THE ARMY'S MILK SUPPLY.

By Lieutenant W. B. V. GATES, M.B.E.,
Royal Army Service Corps (R. of O.).

Cow's milk, although intended by Nature for the calf, has from time immemorial found its place in the dietary of the nations.

According to authorities, the domestication of cattle occurred some 6,000 to 10,000 years ago. From these early days up to the present time the cow has continued to be a faithful servant of man. The cow was worshipped in Babylonia and Egypt about 2,000 B.C.; Hathor, the goddess who watched over the fertility of the land, was depicted as one.

The soldiers of Jenghiz Khan, the Mongol emperor who conquered Asia and a large part of Europe in the thirteenth century, carried dried milk as part of their rations.

Milk products found also an important place in the dietary of the Vikings during their extensive sea voyages in Northern Europe, and even across the Atlantic.

The first settlers in the New World—the Pilgrim Fathers—made the mistake of not taking cattle with them, and as a result of the absence of milk, the death rate, particularly amongst the children, was extremely high. In fact, nearly fifty per cent of the "Mayflower" emigrants died during the first winter, including every child under two years of age. This mistake was, however, speedily realized and rectified by the inclusion of milch cows in all further expeditions.

History teaches us, therefore, that milk has from the earliest times been regarded as a food of high nutritive value. This is borne out by its analysis.

Table I.—Analysis of Milk. (Droop-Richmond.)

Water	87·34 per cent.
Fat	3·75 ,,
Milk sugar	4·70 ,,
Proteins	3·40 ,,
Ash	0·75 ,,
Other constituents	0·06 ,,
	100·00 per cent.
Calory value per ounce	17

The high water content should be noted, as it is a fact of considerable significance when one thinks of the time, energy and expense involved in the transportation of the thousands of tons of water present in a day's consumption of liquid and condensed milk.

Milk, as in the past, forms part of the daily ration of the soldier, and in view of its nutritive value rightly so. It is the question of the means of coping with the supply of this commodity with which we are immediately concerned, for it must not be forgotten that of all forms of food, milk, being

the ideal medium for bacterial growth, ranks first as the most perishable and the most liable to spread disease through contamination.

The cow in the first place may, and in fact often does, contaminate its milk with the germs of the tuberculosis from which it is itself suffering, while during the period intervening between leaving the cow and its consumption a hundred chances of infection present themselves—dirty receptacles, wind-borne particles, flies and other insects, etc. Cows are extremely prone to tuberculosis, and it is stated that at least 2,000 infants die yearly from this scourge contracted from raw milk. As to the huge number who drag through a sickly childhood to become further progenitors of similar unhappy creatures nothing is said. Other diseases, such as diphtheria, scarlet fever, undulant fever, etc., have repeatedly been spread by contaminated milk; only last year several persons died in Brighton from a milk epidemic.

In any consideration of the Army's milk supply, particular attention must therefore be paid to the form in which this highly nutritious but potentially dangerous food is to be supplied.

In common with other supplies in general, the provision of milk must of necessity fall into two main categories: (1) supply at home; (2) supply abroad. And in both cases we must distinguish between peace and war conditions.

At home, in time of peace, little difficulty is experienced in obtaining supplies in barracks at any rate, raw milk from neighbouring farms and creameries or condensed milk being used. In summer raw milk not infrequently turns sour, and occasionally the supply is deficient. Condensed milk, on the other hand, cannot be regarded as favourably from the standpoint of nutritive value, owing to the long heat treatment undergone during manufacture, which affects its vitamin content and destroys part of its mineral salts.

During training periods, in which conditions most nearly approximate to those experienced on active service, the use of condensed milk becomes general for obvious reasons.

The factors of weight and ease of distribution play the predominating part in the choice of a milk for military use, and up to the present, condensed milk, because of the reduction in water content, coupled of course with its keeping powers and packing, has proved the most suitable for this purpose.

During the war, owing to the concentration of large numbers of men in camps, often somewhat inaccessibly located, condensed milk was used for the major part during the training period in this country. In recent years pasteurization has greatly improved the keeping quality of raw milk, while the use of rail and road tankers has facilitated its distribution. It, however, presents many handling difficulties even after arrival in camp, so that the use of small tins of preserved milk of one sort or another will in all probability again be resorted to in the future under similar circumstances.

Abroad, both in peace and war, local supplies of milk can rarely be depended upon. In the East, quite apart from any question of sufficiency of supply, local milk is rarely of good quality, while the danger of contamination is such as to preclude its universal use. This applies in a greater or less degree to the majority of foreign stations or likely overseas theatres of war, so that the use of a safe milk in compact form becomes essential. The two forms which are available at present are condensed milk and the more recent discovery, powdered milk.

TABLE II.—ANALYSIS OF CONDENSED MILK (UNSWEETENED). (H. E. COX.)

Water	66·18 per cent.		
Milk solids	33·82 ,,		
Fat		9·28	per cent.
Lactose		13·33	,,
Protein		9·16	,,
Ash		2·05	,,
	100·00		
Calory value per ounce	48		

Condensed milk is prepared by first pasteurizing raw milk by holding it at a temperature of 145° to 150° F. for half an hour, and then evaporating it in a vacuum pan for some two or three hours at a temperature of 130° to 140° F. After being poured into tins, it is sterilized at a temperature of about 230° F.

Authoritative investigations of this process have shown that the long heat treatment, although effective in preserving the milk, is partially destructive of the vitamins and mineral salts. Recent researches have shown that diets devoid of vitamins and essential salts lead to complex diseases such as scurvy, rickets, beri-beri, etc., so that the form of heat treatment used in producing a condensed milk for military use is seen to be of paramount importance.

In the light of present-day knowledge, condensed milk, although satisfying many of the requirements of active service conditions, is known to possess other weaknesses quite apart from the question of vitamin and mineral deficiencies, which render it far from being the ideal form of preserved milk for military purposes.

Although sound tins present milk in a convenient form which is fairly sterile, the danger of contamination, after the tin is once pierced, by flies and dust remains, owing to the fact that the product is, like ordinary raw milk, still liquid, and that the tin, once opened, cannot be effectually closed.

Who is there who, having been in the East, has not been nauseated to find on visiting the cook-house (an unwise thing to do, but essential at times), a tin of condensed milk which has been pierced and part of its contents used, standing on the table black with flies attracted to the liquid exuding from the puncture made for pouring out?

Again there is always the danger of finding one's supplies blown or putrid owing to damage to tins during transit. The period during which condensed milk will keep even when delivered in a sound condition is not really sufficiently long for overseas campaigns, and having once passed its warranty, it cannot, even in an emergency, be used with safety.

From the point of view of nutritive value a comparison of the analysis of condensed milk given in Table II and that of milk powders (Table III) is of interest. Whereas the fat content of condensed milk is only 9·28 per cent, that of the milk powders is 27·3 per cent and 28·2 per cent, while the calory value is 48 as against 150 and 152.

These data are of great significance, for the problem of food supply in modern warfare is that of providing the maximum calory value per pound of foodstuffs transported. The use of condensed milk, apart from involving the uneconomic transportation of sixty-five per cent of useless water, is thus seen to be extremely defective also in regard to this important desideratum.

We will now turn to a consideration of the more modern and alternative form of preserved milk, namely milk powder, of which there are two main varieties.

The following are analyses of the powders in their dry form (not reconstituted); they are only general and will in practice be found to vary according to the composition of the original milk :—

TABLE III.—ANALYSES OF MILK POWDERS.

	(1)	(2)
Moisture	2·5 per cent.	1·5 per cent.
Fat	27·3 ,,	28·2 ,,
Proteins	26·6 ,,	26·7 ,,
Lactose	37·6 ,,	37·9 ,,
Mineral matter	6·0 ,,	5·7 ,,
	100·00 per cent.	100·00 per cent.
Calorie value per ounce ..	150	152

Milk powders are made by drying milk, either full cream, half cream, or separated, thereby removing all but two to three per cent of the natural water content of the milk.

In recent years the manufacture of these products has reached a high standard of perfection and the powers that be are for various reasons, which are gone into fully below, turning more and more to this form of milk for overseas and active service use.

The methods of powdering milk may be broadly divided into two classes: (1) Roller methods; (2) spray methods.

(1) ROLLER METHODS.

Milk specially chosen for its cleanliness and freedom from bacteria is brought into the creamery from neighbouring farms as soon as possible after milking, and is passed through a centrifugal cleaner which removes the

natural slime of the milk. It is then run on to twin steel rollers internally steam heated and revolving in opposite directions. The milk dries on the rollers in the form of a film, is scraped off by tangential knives and falls as a powder, which is sifted and packed in air-tight tins.

In the modern type of roller machines the milk is only heated for two to three seconds at a temperature of 98° C., thereby ensuring a full conservation of the vitamins and mineral salts, while yielding at the same time bacteriological sterility. This feature, a result of the short heat treatment, particularly commends this process of powdering.

The curds formed in the stomach by roller powder are soluble and finely divided and therefore far more easily digested than those of raw milk or spray process powders which set in heavy, turgid clots. This fact is of no little significance when the body of the soldier is considered as a work-performing machine having a limited energy output, the conservation of which we are at such pains to ensure in other directions by fatigue-reducing expedients, such as lighter clothing and equipment, etc.

In the hospitals where the placing of a minimum strain on the digestion is an even more necessary precaution in order to conserve lowered vitality, the use of roller process powder is obviously of advantage, not only because of its digestibility, but because of its freedom from pathogenic organisms.

(2) Spray Methods.

In these methods the milk is first strained, then pasteurized for half an hour at 145° to 150° F. and subsequently fed into vacuum pans where it is evaporated to the consistency of condensed milk. It is then sprayed with a blast of hot air at about 180° to 190° F. in special chambers. This reduces the milk to a powder which falls to the bottom of the chamber, from whence it is removed and sifted.

Spray powder, although subjected to this long heat treatment, which is not desirable from the point of view of vitamin preservation, is not so sterile as roller powder, does not possess good keeping qualities, and, as has been already remarked, is not nearly so digestible. The development of rancidity—a tallowy, cheesy smell—is characteristic of spray powders (full cream) and develops after a few months, particularly in the tropics. Rancidity is an indication that the powder is not fresh, or is keeping badly and although a sign of age or poor quality in any milk powder made by no matter what process, it is not definitely injurious if the powder is used only for a short time. This is a distinct advantage over condensed milk, which if once exposed to the air through damage to tins, etc., rapidly decomposes and becomes toxic. Spray powder when once mixed has a more complete solubility, but in the mixing is inclined to cake into little insoluble balls. On the other hand roller powder mixes easily without this phenomenon, although the fat does not remain in as good a state of emulsification.

The use of a machine termed an emulsifier is unnecessary where full-cream roller powder is used, although advisable with spray powder owing to these mixing difficulties. Where full-cream roller powder is used the requisite quantity can be taken from its tin and merely stirred into a hot dixie of tea; but in large standing barracks or camps, or on board ship, when mixing in bulk quantities is required, the use of such a machine may under circumstances be advantageous to facilitate and expedite centralized preparation. These emulsifiers, popularly known as "iron cows," are used on many steamships and mix up spray process separated milk powder and butter. The use of full-cream roller powder, which obviates the complication of the addition of butter and presents the possibility of simple mixing without any apparatus, is becoming more general owing to the better keeping quality and solubility of present day roller powder, the manufacture of which in the last few years has improved enormously.

Condensed milk, as now supplied to the Services, is unsweetened, and packed in 12-ounce tins, 4 dozen in a wooden case—a case having a liquid equivalent of 9 gallons.

Roller milk powder can be supplied in 12-ounce vacuum tins in wooden cases of 2 dozen—a case having a liquid milk equivalent of 13½ gallons.

The following table shows the comparative data and gives an economic comparison of roller process milk powder and condensed milk. It shows at once the respective merits of the two alternative forms of preserved milk available for military purposes.

TABLE IV.

	12-oz. tin					1 Case			
	Liquid milk equivalent	Cubic capacity in cc.	Cost	No. of tins per case	Warranty period	Liquid milk equivalent	Cubic capacity	Gross weight	Warranty period
Evaporated milk	1½ pt.	420 c.c.	Same	48	1 year	9 gal.	1·2 c. ft.	53 lb.	1 year
Milk powder ..	1½ pt.	980 c c.	Same	24	2 years	13½ gal.	1·2 c. ft.	40 lb.	2 years

i.e.—1 lb. gross weight evaporated milk is equivalent to 1·36 pints milk (calory value 462).
1 lb. gross weight milk powder is equivalent to 2·70 pints milk (calory value 918).
or— 1 cubic foot of an evaporated milk case is equivalent to 7·5 gallons milk (calory value 20,400).
1 cubic foot of a milk powder case is equivalent to 11·1 gallons milk (calory value 30,192).
or— 1 gallon milk (calory value 2,720) carried respectively in the form of evaporated milk and powered milk is characterized as follows :—

TABLE V.

Equivalent of 1 gallon	Weight (gross)	Capacity (gross)	Cost
Evaporated milk ..	5·88 lb. (1 gal.) ..	0·13 cubic feet ..	Same
Milk powder ..	2·96 lb. (1 gal.) ..	0·09 cubic feet ..	Same

The above data, therefore, show clearly that milk powder, if substituted

for evaporated milk, would mean a *reduction in weight of one-half and in bulk of one-quarter of the Army's milk ration and would involve only half the present turnover of stocks owing to its two-year warranty.*

From the point of view of transportation, condensed milk having sixty-five per cent of water is seen to be thoroughly uneconomic, while its calory value is less than one-third that of milk powder. To take an example, 1½ ounces of condensed milk is the normal daily active service ration, of which nearly one ton a day is used by a division at full strength. This means that ten hundredweights per day per division in the shape of unevaporated water is needlessly carted about, probably involving many hundreds of wasted ton miles between point of origin and point of usage, while apart from this the product thus laboriously handled is only one-third as productive of energy as the article which could be so advantageously substituted for it. *All this waste* of time, labour and transport is avoided with powdered milk, which has three times the food value, contains not more than two to three per cent of moisture, and is in its dry state only half the weight of a corresponding equivalent of liquid milk in condensed milk form.

To sum up, in comparison with condensed milk, *all* powdered milks have the following advantages:—

(1) Weight for weight, they are half again as compact because they contain, practically speaking, no water;

(2) They are more than three times more nutritive and energy producing;

(3) They are more sterile, cannot become "blown" or "decompose" even if tins are damaged in transit, and can be used without danger even if several years old;

(4) They are more digestible—of value on the ground of conservation of energy;

(5) More hygienic and economical in use, as the tin can be re-closed after initial opening, and used again, while flies are not attracted to a dry powder.

They can therefore, as we have seen, justifiably claim superiority to condensed milk on practically every score—economy, food value, transport, length of life, sterility, palatability, digestibility, vitamin and mineral content, and economy in use.

Of the powdered milks, those made by the roller process, or better still, if obtainable, those made by the improved roller process, perfected by a well-known firm of milk food manufacturers, are the more suitable for military purposes owing to:—

(1) Far better keeping qualities, nearly double that of condensed milk and spray process powder.

(2) Greater sterility.

(3) Higher mineral and vitamin contents which are not impaired by the short heat treatment involved in the roller process.

From an impartial and unprejudiced survey of the desiderata, and of the degree in which these are satisfied by roller process milk powder, one is forced to the conclusion that in the use of this form of preserved milk, whenever fresh cow's milk is unobtainable, lies the ideal solution to the question of the Army's milk supply.

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