

EXPERIMENT STATION LIBRARY
OF THE
WASHINGTON AGRICULTURAL COLLEGE

BULLETIN No. 25.

NEW SERIES.

REPORT

—OF—


AGRICULTURAL EXPERIMENT STATION,

Agricultural and Mechanical College,

AUBURN, ALA.

APRIL, 1891.

Effects on Butter by feeding Cotton Seed and Cotton Seed Meal.

 The Bulletins of this Station will be sent Free to any citizen of the State, on application to the Director.

Smith, Allred & Co., State Printers and Binders, 24 Commerce St., Montgomery, Ala.

BULLETIN NO. 25.
AGRICULTURAL EXPERIMENT STATION,

Agricultural and Mechanical College,

AUBURN, ALA.

APRIL, 1891.

BOARD OF VISITORS.

COMMITTEE OF TRUSTEES ON EXPERIMENT STATION:

HON. J. G. GILCHRIST, . . . HON. R. F. LIGON, . . . HON. J. B. MITCHELL.

BOARD OF DIRECTION.

W. L. BROUN President
J. S. NEWMAN Director and Agriculturist
N. T. LUPTON. Vice-Director and Chemist
P. H. MELL Botanist
G. F. ATKINSON Biologist

ASSISTANTS :

ISAAC ROSS. . . 1st Assistant Agriculturist, charge of Live Stock and Dairy
JAS. CLAYTON Second Assistant Agriculturist
J. T. ANDERSON, PH. D. First Assistant Chemist
L. W. WILKINSON, M. SC. Second Assistant Chemist
J. F. WILKINSON, B. SC., Third Assistant Chemist
R. E. NOBLE Fourth Assistant Chemist
A. M. LLOYD, B. SC. Assistant Botanist
W. B. FRASER Clerk and Accountant

EFFECTS ON BUTTER BY FEEDING COTTON SEED AND COTTON SEED MEAL.

N. T. LUPTON.

THE COMPOSITION OF MILK.

The constituents of milk, as usually stated, are water, butter-fat, casein, milk-sugar, and mineral matter, or ash. The proportions of these constituents, and the quality of the milk, vary with the breed of cattle; the quantity, with the materials upon which they are fed and the treatment to which they are subjected. The average results of the analysis of *seventy* samples of Jersey milk, made in the State Laboratory by Dr. Anderson during the months of February, March, and April, 1889, are as follows:

Water.....	84.96	Per cent.
Butter Fat.....	4.95	“
Casein	3.50	“
Sugar	5.84	“
Mineral matter, or Ash.....	0.75	“

Total.....100.00

The average of *twenty-seven* samples, analyzed during the months of November, December, and January, 1890-91, gave:

Water.....	84.97	
Butter-Fat	4.97	
Casein.....	3.58	
Sugar	5.74	
Mineral Matter, or Ash. ...	0.74	

Total.....100.00

These samples from the same herd of registered Jerseys, show in the two series an average composition of remarkable uniformity. The feed-stuffs used were different during the two periods, the latter samples being those analyzed during an investigation of some of the effects produced by

feeding on cotton seed and cotton seed meal, to be discussed in a subsequent part of this Bulletin. Johnston and Cameron, in a late edition of their elements of Agricultural Chemistry, give, in the following table, what may be regarded as a fair average composition of milk of different animals, without reference to breed. Jersey milk contains less water than the average here given, and is especially rich in butter-fat:

	Water.....	Butter-fat.....	Casein...	Sugar ..	Min'l matter
Cow.....	87.00.....	3.80.....	4.00	4.57.....	0.72
Goat ...	86.49.....	5.69.....	3.51	3.69.....	0.62
Ewe.....	83.03.....	5.33.....	6.98.....	3.94.....	0.72
Mare...	90.36.....	1.05.....	1.95	6.24.....	0.40
Ass	89.01.....	1.85.....	3.57	5.05.....	0.52
Sow	81.76.....	5.83.....	6.18	5.33.....	0.90

CHANGES WHICH MILK NATURALLY UNDERGOES.

The butter-fat consists of small globules, somewhat lighter than water, which rise to the top when milk is allowed to stand, and with a little water and casein, constitute the cream. The agitation of this cream, in the process of churning, causes the fat-globules to cohere and form butter.

The casein is a nitrogenous substance which undergoes spontaneous decomposition on exposure to the air. This decomposition develops a growth, or organism, called a ferment, which changes the milk-sugar into lactic acid and renders the milk sour. The germs of these organisms which cause milk to ferment, are known as bacteria, or microbes and are found abundantly in the air, in water, and also on plants and animals. The casein held naturally in solution, is rendered insoluble by the lactic acid and separates as curd.

THE COMPOSITION OF BUTTER.

Butter consists mainly of the fat found in milk, and, as just stated, is formed by the fat globules which are made to cohere by agitation, as in the operation of churning. More or less water, casein or curd, and salts, are mixed

with the butter-fat. The average composition of the best Jersey butter as determined in this laboratory, is as follows :

Fat	86.06
Casein or Curd.....	1.87
Water.....	9.61
Salts (chiefly, common salt).....	2.46
	<hr/>
Total.....	100.00

When prepared for the market, a small percentage of sodium chloride; or common salt, about one ounce to the pound, is added to impart a desirable taste. Dairymen have long known that consumers of butter prefer that which has a bright yellow or golden color, such as results from feeding on the rich pastures of spring and early summer. To impart this color to butter of lighter shades, a coloring matter known as annatto, is sometimes used. It is gotten from the fruit of a tree that grows in South America, and is said to be harmless.

THE EFFECT OF COTTON SEED AND COTTON SEED MEAL.

An investigation was undertaken in this laboratory, a few months ago, to determine the effect of cotton seed and cotton seed meal on the composition of the butter fat, especially on the volatile acids, the melting point, and the specific gravity of the butter produced.

Several chemists of late years, have called attention to changes produced by the use of the feed-stuffs mentioned, especially Prof. Harrington of the Texas Experiment Station and Dr. Wiley of the Department of Agriculture, Washington D. C. This subject was thought to be of sufficient scientific and practical importance to justify an extended investigation. For this purpose, a herd of registered Jerseys at the Experiment Station, was divided into two groups, one consisting of ten cattle and the other of a single cow. The cattle of group No. 1 were fed for a preparatory period of ten days on the customary ration used at the station, excluding cotton seed meal and hulls, the single cow was fed on the same ration. At the end of the preparatory period, samples of

milk and butter were taken for one week, on Monday, Wednesday, and Friday, and carefully analyzed. The milk of the ten cattle composing group No. 1, was mixed and churned as a whole; that of the single cow was kept separate and churned by itself. The first preparatory period was for ten days; after that, the preparatory and experimental periods extended over seven days each.

The daily rations for the different periods which represent the kind and quality of food actually consumed, were as follows :

1st period, preparatory and experimental :

Ground Oats.....	5 lbs.
Ground Corn.....	5 "
Bran.....	5 "
Nutritive Ratio.....	1:5.8

2d period :

Cotton Seed Meal.....	3 lbs.
Ground Oats.....	4 "
Bran.....	5 "
Ensilage.....	11 "
Nutritive Ratio.....	1:3.75

3d period :

Cotton Seed Meal.....	4 lbs.
Cotton Seed Hulls.....	9 "
Ensilage.....	4½ "
Nutritive Ratio.....	1:5.08

During the fourth period, the cattle were confined exclusively to raw cotton seed and cotton seed hulls; and during the fifth period to cooked cotton seed and cotton seed hulls. They were allowed as much as they would eat. The nutritive ratios mentioned above, are calculated from the following analyses of feed-stuffs used.

In compounding the rations, the object was not so much to conform with strictness to the German standard, as to bring the cows gradually under the influence of cotton seed, cotton seed meal, and hulls without injury to their health.

COMPOSITION OF FEED STUFFS USED AT THE EXPERIMENT STATION.

	Corn.	Oats.	Bran.	C. S. Meal.	Cotton Seed.	Ensilage.	C S. Hulls.
Water.	14.15	10.55	12.81	8.48	10.11	60.93	12.76
Ash.	1.20	3.12	5.49	6.47	3.90	2.43	2.94
Crude Protein (albuminoid)	10.36	14.41	17.28	47.72	7.40	3.22	2.78
Ether Extract (Fats & oils.)	3.79	4.67	4.17	8.22	20.77	1.82	2.17
Crude Fibre.	1.68	10.45	8.02	7.28	24.61	13.76	44.84
Nitrog'n free ext (starch etc)	68.82	56.80	52.23	21.83	33.21	17.84	34.51
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The results of the analyses of samples of milk and butter, taken immediately after each milking and churning, are given below. The first two tables give the composition of each sample of milk analyzed, also, the volatile acids, melting point, and specific gravity of the butter from the same milk; the third table gives the average composition for each experimental period.

THE COMPOSITION OF JERSEY MILK.

BUTTER FROM THE SAME MILK.

118

DATE Group I.	WATER Per Cent	BUTTER FAT PerCent	CASEIN Per Cent	SUGAR Per Cent	ASH Per Cent	VOLATILE ACIDS. Expressed in CC one-tenth nor- mal alkali for 5 grains of fat.	MELTING POINT C°	SPECIFIC GRAVITY at 100° C	RATION
Nov. 19	85.76	5.53	3.95	3.96	0.80	30.0	35° 9	0.90257	} Period I. Ground Oats... 5lbs " Corn... 5 " " Bran... 5 "
" 21	84.95	5.20	4.05	5.09	0.81	29.6	35° 3	0.90311	
Dec. 1	84.15	5.73	4.06	5.24	0.82	29.7	36° 0	0.90411	} Period II. Cotton Seed Meal. 3lbs Ground Oats... 4 " Bran... 5 " Ensilage... 11 "
" 3	83.62	5.51	3.88	6.19	0.80	30.5	36° 3	0.90165	
" 5	84.26	5.16	3.90	5.98	0.80	31.4	36° 1	0.90265	
" 15	84.53	5.96	3.64	5.12	0.75	28.4	36° 6	0.90081	} Period III. Cotton Seed Meal. 4lbs C. S. Hulls... 9 " Ensilage... 4½ "
" 17	83.35	6.07	3.60	6.03	0.75	26.9	37° 6	0.90194	
" 19	84.71	5.79	3.57	5.19	0.74	27.1	38° 1	0.90306	
Jan. 5	84.27	6.41	3.58	5.01	0.73	22.0	43° 6	0.90021	} Period IV. Raw Cotton Seed. Cotton Seed Hulls.
" 7	84.59	6.11	3.34	5.22	0.74	21.9	43° 9	0.89721	
" 9	84.51	5.84	3.56	5.37	0.72	22.4	43° 4	0.89955	
" 19	85.84	4.87	3.39	5.16	0.74	23.1	42° 7	0.90462	} Period V. Cooked Cotton Seed. Cotton Seed Hulls.
" 21	84.89	5.95	3.31	5.08	0.77	22.2	42° 3	0.90057	
" 23	85.38	5.53	3.31	5.04	0.74	22.1	43° 0	0.90266	

8

THE COMPOSITION OF JERSEY MILK.

BUTTER FROM THE SAME MILK.

119

6

DATE Group II.	WATER Per Cent	BUTTER FAT Per Cent	CASEIN Per Cent	SUGAR Per Cent	ASH Per Cent	VOLATILE ACIDS Expressed in cc one-tenth normal alkali for 5 grains of fat.	MELTING POINT C°	SPECIFIC GRAVITY at 100°C	RATION
Nov. 24	85.53	4.67	3.84	5.23	0.73	31.4	35° 1	0.90188	} Period I. Ground Oats... 5 lb " Corn... 5 " " Bran... 5 "
" 28	84.03	5.93	3.93	5.30	0.81	31.5	33° 4	0.90458	
Dec. 8	85.71	4.75	3.56	5.30	0.68	....	....	.....
" 10	85.68	4.53	3.84	5.24	0.71	31.7	36° 5	0.90282	} Period II. CottonSeed Meal. 3lbs Ground Oats... 4 " Bran... 5 " Ensilage... 11 "
" 12	85.63	3.94	3.66	6.02	0.75	30.6	36° 2	0.90022	
" 22	85.26	4.74	3.42	5.86	0.72	25.5	37° 5	0.90192	
Jan. 2	84.31	5.85	3.69	5.42	0.73	25.4	41° 3	0.89798	} Period III. CottonSeed Meal. 4lbs C. S. Hulls... 9 " Ensilage... 4½ "
" 12	85.17	5.12	3.40	5.60	0.71	20.5	43° 5	0.89751	
" 14	85.10	4.76	3.47	5.98	0.69	19.2	41° 0	0.89929	
" 16	85.54	4.80	3.34	5.64	0.68	21.4	43° 0	0.89883	} Period IV. Raw Cotton Seed. Cotton Seed Hulls.
" 26	86.21	4.87	3.13	5.09	0.70	22.0	43° 3	0.89775	
" 28	86.00	4.88	3.12	5.28	0.72	22.1	43° 3	0.89994	} Period V. Cooked Cotton Seed. Cotton Seed Hulls.
" 30	85.39	6.00	3.18	4.72	0.71	21.7	44° 0	0.89803	

THE AVERAGE COMPOSITION OF JERSEY MILK.

BUTTER FROM SAME MILK.

PERIOD	WATER Per Cent	BUTTER FAT Per Cent	CASEIN Per Cent	SUGAR Per Cent	ASH Per Cent	VOLATILE ACIDS Expressed in cc one-tenth nor- mal alkali for 5 grains of fat.	MELTING POINT C°	SPECIFIC GRAVITY. At 100°C.
Group I								
I	85.35	5.36	4.00	4.52	0.81	29.8	35° 6	0.90284
II	84.01	5.47	3.95	5.80	0.81	30.5	36° 1	0.90280
III	84.20	5.91	3.60	5.45	0.75	27.5	37° 4	0.90194
IV	84.46	6.12	3.49	5.20	0.73	22.1	43° 6	0.89899
V	85.37	5.45	3.36	5.09	0.75	22.5	42° 7	0.90262
Group II								
I	84.78	5.30	3.89	5.26	0.77	31.4	34° 2	0.90323
II	85.67	4.41	3.69	5.52	0.71	31.1	36° 3	0.90152
III	84.79	5.30	3.37	5.64	0.72	25.45	39° 4	0.89995
IV	85.27	4.89	3.40	5.74	0.69	20.4	42° 5	0.89854
V	85.87	4.92	3.14	5.03	0.71	21.9	43° 5	0.89857

The following table, taken from a record carefully kept at the dairy, gives the aggregate amount of milk and butter produced by group No. 1, consisting of ten cows, for each experimental period of seven days.

	Milk in Pounds.	Butter Pounds.	Pounds of milk for 1 lb. butter.
Period I	.....1414½	..... 82	.....17.2
“ II	.....1275	.....85½	.....14.9
“ III	..... 975	.....91	.....10.7
“ IV	..... 896	.....75	.....11.9
“ V	..... 716	.....58	.....12.3

As will be observed, there is a marked falling off in the quantity of milk and a corresponding increase in the amount of butter, produced during the first three periods as the cattle were getting more and more under the influence of cotton seed meal.

During the remaining periods, the quantities of both milk and butter diminished, the ration being confined to cotton seed and cotton seed hulls, without reference to having it well-balanced as a milk ration.

The general effects of these valuable feed stuffs when used in carefully prepared rations will be hereafter investigated; at present, we are concerned only, as previously stated, with their effects on the volatile acids, melting point, and specific gravity of the butter-fat produced under their influence. For these effects, attention is called to the above tabular statements, from which the following conclusions are drawn.

1. The quantity and, to some extent, the quality of milk and butter vary with the feeding.
2. The milk increases in richness, or yield of butter, by the use of cotton seed and cotton seed meal, but diminishes in quantity.

The opinion of some that the quality of butter and milk is not affected by the feed stuff, is not sustained by these experiments.

3. Cotton seed and cotton seed meal increase in a marked degree the melting point of butter, the increase in these experiments, amounting to eight or nine degrees centigrade, and diminish to a corresponding extent, the volatile acids, while the specific gravity remains virtually the same.

The richness of cotton seed meal in albuminoids, or crude protein, renders it of prime importance to mix it with one or more feed stuffs poor in this nitrogenous compound, such as ensilage, hay, or cotton seed hulls.

It may be stated in this connection, that no change was observable in the color of the butter from feeding cotton seed and cotton seed meal. The samples, still in the laboratory, are all of a beautiful golden yellow.

It is proper to state that the analytical work represented in the above tables, was done by Dr. J. T. Anderson, first assistant in the chemical laboratory.