

UTILIZATION OF BUTTERMILK IN THE FORM OF CONDENSED AND DRIED BUTTERMILK¹

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ANNUAL VOLUME OF BUTTERMILK PRODUCED IN UNITED STATES

According to figures compiled by the United States Department of Agriculture the total output of American Creamery butter in 1921 was 1,054,938,329 pounds.

Assuming that with each pound of butter manufactured there is produced 1.5 pounds of buttermilk, the total production of factory buttermilk would amount to about 1,562,407,494 pounds.

USES OF BUTTERMILK

Aside from its use for feeding purposes, buttermilk has been found valuable and useful as the basis for diverse manufacturing purposes. It is used in bakeries and in the manufacture of prepared foods, for cottage cheese and milk beverages, casein products, lactic acid and similar industrial products.

The volume of buttermilk used for these miscellaneous purposes, however, represents but a very small portion of the total annual supply of buttermilk, and it is fair to admit that at this stage of the industry those sundry purposes are as yet a negligible factor in the solution of the economic utilization of the buttermilk supply.

The basic value of buttermilk lies in the high quality of its solid ingredients for feeding purposes, and it is through the channel of feeding the buttermilk to farm animals and fowl, and to a limited extent to the human family, that the more

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complete and economic utilization of the vast bulk of our annual output of buttermilk must find its ultimate solution.

On the basis of 30 cents per hundred pounds, which is a very conservative estimate when compared with present prices of grain (corn now ranges between 60 and 65 cents per bushel) the value of the annual output of 1,582,000,000 pounds of buttermilk represents a value to the farmer of the country of approximately \$4,750,000.

If disposed of by the butter manufacturer at the conservative price of 1 cent per gallon or 12 cents per 100 pounds, it would net the creameries of the country annually around two million dollars.

A considerable volume of buttermilk is returned direct to the farmer for hog and poultry feeding. This direct outlet is confined largely to local creameries where the cow population is dense and the distance from farm to factory is relatively short. And even in this case, the demand for the buttermilk is very irregular and the facilities for its proper disposition through this channel are entirely inadequate to the supply.

In the larger creameries, that receive their cream supply from a much wider radius, the distance of the average patron from the creamery limits the amount of buttermilk that can be returned direct to the farmer to a very small volume. This is especially true in the case of the creameries located in large cities.

Prior to the World War the great bulk of the buttermilk supply was a complete loss. It was run into the sewer, although some efforts had been made for several years to convert the buttermilk into a more concentrated form and into a form that would render it less perishable and that enhanced its keeping quality.

DEVELOPMENT OF MANUFACTURE OF CONDENSED AND DRIED BUTTERMILK

The manufacture of condensed buttermilk and of dried buttermilk prior to the World War was exceedingly limited. In fact, it did not really go beyond the experimental state, only a very

limited amount of either product reaching the market. The relatively low price of grain feeds and of pork, poultry and eggs did not seem to justify the addition to the price of fluid buttermilk of the comparatively high cost of manufacture into the more concentrated products. Also the process of condensing and drying buttermilk had not as yet reached the point where products of dependable keeping quality were entirely assured.

Practically the only kind of so-called condensed buttermilk then made at all, was not really the result of concentration proper. It was a product made by heating the buttermilk in large tanks to the boiling temperature long enough for the curd to contract and to settle to the bottom, leaving a practically clear whey on top. This whey was drawn off and thrown away. The residue, consisting of the curdy material and as much of the whey as adhered to or remained mixed with it constituted the condensed buttermilk. It is obvious that this product was not a complete buttermilk, much of the lactose, lactic acid and mineral salts having been lost. Only a small quantity of this product ever reached the market.

Small quantities of dried buttermilk were also made and used largely in mixed feeds for poultry.

The feed shortage and the high prices of all farm products caused by the ravages of the World War greatly emphasized the possibilities and the value of preserving such by-products as buttermilk. With prices of farm products doubling and in some instances trebling, and the demand for these products reaching far beyond their supply, the cost of concentrating and of drying buttermilk was no longer a serious obstacle. The farmer and the feeder could afford to pay the price and the manufacture of these concentrated products became a profitable industry.

The processes of manufacture were perfected rapidly and the volume of these finished products, condensed buttermilk and dried buttermilk, increased by leaps and bounds.

Like in other similar industries the attractiveness of the possible profits during the years of forced prosperity created by the war, so in the manufacture of condensed and dried butter-

milk it led to overproduction, I mean production greater than the demand, in normal times. With the general business depression and reaction that set in a few years ago, and the resulting decrease in the demand and depreciation of the value of farm products, these industries too suffered and will continue to suffer to some extent until the period of reconstruction will have reached a point of reasonable stability and comparative normalcy.

However, the efforts put into these industries have by no means been in vain. They have developed definite processes of manufacture of condensed buttermilk and of dried buttermilk. These products have been tried out and found useful and their value as stock feeds has been definitely established and is recognized.

Reports from those close to the industry point to the fact that the volume of production for 1922 is far in advance of 1921 and that there is a rapidly increasing demand on the part of the feeder for these products. Much educational work has been done during the last two years in acquainting the feeder with the value and proper use of these products. This has helped and will continue to assist in accelerating their use and their demand.

The total output of condensed buttermilk in 1921 was 29,313,767 pounds. This represents approximately 87,941,301 pounds of fluid buttermilk or 5.6 per cent of the total annual amount of fluid buttermilk produced. The total output of dried buttermilk for the same year was 7,708,384 pounds. This represents approximately 77,084,000 pounds of fluid buttermilk or 4.9 per cent of the total annual output of the fluid buttermilk. With other words, about 10.5 per cent of the 1,582,407,494 pounds of fluid buttermilk produced in 1921 was utilized for the manufacture of condensed buttermilk and dried buttermilk.

Practically the entire make of 29,313,767 pounds of condensed buttermilk was sold for feeding purposes. Only negligible amounts went to bakeries. Of the total of 7,708,384 pounds of dried buttermilk approximately 200,000 pounds went for human consumption. The remainder was used for feeding purposes.

The great bulk of condensed buttermilk is manufactured by evaporation in the vacuum pan similar as in the case of the manufacture of condensed milk. The process of concentrating

buttermilk in vacuo is covered by patent of the Greck-Hovey Patent Company of St. Paul, Minn.

In the manufacture of dried buttermilk, both the spray process and the roller process have been employed. In the spray process as used in the central west, the buttermilk is first condensed in the vacuum pan and the condensed buttermilk is then atomized and dried in a current of hot air. This process is covered by the Merrill-Soule Company patent. The amount of buttermilk powder so manufactured is very small.

Practically 90 per cent of the entire output of dried buttermilk for the year 1921 was made by the roller process covered by patent of the Collis Products Company of Clinton, Iowa. In this process the buttermilk is kept in a thoroughly agitated condition and is sprayed on a steam heated revolving roller which makes about two revolutions per minute and the temperature of the product reaches about 190 to 200°F. The thin film of drying buttermilk that forms on the roller is automatically removed by a stationary sharp knife. This thin film is still slightly moist when it comes off the roller, but it surrenders the remainder of its removable moisture quickly to the atmosphere. Instead of spraying the uncondensed fluid buttermilk on the roll, the buttermilk may be precondensed and then sprayed on the roll.

Some dried buttermilk is also manufactured by the roller process of the Just-Hatmaker type of machine (two rollers) and by the roller process in vacuum, which was originally invented by Dr. Ekenberg of Stockholm, Sweden, and the machinery of which is now manufactured and patented by the Buffalo Foundry and Machine Company, Buffalo, N. Y.

COMPOSITION

Neither condensed nor dried buttermilk contain any ingredients not present in the original buttermilk, nor is any ingredient present in the original buttermilk decreased or removed except the water. The two products differ from each other only in their degree of concentration. The proportion of the individual

solid ingredients to one another in each product is practically the same and it is the same also as it is in the fluid buttermilk with the exception of the percentage of lactic acid which is relatively much higher and the percentage of milk sugar which is correspondingly lower in the condensed buttermilk than in the dried buttermilk and than in average fluid buttermilk.

The ratio of concentration of condensed buttermilk averages about three to one, but there is a very considerable variation in different lots of condensed buttermilk that reach the market. Since fluid buttermilk averages about 9 per cent total solids and 91 per cent water, the condensed buttermilk averages from about 25 to 33 per cent total solids and from about 67 to 75 per cent water.

In dried buttermilk the ratio of concentration is slightly over 10 to 1. It is more even in its composition. It contains from about 90 to 95 per cent milk solids and from about 5 to 10 per cent water.

KEEPING QUALITY

Condensed buttermilk is a far more perishable product than dried buttermilk. In order to lend it proper keeping quality, the buttermilk before condensing must be soured to a point sufficient to produce a condensed buttermilk with not less than 3 to 3.5 per cent acid, calculated as lactic acid. If the acid content of the condensed buttermilk drops below the above figure, the product deteriorates very rapidly, usually becoming moldy and putrid. Also the contents of remnant barrels of condensed buttermilk mold very profusely unless the surface of the condensed buttermilk is protected from the air, as can be readily done by covering it with heavy paper, or similar material.

Dried buttermilk has very good keeping quality. Its high acid content, which is around 5 per cent, due to its high ratio of concentration, and its relatively low moisture content, act as effective preservatives. It keeps best, however, when protected against air and heat.

FOOD VALUE AND MARKET PRICE

From the standpoint of the percentage ingredients as determined by chemical analysis, the relative food value of condensed buttermilk and of dried buttermilk is controlled entirely by the ratio of concentration or the percentage of total solids. On this basis, the dried buttermilk has at least three times the food value of condensed buttermilk and condensed buttermilk has about three times the food value of fluid buttermilk. The market price of condensed buttermilk for feeding purposes is about 5 cents per pound. The market price of dried buttermilk for feeding purposes is about 8 cents per pound. Feeders who buy these concentrated products direct from the manufacturer may secure them at a reduction of from $\frac{1}{2}$ to $1\frac{1}{2}$ cents or slightly over. The above prices are jobbers' prices to the feeder.

Based on the percentage of total solids in the two products, therefore, it would appear that the feeder of dried buttermilk receives considerably more milk solids and therefore greater food value for every dollar expended than the feeder of condensed buttermilk. Also there is much less danger of loss by spoiling, there is less storage room required and the cost of transportation is less than in the case of condensed buttermilk. Comparing dried buttermilk with an average per cent of solids of $92\frac{1}{2}$ per cent and a cost to the feeder of 8 cents per pound, and condensed buttermilk with an average per cent of solids of 27 per cent and a cost of 4 cents per pound with the value of fluid buttermilk testing 9 per cent solids, the feeder when buying dried buttermilk is paying at the rate of 78 cents per hundred pounds or 6.3 cents per gallon of fluid buttermilk. In case of condensed buttermilk he is paying at the rate of \$1.33 per hundred pounds, or of 11 cents per gallon of fluid buttermilk.

When sold direct by manufacturer to the feeder the price to the feeder is considerably less. Dried buttermilk sells at $6\frac{1}{2}$ cents and condensed buttermilk sells at $3\frac{1}{2}$ cents per pound. At these prices the feeder, when buying dried buttermilk, would be paying at the rate of $65\frac{3}{4}$ cents per hundred or $5\frac{1}{2}$ cents per gallon of fluid buttermilk. When buying condensed buttermilk he would

be paying at the rate of \$1.16 per hundred or 9½ cents per gallon of fluid buttermilk.

It is further claimed that in the case of condensed buttermilk, the real value of the product as a feed is materially augmented by its very high content of acid, calculated as lactic acid. Condensed buttermilk contains about 3.5 per cent acid.

That lactic acid in the diet has a value as a tonic is generally admitted by nutrition and health experts. Its value lies in cleansing the intestines from putrefaction and keeping them in a healthy condition; in accelerating the power of assimilation of other feeds in the ration, thereby augmenting their digestibility and their economy as feeds; and in giving the animal greater capacity for the consumption of feed and water.

To what extent this tonic effect of condensed buttermilk does increase the value of this product, is as yet undetermined. It is reasonable to assume that the effect is advantageous but the information available is as yet too limited to interpret this value in terms of dollars and cents.

VITAMINE PROPERTIES

There are no experimental data on record, or at least I have been unable to find any, on the relative vitamine properties of condensed and dried buttermilk, nor even of liquid buttermilk. However, the effect of condensing and dehydrating of milk has been subjected to considerable study and it may be justifiable to use these data as an approximate criterion of the vitamine properties in the buttermilk products.

Ellis and Macleod (1), Sherman and Smith (2), Funk (3), and Eddy (4), in their respective reviews of experimental results with condensed milk and dried milk when fed to rats, other animals and to children, point out that neither the fat soluble A nor the water soluble B vitamins were noticeably affected by the processes of evaporation and drying.

Vitamine C, the antiscorbutic vitamine, on the other hand, suffered variably according to the process used. Condensing in vacuo and drying by the roller process had the least unfavorable effect. The spray drying process at high temperatures in the

drying chamber and exposure of the milk powder for several hours on the floor of the drying chamber practically destroyed vitamine C.

These data suggest quite clearly that neither the condensing of buttermilk in the vacuum pan, nor the drying of the buttermilk by the roller process, both processes whereby the great bulk of condensed buttermilk and dried buttermilk respectively, are manufactured, have any appreciable effect on the vitamine properties of the finished product.

The fact that the fat soluble A and the water soluble B vitamins are preserved during the processes of heating, condensing and dehydrating is important because the grain feeds are deficient in these vitamins and the buttermilk products thus are a valuable supplement to these feeds. The possible depreciation or destruction of vitamine C in the buttermilk products is of negligible importance as the grain feeds amply supply this vitamine.

However, it should be understood that the results above referred were obtained with milk products and not with buttermilk products. It is possible, though not probable, that the same processes that are harmless or negative as far as their effect on the vitamine properties of sweet milk is concerned, may have a different influence in the case of highly acid buttermilk.

DIGESTIBILITY

Accurate data on the relative digestibility of dried and condensed buttermilk as compared with fluid buttermilk are likewise lacking. Dr. Miner (5) of the Miner Laboratories, Chicago, reports a limited number of digestibility tests made in the laboratory. These tests indicated that the digestibility of the condensed and dried buttermilk was equal to that of the fluid buttermilk. These results correspond with those of digestibility tests with condensed and dried milk reported by numerous investigators. However, the digestibility tests on the condensed and dried buttermilk were restricted to laboratory tests only and limited in number. They therefore should be accepted as an indication rather than as a proven fact.

FEEDING EXPERIMENTS

Results of carefully executed feeding experiments that show the comparative food value and economy are as yet too limited to arrive at definite conclusions and in many cases the experiments were made with products especially furnished for the purpose by the manufacturer. While experiments conducted under such circumstances are of unquestionable value, the results obtained therefrom, should be amply verified by experiments on a broader scale with products as they appear in the trade, before they can be accepted as scientifically established and unbiased facts.

Evvard and Dunn (6) of the Iowa Experiment Station report experimental results with dried buttermilk for pigs. Dried buttermilk was added to the basal ration of corn, tankage and salt. The dried buttermilk increased the gains on pigs and decreased the feed requirements for a 100-pound gain. The buttermilk proteins proved more efficient than the tankage proteins, but the buttermilk proteins cost more than the tankage proteins. From the standpoint of economy, tankage at \$100 per ton for market pig feeding proved much more efficient than buttermilk powder at \$200 per ton, the relative prices at the time of the experiment. On the basis of the above prices and the relative feeding results these investigators place the value of buttermilk powder at \$4 per hundred weight.

Mr. H. I. Macomber (7) of the Poultry Division of the United States Department of Agriculture reported experiments with laying hens. Fifteen per cent of dried buttermilk was fed in a poultry mash as compared with 25 per cent meat scrap of a 55 per cent protein analysis. The hens were laying as well on the buttermilk as on the meat scrap. Condensed buttermilk was also used, for its tonic value, but not to replace all of the animal protein feed. While the experiment is not as yet completed and it is too early for accurate figures as to cost, indications are that 15 per cent dried buttermilk in the mash will cost as much as 25 per cent of the meat scrap with present prices. Their observations are that the dried buttermilk is a much easier form of feed to handle than the condensed buttermilk and that the dried

buttermilk apparently was as satisfactory as a feed. Macomber further reports that both of these feeds have also been used in poultry fattening tests with the same comparative results as noted in the feeding of laying hens. He concludes that in his opinion more experimenting is required to arrive definitely at conclusions regarding the relative merits of dried and condensed buttermilk.

Philips (8) in Purdue Bulletin 258 reports results of feeding experiments with fluid and dried buttermilk with laying hens. Pullets in the dried buttermilk pen laid on an average of 189.4 eggs, in the fluid buttermilk pen 164.7 eggs, in the no buttermilk pen 56.6 eggs. It cost 16 cents for feed to produce one dozen eggs in both the dried and the fluid buttermilk pens, and 33 cents in the no buttermilk pen.

The profit over feed from the dried buttermilk pen was \$5.69, from the fluid buttermilk it was \$4.92, and from the no milk pen it was \$0.78. The feeding value of dried buttermilk was \$55.10 per 100 pounds, and of the fluid buttermilk it was \$5 per 100 pounds.

The dried buttermilk produced the best fertility of eggs and the fluid buttermilk the poorest. The mortality in the dried buttermilk pen and the fluid buttermilk pen was the same. That in the no milk pen was much heavier.

Similar results are also reported in experiments with chickens conducted at the Iowa Experiment Station, but the experiments are not as yet entirely complete.

SUMMARY

The utilization of the great bulk of the vast volume of creamery buttermilk annually produced in the form of condensed buttermilk and dried buttermilk gives promise to be of distinct economic value both to the feeder of farm animals and as a means to minimize waste of a valuable marketable by-product to the creamery.

While considerable quantities of these concentrated by-products are now being manufactured and marketed to the advantage of feeder and manufacturer, this industry is as yet in its infancy.

This, together with the fact that supplies such as coal and package, also labor and transportation, are as yet abnormally high, has been a handicap that has worked against the full realization of the possibilities of maximum efficiency and of minimum cost of manufacture.

Knowledge of the comparative feeding value of these two products is as yet limited but much and extensive experimental work is in progress, the result of which promises to reveal facts of great economic value to feeder and manufacturer. Information now available indicates that the food value, digestibility and vitamine properties originally contained in the fluid buttermilk are not materially affected by the processes of condensation and drying now used in the manufacture of these products.

REFERENCES

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