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OPERATIONAL RATIONS — PROBLEMS IN THE ATTAINMENT OF NUTRITIONAL RELIABILITY

By Harry Spector

The rations and food packets designed to maintain the fighting efficiency of our Armed Forces in the novel tactical situations of Twentieth Century global warfare are described. Essential military requirements are defined and illustrate the severe limitations imposed on development of rations of nutritional reliability. This article frankly explores the challenging problems involved in (1) determining nutrient stability, (2) establishing special nutrient requirements under combat stresses, and (3) ration evaluation. How unavoidable nutrient losses are counteracted to provide required amounts at time of consumption is exemplified by the vitamin fortification program.

Burning deserts, oceans, mountains, jungles, and freezing polar regions can no longer be regarded as barriers to military movements. To invent or to adapt equipment and machinery necessary to conduct military operations in any area of the world has come to be an absolute requirement for our own and other Armed Forces. But the efficiency of our Armed Forces is in the final analysis dependent not upon machines but upon the ability of individual men to withstand extremes of climate and terrain. Fed poorly their fighting efficiency drops. The major objective of rations development is therefore to provide the soldier with suitable food in order to help maintain his fighting efficiency under all circumstances.

Tactical situations, climate, terrain, and feeding methods and equipment create a large number of feeding problems which are met by a number of different rations, supplementary packs and food packets.

operational rations

Whenever the tactical situation permits, troops are subsisted mainly on *Field Ration A*, a garrison type of ration designed for large group feeding. Issued in bulk, it is prepared by Army cooks and bakers with ample kitchen facilities. *Field Ration A* contains a large proportion of perishable items such as fresh or frozen meats, fruits, vegetables, and dairy products, and hence refrigeration must be available. Food purchases are based on master menus submitted by the Food Service Division, QMC. Market conditions sometimes necessitate local modifications of these. Slide 1

Operational Ration B, similar to the *Field Ration A* except that nonperishable food has been substituted for perishable foods, is used mainly Slide 2

in overseas theatres, where cooking facilities are available but refrigeration equipment is almost always lacking. When obtainable, fresh foods are used to supplement this ration. Tactical situations permitting, field commanders are required to serve personnel at least one hot meal daily from this ration.

For troops subsisted on A and B rations the problems of adequate nutrition are not much different from those encountered in any type of mass feeding. But in all combat phases of military operations whether preparational, active combat, support, or in survival situations the maintenance of physical fitness through adequate nutrition is a complex and difficult problem.

The distinctive feature of packaged operational rations is that they are designed for use without kitchen facilities. This does not exclude, however, the preparation of hot meals with rudimentary cooking facilities. Thus, tank crews, wire crews, anti-aircraft gun crews, and radar detachments, which usually operate a considerable distance from their unit kitchens, are provided the *Small Detachment Ration, 5-in-1*—food for 5 men for 1 day. This ration may also be utilized by small groups advancing beyond the immediate range of the kitchens and prior to commitments to battle, and by troops relieved from action but not yet supported by their kitchens.

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To avoid monotony, five different menus are provided. The five menus are various combinations of 14 canned meat items, 7 kinds of vegetables, 5 kinds of fruit, 5 types of jam, 4 dessert units, soup, crackers, cereal, bread, cheese spread, confections, peanuts, beverages, sugar, milk, and accessory items consisting of cigarettes, matches, toilet tissue, water purification tablets, chewing gum, sugar, salt, can opener, and soap.

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The *Individual Combat Ration C* is for the use of one soldier. Designed for rapid issue under combat conditions when each man is "on his own," it has also been successfully used in small group feeding. In fact this ration has a greater variety of uses than any other, and is the principal ration used by combat troops when they have been denied the use of their unit kitchens. The C ration is packed in 6 menus. Each menu is composed of 3 cans of 11 different meat-type items, three cans of bread-type units consisting of a confection item, beverage, jam and crackers, cookies and a fruit unit with 6 varieties.

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In the Arctic, small patrols or trail teams may have to operate away from their base for several days during which time re-supply may not be feasible. These men must be entirely self-supporting. Food, shelter, extra clothing, weapons, ammunition and other equipment must be carried for the period of patrol. Due to these many items necessary for survival under arctic winter conditions, the weight and bulk of the load to be carried are greater than for a comparable mission in a temperate climate. In cases of an unmounted patrol, all equipment must be transported by backpack or, with favorable snow conditions, by sled. Since mobility is essential in today's warfare, weight and bulk of loads to be carried are critical. Troops operating under these conditions must therefore have available a ration combining high caloric content with minimum weight and bulk. High acceptability when eaten either hot or cold in an ambient temperature

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as low as —65° F. is also required to assure complete consumption.

To meet these strict requirements the *Frigid Trail Ration* was developed. Perhaps the most interesting component of this ration is the dehydrated meat food bar. Reconstituted by adding water and then used as a gruel, or by the addition of dehydrated onion and proper rehydration, as a fried pattie, this Institute-inspired development constitutes a good answer to the problems of palatability, nutrition, and utility, all of which are basic in the design of such a ration. The *Ration, Individual, Trail, Frigid* consists of the following: 2 dehydrated meat bars, 2 cereal bars, raisins, almonds, sandwich cookies, crackers, chocolate, assorted hard candies, dehydrated bean and chicken soups, and a beverage packet.

The *Aid Station Special Item Pack Ration Supplement* was designed to supplement the normal issue of prescribed rations. It provides a variety of hot, stimulating beverages for combat zone casualties clearing through medical aid stations and, as necessity may require it, for litter bearers returning with the wounded from the fields of combat. The beverages, either coffee, tea, or cocoa assist in the treatment of shock and promote comfort and general well-being. The *Aid Station Supplement* contains sugar, milk, toilet tissue, can openers, and plastic spoons in addition to the beverage components which provide approximately 290 twelve-ounce drinks.

Evacuation hospitals and mobile surgical units in theatres of operation require supplementary foods for their patients. Designed for use in all medical installations other than aid stations, the *Hospital Special Item Pack Ration Supplement* contains an assortment of nutritious, easily digested foods and beverages. Included is a variety of fruits, fruit juices, soups, compressed cereals, beverage ingredients, and various accessory items such as plastic spoons, can openers, paper towels, and toilet tissue. The hospital pack is well adapted to making liquid, light, and soft-type diets. Since most items are concentrates, the only preparation required is the addition of water.

To differentiate balanced rations from emergency subsistence, the term "food packets" is used. These packets consist of precooked or prepared foods which may be eaten hot or cold. Food packets are designed for the use of individuals under operating conditions when kitchens are not available and when there are no immediate means of planned re-supply. Minimum bulk and weight are essential characteristics of these.

In the initial or assault phase of combat, men are unable to carry bulky or heavy rations. The *Assault Food Packet,* a palatable, lightweight food unit was designed to meet the requirements of the individual under assault conditions. Obviously, no cooking facilities are available, and a complete ration is out of the question until resupply is established. The *Assault Food Packet* is not a meal or any fraction of a meal, nor do any number of units constitute a ration since the packet is limited in components and therefore in some essential nutritional factors.

Eight menus provide sufficient variety to relieve monotony and alleviate hunger of individuals in assault operations. Each food packet contains one can of meat, one can of B-unit consisting of one oatmeal

cookie and two round crackers and one accessory packet. The meat items are canned beef and corn, pork and applesauce, beef and pork loaf, canned ham and eggs, hamburgers, canned chicken, pork sausage patties, and canned cheese with bacon. The accessory items are chocolate or starch jelly bars, chewing gum, soluble coffee, sugar, can opener, plastic spoon, cigarettes, toilet tissue, and water purification tablets.

The *In-Flight Individual Combat Food Packet* is designed for passengers and crews of bomber-type aircraft and transports in flight for periods extending over one or more meals. It furnishes a fully adequate meal during a flight mission and causes no physiological distress at high altitudes. Each food packet consists of one can of meat, a can of fruit, a bread-type unit (5 round crackers), a dessert unit (consisting of a can of cookies and candy) and an accessory packet. Current procurements provide a variety of 10 meat items, 5 desserts and 5 fruits.

Fighter pilots have a definite need for a food packet while actively engaged in flight. Unappeased hunger has been shown to decrease combat efficiency. The *Air Crew Lunch* designed to meet this situation consists essentially of carbohydrate in the form of candies ready to eat without preparation. The package is designed to fit conveniently in the pilot's flying suit pocket and can be opened and closed with one hand so that the pilot may conveniently eat the contents without releasing the airplane controls. This packet is not intended to replace or to substitute for any fraction of the pilot's authorized daily ration of food.

Airborne personnel are occasionally forced to make landings or to parachute out of their aircraft in areas remote from sources of food. To survive for extended periods and maintain physical strength and mental alertness under such conditions, they must carry some food with them. As water will probably be scarce, the stranded flier is likely to be much more concerned with thirst than with the prospect of starvation. Therefore, the paramount feature of survival food packets must be the ability to conserve the body fluids, as well as supply energy.

The *Individual Survival Food Packet, SA,* was developed as the food component of survival kits carried aboard military aircraft operating over arctic regions. Nutritionally, it is designed to sustain life with a minimum recovery time, until rescue can be effected, and is based upon the minimum daily water requirement of approximately one quart. The components are compressed cereal, fruit and nut bars, starch jelly bars, cigarettes, bouillon, tea, coffee, and halazone tablets. Approximately 1800 calories are furnished.

The *Survival Food Packet, ST,* is designed for air crews operating over tropical regions. It consists of starch jelly bars, tea, coffee, sugar, halazone tablets, and cigarettes. Physiologically, the pure carbohydrate diet is beneficial because of its water-sparing characteristics and its anti-ketogenic action. Chewing gum is added to aid in keeping the mouth moist.

The *Life Raft Tablet Ration* is stored in all types of lifesaving craft carried aboard ship. Intended for use when ships are abandoned at sea in emergencies, it contains 5 sucrose-citric acid tablets, 8 sucrose-lipid-citric acid tablets, 7 malted milk tablets, multi-vitamin tablets, and chewing gum.

How tactical situations are integrated with logistics of ration use is shown in Chart I on pages 6 & 7.

essential requirements

Unless rations, supplements, and packets possess the functional qualities which are necessary or desirable under the circumstances of their use, they will fail wholly or in part to fulfill their purpose in the field. The success of a ration in meeting this challenging objective is measured in terms of four types of military characteristics — these are the guide lines of ration planning—nutritional adequacy, acceptability, stability, and field utility. These military characteristics are defined in the following table. Requirements common to all packaged operational rations are also included.

military characteristics of packaged operational rations

A. *Nutritional Adequacy.* Maintenance of military efficiency, morale, general health, physical fitness, and biochemical balance of personnel engaged in military operations:

1. shall provide maximum nourishment compatible with the tactical situation;
2. shall promote desirable physiological effects;
3. shall have no detrimental physiological effects (abnormal thirst, gastric disturbance).

B. *Acceptability.* Assurance of consumption, thereby assuring nutritional adequacy:

1. shall provide sufficient variety to be palatable and acceptable when consumed for several consecutive days;
2. shall be palatable when eaten hot or cold.

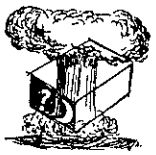
C. *Stability.* Retention of acceptability and nutritional adequacy:

1. shall be stable for 2 years at fluctuating temperatures ranging from −65° F. to 130° F. and relative humidity from 10 to 90%;
2. shall be stable for 1 year at a constant temperature of 100° F. and 90% R.H.

D. *Military Utility.* Facilitation of conduct of military operations:

1. shall be economical of weight and space;
2. shall be suitable for the individual to carry;
3. shall be easily prepared for consumption under all climatic conditions;
4. shall be capable of withstanding military handling during transportation and storage.

New weapons — rockets, guided missiles, jet propelled planes, long range bombers, and snorkle-equipped submarines — have had a decided impact on military feeding. When we come to consider atomic warfare, we do not even know what the problems may be. We do know, however, that we must intensify our research in order to assure the kind of nutrition that will enable men under the extreme tensions of modern military life to cope with new weapons and new forms of warfare. If these weapons are to provide an advantage over the enemy, the men who operate them must also have a superiority in physical fitness that can be achieved only by adequate nutrition.



Attainment of adequate nutrition at the time of actual consumption requires constant examination and re-examination of the nutritive value of operational rations. One stubborn obstacle stands in the path of an easy attainment of nutritional adequacy; namely, the severe limitation imposed by the essential requirements of acceptability, stability, and field utility.

Chart 1. Rations Designed for Varying Operational Conditions

Special Ration	*Operational Phase*	*Military Activity*	*Type of Feeding*		*Representative Composition*
			Method	*Equipment*	
Field Ration A	FIELD Base	Normal maintenance and supply	Issued in bulk	Refrigeration Kitchen facilities	Perishable; fresh, frozen grocery type foods
Operational B	U. S. A. Overseas	Training, Movement	Large group	No refrigeration	Similar to A, except non-perishable
Small Detachment 5-in-1	Close to Battle front Just before or after attack	(Tank, gun, and wire crews) Combat maintenance and supply Preparation Support (Patrol or on the "trail")	Small group	Small detachment cooking sets	5 menus: canned: meat items, vegetables, fruit, cereal, crackers, jam, cheese spread, beverages, soup, milk, confections
Individual Trail Frigid TF			Individual	One burner stoves Rarely available	Dehydrated: meat bars, soups, cereal bars, chocolate, raisins, nuts, cookies, beverages, crackers, hard candies
Hospital Supplement HS	COMBAT	Evacuation hospitals, Mobile surgical units	Large group	Field cooking equipment	Fruits, fruit juices, compressed cereals, soups, beverages (Concentrates—need only water for liquid, light, soft-type diets)
Individual Combat C	Battle Front	Active Fighting	Individual	One burner stoves Fuel tablets Rarely available	6 menus 3 cans meat items 3 bread-type units 1 fruit unit beverages
Aid Station Supplement AS		First-aid and clearing of combat casualties	Large group	Simple cooking equipment	Hot stimulating beverages cocoa, coffee, tea (Promote comfort and treatment of shock)

Food Packet	*Operational Phase*	*Military Activity*	*Type of Feeding*		*Representative Composition*
			Method	*Equipment*	
Individual In-Flight IF	COMBAT	Passengers, crews of bomber-type aircraft and transports	INDIVIDUAL	Aircraft heating ovens ↑	10 menus: 1 can meat, 1 can fruit, 1 bread-type unit, 1 dessert unit, accessory items
Individual Fighter Pilot FP	Battle Front	Flying fighter-type aircraft		Rarely Available	Snack: chocolate bars, gum, assorted candies
Individual Assault IA		Early phases of assault, airborne or amphibious		↓ Fuel tablets	8 menus: 1 can meat, 1 can B unit, accessory packet
Individual Survival SA	(Arctic aircraft)	Self-preservation until rescue		Solid, liquid fuel ↑	Compressed cereal, fruit, and nut bars; starch jelly bars, beverages
Life Raft Tablet Ration	SURVIVAL Isolation			Rarely Available	Tablets: sucrose-citric acid, sucrose-lipid-citric acid, malted milk, gum, multi-vitamin tablets
Survival ST	(Tropic aircraft)			↓	Starch jelly bars, beverages, gum

ration evaluation

Whether or not a ration is nutritionally adequate, that is, provides the minimum allowances of nutrients prescribed by Army Regulation 40-250, must be determined quantitatively by computing the total nutritive value from reliable data on the nutrient content of component ration items. Conventional tables for food composition are not a valid source of nutrient data for most components of packaged rations. Almost all of the published data represent naturally occurring or standard foods in general use, whereas a majority of the ration components are especially formulated to meet military requirements. It is necessary therefore to determine the nutrient content by laboratory analysis of ration items manufactured according to formulations prescribed by specifications. Furthermore, the effects of storage are such that the average values given in standard tables of food composition may not apply to ration items. To properly integrate all aspects of nutritive values of rations, a centralized source of this type of information must be established and kept up to date.

The food composition reference manual just completed is based on extensive data obtained from QMF &CI analyses. The manual lists the nutritive values of standard ration unit weights of all packaged operational ration components.

The numerous interfering substances developed during processing and high temperature military storage create special problems in assaying rations for vitamins. Assay for ascorbic acid and thiamine is especially difficult because the methods used for these vitamins depend on the measurement of reducing ability and fluorescence, respectively. With regard to vitamin A, supplied in rations by a mixture of dairy products (animal vitamin A) and green and yellow vegetables (carotene), the latter contributing the greater proportion, calculation involves the use of the conversion factor derived from the growth-promoting properties of pure beta-carotene when fed to vitamin A depleted rats (0.6 gamma of beta-carotene = 1 USP unit of vitamin A). It has been demonstrated that the growth-promoting property of carotene from various food sources differs greatly from that of beta-carotene, depending on source. Furthermore, the nutritional status of the individual at the time of feeding and the composition of the diet have been shown to be important factors in the utilization and conversion of carotene into vitamin A. The use of a single conversion factor is therefore, unreliable in estimating vitamin A activity and the total vitamin A content of the ration.

The chromatographic method of assay for vitamin A precursors is based upon the separation of the biologically active carotenoid pigments (reported as beta-carotene) from the total carotenoid pigments. The beta-carotene content is responsible for the greater portion of the vitamin A activity of fruits and vegetables, but there are other precursors with varying vitamin A equivalents.

Collaborative assays with other interested agencies and correlation of chemical, physical, and microbiological methods of vitamin analysis with biological assay methods are required to insure reliable vitamin data for ration items.

Quartermaster coordinated research and development on dehydration has drawn attention to the need for more information on the

nutritive value of dehydrated fruits, vegetables, meats, and eggs. Dehydrated commodity items have great utility advantages both for military and civilian feeding in time of emergency. Dehydrated white potatoes already have a wide scale use in the standard B rations. The scope of the dehydration program and the complexity of the problems indicate the need for a coordinated attack by industry, the U.S.D.A., research institutions and the QMF&CI.

Operational rations produce fairly good growth in rats but a greater growth rate is observed when the rations are supplemented with proteins and vitamins. Packaged rations which contain processed foods may be in actuality incomplete in nutrients despite the fact they appear to meet, by calculation, nutritional standards (N.R.C. and O.S.G. AR 40-250). It is important therefore to devise and conduct feeding tests with laboratory animals (rats, guinea pigs, chicks, dogs, and monkeys) to ascertain the physiological availability of the nutrients in packaged rations. Such studies are useful as a guide to possible nutritional inadequacies.

Extreme storage temperatures and long military supply lines explain the significant losses of nutritional value before rations reach the fighting area. The effects of storage under various known conditions of temperature and humidity on the nutrient stability and physiological availability of rations as consumed must be determined. It is also desirable for practical reasons to establish a correlation between laboratory storage tests (high temperature, short-time. 100° F. for 6 months) and military storage for loss of nutritional factors in rations.

Animal experimentation is useful as a "pilot test" providing guiding information on the nutritional adequacy of operational rations. However, due to qualitative, but particularly quantitative, species differences between laboratory animals and man in their nutritive requirements, information secured on animals is frequently inapplicable to man. Under stress conditions, the laboratory animal generally responds so differently, in kind or degree, from the human subject as to render comparison dubious. It is therefore essential to ascertain the significance of feeding tests with laboratory animals in relation to the nutritional welfare of members of the Armed Forces before proceeding to ration modifications. To achieve this purpose, arrangements have been made for collaboration with the Quartermaster Climatic Research Laboratory for using enlisted personnel for evaluating the nutritional adequacy of operational rations and, in addition, for studying the relationship of nutrition to climatic stress. To impart realism and vitality to laboratory investigations of combat rations, field studies in collaboration with other National Military Establishment agencies will also be a profitable source of data.

nutrient requirements under combat stress

The Surgeon General prescribes basic standards of diet for the Armed Forces. Army Regulation 40-250 dictates the minimum allowances of nutrients which a ration must supply in order to be considered adequate. These values, patterned after the recommendations of the National Research Council, were modified in the light of previous experience to meet the needs of the Army. They now reflect what are considered to be practicably obtainable levels.

"Recommended Allowances" is a term adopted by the Food and Nu-

trition Board to avoid any implication of finality or of minimal or optimal requirements which could have been inferred from the term "Standard." "Recommended Allowances" are understood to represent levels of nutrient intakes which the board recommends as *normally desirable goals or objectives.* In normal civilian feeding the recommended allowances can be attained with a good variety of common foods which will also provide other minerals, and vitamins for which requirements are less well known.

It is not safe to make this assumption for operational rations since they consist largely of processed foods. Furthermore, members of the vitamin B complex group other than thiamine, riboflavin, and niacin should be given consideration in planning military rations. Considerable evidence has been obtained suggesting a need for additional pyridoxine in operational rations.

General Doriot has said: "It is one thing to feed a man; it is yet another to maximize the safety and efficiency of a soldier through food. Food is a munition and our objective is to maximize its military effectiveness." Within the wide range of normal function of physiological processes, there undoubtedly exists a more limited area of optimum function, representing an ideal state of physical fitness. If essential food nutrient substances are not available in sufficient quantities, deviations from the limits of optimum function must result. The deviation may be so slight that it is unrecognized by present methods of appraisal, yet may cause lack of stamina, decreased efficiency, lessened physical fitness, diminished resistance to disease, and may delay recovery from wounds and illnesses.

The search for new information concerning military nutrition is being directed toward a description and development of the ideal or optimum operational ration—one which will permit military personnel to carry on their activities with greatest possible efficiency, and least likelihood of disease.

Diet is only one pillar of good nutrition. Nutritional deficiencies may result not only from simple failure to obtain the right kind of food, but also from factors which interfere with ingestion, absorption, metabolism, or utilization of needed nutrients, or increase the nutrient requirements. In modern global warfare military personnel are frequently exposed to various conditions and degrees of environmental, physiological, and psychological stress. Such climatic extremes as the tropics and the Arctic, and stresses induced by combat, fatigue, or complete isolation, produce changes in metabolism and food requirements. Understanding of the nature and extent of such changes is basic to designing rations which will best meet the nutritional requirements of troops under these types of stress.

More information on the relationship of nutrition to climatic stress is needed, as a critical analysis of the available experimental and observational findings will show. Fundamental physiological information is meagre concerning the effect of diet under conditions of climatic stress on those organs and systems of the body most intimately concerned with tolerance to climatic stress. Adequate knowledge of the role of body temperature, the transfer of oxygen from the atmosphere to the tissues, and the heat economy of the human subject under these stresses has not yet been obtained.

Although we have some knowledge of the nutritional reactions of work fatigue, and of injury, we

know almost nothing about the interactions of these two under the emotional stress of combat further complicated by completely foreign environmental influences. Another, possibly additive, stress should also be mentioned—atomic radiation. Its effect on nutrient metabolism and nutrient requirements will require extensive data and intensive study.

the all-purpose survival ration problem

Logistical reasons have emphasized the need for a survival ration acceptable to all the using agencies and adapted to use in all climates. Space and weight limitations in planes and ships suggested immediately a compact, high calorie food. Our best interim solution to an all-purpose survival ration is the high-carbohydrate food packet. This packet will support life for short periods of time, but it is not optimal. The goal is a ration which will maintain the best possible state of physical well-being, enable the survivor to cope with his adverse environment until rescue takes place, and assist him to recover more quickly from shock and at least his minor injuries. Special emphasis has therefore been placed upon designing a ration containing protein in the right quantity and of the optimal amino acid combination to spare and replenish body tissues and to bring the ration closer to nutritional adequacy. Protein in the ration would (1) aid men suffering from injury, burns, loss of blood, or shock, (2) improve palatability and acceptability of the ration, (3) promote a sense of well-being, and (4) increase the morale of the victims of disaster.

Data on the nutritional requirements of men on reduced caloric intakes show that dietary protein nitrogen is not efficiently utilized for preserving body tissues on daily intakes of less than 1500 to 1800 calories. When the diet contains this number of calories, the remaining energy requirements are derived from body fats. At lower caloric levels, however, the dietary protein is burned for energy. Since the nitrogenous end products of protein thus metabolized require additional urinary water for excretion it would be both hazardous and uneconomical to feed protein when the water resource is limited.

Information is needed on:

a. minimal caloric levels for dietary protein nitrogen utilization
b. the most efficient combination of amino acids or proteins for maintenance of nitrogen balance and optimum nutrition at low caloric intake
c. the role of steroid hormones and electrolytes in nitrogen metabolism
d. the effects of greatly increased outputs of energy upon nitrogen metabolism.

nutrient stability

Lack of fresh food, extensive use of processed foods, extremes of storage temperatures, and long supply lines make the daily supply of adequate amounts of the required nutrients in packaged operational rations a critical problem. Knowledge of vitamin and amino acid losses incurred in processing, storage, and preparation of foods, and the development of means for preventing or counteracting these losses is essential to maintaining the general health and fighting efficiency of combat troops.

Fresh meat products enjoy an enviable position in the American dietary and are a source of protein of high biological value and of vita-

mins of the B complex. Their inclusion in the combat type of ration is mandatory. The real problem from a military point of view is retaining these fine qualities in the processed product—both canned and dehydrated. It is significant therefore that supplementation with casein and B vitamins of three of the combat rations containing canned meat products as the main source of protein, is able to effect a marked improvement in the growth responses of the test animals.

Operational rations are designed to include adequate amounts of high quality animal protein, but the effect of processing and storage on the biological value of the protein may change the picture. We need to know what the values are when the ration is eaten by the soldier in the field. Amino acid values as commonly determined by microbiological and chemical methods may not reveal the true biological value since acid hydrolysis masks the damaging effect of processing and does not give us a true account of the availability to the body of the component amino acids. A rapid method for the determination of the biological value of protein, involving the use of the animal microorganism *Tetrahymena geleii* W, whose nutritional requirements for amino acids have been found to approximate those of some mammals, promises to give us a much more satisfactory means of determining the biological value at time of actual consumption.

Mushy texture and undesirable canned meat flavor are major defects of available canned meat items. Improvement of these items to meet military "ideals" depends upon development of new manufacturing procedures or modification of existing canning procedures. Emphasis at present is on those factors related to heat treatment. New techniques of processing meat for canning currently being investigated by the Institute include: (1) dielectric heating, (2) short-time high temperature sterilization, and (3) high voltage electron bombardment. Should these techniques prove successful, it will still be necessary to conduct collaborative studies to determine how these methods affect the retention and availability of vitamins and amino acids. They may be beneficial; we do not know.

vitamin fortification

Considerable losses of vitamins A and C which are sensitive to oxidation, and of thiamine which is sensitive to heat, take place during processing and storage of ration items. The greater portion of vitamin A in operational rations is derived from plant sources. Due to the poor and varying utilization and conversion of carotene into vitamin A by man, it is necessary to include greater quantities of animal vitamin A in rations. At present the Frigid Trail Ration and several menus of the 5-in-1 and C rations fail to furnish the minimal level of vitamin A prescribed by The Surgeon General's Office. The lack of satisfactory dairy spreads is the source of the difficulty.

Processing losses of thiamine in canned food items have been found to run from 50 to 60 per cent with additional losses of 30 to 50 per cent occurring during storage for 6 months at 100° F. In order to provide the recommended daily allowances of this and other vitamins at the time of consumption it is necessary to fortify operational ration items.

Most rations adequately supply vitamin C, but only because of the fortified beverage powders which they contain. Almost 100 per cent

of the ascorbic acid in the Individual Combat (C) and Frigid Trail rations is supplied by these fortified powders. Since many soldiers do not drink coffee, tea or cocoa, however, they do not get an adequate amount of ascorbic acid unless other fortified carriers of this vitamin are provided.

Many items which have been tested as possible vitamin carriers are not being used because they have been found to be unstable, unacceptable, or have limited utility. Needed therefore are stabilized forms of vitamins and/or substances which will promote the retention of vitamins added to ration items. The frequent substitutions and changes made in rations and ration components make it essential also to establish a greater number and variety of stable and acceptable fortified carriers. Work is proceeding toward this objective.

meeting the challenge

Innovations in military techniques and tactics, let me repeat, are continually adding new elements and demands to the problems of feeding personnel during combat phases of military operations. Maintaining operational efficiency through adequate nutrition under these circumstances is a challenge to fundamental and applied research. In its effort to meet this challenge the Institute is fortunate in having the guidance of the Committee on Foods, a part of the National Research Council Advisory Board on Quartermaster Research and Development Problems. This group's Subcommittee on Nutrition counsels the Institute on the special nutritive requirements of troops, on procedures of evaluating rations, areas for contract research, and on placement of contracts. The membership of this subcommittee includes medical nutritionists with wartime experience under The Surgeon General. With these resources for present and future planning our ability to make our Armed Forces equal to the demand of swift moving, highly mechanized warfare is greatly improved.

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