THE EFFECT OF COTTONSEED FEEDING ON BUTTER FAT

By J. F. GEISLER

Cottonseed meal as a cattle food is of great economic importance. Because of its exceptionally high protein content it is of particular value in the dairy industry as an adjunct in the fodder rations, as it has been found to stimulate the production of milk besides improving the cattle through supplying them with norishing food. The effect of cottonseed feeding on butter fat has frequently been the subject of investigation and controversey.

Food affects the characteristics of butter fat, and to an extent greater than is generally supposed. Butter fat is milk fat. It is characteristically different from animal and vegetable fats and oils through its high content of what are collectively termed volatile soluble fatty acids, principally butyric and caproic. As long as cattle were fed or as long as they subsisted on grass, hay, clover and the usual farm products the variations in the composition of butter fat were not so noticeable or suspected, as they were in later years with the introduction of concentrated cattle feed; i.e., oil cakes and seed meals. These led to investigations which, through the use of more exacting critical analytical methods by numerous observers gradually established the fact that the composition of butter fat and departure from ordinary accepted standards was directly traceable to the kind and character of food.

As the cow is the medium for the production of the milk from which butter is made, it is of interest to briefly note some advances in the general knowledge of the effect of feed on the milk and thence on the butter fat. Thus Dr. Haase at the Agricultural Experiment Station in Moecken, Saxony, fed several cows, first upon hay, which he called normal fodder; secondly upon hay in connection with bean meal and rape meal, which are rich in albuminoids from which the cheese portion of milk is derived; thirdly upon hay in connection with oil and starch which contain carbohydrates from which the buttery portion of milk is derived. After a careful chemical analysis of the milk produced from several different kinds of food, he found so little difference in the corresponding kinds of milk that it could not be regarded of any practical account (U. S. Dept. Rep., 1871, p. 370). Dr. Kühn (Ibid, p. 370) who made several experiments on the same subject declares "that variations in fodder are not manifested in the quality of the milk, but in the quantity only." Dr. Wolff (Ibid, p. 370), Director of the Experiment Station at Hohenheim in Wurtenberg, who has conducted a long series of investigations on the subject, says "the quality of the food exercises no influence on the quality

of the butter in the milk except in the taste, while its influence becomes readily and distinctly manifested in the quantity of the milk yielded and in the increase or decrease of the live weight of the animals." Owing to inefficient methods in butter fat analysis up to that period, those opinions lose their edge of accuracy; for more efficient methods for butter fat analysis were not introduced until some years later.

Bearing on the increase of the yield of milk by feeding cottonseed meal Horace Colburn (U. S. Dept. Agr. Rep. 1869, p. 284) claimed "by feeding his cows 2 quarts each of cottonseed meal and fine meal per cow per day, in addition to hay, that in one week the cows thus fed doubled their yield of milk, the product also improved in quality while the animals made a decided improvement in appearance." Similar experience was reported by Leander Morey (Ibid, p. 440), and Belcher (Ibid, p. 440) as well as two other proprietors where cottonseed meal was fed liberally. Garget or constipation was not observed at any of these dairies as the result of the feeding. It would appear that these cows were exceptionally responsive in the increased yield of milk, and would need verification.

Definite differences in the effect of food upon the character of butter fat appear to have received recognition in 1874: "The character of the food has some influence on the character of the butter, but breed has more." (U. S. Dept. Agr. Rep. 1874, p. 254). Reaching a later period, the report by N. T. Lupton and Dr. J. T. Anderson: *Effect on Butter by Feeding Cotton Seed and Cotton Seed Meal.* (Bull. No. 25, New Series, Alabama Agr. Exper. Station, April 1, 1891) gives the details covering the investigation as to the composition of the various feeding rations and the effect of these upon the composition of the butter fat, showing a gradual lowering of the Reichert-Meissl number (ratio of volatile coluble fatty acids) from 30 to around 22, and the raising of the melting point of the fat gradually from 35 deg. C. to around 43 deg. C. These data together with finding that more or less definite color reaction for cottonseed oil was obtained on testing the butter fat, ought to effectually answer he question whether the feeding of cottonseed meal may affect the composition of butter fat. The data have been confirmed by others, as well as myself, and will be referred to later.

From researches by A. Zeitschek *On the influence of feeding stuffs on the composition of milk fat* (Landw. Vers. Stat. 74, (1911) No. 3-5, pp. 250-262) it is demonstrated that rations consisting of feeds which have a high iodin number, such as maize, bran, rapeseed cake, cause a rise in the iodin number of the milk fat, whereas the Köttsdorf and Reichert-Meissl numbers are lowered. The fat in the feeds influence the composition of the milk fat. Toward the end of the lactation period the saponification and Reichert Meissl numbers were lowered, while the iodin

number, refractive index, and melting point were raised. After change in feed the saponification and iodin numbers of the milk were quicker to change than the Reichert Meissl number. The physical character of butter is known to be affected by the kind of food; thus gluten meal, linseed meal and wheat bran are considered as productive of soft butters, while wheat straw and cottonseed meal are reputed to yield moderately hard to hard butters. In southern states and elsewhere where cottonseed meal has entered largely into the rations hard butters of high melting point are of frequent occurrence. Through the courtesy of C. D. Grinnells, in charge of Dairy Investigation, and R. Y. Winters, Director of the North Carolina Experiment Station at Raleigh, N. C., I was furnished with samples of butter which had been produced from the milk of cows under known conditions of feeding, amount of food and character of rations in which known percentages of cottonseed products played their active part. The series under way could not be completed in time for this paper, but two may be cited. They tell their story effectively. The feeding experiments were conducted from Dec. 4, 1925, to Feg. 11, 1926, during which period the feed for Groups I and III consisted of the following rations:

	Group I			Group III		
Concentrates	33.4%	Corn 16.6% Cott. S. M. 16.6%		32.1%	Corn 5.3% Cott. S. Meal 26.7%	
Roughage	66.6%	Alfalfa hay 22.2% Silage 22.2% Hull (Cott.) 22.2%		67.9%	Alfalfa hay 22.8% Silage 22.8% Cott. Hulls 22.3%	

The analyses of the resulting butters showed the following:

	Group I	Group III
Reichert-Meissl No.	23.58	24.86
Polenske Number	1.76	1.38
Melting Point *	39.5° C	43.1° C
Congealing Point **	31. ° C	30. ° C
Iodin Number	36.53	37.41
Turbidity Test	87	85
Refractive Index	1.4540 (at 40°C)	1.4550
Consistency	Very firm	Very firm
Cotton seed oil reaction	Faint	Faint

Particular attention is called to the increase in melting point through the feeding of a larger per cent of cottonseed meal.

From an investigation of western butters recently made by me in the early part of September, 1925, it appears that there is a general lowering of the Reichert-Meissl number in the commercial butters of the New York Market. None of the twenty samples specially examined gave any reaction for cottonseed product, and from investigation regarding the feed, pasturage appears to have been the principal food,

and in none was cottonseed meal or concentrates a part of the rations.

The following are the analyses of these twenty samples of butter from the New York market:

	Reichert Meissl No.	Polenske No.	Iodin No.	Melting Point*	Congealing Point**	Turbidity Test
No. 1	25.90	2.12	39.87	37.0°C.	27.2°C.	52.
2	25.71	1.91	38.67	38.2°C.	26. °C.	60.
3	26.09	1.98	39.37	38.5°C.	25.8°C.	56.
4	23.26	1.78	39.79	38.3°C.	27. °C.	68.
5	25.84	1.77	40.40	37.2°C.	27.2°C.	52.
6	25.44	2.04	41.42	38.8°C.	27. °C.	56.
7	25.90	1.86	39.33	37.2°C.	27.5°C.	50.
8	27.16	2.08	39.20	36.5°C.	26.8°C.	52.
9	26.41	2.00	38.84	38.0°C.	27.8°C.	51.
10	27.06	1.92	40.5	38.0°C.	27.5°	58.
11	24.86	1.84	42.5	38.3°	27.2°	54.5
12	24.92	1.38	42.17	38.3°	27.5°	55.5
13	26.83	1.88	39.73	38.5°	27.8°	55.5
14	26.27	2.01	38.56	37.0°C.	27.3°C.	49.
15	25.91	1.66	38.56	37.2°C.	28.0°C.	49.5
16	24.90	1.44	43.87	38.3°	27. °	48.
17	24.29	1.51	44.08	38.3°	26.6°C.	53.
18	27.14	1.70	41.53	38.5°	27.5°	53.
19	25.6	1.84	38.00	37.2°	27.2°	47.
20	28.24	1.83	38.60	37.2°	24.6°	46.

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*Regarding the Melting Point the degrees here recorded represent the temperature at which the melted fat finally clears. Butter fat being a mixture of glycerides of varying melting points usually softens around 29 to 30° C. and at 32 to 34° C. becomes semi-transparent. However 1 to 2 per cent of the mass does not melt clear until a higher temperature is reached and represents a more fixed determinable factor.

**The Congealing Point is the degree at which the melted fat shows the first signs of crystallization on cooling.