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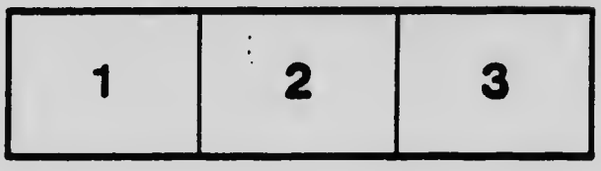


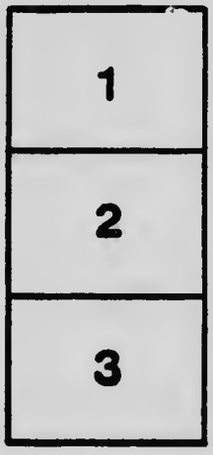


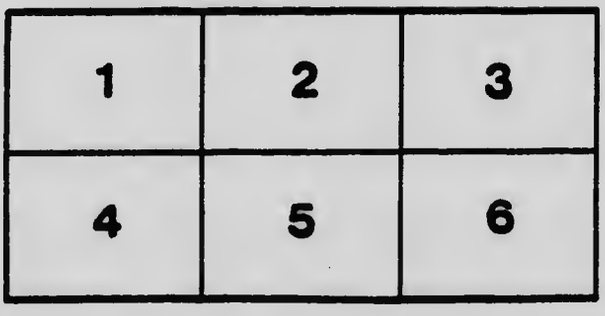

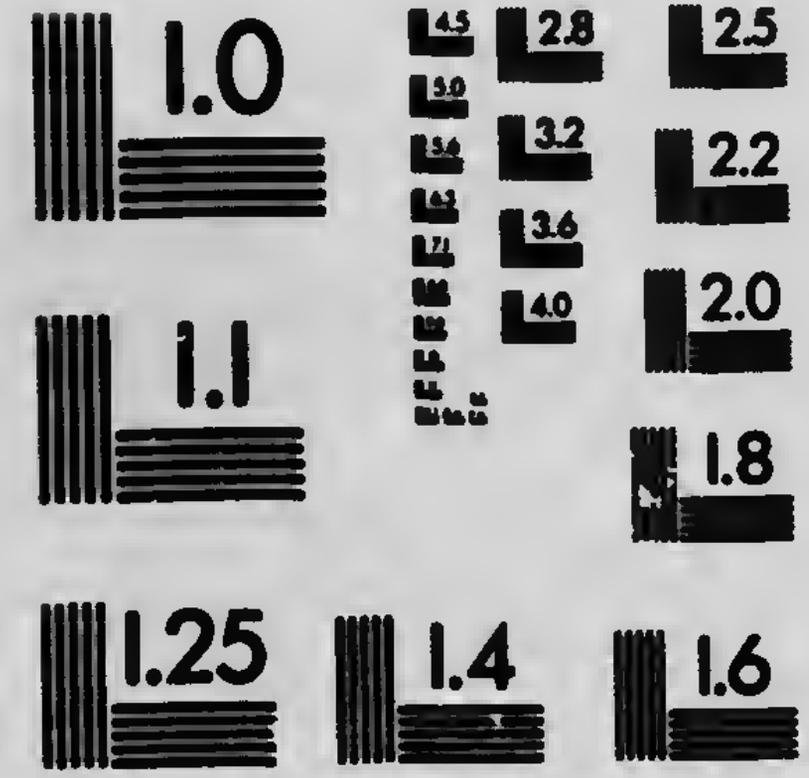

BULLETIN 221] [APRIL, 1914.

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

# Food Value of Milk and Its Products

R. HARCOURT

If the true nutritive value of milk and its various products were fully realized they would be more appreciated and much more freely used. They are cheap, palatable, easily digested, and highly nutritious. Excepting in the case of milk, and then only in the case of infants and invalids, they are rarely used as an article of the diet, but are regarded as a luxury to be used as a condiment. They are, however, foods of exceptionally high value, and can very profitably be made to take a more prominent place in our dietaries.

## FOOD AND ITS FUNCTIONS.

A food may be considered anything that when taken into the body will build up its tissues and keep them in repair, or which is consumed in the body to yield force and heat. It is used to form the tissues and fluids of the body, such as muscle, blood and bone, to repair their waste, and, if in excess of the daily requirements, it may be stored in the body in the form of fat for future use. When food or body tissue is consumed in the system, the energy contained therein becomes active and manifests itself in the force or heat required by the body.

To be a complete food it must contain all the constituents required by the healthy growing animal. These are protein, fat, carbohydrates and mineral matter. The protein compounds are necessary for the building up of new and the repairing of the old tissue. When eaten in excess of what is thus needed they may be simply burned to produce force. The body tissue when broken down also yields energy. Familiar examples of protein are lean meat, white of egg, casein of milk and cheese and gluten of wheat. The fats and carbohydrates are used as a source of energy, and when eaten in excess of this requirement may be transformed into fat in the body. Fat is found in meat, lard, milk, oils; and the starches, sugars and woody fibre or cellulose form the bulk of the carbohydrates. The mineral matter of a food is absolutely essential for the formation of bone, and is also present in the tissues and fluids of the body.

The chief function of food in the adult is to repair tissue and to furnish energy to do work. Energy and heat are closely related, and in order to have some measure for expressing the amount of heat that a given food is capable of producing, the calorie is taken as a unit. Roughly speaking, this is the amount of heat required to raise the temperature of one pound of water 4 degrees Fahrenheit. One pound of sugar or starch would, if burned and all the heat utilized, raise 1,860 pounds of water 4 degrees in temperature. The fuel value of protein as it is ordinarily burned in the body is very nearly the same as that of one pound of carbohydrates, but fats have a fuel value of two and a quarter times that of protein and carbohydrates, or 4,220 calories per pound. Thus, while the protein of meat, eggs, etc., are the only materials in the food that will produce muscle, they have no greater value as an energy-producer than carbohydrates. Thus, the problem in arranging balanced dietaries is to use just enough protein to do the work which they alone can do, and use the cheaper fats and carbohydrates as the energy producers.

Very few, if any of our food materials form a complete and balanced food in themselves. The mother's milk is for the infant, but for the adult it is too bulky. Bread is as nearly complete as any of our ordinary foods, but it is a little low in the protein compounds. Milk used along with bread improves it in this respect and the two form a fairly complete and balanced diet. The best foods or diets are those which perform their function in the most thorough and complete manner; that is, with as little waste as possible and with the best physiological results.

There are, however, several other factors which must be considered in judging of the value of a food. These are: digestibility, palatability; they must agree with the system, and they must be reasonably cheap.

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## COMPOSITION OF MILK.

Milk, as supplied to the consumer, may vary widely in composition. But the average milk is slightly heavier than water, its specific gravity ranging form 1.029 to 1.034 at 60° F., and the following is possibly a fair average of the composition:

| | | |
|---|---|---|
| Water | 87.5 | per cent. |
| Protein: Casein | 2.4 | " " |
| Albumin | .7 | " " |
| Fat | 3.7 | " " |
| Sugar | 5.0 | " " |
| Ash | .7 | " " |
| Fuel Value per 100 gms. | 67 | calories |

The proteins amount to about 25 per cent. of the total solids, which is a much larger proportion than exists in many foods, including meats. The casein is the most abundant constituent, and is readily coagulated by an acid, either by that found in the milk when it sours, or when an acid, as vinegar for example, is added. It may also be curdled or coagulated by rennet, and the curd thus produced is utilized in the manufacture of cheese. It differs from many other forms of proteins in the amount of phosphorus it contains. Besides the casein, there is a small amount of albumin present, which is very similar to that which occurs in blood and the white of egg.

The fats are commercially the most important of the constituents of milk. The color and opaqueness of milk are due mainly globules of fat, which are very minute and almost numberless. These are held in the liquid in the form of an emulsion, which possibly helps to explain why the fat of milk is so easily absorbed when used as a food.

The sugar of milk is similar in composition to cane sugar, but it is not nearly so sweet. This sugar readily undergoes fermentation with the formation of lactic acid. This change always takes place when milk sours, and it is this acid which thickens the milk, due to the coagulating of the casein.

The ash material is made up of a great variety of compounds, but it is particularly rich in those required for building bone and to supply the mineral constituents of the blood.

## Nutritive Value.

Milk is thus particularly adapted for use as a food by man for several reasons. It contains all of the four classes of nutrients—proteins, fats, carbohydrates, and mineral matter—in more nearly the proper proportions to serve as a complete food than any other food material. For the adult it is too bulky, and can well be used with a food rich in carbohydrates to supply the greater amount of energy exacted by the grown person. It is in a form well adapted for various uses in combination with other food substances, and in the preparation of various dishes for the table. Furthermore, at the prevailing prices it is an economical food.

## Digestibility of Milk.

By digestibility of food several things are, or may be, meant. One is the proportion of a given food material or of each of its several constituents which an ordinary person may digest; another is the ease with which it is digested or the time required by the process. It may also mean whether the food material does or does not agree with the user.

[illegible] people are differently constituted with respect to the chemical changes the food undergoes in the process of digestion and in the effects produced. This is true in the digestion of milk as it is with other foods. With most people milk is a wholesome, digestible and nutritious food, there are others who are made ill by it, just as there are people who cannot eat eggs, fruits, or other materials without feeling ill effects. But this does not detract from the value of these foods for those with whom they do agree.

Taking up more particularly the question of the completeness of digestion, experiments show that different people vary in the amounts which they can digest from the same food. The differences, however, are not as great as might be supposed. The results, in so far as they apply to milk alone, and in comparison with other food materials, is summarized by Dr. Langworthy* as follows:—

"The protein of milk, especially when it is used with other food materials, is quite readily and completely digested. In this respect it is like the protein of ordinary meats and fish. The protein of vegetable foods is much less easily digested. Thus, in potatoes and whole wheat and rye flour it may sometimes happen that as much

*Farmers' Bull. No. 74, U.S.A. Dept. of Agriculture.

as one-fourth of the protein may escape digestion and thus be useless for nourishment. From one-sixth to one-tenth of the protein of wheat flour, corn meal, beans, and peas may in like manner be assumed to escape digestion, or rather to leave the body without being used for nutriment. These estimates assume that the materials are cooked and eaten in the usual way. Under the same circumstances, from nine-tenths to the whole of the protein of milk, meats, and fish are assumed to be digested. The digestibility of the fats is likewise variable. Sometimes a large part of the fat of the food fails of digestion. In general it may be assumed that about 5 per cent. of the fat of milk, meat, eggs, butter, and lard, and a considerably larger proportion of the fats of some vegetable foods, will usually escape digestion. When, however, the diet contains a very large amount of fat—for instance, when it consists largely of fat meat—the digestion is less complete. One way in which the fat of ordinary foods is digested is by being made into an emulsion in the intestine. The fat of milk is an extremely fine emulsion, and is thus in a sense "pre-digested," or in a partly digested form before it is taken into the stomach. This may help to explain why it is so easily digested.

"The carbohydrates, which make up a large part of vegetable foods, are in general very digestible. Cane sugar is believed to be completely digested, and this is assumed to be the case with the sugar of milk.

"The animal foods have in general the advantage of the vegetable foods in digestibility in that they contain more protein and their protein is more digestible. Milk ranks among the most digestible of the animal foods in respect to all its ingredients."

## Effects of Cooking.

Cooking changes the texture of a food material and affects its digestibility to a greater or less extent. In general, it increases the digestibility of vegetable food materials. In the case of milk the experience of different persons with cooked and uncooked milk is quite varied, and the results of experiments are conflicting. The most common experience seems to indicate that cooking or boiling the milk makes the proteids somewhat more difficult to digest. There are, of course, exceptions.

## Skim Milk.

The average skim milk contains nearly 10 per cent. of milk solids or nutritive ingredients, while whole milk contains about 13 to 14 per cent. The chief material removed from the milk in skimming is the fat. Thus, naturally, the skim milk must be richer in the valuable protein materials than the whole milk. The amount of fat left in the skim milk must of necessity vary with the completeness of the skimming, and frequently varies from less than one-tenth of one per cent. to as much as three-tenths or even four-tenths of one per cent.

The value of skim milk as a food is not generally appreciated. Taken alone it does not satisfy the sense of hunger, for very large quantities would be required to furnish the food materials desired; but it is a cheap source of very digestible proteins, and when taken with bread or used in cooking it forms a very nutritious addition to the diet. Quoting again from Dr. Langworthy's writing we have the following comparisons:—

"A pound of lean beef (round steak, for example) contains about 0.18 pound of protein and has a fuel value of 870 calories. Two and a half quarts, or 5 pounds, of skim milk will furnish nearly the same amount of protein and have about the same fuel value as the pound of round steak. Two quarts of skim milk has a greater nutritive value than a quart of oysters; the skim milk has 0.14 pound of protein and a fuel value of 470 calories. The nutriment in the form of oysters would cost from 30 to 50 cents, while the two quarts of skim milk would have a market value of from 4 to 6 cents, and a value on the farm of from 2 to 4 cents. An oyster stew made of one part oysters and

two parts skim milk would owe its nutriment more to the milk than to the oysters. Bread made with skim milk would contain more protein than when made with water. A lunch or meal of bread and skim milk is very nutritious, as the following computation shows:

COMPOSITION AND COST OF A LUNCH OR MEAL OF BREAD AND SKIM MILK.

| Food Materials. | Amount. | Estimated Cost. | Protein. | Fuel Value. |
|---|---|---|---|---|
| | | Cents. | Pound. | Cals. |
| Bread | 10 oz. | 3 | .06 | 755 |
| Skim Milk | 1 pt. | 1 | .03 | 170 |
| Total | ..... | 4 | .09 | 925 |

"The commonly accepted standard for a man at ordinary muscular work calls for 0.28 pound of protein and a fuel value of 3,500 calories per day, so that the above lunch furnishes very nearly one-third of a day's nutriment and at a cost of about 4 cents. If whole milk were used instead of skim milk, the cost would be about 6 cents and the fuel value 1,080 calories, while the protein would remain the same in amount.

"The following lunch, such as might be obtained in a restaurant or lunch room, will serve for the purpose of comparison:

ESTIMATED COST AND NUTRIENTS OF A RESTAURANT LUNCH.

| Food materials | Amount | Estimated cost | Protein | Fuel value |
|---|---|---|---|---|
| | Ounces | Cents | Pound | Calories |
| Soup | 8 | ..... | 0.01 | 75 |
| Beef | 2 | ..... | .02 | 275 |
| Potatoes | 2 | ..... | .... | 100 |
| Turnips | 1 | ..... | .... | 15 |
| Bread | 4 | ..... | .02 | 300 |
| Butter | ½ | ..... | .... | 100 |
| Coffee: | | | | |
| Milk | 1 | ..... | .... | 20 |
| Sugar | ½ | ..... | .... | 55 |
| Total | .... | 15 to 20 | .05 | 940 |

"It will thus be seen that the 15-cent lunch containing nine different food materials did not have any greater nutriti[ve] value than the 4-cent lunch of bread and skim milk."

The constituent of our food which cost the most, has the greatest physiological value, and which is most apt to be lacking in ordinary dietaries, is protein. Skim milk has nearly all the protein of the whole milk. It has practically all the value of the whole milk for building and repairing tissues, for the making of blood, muscle and bone, and about half the value of the whole milk for supplying heat and muscular energy. When these facts are fully understood, skim milk will doubtless be more wisely utilized.

## CREAM AND BUTTER.

Ordinary cream contains approximately about four and one-half times as much fat as an equal volume of milk, and slightly less protein and carbohydrates than whole milk. It is, naturally, chiefly valuable for its heat producing power, just as skim milk is valuable for its muscle-forming properties. When we consider that a pound of butter costs very little more than a pint of cream, and that the butter contains fully two and one-half times as much fat as the cream, it will be seen that cream is not an economical food.

### Buttermilk.

The average composition of buttermilk is quite similar to that of skim milk, though it contains slightly less protein and sugar and a little more fat. It has, consequently, about the same value as skim milk. The acid developed in souring the cream gives it a sour taste and possibly gives to it some physiological effects not enjoyed by the skim milk.

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## CHEESE.

The cheese used in largest quantity in the homes of this country is the Canadian Cheddar. It was formerly made in the farm homes, but it has now become a big commercial enterprise and practically all of it is made in factories, of which there are over 1,000 in the Province of Ontario alone. In the year 1912 these factories manufactured 129,655,063 pounds of cheese, valued at $16,574,573.00. A large amount of this cheese is exported annually, and it is to be feared that very little of the best cheese finds its way into Ontario homes. Comparatively little of the soft, or what are sometimes called fancy cheese are made here, although it is estimated that probably one-tenth of the total amount of cheese consumed in the Province is made up of the numerous varieties included under this name.

Briefly, the general process of cheese-making is as follows: The casein of the milk is coagulated by rennet, forming a curd, which mechanically holds nearly all the fat of the milk. The curd is broken up and after heating to a temperature of 98 to 104° F., and developing a certain amount of acid, the whey is drained off. This contains nearly all the sugar and albumin of the milk. After allowing the curd to be still further modified by the action of acid and rennet, it is salted and pressed, and set away to ripen. During this "ripening" process the tough, rubbery curd is broken down into a material of a mellow and almost buttery constituency. By varying the proportion of butter fat retained or added to the milk, or by varying the methods of separating, preparing, seasoning, and handling the curd, and by changing the temperature and general conditions under which the curd is ripened, an almost innumerable variety of cheese may be prepared. Many of the soft or fancy cheese on the market are desirable foods, but, owing to the higher flavor common to many of these and to the fact that they are more expensive, they will always be used as condiments and can never take the place of Cheddar cheese as an article of food.

## Nutritive Value.

Cheese is one of our most concentrated foods. More than one-fourth of its weight is protein, about one-third fats, and one-third water. It is not only valuable for the amount of protein, or muscle-forming material, and fat it contains, but, also because of the ease with which it can be kept and prepared for the table and for the variety of ways in which it may be served.

As a further indication of the high nutritive value of cheese, it may be pointed out that one-pound of cheese contains nearly all the protein and fat in one gallon of milk. Or, if we compare it with other protein foods, we find that one pound of cheese has nearly the same food value as two pounds of fresh beef, or any other fresh meat food, and it is also equal to two pounds of eggs or three pounds of fish.

## Digestibility of Cheese.

Unfortunately, there is a widespread belief that cheese is indigestible, particularly in the sense of being hard to digest. Associated with this idea there is another popular belief that green cheese, or even cheese at any stage in the ripening, causes constipation. There is a marked difference between the tough, rubbery nature of the green cheese and the mellowed substance of the "cured" or "ripened" cheese. The former contains very little water-soluble material, whereas in a well-ripened cheese more than half of the protein may be soluble in water. It is a well known fact that the constituents of milk are very digestible and make an almost perfect food. Yet, even with this food there is a slight tendency to constipation, possibly due to the fact that, like cheese, it is so completely digested that there is very little residue left in the system. Again, with regard to the difficulty of digestion, it is hard to understand why the use of rennet, the development of a small amount of acid and the heating of the curd to about 100° F. should render the constituents of milk so indigestible as they are commonly regarded.

Another interesting question regarding the food value of cheese is with reference to whether cheese has a place as a staple food product, whether it is to be used only as a luxury, or as a so-called appetizer. It may not, as is true with many other foods, "agree" with certain individuals, but cheese is too cheap and nutritious a food to be left out of our list of food substances for this reason. It is well known that with many European people cheese forms a large part of the diet, replacing meats as a source of animal proteids. It is, therefore, a question well worth considering whether we could not with economy use cheese in many ways to replace the more highly priced nitrogenous foods (meats) now in general use. This of course refers to the Cheddar cheese and not to the higher-priced soft or fancy cheese.

Owing to the widespread idea that cheese is indigestible, it may be well to include here a rather full statement of the results of some experiments carried out under the direction of the Office of Experiment Stations, United States Department of Agriculture, first, at the Wesleyan University, Middletown, Ohio, and second, in conjunction with Prof. Snyder at the Minnesota Expt. Station.

The work at Middletown was planned to include green and ripe cheese, and cheese made with different quantities of rennet and ripened at different temperatures. The diet in these experiments consisted of a basal diet of whole wheat bread and bananas, as these two articles have been thoroughly studied and the

digestion coefficients have been determined. A total of 184 experiments were made and a total of 65 human subjects were used. Each experiment lasted three days. The subjects were mostly students of the Wesleyan University between the ages of 19 and 32 years. The results of the experiments are summarized as follows:—*

"The results of the several digestion experiments in the different series are summarized in the following tables. In these tables the results are given for the digestion coefficient of the fat and the availability of the energy, both in the total diet and in the cheese alone.

"The amount and exact composition of the basal ration used in the experiments is not given, for the reason that it varied in different experiments with the several subjects, and space will not allow its insertion. All of the data for tho entire series of experiments are in the Office of Experiment Stations, Department of Agriculture, Washington, D.C., where they may be consulted by those who wish a more detailed account of the work. As previously mentioned, the basal ration was bananas and bread. The amount of cheese eaten per man per day varied somewhat, according to the appetite and preference of the subjects, but an average was not far from 0.5 to 1 pound per day. The exact amount eaten was in every case recorded, as were all other experimental data. While it is believed that the variations in the amount of the basal ration doubtless affected to some extent the digestibility of the cheese, it is thought best not to enter into this subject in this brief account of the work. From the character of the diet it will be seen that practically all of the fat and the greater part of the proteid came from the cheese.

RESULTS OF DIGESTION EXPERIMENTS WITH CHEESE CURED IN DIFFERENT WAYS ADDED TO A BASAL RATION. MIDDLETON EXPERIMENTS.

| Kind of Rations. | Age of Cheese | Digestibility of Proteids | | Digestibility of Fat | | Availability of Energy | |
|---|---|---|---|---|---|---|---|
| | | In total diet | In Cheese alone | In total diet | In Cheese alone | In total diet | In Cheese alone |
| | Days | % | % | % | % | % | % |
| Low-rennet cheese held at 60° F. added to basal ration of bread and bananas | 1 | 88.1 | 99.4 | 92.8 | 95.8 | 90.0 | 91.6 |
| | 9 | 86.3 | 94.3 | 92.8 | 95.4 | 90.0 | 88.9 |
| | 16 | 88.6 | 98.3 | 94.9 | 97.4 | 90.8 | 91.3 |
| | 30 | 86.8 | 95.2 | 92.4 | 94.3 | 89.6 | 87.7 |
| | 44 | 88.6 | 97.0 | 95.2 | 97.3 | 91.2 | 92.1 |
| | 58 | 88.1 | 96.9 | 95.3 | 97.2 | 91.0 | 91.8 |
| | 93 | 91.0 | 100.6 | 96.2 | 97.9 | 91.8 | 93.9 |
| | 123 | 87.6 | 96.1 | 93.9 | 96.5 | 89.5 | 88.4 |
| | 156 | 90.7 | 100.3 | 94.8 | 96.4 | 90.7 | 91.4 |
| High-rennet cheese held at 60° F. added to basal ration of bread and bananas | 1 | 89.1 | 99.7 | 92.8 | 95.3 | 90.8 | 91.4 |
| | 9 | 88.7 | 98.7 | 95.4 | 97.9 | 90.5 | 90.4 |
| | 16 | 88.6 | 98.3 | 93.9 | 95.3 | 91.1 | 92.0 |
| | 30 | 85.5 | 92.6 | 93.1 | 97.1 | 89.2 | 86.5 |
| | 44 | 88.4 | 97.8 | 95.0 | 96.4 | 90.7 | 91.1 |
| | 58 | 87.4 | 94.7 | 93.9 | 97.0 | 90.3 | 89.8 |
| | 86 | 89.0 | 97.2 | 94.3 | 95.9 | 90.8 | 91.4 |
| | 115 | 90.0 | 100.5 | 92.6 | 95.0 | 90.0 | 89.6 |
| | 142 | 91.1 | 100.4 | 94.5 | 96.1 | 91.1 | 92.5 |
| Low-rennet cheese held at 40° F. added to basal ration of bread and bananas | 30 | 87.0 | 95.7 | 93.8 | 95.8 | 90.5 | 90.2 |
| | 44 | 88.1 | 96.2 | 94.4 | 95.4 | 90.8 | 90.9 |
| | 58 | 90.5 | 101.5 | 93.7 | 95.4 | 91.3 | 92.8 |

* Circular No. 166, Bureau of Animal Husbandry, U.S. Dept. of Agri.

| Kind of Rations | Age of Cheese | Digestibility of Proteids | | Digestibility of Fat | | Availability of Energy | |
|---|---|---|---|---|---|---|---|
| | | In total diet | In Cheese alone | In total diet | In Cheese alone | In total diet | In Cheese alone |
| | Days | % | % | % | % | % | % |
| Low-rennet cheese placed at 40° F. when two weeks old added to basal ration of bread and bananas..... | 30 | 87.8 | 97.0 | 92.5 | 94.5 | 90.3 | 89.7 |
| | 44 | 85.4 | 91.6 | 94.6 | 96.6 | 90.4 | 89.6 |
| | 58 | 89.4 | 99.6 | 95.3 | 97.1 | 91.4 | 93.2 |
| | 128 | 89.9 | 101.1 | 94.9 | 97.5 | 90.7 | 91.5 |
| | 155 | 88.9 | 98.0 | 94.3 | 95.9 | 90.4 | 90.7 |
| High-rennet cheese held at 40° F. added to basal ration of bread and bananas..... | 9 | 86.6 | 94.9 | 94.3 | 96.8 | 90.3 | 89.7 |
| | 16 | 87.1 | 95.4 | 91.7 | 93.1 | 90.1 | 89.3 |
| | 30 | 86.9 | 95.2 | 93.6 | 97.6 | 90.3 | 89.6 |
| | 44 | 88.0 | 97.2 | 94.0 | 95.3 | 90.8 | 91.3 |
| | 58 | 90.8 | 100.7 | 94.6 | 97.7 | 91.2 | 92.3 |
| High-rennet cheese placed at 40° F. when two weeks old added to basal ration of bread and bananas..... | 30 | 89.4 | 99.7 | 94.7 | 98.8 | 91.3 | 92.6 |
| | 44 | 90.4 | 101.8 | 95.2 | 96.6 | 91.5 | 93.5 |
| | 58 | 90.3 | 99.9 | 95.7 | 99.0 | 91.3 | 92.4 |
| | 115 | 89.9 | 101.2 | 94.5 | 97.2 | 90.5 | 91.0 |
| | 142 | 92.6 | 104.5 | 94.8 | 96.4 | 91.5 | 93.4 |
| Low-rennet cheese held at 32° F. added to basal ration of bread and bananas..... | 9 | 90.3 | 102.1 | 94.7 | 97.4 | 91.2 | 92.5 |
| | 30 | 86.0 | 93.9 | 94.2 | 96.2 | 89.9 | 88.4 |
| | 44 | 84.6 | 90.3 | 92.0 | 93.9 | 89.7 | 87.6 |
| | 58 | 88.1 | 97.3 | 94.8 | 96.6 | 91.2 | 92.4 |
| High-rennet cheese held at 32° F. added to basal ration of bread and bananas..... | 9 | 84.9 | 91.7 | 91.5 | 93.8 | 89.6 | 87.9 |
| | 16 | 89.7 | 100.4 | 92.7 | 94.1 | 90.9 | 91.6 |
| | 30 | 87.4 | 96.1 | 94.4 | 98.5 | 90.5 | 90.5 |
| | 44 | 89.5 | 100.1 | 94.5 | 95.9 | 91.2 | 92.7 |
| | 58 | 89.2 | 98.0 | 92.8 | 95.9 | 90.7 | 91.0 |
| Low-rennet cheese, green curd, added to basal ration of bread and bananas..... | ..... | 89.2 | 99.1 | 93.4 | 96.9 | 89.7 | 88.8 |

"The results in the table show that there is little or no difference in the comparative digestibility of cheese at different stages of ripening. The perfectly green curd was evidently as digestible and, so far as nutritive value was concerned, was as good a food as the same cheese at any stage of ripening. The casein of cheese either fresh from the press or thoroughly ripened is very highly digestible. The cheese was eaten in comparatively large quantities, and it was evidently well assimilated.

"A record of the health of each individual was kept, and also notes on the palatability of the cheese ration. At first 1,350 grams of bread were fed with 2,025 grams of bananas and 450 grams of cheese. The length of the experiment was three days, and this would make practically one-third of a pound of cheese per day. The bread was finally reduced to 1,200 grams and the cheese increased first to 525 grams and then to 600 grams for the three days. On the whole, the cheese was very palatable and, with a few exceptions, the amount given was not considered excessive by the person eating it. A number of the subjects wanted more of the cheese. The subjects of the experiments were about equally divided in the preference for a mild or a strong cheese.

"Contrary to general belief, the green curd did not appear to cause constipation. In fact, constipation resulted more frequently after the cheese had had time to become well ripened. There also seemed to be more distress from the cheese diet with the well-ripened cheese than with the green cheese."

## Minnesota Experiments with Cheese.

The primary objects of the Minnesota experiments was to study the digestibility of older cheese than had been used in the Connecticut experiments, and to study the digestibility of other varieties, as well as the so-called condimental value of some of the more highly flavored varieties. In these experiments the basal diet was bread and oranges, which were previously studied. The duration of each experiment was, as in the Connecticut experiments, three days.

## Summary of Results.

The results of the Minnesota experiments are shown in the following table:

Results of Digestion Experiments With Cheese of Different Kinds Added to a Basal Ration.—Minnesota Experiments.

(In each case the value represents the average of experiments with four subjects).

| | Digestibility of Nitrogen. | | Digestibility of Fat in total diet. | Availability of Energy. | |
|---|---|---|---|---|---|
| | In total diet. | In cheese. | | In total diet. | In cheese. |
| | % | % | % | % | % |
| Old cold-storage cheese (435 grams added to basal ration) | 92.53 | 91.79 | 91.04 | 92.33 | 86.13 |
| Old cold-storage cheese (585 grams added to basal ration) | 93.79 | 96.36 | 93.64 | 92.21 | 87.08 |
| Green cheese (750 grams added to basal ration) | 94.39 | 96.29 | 89.96 | 92.29 | 86.45 |
| Green cheese (1,050 grams added to basal ration) | 94.33 | 95.83 | 93.72 | 91.25 | 86.40 |
| Roquefort cheese (520 grams added to basal ration) | 93.13 | 93.57 | 91.04 | 92.40 | 87.15 |
| Swiss cheese (605 grams added to basal ration) | 92.67 | 92.19 | 90.84 | 92.00 | 84.38 |
| Skim-milk cheese (1,000 grams added to basal ration) | 95.10 | 96.65 | 88.55 | 90.47 | 79.68 |
| Camembert cheese (605 grams added to basal ration) | 91.65 | 88.65 | 89.17 | 92.87 | 83.59 |
| Camembert cheese (240 grams added to basal ration) | 91.07 | 83.22 | 80.86 | 92.25 | 74.95 |
| Roquefort cheese (295 grams added to basal ration) | 90.82 | 82.59 | 88.70 | 92.41 | 82.18 |
| Cottage cheese (540 grams added to basal ration) | 92.85 | 92.68 | ..... | ..... | 90.98 |

*Circular 166, Bureau of Animal Husbandry, U.S. Dept. of Agriculture.

"In the discussion of the results and the interpretation of the digestion coefficients it is believed that the calories should be taken as the indirect index of digestibility of the fats rather than the fat determinations.

"In the calculations of the results it was assumed that the bread and oranges had the following digestibility: Protein, 93 per cent.; carbohydrates, 98 per cent.; calories, 98 per cent.

"As so little fat was contributed by the bread and oranges, it was deemed best by Prof. Snyder, under whose direction the tables of results were prepared, not to make any special calculations for the digestibility of the fat of the cheese alone.

"The factor for the digestibility of the protein of the bread and oranges is higher than was found in the numerous experiments for bread alone, but it was assumed because it appeared from the first series of results that cheese in the ration increased the digestibility of the protein of the other foods. This assumption appeared to be verified by the later tests which had for their special object the influence of the cheese upon the digestibility of the basal ration.

"The work both at Middletown and in Minnesota, while demonstrating the same general fact of the high food value, actual and comparative, of cheese in all stages of ripening, does not give identical figures for the digestibility of protein in the total diet or in the cheese. A different basal ration was used in the Minnesota experiment from that used at Middletown. White bread was used in Minnesota, while whole-wheat bread, which has a decidedly lower digestibility, was used in the experiments at Middletown.

"Nothing unusual was noted in the health of the subjects used in the experiments at the Minnesota Experiment Station. One of the subjects believed before beginning the experiments that a cheese diet did not agree with him, but found that it had no ill effects.

"In considering the results shown in the table, it is apparent that all the kinds of cheese used in the experiments are very digestible. In comparing the old cheese with the green cheese the latter was evidently the more digestible, which was not the case in the Middletown experiments, where the slight difference was in favor of the well-cured cheese. However, the difference between the digestibility of green and cured cheese in either series of experiments is well within the limits of variation ascribable to personal peculiarity of the subjects and were to be expected in this kind of work.

"Particular interest attaches to the evident digestibility and food value of skim-milk cheese. This is a product which has not been viewed with very great favor by the public in general. The physical properties of cheese made from skim-milk have been such as to give consumers the impression that it was indigestible and, on the whole, of questionable value as food. The establishing of the actual food value of this comparatively cheap product will at some future time doubtless be of great economical importance. Skim-milk cheese made up in a way to be agreeable to the taste could be sold at a price that would attract the attention of the laboring classes. Cheese made from skim-milk and sold for whole-milk cheese is a fraud that is a positive injury to the dairy business; but cheese made from skim-milk and sold for what it is is worthy of serious consideration on the part of both producer and consumer. It is very likely that the time is not many years distant when a comparatively large quantity of cheese from skim-milk will be made with profit to the dairy industry and will be consumed at a pronounced saving by the laboring class in general.

"In the same connection attention is called to the food value of cottage cheese established by this work. This is another cheap and to many a very palatable product that could be introduced to a much greater extent in the dietary at a great saving in the total cost of food.

"In general, the table shows that all kinds of cheese, even the very high-flavored and so-called condimental cheeses, have a high food value. But the so-called condimental value of cheese when eaten in small quantities as a stimulus to the digestion of other foods was not demonstrated. Where the cheese was eaten in small quantities the digestibility of the basal ration fell below the assumed digestion coefficient. The fact

that in the work done at Middletown the digestibility of the basal ration was increased in many cases at least is no evidence that cheese has any particular properties as a stimulant to digestion, as it has been shown that other foods, such as meat, might have the same effect. This is a physiological phenomenon that may perhaps be explained on some other basis than that of condimental effects."

## Cheese as a Food.

The experiments described have not only shown that cheese, even green cheese, is very thoroughly digested and that it can, when properly arranged in the diet, be used in comparatively large quantities without causing any pronounced physiological disturbances, but they have also established the fact that cheese is a valuable food, and that it can be safely used as a substitute for other protein food in the diet. In connection with the use of raw cheese there is, however, one point that should be emphasized, and that is that it should be thoroughly masticated, otherwise the digestive juices do not readily penetrate the fatty matters of the cheese.

In this country cheese is used chiefly for its flavor or as a condiment, and little thought is given to the food value of it in the diet. However, in view of the facts established by the above experiments, housekeepers would be justified in going farther and using cheese as a source of protein material for the diet, or, in other words, use it as a substitute for meats. In doing this they will but follow the example of people in the older European countries, where long experience has not only established the value of the full cream cheese such as the Cheddar, but also the high value of skim milk cheese and the home-made Cottage cheese.

Estimates made by the United States Department of Agriculture show that the people of that country use about 175 pounds of meat annually per capita, besides fish and poultry, while the annual consumption of cheese is only about 4 pounds per capita. It is probable that if we had similar data gathered in this country the results would be about the same. Even granted that fresh meats are more palatable to most people, it is a question whether it is a good practice to use so little cheese when meats of all kinds are so expensive. There are some dishes that may be prepared in which cheese is one of the sources of protein, and, if such dishes were made to substitute meat once or twice a week a saving would be effected.

In order that the above phase of the question may be more clearly realized, a knowledge of the composition of cheese in comparison with other foods is desirable. But, since the market prices vary, it may be better to make the comparison on the basis of the amount of the food constituents that may be obtained in the different foods for a given amount of money expended. The following table shows the number of pounds of protein, fat, carbohydrates and the fuel value of one dollar's worth of a number of our common foods:

| | Price. | Protein. | Fat. | Carbohydrates | Fuel Value. |
|---|---|---|---|---|---|
| | | lbs. | lbs. | lbs. | Calories. |
| Milk | 8 cts. per qt. | 1.04 | 1.27 | 1.66 | 10,402 |
| Skim-milk | 10 " gal. | 3.4 | .30 | 5.1 | 17,070 |
| Buttermilk | 10 " gal. | 3.0 | .50 | 4.8 | 17,362 |
| Butter | 30 " lb. | .3 | 2.83 | .... | 12,000 |
| Cheese | 20 " lb. | 1.39 | 1.84 | .... | 10,360 |
| Beef, hind quarter | 14 " lb. | 1.10 | 1.31 | .... | 7,563 |
| Beef, flank | 12½ " lb. | 1.34 | 1.51 | .... | 8,924 |
| Beef, sirloin | 24 " lb. | .69 | .68 | .... | 4,132 |
| Veal, cutlets | 22 " lb. | .91 | .34 | .... | 3,145 |
| Mutton chops | 20 " lb. | .67 | 1.44 | .... | 7,326 |
| Ham, cooked | 40 " lb. | .50 | .56 | .... | 3,304 |
| Eggs | 25 " doz. | .79 | .56 | .... | 3,353 |
| White bread | 4 " lb. | 2.10 | .50 | 12.2 | 28,710 |
| Flour | $3.00 per cwt. | 3.25 | .03 | 25.3 | 54,057 |
| Rolled oats (in packages) | 7 lbs. per 25c. | 3.5 | 1.9 | 20.0 | 51,730 |
| Farinas (in packages) | 6 lbs. per 25c. | 2.3 | .24 | 18.7 | 40,070 |
| Potatoes | 90 cts. per bag. | 2.18 | .10 | 15.6 | 33,492 |
| Beans | 5 cts. qer lb. | 3.90 | .54 | 12.0 | 31,000 |

No attempt has been made to calculate the amount of digestible constituents, but it is probable that over 95 per cent. of the protein of the milk and meats, and about 80 per cent. of that of the cereals would be digested. The fat of the cereals would be less digestible than that of the milk and meats, and sugar of the milk would be almost entirely absorbed, while a considerable proportion of the carbohydrates of the bread and oatmeal would resist the action of the digestive juices. It is also quite probable that more energy would be required to digest the vegetable foods. However, after allowing for this, it is evident that the cereal foods are a cheap source of protein and carbohydrates and that it is because of the presence of the latter cheap heat-producing materials that this class of food has such a high fuel value.

Taking the figures as they stand, it is evident that milk furnishes protein and fat more cheaply than the various cuts of the meats. Skim milk and buttermilk, when they can be purchased, are particularly cheap sources of protein, and are probably the cheapest source of this constituent among all our foods. Butter is valuable almost entirely for the fat it contains, and as an energy producer is as cheap as any of the meats, while cheese as a source of protein and fat is very much cheaper than the meats. Thus, one dollar expended on cheese at 20 cents per pound will furnish about twice as much protein, nearly three times as much fat, and about two and one-half times as much energy as the same amount of money spent on sirloin steak at 24 cents per pound. From the above it is evident that one dollar spent on milk, or any of its products excepting butter, will furnish more protein, or muscle-forming material, and more energy, as indicated in the fuel value column, than fresh meats. Furthermore, there is no reason why the cheaper milk products should not at least partly replace the more expensive meats. There is, however, the whole problem of palatability to contend with and it is very doubtful if there are many people who will give up meats for milk products, unless these are put up in a form that is equally palatable.

## Cheese as a Substitute for Meat.

From the standpoint of composition meat and cheese may be readily compared with one another. Neither one contains any appreciable quantity of the carbohydrates, and both are valuable for the protein and fat they possess. Furthermore, they are about equally well digested, and there is no reason to suppose that the nutrients of one are any more valuable than the other. One pound of cheese will, however, furnish just about as much actual nourishment as two pounds of fresh meat. Yet, it is extremely doubtful if cheese will ever entirely replace meat as a source of protein and fat, nor is it desirable that it should, unless strict economy in the diet is essential. Meat and gravy form a natural relish for the vegetables, just as cheese does for the breads. Both have their places in our dietaries. At the same time, economy would be effected if cheese was given a more prominent place in our diet and used in at least one meal a day with the deliberate intention of procuring the essential proteins from this source rather than from the more costly meats. Bread and cheese can be used in such amounts as to constitute what is called a balanced diet, i.e., in such amounts as to supply the right proportions of muscle-forming foods in comparison with the energy value. But fruit added to the diet would render it more attractive and palatable and favor digestion. It also tends to decrease the possibility of constipation. A case was investigated and reported by the Office of Experiment Stations, U. S. Department of Agriculture, of a man who lived for months upon a diet of bread, cheese and fruit, and who remained in good health and active and did not weary of the monotony of the diet. It will generally be found that the watery and refreshing fruits or succulent vegetables with their large supply of cellulose are a pleasant contrast to the concentrated and fatty cheese. Thus, when planning menus in which a cheese dish is the chief feature, pains should be taken to supply crisp, watery vegetables or fresh fruit salads.

## Cheese Dishes and Their Preparation.

Cheese may also be cooked in a great variety of ways; but, owing to its concentrated and fatty nature, it must be mixed with other materials and cannot, like meat, be cooked by itself. There may, however, be many tasty dishes prepared by housekeepers who for one reason or another are interested in lessening the amount of meat which they provide or to substitute some other food for it. The problem with the average family may more often be the occasional substitution of other palatable dishes for the sake of variety, for reason of economy, or for some other reason than the general replacement of meat dishes by other things.

The following recipes for cheese dishes have been prepared by Miss Watson, Director of Home Economics, Macdonald Institute, Guelph, who has also made the calculation of the cost. The prices of the materials used in these calculations were about the present prices for the various articles in Guelph, which are as follows:

| | | |
|---|---|---|
| Porterhouse steak | 25 | cents per pound |
| Beef, as in hash, beef loaf | 18 | " " " |
| Butter | 35 | " " " |
| Cheese | 20 | " " " |
| Eggs | 35 | " " doz. |
| Milk* | 7 | " " quart |

*Skim milk was charged at the same rate as whole milk, because the family buys whole milk, uses the cream for tea, coffee and cereals, and the skim milk for cooking.

| | | |
|---|---|---|
| Bread | 4 | cents per pound |
| Dripping* | 18 | " " " |

With each recipe the total cost of the materials is given, also the cost per 100 calories and the cost per pound of protein. Like all such estimates, these calculations only give the relative cost. The housekeeper may estimate the comparative cost of the various dishes by taking into account the amount of materials used and the prices paid for the ingredients at any particular time. Furthermore, these recipes are not set down to be slavishly followed. The skillful cook may lessen the cost by reducing the number of eggs or by substituting less expensive fats for the butter, and will evolve many variations to suit the taste of the consumers.

### Macaroni and Cheese. Baked.

1 cup macaroni.
2 cups skimmed milk.
3 tablsp. butter.
4 tablsp. flour.
1 cup grated cheese.
½ teasp. salt.
Pepper.
¼ cup dried crumbs.
1 teasp. butter.

Add 2 teasp. salt to 2 quarts water. When boiling rapidly, drop in the macaroni broken into inch pieces, and boil hard 20 minutes. Drain and pour cold water through to prevent sticking together.

Melt the 3 tablsp. butter in a saucepan; add the flour and stir over the fire until frothy; add the milk and stir constantly until it thickens and boils. Season to taste with the salt and pepper; add the cheese and cooked macaroni; mix carefully, turn into a baking dish.

Butter the crumbs by adding the teasp. butter and stirring over the fire; sprinkle them evently over the dish of macaroni and bake until thoroughly heated, about 20 min.

Note.—This may be served in a vegetable dish, without the crumbs and baking, but the macaroni must then be heated in the sauce.

| | |
|---|---|
| Cost per 6 persons is | 16.5 cents |
| " per 100 calories is | .92 " |
| " of 1 lb. proteid from this food is | $1.04 |

### Welsh Rabbit.

1 lb. cheese.
½ cup water.
1 teasp. salt.
Cayenne.
Bread—10 oz.
12 pieces—3" x 4" x ¼"

Prepare the toast, arrange on a platter and keep it warm. Grate the cheese, or chop it fine. Put the water, salt, cayenne and cheese into a frying pan; set it over gentle heat and stir constantly with the flat of a fork until the cheese melts and the whole is creamy. Lift from the heat, beat hard for a moment, pour it over the toast and serve at once.

Note.—The success of this dish seems to lie in the choice of a mild flavored cheese which melts well, and the slow raising of the temperature to the melting point, which permits of thorough mixing and beating.

Beer, ale, cider or ginger-ale, may replace the water. Onion juice or garlic may be used to flavor.

| | |
|---|---|
| Cost for 6 persons is | 22.5 cents |
| " per 100 calories is | .77 " |
| " of 1 lb. proteid from this food is | 67.2 " |

### Milky Cheese Toast.

1 lb. bread.
3 cups whole milk.
½ cup grated cheese.
1 tablsp. flour.
1 tablsp. butter.
¾ teasp. salt.
Pepper.

Toast the bread and pack into a vegetable dish or arrange on a deep platter and keep warm.

*Dripping was reckoned at the same price as meat, as it is usually purchased at the same price as the meat.

Put the milk to heat in a double boiler. Mix the flour and butter in a small bowl, and thin down with warm milk, a little at a time, until thin enough to pour easily. Add it to the hot milk, stirring constantly until it thickens. Season to taste and cook at least ten minutes longer. Just before serving time add the cheese, stir until it melts, pour it over the toast and serve at once.

| | |
|---|---|
| Cost for 6 persons is | 11.8 cents |
| " per 100 calories is | .56 " |
| " of 1 lb. proteid from this food is | 67.8 " |

### Cheese Custard.

3 eggs.
2 cups skimmed milk.
1 cup grated cheese.
1 teasp. salt.
½ teasp. mustard.
Pepper.
Bread—10 oz.
12 pieces—3" x 4" x ¼"

Make the toast, arrange on a platter and keep warm.

Mix salt, pepper and mustard in the top of a double boiler. Add three eggs and beat enough to mix well; add the milk and cheese and mix thoroughly. Stand over the fire and stir constantly until hot, then stand in the hot water and stir until it thickens like custard (that is, until it begins to coat the spoon). Pour over the toast and serve at once.

Note.—This dish cannot be kept hot successfully: Better keep the family waiting for the dish than the dish for the family.

This may be used over soda biscuits, plain bread slices, or milk biscuits heated over, and split.

| | Alone | On toast. |
|---|---|---|
| Cost for 6 persons is | 16.5c. | 19 c. |
| " per 100 calories is | 1.7c. | 1.1c. |
| " of 1 lb. proteid from this food is | $1.28 | 72.3c. |

### Cheese Soup.

4 cups skimmed milk.
1 cup grated cheese.
1½ tablsp. flour.
1 teasp. salt.
Pepper—black, cayenne, or paprika.

Reserve ½ cup cold milk, and put the rest to heat in a double boiler. Mix the flour with an equal bulk of cold milk, and thin down with the remainder; stir this into the hot milk and stir until it thickens. Season to taste with the salt and pepper and cook 10 minutes longer. Add the cheese, stir until it begins to melt and serve at once.

Variations.—The seasoning may be varied with celery salt, allspice or mace. A little finely chopped onion or carrot, or celery may be boiled 20 minutes in a little water, and the water alone, or the whole, added to the milk before thickening. The water from dinner vegetables will serve the same purpose, replacing part of the milk.

| | |
|---|---|
| Cost for 6 persons is | 10.6 cents |
| " per 100 calories is | 1.1 " |
| " of 1 lb. of proteid from this food is | 76.1 " |

### Cheese Pudding.

12 pieces bread—10 oz.
2 cups grated cheese.
2 cups skimmed milk.
½ teasp. salt.
½ teasp. mustard.
Pepper.

Toast the bread, and fit a layer into the bottom of a baking dish. Put next a layer of half the cheese; then a layer of toast covered with the remaining cheese; top with another layer of toast. Season the milk with salt and pepper; pour it over the contents of the dish; bake in a quick oven about 30 minutes and serve at once.

Note.—The quantity of milk will vary somewhat according to the bread used. Each person should determine the quantity suited to her conditions and change the recipe figure accordingly. The result should be a spongy mass.

| | |
|---|---|
| Cost for 6 persons is | 15.3 cents |
| " per 100 calories is | .77 " |
| " of 1 lb. proteid from this food is | 66.7 " |

### Cheese Souffle.

3 tablsp. butter.
4 tablsp. flour.
1 cup milk.
4 eggs.
1 teasp. salt.
Cayenne.
1 cup grated cheese.

Separate the egg-yolks and whites, and set the whites aside to get as cold as possible.

Melt the butter in a saucepan; add the flour and stir until frothy over the fire; add the milk and stir constantly until thickened and cooked. Take from the fire, drop in the egg-yolks and mix thoroughly; mix in the cheese, salt and pepper, and set aside to cool.

When it is cold, beat the egg-whites stiff, add a little and mix it in to soften the mixture; add the rest and fold it in lightly to keep it as foamy as possible; turn into a buttered baking dish, and bake in a slow oven 45 to 60 minutes.

This needs a rather strongly flavored cheese.

| | |
|---|---|
| Cost for 6 persons is | 19.3 cents |
| " per 100 calories is | 1.6 " |
| " of 1 lb. proteid from this food is | $1.55 |

### Cheese Sauce.

2 cups skimmed milk.
¼ cup butter.
¼ cup flour.
½ cup grated cheese.
1 teasp. salt.
½ teasp. mustard.
Pepper.

Bread—10 oz.
12 pieces—3" x 4" x ½"

Mix the salt and mustard in a saucepan; add the butter and melt it; add the flour and stir over the fire until frothy; add the milk and stir constantly until it thickens and boils. Add the cheese and stir until it melts; season to taste with pepper, and pour over the toast. Serve at once.

Variations—

1. May be used over soda-biscuits, split hot biscuits, poached eggs, hard-boiled eggs, or vegetables.
2. The butter may be replaced by sweet dripping or other fat, lessened in amount, or omitted. In the latter case the flour must be used as in cheese soup.
3. If this sauce is to stand any length of time, make in a double boiler and add the cheese just before serving.
4. A mild cheese is best, or at least only a small proportion of strong cheese.

| | Alone. | On Toast. |
|---|---|---|
| Cost for 6 persons is | 10.2c. | 12.7c. |
| " per 100 calories is | 1.0c. | .72c. |
| " of 1 lb. proteid from this food is | $1.33 | $1.28 |

### Cheese Gnocchi.

¼ cup butter.
¼ cup flour.
¼ cup cornstarch.
½ cup cheese, grated.
2 cups skimmed milk.
2 egg yolks.
1 teasp. salt.
Pepper (black, cayenne or paprika).

Mix the flour, cornstarch and seasoning with enough cold milk to heat in a double boiler. Stir the mixture into the hot milk; stir constantly until it thickens, and occasionally for 15 minutes. Stir in the butter. Add the cheese and the egg-yolks and stir until the cheese melts. Turn into shallow buttered pan to cool.

When cold, cut into squares, arrange on a platter a little distance apart; sprinkle the rest of the cheese over the tops. Heat in a quick oven until the top cheese melts, and serve at once.

Note.—The mixture may be made some time before the meal hour.

| | |
|---|---|
| Cost for 6 persons is | 15.2 cents |
| " per 100 calories is | .94 " |
| " of 1 lb. proteid from this food is | $1.19 |

### Scrambled Eggs and Cheese.

6 eggs.
1½ cup grated cheese.
1 teasp. chopped parsley.
1 teasp. salt.
Pinch of nutmeg.
Pepper.

Break the eggs into a bowl, and sprinkle the parsley on top of the cheese. Melt the butter in a frying pan over gentle heat. Turn in the eggs, and immediately sprinkle the cheese over them. With a bread-bladed knife begin to scrape the mass from the bottom as it sets. The object is to cook the mass without mixing the yolks and whites too thoroughly, and yet avoid hardening them. When the mass is jellied, turn at once into a hot vegetable dish, or over toast on a platter, and serve at once.

| | |
|---|---|
| Cost for 6 persons is | 26 cents |
| " per 100 calories is | 2 " |
| " of 1 lb. proteid from this food is | $1.35 |

The following recipes of common dishes that do not contain cheese are given for comparative purposes:

### Beef Loaf—With Gravy.

1½ lb. lean beef minced.
1 egg.
3 tablsp. dripping.
1½ teasp. onion juice.
1½ tablsp. chopped parsley.
1½ teasp. salt.
3 tablsp. flour.

| | |
|---|---|
| Cost for 6 people is | 30.1 cents |
| " per 100 calories is | 2.31 " |
| " of 1 lb. proteid from this food is | $2.9 " |

### Bacon and Eggs.

| | |
|---|---|
| 1½ lb. bacon | 37½ cents |
| 6 eggs | 18½ " |
| Cost for 6 people is | 56 cents |
| " per 100 calories is | 1.23 " |
| " of 1 lb. proteid from this food is | $2.32 |

Note.—Above assumes that all the bacon fat is sent to the table and consumed.

### Hash.

2 lbs. cold potatoes.
2 lbs. cold cooked lean beef.
3 tablsp. dripping.
1 cup water or gravy.
Salt, pepper.

| | |
|---|---|
| Cost for 6 people is | 25.4 cents |
| " per 100 calories is | 1.46 " |
| " per 1 lb. proteid from this food is | $1.00 |

In the following table the various dishes the receipes of which are given above are arranged acording to the cost of 100 calories of heat:

| | |
|---|---|
| 1. Beef Loaf | 2.31 cents |
| 2. Scrambled Eggs and Cheese | 2. " |
| 3. Hash | 1.46 " |
| 4. Cheese Souffle | 1.6 " |
| 5. Bacon and Eggs | 1.23 " |
| 6. Cheese Custard on Toast | 1.1 " |
| 7. Cheese Soup | 1.1 " |
| 8. Cheese Gnocchi | .94 " |
| 9. Macaroni and Cheese | .92 " |
| 10 Cheese Pudding | .77 " |
| 11. Welsh Rabbit | .77 " |
| 12. Cheese Sauce on Toast | .72 " |
| 13. Milky Cheese Toast | .56 " |
| Dishes to compare with: | |
| Cheese, Cheddar | .93 " |
| Cottage Cheese | .98 " |
| Bread | .33 " |

On this basis of comparison beef loaf is the most expensive. Flour and bread, rich in starch, which has a fuel value equal to protein, have, however, much to do

with the reduction in the cost of 100 calories in some of the other foods. At the bottom of the table the cost of 100 calories of heat in our ordinary Canadian cheese, cottage cheese and bread are given for comparison.

A comparison has also been made on the basis of the cost of one pound of protein in each of the various dishes. These are as follows:

| | |
|---|---|
| 1. Bacon and Eggs | $2.32 |
| 2. Cheese Souffle | 1.55 |
| 3. Scrambled Eggs and Cheese | 1.35 |
| 4. Cheese Sauce on Toast | 1.28 |
| 5. Cheese Gnocchi | 1.19 |
| 6. Macaroni and Cheese | 1.04 |
| 7. Hash | 1.00 |
| 8. Beef Loaf | 92.9c. |
| 9. Cheese Soup | 76.1 |
| 10. Cheese Custard on Toast | 72.3 |
| 11. Milky Cheese Toast | 67.8 |
| 12. Welsh Rabbit | 67.3 |
| 13 Cheese Pudding | 66.7 |

Compare with:

| | |
|---|---|
| Porterhouse Steak | 4.00 |
| Bread | .44 |
| Cheese, Cheddar | .71 |

At the bottom of the above table the cost of one pound of protein in cheese, steak and bread are given. From this it will be seen that bread furnishes the cheapest protein, then cheese and steak in the order named. It is also evident that the cost per pound of protein in the various dishes must vary largely as one or other of these constituents predominates.

There are really two classes of foods in the above list, those which are valuable solely for their protein and fat, and those which contain a certain amount of the cheaper carbohydrate materials derived from bread, wheat or potatoes. Thus, the following are interchangeable dishes in the dietary, and may be directly compared with one another:

Hash—a mixture of meat and potatoes } with { Cheese Custard on Toast. Macaroni and Cheese. Cheese Pudding. Welsh Rabbit. Cheese Sauce on Toast. Milky Cheese Toast.

or

Beef Loaf and Bacon and Eggs. } with { Cheddar Cheese. Cottage Cheese. Scrambled Eggs and Cheese. Cheese Souffle. Cheese Soup.

Bread, as a representative of the cereals as a class, is one of the cheapest sources of heat and protein to the body, and cheese and milk, especially skim milk, are the cheapest source of animal protein. The two together can be used to make a well balanced diet, perfect in every way from the food ingredients' standpoint, but lacking in variety and in palatability. The physical condition of cheese renders it difficult to make into tasty cooked dishes without mixing with other materials, especially with eggs, and as eggs are among the most expensive foods, this naturally increases the cost of the cooked preparations. There are, all together,

a great variety of ways in which cheese may be used as a condiment and as a cheap source of the proteins. Milk, both raw and cooked, has been used in this way for ages, but the true food value of cheese does not seem to have been as fully realized.

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## SUMMARY.

Milk contains all of the four nutrients—proteins, fats, carbohydrates, and mineral matter—in nearly the proper proportions to serve as a complete food. It is too bulky to form the whole food of an adult person, but it is well adapted for various uses in combination with other food substances, and in the preparation of different dishes used as food. It also has the advantage of being a cheap food.

Skim Milk is a cheap source of digestible proteins, and when taken with bread or used in cooking it forms a very cheap and nutritious addition to the diet. Two and a half quarts, or five pounds, of skim milk will furnish nearly the same amount of protein and have about the same fuel value as a pound of round steak. Buttermilk has about the same nutritive value as the skim milk, and both substances are so cheap that they could be used in large quantities with economy.

Cheese is one of our most concentrated foods. More than one-fourth of its weight is protein, about one-third fat, and one-third water. It is not only valuable for the amount of protein, or muscle-forming material, and fat it contains, but, also because of the ease with which it can be kept and prepared for the table and for the variety of ways in which it may be served.

Unfortunately there is a wide-spread belief that cheese is indigestible, but extensive experiments have fully demonstrated that it is as fully digested as milk or meat. With this in mind, it may be pointed out that one pound of cheese will furnish about as much protein and fat as one gallon of milk, or as much nourishment as two pounds of fresh meat, two pounds, or fifteen eggs, or three pounds of fish. It may not agree with every person, but the same may be said of many other foods. Yet it is not desirable that cheese should entirely replace these other protein foods, unless strict economy in the diet is essential. Meat and gravy form a natural relish for vegetables, just as cheese does for the breads. Both have their place in our dietaries. At the same time, economy would be effected if cheese was used in at least one meal a day with the deliberate intention of procuring the essential proteins from this source rather than from the more costly meats.