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THE INHERITANCE AND RELATIONSHIPS BETWEEN SOME DAIRY CHARACTERS IN THE EGYPTIAN BUFFALOES

By

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SUMMARY

A statistical analysis was undertaken on two herds of buffaloes located at the Sakha and Sids Experimental Stations maintained by the Ministry of Agriculture. Data included 2281 normal records covering a period of twenty years. The main purposes of this analysis were to study the inheritance of some dairy traits, and to investigate the interrelationships between these characters.

Economic traits studied were the milk yield in the first 90 days of lactation period (intensity), maximum weekly production, total milk yield, 305 day milk yield, lactation period and persistency. Investigation have led to the following conclusions:

(1) The repeatability estimates for different characters ranged between 0.18 to 0.41, while heritability estimates ranged from 27% to 43%.

(2) The phenotypic correlations between characters studied for pooled data obtained ranged from 0.233 to 0.889 and all estimates were highly significant.

(3) Most of the genetic correlations obtained in this study were more than 0.50 and some of these estimates were close to unity.

Moreover, the genetic correlation between intensity of milk yield for the first and second lactation is unity.

INTRODUCTION

The water buffalo is the main dairy animal in many countries in the Middle and the Far East. Little is known about the phenotypic and the genetic correlation between different traits in buffaloes, although the repeatability and heritability of some characters were reported by some workers, El-Itriby and Asker (1965).

This invstigation was carried out to provide more information on the inheritance of some dairy characteristics in buffaloes and to estimate the interrelationships between these traits. Such useful information are needed in planning improvement plans. Two of the tratis studied can be measured early in the lactation period and may have practical application in selecting dairy animals. These two tarits are the milk yield in the first 90 days (intensity) and the maximum weekly production.

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MATERIAL AND METHODS

Milk records collected over the last twenty years on two herds of buffaloes maintained by the Animal Production Department, Ministry of Agriculture, were utilized in this investigation. One of the two herds is located at Sakha Experimental Station in the northern part of the Delta, while the other herd is kept at Sids Station which is about 100 miles south of Cairo. The number of buffaloes at Sakha and Sids Stations were 571 and 292 having 1457 and 824 normal lactations in the two stations respectively.

Repeatability and heritability of different characters were estimated according to Lush (1949) and the method developed by Hazel (1943) was used incalculating the genetic correlations between different tratis. The standard error for the genetic correlations was worked out using the method reported by Robertson (1959). The formula presented by Falconer (1961) was applied to obtain the environmental correlations between characters. Statistical analysis carried out in this report were according to Snedecor (1956).

The following symbols were used trhoughout this report.

Item	*Symbols*
Intensity	Int.
Total Milk Yield	T.M.Y.
Maximum Weekly Production	Max. W. Prod.
Lactation Period	L.P.
Persistency	Persis.
Repeatability	Rep.
Heritability	h^2
The Phenotypic Correlation Between X and Y	r_p
The Genetic Correlation between X and Y	r_A
The Environmental Correlation between X and Y	r_E

RESULTS AND DISCUSSION

Repeatability and Heritability of Characters Studied :

Estimates obtained as the repeatability of characters studied are shown in Table 1, based on 1614 records collected in the first four lactations. The repeatability of 0.41 and 0.40 of total milk yield and 305 day milk yield of buffaloes may suggest that a fair proportion of culling might well be done on the performance of the first lactation rather than waiting till subsequent ones. Estimates obtained are similar to corresponding values for other studies on buffalo (Ashfaq and Mason (1954), El-Itriby and Asker (1965) and Singh and Desai (1962).

The repeatbility of 0.27 for the lactation period in this work is very close to that obtained by other workers [Asker et al (1953) and Mahadevan (1961)]. Repeatability of maximum weelky production is identica to that of intensity being 0.34. This result is in close agreement with that reported by Singh and Desai (1961). who found it to be 0.39 working on Hariana cattle.

Repeatability of persistency in buffaloes was reported by Asker and Bedeir (1961) to be 0.22 which is close to the value obtained in the present study (0.18), while Maymone and Malossini (1962) found it to be 0.07 in Italian buffaloes. Rendel et al (24) studied the repeatability of yield in the first 70 days and found it to be 0.38 compared to 0.34 for milk yield in the first 90 days in buffaloes.

TABLE 1.—Repeatability and heritability of characters studied

Characters	Repeatability No. 1614 Rep. S.E.	$h^2 \pm$ S.E. (1) No. Sires 67 No. offspring 618	$h^2 \pm$ S.E. (2) No. Sires 33 No. offspring 255
Int.	0.343±0.222	0.348±0.134	0.384±0.122
Max. Weekly Prod. .	0.342±0.022	0.432±0.147	0.434±0.116
T.M.Y.	0.414±0.021	0.485±0.146	0.272±0.132
305 day M.Y. . . .	0.405±0.021	0.394±0.142	0.268±0.138
L.P.	0.270±0.023	0.244±0.119	0.274±0.138
Persis.	0.180±0.024	0.267±0.122	0.332±0.144

(1) Heritability on basis of half-sibs

(2) Heritability on basis of daughter dam regression.

Thirty three sires and 255 daughter dam pairs having the first records were available for estimating the heritability of various characteristics. The number of animals included in the half-sibs analysis was 618. In Table 1 the heritability estimate of milk yield for buaffloes was 27.0% which is in close agreement with the finding of Hilmy (1954), Ashfaq and Mason (1954) and El-Itriby and Asker (1956). The value obtained for the heritability of the length of lactation period in buffaloes is in agreement with the results reported by Hilmy (1954). The present result is higher than 1.10% and 13.8% reported by Asker at al (1953) and El-Itriby and Asker (1965).

It can be seen also from Table 1 that the heritability estimates for maximum weekly production and yield in the 90 days are higher than other traits studied in this respect. The heritability estimate of maximum weekly production in buffaloes was found to be 43.0%. Asker and Bedeir (1961) obtained a lower estimate for the same character in buffaloes being 13.0% which may be due to the limited number of daughter dam pairs used in their study.

No information are available on the heritability of partial records in buffaloes. Rendel et al (1957), in England however, found the heritability of the yeild in the first 70 days to be 36.0% which is very close to 38.0% found in the present work. Johansson (1961) reported that estimates of heritability of milk yield using partial first records were of the order 30.0% and 34.0% for 100 and 200 day milk yields respectively. This result is in agreement with our finding on intensity.

Asker and Bedeir (1961) analysing the records collected on a herd of buffaloes concluded that heritability of persistency of lactation was 23.0% which is lower than that found in the present work. Results on cattle obtained by Madadevan (19 1) and Sana Allah (1952) on heritability of persistency demonstrated that 15.0 to 30.0 percent of the total variance in persistency is due to genetic differences between indivduals. These results on dairy cattle are in agreement with our work on buffaloes.

It can be seen from the present analysis that the repeatability and heritability for the amputated lactation was found to be slightly higher than those for the total lactation. Such finding may be due to the increasing effects of various environmental factors towards the end of lactation. Heritability of all characters was the same using both methods, i.e. half sibs and daughter dam regression, except in the cases of total milk yield and 305 day milk yield as presented in Table 1. The same table indicates that heritability on the basis of daughter dam pairs is more efficeint than using the half-sibs method, because its sampling variance is less in most of the characters studied.

Interrelationship between different Characters :

Table 2 includes the phenotypic, genetic and environmental correlations between various characters. The phenotypic correlations were based on 618 first lactations, while 255 daughter dam pairs were utilized in calculating the genetic correlations. The daughters were the progeny of 33 sires, and each sire had at least two daughter dam pairs. It can be seen, that the phenotypic correlations obtained ranged from 0.233 to 0.889 and all estimates are statistically highly significant.

The phenotypic correlations between intensity and 305 days milk yield as well as that between maximum weekly production and 305 days milk yield are high being 0.738 and 0.736 respectively. These results are in agreement with similar work in Italy reported by Salerno (1960) on buffaloes. On dairy cattle, Madden et al in the United States, Rendel et al (1957) in England, Van Vleck and Henderson (1961) in New York State reported high phenotypic correlations bet- ween milk production in the first part of the lactation and 305 days milk yield.

This estimate on the correlation between maximum production and 305 days milk on buffaloes (0.786) is in line with results obtained by Asker et al, (1958) in U.A.R. and Ventakaratnam and Venkeyy (1964) in India. It may be stated therefore, that in addition to intensity (first 90 days), maximum milk yield for both cattle and buffaloes is a reliable criterion for evaluating the mliking capacity of dairy animals.

The relationship between persistency and 305 days milk yield in the present study (0.69) is very close to that reported by Asker and Bedeir (1958) on buffaloes. It can be suggested also that it is spossible to combine a high initail yield with as reported by Sana Allah (1952) and Asker and Bedeir (1961).

TABLE 2.—**Phoonotypic, Genetic and Environmental Correlations Between Different Characters**

Characters correlated	r_p	r_A	r_E
Int.+305 days M.Y. . .	0.738±.037	0.885±.069	0.684
Int.+L.P.	0.414±0.37	0.463±.222	0.395
L.P.+T.M.Y.	0.859±0.21	0.671±.191	0.928
L.P.X. Persis	0.762±.026	1.00±2.001	0.661
Persis.×305 day M.T. . .	0.697±.029	0.931±.044	0.599
Int.×Persis.	0.233±.039	0.498±.197	0.086
Maximum weekly Prod. + 305 day M.Y.	0.786±.025	0.697±.135	0.852

The observed highly significant correlation between lactation period and persistency (0.762), indicates the importance of lactation period on persistency of lactation. This conclusion agrees with that reported by Asker and Bedeir (1961) studying buffaloes and Blau (1961) who indicated that the longer the lactation period the greater is the persistency of a cow. The strong relationship presented in this study between lactation period and total milk yield is very close to the results obtained by Mahadevan (1956), Asker et al (1958) and Venkataratnam and Venkeyy (1964).

Genetic Correlation :

The phenotypic correlation is not a staisfactory guide to the relationship between two traits, and therefore, the genetic correlations between different characters were also claculated. The genetic correlation is actually a description of the relation between the additive deviations caused by genes in two traits, and it can be utilized more accurately as a basis of selction for the two characters.

Most of the work reported on the genetic correlations between different characters in dairy cattle has been undertaken during the last 20 years. The gentic corrleation between different characters computed by the daughter dam method is presented in Table 2. The estimate of the genetic correlation on the basis of half sibs was calculated only between intensity and 305 days milk yield. The available number of half sibs in the two herds used came to 618. The two estimates of the genetic correlation between intensity and 305 days milk yield were very close being 0.885 $\pm$ 0.069 and 0.792 $\pm$ 0.111 respectively. However, the daughter dam method is considered to be more efficient than the half sibs method, bacause the sampling variance is lower using the former method.

Most of the genetic correlations obtained in this study were more than 0.50 and some of these restimates were close to unity Table 2. The genetic correleation between persistency and 305 day milk yield on one hand and persistency and length of lactation on the other were 1.003 and 0.931 respectively. Such findings suggest the similarity of genes affecting these characters. These results also indicate that genes responsible for intensity or maximum production influence to a great extent 305 days milk yield.

The genetic correlation between intensity and 305 days milk yield in buffaloes (0.885) is very close to that reported by other workers on dairy cattle. Madden *et al* (1955) found the genetic correlation between yield in the first 90 days and 305 day milk production to be 1.12. Rendel *et al* (1957) obtained a genetic correlation of 0.76 between seventy day milk production and 305 day milk yield. The genetic correlations between part records and total production reported by Hickman (1960). Van Vleck and Henderson (1961) and Lamb (1963) are all close to unity and in agreement with our findings.

The genetic correlation between intensity of milk yield for the first and second lactation was also estimated and came to 1.084 which can be taken as unity. Such finding indicates that the genes responsible for intensity of milk during the first lactation are also responsible for intensity of milk yield during the second lactation. Khishin (1949), Asker (1949) and Ragab (1950) stuided this problem on intensity, butterfat percentage and milk yield respectively on diary cattle. They concluded in all cases that the genetic correlations between the characters in the first and second lactation came to unity. On the other hand, Freeman (1960) is of the opinion that different sets of genes, to some extent influence milk production in different lactations. He obtained a genetic correlation of 0.68 for milk yield in cattle in the first and second lactations.

Environmental Correlation :

Concerning the correlation between characters of the same individual it is not surprising to find that many characters of the individual within a population are more or less strongly correlated to one another e.g. lactation period and total milk yield, maximum weekly production and 305 day milk yield.

The phenotypic correlation between traits may be the result of a combination of genetic and environmental correlations. Figure 1, which is drawn according to Wright's method (1923) of path coefficients as pointed out by Falconer (1961), illustrates how the genetic and environmental correlations combined together produce the phenotypic correlation between the two traits X and Y. This is expressed in the following equation :

$$r_{p_{xy}} = h_x\, h_y\, r_{A_{xy}} + e_x\, e_y\, r_{E_{xy}}$$

where h = the square root of heritability

e = the square root of (1 — h2)

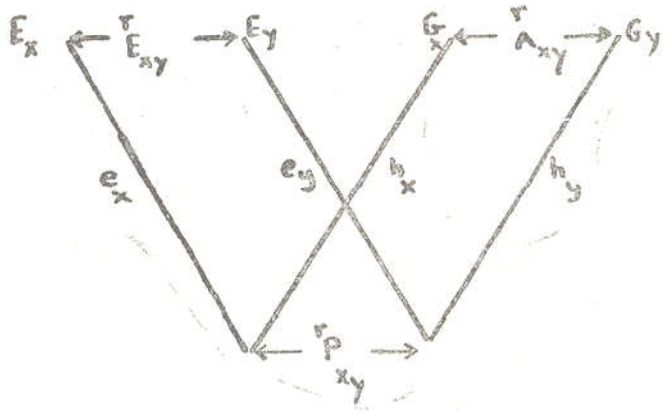

FIG. 1—Path diagram showing how the phenotypic correlation (r_p) between two characters x and y, is composed of the gentic correlation (r_A) and the environmental correlation (r_E)

Further examination of Table 2 shows that the genetic correlation between the intensity and 305 day milk yield (0.885) is higher than the environmental correlation (0.684). Both characters have heritability estimates of 0.38 and 0.27 respectively. This to some extent indicates the importance of the genetic correlation compared to the environmental correlation, which suggests that the phenotypic correlation is mainly determined by genetic correlation. Therefore, selection for these two characters would be based on their phenotypic relation. In other words genes responsible for the intensity influence to a great extent 305 day milk yield. On the other hand heritability estimates of lactation period and total milk yield were relatively low indicating that the phenotypic correlation is affected mainly by the environmental correlation which was found to be 0.928 as compared to 0.674 for the genetic correlation.

Relative Rate of Progress :

It has been shown earlier that the heritability of intensity exceeds that of 305 day milk yield, whereas the genetic correlation between the two traits came to 0.89. As a result, the rate of progress when selecting on part records would improve production as selecting on the complete record itself. The phenotypic correlation evaluated between both kinds of records for the same group of sires was highly correlated and the part lactation was just as repeatable as those based on 305 days milk yield.

The expression used for calculating the rate of progress was applied by Madden et al (1955) who reported that selecting on the cumulative part record Madden et al (1955) who reported that selecting on the cumulative part record would improve production nearly as much as selecting on the complete record ran in from 0.74 to above unity.

This expression :

$$rA \sqrt{h^2p \ / \ h^2C}$$

where : r_A is the genetic correlation between whole and part records.

h^2_p is the heritability of part record.

h^2_C is the heritability of complete records.

Searl (1961) VanVleck and Henderson (1961) and Lamb (1963) showed that selection on part records differ very little from when selecting on lactation yeild. It can be concluded that selection of cows as well as buffaloes on part records will achieve progress in improving genetic merit for 90 day milk yield almost as quickly as well selection on complete yield records. The practical situation considred includes predicting 305 days milk yield from the intenstiy.

The high genetic and phenotypic correlations which exist between the 305 days milk yield and intensity strongly indicate the possibility of proving sires based on short records. Similar to those of other workers, our results on buffaloes support the contention that part records are excellent guide to the total milk yield. Intensity of lactation can be used as the basis of selection for buffaloes kept for breeding purposes and culling can be made before a record is complete with little loss in efficiency. Such procedure, will lead to a decrease in the geneation interval and consequently the gentic gain per year is increased. If generation interval can be decreased or selection intensity increased by the use of part records, then the genetic progress may be more rapid with selection based on part records than with selection on complete yield.

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وراثة بعض صفات انتاج اللبن فى الجاموس المصرى والعلاقات المتبادلة بينها

الملخص

أجريت هذه الدراسة الاحصائية على قطيعين من الجاموس أحدهما فى سخا والآخر فى سدس فى مزارع وزارة الزراعة التجريبية •

وقد شمل البحث ٢٢٨١ سجلا طبيعيا من سجلات اللبن للجاموس جمعت على مدى عشرين عاما • وكان الهدف من البحث هو دراسة بعض صفات انتاج اللبن فى الحيوان من الناحية الوراثية وكذلك دراسة الناحية الوراثية للعلاقات التى توجد بين هذه الصفات وبعضها لبعض •

وقد أظهر البحث النتائج التالية :

أولا ــ أن المعامل التكرارى لغزارة انتاج اللبن (محصول الـ ٩٠ يوما الأولى من الموسم) وأقصى انتاج أسبوعى وناتج اللبن الكلى وناتج اللبن فى ٣٠٥ يوما ثم طول موسم الحليب والمثابرة على الحليب • تراوحت بين ١٨ و ٤١ بينما تراوحت القيمة الوراثية لنفس هذه الصفات بين ٢٧ر ، ٤٣ر •

ثانيا ــ كان معامل التلازم المظهرى من هذه الصفات وبعضها يتراوح بين ٢٣٣ر و ٨٨٩ر وكانت كل المعاملات ذات دلالة احصائية معنوية •

ثالثا ــ كانت كل معاملات التلازم الوراثية التى قدرت بين بعض هذه الصفات أكثر من ٥٠ر وبعضها كان أقرب ما يمكن للواحد الصحيح • وكان معامل التلازم الوراثى على وجه التحديد بين غزارة انتاج اللبن فى أول موسم وثانى موسم واحد صحيح •