FACTORS AFFECTING THE YIELD OF COTTAGE CHEESE

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The major interest of plant operators in cottage cheese yields has centered around those factors affecting the amount of curd that can be recovered from a definite amount of skimmilk. Curd yields are important to the industry because they affect profits, and cottage cheese is one of the more profitable dairy products. If we may assume a total raw material and processing cost of 12¢ per pound of dry curd with a yield of 15 lb. of curd per 100 lb. of skimmilk of 9% solids (1.67 lb. curd per pound of solids), an improvement in that yield of 0.5 to 15.5 lb. per hundred or 1.72 lb. curd per pound of solids would mean a reduction of 0.4¢ per pound in the cost of curd. This is a very significant figure, when any possible reduction in costs without sacrifice of quality is important. It is believed that an increase in cottage cheese curd yields to the extent indicated above is attainable in many operations.

WHAT IS GOOD CURD YIELD AND HOW SHOULD IT BE CALCULATED?

Several investigators have called attention to the fact that it is the protein content of the milk, principally the casein, that is the determining factor in yield insofar as the composition of the milk is concerned. It is true that an accurate expression of curd yields should take into account the casein content of the skimmilk as well as another factor of limiting importance; namely, the moisture content of the curd. Such accuracy is important if we are to determine the efficiency of a plant in terms of its available milk supply and its success in recovering a satisfactory proportion of the solids in that supply. Such accuracy is also important if we are to make meaningful comparisons between various plants in terms of the recovery of a satisfactory proportion of solids. For practical purposes, however, the actual pounds of curd secured in the daily operation under routine operating conditions, curd of such a moisture content that will produce a satisfactory finished product and one that will comply with the legal standard for moisture, is the important figure and, when converted to pounds of curd per pound of solids, is a practical measure of plant efficiency. An important factor in determining that efficiency is the closeness of control over the moisture content of the curd and of the finished product.

Commonly used methods for the expression of yields on a practical basis are (1) pounds of curd per 100 lb. of skimmilk, and (2) pounds of curd per pound of solids in the skimmilk. It is believed there would be common agreement that a curd yield of 15.5 lb. per 100 lb. of skimmilk of 9% solids, or 1.72 lb. of curd per pound of solids, is a good, satisfactory yield with present conventional methods of making cottage cheese. Some plants improve this yield by better recovery of solids from skimmilk fortified with added solids-not-fat in the form of low-heat condensed skimmilk or spray process nonfat dry milk, and for such operations it is believed that a yearly average of 1.80 lb. of curd per pound of solids is a workable, attainable plant standard, based on the actual pounds of curd taken from the vat. Fluctuations below this figure in the summer and above it in the cold winter months are commonly experienced, probably due to variation in the solids content of the milk.

A third basis of expressing curd yield is the pounds of curd per pound of casein, and since casein is by far the most important cheese-making constituent of the solids, it is perhaps the most accurate of the indices commonly used. Assuming a fortified skimmilk of 11.0% solids with a casein content of 3.2%, our standard yield of 1.80 lb. of curd per pound of solids becomes 6.18 lb. of curd per pound of casein. Lundstedt (6) calculated that the correct factor to use in estimating the pounds of curd of 79% moisture per 100 lb. skimmilk of 9.0% solids was six times the casein content, when 36.2% of the solids is retained in the curd and the casein is 28.7% of the skimmilk solids. On this basis, the casein content of the skimmilk was 2.58% which, divided into the yield obtained of 15.5 lb. of curd, gave the factor of 6.

The Walker casein test, employing formalin to free the acidic protein groups for titration against 0.1 *N* sodium hydroxide, may be used to secure quite accurate figures on the casein content of the fluid or fortified skimmilk in the cheese vat. It should be in common use in cottage cheese plants and has special value at times when yields are running abnormally low or high.

FACTORS AFFECTING CURD YIELDS

Curd yields are determined by the interaction of a number of factors and the accuracy of the final yield figure is dependent upon the accuracy with which these various factors are determined. The following items must be taken into consideration:

1. *The composition of the skimmilk with particular reference to the total solids and protein content.* Factors influencing the total solids and protein content of whole milk and the skimmilk separated from it are (1) breed of the cow, (2) stage of lactation, (3) season of the year, and (4) diseased conditions of the udder, such as mastitis. In general, total solids varies with the

fat content and higher curd yields are secured from skimmilk separated from high-fat milk, as reported by a number of investigators and confirmed in plant practice. The high fat, protein, and total solids content of Jersey and Guernsey milk as compared to Holstein milk has been demonstrated by Overman and associates (8), and Turner (10) has prepared a table from their data which has been quite widely quoted. Jacobsen and Wallis (5), in their study of factors that affect the composition of milk, found a decrease in total solids content during the first 3 mo. of lactation with the Jersey, Guernsey, Ayrshire, and Holstein breeds. A general trend upward was noted during the middle months and the last 4 mo.

Seasonal variations in the composition of milk have been studied by a number of investigators. Honer and Herzer (4), reporting on the composition of Mississippi milk, stated that the casein content followed and appeared largely responsible for the over-all fluctuation in the total protein content. The highest average for casein appeared during November at 2.89% and the lowest during February at 2.55%. Declining gradually from November through March, the average casein trend remained low from March through July, then steadily increased to November. An extensive two-year study of the geographic and seasonal variations in the composition and vitamin content of nonfat dry milk solids was reported by O'Malley, Baldi, and Gross (7) in 1944. Their results showed that the protein content was lowest in February, March and April, with the lowest average in March (35.98% in the powder), and that it was highest in September, October, and November, with the highest average in October (38.21%). White and Judkins, as reported by Jacobsen and Wallis (5), found that regardless of the time of calving, the percentages of fat and of solids-not-fat were lower during the warm months and higher during the cold months of the year. It is readily apparent that when the seasonal effects contributing to low solids and low protein content are superimposed on similar effects for the period of lactation, abnormally low yields are the result.

Milk from cows suffering from mastitis is noted for its poor cheese-making qualities, because of its lowered casein content, increased content of whey proteins, higher pH, and other abnormalities. Undoubtedly, the inclusion of such milk in mixed supplies has reduced curd yields in cottage cheese plants and produced abnormal conditions of coagulation in the vats. Waite and Blackburn (11) recently reported on the chemical composition and the cell count of milk and stated that when the cell count approached 1,000,000 per milliliter, the casein content of the milk was decreased; with a 500,000 cell count, there was decreased production and less solids-not-fat content. A condition of subclinical mastitis led to a decreased solids-not-fat content.

In any event, whether the solids content of the skimmilk is low, high, or average, we must know what it is, if we are to get an accurate expression of curd yields on the preferred basis of pounds of curd per pound of solids. Using the Mojonnier solids test is the most accurate method, but a lactometer may be used with a table for converting lactometer readings into per cent solids. Supplies of fluid skimmilk should be tested at least weekly throughout the year by the Mojonnier method, to obtain the trend of the solids content and permit greater accuracy in charging solids to the cheese-making operation.

FORTIFICATION WITH ADDED SOLIDS

The addition of low-heat condensed skimmilk or Extra-grade spray process nonfat dry milk to fluid skimmilk has been demonstrated to improve the recovery of milk solids in the cottage cheese curd. Bender and Tuckey (1), studying the recovery of skimmilk solids in cottage cheese curd, reported that 38.8% of the solids was recovered from skimmilk of 9.71% solids content as compared to 32.2% recovery for skimmilk of 8.92% solids. Theoretically, it should be possible to secure increasing yields with solids levels in the milk up to 15.0% or possibly higher, but handling very large amounts of curd under commercial conditions in conventional cheese vats becomes a difficult problem and the tendency has been to secure maximum yields per pound of solids at somewhat lower levels. It is believed that not much is gained, and some loss may be experienced, by fortifying skimmilk to more than 11.0% solids.

2. *Accuracy of determination of volume or weight of skimmilk.* In skimmilk reconstituted 100% from powder, the problem is simplified by the use of weighed bags. Weigh tanks, or storage tanks equipped with volumetric gauges, may be used for fluid skimmilk. In their absence, cheese vats may be calibrated by the use of milk or water meters with a marked stainless steel gauge in a fixed position in the vat, using water at the setting temperature. Repetitive filling of the vat with fixed, measured volumes of water is a laborious but sometimes necessary procedure. Hydraulic load cells mounted under the storage tank or under the cheese vat are under study at the present time and if found practical and accurate will be one answer to the problem of getting an accurate figure on the weight of skimmilk made into cheese.

3. *Accuracy of weight of curd or finished, creamed cheese.* Obviously, the most accurate figure on the weight of the curd is obtained by weighing it before creaming. This may be done in operations involving the use of mechanical mixers and, with careful control of the weight or volume of cream used, provides efficient composition control. In some small operations the curd is weighed into curd cans containing weighed or measured volumes of the creaming mixture. Here again, hydraulic load cells in-