INHERITANCE OF BUTTERFAT PERCENTAGE IN JERSEY COWS*

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For many years milk of the different dairy breeds has been advertised as containing a certain definite percentage of butterfat. The American Jersey Cattle Club has proclaimed that the test of Jersey milk averages approximately 5.36 per cent. That this percentage varies only slightly with age, is proved by a study of all the 365-day records completed to January 1, 1926.

The records that have been completed each year since the adoption of the Register of Merit indicate that over a period of over twenty-three years the fat percentage of Jersey milk has remained quite constant. This is shown in table 2 which gives the butterfat percentage and total fat production for the first six years after the adoption of the Register of Merit and for the last four years.

The average percentage of all the yearly tests completed is 5.365 per cent, which means that there were many records averaging lower than this, and of course, many more with higher tests. The increase in total yearly fat production indicates that breeders have constantly striven for increased yields. Their success is evident. It is also shown that the greater fat production has been accomplished only by increasing the milk producing capacity of the Jersey cow. This may be accounted for in two ways; either there is less variability in the percentage of fat than in the milk yield, or it is because dairymen have heretofore paid little attention to the butterfat percentage in their breeding operations. If the percentage of fat in milk is a definite character, inherited separately and independently of other factors, it would appear that breeders were neglecting to use an important tool for the improvement of dairy production.

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Roberts, (1) in an investigation conducted in 1918, found a negative correlation between the percentage and milk yield of

TABLE 1

AGE	NUMBER OF 365-DAY RECORDS	AVERAGE FAT PERCENTAGE
		per cent
Yearling	1,365	5.433
Jr. 2	4,091	5.437
Sr. 2	1,901	5.469
Jr. 3	2,010	5.427
Sr. 3	1,550	5.424
Jr. 4	1,537	5.417
Sr. 4	1,291	5.374
5 years	2,256	5.321
6 years	1,653	5.253
7 years	1,226	5.265
8 years	802	5.248
9 years	511	5.215
10 years	296	5.182
11 years	169	5.163
12–23 years	201	5.273
All ages	20,859	5.365

TABLE 2

YEAR	NUMBER OF 365-DAY TESTS	AVERAGE YEARLY BUTTERFAT	AVERAGE YEARLY FAT PERCENTAGE
		pounds	*per cent*
1904	18	348.61	5.402
1905	48	399.02	5.451
1906	78	403.53	5.315
1907	92	433.71	5.482
1908	103	430.83	5.441
1909	173	425.42	5.430
1922	2431	487.34	5.368
1923	1979	512.32	5.392
1924	1498	519.99	5.375
1925	1191	529.94	5.362

Jerseys, Guernseys and Holsteins. For the Jersey breed he reported a correlation of -0.354 ± 0.013. This was a more pronounced negative correlation than for the Guernsey and Holstein

breeds. Wilson (2) however, states that the characters of fat percentage and milk yield are independent and have no effective influence upon each other. Graves (3), from a study of Holstein sires, also concluded that in Holstein cattle the percentage of

TABLE 3

Analysis of records with high fat percentages

Test of 80 cows with high tests who have tested dams	6.958 %
Test of 80 dams of cows who have high tests	5.952 %
Difference	1.006 %
Test of 63 cows with high tests who have tested sisters out of same dams.	6.988 %
Test of 63 maternal half sisters of 63 high testing cows	5.834 %
Difference	1.154 %
Test of 41 high testing cows who have both tested dams and tested maternal half sisters	6.985 %
Test of 41 dams of above high test cows	5.885 %
Difference	1.100 %
Test of 41 maternal half sisters of above high testing cows who also have tested dams	5.844 %
Difference	1.141 %
Test of 59 high testing cows who have tested paternal grandams	6.984 %
Test of 59 paternal grandams of high testing cows	5.626 %
Difference	1.1358%
Test of 141 high testing cows who have tested half sisters by same sire	6.952 %
Average test of half sisters (by same sire) of high testing cows	5.893 %
Difference	1.059 %
Test of 53 high testing cows who have tested daughters	6.965 %
Test of 53 daughters of high testing cows	6.105 %
Difference	0.860 %
Test of 6 high test cows with proven sons	6.90 %
Test of daughters of 6 proven sons of high test cows	5.78 %
Difference	1.12 %
Average fat yield of 160 high testing cows	494.8 pounds

butterfat and milk yield seem to be inherited separately. His data also indicated that both the sire and dam contribute to the inheritance of the fat test of their daughters and that improvement in yield of butterfat can be brought about by selection for both milk yield and percentage of fat.

It was with the object of continuing this work previously begun by others, and possibly throwing more light on the subject of inheritance of butterfat percentage, that the following study was made.

TABLE 4

Analysis of records with low fat percentages

Test of 44 cows with low test who have tested dams	4.133%
Test of 44 dams of cows who have low tests	4.812%
Difference	0.679%
Test of 41 cows with low tests who have tested sisters out of same dams	4.121%
Test of 41 maternal half sisters out of low testing cows	5.035%
Difference	0.914%
Test of 26 low testing cows who have both tested dams and tested maternal half-sisters	4.140%
Test of 26 dams of above low test cows	4.761%
Difference	0.621%
Test of 26 maternal half-sisters of low test cows	4.905%
Difference	0.765%
Test of 42 low testing cows who have tested paternal grandams	4.130%
Test of 42 paternal grandams of low test cows	4.990%
Difference	0.860%
Test of 111 low testing cows who have tested sisters by same sire	4.168%
Average test of half-sisters (by same sire) of low test cows	4.660
Difference	0.492%
Test of 46 low testing cows who have tested daughters	4.167%
Test of 46 tested daughters of low testing cows	4.910%
Difference	0.743%
Test of 5 low test cows with proven sons	4.19 %
Test of daughters of 5 proven sons of low test cows	5.14 %
Difference	0.95 %
Average fat yield of 135 low testing cows	425.1 pounds

DATA PRESENTED

A study of all the records in the Consolidated Register of Merit volume revealed that of the 21,000 cows listed, 160 had completed long time tests averaging above 6.75 per cent in butterfat. Fifty-three of these records averaged higher than 7.00 per cent. The average percentage of the tested dams of these 160 cows was

determined, and also the fat percentage of their tested maternal and paternal half-sisters. Likewise the yearly fat percentage of the tested daughters of these high testing cows was looked up. Proven sons of these high testing cows were included and the tests of their daughters recorded.

A similar study showed that 135 Jersey cows had completed tests with yearly average butterfat percentages lower than 4.25 per cent. Tests of their dams, sisters and daughters were determined exactly as described for the cows testing above 6.75 per cent.

Of course in a considerable number of cases, either the dam, sisters or daughters were not tested. This reduces the number of animals that can be used in the final analysis. The average results of both these tabulations are presented in tables 3 and 4.

In analyzing these studies too much emphasis should not be given to the final average percentages found. The uniformity of the inheritance of high or low butterfat tests and the amount of variation are important items that cannot be seen in the tables. The averages obtained do show that there is a noticeable tendency for the butterfat percentages to approach the average of the breed. Daughters of extremely high or low testing cows rarely tested as high or as low as their dams. Of the high testing cows there were only ten having tested dams with percentages below the breed average. The average tests of the paternal half-sisters of cows out of these ten dams all exceed the breed average by a considerable amount. In fact, the average tests of the daughters of seven of the ten sires are above 6.00 per cent. This would indicate that the cows with high tests out of average testing dams inherited their fat percentage from their sires. Fifteen of the low testing cows are out of dams with percentages above 5.00, yet in each of these cases the sires of these fifteen cows transmitted especially low tests to all their daughters.

It is significant that as far as known, every cow with a high test was either out of a dam with a percentage considerably above the average for the breed, or else was sired by a bull who transmitted high tests to the majority of his daughters. Similarly,

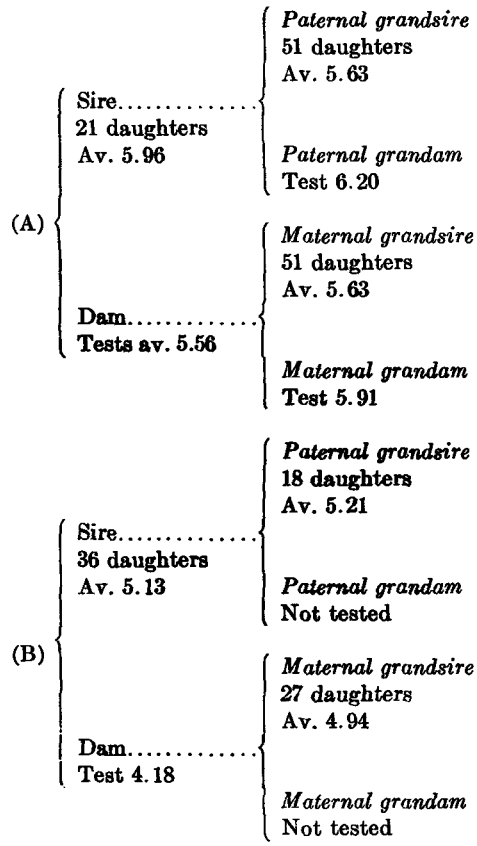
the low testing cows were in every case either out of a low testing dam or by a sire whose daughters were low testers.

There were seven cases of mating a dam testing above 6.00 per cent with a sire all of whose daughters averaged over 6.00 per cent. In each of these cases the daughter averaged above 6.87 and four were above 7.00 per cent.

From the above lists two nationally known sires were chosen for further study. One of these bulls (A) has 20 tested daughters who have an average butterfat percentage on yearly test of 6.57 per cent. Considering the number of daughters, this bull leads the breed in the high tests of his offspring. The other sire (B) equally well known, has 34 Register of Merit daughters with an average butterfat percentage of only 4.71. It happened that the dam of each of the twentv daughters of A was tested. The average test of the dams was 5.72 per cent. As the dams were high testers the bull must have been remarkably prepotent to increase the test an average of 0.85 per cent. This bull has two proven sons whose daughters average 6.63 and 5.54 per cent respectively.

Twenty-five of the Register of Merit daughters of B were out of tested dams. The twenty-five daughters averaged 4.68 while their dams averaged 5.13. This again illustrates a bull especially prepotent except that he transmitted low tests to all of his daughters. Only one daughter did he sire that tested above the average for the breed. B has eight proven sons and each inherited the factor for low tests from their sire. Daughters of these proven sons averaged but 4.98 per cent of fat.

As these two sires were so remarkably prepotent, a study was made of their pedigrees. These are given in skeleton form and explain in a large degree the transmitting ability of both sires. The pedigree of A is a good illustration of the continuous mating of high testing animals with the result that a bull was obtained remarkably prepotent in transmitting high tests to his offspring. In total fat production, the daughters of A averaged 829.6 pounds of fat when calculated to a mature 365 day equivalent, while their dams averaged 752.4 pounds.



To study further the relation between butterfat percentages and total fat and milk production, all of the 365-day records in the Consolidated Volume made by mature cows from five to eight years of age, were arranged in columns according to the test percentages. There were fourteen groups ranging from the lowest tests to the highest. The average fat and milk production of each group is shown in table 5.

All records exceeding 700 pounds of fat were arranged in groups and the average fat percentage of each group determined. These are listed in table 6.

There were 393 yearly records completed during 1926 by cows over five years of age. Table 7 shows the degree of correlation

TABLE 5

Classification of all 365-day records in Consolidated R. of M. Volume made by cows from 5 to 8 years of age

AVERAGE YEARLY FAT PERCENTAGE	NUMBER OF COWS IN EACH GROUP	AVERAGE FAT YIELD	AVERAGE MILK YIELD
per cent		*pounds*	*pounds*
3.50–4.20	22	492.1	12,079
4.21–4.40	80	487.0	11,326
4.41–4.60	203	498.9	11,087
4.61–4.80	364	498.1	10,598
4.81–5.00	552	511.3	10,435
5.01–5.20	641	514.0	10,078
5.21–5.40	625	530.6	10,011
5.41–5.60	648	528.9	9.616
5.61–5.80	511	539.1	9.458
5.81–6.00	359	548.1	9,290
6.01–6.20	236	558.9	9.163
6.21–6.40	128	559.5	8,881
6.41–6.60	79	545.6	8,394
6.61–7.50	65	580.3	8,480

TABLE 6

Analysis of R. of M. records above 700 pounds of butter fat

YEARLY PRODUCTION OF FAT	NUMBER OF COWS	AVERAGE BUTTERFAT PERCENTAGE
pounds		*per cent*
950–1141	39	5.835
900–950	47	5.633
850–900	87	5.637
800–850	161	5.632
750–800	280	5.631
700–750	589	5.487
700–1141	1,203	5.562

TABLE 7

NUMBER OF ANIMALS		MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIABILITY	CORRELATION BETWEEN MILK AND FAT PERCENTAGE	CORRELATION BETWEEN TOTAL FAT AND FAT PER CENT
393	Milk.....	11433±76.8	2255.0±54.2	19.72±0.47	−0.311±0.0310	
	Per cent fat.....	5.430±0.018	0.552±0.011	10.16±0.24		
	Total fat.....	618.8±3.46	101.5±2.44	10.45±0.39		+0.233±0.0324

between milk and fat percentage and between total fat production and fat percentage of these tests.

The results shown by tables 5, 6 and 7 indicate that there is a correlation between total fat production and percentage of butterfat and that the fat production increases as the fat percentage increases. The milk yields shown in tables 5 and 7 agree with the findings of Roberts (1) in that they indicate a negative correlation between fat percentage and milk yields. It is very significant, however, that although this negative correlation exists, nevertheless the milk yields do not decrease in the same ratio as the fat percentages increase. In other words the decline in milk flow is not sufficient to prevent the total fat from increasing as the test increases. This is further confirmed in table 5. If the milk flow declined in proportion as the butterfat percentage increases, there would be no justification for the breeding of higher testing cows.

SUMMARY

1. Butterfat is a variable factor although the degree of variability is less than for milk yield.

2. Both the sire and dam contribute to the inheritance of their daughters, governing fat percentage.

3. A parent may be prepotent in increasing the fat percentage of the offspring separately from affecting the milk yield, or may increase or decrease both the percentage of fat and the milk yield.

4. Although there is a negative correlation between milk yield and fat percentage, there is a positive correlation between total fat production and fat percentage.

5. Improvement in total butterfat production can be accomplished by selection for high fat percentage as well as selection for large milk yields.

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