

Army Use of Edible Fats and Oils*

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A ration is the allowance of food for one man for one day. Army rations are divided into two main groups, the Garrison Ration and the Field Ration.

The items of the Garrison Ration and the allowable quantities of each are prescribed by the President of the United States. It consists of thirty-nine food items, including meats, dairy products, cereals, beverages, vegetables, condiments, and spices, as follows:

Article	Quantity
Meat:	
Bacon.....	2 oz.
Beef, fresh.....	10 oz.
Chicken, fresh.....	2 oz.
Pork, fresh.....	4 oz.
Eggs, fresh.....	1 each
Dry Vegetables and Cereals:	
Beans.....	.5 oz.
Rice.....	.6 oz.
Rolled Oats.....	1.5 oz.
Fresh Vegetables:	
Beans, string, canned.....	3.0 oz.
Corn, canned.....	2.0 oz.
Onions.....	2.0 oz.
Peas, canned.....	2.0 oz.
Potatoes.....	10.0 oz.
Tomatoes, canned.....	2.0 oz.
Fruits:	
Apples, canned.....	1.5 oz.
Jams or preserves.....	.5 oz.
Peaches, canned.....	1.2 oz.
Pineapple, canned.....	1.2 oz.
Prunes.....	.3 oz.
Beverages:	
Coffee, roasted or roasted and ground.....	2.0 oz.
Cocoa.....	.3 oz.
Tea.....	.05 oz.
Milk:	
Milk, evaporated.....	1.0 oz.
Milk, fresh.....	8.0 oz.
Lard:	
Lard.....	.64 oz.
Lard substitute.....	.64 oz.
Butter.....	2.00 oz.
Flour, wheat.....	12.00 oz.
Baking Powder.....	.09 oz.
Macaroni.....	.25 oz.
Cheese.....	.25 oz.
Sugar.....	5.00 oz.
Cinnamon.....	.014 oz.
Flavoring Extract.....	.02 oz.
Pepper, black.....	.04 oz.
Pickles, cucumber.....	.16 oz.
Salt.....	.5 oz.
Sirup.....	.5 oz.
Vinegar.....	.16 oz.

This does not mean that the diet of the American soldier is limited to the items of the Garrison Ration. The ration is used merely to establish the money allowance for the purchase of foods for the Army. Actually, Army messes are privileged to buy practically any item of food to be found on the market, provided the cost thereof does not exceed the money value of the ration. Regulations provide a wide list of substi-

tutive items for each of the ration items. The Garrison Ration is used wherever troops are in permanent quarters with kitchen and dining hall facilities for cooking and serving meals.

The Field Ration is used by field forces when away from permanent camps and stations. It is cooked in field kitchens wherever available and served in field mess kits. It is prescribed by the Commander of the field forces. Field Ration "A" is as nearly like the Garrison Ration as possible, and consists largely of fresh foods—fresh meats, fresh vegetables, fresh fruits, fresh milk, etc.—and is prescribed when field forces are sufficiently near to supply points to obtain fresh food supplies. Field Ration "B" is prescribed when troops are removed from sources of fresh food supplies. It consists largely of preserved foods—canned fruits, canned or dried vegetables, canned meats, canned or dried milk, etc. Field Ration "C" is a canned ration designed to be carried by the soldier when departing on missions where mess kitchens cannot keep up with rapidly-moving troops, or cannot follow into dangerous territory. It consists of three (3) cans of meat products (meat and beans, meat and vegetable hash, and meat and vegetable stew), and three (3) cans of a Bread Unit, each containing bread, soluble coffee, sugar, and candy.

Field Ration "D" is an emergency ration consisting of three (3) 4 oz. chocolate bars. The chocolate has a high calorific value due to added cocoa fat, it contains a given portion of skimmed milk powder, and is stabilized with oat flour. This chocolate has a softening point of approximately 120° F. so it can be carried safely in the soldier's clothing. It is designed to be eaten only when all other sources of food are exhausted. Field Ration "K" is a highly concentrated ration consisting of three (3) meals, each packaged in a rectangular water-proof and gas-proof container, that can be easily stowed away in pockets or in the soldier's pack. It is designed for use by aviators, parachute troops, motorized units, landing parties, etc., where volume and weight are important factors.

The American soldier in the field is considered to perform duties equivalent to a man at hard work. The ration is intended to provide a calorific intake of approximately 4,000, which is believed to be more than ample for ordinary and usual duties. For duty in Alaska and other cold climates, the ration allowance of vegetables is increased by 20 per cent, and the allowance of bacon is increased 33 $\frac{1}{3}$ per cent. Due and careful consideration is given, also, to the proper balance of protein, carbohydrates, fats, minerals, and vitamins. For proper balance, it is believed that the soldier should have approximately the following daily intake:

Protein.....	120 grams
Fat.....	108 grams
Carbohydrate.....	575 grams
Calories.....	4,000
Minerals (calcium, iodine, iron, phosphorous, potassium, sodium)	
Vitamins	

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The Garrison Ration and Field Ration "A" amply provide for all these essential factors. Fresh meats, fresh milk, eggs, and cheese, provide ample quantities of complete protein. Fresh and dry vegetables, fruits, cereals, sugar, and sirup, furnish the necessary carbohydrates. Fresh and dry fruits and vegetables, meats, cereals, milk, and cheese, provide ample percentages of minerals. The vitamins and regulatory foods are found in fresh meats, dairy products, fresh fruits, fresh vegetables, pickles, eggs, etc. It is only when troops are reduced to the more restricted field rations that serious consideration need be given to food deficiencies. These have already been considered in providing rations for our troops overseas.

While the members of this Society are interested in the dietetic and nutritional value of the Army ration, as Oil and Fat Chemists you are, perhaps, more directly and vitally interested in the fat components of the ration. Let us then discuss the fat requirements of the body, the digestibility of fats, and absorption and utilization within the body, and the palatability given to foods by fats.

Soldiers should receive from 35 to 40 per cent of their caloric intake from fats. In terms of grams, this is from one to two grams of fat per kilogram of body weight per day. The intake of fat is limited owing to the inability of the body to digest and absorb a great quantity. The body may build up tolerances for fat by gradual increase in the intake. An excess in fat intake delays emptying time of the stomach, and may result in acidosis, obesity, and biliary disturbances, and may be the cause of certain forms of skin disturbances. An insufficiency of fat may result in malnutrition and constipation, while insufficiency of vitamin-carrying fats may result in deficiency diseases.

In the digestion of fat, no change occurs in the mouth or stomach, except in the case of finely divided fats, such as egg yolk and cream. The presence of fat in the stomach depresses the secretion of hydrochloric acid, causing delay in the emptying time of the stomach. In the small intestines, fats are split into fatty acids and glycerol by lipase, a digestive enzyme of the pancreatic secretion. Fatty acids are further emulsified by the action of bile, one of the secretions of the liver. Insufficient secretion of bile during digestion will cause a loss of fat in the feces. Both glycerol and emulsified fatty acids are absorbed by the lacteals and carried with the lymph to the blood stream via the thoracic duct. Fats with low melting point are more completely digested than those of high melting point. Hydrogenated fats with a melting point of 50° C. or higher are only partially assimilated. However, when those harder fats are fed in an admixture with soft or liquid fats, they are more readily digested. From 90 to 95 per cent of the fat eaten is assimilated. Fats containing large percentages of the unsaturated acids, (lard, olive oil, cotton seed oil, corn oil, peanut oil, etc.) have been found to be almost completely digested and absorbed into the body.

Fat is the body's most concentrated source of energy. It has higher food value than carbohydrates, but cannot be substituted entirely for the latter, since fats require a certain amount of carbohydrates to complete their combustion. If combustion of fats is incomplete, certain toxic acids (acetone, oxybuteric, and diacetic acids) are formed. Ketosis has been observed in persons during maximal work on a low

carbohydrate intake. Individuals performing maximal work reach a stage of exhaustion much sooner when on a high fat diet than on a diet rich in carbohydrates, due to blood sugar deficiency. The administration of glucose brings prompt relief from such deficiency. Fats and carbohydrates are about equally well-utilized in the production of muscular work. Fat not used in the production of energy is deposited in the fatty tissues and becomes available for future fuel. This fatty tissue conserves body heat, and is of some importance from a military viewpoint. Fat is deposited around the vital organs and protects them from mechanical injuries. Fats are limited protein spacers. They are carriers of vitamins A, D, and E, and in that capacity promote growth, increase resistance to infection, and promote the utilization of calcium and phosphorus.

In the stomach, fats retard the appearance of hunger by delaying the emptying of that organ. This, again, is an important function for military consideration. The body is capable of synthesizing from carbohydrates and from those amino acids which are glucose formers, all of the fatty acids which are commonly found in the body fats of animals. The body does not, however, possess the power to synthesize unsaturated fatty acids of the linoleic, linolenic, and arachidonic acids. These are indispensable for some metabolic processes or as structural units of protoplasm. Depletion of these unsaturated fatty acids in the diet halts growth and physical development. Olive oil, lard, corn oil, linseed oil, fats or lecithin from egg yolk, and poppy seed oil, contain relatively large amounts of unsaturated fatty acids, and are corrective for conditions arising from such dietary deficiencies.

Fats are derived from both animal and plant life. Animal fats are almost entirely the triglycerides of stearic, palmitic, and oleic acids. They consist of a framework or stroma of connective tissue, enclosing in its meshes the large fat cells. Within the cell wall fat globules are deposited. Fat deposits are found most abundant between the outer surface of the muscular structure and the skin, lining the internal cavities (abdominal, pelvic, and thoracic), around the internal organs, and, lastly, between muscle bundles and within the muscle tissue itself. Intermarbling of fat within the lean has a great bearing upon the flavor of the meat. Not only is the fat deposited in visible amounts between the muscle groups of the feeding animal, but it actually replaces some of the moisture within the muscle fibers. Under the influence of heat, much of the moisture of meat is forced out by the contracting muscle fibers. In the case of lean meat this leaves the meat dry and less flavory. With marbled meat, however, the fat cells burst under the influence of heat, and much of the escaping fat is absorbed by the muscle fiber, making it juicy and flavorful.

The principal meat item and, indeed, the principal food item of the American soldier is fresh beef. The ration provides an allowance of 10 ounces of fresh carcass beef a day, and that is just about what the soldier consumes. The grade of carcass beef prescribed by Federal specification is the market grade known as Low Good. This is not the highest grade of beef on the market, and there are many lower grades. Higher grades would be uneconomical, because they are relatively high in price and are very wasteful because of the excess fat they carry. On the other hand, lower grades are uneconomical because they are deficient in flesh,

have a large percentage of bone to meat, and are less palatable and nutritious because of fat deficiency. The intermediate grade purchased for the military services represents the most economical beef because of its relative lack of wastefulness and because of its fine palatability as well as nutritional value. Low Good beef is not entirely free of waste, since in carcass form it, too, carries some excess fat in the kidney knob, cod fat, heart fat, etc.

When carcass beef is used in the Army post mess, this fat is rendered and used to some extent in soup stock, and the excess that cannot be so used is converted into soap for use in the kitchen. In the field such fat is wasted. The use of boneless beef was introduced into the Army maneuvers during 1940, and its use has now grown to such an extent that more than three-fourths of the beef now used in the Army within the United States is boneless beef. In this method of preparation the excess fat of beef carcasses is removed and used by the packers, to meet the ever-growing demand for fats in the civilian and military needs. It eliminates gross waste in the field. Seven ounces of boneless beef is used in lieu of 10 ounces of carcass beef.

In the preparation of canned meat items, (corned beef, roast beef, corned beef hash, chili con carne, the M-Units of Field Ration "C"), and in sausage (Vienna style, bologna, frankfurters, cervelat, salami), a much lower grade of beef is used, because in most of these products considerable percentages of fat are detrimental to appearance, texture, and palatability. South American corned beef carries greater percentages of fat than does the domestic pack. This is due to the requirements for additional fat in the product prepared for England, which brought about the addition of tallow, although South American cattle used for canning purposes carry more fat than do domestic canners.

Beef fat is composed largely of stearin, palmitin, and olein. It contains comparatively little of the unsaturated fats. Its vitamin content is low. It is almost completely digestible. Its flavor is distinctive and pleasant. It adds great zest and palatability to beef cooked in any way—fried, broiled, roasted, stewed, or boiled. As oleo stearin it is used in shortenings; as oleo oil it is used in great quantities by the cracker industry; as oleo stock it is used in shortenings and oleomargarine; as edible tallow it enters into many edible products.

Fresh pork may be purchased by the Army as carcass pork, but practically all is bought in the form of cuts since these lend themselves better to preparation in large messes. As cuts, pork presents but little problem in the matter of excess fat. Most pork cuts are defatted to the proper degree for cooking in whatever form desired. Hams and bacon constitute the foremost cured and smoked pork products. For many years the Federal specification for smoked hams restricted Army purchases to regular hams. That restriction was recently removed. Recent instructions from the Office of The Quartermaster General have directed that on future purchases of hams for use within the United States, they shall be skinned hams only. This same directive also directs that means be adopted to remove fat from hams as far as possible, in order to comply with the fat conservation program. For overseas use smoked hams will also have shanks

removed. This is being done primarily to conserve shipping space, but it will conserve some pork fat as well. Bacon provides considerable fat. Army bacon contains approximately 20 per cent of lean only and 6 per cent of skin, the balance being fat. During the first World War the Army accepted many extra short clears for bacon use. These ran much higher in fat than bacon bellies, since the attached fatback carries no lean.

Veal carries practically no fat. Mutton and lamb carry practically the same proportions of fat as does beef, and this fat is somewhat similar to beef fat in consistency, though it is quite different in flavor and palatability. It is more deficient in vitamin content, and cannot be used so freely and extensively in edible products as beef fat. Sliced dried beef is practically free of fat. Hearts, livers, kidneys, sweetbreads, and other glandular organs carry appreciable quantities of fat rich in Vitamin A. Pigs feet, scrapple, head-cheese, tongues, and similar products and organs carry variable quantities of fat.

The Army purchases considerable quantities of poultry—broilers, fryers, roasters, fowl, turkeys, geese, and ducks. Serving of poultry on Sundays and holidays has become almost a tradition. The grade purchased requires a proper proportion of fat varying with the class of poultry. The fat content is greatest, of course, in fowl which is used mostly for fricassee. The fat of poultry is largely consumed with the meat, except in the case of fricassee, where it is consumed in the gravy. In the preparation of canned chicken for F. S. C. C., the chicken is pre-cooked until little or no fat remains. Only 9 per cent of broth is added to the meat in the can, and this broth has but little fat. New specifications for Army canned chicken provides for the use of approximately 25 per cent of broth, and this broth must contain not less than 15 per cent of fat. It is believed that this added chicken fat will add greatly to the palatability, as well as to the nutritional value of this product.

The Army uses comparatively little fresh fish. Most of the fish consumed is in the form of fillets, or such frying fish as halibut, none of which contains fat in appreciable quantities. Fish fat is not relished by the average American soldier. Most of the canned salmon purchased for Army use is of one of the red varieties, Chinook and Sockeye, which yield rich, golden oil which gives zest and palatability to the product. Canned sardines have little or no oil or fat of their own. Some sauce must be added to this product to give the desired palatability. The oils used are chiefly olive and cotton seed, or peanut. Tuna fish oil is practically inedible. In preparing tuna, all oil is cooked out, and cotton seed oil added in the can.

The allowance of lard in the Army ration is .64 of an ounce. At one time the Army used lard exclusively as a shortening and cooking fat. Lard manufacturers, however, during the years of large lard exports, failed to keep step with the rapid improvement in the manufacture of vegetable shortenings. As compared to the latter, lard had inferior keeping qualities and had such a low smoke point that it was very disagreeable to use in the mess kitchen, particularly for deep-fat frying, and fell into disuse in the Army. During recent years practically no lard has been purchased by Army messes. During the last year the Subsistence Research Laboratory, with the help of the American Meat Institute, has developed a type of lard aptly named

"War Lard," that has greatly improved qualities as regards the undesirable characteristics mentioned. The base is a refined lard of good quality. Its stability is increased by the addition of 4 per cent or more of hydrogenated lard flakes. Its melting point is raised to not less than 45° C., and the smoke point has been greatly improved. For overseas use lecithin is added, and the lard is packaged in hermetically sealed containers. Under direction from the Office of The Quartermaster General, the use of this lard is mandatory. At the present time there is considerable activity in investigations of suitable anti-oxidants to inhibit the development of rancidity and other off-flavors due to fat decomposition. In addition to lecithin, gum guaiac, wheat germ oil, dextrose, and alpha tocopherol have been used. The above materials are very well known to the industry. The Army is deeply concerned in the stabilization of lard to the extent that it will remain wholesome for at least two months without refrigeration.

In addition to lard the ration provides for an allowance of .64 of an ounce of lard substitutes. The Federal specification for lard substitutes is old and out-dated. It provides for two types—vegetable shortening and animal shortening. It does not provide for any of the new and improved shortenings of high stability, high smoke point, and greater plasticity. It is intended to revise this specification soon to include such improved shortenings.

For salad oils the Army purchases olive oil; for salad and cooking use, vegetable salad oil. Salad dressing and mayonnaise are purchased in considerable quantities. The latter must contain a minimum of 50 per cent of vegetable oil, and not less than 78 per cent of oil and egg yolk combined. Peanut butter is also used in somewhat limited quantities.

Lard and the vegetable oils are practically devoid of vitamin content. Lard substitutes made from animal fats contain the very limited content carried by beef fat.

Dairy products are rich sources of highly desirable fats. The butter allowance is 2 ounces per man per day. In camp or on maneuvers within the United States, butter is served from one to three times daily. With adequate refrigeration, or for a short time without refrigeration, butter as produced is the ideal spread for bread. For tropical use where adequate refrigeration is not available, butter is too unstable and soft. A spread for bread of stable character for overseas use where refrigeration may be wholly absent is an urgent need. Several creameries and oleomargarine manufacturers have been working on this problem. Many products of varying degrees of hardness, melting points and softening points, some made wholly of vegetable oils with no moisture present, many oleomargarines, and many modified butter products with various percentages and kinds of harder fats, have been offered. Because of the restriction against the use of oleomargarine by Federal agencies, attention has been largely directed to butter. At present large purchases are being made of a "spread for bread," composed of 85 per cent butter and 12 per cent of a fully hydrogenated vegetable oil to bring the melting point well above 110° F., with salt, benzoate of soda, and diacetyl added, and the permitted use of an emulsifying agent. So far this product has been giving satisfaction overseas. This does not mean, however, that

this is the last word on this product and that no further research is desired. It is believed that further improvement can be made in the product, particularly from the standpoint of flavor.

While natural cheese, mostly Cheddar, is used in considerable quantities by troops within the United States, for overseas purposes pasteurized cheese in hermetically sealed cans is stipulated. Likewise, the fresh milk commonly consumed at home is replaced overseas by canned, evaporated milk, and dried, powdered, whole or skimmed milk and malted milk. Within the United States, particularly, ice cream is a common and frequent addition to the menu. Cream is used but little in Army messes, evaporated milk being used in its stead. Of late consideration has been given to sterile milk, concentrated milk and cream in sealed containers, so prepared that they do not possess the highly cooked flavor of evaporated milk. These products are desirable for the purpose of providing a palatable beverage in the field.

Milk fats are glycerides of olein, palmitin, stearin, myristin, butin, butyrin, caproin, caprylin, and caprinin. They owe their aroma and bouquet to the last four, which are soluble and volatile acids. No other natural fats possess such palatability and taste appeal. No other fats used in quantities possess such high vitamin content.

Army hard bread as used in previous wars contained no shortening, because of the instability of all shortenings made prior to and for several years following the first war. Shortening added to hard bread turned rancid in a short time, and since hard bread had to have a keeping life of months, if not years, the inclusion of such shortenings was precluded. In the modern version of hard bread used in Field Rations "C" and "K," shortenings with active free oxygen keeping test qualities of 100 hours or more are required. The biscuits made with this shortening have excellent keeping qualities, and have proven entirely satisfactory under field conditions. These biscuits contain relatively high percentages (8½ to 16) of shortening to provide the high calorific value desired in these rations. The shortening content of Army bread, prepared biscuit and short bread mixtures, prepared cake mixtures, prepared pie dough mixtures, prepared doughnut, pancake, and waffle mixtures, and for crackers and cookies, is prescribed.

The above covers the principal fat carrying foods used by the Army. A typical Army menu for one day (Sixth Corps Area menu for May 1, 1942) shows a fat content of .39 of a pound per 100 men, or 177 grams per man. The fat containing foods were fish, bacon, veal, eggs, milk, cheese, mayonnaise, shortening, and bread. It will be noted that these include animal and vegetable fats, hydrogenated fats and fats with unsaturated fatty acids, vitamin and non-vitamin bearing fats, fats of high flavor and fats with reduced flavor. It appears that in the selection of available natural foods for Army use, an adequate supply of necessary fats is obtained. In keeping with the trend to restrict the civilian consumption of edible fats and oils, some restriction may be placed eventually on the use of fats in the Army mess. It is certain, however, that sufficient fats will be retained in the diet to insure palatability of the food, furnish the necessary calorific and energy value, and provide the nutritional attributes accompanying such fats.