A COMPARATIVE STUDY ON COMPOSITION AND SOME PROPERTIES OF MILK FROM DIFFERENT SPECIES

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ABSTRACT

Milk from five different species (cow, buffalo, goat, sheep and camel) were analyzed compositionally. Results showed that there were significant differences among sheep's milk and other species, since it contained the highest figures for total solids (TS), fat, protein, ash, calcium contents, acidity and apparent viscosity. Also, there were significant differences between sheep's milk and both of camel's and goat's milk in pH values. While no significant differences between cow's and buffaloe's milk and between goat's and sheep's milk in pH values. Cow's, camel's and goat's milk were not significantly ($P > 0.05$) different in TS and fat contents, and between goat's and cow's milk in protein content. Also among goat's, cow's, sheep's and camel's milk in lactose content, and between cow's and camel's milk in ash content. Concerning major and trace elements, there were significant differences among all species in Ca, Mg, P, K, Fe and Zn contents. Sheep's milk was higher in Ca and P contents than other species. But, there were no significant differences between goat and Buffaloe's milk in Na content, also between goat, buffalo, sheep's milk in Cu content, and between buffalo, goat, camel and sheep's milk in Cd content.

***Key words**: Milk, different species, chemical composition, physical properties.*

INTRODUCTION

The chemical composition and properties of milk are of importance to the dairy men, processing and consumers. Milk composition is affected by several genetic or environmental factors. Among the latter group of factors, certain feeds consumed by the animal are known to have anoticeable impact. Moreover, during the last three decades animal feeding conditions and even kinds of feeds given to the cattle have somewhat been modified.

Recently, an increasing interest has been focused on goat's and camel's milk because of their healthy effect beyond their nutritional

value. Goat's milk has been described as having a higher digestibility and lower allergenic properties than cow's milk. In addition goat's milk has been characterised with certain therapeutic values in human nutrition (Martin *et al.*, 2003 and Herrero and Requena, 2006).

Camel's milk is important component in the human diet in arid and semi arid zones. This milk contains all the essential nutrients. It's chemical composition is remarkably different from that of cow and other milks. Moreover, the qualitative compounds of milk differ between the African and Arabic camels.

Although the composition of different kinds of milk has been studied in various parts of the world (Farag and Kebary, 1992, Mehaia *et al.*, 1995; and Spanghero and Susmel, 1996). The present investigation was undertaken to give more details on composition and properties of buffaloe's, cow's, goat's, sheep's and camel's milk produced under the Egyptian environment.

MATERIALS AND METHODS

Milk samples:

Twenty individual milk samples of both lactating buffaloes and Damascus goats were obtained from the herd of El-Raheb, Faculty of Agric., Minufiya Univ. Also, 20 individual samples of cow's milk were obtained from the local region of Minufiya, while for camel's milk were samples obtained from Maghrabi camels from the Animal Breeding in Marsa-Matroh, Research Station, Animal Production Institute. Also, 20 individual samples from sheep's milk was obtained from the Finland local sheep from the Animal Breeding in Sakha, Research Station, Animal Production Institute. Samples from each type were pooled immediately refrigerated in an ice box and transported to the laboratory for analysis.

Methods of analysis:

Physical properties:

Specific gravity of milk was carried out by Quivenne lactometer standardized at 15°C. The viscosity was measured using coaxial cylinder viscometer (Bohlin V88, Sweden) attached to a work station loaded with soft ware V88 viscometry programme. The system (C30) was filled with the milk sample at room temperature, 22°C and

measurement of viscosity was carried out in the up mode at shear rate 42 1/s.

Chemical analysis:

pH values of milk were measured using pH meter (Orion Research Cambridge, M.A, U.S.A). Titratable acidity, total solids, fat, protein and ash were determined according to A.O.A.C. (1990). Lactose was calculated by difference {TS-(Fat + protein + Ash)}. Total Na, K, Ca, Mg, Fe, Mn, Zn, Cu, Pb and Cd of milk were determined according to Sotera and Stux (1979) using Atomic Absorption Spectrophotometer (Unicam 989 Solaar, USA). While Inorganic Phosphorous content was determined according to Snell and Snell (1949).

Statistical analysis:

Factorial design one factor X 3 replicates and the completely randomized design were used to analyze all the data, and student Newman Keuls test was followed to make the multiple comparisons (Steel and Torrie, 1980) using Costat program. Significant differences were determined at ($P \leq 0.05$).

RESULTS AND DISCUSSION

Physical properties:

Specific gravity of different milk samples are shown in Fig. (1). There were no significant differences ($P > 0.05$) in specific gravity among all species (Table 3). These results are in agreement with those obtained by Odjakova *et al.* (2002) for sheep's milk; Kanwal *et al.* (2004) for cow's milk; Patino (2004) for buffaloe's milk; Farag and Kebary (1992) and El-Nawawy (1994) for camel's milk.

Appearant viscosity (Mpa) of different milk samples are illustrated in Fig. (2). Results in Table (3) indicated that there were significant differences ($P \leq 0.05$) among all species. Sheep's milk had the highest average of viscosity (3.33), while camel's milk was the lowest (1.58). These results are in line with those found by Haggag *et al.* (1991) for buffaloe's milk; Majee *et al.* (1994) for goat's milk; Sankhla *et al.* (2000) for camel's milk and Awaz *et al.* (2003) for cow's milk.

Chemical Composition:

Total solids (TS) content are shown in Fig. (3). Goat's, camel's and cow's milk were not significantly ($P > 0.05$) different from each other; while sheep's and buffaloe's milk were significantly ($P \leq 0.05$) differenet from each other and also with that of goat's , cow's and camel's milk (Table 3). Sheep's milk had the highest TS, while goat's milk had the lowest. These results are in agreement with those reported by Ceron *et al.* (2002) and Toopchi and Ayazi (2004) for buffaloe's milk; Wangoh *et al.* (1998) and Moustafa *et al.* (2000) for camel's milk; Hafez and Hamzawi (1991) for cow's milk; Aganga *et al.* (2002) for goat's milk and Lujerdean *et al.* (2003) for sheep's milk.

Fat content of milk samples are illustrated in Fig. (4). Fat content was the highest in sheep's milk (8.0%) and lowest in cow's milk (3.7%). Fat contents showed that cow's, camel's and goat's milk were not-significantly ($p>0.05$) different from each other. While, buffaloe's and sheep's milk were significantly different ($p \leq 0.05$) from each other and from cow's, camel's and goat's milk (Table 4). These results are in accordance with those obtained by Ceron *et al.* (2002) and Toopchi and Ayazi (2004) for buffaloe's milk; Wangoh *et al.* (1998) and Moustafa *et al.* (2000) for camel's milk and Kuchtik and Sedlackova (2003) for goat's milk and Lujerdean *et al.* (2003) for sheep's milk.

Protein content of different milk samples are given in Fig. (5). The average protein content was 3.05% for cow's; 3.85% for buffaloe's; 3.15% for goat's; 5.56% for sheep's and 3.32% for camel's milk. Goat's and cow's milk were not significantly different ($p > 0.05$) from each other in protein content. While, camel's, sheep's and buffaloe's milk were significantly different ($P \leq 0.05$) from each other and from those of other species (Table 3). These values are in agreement with those found by Kanwal *et al.* (2004) and Patino (2004) for buffaloe's milk; Moustafa *et al.* (2000) and Zhang *et al.* (2005) for camel's milk; Zeng *et al.* (1997) for goat's milk; Csanadi *et al.* (2004) for sheep's milk.

There were no significant differences ($P > 0.05$) in lactose content among goat's, sheep's, camel's and buffaloe's milk (Fig. 6 and Table 3). These results are supported by Patino (2004) for buffaloe's milk; Mehia *et al.* (1995) for camel's milk; Ahamefule *et*

al. (2003) for cow's milk; Miklic and Rogelj (2000) for goat's milk; Lujerdean *et al.* (2003) for sheep's milk.

Ash content in different milk samples are given in Fig. (7). The average ash content was 0.90% for buffaloe's; 0.79% for camel's; 0.80% for cow's; 0.77% for goat's and 0.95% for sheep's milk. Camel's, goat's and cow's milk were not significantly different from each other ($P > 0.05$). Significant differences were observed between buffaloe's, sheep's milk and with the other milks (Table 3). These results are in accordance with those reported by kholif (1997) for buffaloe's milk; Gorban and Izzeldin (1997) and Wangoh *et al.* (1998) for camel's milk; Ahamefule *et al.* (2003) for cow's milk; Ochoa *et al.* (2002) and Ahamefule *et al.* (2003) for sheep's milk.

The average values of titratable acidity and pH are shown in Figs. (8 and 9). Sheep's milk showed the highest titrtable acidity (0.20%). The lowest titratable acidity (0.16%) was observed in camel's milk. The highest pH values was noticed in cow's milk (6.67), while the lowest was in camel's milk (6.4). No significant differences among camel's, cow's and goat's milk, also between sheep's and buffaloe's milk in titratable acidity. Also, no significant differences ($P > 0.05$) between sheep's and goat's milk, and between cow's and buffaloe's milk in pH value, camel's milk was decreased significantly ($P \leq 0.05$) in this respect (Table 3). These results are in agreement with those found by El-Alamy (1990) for goat's milk; Farag and Kebary (1992) and El-Nawawy (1994) for camel's milk; Kholif (1997) and Patino (2004) for buffaloe's milk and Simos *et al.* (1996) and Kanwal *et al.* (2004) for sheep's and cow's milk.

Minerals:

Major minerals:

Data in Table (1) indicated that ewe's milk had the highest average calcium (Ca) content (194.33 mg/100 g milk), while camel's milk had the lowest (106.66 mg/100 g milk) compared to the other species. There were significant differences ($P \leq 0.05$) in average calcium content among all species (Table 4), being in the order of sheep's milk > Buffalo > goat > cow > camel's milk. These results are in accordance with those obtained by Rincon *et al.* (1994) for sheep's milk; Kholif (1997) for buffaloe's milk; Farag and Kebary (1992) and Gorban and Izzeldin (1997) for camel's milk; Alichandis and

Table (1): Average major minerals content (mg/100 g) of milk samples from different species.

Source	Calcium Ca	Magnesium Mg	Phosphorous P	Sodium Na	Potassium K
Cow	116.88 ± 1.49	8.36 ± 0.33	90.00 ± 0.84	45.13 ± 1.72	132.03 ± 1.00
Buffalo	184.40 ± 1.14	31.00 ± 0.24	104.44 ± 0.76	52.00 ± 1.94	178.00 ± 2.70
Goat	139.92 ± 0.15	13.23 ± 0.20	111.00 ± 0.91	52.57 ± 2.14	160.00 ± 2.66
Sheep	194.33 ± 0.33	18.97 ± 0.33	136.68 ± 0.84	40.68 ± 1.94	129.00 ± 2.79
Camel	106.66 ± 1.00	10.42 ± 0.35	119.08 ± 0.35	47.00 ± 1.00	172.00 ± 1.25

* Averages followed by standard error (± SE)

Polychroniadou (1996) for goat's milk and Rincon *et al.* (1994) for cow's milk.

Results in Table (1) showed that buffaloe's milk had the highest average magnesium content (31.00 mg / 100 g) while, sheep's milk contained higher magnesium (18.97) than those of camel's (10.42), cow's (8.36) and goat's milk (13.23 mg / 100 g). There were significant differences ($P \leq 0.05$) in this respect (Table 4). These results are in agreement with those reported by Celik and Ozdemir (2003) for sheep's milk; Mehia *et al.* (1995) for camel's milk; Rincon *et al.* (1994) and Alichandis and polychroniadou (1996) for cow's and goat's milk., but they were lower than those obtained by El-Alamy *et al.* (1990) for goat's milk.

Data in Table (1) indicated that sheep's milk had the similar phosphorous (P) content (136.68 mg /100 g). Camel's milk had higher P content (119.08) than buffaloe's (104.44), cow's (90.00) and goat's milk (111.00 mg / 100 g). There were significant differences ($P \leq 0.05$) in average P content among all species (Table 4). These results are supported by Kholif (1997) for buffaloe's milk; Zhang *et. al.* (2005) for camel's milk; Alichandis and Polychroniadou (1996) for goat's milk, but they were lower than those reported by Alichandis and Polychroniadou (1996) for sheep's milk and were a slight higher than those obtained by Antunac *et al.* (2001) for goat's milk.

Data in Table (1) indicated that buffaloe's and goat's milk contained the same of sodium amount (Na) (52.00 and 52.57 mg/100 g, respectively) which were higher than those of camel's (47.00), cow's (45.13) and sheep's milk (40.68 mg / 100 g). There were significant differences ($P \leq 0.05$) in this respect (Table 4). These results are in accordance with those obtained by Gorban and Izzeldin (1997) for camel's milk; Alichandis and polychroniadou (1996) for sheep's milk; Connor (1994) for goat's milk; Rincon *et al.* (1994) for cow's milk, but they were lower than those reported by Zhang *et al.* (2005) for camel's milk and Celik and Ozdemir (2003) for sheep's milk and were higher than those found by Farag and Kebary (1992) for camel's milk.

Results in Table (1) showed that buffaloe's and camel's milk contained the highest potassium (K) content (178.00 and 172.00 mg/100 g, respectively) compared to other species. Goat's milk was remarkably higher K content (160.00) than those of cow's (132.03)

Table (2): Average trace elements content (ppm) of milk samples from different species.

Source	Iron Fe	Copper Cu	Manganese Mn	Zinc Zn	Lead Pb	Cadmium Cd
Cow	0.50 ± 0.046	0.15 ± 0.031	0.23 ± 0.031	3.04 ± 0.19	0.019 ± 0.19	0.005 ± 0.46
Buffalo	1.22 ± 0.038	0.24 ± 0.011	0.21 ± 0.011	4.52 ± 0.44	0.017 ± 0.45	0.004 ± 0.420
Goat	0.55 ± 0.008	0.25 ± 0.002	0.26 ± 0.022	2.61 ± 0.12	0.016 ± 0.42	0.003 ± 0.52
Sheep	0.92 ± 0.033	0.24 ± 0.013	0.24 ± 0.035	4.32 ± 0.29	0.018 ± 0.22	0.003 ± 0.29
Camel	3.46 ± 0.043	0.33 ± 0.031	0.45 ± 0.033	2.88 ± 0.11	0.017 ± 0.33	0.004 ± 0.50

* Averages followed by standard error (± SE).

Table (3): Statistical analysis of composition and properties of milk samples from different species.

Properties	Effect of different species◊					
	Mean squares	Multiple comparisons				
		Cow	Buffalo	Goat	Sheep	Camel
Specific gravity	0.035	A	A	A	A	A
Appearant viscosity (mpa's)	1.546*	D	B	C	A	E
Total solids (TS) %	28.0289*	D	B	D	A	C
Fat content %	12.6503*	C	B	C	A	C
Total protein %	0.3139*	D	B	D	A	C
Lactose %	0.0223*	A	B	B	B	AB
Ash %	0.0185*	C	B	D	A	C
Titratable acidity (TA) %	0.0201*	BC	AB	BC	A	C
PH value	0.0502*	A	AB	B	B	C

* Significant at 0.05 level.

◊ For each effect the different letters in the same row means the multiple comparisons are different from each other. Letter A is the highest mean followed by B, C .....etc.

Table (4): Statistical analysis of minerals content and milk samples from different species.

Properties	Effect of different species◊					
	Mean squares	Multiple comparisons				
		Cow	Buffalo	Goat	Sheep	Camel
Major elements (mg /100g milk)						
Calcium (Ca)	2246.201*	D	B	C	A	E
Magnesium (Mg)	230.028*	E	A	C	B	D
Phosphorus (P)	900.821*	E	D	C	A	B
Sodium (Na)	73.748*	C	A	A	D	B
Potassium (K)	1532.223*	D	A	C	E	B
Trace elements (ppm):						
Iron (Fe)	4.511*	E	B	D	C	A
Copper (Cu)	0.013*	C	B	B	B	A
Manganese (Mn)	0.029*	C	D	B	BC	A
Zinc (Zn)	2.323*	C	A	E	B	D
Lead (Pb)	0.003*	A	AB	B	AB	AB
Cadmium (Cd)	0.00001*	A	AB	B	B	B

* Significant at 0.05 level.

◊ For each effect the different letters in the same row means the multiple comparisons are different from each other. Letter A is the highest mean followed by B, C .....etc.

and sheep's milk (49.16 mg / 100 g). There were significant differences ($P \leq 0.05$) among all species (Table 4). These results are in accordance with those found by Kholif (1997) for buffaloe's milk; Alichandis and Polychroniadou (1996) for goat's and sheep's milk; Mehia *et al.* (1995) and Zhang *et al.* (2005) for camel's milk, but were a slight higher than those reported by Antunac et al. (2001) for goat's milk; Celik and Ozdemir (2003) for sheep's milk and Gorban and Izzeldin (1997) for camel's milk and were lower than those found by Rincon *et al.* (1994) for cow's milk.

Trace elements:

Data in Tables (2 and 4) indicated that camel's milk showed the highest average iron (Fe) content (3.46 ppm). Buffaloe's milk was slightly high ($P \leq 0.05$) in average Fe content (1.22) compared to cow's (0.50), goat's (0.55) and sheep's milk (0.92 ppm). There were significant differences ($P \leq 0.05$) in average Fe content in all species (Tables, 2 and 4). These results are supported by Al-Awadi and Srikumar (2001) for camel's milk and Rincon *et al.* (1994) and Alichandis and Polychroniadou (1996) for cow's, goat's and sheep's milk, but they were higher than those obtained by Gorban and Izzeldin (1997) for camel's milk.

The results in Tables (2 and 4) showed that the average copper (Cu) content is similar in buffaloe's, goat's and sheep's milk. Camel's milk was the highest in Cu content (0.33 ppm) compared to other species. Cow's milk showed the lowest average Cu content (0.15 ppm). There were non-significant differences ($P > 0.05$) in average copper content among all species (Table, 4). These results are in line with those reported by Al-Awadi and Srikumar (2001) for camel's and cow's milk and Aganga *et al.* (2002) for sheep's and goat's milk.

As shown in Tables (2 and 4), camel's milk had the highest manganese (Mn) content (0.45 ppm). Goat's milk had higher Mn content (0.26) than those of sheep's (0.24), cow's (0.23) and buffaloe's (0.21). These results are in agreement with those found by Rincon *et al.* (1994) and Aganga *et al.* (2002) for goat's and sheep's milk and Gorban and Izzeldin (1997) and Al-Awadi and Srikumar (2001) for cow's and camel's milk.

Data in Table (2) showed that the average zinc (Zn) content (ppm) of buffaloe's milk was (4.52) and sheep's milk was (4.32).

Cow's milk showed higher average Zn content (3.04) than those of camel's (2.88) and goat's milk (2.61). There were significant ($P \leq 0.05$) differences among all species in this respect (Table 4). These results are in accordance with those obtained by Kholif (1997) for buffaloe's milk; Gorban and Izzeldin (1997) for camel's milk and Aganga *et. al.* (2002) for goat's and sheep's milk.

Results in Tables (2 and 4) indicated that the different milk samples from different species had a lower lead (Pb) and cadmium (Cd) contents and there were slight differences concerning lead and cadmium contents between cow's and other species. These results are in agreement with those obtained by Rodriguez *et al.* (1999) for cow's and goat's milk. But lead content were lower than the content reported by Farag and Kebary (1992) for camel's milk.

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الملخص العربى

دراسة على التركيب وبعض خواص لبن الأنواع المختلفة من الحيوانات

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يهدف البحث الى دراسة التركيب الكيماوى وبعض الخـواص لألبـان مختلفة من خمس حيوانات مختلفة تشمل الأبقار والجاموس والمـاعز والأغنـام والإبل تحت الظروف المصرية وتم أخذ ٢٠ عينة فردية من الحيوانات الخمس كل على حده **وأوضحت النتائج المتحصل عليها بعد تحليلها احصائيا مايلى:**

- وجود فروق معنوية ($P \leq 0.05$) بين لبن الأغنام ولبن الأنواع الأخرى (الأبقار-الماعز-الإبل والجاموس) فى كل من اللزوجة الظاهرية، الجوامد الكلية، الدهن ، البروتين، الرماد والحموضة حيث كان لبن الأغنام أعلاها فى تلك المكونات. كما وجد فروق معنوية ($P \leq 0.05$) أيضا بين لبن الإبل ولبن الأنواع الأخرى فى قيم الرقم الهيدروجينى.
- لم توجد فروق معنوية ($P > 0.05$) بين لبن كل الأنواع فى الوزن النوعى ، كذلك كانت الفروق غير معنوية بين لبن الأبقار والجاموس وكذلك بين لبن الأغنام والماعز فى قيم الرقم الهيدروجينى، وكذاك بين الإبل والماعز والأبقار فى الجوامد الكلية والدهن، وبين لبن الماعز والأبقار فى البروتين، وبين الماعز والأبقار والأغنام والإبل فى اللاكتوز، وبين الأبقار والإبل فى الرماد.
- لوحظ أن لبن الأغنام تميز باحتوائه على أعلى متوسط من الكالسيوم والفوسفور وكانت هناك فروق معنوية ($P \leq 0.05$) بينه وبين لبن الأنواع الأخرى كما أن الفروق كانت معنوية ($P \leq 0.05$) فى لبن الأنواع الخمسة فى كل من المغنيسيوم والفوسفور والبوتاسيوم والحديد والزنك.
- لوحظ عدم وجود فروق معنوية ($P > 0.05$) بين لبن الماعز والجاموس فى عنصر الصوديوم، أيضا بين الماعز والجاموس والأغنام فى عنصر النحاس، وبين الجاموس والأغنام والإبل والماعز فى عنصرى الرصاص والكادميوم.