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Standardization of Milk With Skimmilk Powder for the Manufacture of Cheddar Cheese

By

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Standardization of Milk With Skimmilk Powder for the Manufacture of Cheddar Cheese

By H. C. Hansen and D. R. Theophilus

Introduction

STANDARDIZATION of milk used for the manufacture of cheddar cheese is a common practice in many cheese plants receiving high test milk. The purpose of standardizing milk for making cheddar cheese is not to evade the letter or intent of any law governing the composition or sale of cheese. Lower cost of manufacture and high quality cheese meeting all legal requirements are the basic reasons for standardization.

Standardization is usually accomplished by separating a portion of the milk and then adding sufficient skimmilk to the remaining milk to lower the butterfat content to a predetermined standard. This procedure is countenanced by regulatory authorities in most of the cheese producing states provided the finished cheese fulfills the legal requirements for butterfat and moisture content.

The use of skimmilk powder instead of liquid skimmilk, first, would eliminate skimming any milk; second, would make possible a more constant ratio between the solids-not-fat and butterfat than exists in milk standardized for butterfat alone; and third, would avoid the necessity of disposing of part of the butterfat in the form of cream at cream prices when it was purchased at whole milk prices.

Regulatory authorities and experimental workers have frowned upon the practice of the standardization of milk when used for the manufacture of cheddar cheese. They have felt that standardization was an effort to evade the spirit of the laws governing the composition of cheese and believed that standardized milk resulted in lower quality cheese. Therefore, in order to protect the quality and reputation of cheese from any region or state, they believed it necessary to discourage standardization practices.

Standardization of milk is permitted in the manufacture of other dairy products, and it seems that standardization

of milk for the manufacture of cheddar cheese should be permitted, provided a good standard quality cheese of legal composition is made. In New Zealand cheese is being made from standardized milk on a commercial scale for export purposes. (1)

Legal Requirements for Cheddar Cheese

The Federal standard (1928) for cheddar cheese is as follows: "Cheddar cheese, American cheese, American cheddar cheese, is the cheese made by the Cheddar process from heated and pressed curd obtained by the action of rennet on whole milk. It contains not more than 39 per cent of water, and in the water-free substance, not less than 50 per cent of milk fat."(5)

According to the Bureau of Dairy Industry, 1928,(2)the laws or regulations of seven states specify the Federal standard for fat content. Twenty-five states require 50 per cent of fat in the water-free substance, while four others specify 30 per cent fat. Two states require more than 30 per cent fat, and only one allows less than 30 per cent fat, while one state requires 50 per cent of total solids to be fat. Eight states have no law of regulation governing the fat content of cheddar cheese.

With respect to the moisture content of cheddar cheese, the laws or regulations of six states specify the Federal standard, two permit a maximum of 40 per cent, six allow a maximum of 39 per cent and thirty-four states have no law or regulation governing the moisture content.

One state has a minimum total solids content law of 61 per cent for cheddar cheese.

Therefore, cheese to meet the legal requirements of all states must contain not less than 50 per cent of fat in the dry matter and must not contain more than 39 per cent of moisture.

Review of Literature

Van Slyke and Price (6) (1927) conclude that cheese made from low fat milk is inferior in quality to cheese made from high fat milk. The Ontario Agricultural College in the College Report for 1896 (4) (1896) states, "The quality of the cheese is not determined by the percentage of fat in the milk. The fat is but one factor in the problem—an excess of fat in the milk is of no advantage."

Veale (7) (1928) states, "—a cheese can be quite satisfactory in regard to its fat content if made from normal whole milk of a fat test as low as 3.4 per cent. Furthermore, it

proves that no adequate premium in price can be commanded by cheese substantially higher in fat content and hence that the use of high testing milk for cheese making is economically unsound for the reason that no return may be obtained for a very considerable portion of the excess butterfat."

He further concludes, "Milk reasonably low in fat can be made up into cheese of high moisture content which may have just as good body and texture and be indistinguishable on these grounds alone from another cheese containing much less moisture and made from milk of higher fat content."

In regard to the economy of low test milk, he says, "An economic waste of butterfat is occurring whenever milk containing more than 4 per cent of butterfat is made up into cheese."

No experimental data are available on the standardization of milk for the manufacture of cheddar cheese.

Methods

This investigation consisted of the manufacture of cheddar cheese from milk standardized with skimmilk powder to various ratios of solids-not-fat to butterfat. The milk used was produced by the University herd consisting of Holsteins and Jerseys. The butterfat content ranged from 3.0 to 4.2 per cent and the average test of all batches of milk was 3.62 per cent. The milk was dumped into a large coil pasteurizer and thoroughly mixed while four portions of 150 pounds each were drawn out and placed in four cheese vats. Fat tests and lactometer readings were taken of each vat at 60 degrees Fahrenheit. The milk in vat No. 1 was used as a check. The ratio of fat to solids-not-fat of the milk in vats 2, 3, and 4 was standardized to a ratio of 1:2.6, 1:2.8, and 1:3.0, respectively by the addition of skimmilk powder.

These ratios were used because preliminary trials showed that a ratio of 1:2.6 was the lowest limit requiring the addition of skimmilk powder if low testing milk was used, and a ratio exceeding 1:3.0 in many cases resulted in cheese with slightly less than 50 per cent fat in the dry matter.

The method of standardization was repeatedly checked by making a chemical analysis of the milk for fat and total solids and was found to be correct within the limits of experimental error.

The skimmilk powder used for standardization was manufactured by the spray-drying system and had the following chemical composition which compares closely with analyses reported by Hunziker, [3] (1926):

Water	5.27 per cent
Butterfat	1.43 per cent
Protein	37.06 per cent
Milk sugar	48.27 per cent
Ash	7.97 per cent
Acidity	.15 per cent

After standardization, two per cent of starter and 14 c.c. of rennet per 100 pounds of milk were added. The regular procedure for making cheddar cheese was then followed with the methods in all four vats as nearly alike as possible.

All cheese was weighed and paraffined when four days old.

Each batch of cheese was scored for flavor, body and texture, and color at 6, 12 and 18 weeks of age.* Chemical analysis for fat, moisture, casein, ash, and calculated per cent of fat in dry matter was made of each batch of cheese at six weeks of age. The storage temperature was maintained between 50 and 60 degrees Fahrenheit.

Two deviations from the normal manufacturing procedure experienced were: first, the time necessary for coagulation was decreased very slightly when large amounts of powder were used, due to the acidity in the skimmilk powder; and, second, the acidity of the whey at the time of milling increased with the increase in the amount of skimmilk powder used.

Method of Chemical Analysis

The method used in making the chemical analyses was that recommended by the A.O.A.C. with the following modifications:

Fat was extracted from one gram of cheese by ether for 48 hours, after which time the ether was evaporated off and the ether flasks put in an oven at 100 degrees Centigrade for one hour to dry. The flasks were then removed, cooled to room temperature and weighed.

Casein was calcuated from the nitrogen by using the factor 6.38. The nitrogen was determined by the Kjeldahl method, using two grams of cheese.

Ash determination was made by exposing a two-gram sample in a porcelain dish to a temperature of 750 degrees Centigrade for six hours.

Moisture was determined by drying to constant weight two grams of cheese in a porcelain dish at a temperature of 50 degrees Centigrade under 12 inches of vacuum. The samples were weighed each day until the weight was constant, which usually required five days.

*The score card approved by the Western Division of the American Dairy Science Association was used. This score card does not permit any criticism of flavor when the score is 37 or above.

Cost of Production

The main reason for the practice of standardizing milk for the manufacture of cheddar cheese has been to lower the cost of producing one pound of cheese. The use of skimmilk powder as a standardizing medium reduces the cost of raw materials per pound of finished cheese and thus lowers the cost of producing or manufacturing one pound of finished cheese as shown in Table I.

TABLE I

Cost of Production.
(Average of All Cheese)

No. of Batches	Ratio fat to solids - not-fat	Butterfat (lbs.)	Butterfat (@ 50c per lb.)	Skimmilk Powder Used (lbs.)	Cost of Skimmilk Powder (@ 10c per lb.)	Total Cost Standardized Milk (150 lbs.	Yield of Cheese (150 lbs. milk)	Cost of Raw Material per lb. of Cheese	Return per lb. of Powder Used (Cheese at 20c per lb.)
	(Check)								
14	1:2.38	5.43	$2.71	.....	.....	$2.71	13.40	20.2c	.....
14	1:2.6	5.43	$2.71	1.64	$.16	$2.87	14.66	19.5c	15.3c
14	1:2.8	5.43	$2.71	2.65	$.26	$2.97	15.38	19.3c	14.9c
14	1:3.0	5.43	$2.71	3.72	$.37	$3.08	16.77	18.4c	18.1c
42	Ave. for stndrzd. milk	5.43	$2.71	2.67	$.26	$2.98	15.60	19.1c	16.5c

The cost of raw materials per pound of finished cheese was 20.2 cents for all check batches (made from unstandardized milk) while the average for all cheese made from standardized milk was 19.1 cents with an average range from 19.5 cents to 18.4 cents for the different ratios of fat to solids-not-fat.

When the cheese was valued at 20 cents per pound, the average return per pound of skimmilk powder used was 16.5 cents. For each cent increase in the value of cheese above 20 cents there is an additional one-cent return per pound of skimmilk powder used. Thus, the average return per pound of skimmilk powder would be approximately 21 cents if the cheese were valued at 25 cents per pound.

Another economic advantage which cannot be easily evaluated is that in standardizing milk with skimmilk powder all butterfat purchased at while milk prices is sold in the form of cheese at cheese prices. This is not true if the milk is standardized with liquid skimmilk since a portion of the whole milk must be separated to obtain skimmilk for standardization purposes. The butterfat in the cream is sold at cream prices, whereas this butterfat was purchased at whole milk prices.

Chemical Composition of the Cheese

Since skimmilk powder proved profitable for standardizing milk for the manufacture of cheddar cheese from the standpoint of both the cost of raw materials and returns per pound of powder used, the next consideration is whether the resulting cheese meets legal requirements. Table II shows the chemical composition of the cheese. Milk with the fat and solids-

TABLE II

Chemical Composition of Cheese Made From Standardized Milk
(Average of All Cheese)

No. of Batches	Ratio fat to solids--not-fat (Check)	Lbs. of Milk	Lbs. of Fat	Lbs. Skimmilk Powder added per 150 lbs. milk	Chemical Analysis of Cheese				Fat in Dry Matter (per cent)
					Moisture (per cent)	Fat (per cent)	Casein (per cent)	Ash (per cent)	
14	1:2.38	150	5.43	.....	37.25	35.91	23.19	3.61	57.22
14	1:2.6	150	5.43	1.64	38.84	33.21	24.19	3.75	54.29
14	1:2.8	150	5.43	2.65	39.44	31.82	24.99	3.69	52.54
14	1:3.0	150	5.43	3.72	40.96	29.36	25.82	2.90	49.73

Note: Analysis made at 6 weeks of age.

not-fat standardized to ratios of 1:2.6 and 1:2.8 produced cheese fulfilling the legal requirements for percentage of fat in the dry matter. However, a ratio of 1:3.0 resulted in cheese which in ten batches out of fourteen fell slightly below the Federal requirement for percentage of fat in the dry matter. Therefore the use of the ratio of 1:3.0 is not recommended

With the increase in the amount of skimmilk powder used, there was a corresponding increase in the moisture content. In the ratio of 1:2.8 seven out of fourteen batches and in the ratio of 1:3.0 fourteen out of fourteen batches exceeded the maximum legal limit of 39 per cent moisture permitted by some states.

Casein is recognized as the water holder in cheese. Therefore, as more casein was added to the milk in the form of skimmilk powder during the standardization process, the moisture content of the resulting cheese was higher. Table I shows that as the amount of skimmilk powder used increased there was an increase in yield of cheese. This increase in yield can be partially accounted for in the increase in the moisture and casein content of the cheese as shown in Table II.

Quality of Cheese

Cheese to be marketable must not only fulfill legal requirements, but also have sufficient quality to satisfy the consumer. Quality is indicated primarily by its flavor, and body and tex-

ture score. Table III shows that there is little or no difference in the average flavor scores of the cheese at six and twelve weeks of age when cheese from the check batches is compared with cheese made from standardized milk. The same is true of the scores for body and texture, and total scores. However, at eighteen weeks the check cheese was very slightly higher in the average score for flavor and total score than the cheese from the standardized milk. This advantage in score of the check cheese was not uniform for it occurred in only six out of fourteen batches. These results indicate that standardization of milk with skimmilk powder has no appreciable influence upon the quality of the finished cheese.

TABLE III

Flavor, Body and Texture, and Total Scores of Cheese at Six, Twelve, and Eighteen Weeks of Age
(Average of All Cheese)

	Check	Ratio Fat to Solids-not-fat		
		1:2.6	1:2.8	1:3.0
No. of Batches	14	14	14	14
Flavor at 6 Weeks	35.71	35.46	35.71	35.75
Body and Texture at 6 Weeks	29.16	29.16	29.21	29.02
Total Score at 6 Weeks	89.62	89.66	89.92	89.73
Flavor at 12 Weeks	36.03	35.67	36.10	35.96
Body and Texture at 12 Weeks	29.26	29.17	29.21	29.19
Total Score at 12 Weeks	90.19	90.21	90.39	90.13
Flavor at 18 Weeks	36.07	35.64	35.71	35.46
Body and Texture at 18 Weeks	29.37	29.48	29.46	29.38
Total Score at 18 Weeks	90.34	89.73	89.68	89.55

An analysis of the flavor criticisms of the cheese at different ages showed that the check cheese and standardized cheese at 6, 12, and 18 weeks of age had approximately the same flavor criticisms. At 18 weeks two cheeses in the 1:3.0 ratio in which a relatively large amount of skimmilk powder was used, due to the higher fat content in the milk, showed a slight powdered milk flavor which was classed as foreign when scored.

The body and texture criticism for both the check cheese and the standardized cheese were practically identical in type and frequency at all ages except that there was a slight increase in the occurrence of the criticism mealy as the amount of skimmilk powder used was increased.

Fat Loss and Yield of Cheese

Butterfat loss in whey is a very important factor influencing the yield of cheese. Since one function of casein is to

hold the fat globules in the curd, and milk standardized with skimmilk powder contains more casein than normal milk, the amount of fat lost in the whey might be expected to be decreased due to the presence of the larger amount of casein. That this is true is shown by Table IV. The average fat losses in the whey varied from 0.261 per cent in the check batches to 0.217 per cent in the 1:3.0 ratio of fat to solids-not-fat. The reduced loss of fat in the whey of standardized milk was quite uniform. In only eight out of forty-two instances did the fat loss in standardized milk exceed the loss of fat in the unstandardized milk. Therefore, with the increase in the amount of skimmilk powder used there is usually a decrease in the loss of butterfat in whey.

TABLE IV

Average Fat Loss and Yield of Cheese per 100 Pounds of Milk, Per Pound of Butterfat and Per Pound of Solids-not-fat

	Check	Ratio Fat to Solids-not-fat		
		1:2.6	1:2.8	1:3.0
No. of Batches	14	14	14	14
Average fat losses	.26%	.26	.23	.22
Ave. yield per 100 lbs. of milk .	8.93lb	9.77	10.25	11.18
Ave. yield per lb. of butterfat .	2.51lb	2.74	2.90	3.08
Ave. yield per lb. of solids-not-fat	1.03lb	1.03	1.01	1.03

The yield of cheese per 100 pounds of milk and per pound of fat increased as the amount of skimmilk powder used was increased. The yield of cheese per pound of solids-not-fat was quite constant in all the ratios of fat to solids-not-fat. Solids-not-fat obtained in the form of cheese were equal to those in the milk from which the cheese was made. This was true regardless of the amount of solids-not-fat added in the form of skimmilk powder, indicating that the solids-not-fat supplied by the skimmilk powder were as efficient for cheese production as the solids-not-fat in the original check batch of normal milk. Thus, the increased yield of cheese due to the addition of skimmilk powder may be attributed to the efficiency of the solids-not-fat of the skimmilk powder for cheese production and to the reduced loss of fat in whey due to greater casein content of the standardized milk.

Comparison of Two Methods of Adding Skimmilk Powder

Skimmilk powder was added to the milk by two methods. In the first method, the dry powder was placed in a metal strainer and milk run over it at a temperature of from 50 to 60 degrees Fahrenheit. If the temperature of the milk exceed-

ed 65 degrees Fahrenheit the skimmilk powder tended to gum and did not dissolve readily.

In the second method one pound of skimmilk powder was dissolved in four pounds of cold water, 50 to 55 degrees Fahrenheit, thus making a 20 per cent solution. This solution was added directly to the milk when standardizing. Caution should be observed when dissolving skimmilk powder that only clean pure water be used and that the solution is not kept over 24 hours and then only in cold storage. These precautions are necessary in order to reduce chances of contamination and to prevent the souring of the solution.

For each method the milk was split into four batches. One batch was used as a check and the remaining three were standardized to ratios of fat to solids-not-fat of 1:2.6, 1:2.8, and 1:3.0 respectively. The milk used for comparing the two methods was not split batches. Therefore, since identical milk was not used for each method the comparisons are limited

Influence on Quality

The flavor, body and texture, and total scores of cheese made from milk standardized by the two methods are shown in Table V. At six weeks of age there was practically no

TABLE V

Effect of Two Methods of Adding Skimmilk Powder on The Quality of Finished Cheese

		Dry Skimmilk Powder								
	No. Batches	Score at 6 Weeks			Score at 12 Weeks			Score at 18 Weeks		
		Flavor	Body & Texture	Total	Flavor	Body & Texture	Total	Flavor	Body & Texture	Total
Check	9	35.88	29.13	89.69	36.11	29.19	90.19	36.28	29.42	90.25
1:2.6	9	35.61	29.25	89.80	35.77	29.11	89.89	35.83	29.50	89.86
1:2.8	9	35.72	29.25	89.97	35.94	29.27	90.11	35.61	29.50	89.44
1:3.0	9	35.72	28.97	89.69	35.83	29.19	89.97	35.39	29.33	89.25
		20 Per Cent Water Solution								
Check	5	35.40	29.20	89.50	35.80	29.40	90.10	35.60	29.40	90.00
1:2.6	5	35.20	29.00	89.30	36.40	29.40	90.80	35.30	29.30	89.50
1:2.8	5	35.70	29.15	89.85	36.40	29.40	90.80	36.00	29.40	90.30
1:3.0	5	35.60	29.10	89.80	36.30	29.20	90.40	35.60	29.50	90.00

difference between the cheese resulting from the two methods of adding skimmilk powder. Although at 12 and 18 weeks of age the cheese from the milk standardized by the water solution method to 1:2.8 and 1:3.0 was uniformly slightly higher in flavor score and total score, nevertheless, in general, the difference in quality of the cheese made from the two methods of standardization was so slight that no distinct

advantage could be attributed to either method of adding skimmilk powder.

Influence on Chemical Composition

The chemical analyses of the cheese made from the two methods of adding skimmilk powder are presented in Table VI.

No difference in chemical composition was found in the cheese made from milk standardized by the two methods that cannot be directly attributed to the difference of the original unstandardized milk.

TABLE VI

Chemical Composition of Cheese Made from Milk Standardized With Dry Skimmilk Powder and With a 20 Per Cent Solution of Skimmilk Powder

(Average of All Cheese)

Ratio Fat to Solids not fat	Dry Milk Powder					20 Per Cent Milk Powder Solution				
	No. Batches	Moisture Per cent	Fat Per cent	Casein Per cent	Ash Per cent	No. Batches	Moisture Per cent	Fat Per cent	Casein Per cent	Ash %
Check	9	37.24	36.45	22.73	3.57	5	37.27	34.97	20.04	3.69
1:2.6	9	39.38	33.06	23.88	3.65	5	37.85	33.88	24.74	3.91
1:2.8	9	39.48	31.88	24.94	3.69	5	39.47	31.72	25.11	3.68
1:3.0	9	41.54	28.78	25.70	3.96	5	39.52	30.41	26.05	3.69

The advantage of the 20 per cent water solution method is that less time is required to dissolve the skimmilk powder.

Comparison of Low Test and High Test Milk for Cheese Making

The yield of cheese is chiefly dependent upon the fat and casein content of milk. If fat and casein were always found in milk in the same relative proportions, the yield of cheese would increase proportionately with the increase in milk fat. However, high test milk usually contains less casein in proportion to fat than does low test milk. Therefore, the yield of cheese per pound of fat does not increase proportionately with increase of the fat content of milk. Although the yield of cheese is greater from high test milk, the yield per pound of fat is less and the cost of production greater. For this reason high test milk is discriminated against, or is standardized to a lower fat content. Veale [7] (1928) of New Zealand claims that the use of milk containing more than four per cent butterfat for the manufacture of cheese results in an economic waste of butterfat.

In Table VII are given the flavor, body and texture, and total scores of cheese made from low test and from high test milk, and also the same scores for cheese made from low test and high test standardized milk.

A comparison of three cheeses made from low test milk containing 3.0, 3.2 and 3.3 per cent of fat, respectively, with three cheeses made from high test milk containing 3.9, 4.0, and 4.2 per cent of fat, respectively, showed no distinguishable difference in quality as measured by the flavor, body and texture, and total scores.

When the same milk in each instance was split into duplicate batches and standardized to ratios of fat to solids-not-fat of 1:2.6, 1:2.8, and 1:3.0, respectively, by the addition of skimmilk powder, no distinguishable difference in quality was found.

TABLE VII

Comparison of Flavor, Body and Texture and Total Scores Of Cheese Made from Low Test and High Test Milk

Ratio of Fat to Solids not.fat	Pct. Butterfat in Milk	Scores at 6 Weeks			Scores at 12 Weeks			Scores at 18 Weeks		
		Flavor	Body & Texture	Total Score	Flavor	Body & Texture	Total Score	Flavor	Body & Texture	Total Score
Check	3.0	35.5	29.5	90.0	36.5	29.0	90.5	37.5	29.5	92.0
1:2.8	3.0	36.0	29.0	90.0	37.0	29.5	91.5	37.5	29.5	92.0
1:2.9	3.0	36.0	29.25	90.25	36.5	29.5	91.0	37.0	29.5	91.5
1:3.0	3.0	36.0	29.5	90.5	36.0	29.5	90.5	36.5	29.5	91.0
Check	3.2	36.0	29.5	90.5	36.5	29.5	91.0	36.5	29.5	91.0
1:2.6	3.2	35.5	29.0	90.0	36.5	29.5	91.0	35.5	29.5	89.5
1:2.8	3.2	36.5	29.25	90.75	36.5	29.5	91.0	36.0	29.5	90.5
1:3.0	3.2	36.5	29.0	90.5	37.0	29.5	91.5	35.5	29.5	90.0
Check	3.3	36.0	29.0	90.0	36.0	29.5	90.5	35.5	29.5	90.0
1:2.6	3.3	35.5	29.25	89.75	36.0	29.5	90.5	36.0	29.5	90.0
1:2.8	3.3	36.0	29.25	90.25	36.5	29.5	91.0	36.0	29.5	90.5
1:3.0	3.3	36.0	29.25	90.25	35.5	29.5	90.0	36.0	29.5	90.5
Check	3.9	35.0	29.5	89.5	35.5	29.5	90.0	36.0	29.5	90.5
1:2.6	3.9	35.0	28.5	88.5	35.0	29.5	89.5	35.5	29.5	89.0
1:2.8	3.9	35.5	29.5	90.0	36.0	29.0	90.0	36.0	29.5	90.0
1:3.0	3.9	36.0	28.0	89.0	36.5	29.0	90.5	36.5	29.0	90.0
Check	4.0	36.5	29.5	91.0	36.5	29.25	90.75	36.5	29.0	90.5
1:2.6	4.0	35.5	29.5	89.5	36.0	29.0	90.0	36.0	29.5	90.0
1:2.8	4.0	36.0	29.0	90.0	36.0	29.0	89.5	35.5	29.5	89.0
1:3.0	4.0	35.5	29.5	89.5	35.5	29.0	89.0	34.0	29.0	88.0
Check	4.2	36.5	29.0	90.5	36.0	29.0	90.0	37.5	29.5	92.0
1:2.6	4.2	36.0	29.5	90.5	36.0	29.0	90.0	36.5	29.5	90.5
1:2.8	4.2	35.5	29.5	90.0	36.0	29.0	90.0	36.0	29.5	90.0
1:3.0	4.2	35.5	29.5	90.0	36.0	29.25	90.25	36.5	29.25	90.25

Table VIII shows the chemical composition at six weeks of age of cheese made from low test and from high test milk and of cheese made from the same milk standardized. The chemical analyses show that cheese made from low test milk contains more moisture, more casein, and less fat than cheese

from high test milk. However, there is no important difference in moisture, fat, or casein content between cheese made from standardized high test milk and cheese made from standardized low test milk when standardized with skimmilk powder.

Table VIII also shows that the difference in yield of cheese per pound of butterfat between high and low test milk is practically eliminated when the milk is standardized with skimmilk powder.

When high test milk is standardized with skimmilk powder, the resulting cheese is the same in quality and composition as cheese made from low test milk and is practically

TABLE VIII

Chemical Composition of Cheese At Six Weeks of Age Made From Low Test and High Test Milk

Ratio Fat to Solids-not-fat	Per cent Butterfat in Milk	Lbs. Skimmilk Powder added	Lbs. Cheese per Lb. of Butterfat	Per cent Fat Lost in Whey	Chemical Analysis				Per cent Fat in Dry Matter
					Per cent Moisture	Per cent Butterfat	Per cent Casein	Per cent Ash	
Check	3.0	.....	2.91	.20	40.55	31.06	25.02	3.35	52.24
1:2.8	3.0	.04	2.97	.18	39.35	30.71	26.37	3.57	50.63
1:2.9	3.0	.05	3.05	.18	40.26	30.01	26.39	3.32	50.23
1:3.0	3.0	.94	3.22	.14	40.30	29.49	26.93	3.26	49.39
Check	3.2	.....	2.66	.22	37.97	33.47	25.60	2.95	53.79
1:2.6	3.2	.05	2.66	.24	37.63	32.30	25.95	4.05	51.86
1:2.8	3.2	.52	2.79	.24	38.37	32.18	26.05	3.39	25.23
1:3.0	3.2	1.49	3.02	.20	39.14	30.55	27.00	3.30	50.19
Check	3.3	.....	2.65	.20	40.30	33.22	22.90	3.56	55.64
1:2.6	3.3	.55	2.85	.24	39.35	32.84	24.29	3.49	54.11
1:2.8	3.3	1.55	2.95	.22	39.17	32.33	25.27	3.22	53.14
1:3.0	3.3	2.54	3.00	.20	40.82	28.87	26.61	3.68	48.78
Check	3.9	.....	2.43	.28	39.00	35.37	22.37	2.86	57.98
1:2.6	3.9	2.64	2.70	.28	39.80	33.38	23.90	2.89	55.44
1:2.8	3.9	3.81	2.78	.26	41.05	31.36	24.89	2.68	53.59
1:3.0	3.9	4.98	2.87	.29	40.49	29.71	25.67	4.10	49.42
Check	4.0	.....	2.33	.38	36.75	37.84	22.08	3.30	59.82
1:2.6	4.0	3.00	2.69	.30	38.55	34.75	22.98	3.70	56.55
1:2.8	4.0	4.20	2.85	.32	39.06	32.83	24.60	3.51	53.87
1:3.0	4.0	5.40	3.04	.30	42.07	29.54	25.72	2.64	50.99
Check	4.2	.....	2.34	.32	37.50	37.57	21.89	3.08	60.11
1:2.6	4.2	3.64	2.72	.24	41.13	32.15	23.81	2.88	54.61
1:2.8	4.2	4.90	2.82	.28	38.13	33.78	24.49	3.59	54.69
1:3.0	4.2	6.16	2.92	.26	42.27	28.82	25.23	3.66	49.83

equal in yield per pound of butterfat. Therefore, high test milk need not be discriminated against when used for the manufacture of cheddar cheese as it is possible to standardize the milk by the addition of skimmilk powder.

Summary and Conclusions

Cheddar cheese was successfully manufactured from milk to which skimmilk powder had been added.

The milk was split into four batches consisting of a check batch and three batches standardized by the addition of skimmilk powder to ratios of fat to solids-not-fat of 1:2.6, 1:2.8, and 1:3.0 respectively.

When cheese was valued at 20 cents per pound, the average return per pound of skimmilk powder used was 16.5 cents. The return per pound of skimmilk powder used increases approximately one cent with each one cent increase in the selling price of the cheese.

Cheese meeting the legal requirements for fat in the dry matter was produced from the milk standardized to ratios of 1:2.6 and 1:2.8, fat to solids-not-fat. When a ratio of 1:3.0 was used the resulting cheese often exceeded the legal standard for moisture and was slightly below the minimum requirements for fat in the dry matter.

Skimmilk powder added to milk had no distinguishable effect upon the quality of the finished cheese as measured by flavor, body and texture, and total scores.

Loss of fat in the whey was decreased with the increase in the amount of skimmilk powder used.

Yield of cheese per pound of fat and per 100 pounds of milk increased with increase in amount of skimmilk powder used.

Solids-not-fat added as skimmilk powder proved just as efficient for cheese production as the solids-not-fat in normal milk.

Increase in yield of cheese from standardized milk was due to the efficiency of the solids-not-fat in the skimmilk powder for cheese making and to the higher moisture content and decreased fat loss in whey; both caused by the increased casein content of the milk.

Skimmilk powder may be added to the milk either as a 20 per cent solution of cold water or by placing the powder in a metal strainer and pouring milk at 50 to 60 degrees Fahrenheit over it.

When high test milk is standardized with skimmilk powder, the resulting cheese is the same in quality and composition as cheese made from low test milk and is practically equal in yield per pound of butterfat. Therefore, high test milk need not be discriminated against when used for the manufacture of cheddar cheese as it is possible to standardize the milk by the addition of skimmilk powder.

Skimmilk powder yielded profitable returns in the manufacture of cheddar cheese when used for standardizing the solids-not-fat to fat in milk; resulted in good quality cheese of legal composition; eliminated the necessity of skimming part of the milk to reduce the butterfat test in order to get the maximum yield per pound of fat; and made possible the sale of all butterfat at cheese prices when purchased at whole milk prices instead of selling part of it as cream.

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