almost confined to the protein fed group.

It has become clear as a result of these and other investigations that a pure carbohydrate ration would be the ideal survival ration for all theatres of war. The results of all these laboratory investigations have been actually translated in practice for formulating emergency rations of most of the countries, who have agreed in principle to compose their survival rations with pure carbohydrate [12, 13].

At the present time there is no emergency ration for the IAF. During war time Mark IV ration, imported from U.K. was used as survival ration for the IAF, but because of the difficulties in procuring, the ration is not longer in use. In the case of I.N., biscuits are being used, but as these produce excessive thirst these have been found not to be suitable.

On the basis of theoretical grounds already covered in the preceding paragraphs, a pure carbohydrate ration like glucose candy bar, boiled sweets, glucose jelly bar, or groundnut candy bar (containing 5—7 per cent protein), manufactured by Indian firms may be the ideal material of choice. It is however necessary to investigate the storage stability and palatability of some of these products and these are now being studied at DSL. The final choice of the survival ration may however be made after holding a user trial to assess the operational utility of all these four materials.

Provision of water in survival packs

In designing survival pack, the question of the weight of the water to be issued needs very careful consideration. Normally, a healthy man, at rest and in a temperate climate, loses about 900 ml. of water through the respiratory passages and skin, and about 400 ml. in the urine when he is not drinking any water. He generates about 100—200 ml. of water through his own metabolism. His requirement is therefore just over a litre a day. However in emergency it is not possible to meet this requirement completely and only that amount is recommended which when taken with the food components is likely not to reduce the body weight by more than 10 per cent.

The size of the water ration can thus be determined by knowing the period for which the man has to be kept surviving. If for example, it is decided to design the ration for six days, it can be calculated that the size of water ration would be about 500—600 ml. per day. This has been experimentally proved in a survival raft trial conducted by Royal Navy in the tropics, where men were given 500 ml. of water and 100 gm. of sugar per day and it was found that at the end of 5 days and with loss of body water of the order of 5 per cent survivor did not require medical attention and were in a physically fit condition. Tests also confirmed that the net daily water loss of survivors under tropical conditions was the same as under temperate conditions and it was thus possible to adopt a standard water ration for use in any latitudes.

Taking these theoretical considerations into account, a supply of water ration of 500 ml. per day for 5 drinking days seems to be quite adequate to meet the requirements of IAF personnel after a casualty or of the shipwrecked survivors. No water is to be issued for the first 24 hours since the survivor is assumed to have his body water reservoir full when he boards the plane or the life boat. The water ration thus is expected to last for 6 days. Finally it must be emphasized that the actual water ration will be supplemented by the provision of any water which he would come across, though in desert areas the chances are very remote.

As the shipwrecked person is surrounded by sea water, it has been suggested from time to time that he could benefit by adding small amounts of it to his water ration. The main objection in the use of sea water is this that man can concentrate his urine maximally to about 2 per cent, of salt as sodium chloride so that if he drinks 100 ml. of sea water containing 3·5 per cent NaCl he has to excrete 175 ml. of urine to remove the 3·5 g. salt load, suffering thereby a net loss 75 ml. of water. In case all the ingested salt is not lost, concentration of salts in his body fluids would be increased and would lend to provoke further thirst which steadily worsens with continued sea water ingestion. On the basis of these arguments Harvey and McCance categorically advise that sea water should never be drunk. 'Never drink sea water'—these are the words engraved on the sea water desalting kit of the U. S. Naval survivor.

Some observations on the other hand suggest that certain mixtures of sea and fresh water would serve better to quench thirst, and to supplement the water ration beneficially. Ladell[14] considers that from the stand point of physical fitness rather than overall survivaltime, drinking small amounts of sea water might be advantageous to the water economy of the survivor. Bombard,[15] an advocate of the views that castaways short of fresh water should drink from the ocean, tested his convictions by crossing the Atlantic alone in a dinghy drifting for sixtyfive days during which period he subsisted on sea water, fish catches and rain water.

Leaving aside this unique case of depending solely on sea for food and water, the issue is to assess to what extent sea water be admixed with freshwater supplies to supplement the ration. This question has not been examined in all its perspectives, though it is suggested from certain experiments that mixtures containing more than 30 per cent sea water are deleterious to health.

Considerable efforts are being made in recent times in the U. K. and U.S.A. to evolve some method for desalting of sea water. The most widely used devices are the following:—

(1) solar stills,

(2) rain collecting devices,

(3) synthetic zeolites.

In view of the low capacity and high cost of silver Barium zeolite, it has never become popular. One part of the zeolite can desalt only six to eight parts of sea water, and the potable water prepared is practically a 1 : 9 admixture, or 10 per cent sea water; *i.e.*, 90 per cent of the osmotic activity is extracted in the desalting process.

For tropical waters, solar stills would probably be the material of choice. Water obtained thereby may be supplemented by that obtained from rain collecting device.

It is surprising that the question of incorporating glucose or any other carbohydrate, with or without any flavouring agent in canned emergency water supplies has not received much attention. Glucose, it must be emphasized here, does not compete spacewise with water, as the volumetric displacement of water when glucose is dissolved, is almost equal to the water it yields on oxidation. Attempts may therefore be made to explore the possibility of using water supplies containing some carbohydrate in the form of soft drinks.

The problem of development of the container in which this water has to be supplied has not yet been solved completely. The present practice in most countries is to supply canned water in metallic cans. These however, suffer from the drawback that the cans increase the weight of each fluid ounce of water by 25 per cent. If the cans are to withstand shock loads, without suffering an acceptable degree of damage, they require a reasonable amount of cushioning material. Trials with various types of cushioning material indicated that these made the bottle unusually heavy.

In recent times, serious considerations are being given to introduce alkathene bottles as the container for canned water. Preliminary trials with water bottles manufactured from alkathene indicate that though these are better than the metallic cans from the operational point of view, they suffer from the disadvantage that taintness develop in water when stored for 2 years at tropical temperatures. Recently this difficulty has been overcome by incorporating 2 per cent carbon black in the polythene during manufacture, but special filling techniques are required for putting the water in the bottles.

At the present time canned water is not being supplied to Indian personnel of any of the three Services. In view of the limited requirements of this item, it has not been possible to procure the item from Indian firms. Most recently a few firms have shown interest in canning of water in metallic container, though the products they have supplied so far are not up to the A. S. C. Standard. The main difficulty associated with procurement of water through these firms is that water used for canning, though obtained from water supplies of some of the biggest cities of India, composition of these was much on the higher side as compared to that allowed in the A. S. C. Specification. It is necessary therefore that to make water acceptable, prior to canning, some initial treatment has to be given to such water to lower the contents of most of the constituents[2].

Survival Ration for Tropical Jungle Regions

The need for this type of ration arises in situations where there is a bail out, ditching or forced landing into primitive isolated regions like jungle areas of North East India (Assam), or behind the enemy lines, where the primary requirement is not of drinking water, which can be found, but for a ration which will support high level of external work. As the survivor is expected to traverse considerable distance, requirements of calories are expected to be quite high. Thus, in contrast to the survivor in desert areas, where antiketogenic and body-protein sparing powers of the ration are the most vital ones, caloric density of the pack and acceptability play more important roles in this situation. It will therefore be necessary to make allowance of more calories in this ration as compared to that for the desert areas. A ration usually consisting of 2,000 calories and of the multicomponent type may be recommended to be introduced for this situation. It may be pointed out that this ration may also be used in Bomber and by personnel of Medical paratroops flight.

As to the exact composition of the ration some exploratory work has to be done before finalising the components. The items should be mostly of the canned or packaged type like groundnut candy bar, milk chocolate bars, boiled sweets, biscuits and cheese canned. Extensive trials are however needed before any action can be taken for finalisation of the ration and its introduction to the services.

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Discussion

The discussion on the paper was initiated by Capt. Batra, I. N., Director of Personnel Services, who suggested that during planning for survival rations for shipwrecked sailors at sea in India the period of five days is too small. It would be better if the planning is done for at least ten days. Dr. Nath mentioned that the decision on the number of days for which the shipwrecked personnel have to be kept surviving depends upon the route in which the ship is flying and on the space available in the life of raft, and if operational conditions make it absolutely necessary to have the ration for ten days this can be easily done provided the requisite space can be obtained in the lifeboat.

In reply to a question by Dr. B. C. Ray Sarkar (DSL) on the mechanism of hypercholesterolemic properties of hydrogenated oils, Dr. Nath stated that normal cholesterol is metabolised in association with essential fatty acids which cannot be synthesised in the body. In a diet where the sole source of fat is hydrogenated oil the amount of essential fatty acid is too low to esterify the cholesterol and as such the normal transport and the metabolism of cholesterol is disturbed. As a result cholesterol tends to accumulate in the blood stream resulting thereby in the production of cholesterolemia.

Col. Kapur (Development Cell, CGDP) wanted to know whether dehydration of foodstuffs affects the calorific value of the food and whether it would be possible to preserve vegetables by keeping them under snow for a long period. The speaker mentioned that dehydration does not appreciably reduce the calorific value of the foodstuffs though there is slight decrease in their vitamin content. It is not possible to preserve the vegetables or meat for a longer period by keeping them buried under snow. It was mentioned in this connection that a trial undertaken in this direction in J. & K. succeeded in preserving foodstuffs by this technique only for a period of three weeks.

Stimulating discussion then took place on the question of need of providing more animal protein in the service ration, specially in the ration of the army and General Chaudhuri (DGAFMS) and Brigadier Kapila (DRH) and others made valuable contribution by recalling their experience during last two wars. They said that incidence of certain diseases like tuberculosis, infective hepatitis etc. were most prevalent whenever fresh animal protein was in short supply. Dr. Nath summed up all the available informations by stating that in absence of any suitable method for assessing the need of animal protein the exact requirement cannot be laid down quantitatively. The results of workers in this field seem to indicate that the army ration supplying about 110 grams of protein including 20 grams of animal protein would be adequate in supplying the animal protein, but certain evidences like high incidence of certain diseases (as for example, anaemia and diseases of the blood-forming organs) and the longer time taken to recuperate after illness by army as compared to their colleagues in the navy and air force emphasises the need for a greater amount of animal protein in the ration of the former and he stressed that some more studies should be undertaken in this direction.

In reply to a question by chairman on the percentage of unsaturated fatty acids that were required in the diet it was stated that on the basis of existing knowledge a diet supplying one per cent essential fatty acid or ten per cent of the total fat intake would be adequate.

Concluding remarks by General Chakravarty

General Chakravarty said that this was a very important subject for research and attempt should be made to co-ordinate this work with other organisations as well. So far as he was concerned, he said, he was going to start that work in Bengal on his return.