Milk as a Valuable Foodstuff

by E. Rannak

TALLINN 1966

U.S.S.R.

THE MINISTRY OF THE MEAT AND MILK INDUSTRY
OF THE ESTONIAN S.S.R.

MILK AS A VALUABLE FOODSTUFF

BY E. RANNAK

THE INTERNATIONAL SEMINAR FOR THE
FELLOWSHIP GROUP OF THE U N O
ON THE MILK INDUSTRY IN THE ESTONIAN S.S.R.

TALLINN 1966

CONTENTS

Introduction

According to geographical location, traditions, economic conditions and other factors, people live on very different foodstuffs.

In polar regions and in some desert areas the food of native population consists mostly of animal products, mainly meat, which is fairly fat.

In countries with a temperate climate, economically highly developed countries the use of cereals in food, prevails although meat, dairy produce, fat and sugar are also used abundantly. The consumption of vegetables and fruit is however moderate.

In countries with a hot climate, food products of vegetable origin are mainly used.

Suitably chosen foodstuffs can however ensure a nutrition of full value in different geographical regions, which is the basis of good health of the population. This follows from the fact that, irrespective of a very different assortment of foodstuffs, the food can nevertheless contain the necessary quantities of components, required by the human organism.

Recommended Dietary Allowances

The human organism (just as that of animals) requires for vital activity the following food components: protein, fat, hydrocarbons, about 15 mineral elements and approximately 20 vitamins. Protein consists of amino-acids of which the presence of a certain number (from 10 to 8) in adequate quantities is obligatory in all food.

Fats must contain in a daily food ration 5-10 g of the so called essential fatty acids. In different food products about 50 of these are found, but in widely varying quantities.

In order to back up scientifically the correct choice of

food products in present day changing nutrition conditions, in many countries, the so called "physiological requirements of nutrients (Recommended Dietary Allowances)" have been worked out.

In these tables of requirements the energy and the amount of best known food components required daily by a human organism are given. These data differ according to a person's age sex, situation and intensity of physical work.

Using the physiological allowances and knowing the chemical composition of food products (show tables), it is possible to calculate the quantities of food products required for nourishment of a population and to estimate their nutritional value.

The physiological requirements of nutrients in force in the U.S.S.R. and in other countries, have been until recently repeatedly ammended.

In those allowances in U.S.S.R. is foreseen the daily average amount of food per person, which must contain protein 100 g, fat (oil) 100 g and hydrocarbons 405 g. Expressed in energy units these quantities amount to 3000 kilocalories.

This quantity of food products satisfies the requirements of a medium size and weight man (of approximately 70 kg) in the case of easy physical occupation. In the case of physical work the requirements of food products are larger.

The necessary amounts for men are characterized by the energy values of food products, which according to the U.S.S.R. norms are:

- without physical work ..... 3000 kcal
- for easy work ..... 3500 kcal
- for work of medium hardness ..... 4000 kcal
- for hard work ..... 4500 kcal

According to age, the food requirements of children are less. So for instance, the food ration of children from six months to one year should correspond to an average of about 800 kcal.

The younger the child and the more intensive the physical ocupation of a person the larger should be the respective amounts of protein and fat in their food.

For growing children, who usually are active bodily and

for physically working adults, the necessary amount of protein in food rises to 15 % and of fat to 34-35 % by caloricity, the respective average figures being 14.1 and 30.1 %.

The requirements of mineral substances are given in a comparatively general (or commonly) form.

According to allowances the daily ration for adults is: calcium 800 mg, phosphorus 1600 mg, ferrum 15 mg; for children the respective figures are 1000, 1500-2000 and 15 mg.

As seen from table 1 in the U.S.S.R. the physiological vitamin allowances are given in detail.

Table 1

Daily minimum physiological allowances for vitamins

	Vitamins							
	A[x]		B_1	B_2	PP	B_6	C	D[xx]
	IU	mg	mg	mg	mg	mg	mg	mg
1	2	3	4	5	6	7	8	9
1. Adults:								
a) work of medium hardness	5000	1.5	2	2.5	15	2	70	
b) hard work	5000	1.5	2.5	3.0	20	2	100	
c) very hard work	5000	1.5	3.0	3.5	25	2	120	
2. Pregnant women	6600	2.0	2.5	3.0	20	4	100	
3. Lactating mothers (to the 7-th month)	6600	2.0	3.0	3.5	25	4	120	to 500
4. Children:								
a) to 1 year	1650	0.5	0.5	1.0	5	0.5	30	
b) to 3 years	3300	1.0	1.0	1.5	10	1.0	40	
c) from 4-6 years	3300	1.0	1.5	2.5	10	1.5	50	
d) from 7-12 years	5000	1.5	1.5	3.0	15	1.5	60	
e) from 13-15 years	5000	1.5	2.0	3.0	20	2.0	70	
5. Youths (16-22 y.)	5000	1.5	2.5	3.5	25	2.0	70	

x) At least 1/3 of the requirement should be satisfied by food

products containing A-vitamin, the rest with food products rich in carotene, which is practically three times less than that of A-vitamin. Thus 3300 international units (IU) correspond to 1 mg of A-vitamin on to 3 mg of B-carotene (Animal products can contain A-vitamin, vegetables - carotene).

xx) 1 gr of D-vitamin (=0,001 mg) in equivalent to 40 IU.

The organism of an adult person can function normally and remains healthy even when the food contains about three times less protein, than indicated in the allowances of the U.S.S.R.In this case the protein should be of high nutritional value mainly of animal origin, containing all necessary amino-acids in adequate quantities. As another extreme a three times higher content of protein should be mentioned, in which case the food also may still remain healthy (food of Eskimos). The content of fat and hydrocarbons being able to replace each other as main sources of energy of the organism, may also vary in the food in wide limits. Protein, inasmuch as it can be considered as a source of energy, may also be substituted by fat and hydrocarbons.

The allowances are called to satisfy not only the physiological requirements, but they must also ensure the social, psychological well-being in so far as this depends on the content of protein, fat and hydrocarbons in food products.

Apart from this, dietary allowance of mineral nutrients and vitamins shoud be considered as physiological minimal amounts. A larger or smaller content of these components does not influence appreciably the taste of food, but a noticeable deficiency prolonged over a considerable time, will certainly result in some kind of health derangement. Exeessive quantities of these components, even several times above the allowances, are not injurious to health.

The physiological quotas approved by many countries are similar to those of the U.S.S.R., although they are in some parts lower.

The Physiological Basis for Evaluating of Food and Foodstuffs

The value of food is estimated according to the presence in its composition of all the components necessary for human organism.

According to this requirement food of full value can only be prepared on the condition that food products of a complex composition are available. Of late in many countries such choice has become difficult by reason of economic conditions and lack of knowledge.

Insufficient meat, milk and other products of animal origin are being used, whereas the consumption of refined food products (sugar, rice, etc.) is continuously widening. In these countries the content of protein, fat, minerals and vitamins in food is not sufficient. In economically well-to-do and strong countries, because of a high consumption of refined food products, the food very often contains insufficient mineral substances and vitamins, except for sodium and chlorine, which are the constituent parts of salt. The latter is widely used nearly everywhere as an addition to food. Usually food contains several times more of sodium and chlorine than the natural foodstuffs and than the human organism requires.

This trend in the dietry of people should be accounted for in order to estimate correctly from the point of view of healthy nutrition the value of foodstuffs , including dairy produce.

For a comparative estimation of the nutritive value of various foodstuffs it is necessary to take comparable quantities of these products, expressing their composition by a suitable uniform unit.

Just as in physiological allowances the quantities of food products are expressed by their value in energy units, in kilocalories, food products are compared with each other by their equicaloric quantities. The quantities corresponding equivalents to 3000 kcal are used, although other quantities may be used as well. As a unit of separate nutrients components of foodstuffs the physiological daily allowances of each component or its daily rations of nutrients (DRN) is used. As all vitally important nutrients are ultimately equal in the sense, that at the absence of only one of them life is impossible, these quantities can be summarized in terms of DRN and take the average value. Thus a numerical picture can be obtained of the extent of saturation of a certain food

product, dish, etc, with separate food components or on the average with all components[x]. (Show fig. 1 and 2 and table 2).

It appears that according to the requirements of an adult person cow's milk is not a very well balanced food product, although on the average it is comparatively well saturated with all food components. In the following text these questions will be considered in more detail.

General Description and Composition of Human and Animal Milk

After birth milk is the only food of all mammals. But it does not follow from the above, that milk is as valuable a food for grown up species as it is for sucklings. The more so, that the conception of feeding grown up species with the milk of the same species would not be practicable.

According to table 2, the milk composition of different animals is far from being identical.

Table 2

Chemical composition (%) of animal and human milk

Source of milk	Water	Protein		Fat	Milk sugar (hactose)	Mineral substances (ash)
		total	albumin +globulin			
1	2	3	4	5	6	7
1. Woman	88.0	1.5	1.0	4.5	6.5	0.3
2. She-ass	90.1	1.8	0.5	1.3	6.2	0.47
3. Mare	89.6	1.8	0.6	1.7	6.5	0.4
4. Cow	87.6	3.3	0.6	3.7	4.7	0.7

x) This method of food nutrition value estimation was for the first time published by the author in 1955 in publication Nr.68 of the Tallinn Polytechnic Institute and was made use of at the Biochemists' Congress in Moscow in 1961 and in an article in Nr.5, 1966 of the journal " Общественное питание" (Social Dietry). Same method has been used by some authors at home and abroad, as for instance the Czecho-Slovak scientists I.Hruby and F.Strimiska (Die Nahrung 9 H.5, 536-550, 1965).

1	2	3	4	5	6	7
5. She-goat	87.2	3.5	0.7	4.0	4.5	0.8
6. Camel, one humped	87.6	3.7	0.9	4.0	4.8	0.7
7. Camel, two humped	83.8	3.8	0.9	5.4	5.0	0.8
8. Zebu	84.3	4.4	1.1	6.9	3.4	0.7
9. Sheep	84.1	5.0	0.8	6.0	4.0	0.9
10. Buffalo	82.2	4.5	0.6	7.5	5.0	0.8
11. Yak	81.6	5.6	-	7.8	5.0	0.9
12. Reindeer	65.0	10.5	2.2	20.0	3.0	1.5
13. Whale	60.9	12.0	3.8	22.2	1.8	1.7
14. Dolphin	48.8	-	-	43.8	1.3	(0.57)
15. Guinea-pig	41.1	11.2	-	45.8	1.3	(0.57)

In detail cow's and human milk have been investigated. These milks contain too little of some food components, even for the newborn of the same species. The deficiency of iron in milk was determined at the end of the 19th c. by the professor of Tartu University G.Bunge. Later it was found that, compared with human physiological requirements, there are deficiencies of other food components in milk , namely of many microelements as copper, manganese and PP vitamin. The chemical composition of milk of the same kind of animals or of human beings varies also considerably depending on hereditability, nourishment, period of lactation etc. At the beginning of lactation, especially on the first and second day, the milk contains A- and E-vitamins and copper 2 to 4 times more, than in the later period. In the case of cow's milk this abundance of protein depends mainly on a large content of it in the primary milk. During the entire period of lactation the composition of milk changes, but not very much. In spite of seasonal nourishment differences the composition of milk remains fairly stable in respect of most food components. Only the content of vitamins dissoluble in fat may undergo considerable seasonal changes. So for instance, milk received in the Moscow group of dairy enterprises contained in spring and autumn from 2-8 times more these vitamins than in winter and spring. In February and

March the content of A-vitamin in the milk was very small (scarcely measurable); in August the amount of A-vitamin rose sharply, increased towards the end of the year noticeably and fell then in January to a nine times lower level. In the case of human beings the content of vitamins dissoluble in fat also depends on seasonable changes of food. In distinction from animal milk a similar variation occurs in human milk with the content of C-vitamin, being on a minimum level in spring and rising to a maximum value in autumn.

These seasonal vitamin deficiencies may be avoided if animals and human beings are provided with fodder rich in vitamins (root-crops, vitamin-hay, silo, cod-liver oil,etc) or food (vegetables and fruit, liver, cod-liver oil, preparations of C- and other vitamins,etc). In spite of wide fluctuations of some food components in milk, it is nevertheless a very good foodstuff of complex composition easy to digest and tasty. Milk contains plenty of high value protein, calcium, vitamins B-2 and B-12. Compared with the requirements of human organism, milk contains most other food components in adequate quantities.

Besides of cow's milk that of other animals is used very little, although some animals are from this point of view of considerable importance, as for instance reindeers in polar regions and camels in deserts and countries with a dry and hot climate. In most cases animal milk differs greatly from cow's milk, but from available incomplete data it may be inferred, that it is in all cases of a fairly complex composition.

On milking, and still more afterwards different lactic bacteria and other microorganisms find their way into the milk. For this reason milk becomes easily sour and on standing open even deteriorates. For this reason and in order to prepare food products of different taste various dairy produce are prepared.

Dairy Produce and the Distribution of Food Components on their Production

Sweet milk becomes sour in the course of a few hours or a

few days. This happens quicker in warm surroundings (25-40°C) than in a cool atmosphere (0-10°C).

According to local conditions milk becomes sour as the result of vital activity of lactic bacteria of one or another kind.

Evidently different kinds of sour milk were being produced already since the time of beginning to use animal milk as food. Recently these food products are produced in large quantities. They are partly obtained as in the older days, by natural fermentation, although industrial production widens quickly. In these processes pasteurized milk is used as the initial product. For fermentation pure cultures of microorganisms are used. By fermentation various sour milk products are obtained.

Besides of ordinary sour milk (prostokvasha) "kefir", "jougurt", "acidofeil milk" (fermented cow's milk products) and "koumyss" (fermented mare's milk) are widely known. Similar products are made from thin (skimmed) and butter-milk. Those are known as thin milk or buttermilk products.

As a rule the inhabitants of towns use nowadays not sweet, but pasteurized milk i.e. milk heated at a temperature of 65-100°C from half an hour to several seconds. In this milk most microbes are destroyed and it keeps rather better than sweet milk.

Compared with sweet milk, products made of sour milk contain less milk sugar, which has been transformed on fermentation into lactic acid or in small part even into ethylalcohol. (In the case of "kefir" and "koumyss".

As lactic acid and alcohol are digested and used by the organism like sugar for generation of energy, the value of energy of sour milk products remains approximately the same as that of the initial milk. The content of other food components does not change appreciably during the process of formation.

On skimming (separation) the milk, the vitamins dissoluble in fat are separated together with cream. Of these A- and D-vitamins are eliminated well-nigh completely and vitamins E- and K- partially. For this reason products of thin milk, as for instance buttermilk, contain little vitamins dissoluble in fat, especially vitamins A- and D-.

It follows from the above that the nutritiousness of sour milk products may be estimated to be as high as that of initial sweet-skimmed and pasteurized milk, but sour milk products may be of varying and very different taste.

Butter, cream, cheese and curds, just as sour milk products, were known to people long ago, but industrial production in large quantities began only several centuries ago, especially in the last decennaries.

From the end of the last century cream is being obtained with the aid of a centrifugal apparatus called the milk skimmer (cream-separator). Most of the cream is used for butter production.

On butter production the food components of milk are so divided that practically all fat, also A- and D-vitamins pass in the butter, whereas E- and K-vitamins pass in the butter only partially. All other food components remain in the skimmed and the buttermilk. From the balance of the more known five vitamins and three mineral elements it can be seen that on the average only 7,5 % of these (mostly A-vitamin) pass into butter, whereas 92,5 % remain in the skimmed and butter-milk.

Cream and sour cream are foodstuffs which by composition and nutritional value come between milk and butter. The higher their content of fat, the nearer they are to butter.

On producing curds or cheese from unskimmed milk, besides of protein (mainly casein) nearly all fat and vitamins dissolved in it pass from milk into these products.

Producing curds or cheese from unskimmed or skimmed milk, most calcium and phosphorus, a small part of milk sugar and other components mainly vitamin B-2, pass into these products in dependence of processing details.

In the process of production most cheeses pass a fermentation period. During this period the vital activity of microorganisms raises the content of B-vitamin in some cheeses.

Some data about milk and dairy products are given in table 3.

Tabel 3

Chemical composition of milk and some products obtained by its processing.

Denomination of product	Content in %%					Calori-city kcal/ 100 g
	Pro-tein	Fat	Milk-sugar	Ash (mi-neral substance)	Dry sub-stances total	
1	2	3	4	5	6	7
Cow's milk	3.3	3.7	4.7	0.7	12.4	67
Skimmed milk	3.3	0.1	4.8	0.7	8.9	34
Butter-milk	3.4	0.3	4.8	0.6	9.1	36
Whey (cheese-water)	1.1	0.1	4.8	0.5	6.5	25
Curds, 20 % of fat	13.2	20.0	2.4	0.7	36.3	253
Curds, fatless	16.1	0.5	2.8	0.7	20.1	86
Cheese, Swiss, Altai etc.	24.9	31.8	2.8[x)]	2.1	61.6	409
Butter, sweet	0.5	83.5	0.5	0.1	84.6	781

x) Organic acids.

In the last decennaries more and more condensed and powder-milk is being produced from skimmed and unskimmed milk.

As to nutritive value the sugarless condensed and powder milk may be taken to be of approximately the same value as the milk used for their production. The basic difference depends on the removal of water, as this can be easily added when using the milk for food. Addition of sugar makes the products one-sided as sugar does not contain any other food components besides itself.

Nutritive Value and Sparingness of Milk and Dairy Produce

As mentioned at the beginning, highly are physiologically rated those foodstuffs , which contain a large quantity of digestive mineral elements and vitamins. Of primary importance is as well the presence of protein with plenty of amino-acids. From

this point of view we shall briefly evaluate the mentioned food products.

Comparing with physiological allowances the content of food components in equicaloric quantities (3000 kcal) of cows milk and other dairy produce the following may be said.

1) Whole (unskimmed) milk, acidified milk obtained from whole milk, condensed and powder milk made of whole milk contain a fairly large amount of high quality protein and other known food components. They contain too little iron, copper, manganese, PP-vitamin and perhaps as well K- and D-vitamins.

2) The digestible organic substance in butter, supplying energy to the organism consists of fat only.

Butter contains also a fair amount of A-vitamin, little of D-vitamin, colin and iodine. All other food components are present in negligible quantities or they are altogether absent.

3) Skimmed milk, butter milk, and acidified, condensed and powder milk made of them, taking into account the digestible organic matter, compared with food products of p.1, are approximately twice as rich sources of protein and of all other food components, except fat and four vitamins dissoluble in fat.

4) Cheeses and especially curds (without sugar) contain in their digestible organic substance appreciably less vitamins and mineral elements dissoluble in water, than food products mentioned in p.1 and practically not at all milk-sugar.

On preparing these food products the added quantity of salt is very often excessive. In the interest of healthy nourishment it should be stressed that the amount of salt added to food must be moderate.

5) Cheese water (whey) contains all sugar of the initial milk, 1/3 of protein, the greater part of mineral substances and vitamins dissoluble in water. For this reason the use of whey as human food, in a suitable form, is advisable.

6) Cream and dairy products sweetened with sugar are fairly one-sided food products and more so the larger the amount of fat in them and sugar added to them.

The animal organism uses the fodder on milk production

fairly effectively i.e. with a good efficiency factor. For this reason the prime cost of milk, as compared with meat and eggs is moderate - when considering its caloricity or the average content of food components (or nutrients).

The prime cost of dairy produce depends on the cost of processing technology and from distribution of whole cost of production among the separate products (main products, auxiliary products, residue).

According to old traditions the monetary value of fat content of milk is estimated high in comparison with protein and other food components.

This does however not permit to infer that costlier dairy produce (butter and cream) are also the best from the point of view of healthy nourishment.

As conclusion it may be said that all dairy products with the exception of butter and cream are valuable sources of protein and many other food components.

Э. Раннак
Молоко как ценный
пищевой продукт

Ротапринт ЦБТИ ЭССР. Заказ № 2216-10928. 150.