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PHENOTYPIC CORRELATIONS AMONG EGYPTIAN BUFFALO MILK PRODUCTION AND ITS MAJOR CHEMICAL CONSTITUENTS

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ABSTRACT

Nine thousand lactations were used in this work to study the phenotypic correlations among milk production and some of chemical constituents of milk of the Egyptian buffaloes. With regard to the milk yield and its components, all of the correlation coefficients were positive and highly significant (P<0.001), with the exception of coefficients between milk at 1st-lactose and milk at 2nd-fat (P<0.01). The given milk yields and the percentage of its components showed that all of the correlation coefficients were negative and low, with the exception of those between milk at 1st-lactose and total solids (r=0.020 and 0.037), respectively, milk at 3rd-fat and total solids (r=0.066 and 0.004), respectively, milk at 4th-fat (r=0.002), milk at 5th-protein and solid non-fat (r=0.037 and 0.271), respectively. A statistically significant (P<0.05) positive correlation between milk at 5th and lactose (r=0.377*) was recorded. All of the correlation coefficients were positive and highly significant (P<0.001) between daily milk yield and its components, while negative coefficients were noticed among the percentage of fat-protein, lactose and solid non-fat contents (r=-0.131, -0.177 and -0.185), respectively, protein-lactose (r=-0.216), lactose-total solids (r=-0.213).

Keywords: Phenotypic correlations, Buffalo's milk yield, Chemical constituents.

INTRODUCTION

Buffaloes are widely distributed throughtout different parts in the world and are considered as a multipurpose animals. Concerning milk production, buffalo is the second global milk producing animal all over the world, since about 90 million tons were produced in 2009 representing 13% of the total world milk production with an annual growth rate of ≈ 3.1% as compared with 1.3% annual increase in cow milk (IDF, 2010). In Egypt, Buffalo milk production occupies the first order, whereas cow milk becomes in the second one.

The composition, properties and processing of buffalo milk and its products have been reviewed by Gokhale *et. al.* (2001), Pandya *et. al.* (2004) and recently by Abd El-Salam and El-Shibiny (2011). However, it is of great interest to find out the correlations between some traits with respect to buffalo milk, such as correlations between milk yield and the main milk constituents.

Correlation among two or more traits could be one of three types namely phenotypic correlation which shows the direction and intensity between the phenotypic values of the traits. Genotypic correlation gives the direction and intensity of the additive values of the traits, and environment correlation which shows the direction and degree of relationship between the

deviations produced by the environment conditions (Dronca, 2007). In this study, the phenotypic correlations among the quantitative and qualitative indices of the milk production were calculated in milk samples belonging to Egyptian buffaloes from the Tabanoha village, Dakahlia governorate, Egypt.

MATERIALS AND METHODS

Nine thousand lactations taken in 30 multiparous Egyptian buffaloes starting from the fifth day after partum until the fifth months of lactation were assembled from daily milk records from buffalos kept at small-scale farmers in the Tabanoha village, Dakahlia governorate. All animals were calved naturally, disease-free and placed under regular feeding. Milk samples were collected twice daily. Animals were kept under the regular systems of feeding and management adopted by the Egyptian farmers. The buffaloes were housed in hovel and were continually tied, throughout the experimental period (till day 155 postpartum). They were fed on berseem (Egyptian clover) and concentrates during winter-spring season and crop residues and concentrates and darawa during summer-autumn season.

Milk samples were collected twice daily and milk yield was determine. The samples were collected starting from 5 days postpartum until five months or the end of the experimental period (155 days postpartum).

Composite individual milk samples were taken weekly from morning and evening milk (5 ml/kg of produced milk) and analyzed for fat content by the standard Gerber method (B. S. I. 1962), lactose was determined according to (AOAC, 1995), and protein content by the micro Kjeldahl method (AOAC, 2000). Total solids (TS) content was determined gravimetrically using the method of Oser (1965) and solid not fat (SNF) was calculated by the difference (TS% - fat %). The correlation coefficients and their significance were calculated, using statistical software (SAS, 2004).

RESULTS AND DISCUSSION

Data in Table (1), indicated that the higher productivity for average milk yield, fat, protein, lactose, total solids and solids non-fat was recorded in 2nd month of lactation (293.47±39.12, 19.44±4.66, 12.63±1.74, 15.57±2.38, 48.58±7.55 and 29.73±3.77, respectively), while the lowest productivity values were 222.62±73.64, 15.70±4.98, 9.75±3.33, 11.42±4.18, 38.01±12.08 and 22.37±7.67, respectively and were recorded in 5th month. Higher values of the percentages of protein and lactose were in 1st month (4.51±0.45 and 5.56±2.01, respectively), while the lowest values were recorded in 4th month (4.27±0.33 and 5.03±0.55, respectively). The highest percentages of fat, solid non-fat and total solids were 7.17±1.25, 10.28±0.45 and 17.16±1.18, respectively and recorded in 5th, 1st and 5th months of lactation, respectively, while the lowest corresponding values were in 1st for fat and 4th month for solid non-fat and total solids (6.18±0.47, 9.92±0.57 and 16.20±1.63%, respectively).

Average daily milk yield, fat, protein, lactose, total solids and solids non-fat were 8.64±1.16, 0.57±0.08, 0.38±0.05, 0.45±0.07, 1.43±0.19 and 0.87±0.12 Kg, respectively. Average percentages of the daily production of fat, protein, lactose, total solids and solids non-fat were 6.60±0.50, 4.38±0.20 and 5.21±0.43, 16.46±0.53 and 10.10±0.23 (Table 2). Afzal *et al*., (2007) showed that the milk production increased with increasing lactation length and it was the lowest in the lactations of less than 240 days and the highest in lactation lengths of >361 days (P<0.05).

Table (1): The means and standard deviation of milk yield (Kg) and gross chemical composition of milk during five months of lactation.

Lactation month	1st	2nd	3rd	4th	5th
			Milk yield (kg)		
	247.33±51.22	293.47±39.12	282.65±48.75	256.78±54.49	222.62±73.64
			Milk composition (%)		
Fat	6.18±0.47	6.63±1.25	6.34±0.83	6.71±1.19	7.17±1.25
Protein	4.51±0.45	4.31±0.32	4.42 ± 0.39	4.27 ± 0.33	4.38±0.21
Lactose	5.56±2.01	5.31±0.47	5.09±0.41	5.03±0.55	5.08±0.40
TS	16.41±0.93	16.57±1.49	16.25±1.22	16.20±1.63	17.16±1.18
SNF	10.28±0.45	10.15±0.44	10.13±0.33	9.92±0.57	10.01±0.42
			Yield of milk constituents (kg)		
Fat	15.47±3.38	19.44±4.66	17.94±4.05	17.22±4.55	15.70±4.98
Protein	11.30±2.47	12.63±1.74	12.47±2.32	10.94±2.26	9.75±3.33
Lactose	13.84±5.65	15.57±2.38	14.37±2.77	12.89±3.23	11.42±4.18
TS	40.52±8.90	48.58±7.55	45.93±8.69	41.56±9.15	38.01±12.08
SNF	24.95±5.93	29.73±3.77	28.63±5.02	25.45±5.57	22.37±7.67

TS%= percentage total solids and SNF%= percentage solids not Fat.

Table (2): The means and standard deviation of daily milk yield and some chemical composition its.

DMY (kg)	DFY (kg)	DPY (kg)	DLY (kg)	DTSY (kg)	DSNFY (kg)
8.64±1.16	0.57±0.08	0.38±0.05	0.45±0.07	1.43±0.19	0.87±0.12
DFY (%)	**DPY (%)**	**DLY (%)**	**DTSY (%)**	**DSNFY (%)**	
6.60±0.50	4.38±0.20	5.21±0.43	16.46±0.53	10.10±0.23	

DMY (Kg.)= Daily milk yield (Kg), DFY (Kg)= Daily fat yield (Kg), DPY (Kg)= Daily protein yield (Kg), DLY (Kg)= Daily lactose yield (Kg), DTSY (Kg)= Daily total solids yield (Kg), DSNFY (Kg)= daily solids not fat yield (Kg), DFY (%)= percentage daily fat yield, DPY (%)= percentage daily protein yield, DLY (%)= percentage daily lactose yield, DTSY (%)= percentage daily total solids yield and DSNFY (%)= percentage daily solids not fat yield.

The fat content of buffalo's milk in the present study was lower than the mean values (7.14%) obtained by Abd El_Salam and El-Shibiny, (1966) and Asker *et al*., (1974). Fat content was higher in the months of September to January as compared to February to August as obtained by Barlowska *et al.* (2011).

Also buffalo's milk samples in this study were found to contain fat at a lower value than that found by Castagnetti *et al.,* (1996) who recorded fat at a higher level (8.54%). On the other hand it was higher than that detected by

Kholif *et al.*, (1994) and Abou-Arab, (1996) who reported that fat content, was 6.0% that very close to values of 6.57-7.97% given by Xue Han *et al*., (2012).

Protein content was higher than that detected by Kholif *et al*., (1994) (3.23%) and Abou-Arab, (1996) (3.41%) and close to the range (4.49-4.73%) obtained by Xue Han *et al*., (2012).

The result of lactose content is in agreement with the range (4.99-5.24) reported by Abd El-Salam and El-Shibiny, (1966), while it was higher than the range given by Xue Han *et al*., (2012) (4.49-4.73%). Average content of total solids a percentage is in agreement with the range (16.39-18.48%) recorded by Xue Han *et al*., (2012). Barlowska *et al*., (2011) found that the content of total solids was higher in the months of November to March, as compared to April to October. On the other hand solid non-fat content was close to the range (9.8–10.1%) detected by Abd El_Salam and El-Shibiny (1966).

However, in the recent review article given by Abd El_Salam and El-Shibiny (2011) marked variations were recorded with respect to chemical composition of buffalo milk in Egypt and different countries such as China, India, Italy, Pakistan, Bangladesh, Argentina, France, Germany, Turkey …… etc. the authors attributed such great variations to some factors including breed of buffalo, lactation number, stage of lactation, feeding system and incidence of subclinical mastitis. In our knowledge, buffaloes are less susceptible to subclinical mastitis as compared with cows under similar conditions.

As indicated in Tables 3, 4 with regard to milk yield and its contents, all of the correlation coefficients were positive and highly significant ($P<0.001$), with the exception of coefficients between milk at 1^{st}-lactose and milk at 2^{nd}-fat ($P<0.01$). These results are in agreement with those reported by Simona *et al*., (2009) who found that correlations among the milk yield and the yield of milk chemical components in Romanian black and white cows were positive taking values over 0.900, and highly significant ($P<0.001$). The highest correlation coefficients were among milk in 3^{rd}-solied non-fat ($r=0.981^{***}$) and milk at 5^{th}-protein, lactose, total solid and solid non-fat ($r=0.987^{***}$, 0.985^{***}, 0.976^{***} and 0.994^{***}, respectively), while the lowest correlations were between milk at 1^{st}-lactose and milk at 2^{nd}-fat ($r=0.493^{***}$ and 0.544^{**}, respectively).

Table (3): Correlation coefficients between monthly milk yield and major milk constituents.

Months	Traits				
	Fat (kg)	Protein (Kg)	Lactose (Kg)	TS (Kg)	SNF (Kg)
1st	0.881***	0.689***	0.493**	0.925***	0.878***
2nd	0.544**	0.860***	0.795***	0.810***	0.939***
3rd	0.809***	0.882***	0.901***	0.920***	0.981***
4th	0.736***	0.931***	0.881***	0.891***	0.959***
5th	0.850***	0.987***	0.985***	0.976***	0.994***

TS (Kg) = Total solids content and SNF(Kg) = Solids not fat content.

Table (4): Correlation coefficients between the percentage of monthly milk yield and some chemical constituents of milk.

Months	Traits				
	Fat (%)	Protein (%)	Lactose (%)	TS (%)	SNF (%)
1st	- 0.064	-0.207	0.020	0.037	-0.093
2nd	- 0.018	-0.202	-0.167	-0.070	-0.356
3rd	0.066	-0.062	-0.057	0.004	-0.058
4th	0.002	-0.197	-0.051	-0.044	-0.125
5th	- 0.284	0.037	0.377*	-0.227	0.271

TS%= percentage total solids and SNF%= percentage solids not fat.

The given milk yields and the content of its major components, it could be seen that all of the correlation coefficients were negative and low, with the exception of these between milk at 1st-lactose and total solids (r=0.020 and 0.037, respectively), milk at 3rd-fat and total solids (r=0.066 and 0.004, respectively), milk at 4th-fat (r=0.002), milk at 5th-protein and solid non-fat (r=0.037 and 0.271, respectively).

A statistically significant (P<0.05) positive correlation was established between milk at 5th lactation and lactose (r=0.377*). Correlations between milk yield and qualitative indices of milk (fat percentage, protein percentage, lactose percentage, solids non-fat percentage and total solids percentage) varied between r=-0.002 with fat content until r=0.187, with protein content, but the values did not reach the level of statistical significance (P>0.05). The content of milk constituents was highly significant (P<0.001) with values varied from r=0.427 between butterfat and lactose contents to r=0.911 between lactose and solids non-fat percentages **Simona *et al*., (2009).**

Table (5): Correlation coefficients between daily milk yield and yield of some chemical constituents (kg).

Traits	DMY(kg)	DFY(kg)	DPY(kg)	DLY(kg)	DTSY(kg)	DSNFY(kg)
DMY(kg)	1	0.752***	0.890***	0.845***	0.892***	0.984***
DFY(kg)		1	0.796***	0.676***	0.938***	0.756***
DPY(kg)			1	0.773***	0.921***	0.908***
DLY(kg)				1	0.799***	0.860***
DTSY(kg)					1	0.904***
DSNFY(kg)						1

Table (6): Correlations coefficients between some daily chemical components of milk (%).

Traits	Fat%	Protein%	Lactose%	TS%	SNF%
Fat%	1	-0.131	-0.177	0.827***	-0.185
Protein%		1	-0.216	0.070	0.306
Lactose%			1	-0.213	0.201
TS%				1	0.105
SNF%					1

It could also be observed from Tables 5 and 6 that the correlation coefficients of the milk yield and milk components was positive and highly significant (P<0.001), while Ayadi *et al.,* (2014) obtained that negative correlations between the daily milk yield and fat and protein contents. Negative coefficients were showed among the content of fat-protein, lactose and solid non-fat (r=-0.131, -0.177 and -0.185, respectively), protein-lactose (r=-0.216), lactose-total solids (r=-0.213). A High positive significant coefficient (P<0.001) was detected between the percentage of fat and total solids (r=0.827***), while the lowest coefficient were showed among the percentage of protein and total solids (r=0.070). On the other side, the highest coefficient was found between daily milk yield and solid non-fat (r=0.984***) however the lowest one was reported between daily fat yield and lactose yield (r=0.676***).

The study given by Kholif (1997) on Egyptian buffalo milk revealed that milk fat content positively and significantly correlated with TS% and total protein%, while it was negatively and significantly correlated with SNF% and lactose. At the same time, TS% positively and significantly correlated with SNF% and total protein% and negatively and significantly correlated with lactose%. Moreover, the author found that SNF positively and significantly correlated with protein% and lactose%, whereas protein% negatively and significantly correlated with lactose%. Finally, the detalied study given by Kholif (1997) on Egyptian buffalo milk revealed that the lactation number was found to have a significant effect on milk yield which ranged between 1340 and 2030 kg/ season and significantly affected TS, SNF and lactose content, whereas fat and protein content were not affected by lactation number. Moreover, the author mentioned that stage of lactation significantly affected milk yield and milk constituents including fat, TS, SNF, protein and lactose. On the other hand, Kholif (1997) found that buffalo milk yield correlated positively and significantly with lactose%, and negatively and significantly correlated with Fat%, TS% and total protein%.

CONCLUSION

Phenotypic correlation coefficients among the milk yield and major chemical constituents yield were highly significant (P<0.001), and had values varying from r=0.493 to r=0.994.

Phenotypic correlation coefficients among the daily milk yield and major chemical constituents of the buffalo's milk were highly significant (P<0.001), with values varying from r=0.676 and r=0.938.

Phenotypic correlation coefficients among the major milk components were non-significant (P>0.05), taking values from r=-0.216 to r=0.306. With the exception of correlation coefficient among Fat% and TS% was highly significant r=0.827.

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الإرتباط المظهري بين إنتاج اللبن وبعض مكوناته الكيميائية في الجاموس المصري

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أُستخدمت في هذه الدراسة ثلاثون سجل للبن شهرياً بهدف دراسة الإرتباط المظهري بين إنتاج اللبن وبعض مكوناته الكيميائية في الجاموس المصري.

دلت النتائج أن جميع مُعاملات الإرتباط بين إنتاج اللبن ومكوناته الكيميائية كانت إيجابية وذو مستوي معنوي مرتفع (أقل من ٠.٠١), بإستثناء الإرتباط بين كمية اللبن وكمية اللاكتوز بنهاية الشهر الأول وكمية اللبن وكمية الدُهن في نهاية الشهر الثاني عند مستوي معنوية (أقل من ٠.٠١).

بالنسبة لإنتاج اللبن والنسبة المئوية لمكوناته وجد أن جميع معاملات الإرتباط كانت سلبية ومنخفضة التأثير باستثناء ما بين كمية اللبن مع النسبة المئوية للاكتوز (r=0.020) والنسبة المئوية للمواد الصلبة الكلية (r=0.037) بعد شهر, ومع النسبة المئوية للدهن (r=0.066) والنسبة المئوية للمواد الصلبة (r=0.004) بعد ٣ شهور, ومع النسبة المئوية للبروتين (r=0.037) والنسبة المئوية للمواد الصلبة اللادهنية (r=0.271) بعد ٥ شهور, وجد أنه توجد علاقة إيجابية ذو مستوي معنوي (أقل من ٠.٠٥) للإرتباط بين كمية اللبن المنتجة بعد ٥ شهور وكمية اللاكتوز باللبن (r=0.377*).

كانت كل الإرتباطات المظهرية بين اللبن ومكوناته الكيميائية موجبة وذو مستوي معنوية مرتفع عند أقل من ٠.٠٠١, بينما كانت الإرتباطات سالبة ما بين بعض المكونات وبعضها حيث وجد أنها كانت سالبة بين النسبة المئوية للدهن والبروتين (r=-0.131) وبين النسبة المئوية للدهن واللاكتوز (r=-0.177) والدهن والمادة الصلبة اللادهنية (r=-0.185) وبين النسبة المئوية للبروتين واللاكتوز (r=-0.216) والنسبة المئوية للاكتوز والمادة الصلبة الكلية (r=-0.213).