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Effect of crossbreeding between two Egyptian goat breeds on physicochemical, technological and nutritional characteristics of goat milk

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Abstract

Milk samples of two different crossbreds of Egyptian goats were analyzed for their physicochemical, technological and nutritional characteristics, in order to evaluate the effect of crossbreeding on milk properties. Crossbred goats (50% Damascus : 50% Barky) had better milk properties than milk of the Barky breed, but less than that of Damascus goats. Upgrading with Damascus goats (75% Damascus : 25% Barky) improved all milk constituents. Milk of the second crossbred had better technological properties than that of the first crossbred. Milk of both crossbreds had a satisfactory balance of essential amino acids, although lower than that of milk of the parent breeds.

Keywords: Damascus goats, Barky goats, crossbreeding, milk quality
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Introduction

Improving goat productivity in Egypt could be achieved through better management and genetic programs. Milk production varies greatly between different genotypes raised at different locations. Abdel-Salam *et al*. (2000) found that milk production (kg) and lactation period (days) differed between the Damascus, Barky goat breeds and their crosses in the desert of Egypt. In our previous investigation (Salem *et al*., 2000) the different characteristics of milk of Barky and Damascus goat breeds were evaluated. This study evaluated changes of physicochemical, technological and nutritional properties of milk of two different crossbreds developed from a crossbreeding program between Barky and Damascus goats.

Materials and Methods

Individual milk samples of two types of crossbred goats: Crossbreed 1 (50% Barky : 50% Damascus) and Crossbreed 2 (75% Damascus : 25% Barky) were collected from 15 individuals from each cross. The goats were kept in the Borg El-Arab area near Alexandria, Egypt. The samples were cooled at 4 °C and then transported within an hour to the laboratory for analysis. Titratable acidity, specific gravity, fat, total solids, chlorides and ash concentrations were determined, as described by Ling (1956), and lactose by the phenol sulphuric acid method (Marier & Baulet, 1959). Total calcium and magnesium concentrations were determined after dry ashing of the milk samples, using a Shimadzu atomic absorption spectrophotometer (Model 2380) (AOAC, 1980), and potassium and sodium concentrations using a Beckman Flame Photometer, Mark II. Phosphorus was determined spectrophotometrically, using hydroquinone ammonium molybdate (Snell & Snell, 1949). Nitrogen distribution was determined as described by Rowland (1938). The total nitrogen, non-casein nitrogen and non-protein nitrogen levels were determined by the micro-Kjeldahl method (AOAC, 1980). Milk samples were hydrolyzed according to the method of Nagasawa *et al*. (1970) and then analyzed for amino acid composition, using a Beckman Amino Acid Analyzer (Model 119c1). The number of fat globules was determined, as described by King (1957). The method of Dovidov (1963) was used for determining the weight and diameter of casein micelle. The method is based on the scattering light phenomena (Salem *et al*., 2000). Fatty acids were methylated, as described by Vogel (1956) and the methyl esters of the fatty acid concentrations were determined with a Pye Unicam Gas Chromatographer (Model 104 Perkin – Elmer), equipped with a dual flame channel recorder. Detector and injection temperatures were 220 °C and 170 °C, respectively. The results were compared with the properties of milk from pure Barky and Damascus goats, reported earlier (Salem *et al*., 2000), using statistical analyses according to the S.P.S.S. (2003) statistical program.

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Results and Discussion

The results given in Table 1 show that the pH varied between the milk of the two crossbreds and their parent breeds. The lowest pH was recorded on the Damascus milk, while the highest was in the milk of Crossbreed 2. The highest acidity values were in the milk of Crossbreed 1 and Crossbreed 2 goats compared to the milk of the Barky and Damascus goats. The chloride content was the lowest ($P < 0.01$) in milk from Crossbreeds 1 and 2 compared to the milk of Barky goats, and lowest in the milk of Crossbreed 2. The specific gravity values differed slightly between all breeds. The total solids (TS) in the milk of Crossbreed 2 (14.3%) were nearly equivalent to that in the milk of Damascus goats (15.9%). The fat concentration was also considerably higher ($P < 0.01$) in milk of Crossbreed 2 compared to that of Barky goats. Similarly, the protein level was significantly higher in the milk of Crossbreed 2 goats. This increase ($P < 0.01$) in fat and protein concentrations in milk of Crossbreed 2 suggests that they would produce milk with a better yield in cheese-making compared to that from Barky goat milk. The casein concentration was higher ($P < 0.01$) in the milk of Crossbreed 2 than that of Barky and Crossbreed 1, and was closer to the level in Damascus goat milk. The level of ash in the milk of Crossbreed 2 and Crossbreed 1 was higher ($P < 0.01$) than in Barky and Damascus milk. Lactose concentration in the milk of Crossbreed 2 was closer to that of Damascus goat.

Table 1 Average composition of milk from pure and crossbred goats (g/100 g)

Constituents	Barky*		Damascus*		Crossbreed 1		Crossbreed 2	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Moisture[a]	87.8	0.034	84.1	0.024	87.9	0.027	85.7	0.034
Fat[a]	2.85	0.048	5.10	0.196	3.10	0.231	4.20	0.199
Protein[a]	2.15	0.053	4.35	0.06	2.32	0.023	4.22	0.243
Casein	1.52	0.115	3.01	0.073	1.06	0.034	2.95	0.268
Whey protein[a]	0.63	0.120	1.34	0.044	0.70	0.016	1.27	0.131
w.p. / T. protein	29.3		30.8		30.2		30.0	
w.p. / casein	0.41		0.45		0.43		0.43	
Lactose[a]	3.85	0.092	5.46	0.210	4.09	0.240	4.82	0.329
Ash[a]	0.896	0.005	0.969	0.007	0.997	0.005	1.039	0.005
Total solids	9.8		15.9		10.5		14.3	
M.S.N.F.	6.9		10.78		7.41		10.08	
pH	6.8		6.6		6.8		6.9	
Acidity	0.171		0.171		0.189		0.186	
Chloride	0.170		0.170		0.120		0.108	
Specific gravity	1.030		1.030		1.028		1.029	

* Salem *et al*. (2000); s.d. – standard deviation; w.p. – whey protein
[a]Significance – $P < 0.01$; M.S.N.F. – milk solid not fat

Table 2 Mineral concentration of the milk from pure and crossbred goats (mg/100 mL)[a]

Mineral	Barky*		Damascus*		Crossbreed 1		Crossbreed 2	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Ca^{++}	142	1.39	133	2.43	119	3.09	146	6.01
Mg^{++}	19	1.75	16	2.37	13	2.58	18	2.79
Na^{+}	42	1.41	44	2.72	51	3.13	32	2.31
K^{+}	161	5.21	185	11.34	173	11.06	196	13.97
P^{-3}	102	1.03	99	1.80	86	2.23	92	3.65
Ca/P	1.39		1.34		1.38		1.54	
Na/K	0.26		0.24		0.29		0.44	

*Salem *et al*. (2000); s.d. – standard deviation; [a]Significant – $P < 0.01$

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Table 2 shows the mineral concentrations of the milk. Ratios of Ca and K were higher ($P < 0.01$) in the milk of Crossbreed 2 goats compared to that of Barky and Damascus goats, while the concentration of Mg was close to that of milk from the Barky goat. The Na concentration was higher ($P < 0.01$) in the milk of Crossbreed 1 and significantly lower in the milk of Crossbreed 2 compared to the pure breeds. The P concentration in milk of crossbred goats was lower ($P < 0.01$) than in the milk of Barky or Damascus goat.

The concentrations of unsaturated fatty acids in the milk from Crossbreed 2 were lower than that of both the Barky and Damascus goats. The milk fat from Crossbreed 1 had the best ratio ($P < 0.01$) of unsaturated/saturated fatty acids in all breeds studied (Fig. 1). The ratio of essential amino acids varied considerably between the milk of parent breeds and their crossbreds. The lowest value was in milk from Crossbreed 2, followed by the milk of Crossbreed 1 (Fig.2). Generally, milk of both crossbreds has a satisfactory balance of essential amino acids, equalling or exceeding the FAO – WHO – UNU requirements for each amino acid.

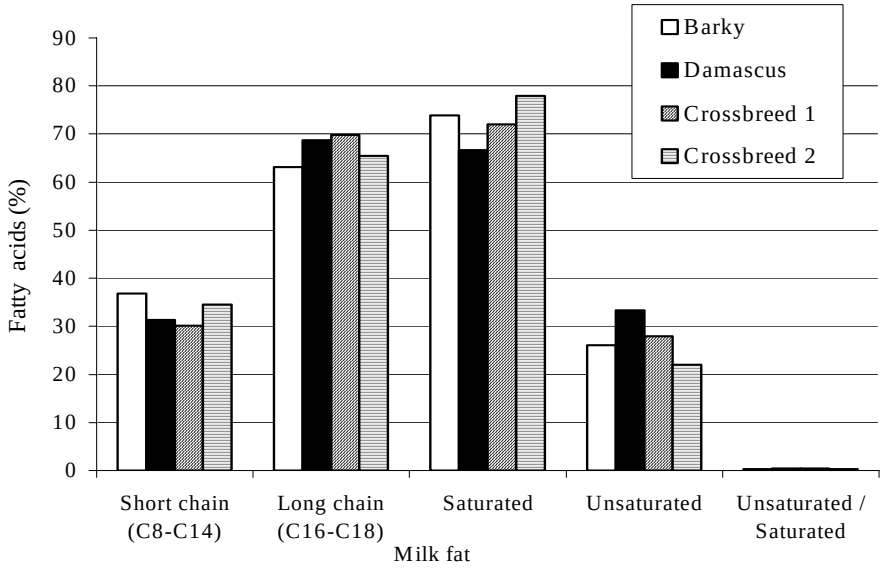

Figure 1 Fatty acid composition of milk from pure and crossbred goats

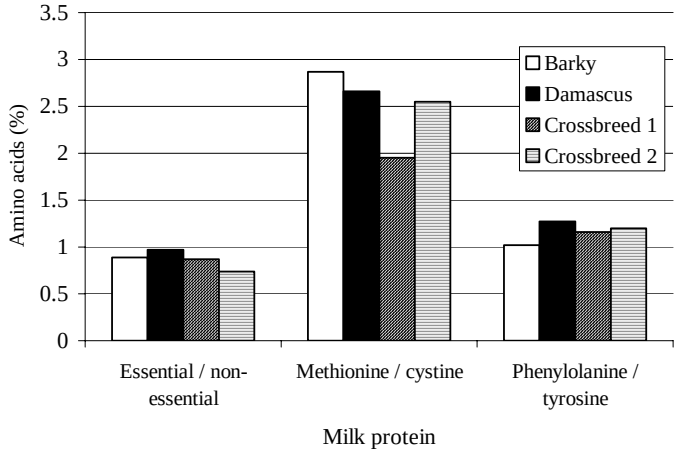

Figure 2 Amino acid composition of milk from pure and crossbred goats

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Table 3 shows that the number of fat globules was lower ($P < 0.01$) in the milk of both crossbreds compared to that of the Barky goat. They were closer to the values of Damascus milk. On the other hand, the size of casein micelles was less ($P < 0.0.1$) in the milk of Crossbreed 1 compared to Barky goat, while that in the milk of Crossbreed 2 was closer to that of Damascus goats.

Damascus and Crossbreed 2 milk had higher ($P < 0.01$) casein and lower fat globule diameters than Barky goat milk. This property is important in cheese-making, since the higher casein content and lower fat globule diameter result in soft curd in cheese-making.

Table 3 The properties of casein micelle and fat globules of crossbred goat's milk (mean values)

Mineral	Barky*		Damascus*		Crossbreed 1		Crossbreed 2	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Fat globules in 1 mL milk	2.9×10^9	0.033	4×10^9	0.274	2.4×10^9	0.273	2.6×10^9	0.296
Diameter of globules (μ)	3.09	0.019	3.01	0.021	3.12	0.023	3.07	0.023
Casein micelle diameter (A^o)[a]	922	3.59	974	3.06	884	3.17	965	3.12

*Salem *et al*. (2000); s.d. – standard deviation; [a]Significant – $P < 0.01$

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