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TABLE OF CONTENTS

A STUDY OF THE COMPOSITION OF MILK PRODUCED IN DIFFERENT AREAS OF MISSISSIPPI

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The composition of milk is important in determining its commercial and nutritive value and is a factor that must be considered when milk is processed into various products. It is, therefore, of direct interest to the milk producer, the consumer, and the milk plant operator.

The composition of milk, especially the portion represented by butterfat, is directly related to the price of milk and milk products. The practice of paying for milk on the basis of its butterfat content is the most common procedure in the industry. Variations in butterfat content not only reflect on the price structure of milk, but this constituent, together with the total solids and solids-not-fat portion, is considered in the legal definition of commercially acceptable milk.

Many states and municipalities have established by law a minimum standard for these components in milk. Mississippi, for example, requires that legal milk contain at least 3.0 percent butterfat, 8.5 percent solids-not-fat, and 11.75 percent total solids. Thus, both the producer and milk plant operator are aware of the commercial importance of the composition of milk and are interested in the variations that occur in this milk characteristic.

The constituents present in milk are also closely associated with the nutritive value of this food. They are, in no small way, responsible for the important position that milk retains in our present American diet. The many fatty acids that are combined in buterfat are a good source of energy and, according to recent research, consist in part of some highly unsaturated fatty acids that are essential in normal nutritional needs. Milk fat also functions as a carrier of vitamin A and D.

The proteins in milk, which are casein, lactoalbumin, and lactoglobulin, are composed of many amino acids, including all those that are essential to proper growth and development. Lactose, or milk sugar, provides energy, plays an important role in calcium assimilation, and creates a mildly acid reaction in the intestinal tract. Milk used in recommended quantities also contains calcium and phosphorus in ample amounts for the development of bone and tooth structure and maintenance, especially for children. There are other valuable constituents present in lesser amounts in milk.

Of equal significance is the part the composition of milk plays in the processing of milk into various products. In cheesemaking, for example, the amount of butterfat and casein in milk determines the degree of standardization practiced during various seasons of the year and establishes the amount of cheese secured from a given quantity of milk. The percentage of these constituents present in milk largely affects the yield in evaporated and condensed milk. The ratio of calcium to phosphates and citric acid in milk, more commonly referred to as the salt balance, affects the heat stability of evaporated milk, determines the rate of rennet action in cheesemaking, and influences the moisture content of the finished cheese.

Defects such as feathering in coffee cream and coagulation of milk used in cooking are, in part, related to this salt balance characteristic. Thus, the intelligent application of techniques in milk processing requires a knowledge of the composition of the milk and the variations that occur in these constituents from season to season.

Milk has been analyzed by many investigators in the northern and northeastern United States, Germany and England. On the basis of these studies, the fact that milk constituents are variable and are subject to the influence of several factors has been established. It has been shown, for example, that the breed of cattle, the type and quantity of feed consumed, the time interval between milkings, the prevailing temperature conditions, the period of lactation, the season of the year, and the individuality of the cow are some factors which influence the composition of milk produced.

Only a limited amount of information pertaining to the composition of southern produced milk is available. Herzer and others (4) at the Mississippi Experiment Station reported that butter produced in Mississippi had chemical and physical characteristics slightly different from northern butter. Fouts and Krienke (3) at the Florida Experiment Station in a preliminary study indicated that Florida milk had a composition within the range of reported analyses from northern and northeastern United States.

More information regarding the composition of milk produced in Mississippi and other southern states is desirable, especially since dairying is increasing in these regions. It is also recognized that a major quantity of Mississippi produced milk involves climatic conditions, breed differences, grazing periods, and types of herbages available for grazing that may vary from those of other established milk producing areas. Furthermore, Mississippi has many soil types which vary in their calcium, phosphorus, and potassium content.

In view of these factors, a study of the composition of milk produced under Mississippi conditions was undertaken. Three objectives were sought in this investigation; (1) to establish the composition of Mississippi produced milk, (2) to determine the seasonal trends in composition, and (3) to compare the composition of milk produced in the different soil areas of the State.

Experimental Procedure

A study was started in January 1948 and continued through May 1949. During this period, milk samples from Biloxi, Hattiesburg, Jackson, Leland, Olive Branch, Tupelo, Starkville, and State College, Mississippi, were analyzed each month. These areas were selected on the basis of soil type, the importance to dairying and the geographical cross-section of the State. A milk processing plant or receiving station in each area cooperated by taking representative samples of their local production once each month. Two samples of one-quart each were taken either by drip samples or from vats representing milk from many cows. One sample was preserved with formalin and the other was unpreserved. The samples were chilled, packed in an insulated container and shipped to the Dairy Manufacturing Department laboratories, where analyses were started immediately upon arrival.

The milk was analyzed for the following constituents and characteristics: butterfat, total solids, serum solids (total solids less butterfat), total protein, casein, albumin, protein in albumin filtrate, lactose, ash, phosphorus, calcium, potassium, sodium, magnesium, chloride, hydrogen ion concentration titratable acidity, lactometer reading and freezing point.

The butterfat was determined by the Babcock method. The total solids content was measured using a procedure approved by the Association of Official Agricultural Chemists and was frequently checked with the Mojonnier method. After obtaining the total solids data, the sample was ashed to whiteness at 550° C. from which the percent ash was determined. The ash was dissolved in dilute hydrochloric acid and made up to 250 ml and the resulting solution was used for phosphorus, calcium and magnesium determinations. Phosphorus was measured by alkali titration of ammonium phosphomolybdate precipitate, while calcium was determined by permanganate titration of calcium oxalate and magnesium by precipitating magnesium pyrophosphate. The results of the ash, calcium, magnesium, and phosphorus were expressed as percent ash, calcium oxide, magnesium oxide, and phosphorus pentoxide, respectively.

Both sodium and potassium were determined from 10 grams of milk using the perchloric acid procedure, a method tentatively approved by the Association of Official Agricultural Chemists. The results were recorded as percent sodium oxide and potassium oxide.

The chloride was analyzed by the Sander's titration method and was expressed as percent chloride.

Hydrogen ion measurements were made with a glass electrode potentiometer. The Hortvet cryoscope was used to secure freezing point values and the Quevenne lactometer was used for lactometer readings.

The determinations of total protein, casein, albumin and protein in albumin filtrate followed the Kjeldahl- Gunning-Arnold method. The factor 6.38 was used to convert nitrogen to protein. The results were expressed as percent total protein, casein, albumin, and protein in albumin filtrate.

Lactose was measured by the gravimetric method of the Association of Official Agricultural Chemists. Frequent checks using the polarimetric procedure were used. Only data from the gravimetric method, however, were recorded and expresed as percent lactose.

All determinations except gravimetric lactose, titratable acidity and freezing point were taken from the preserved milk sample.

The milk samples were adjusted to 15° C. and were thoroughly mixed before the analyses, and all determinations were made in duplicate.

Average Composition

The average composition of Mississippi produced milk, as shown in table 1, included the average of all analyses from June 1948 and each of the following months to and including May 1949. The results of analyses prior to June 1948 were not included in this table in order to avoid any overlapping of seasonal influence. Considering that each sample was analyzed in duplicate, the data on this table represents 180 determinations for each constituent. Since the analyses were equally distributed over a period of one year, the influence of the stage of lactation and season are fairly well proportioned. This table is also representative of the State of Mississippi, since the samples were secured from the northern, central, Delta, and Gulf Coast areas. Furthermore, these results represent the milk of many thousands of animals in these regions. Accordingly, the values shown in table 1 are regarded as a reliable average composition for Mississippi-produced milk.

Table 1. The average composition of milk produced in Mississippi.

Constituent	Percentage
Butterfat	4.72
Total solids	13.83
Serum solids	9.11
Total protein	3.56
Casein	2.71
Albumin	.40
Protein in albumin filtrate	.43
Lactose	4.70
Ash	.71
CaO	.181
P_2O_5	.243
MgO	.024
Na_2O	.072
K_2O	.148
Cl	.088

These results compare favorably with those reported by Sommer (8), which are as follows:

Butterfat	3.9%	Ash	.7%
Total solids	13.1%	CaO	.170%
Total protein	3.2%	P_2O_5	.195%
Casein	2.5%	MgO	.017%
Albumin & Globulin	.7%	Na_2O	.070%
Lactose	5.1%	K_2O	.175%
		Cl.	.100%

A comparison of these two analyses shows that Mississippi-produced milk contains a higher amount of butterfat, total solids, total protein, casein, calcium. phosphorus, magnesium, and ash but less lactose, potassium and chloride than the compared milk composition. The sodium content appeared to be the same for both areas. Further comparison shows that some difference exists in the ratio of milk constituents from the two areas. For example, nearly 34.1 percent of the total solids in Mississippi milk is butterfat, while in the northern analyses, the butterfat represents slightly less than 30 percent of the total solids.

The serum solids in Mississippi milk contain 39 percent protein while the compared analysis shows 35 percent of the serum solids to be protein. Casein makes up 29.7 percent of the serum solids(total solids less butterfat) in Mississippi milk and 27.1 percent for northern milk. The lactose content, however, was lower in the milk studied representing 51.5 percent of the serum solids, while in the northern milk the serum solids contain 55.4 percent lactose. Mississippi-produced milk contains more phosphorus per unit of calcium than the compared analysis.

Undoubtedly, many factors are involved in the difference in milk composition and the ratio of milk constituents as discussed above, but it is very likely that breed predominance is a major contributory influence. This is considered possible because of the fact that Jersey and Guernsey breeds are rather common in Mississippi. It is general knowledge that these breeds produce milk with a higher fat percentage than Holsteins; however, it is also true that the Jersey and Guernsey breeds produce milk with higher amounts of other milk constituents than the Holstein. This is evident from data presented by Overman and others (6), showing the following average percentages for Holstein, Jersey and Guernsey breeds:

	Fat	Ttl. Solids	Protein	Lactose
Holstein	3.41	12.50	3.30	4.89
Jersey	5.05	14.69	3.79	5.00
Guernsey	5.03	14.87	3.89	4.97

There is also evidence that the mineral content varies according to the breed. Jacobsen and Wallis (5) reported that Jersey milk contains 25 percent more calcium and phosphorus than Holstein milk.

On the basis of the above data, it is clear that the results presented in table 1 are in agreement with other analyses involving Jersey and Guernsey breeds. One point of a lack of agreement, however, is in the lactose content. The report by Overman (6) shows a higher lactose content for the Channel Islands breeds than for Holsteins. The lactose content for Mississippi milk was found to be lower than the breeds considered in the data by Overman.

Generally, most information in the literature on milk composition shows lactose to be about 5.00 percent with little, if any, difference due to breed. Some of this information was secured not by a direct analysis of lactose but rather by subtracting the butterfat, protein and ash from total solids. The result attained is, presumably, lactose. It is possible that some error is introduced by the procedure and that the lactose content of all milk is not as high as 5.00 percent. Further evidence to substantiate this theory is the fact that an average relationship exists between lactose and the ash constituents in milk, which is reported in the following pages of this study. In other words, as the ash percentage increases the lactose content declines. On this basis and since the milk from Jersey and Guernsey breeds contains a high ash, it would seem likely that the same milk would be low in lactose. This study conforms to this analogy in that higher ash percentages and lower lactose levels were found than are generally recorded in literature.

Any objective interpretation of the nutritive value of Mississippi milk as far as the constituents listed in table 1 are concerned would conclude that the milk from this region compares favorably with that of other areas. The lesser amounts of lactose and potassium, in all probability, have no practical significance. It may be, however, that Mississippi milk tastes less sweet than northern milk due to the lower lactose content.

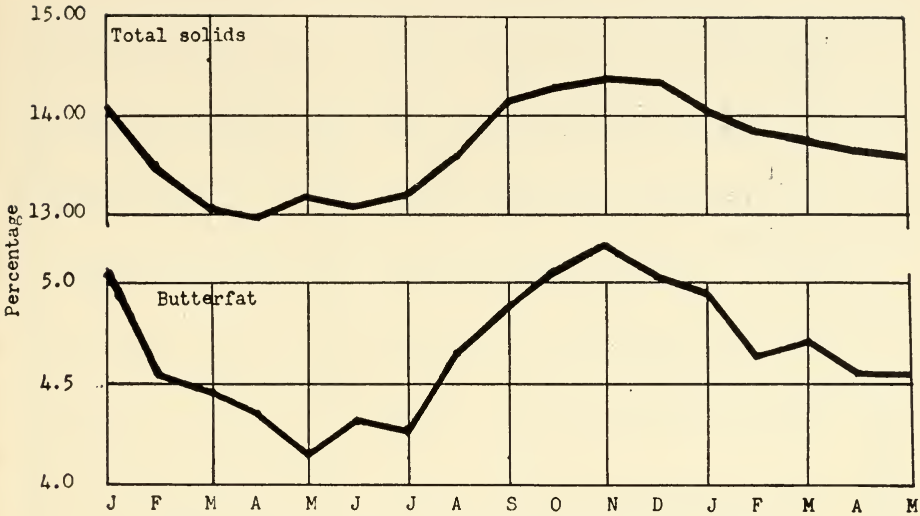

Figure 1. Seasonal trends of butterfat and total solids by months.

Greater yield in cheese manufacture and evaporated milk are possible from this higher solids milk than from a lower solids milk. Thus, a regional difference in these manufacturing characteristics is evident. Because of the higher fat to total solids ratio in Mississippi milk, a regional difference in the degree of fat standardization for cheesemaking becomes necessary.

Seasonal Trends in Composition

Results of this study show that season had an influence either directly or indirectly on many of the milk constituents. The month-to-month averages, as expressed in table 2, followed a definite trend throughout the seasons. Generally, the butterfat and total solids (see Figure 1) showed the most variation and were higher during the winter than during the summer. The maximum average for these components was observed during November at 5.2 percent and 14.42 percent, respectively. A low average of 4.2 percent for butterfat and 12.92 percent for total solids appeared during May. From March through July, the butterfat and total solids were low and from July through November, these constituents gradually increased in percentage. The trends showed a decrease from November through March. Although the butterfat curve generally followed the total solids variation, these two values did not vary in direct proportion.

A comparison of these results with those reported by Turner (9) and Jacobsen and Wallis (5) shows good agreement in that a higher fat and total solids prevailed in winter than in summer milk. However, a difference in the maximum average variation between the seasons is clearly evident. For example, Turner (9) shows a .59 percent maximum difference between the fat content of winter and summer milk from Jerseys, with less difference for the other breeds. Our data show a 1.0 percent difference in the fat content between winter and summer milk. No similar comparison of total solids values is available, but it is noteworthy that a 1.50 percent maximum difference between the total solids content of winter milk and summer milk is shown in table 2.

Some evidence of a difference in the time during which the minimum butterfat and total solids values develop is also apparent when Mississippi milk analyses

Table 2. The average composition of milk by calendar months.

Month	Butter fat pct.	Total solids pct.	Serum solids pct.	Total protein pct.	Casein pct.	Albumin pct.	Protein in albumin filtrate	Lactose pct.	Ash pct.	Phosphorus pct.	Calcium pct.	Potassium pct.	Sodium pct.	Magnesium pct.	Chloride pct.
January	5.07	14.12	9.05	3.60	2.65	.50			.74	.242	.201			.025	.084
February	4.56	13.43	8.87	3.34	2.55	.35			.70	.228	.183			.04	.088
March	4.45	13.05	8.60	3.37	2.60	.31	.47		.72	.245	.187	.163	.058	.043	.084
April	4.30	12.95	8.65	3.45	2.71	.38	.38	4.77	.71	.268	.171	.144	.078	.033	.086
May	4.21	13.24	9.03	3.53	2.73	.35	.42	4.88	.71	.275	.157	.143	.054	.036	.081
June	4.32	13.06	8.74	3.45	2.63	.44	.395	4.82	.71	.248	.169	.152	.071	.031	.087
July	4.27	13.23	8.96	3.37	2.61	.42	.405	4.73	.68	.239	.160	.164	.079	.022	.087
August	4.68	13.59	8.91	3.49	2.69	.39	.46	4.88	.69	.233	.171	.145	.069	.021	.088
September	4.82	14.16	9.34	3.72	2.82	.46	.49	4.79	.72	.242	.180	.135	.075	.035	.083
October	5.04	14.29	9.25	3.81	2.86	.43	.523	4.72	.70	.249	.187	.142	.072	.024	.098
November	5.20	14.42	9.22	3.83	2.89	.43	.48	4.63	.71	.243	.185	.136	.077	.039	.083
December	5.03	14.34	9.31	3.73	2.84	.46	.44	4.56	.72	.238	.195	.137	.077	.025	.084
January	4.91	14.05	9.14	3.64	2.76	.45	.39	4.57	.72	.241	.191	.147	.076	.019	.095
February	4.65	13.80	9.15	3.53	2.66	.415	.45	4.65	.71	.249	.190	.152	.073	.019	.092
March	4.72	13.73	9.01	3.39	2.56	.305	.47	4.68	.70	.240	.187	.151	.086	.016	.084
April	4.54	13.69	9.15	3.43	2.66	.28	.44	4.70	.73	.243	.186	.155	.072	.019	.091
May	4.55	13.61	9.06	3.43	2.65	.37		4.76	.71	.252	.182	.159	.071	.025	.088

Table 3. The average composition of milk collected from June 1948 to May 1949 from various areas of Mississippi

Area	Butter fat pct.	Total solids pct.	Serum solids pct.	Total protein pct.	Casein pct.	Albumin pct.	Protein in albumin filtrate	Lactose pct.	Ash pct.	Phosphorus pct.	Calcium pct.	Potassium pct.	Sodium pct.	Magnesium pct.	Chloride pct.
Biloxi	4.53	13.52	8.99	3.49	2.68	.38	.45	4.71	.71	.245	.180	.153	.077	.025	.089
Hattiesburg	4.55	13.60	9.05	3.47	2.69	.33	.41	4.77	.705	.247	.179	.149	.073	.022	.086
Jackson	4.77	13.86	9.09	3.67	2.78	.40	.48	4.71	.72	.249	.181	.155	.075	.030	.090
Leland	5.32	14.95	9.63	3.69	2.79	.49	.43	4.85	.725	.255	.191	.138	.076	.024	.099
Olive Branch	4.45	13.11	8.66	3.42	2.62	.294	.392	4.56	.68	.232	.172	.143	.080	.023	.084
Starkville	4.81	13.76	8.95	3.56	2.74	.45	.35	4.63	.71	.239	.184	.146	.078	.024	.091
State College	4.60	13.85	9.25	3.72	2.77	.46	.49	4.74	.72	.241	.182	.150	.088	.027	.090
Tupelo	4.50	13.46	8.87	3.46	2.65	.35	.45	4.68	.68	.237	.178	.143	.066	.024	.090

are compared with other reports. This study shows that the month of May is the period when butterfat and total solids are low. For comparison, Jacobsen and Wallis (5) report August as the month during which the minimum values for these constituents were observed in South Dakota. Undoubtedly, the early growing season and the humidity factor in southern areas are largely responsible for this difference; as the summer season progresses accompanied by warm dry weather, the succulent pastures diminish favoring an increase in butterfat and total solids. It is also possible that the stage of lactation may be involved in the development of maximum and minimum constituent levels supplementing the seasonal influence as the case may be.

The butterfat and total solids trends did not show a seasonal duplication for spring 1948 and spring 1949. No information was available to explain these results except that the amount of rainfall during these two periods was quite different. During the spring season 1948 the rainfall was less than during the same period in 1949, and as a result of this, the pastures were showing a lack of moisture, while the same pastures during May 1949 were growing abundantly.

The butterfat and total solids values for each area studied generally followed the average trend as shown in tables 5 and 6.

The serum solids trend as shown in figure 2 and table 2 was lower during the summer than during the winter. Although the serum solids trend showed more irregularity than either the butterfat or total solids, it generally followed the latter. A low average of 8.60 percent serum solids appeared during March and a high of 9.34 percent was noted during September.

From the standpoint of minimum standards as established by law, the seasonal variations in milk become important especially during the months when these constituents are normally low. This study shows that the average low values for butterfat, total solids and serum solids are still above the minimum standards as established for the State of Mississippi. It further indicates that the total solids and serum solids come closer to the mini-

Table 4. Rainfall during January through June 1948 and 1949.

Year	January	February	March	April	May	June	July
1948	3.63	7.94	7.51	5.26	1.08	2.21	3.06
1949	13.85	5.84	5.84	3.96	6.17	4.96	3.68

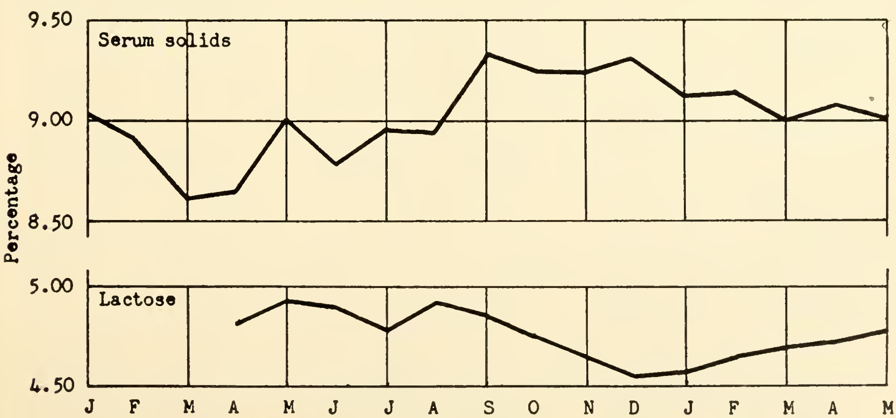

Figure 2. Seasonal trends of serum solids and lactose by months.

Table 5. Percent butterfat of different areas by calendar months.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi	5.2		4.35	4.55	4.8	4.0	4.2	4.5	4.9		5.1	4.7	4.8	4.3	4.5	4.45	4.4
Hattiesburg	5.2	4.35	4.3	4.3	4.3	4.4	4.5	4.5	4.7	4.7	5.1	4.0	4.75	4.4	4.8	4.2	4.6
Jackson	4.75	4.45	4.33	4.2	4.2	4.4	4.3	4.9	4.8	4.8	5.1	6.0	4.8	4.3	5.05	4.6	4.2
Leland	5.2		5.2	4.5	4.3	4.7		5.55	5.5	5.5	5.3	4.0	6.0	5.1	5.7	6.3	5.0
Olive Branch	4.8	4.5	4.2	4.15	3.8	4.0	4.3			5.1	5.3	4.1	4.7	4.55	4.0	4.0	
Starkville	4.7	4.6	4.0	4.1	4.2	4.4	4.5	4.7	4.85	5.5	5.5	5.4	5.2	4.8	4.5	4.0	4.4
State College	5.7	4.7	4.45	4.05	4.3	4.35	3.9	4.2	4.0	4.7	4.6	5.0	4.35	5.4	4.95	4.8	5.0
Tupelo	5.15	4.8	4.8	4.6	3.8		4.2	4.4	5.1	5.0	5.1	5.0	4.8	4.4	4.3	4.0	4.2

Table 6. Percent total solids in milk from different areas by calendar months.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi	13.30		12.73	13.00	13.05	12.71	12.78	13.20	14.34		14.40	13.60	13.73	13.14	13.45	13.37	13.31
Hattiesburg	14.90	13.57	13.45	12.76	13.26	12.57	13.19	13.05	13.91	14.30	14.35	13.95	13.72	13.40	13.86	13.10	13.70
Jackson	13.68	13.00	12.81	13.00	13.30	13.45	12.57	12.95	13.90	14.35	14.47	15.39	14.15	13.65	14.15	13.87	13.42
Leland	13.99		14.44	13.31	13.80	14.12		14.47	14.68	14.80	14.80	14.10	15.87	14.66	15.13	15.80	14.30
Olive Branch	14.17	13.08	12.36	12.35	12.95	12.62	12.26			14.04	14.22	12.92	13.15	13.36	12.60	12.85	
Starkville	13.87	13.15	12.41	13.14	13.10	12.95	12.73	13.50	14.13	14.65	14.80	14.45	14.27	13.75	13.41	13.07	13.40
State College	14.94	15.03	14.04	12.88	13.30	12.98	13.03	13.15	13.85	13.80	14.00	14.45	13.75	14.89	14.10	14.20	14.05
Tupelo	14.00	12.75	12.19	12.98	12.15		12.57	12.75	14.30	14.12	14.29	13.84	13.69	13.26	13.16	13.05	13.10

Table 7. Percent total protein in milk from various areas by calendar months.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi	3.47		3.56	3.57	3.50	3.35	3.44	3.49	3.89		3.70	3.45	3.46	3.55	3.34	3.43	3.36
Hattiesburg	3.60	3.42	3.42	3.41	3.58	3.24	3.27	3.43	3.71	3.78	3.72	3.69	3.50	3.33	3.38	3.29	3.42
Jackson	3.42	3.18	3.57	3.56	3.56	3.59	3.40	3.52	3.80	3.90	3.90	3.90	3.70	3.85	3.55	3.48	3.48
Leland	3.65		3.85	3.54	3.75	3.76	3.43	3.61	3.63	3.58	3.75	3.72	4.20	3.80	3.72	3.55	3.60
Olive Branch	3.65	3.11	2.96	3.17	3.29	3.19	3.30	3.48	3.68	3.88	3.65	3.60	3.20	3.30	3.05	3.35	
Starkville	3.68	3.16	3.21	3.25	3.52	3.27	3.38	3.47	3.60	3.82	3.83	3.80	3.80	3.55	3.38	3.36	3.37
State College	3.80	3.92	3.64	3.82	3.63	3.75	3.63	3.64	3.75	3.83	3.98	3.83	3.79	3.71	3.64	3.68	3.45
Tupelo	3.58	3.25	2.77	3.45	3.44		3.14	3.28	3.80	3.82	3.83	3.60	3.50	3.35	3.11	3.34	3.33

mum standards than the fat content. This means that the normally secreted milk which may not meet the minimum standards would likely be low in either total solids or serum solids rather than in butterfat.

The protein content of the milk studied also varied seasonally. Data shown in figure 3 and table 2 indicated that the total protein was low during the spring season and high during the fall and early winter season, which was similar to the butterfat, total solids and serum solids trends. The maximum average was noted during November at 3.83 percent and the minimum was observed during February at 3.34 percent. Although the plotted curves showed some irregularities, the total protein gradually decreased from November through March remaining at a low level from March through July, and then steadily increased from July to November. This same seasonal pattern in protein levels was found for the milk analyzed from each area, as shown in table 7.

Casein, which represents almost four-fifths of the milk protein, followed and appeared largely responsible for the over-all fluctuation in the total protein content. The results as plotted in figure 3 and expressed in table 2 showed that the highest average for casein appeared during November at 2.89 percent while the

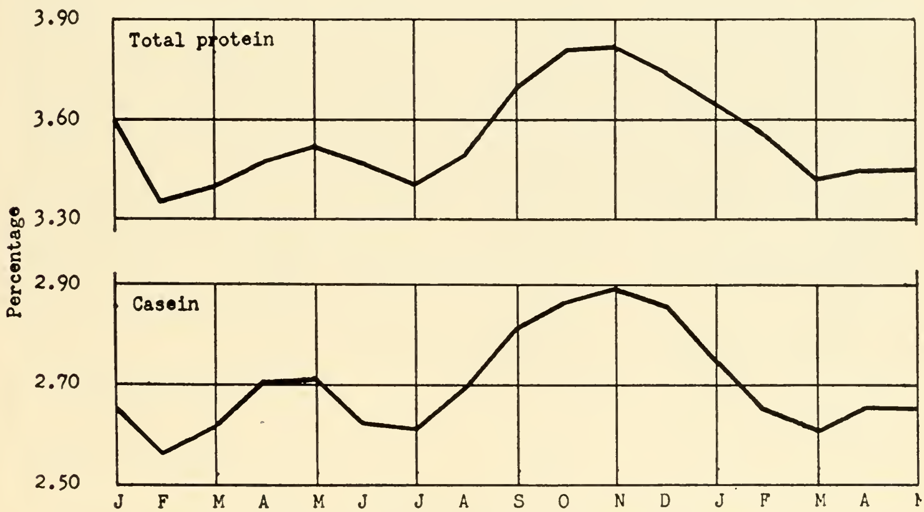

Figure 3. Seasonal trends of total protein and casein by months.

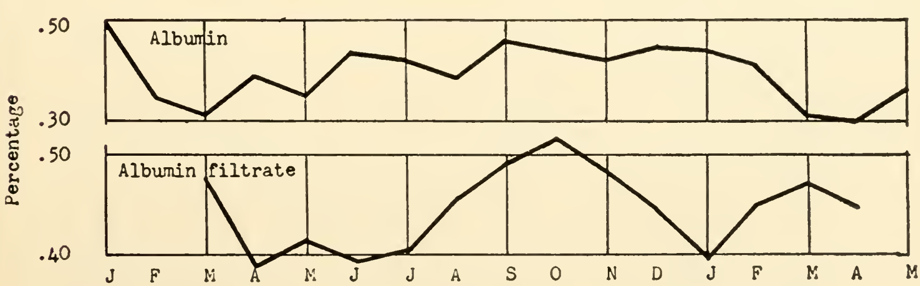

Figure 4. Seasonal trends of albumin and protein in albumin filtrate by months.

Table 8. Percent casein in milk from various areas by calendar months.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi	2.14		2.80	2.81	2.74	2.60	2.73	2.60	2.89		2.97	2.60	2.66	2.55	2.58	2.75	2.65
Hattiesburg	2.66	2.56	2.69	2.72	2.82	2.59	2.59	2.70	2.90	2.84	2.80	2.77	2.81	2.50	2.65	2.53	2.70
Jackson	2.65	2.64	2.62	2.76	2.76	2.61	2.60	2.83	2.88	2.86	2.88	2.90	2.71	2.99	2.70	2.78	2.61
Leland	2.85		3.08	2.84	2.89	2.93	2.63	2.83	2.65	2.52	2.76	2.79	3.10	2.91	2.81	2.79	2.80
Olive Branch	2.65	2.48	2.26	2.62	2.49	2.49	2.50	2.26	2.77	3.09	2.91	2.72	2.59	2.49	2.40	2.60	
Starkville	2.78	2.61	2.45	2.49	2.79	2.54	2.72	2.73	2.79	2.95	2.85	2.86	2.85	2.67	2.53	2.78	2.55
State College	2.85	3.02	2.80	2.89	2.77	2.68	2.73	2.70	2.87	2.81	3.00	2.98	2.77	2.71	2.70	2.78	2.60
Tupelo	2.69	2.01	2.11	2.69	2.70		2.39	2.45	2.80	2.99	3.00	2.79	2.66	2.53	2.35	2.59	2.65

Table 9. Percent albumin in milk from various areas by calendar months.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Biloxi	.325		.305	.35	.40	.38	.41	.36	.42		.30	.45	.38	.35	.38	.33
Hattiesburg	.30	.285	.35	.37	.34	.42	.33	.36	.38	.42	.47	.34	.33	.30	.26	.15
Jackson	.29	.25	.31	.44	.35	.37	.45	.33	.41	.44	.40	.65	.39	.33	.32	.35
Leland	.38		.39	.42	.25	.46	.54	.51	.74	.42	.52	.53	.75	.44	.33	.25
Olive Branch	.86	.26	.275	.37	.40	.39	.29			.33	.45	.42	.30	.28	.21	.27
Starkville	.80	.42	.315	.46	.35	.60	.52	.40	.40	.41	.50	.45	.65	.50	.26	.32
State College	.63	.37	.37	.335	.39	.47	.45	.45	.52	.32	.47	.43	.55	.72	.45	.31
Tupelo	.44	.55	.20	.30	.34		.39	.37	.37	.44	.37	.41	.28	.40	.23	.25

Table 10. Percent ash in milk from various areas by calendar months.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi	.715		.75	.70	.725	.75	.695	.75	.71		.71	.715	.70	.71	.70	.76	.71
Hattiesburg	.75	.73	.77	.705	.705	.69	.705	.72	.705	.71	.69	.715	.675	.705	.71	.76	.71
Jackson	.79	.685	.765	.68	.73	.74	.67	.735	.74	.66	.73	.73	.75	.74	.74	.78	.71
Leland	.86		.77	.755	.78	.755	.705	.71	.74	.71	.72	.74	.76	.67	.72	.75	.73
Olive Branch	.715	.68	.67	.655	.655	.67	.70	.60	.69	.70	.73	.705	.67	.69	.66	.71	
Starkville	.755	.67	.66	.72	.68	.70	.695	.68	.77	.72	.70	.70	.72	.73	.725	.70	.72
State College	.705	.76	.71	.72	.74	.705	.655	.68	.72	.75.	75	.73	.79	.77	.74	.72	.705
Tupelo	.695	.69	.665	.69	.695		.65	.685	.71	.705	.67	.72	.70	.68	.64	.70	.69

lowest percent was observed during February at 2.55. Declining gradually from November through March, the average casein trend remained low from March through July and then steadily increased from July to November. Both the protein and casein percentages showed about the same trend for the spring of 1948 and 1949. The data in table 8 compare the casein content in the milk analyzed from eight areas for each calendar month. Generally, each area followed the average of all areas.

The albumin portion of milk protein of the samples analyzed did not follow the casein trend; however, it did show a seasonal variation. The plotted values in figure 4 based on the results in table 2 indicate that a decline in the albumin content developed from January through March. The albumin content increased during May through July and remained high through the summer and fall until January. The highest point attained for albumin was .50 percent during January and the lowest average appeared during February and March at .28 percent. Generally, the albumin trend for each area was not as consistent with the average of all areas as was true for the casein trend.

The remaining protein not coagulated by heat in the albumin determination was designated as the protein in the albumin filtrate. This portion undoubtedly contained globulin, lesser proteins and other nitrogen bearing compounds. Although the amount of analyzed protein in this filtrate varied more than the albumin portion, the quantity of protein in this fraction averaged the same as the albumin content. The trend as shown in figure 4 and table 2 indicated a possible high level during the late summer and fall followed by a low content from April through July. The maximum portion of protein in the albumin filtrate was observed in October at .52 percent, while a low of .38 to .39 percent was noted during January, April and July.

Considering the protein trend and its relationship with other milk constituents, a close similarity is indicated between the total protein and the butterfat content. As the butterfat content increased, a similar increase in total protein was evident. Furthermore, the variations in milk protein largely determine the fluctuations in serum solids. This was observed from the

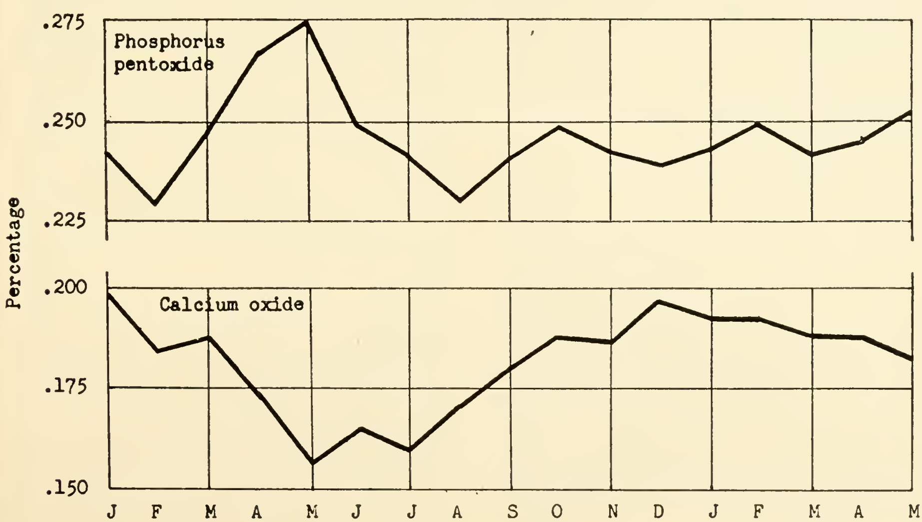

Figure 5. Sasonal trends in calcium oxide and phosphorus pentoxide by months.

fact that the month during which the maximum values in serum solids was noted coincided with the same criteria for total protein. These data are in agreement with the findings as reported by Davis and co-workers (2) at the Arizona Experiment Station and with the report of Overman (6) at the Illinois Experiment Station.

Another variable milk constituent was lactose, more commonly referred to as milk sugar. Although this constituent is one of the larger components of milk, it varied less from season to season than many of the other constituents. Generally, the lactose percentage was slightly higher during the spring and summer than it was during the winter. The highest average lactose content was observed during May and August at 4.88 percent, and the lowest amount was noted during December at 4.56 percent, as shown in figure 2 and table 2. Declining gradually from August through December, the lactose content tended to increase during the spring and summer season. This trend was directly opposite the trends established by butterfat, total solids, serum solids, and total protein. These observations are in agreement with Davis (2) et al and Overman et al (6), in which both workers concluded that an inverse relationship exists between the lactose content and the butterfat, total solids, serum solids, and total protein content.

The ash content, which includes a mixture of all milk minerals, also showed a seasonal fluctuation. Although the results secured show only slight variations, the ash content was higher during the winter season than it was during July and August, as is shown in figure 6 and table 2. The maximum ash content appeared in January at .74 percent, and the minimum value was secured during July at .68 percent. This trend varied inversely with the lactose values and followed the butterfat, total solids, total protein, and serum solids variations.

The results in table 10 show the ash content for each area by calendar month.

Although the total mineral content varied somewhat, the individual constituents making up the ash followed a more definite seasonal pattern. This was especially true for phosphorus which tended to be high during the early spring and low during the summer and early fall and then increased somewhat during the early winter season. The results as shown in figure 5 and table 2 showed a maximum of .277 percent for phosphorus pentoxide during May and a low of .228 percent during February. An increasing trend was noted from February through May, followed by a decline to a near low during August. From July through October, it increased again and then remained fairly uniform until spring. The sharp seasonal increase observed from March through May during 1948 did not repeat during the same months of 1949; however, the analysis for May 1949 showed an increase in the phosphorus trend, indicating that a delayed seasonal influence in this constituent was involved. This same lack of seasonal duplication was observed with the butterfat which was discussed previously.

While the phosphorus tended to increase with the spring season, calcium showed a somewhat inverse trend as shown in figure 5 and table 2. Generally, the calcium averaged low during the spring and summer and high during the winter season. The trend decreased from March through July, and gradually increased to a high point during December. The maximum calcium oxide percentage of .201 percent was noted during January while the minimum of .157 percent was observed during May. The lack of seasonal repetition that was noted with phosphorus also appeared with the calcium content. Data in figure 5 showed a slower decline in spring 1949 than was observed for the same period 1948. It was significant, however, that a decline was

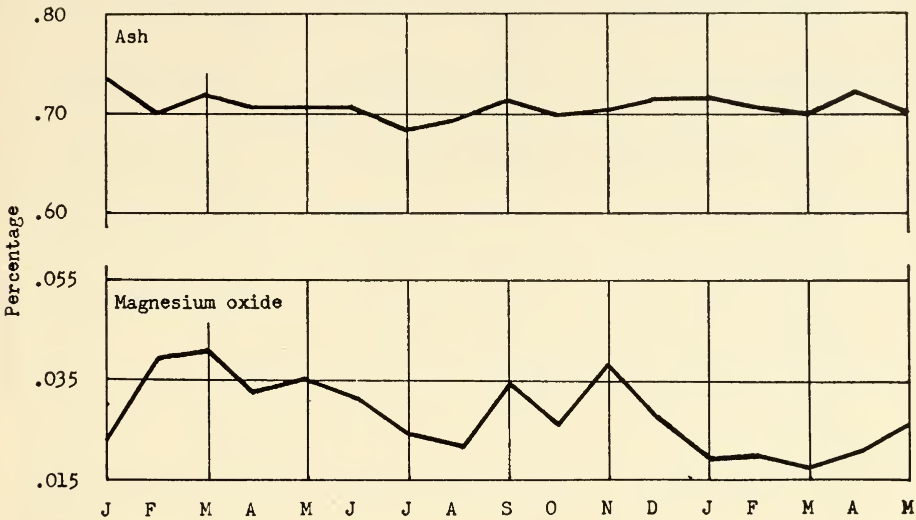

Figure 6. Seasonal trends of ash and magnesium oxide by months.

indicated in the last two months' analyses for 1949.

The results secured in the phosphorus and calcium determinations are in general agreement with the findings of Jacobsen and Wallis (5) who report that the mineral percentage was lower during the summer than during the winter; their results, however, did not show the early spring increase in phosphorus that was observed with Mississippi-produced milk.

The ratio of calcium to phosphorus also varied from season to season. A calcium-phosphorus ratio of 0.94 to 1.00 was noted during May while a ratio of 1.40 to 1.00 was found for December. A gradually increasing ratio was observed from August through December, while from January through May the ratio decreased slightly.

The calcium content varied almost directly with the total solids content, while the prosphorus levels showed some correlation with total solids except for the early spring upward trend that developed. Since the stability of milk proteins is partially dependent upon the balance between calcium and phosphorus, it is evident that milk characteristics involving protein stability would vary from season to season. When the calcium to phosphorus ratio is high the milk would react differently in processing than when the ratio is low. Accordingly, this study shows that more problems involving feathering in coffee cream and coagulation during cooking with Mississippi milk should be experienced during the winter season. Furthermore, winter milk will have a faster rate of rennet action and will favor a lower moisture cheese than spring milk. The technician in the evaporated milk plant must also take this varying ratio into consideration in adjusting his hot well and sterilizing temperature to secure a uniform product throughout the year.

Data shown in tables 11 and 12 are the calcium and phosphorus determinations for each month from milk produced in the different areas. Generally, each area followed the average seasonal trend.

The magnesium trend shown in figure 6 fails to follow any seasonal pattern. A lack of seasonal duplication was noticed especially when January through May of 1948 is compared with the same

Table 11. Percent phosphorus (P_2O_5) in milk from various areas by calendar months.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi	.240		.220	.270	.273	.252	.240	.239	.254		.249	.239	.237	.253	.244	.243	.251
Hattiesburg	.274	.245	.264	.262	.265	.234	.237	.231	.248	.254	.250	.251	.245	.260	.244	.251	.255
Jackson	.213	.243	.266	.249	.274	.260	.247	.244	.254	.255	.255	.240	.248	.245	.243	.252	.249
Leland	.243		.270	.280	.288	.278	.245	.237	.247	.261	.253	.244	.264	.255	.260	.258	.261
Olive Branch	.232	.204	.216	.233	.250	.257	.238	.225	.234	.237	.223	.220	.222	.240	.229	.237	
Starkville	.265	.218	.255	.255	.275	.244	.240	.239	.238	.245	.241	.235	.238	.244	.233	.232	.250
State College	.235	.242	.266	.275	.291	.240	.220	.233	.242	.255	.244	.235	.245	.250	.237	.233	.248
Tupelo	.247	.220	.204	.263	.284		.240	.218	.239	.241	.235	.230	.233	.248	.235	.245	.249

Table 12. Percent calcium (CaO) in milk from various areas by calendar months.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi	.211		.170	.195	.160	.179	.165	.177	.188		.180	.188	.193	.182	.185	.176	.177
Hattiesburg	.210	.185	.199	.182	.160	.159	.154	.167	.181	.186	.180	.189	.191	.187	.187	.186	.184
Jackson	.223	.190	.184	.156	.174	.165	.153	.172	.180	.191	.190	.190	.188	.195	.190	.186	.180
Leland	.251		.209	.196	.185	.173	.167	.181	.183	.194	.205	.200	.202	.194	.203	.210	.187
Olive Branch	.174	.170	.175	.160	.157	.156	.157	.165	.167	.183	.174	.187	.180	.181	.180	.170	
Starkville	.205	.195	.208	.176	.156	.166	.163	.175	.181	.198	.200	.196	.188	.191	.183	.184	.184
State College	.198	.180	.187	.155	.147	.170	.159	.169	.174	.180	.184	.195	.190	.200	.184	.195	.189
Tupelo	.210	.190	.167	.150	.138		.161	.166	.186	.176	.170	.188	.186	.185	.186	.185	.178

Table 13. Percent magnesium (MgO) in milk from various areas by calendar months.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi	.010		.050	.048	.024	.035	.018	.024	.038		.037	.023	.025	.019	.011	.015	.031
Hattiesburg	.031	.037	.04	.023	.045	.017	.015	.009	.031	.020	.044	.013	.028	.021	.022	.017	.025
Jackson	.020	.042	.042	.044	.051	.039	.027	.029	.027	.037	.047	.040	.019	.022	.025	.023	.029
Leland	.045		.06	.013	.05	.030	.013	.013	.045	.019	.030	.036	.012	.020	.011	.020	.025
Olive Branch	.014	.050	.045	.027	.045	.035	.018	.028	.036	.024	.037	.016	.022	.020	.009	.015	
Starkville	.033	.045	.035	.027	.030	.031	.027	.024	.031	.020	.040	.044	.017	.013	.020	.018	.019
State College	.027	.050	.036	.035	.025	.031	.023	.020	.045	.023	.034	.043	.012	.016	.024	.020	.029
Tupelo	.023	.058	.038	.050	.033		.019	.023	.027	.023	.047	.024	.023	.023	.009	.021	.019

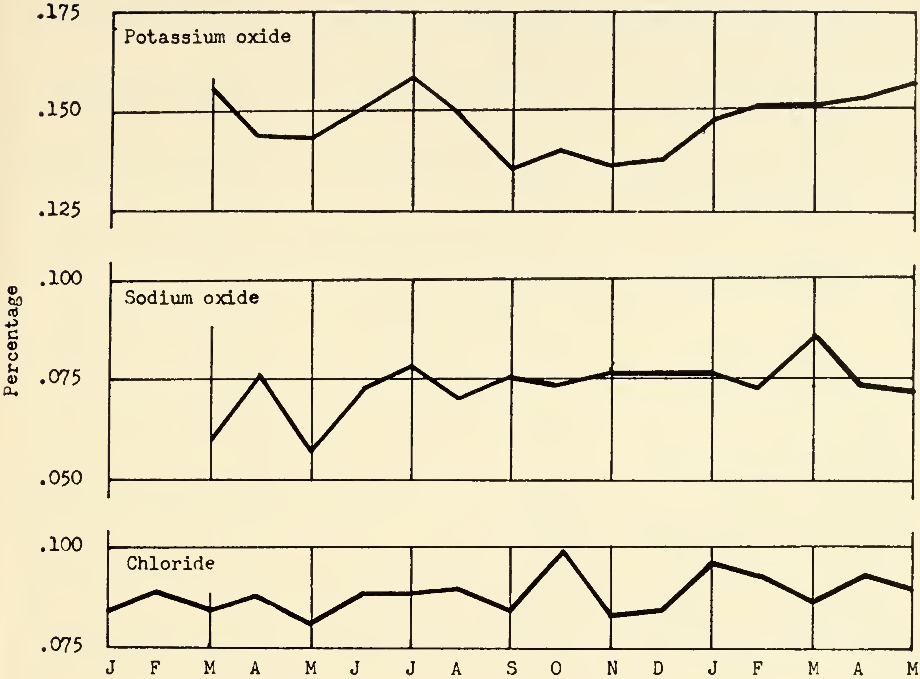

Figure 7. Seasonal trends in potassium oxide, sodium oxide and chloride by months.

months for 1949. The maximum value for magnesium of .043 percent was noted during March 1948 while the lowest point of 0.19 percent was noted during March 1949. Since the quantity of magnesium present in milk is relatively small, it would appear that some experimental error may be involved in this determination. This fact might account for the lack of seasonal duplication.

Further data on the magnesium content are found in table 13 in which the monthly percentages for each area are tabulated.

Potassium in milk was shown to vary somewhat with the season. Generally, the potassium content was lower during the early fall than it was during early spring. The lowest point noted for potassium appeared during September and November at .135 percent potassium oxide while the highest level was observed during July at .164 percent potassium oxide. The plotted values for potassium which are shown in figure 7 appeared to be somewhat inversely related to the butterfat, protein and calcium trends; however, a tendency for a direct relationship between lactose and potassium was noted. Further data on the potassium trends for each area studied are given in table 15.

The sodium content was fairly uniform, showing very little seasonal variation. The plotted trend as represented in figure 7 and table 2 showed a maximum average of .086 percent sodium oxide during March and a minimum of .054 percent sodium oxide for May. The sodium trend indicated little, if any, relationship to other milk constituents.

The chloride percentage remained fairly uniform throughout the study with no definite seasonal trend nor excessive fluctuation apparent. The plotted monthly values which are shown in figure 7 varied between .098 percent chloride in October

Table 14. Percent lactose in milk from various areas by calendar months.

Area	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi	5.03	5.00	4.80	4.81	4.90	4.85	4.75		4.60	4.62	4.60	4.61	4.60	4.70
Hattiesburg	4.65	4.83	4.81	4.92	4.83	4.86	5.00	4.70	4.53	4.62	4.78	4.76	4.72	4.80
Jackson	4.87	4.96	4.91	4.63	4.86	4.71	4.96	4.60	4.60	4.56	4.56	4.58	4.70	4.83
Leland	5.10	4.86	5.12	4.65	5.02	4.90	5.00	4.75	4.72	4.80	4.75	4.80	4.86	4.83
Olive Branch	4.60	4.70	4.76	4.45			4.47	4.55	4.44	4.48	4.62	4.75	4.60	
Starkville	4.83	4.90	4.80	4.63	4.73	4.70	4.71	4.64	4.50	4.41	4.53	4.55	4.67	4.72
State College	4.84	4.90	4.86	4.90	4.92	4.81	4.60	4.53	4.66	4.63	4.83	4.64	4.79	4.75
Tupelo	5.03	4.98		4.89	4.94	4.76	4.66	4.59	4.48	4.50	4.57	4.68	4.70	4.71

Table 15. Percent potassium (K_2O) in milk from various areas by calendar months.

Area	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi		.180	.166	.156	.157	.171	.150	.156		.142	.148	.146	.155	.155	.146	.166
Hattiesburg	.150	.156	.142	.136	.151	.157	.140	.133	.156	.136	.141	.150	.141	.160	.164	.161
Jackson		.183	.168	.168	.170	.176	.142	.137	.159	.137	.140	.167	.167	.167	.153	.165
Leland		.141	.151	.125	.122	.132	.142	.134	.142	.125	.134	.155	.148	.140	.143	.139
Olive Branch	.168	.175	.155	.146	.155	.175	.142	.116	.130	.125	.125	.139	.143	.150	.172	
Starkville	.155	.180	.101	.137	.160	.166	.148	.140	.130	.134	.125	.123	.161	.156	.159	.162
State College	.155	.162	.135	.150	.148	.169	.160	.140	.139	.141	.144	.155	.160	.140	.150	.155
Tupelo	.151	.134	.168	.152		.166	.136	.124	.142	.136	.139	.141	.140	.139	.152	.159

Table 16. Percent sodium (Na_2O) in milk from various areas by calendar months.

Area	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi	.060	.065	.057	.100	.098	.051	.062		.086	.081	.066	.077	.080	.076	.070
Hattiesburg	.061	.105	.064	.053	.065	.071	.070	.077	.073	.080	.083	.045	.080	.093	.087
Jackson	.060	.089	.040	.056	.064	.070	.092	.085	.085	.074	.073	.094	.080	.077	.072
Leland	.051	.090	.070	.101	.101	.102	.087	.061	.074	.075	.057	.080	.086	.043	.069
Olive Branch	.041	.092	.060	.103	.097	.056	.065	.079	.068	.075	.085	.071	.094	.088	
Starkville	.045	.077	.045	.078	.095	.068	.084	.099	.076	.067	.064	.083	.101	.056	.060
State College	.087	.023	.068	.095	.102	.067	.096	.100	.085	.095	.095	.076	.090	.090	.071
Tupelo	.064	.087	.034		.044	.069	.048	.071	.072	.070	.085	.061	.075	.059	.071

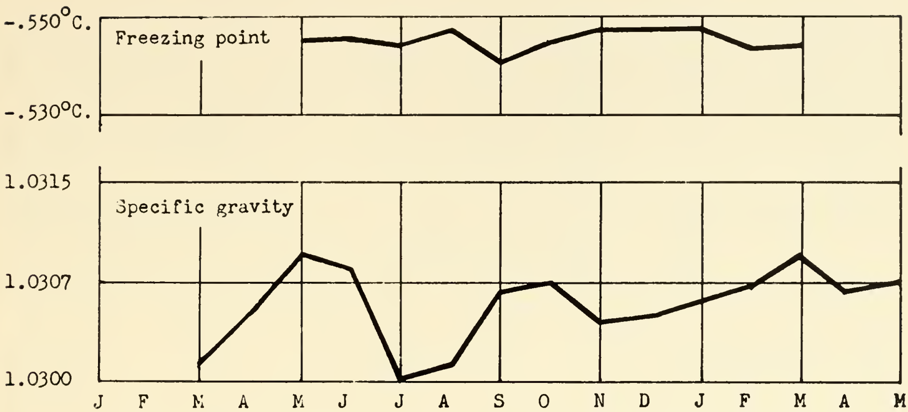

Figure 8. Seasonal trends in freezing point and specific gravity by months.

to a low of .081 percent chloride during May. There was no relationship between the chloride content and the other constituents.

The results of the freezing point determinations and the lactometer readings are shown in figure 8. No correlation exists between the two plotted results. The freezing point values were more uniform than the lactometer readings, and the lowest freezing point was noted during September at -.541° C. while the highest value was observed during December and January at -.547° C. The lactometer reading followed a greater seasonal variation than the freezing point determinations. The lactometer readings were lower during July and August than they were for the remaining months. The highest lactometer readings 1.0314 was observed in March and May and the lowest reading of 1.0299 occurred in July.

The titratable acidity did not vary directly with the pH values. Very little seasonal difference in either of these determinations was noticeable; however, the pH tended to be slightly higher during December to February than during the remaining periods. The titratable acidity was low for July and February and otherwise tended to vary irregularly. The seasonal trends for pH and titratable acidity are shown in figure 9.

A general view of seasonal trends in the composition of milk produced in Mississippi will show some influence which is related to the climatic conditions of this region. The early seasonal decline in butterfat, total solids and protein coincides very closely with the early growing season. As this growing season extends into July which is frequently accompanied by hot, dry weather, a sharp increase in these constituents develops which continues upward until November. Undoubtedly, the decline in succulent grass pastures is partially responsible for this upward trend during the late summer, but it may be further implemented by the fact that many animals approach the later stages of lactation with the early fall season, and continue into winter with little or no milk production in preparation for calving during early spring. Thus, the combined influence of lactation and season might be responsible for the maximum variations secured in the milk constituents from season to season.

Higher yields in cheese manufacture and evaporated milk processing are possible during the winter months than during the summer. However, a greater degree of butterfat standardization may be practiced during the winter because of the higher fat content. Problems involving milk stability will occur more fre-

Table 17. Percent chloride (Cl) in milk from various areas by calendar months.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Biloxi	.090		.099	.089	.088	.088	.086	.086	.095		.089	.089	.098		.080	.095	.083
Hattiesburg	.090	.092	.081	.079	.082	.085	.084	.084	.094	.083	.082	.088		.087		.092	.088
Jackson	.081	.087	.086	.082	.076	.084	.089	.089	.097	.091	.081	.100	.098	.099	.082	.089	.083
Leland	.076		.070	.092	.089	.087	.087	.088	.097	.085	.078	.084	.110	.096		.087	.091
Olive Branch	.085	.091	.082	.082	.069	.078	.079			.084	.084	.088	.087	.086		.090	
Starkville	.086	.086	.091	.084	.077	.094	.091	.088	.094	.089	.090	.094	.097	.089	.085	.092	.091
State College	.084	.091	.090	.092	.085	.095	.086	.093	.090	.088	.082	.092	.090	.093	.090	.090	.093
Tupelo	.078	.083	.067	.089	.086		.088	.088		.093	.089	.094	.088	.095		.090	.087

Table 18. A twelve-month average of some constituents calculated on basis of total solids of milk collected from various soil areas.

Soil classifications as to mineral content	Total solids pct.	Total protein pct.	Lactose pct.	Calcium (CaO) pct.	Phosphorus (P_2O_5) pct.	Potassium (K_2O) pct.	Total protein in total solid pct.	Lactose in total solids pct.	Calcium (CaO) in total solids pct.	Phosphorus (P_2O_5) in total solids pct.	Potassium (K_2O) in total solids pct.
Very high in Ca, P & K	14.95	3.69	4.85	.191	.255	.138	24.68	32.44	1.27	1.70	.922
High in Ca, medium in P&K	13.69	3.56	4.66	.181	.239	.146	26.00	34.03	1.32	1.74	1.06
Medium in Ca, P & K	13.86	3.67	4.71	.181	.249	.155	26.47	33.98	1.30	1.79	1.11
Low in Ca, P & K	13.36	3.45	4.66	.176	.239	.146	25.82	34.88	1.31	1.78	1.09
Very low in Ca, P & K	13.52	3.49	4.71	.180	.245	.153	25.81	34.83	1.33	1.81	1.13

Table 19. Average composition of milk collected from June 1948 to May 1949 from various soil conditions.

Soil classifications as to mineral content	Butter fat pct.	Total solids pct.	Serum solids pct.	Total protein pct.	Casein pct.	Albumin pct.	Protein in albumin pct.	Lactose pct.	Ash pct.	P_2O_5 pct.	CaO pct.	K_2O pct.	Na_2O pct.	MgO pct.	Cl pct.
Very high in Ca, P & K	5.32	14.95	9.63	3.69	2.79	.49	.43	4.85	.725	.255	.191	.138	.078	.024	.099
High Ca, medium in P & K	4.66	13.69	9.03	3.56	2.72	.42	.43	4.66	.70	.239	.181	.146	.077	.025	.090
Medium in Ca, P & K	4.77	13.86	9.09	3.67	2.78	.40	.48	4.71	.72	.249	.181	.155	.075	.030	.090
Low in Ca, P & K	4.50	13.36	8.86	3.45	2.65	.31	.40	4.66	.69	.239	.176	.146	.077	.022	.085
Very low in Ca, P & K	4.53	13.52	8.99	3.49	2.68	.38	.45	4.71	.71	.245	.180	.153	.077	.025	.089

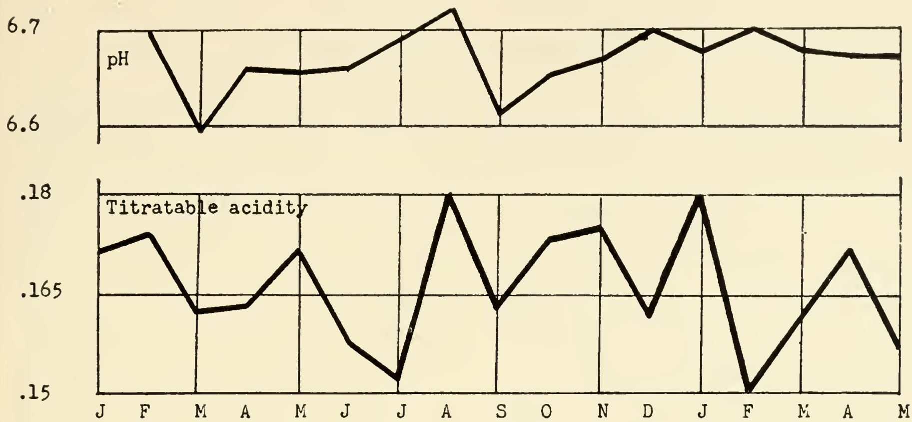

Figure 9. Seasonal trends of pH and titratable acidity by months.

quently during the winter season than during the summer.

The seasonal trends in milk constituents observed for Mississippi milk generally follow that of other regions. Some difference in maximum variation and the months of minimum and maximum values are shown.

Composition From Various Soil Areas

The composition of the soil is known to influence the rate and amount of herbage growth as well as the composition of the herbage. However, less is known regarding the effect of soil composition on the constituents of milk produced by cows grazing on this soil area. In order to determine the relationship, if any, between the actual soil fertility and the composition of milk produced, it would be necesary to know the complete analysis and quantities of feeds consumed by cows. This study was not planned for such a comprehensive undertaking but was set-up to determine the composition of milk delivered by the average patron under average farm conditions. The results of this study, therefore, would not scientifically correlate the soil fertility with milk composition under average farm conditions.

In this study it so happened that the area having a soil rated very high in calcium, phosphorus and potassium supplied milk from a breed which normally produces milk having a high butterfat and total solids content and a herd kept in good physical condition. The milk from this area had the highest butterfat, total solids, serum solids, total protein, lactose, ash, calcium and phosphorus content and averaged the lowest potassium content. Since the breed is less of a factor in the other four soil type areas ranging from high in calcium and medium in phosphorus and potassium to a soil rated very low in these minerals, a direct comparison between the milk produced by cows grazing on these four soil types would be more significant.

The butterfat, total solids and serum solids in the milk samples studied showed no relationship to the mineral content of the soil area in which the milk was produced. The same result was observed with respect to the protein in the milk. Milk produced in a soil area rated very low in calcium, phosphorus and potassium averaged .07 percent less butterfat and protein than milk produced in a soil area rated high in these elements.

The lactose content was noticeably uniform in the samples secured from the different soil areas. One exception noted was that a slightly higher amount of lactose was found in the milk produced in a soil area rated very low in calcium, phosphorus and potassium.

All samples showed a lack of correlation between the ash, calcium, phosphorus, potassium, sodium, magnesium and chloride content in the milk and the mineral richness of the soil in the area of production. In fact, the phosphorus and potassium content in the milk samples were slightly higher in the milk secured from soil areas rated low in calcium, phosphorus and potassium. Except for a lack of information of the amount of supplemental feeding the results suggest that the mineral content of the soil had little influence on milk composition.

Further indication that the minerals in the milk were not significantly different was noted in the freezing point and lactometer values. The freezing point values and lactometer readings were very uniform in the milk from various soil areas. The only exception that developed was noticed in the milk samples secured from a soil area rated very high in calcium, phosphorus and potassium. In this instance, the milk tended to have a higher freezing point and a higher lactometer reading. Again, the breed predominance in this area must be taken into consideration.

Rusoff and Seath (7) report that supplementing a mineral deficient ration with more calcium and phosphorus did not increase or alter the calcium and phosphorus levels in the blood plasma. They further add that no significant increase in milk production resulted by adding these minerals to the ration. While this does not imply that the calcium and phosphorus levels in milk would necessarily be affected, it does seem logical that the milk minerals would also show little correlation to the amount of these constituents in a ration. Furthermore, it is generally agreed by nutritionists and herdsmen that a ration deficient in calcium and phosphorus will cause the cow to draw upon the calcium supply in her bones and teeth in order to maintain a milk supply of normal composition. However, as Becker and others(1) point out, such practice will ultimately result in excessive bone fractures and low milk production. So it seems that the dairy cow will produce milk of a reasonable normal composition as long as the ration is adequate or the reserved constituents in her body are available; when both of these are exhausted, the milk production will decline rather than continue high with an abnormal composition.

While no correlation existed between the milk constituents and the calcium, phosphorus and potassium in the soil, a very definite relationship existed between the total solids content and the other milk ingredients. Considering all milk samples, the milk containing the highest percent of total solids also contained the highest percent of butterfat, serum solids, total protein, casein, ash, phosphorus and calcium. Similarly, the milk having the least total solids was low in the other constituents. Thus a direct relationship was observed between the total solids and the butterfat, serum solids, total protein, casein, phosphorus, calcium and ash. However, the lactose and potassium varied inversely with the total solids content. These findings are in general agreement with the conclusions of Overman (6).

Table 19 further compares some of the milk constituents on the basis of soil richness, and these data indicate the lack of influence of soil richness on the constituents studied in the milk samples.

Summary and Conclusion

Representative milk samples from Biloxi, Hattiesburg, Jackson, Leland, Olive Branch, Tupelo, Starkville and State College, Mississippi, were selected and analyzed each month through 17 calendar months.

The milk samples were analyzed for butterfat, total solids, total protein, casein, albumin, protein in albumin filtrate, lactose, ash, calcium, magnesium, phosphorus, sodium, potassium, chloride, specific gravity, pH, freezing point and titratable acidity.

Higher levels of butterfat, total solids, total protein, casein, ash, calcium and phosphorus were found in the Mississippi milk than were reported for northern analyses. Less lactose, potassium and chloride, however, were found in the milk analyzed than were reported for other areas. The results further indicated a higher ratio of butterfat to total solids, a higher ratio of total protein and casein to serum solids, and a lower ratio of lactose to serum solids than was reported for northern analyses.

The composition of the milk varied from season to season. Generally, the butterfat, total solids, serum solids, total protein, casein, ash and calcium were higher during the winter than during the summer. Phosphorus, except for an early spring increase, varied with the calcium trend. The percent lactose and potassium appeared to be high during the summer and low during the winter. Sodium, chloride and magnesium did not show a seasonal variation. The freezing point varied slightly from winter to summer and the lactometer also showed some variation; no definite seasonal trend was observed in either pH or titratable acidity.

A direct relationship between the butterfat, total solids, serum solids, total protein, casein and calcium was observed. An inverse relationship between these constituents and lactose and potassium was noted. The phosphorus tended to vary with the calcium except for an early seasonal increase in spring followed by a low in August. Ash tended to vary inversely with the lactose content.

The composition of milk produced within the state was quite uniform. Milk samples were selected from areas having a soil rated as very high in calcium, phosphorus and potassium to a soil rated very low in these elements. A slight difference in the butterfat, total solids and protein content was noticed but these variations were not definitely related to the soil condition.

The calcium and phosphorus content of milk from various areas of Mississippi did not vary with the mineral content of soil in the area. A region classed as low in soil minerals supplied milk equal in calcium and phosphorus to a milk produced on a soil area rated high in these constituents. Potassium levels also failed to show any correlation with the quantity of this element in the soil. In fact, the soil area rated the highest in potassium supplied a milk averaging the lowest amount of potassium.

While a direct relationship between the soil mineral levels and the percent of these same elements in milk was not evident, a definite relationship was observed between the calcium and phosphorus content and the total solids content. Furthermore, there was evidence that the lactose content tended to increase as the total solids content decreased.

This study shows that milk produced in Mississippi has a composition within range of other reported composition studies. It indicates that many of the constituents are variable from season to season. It establishes the uniformity of composition in the different regions of the State.

The results of this study suggest that the cheese manufacturer will experience a faster rennet action and a dryer curd formation during the fall and winter. The manufacturer of evaporated milk will likely experience more problems involving milk stability during the fall and winter. It generally shows that if problems in coffee cream feathering, in coagulation of milk during home cooking, and inability to withstand heat treaments are to occur, these will likely appear during the fall and winter.

Higher yields in evaporated milk processing and in cheese manufacture are secured in the winter season than during the summer.

The normal low levels of fat, total solids and solids-not-fat that develop in spring and summer are well within the standards as established by law in Mississippi.

The differences in the results of this study from other milk analyses appear to be largely due to breed rather than any other single factor. However, the climatic conditions and possibly the practice of having cows freshen in the early spring favor an earlier decline in some constituents than is reported in northern areas.

The high maximum variation in butterfat and total solids from winter to summer suggest that better feeding programs can be followed especially in the winter season.

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