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The Effect of Various Levels of Solids Not Fat on the Flavor Acceptability of Fluid Milk

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Processors of market milk have long been concerned over the flat watery flavor of fluid milk in the spring. Sales records show that consumption of milk drops sharply during this season and analyses show a low percent of solids not fat. Herman (3) stated that during certain months, approximately 50 percent of the samples of milk analysed from the herd at the University of Missouri were substandard in solids not fat for some city codes. Roadhouse and Henderson (7) concluded that taste scores of milk followed the trend of the lactose content, the taste score lowering and rising as lactose decreased and increased.

Roadhouse and Koestler (6) stated that the chloride-lactose relation was one of the most important factors affecting milk taste and that the primary taste of skim milk was practically equal to that of the whole milk from which it was separated. By the application of dialysis it was possible to separate milk into two parts (dialyzate and residue) with extreme difference in taste. It was found that nearly all of the milk components producing the primary taste were present in the dialyzate while the components remaining in the residue could be designated as free from taste. By dialysis it was further demonstrated that fat and protein substances as well as certain difficulty dialyzable salts, all of which go to make up a large percentage of the milk content, play only a subordinate part in the primary taste of milk.

MacCurdy and Trout (4) in flavor tests to determine the effect of vat and flash pasteurization generally placed "flat" flavored milk in third place of importance after "cooked" and "feed." Flat flavor in milk usually indicates low solids or added water. Davis et al. (1) state that the percentage of samples falling below the minimum requirements of Arizona for solids not fat were 47.5% for Holstein, 2.2% for Guernsey, and 2.5% for Jersey. Also Davis et al. (2) state that solids not fat content of milk from Holstein cows studied averaged below 8.5% during the spring and summer months.

In the past much emphasis has been placed on the butterfat and most milk plants standardize to a predetermined fat content in various products. Some work has been done on the addition of solids not fat to fortify fluid milk but little work has been done on double standardization for the fluid milk market. The addition of nonfat milk solids will increase the food value of the product by supplying additional increments of essential proteins, lactose, and minerals. Since the consuming public is becoming more protein conscious, these additional solids not fat should meet with favor. If the flavor can also be improved the product should receive greater consumer acceptance, thereby increasing consumption of milk and nonfat milk solids now in surplus.

Various levels of fat and solids not fat in fluid milk were prepared and examined for flavor acceptability by a trained panel. Nelson and Trout (5) concluded that experienced judges were capable of passing upon consumer acceptance. Since definite quality standards have been established for dairy products acceptable to the consuming public a few experienced judges can replace large inexperienced panels and still provide reliable results. In order to speed up the elimination of the least acceptable combinations, two trained judges were used.

The study was divided into four main parts:

Part I. The Effect of Adding 1% and 2% Nonfat Dry Milk Powder to 4% Milk.

Part II. The Effect of Various Levels

of Solids Not Fat on the Flavor Acceptability of Milk at Various Butterfat Percentages.

Part III. A Comparison of the Flavor Acceptability of Double Standardized Milk Pasteurized by the Vat and H.T.S.T. Methods.

Part IV. A Comparison of Certain Combinations of Double Standardized Fluid Milk.

Experimental Procedure and Results

Milk used in this study was mixed milk from the Mississippi State University herd consisting of Ayrshire, Brown Swiss, Guernsey, Holstein, and Jersey cows and was handled through a glass pipeline milker. The milk was cooled over a surface cooler to 40° F. and flowed by gravity into a 500 gallon stainless steel trailer tank. It was delivered to the University dairy products plant daily. Grade "A" low heat nonfat milk solids of clean flavor and high solubility were used to fortify the milk to various percents of solids not fat.

Since most milk marketed as fluid milk in Mississippi contains around 4% butterfat, this level was selected for the initial study. Pasteurized homogenized milk containing 4% butterfat was compared with the same milk fortified with one and two percent solids not fat.

Part I. The Effect of Adding 1% and 2% Nonfat Dry Milk Powder to 4% Milk: Thirty gallons of mixed milk were standardized to 4% butterfat and divided into three lots of ten gallons each. One lot was used as a control; the second lot was fortified with 1.0% solids not fat, and the third lot was fortified with 2.0% solids not fat. The nonfat dry milk solids were added to each lot by mixing the powder with a small amount of the same milk in a Waring blender, then adding to the remainder of the lot. All samples were tested for fat by the Babcock method and for total solids by the Mojonnier method.

Each lot was pasteurized in a stainless steel 50-gallon pasteurizer at 145° F. for 30 minutes, homogenized at 2200 p.s.i., and cooled over a surface cooler to 40° F. The samples were coded and judged by two trained dairy products judges. These judges placed the samples in order of acceptability. Seventy-five comparisons were made.

The results in table 1 indicate that milk fortified with 1.0% solids not fat was selected as most acceptable 38 times and least acceptable 8 times. The 2.0% sample was placed first 14 times and last 46 times. In general the 2.0% level was criticized as being too sweet. This phase of the study indicated that the addition of one percent solids not fat improved the flavor acceptability of 4% fluid milk.

Table 1. Effect of varying the level of solids not fat in 4.0% milk.

Percent S.N.F.*	Percent S.N.F. added	Placings in 75 comparisons**		
		1st	2nd	3rd
9.07	0	23	31	21
10.06	1.0	38	29	8
11.09	2.0	14	15	46

*Average of 5 replications.
**Samples examined twice daily for six days.

Part II. The Effect of Various Levels of Solids Not Fat on the Flavor Acceptability of Milk at Various Butterfat Percentages: Fat levels of 3.0%, 3.5%, and 4.0% were used while the solids not fat content was varied from 9.0% through 11.0% in increments of 0.5%. A control sample in which only the butterfat was standardized to 4.0% was used in each series of flavor comparisons. The solids not fat content of the control sample varied from 8.89% to 9.02%. Milk testing less than 3.0% was not studied since in most sections of this country milk below that percent is classified as skim milk.

Three replications were made at each fat level wherein the solids not fat varied from 9.0% to 11.0%. The usual system of processing and scoring was followed and the samples were placed in order of desirability.

The results of 36 trials at the 3.0% fat level are shown in table 2-A. Milk containing 3.0% butterfat and fortified to 10.0% solids not fat content placed first in flavor acceptabiilty 19 times

and in no comparison was selected least acceptable. Three percent milk standardized to 9.0% solids not fat ranked last in 22 of the 36 trials and in no trial was given a first place. The control sample testing 4% fat was not placed first in any trial and was considered least acceptable 9 times.

Table 2-B shows the effect of varying the solids not fat at the 3.5% butterfat level. At this fat percent, milk standardized to 9.5% serum solids was selected most acceptable 14 times while the same milk with 10% solids not fat was judged best 10 times in 36 comparisons. The samples containing 9.0% and 11.0% solids not fat and the control samples were each found to be least acceptable 12 times.

Table 2-C records the effect of varying the solids not fat at the 4.0% butterfat level. Fluid milk containing 4% butterfat and standardized to 9.5% solids not fat was most acceptable to the judges 19 times in 36 comparisons. Milk standardized to 9.0% solids not fat was selected least desirable 10 times while the same milk containing 11.0% solids not fat was judged last in 13 of the 36 trials.

The results of this study showed that:

(1) Milk testing 3.0% fat was most acceptable when double standardized to 10% solids not fat.

(2) Milk testing 3.5% fat was most acceptable when double standardized to 9.5% solids not fat; and

(3) Milk testing 4.0% fat was most acceptable when double standardized to 9.5% solids not fat.

Table 2-A. Effect of varying the solids not fat level on the flavor acceptability of 3.0% butterfat fluid milk.

Percent S.N.F.*	Placings in 36 trials					
	1st	2nd	3rd	4th	5th	6th
9.01	0	0	1	2	11	22
9.49	4	7	9	9	5	2
10.02	19	9	4	3	1	0
10.51	5	11	12	5	3	0
10.98	8	5	7	10	3	3
Control 9.01**	0	4	3	7	13	9

*Average of 3 replications.
**4.0% butterfat and an average of 9.01% solids not fat.

Table 2-B. Effect of varying the solids not fat level on the flavor acceptability of 3.5% butterfat fluid milk.

Percent S.N.F.*	Placings in 36 trials					
	1st	2nd	3rd	4th	5th	6th
8.97	1	2	6	9	6	12
9.46	14	10	6	3	3	0
9.97	10	13	5	6	2	0
10.47	6	6	11	4	8	1
10.99	2	4	2	7	9	12
Control**	3	2	5	7	7	12

*Average of 3 replications.
**Contained 4.0% butterfat and an average of 9.01% solids not fat.

Table 2-C. Effect of varying the solids not fat level on the flavor acceptability of 4.0% butterfat fluid milk.

Percent S.N.F.*	Placings in 36 trials					
	1st	2nd	3rd	4th	5th	6th
9.04	3	3	8	6	6	10
9.52	19	8	1	3	5	0
10.01	6	11	8	4	5	2
10.51	4	6	5	8	8	5
11.00	1	1	5	7	9	13
Control**	3	7	9	8	3	6

*Average of 3 replications.
**Contained 4.0% butterfat and an average of 8.99% solids not fat.

Part III. A Comparison of the Flavor Acceptability of Double Standardized Milk Pasteurized by the Vat and H.T.S.T. Methods: Eighty gallons of milk from the State University herd were adjusted to 3.0%, 3.5%, and 4.0% butterfat and 9.0% solids not fat. The milk was then divided into four lots. Lots 1 and 2 were fortified to 9.5% or 10.0% solids not fat depending upon the fat content while lots 3 and 4 with 9.0% solids not fat were used as the controls. After double standardization lots 1 and 3 were pasteurized by the vat method at 145° F. for 30 minutes, homogenized and cooled. Lots 2 and 4 were pasteurized by the H.T.S.T. method at 165° F. for 16 seconds, homogenized and cooled.

The results of 24 comparisons are recorded in tables 3-A, 3-B, and 3-C. Table 3-A shows the comparison at the 3.0% butterfat level. The sample which was double standardized to 3.0% butterfat and 10% solids not fat and pasteurized by the H.T.S.T. method was selected most desirable 17 times. In no comparison was it least desirable. The same milk pasteurized by the vat method was selected most desirable only 7 times and least desirable zero times.

Table 3-B shows that the milk double standardized to 3.5% butterfat and 9.5% solids not fat and pasteurized by the H.T.S.T. method was classed as most acceptable 15 times and least acceptable zero times. The same milk pasteurized by the vat method was selected most desirable 6 times and least desirable 3 times.

Table 3-C on the 4.0% butterfat level shows that milk double standardized to 4.0% fat, 9.5% solids not fat, and pasteurized by the H.T.S.T. method was chosen as being most desirable 13 times and least desirable 2 times. The same milk pasteurized by the vat method was selected most desirable 7 times and least desirable zero times.

At each of these levels milk double standardized to the 9.0% solids not fat level and pasteurized by the H.T.S.T. method was least acceptable and was placed last 43 times in the 72 comparisons. Vat pasteurized milk double standardized to the 9.0% solids not fat level was scored least desirable in 24 of the 72 comparisons.

The milk that was pasteurized by the H.T.S.T. method, to which the largest increments of solids not fat were added was judged most desirable at all fat levels. Therefore the data presented in this study indicate that greater benefits were derived from the use of additional solids not fat when milk was H.T.S.T. pasteurized than when the

Table 3-A. A comparison of flavor acceptability of milk pasteurized by the H.T.S.T. and vat methods having 3.0% butterfat and 9% solids not fat and 3.0% fat and 10% solids not fat.

Pasteurization method employed	Percent B.F.	Percent S.N.F.	Placings in 24 comparisons			
			1st	2nd	3rd	4th
H.T.S.T.	3.0	8.98	0	1	7	16
H.T.S.T.	3.0	10.03	17	5	2	0
Vat	3.0	8.98	0	8	8	8
Vat	3.0	10.03	7	10	7	0

Table 3-B. A comparison of flavor acceptability of milk pasteurized by the H.T.S.T. and vat methods having 3.5% butterfat and 9.0% solids not fat and 3.5% fat and 9.5% solids not fat.

Pasteurization method employed	Percent B.F.	Percent S.N.F.	Placings in 24 comparisons			
			1st	2nd	3rd	4th
H.T.S.T.	3.5	9.06	3	1	7	13
H.T.S.T.	3.5	9.52	15	9	0	0
Vat	3.5	9.06	0	6	10	8
Vat	3.5	9.52	6	8	7	3

Table 3-C. A comparison of flavor acceptability of milk pasteurized by the H.T.S.T. and vat methods having 4.0% butterfat and 9.0% solids not fat and 4.0% fat and 9.5% solids not fat.

Pasteurization method employed	Percent B.F.	Percent S.N.F.	Placings in 24 comparisons			
			1st	2nd	3rd	4th
H.T.S.T.	4.0	9.07	2	0	8	14
H.T.S.T.	4.0	9.54	13	8	1	2
Vat	4.0	9.07	2	5	9	8
Vat	4.0	9.54	7	11	6	0

same milk was pasteurized by the vat method.

Part IV. A Comparison of Certain Combinations of Double Standardized Fluid Milk: Based on the results obtained from Part II of this study three lots of mixed herd milk were double standardized to the most acceptable butterfat and solids not fat level while one lot was used as a control at 4.0% fat and 9.0% solids not fat. These four lots of milk were pasteurized by the H.T.S.T. method, homogenized, cooled to 40° F., coded and judged for flavor aceptability by the two judges.

Table 4 shows the results of 12 trials. Each sample was placed in order of flavor acceptability from 1st through 4th place. The milk double standardized to 3.0% fat and 10.0% solids not fat was selected most acceptable 10 times. The same level of milk was placed second 12 times and was scored third and fourth only two times out of a possible 24. The same milk double standardized to 4.0% fat and 9.5% solids not fat was placed first and second a total of 16 times while being placed third and fourth a total of 8 times. The control sample which was double standardized to 4.0% fat and 9.0% solids not fat was placed first 2 times while being judged least desirable in 16 of the 24 trials. These results indicate that milk double standardized to 3.0% fat and 10.0% solids not fat and 4.0% fat and 9.5% solids not fat were the most desirable combinations studied. All combinations of double standardized milk were judged to be more acceptable than the control.

Table 4. A comparison of the most acceptable levels of double standardized fluid milk.

Percent B.F.	Percent S.N.F.	Order of flavor acceptability in 24 comparisons			
		1st	2nd	3rd	4th
3.0	9.98	10	12	1	1
3.5	9.51	4	4	12	4
4.0	9.49	8	8	5	3
4.0	9.08	2	0	6	16

Discussion

Market milk from the Mississippi State University dairy herd containing no added solids not fat is less acceptable than milk fortified with nonfat dry milk to prescribed levels. Milk fortified above the 10% solids not fat level is objectionable and usually criticized as being too sweet. The taste panel indicated that a decrease in fat content can be offset by the addition of solids not fat.

The controlled addition of solids not fat in the form of Grade "A" low heat powder of excellent quality did not impart any objectionable cooked or other off flavor. It had no adverse affect on the keeping quality of the milk as far as flavor acceptability was concerned.

The total solids content of fluid milk may be determined by use of a Cenco moisture balance in less time than is required to determine the butterfat by the Babcock method. Double standardization can then be practiced with little additional time involved.

The authors are fully aware that, at present, the addition of solids not fat is prohibited by law unless labeled as such and are in no way suggesting or recommending that dairy plants violate this regulation. This study simply points to the desirability of double standardization to improve the nutritional value, uniformity of flavor and acceptability of market milk.

Summary and Conclusions

Processors of market milk have long been concerned over the flat, watery flavor of fluid milk in the spring. No doubt this is a factor in the drop in milk consumption during this season. Analyses show a lower percent of solids not fat at this time. Since it is known that solids not fat play an important role in the flavor acceptability of market milk this work was initiated to study the effect of varying both the fat and solids not fat content. The study was designed to determine the desirability of double standardization

in developing a more uniform product from day to day. By the addition of clean flavored solids not fat the milk studied was improved in flavor acceptability.

As an exploratory investigation to determine the effect of fortifying with solids not fat, milk containing 4% fat was fortified with 0%, 1% and 2% solids not fat. The milk containing the 1% added solids not fat was the most acceptable to the judging panel. The addition of solids not fat above the 1% level was less acceptable and was criticized as being too sweet.

In order to evaluate the effect of fat and to reach the most acceptable level of solids not fat at each fat level, market milk samples containing 3.0%, 3.5%, and 4.0% fat were standardized from 9.0% through 11.0% solids not fat in increments of 0.5%. At the 3.0% fat level, milk containing 10.0% solids not fat was selected as the most acceptable. At the 3.5% level the sample containing 9.5% solids not fat was judged most acceptable, and at the 4.0% level and milk containing 9.5% solids not fat was placed first by the judging panel.

In the first phase of this study milk containing 1.0% added solids not fat was selected over milk containing 0% and milk containing 2% added solids. However, further investigation showed that the 1.0% added solids not fat level was less acceptable as the fat was increased and that at 3.5% and 4.0% fat levels a product containing 9.5% or approximately 0.5% fortified solids not fat was the most acceptable. At each fat level milk fortified to some degree with solids not fat was selected over a control sample containing no added solids not fat.

Since added solids not fat may have a tendency to produce a cooked flavor in milk a comparison was made of the vat method and H.T.S.T. method of pasteurization. Samples of the same market milk double standardized to the most acceptable levels were pasteurized by each method and scored by the judges. The milk pasteurized by the H.T.S.T. method was selected as most acceptable. Powder of clean flavor did not impart any cooked or other objectionable flavor to the finished product.

In order to determine the most acceptable level of double standardized milk, samples at each level were processed by the H.T.S.T. method and submitted to the judging panel. Milk containing 3.0% fat and 10% solids not fat, and 4.0% fat and 9.5% solids not fat were selected as the most acceptable levels. All combinations fortified to 10.0% or less solids not fat were more acceptable than the control sample containing no added solids not fat.

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