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Nutritional Value of Algerian Breed Ewe's Milk Related to its Mineral Content

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Abstract: The mineral content and its distribution among soluble and colloidal phases of milk from two ewe's breed (*Ouled-Djellal* and *Rumbi*) (n = 20 each) reared in Algerian area steppe, were studied. The ewes were balanced for age and weight. All were in middle period of lactation. Individual milk samples were taken from each ewe third time from lactating period during spring season. Major elements of milk samples were slightly higher in milk from *Rumbi* than from *Ouled-Djellal* breeds. Results show that only Potassium, Sodium and Zinc were significantly influenced by breed type. *Rumbi* ewe's milk gave the highest values ($p \leq 0.05$) (1056±47.76, 667±79.75 and 7.7±0.99 ppm) than *Ouled-Djellal* ewes (974±18.83, 667±92.49 and 7.7±1.39 ppm, respectively). The average contents of trace elements in this study arranged according to the following order Zn<Fe<Cu<Mn. Mineral elements are unevenly distributed among soluble and colloidal phases of ewe's raw milk analyzed. Algerian milk from sheep breeds constitutes a source of minerals especially for rural population.

Key words: Algeria, milk, mineral, nutrition, *Ouled-Djellal* ewe, *Rumbi* ewe

INTRODUCTION

Minerals play an essential role in the human organism. Milk and dairy products are well known that are richer and good dietary sources of Ca and P. In Africa and Asia, sheep milk is a major food and a good source of minerals that are vital in human nutrition because they are components of body tissues and fluids (Mwaura and Akinsoyinu, 2010). The chemical form in which a macro mineral and trace element is found in milk is important, because it will influence the degree of intestinal absorption and utilization, transport, cellular assimilation and conversion into biologically active forms and thus bioavailability (Cashman, 2006). The impact of mineral elements in milk on the health status of individuals is highlighted by the literature review of Cashman (2006).

The mineral composition of milk is influenced by a number of factors including breed, stage of lactation, feed, infection of the udder, season of the year and environmental conditions (Coni *et al*., 1995; O'Connor, 1995; Rodriguez *et al*., 2002; Bianchi *et al*., 2004; Ivanova, 2011). The effect of breed in mineral content was documented overall the world such as Karaouniki and Serron (Polychroniadou and Vafopoulou, 1985), Corriedale and Hampshire (Sosa *et al*., 2001), Yankansa (Mwaura and Akinsoyinu, 2010), Karakachan (Ivanova, 2011), East-Friesian, Awassi and Synthetic population Bulgarian (Ivanova *et al*., 2001), Srednostaroplaninska and Tetevenska (Gerchev and Mihaylova, 2012).

The ewe's milk from Algerian breeds was studied for their chemical composition (Yabrir *et al*., 2013a) as well as for their variation (Yabrir *et al*., 2013b). But there is no information, in our knowledge on the minerals of this milk. Thus, this investigation constitute the first and preliminary study carried out concerning the mineral content and its distribution between the soluble and colloidal phases of milk from *Rumbi* (RB) and *Ouled-Djellal* (OD) ewe's breeds reared in central steppe area of Algeria.

MATERIALS AND METHODS

Animals and sampling: This study was carried out using two flocks; one of RB breed, the other of OD's located in Algerian area steppe. Ewe's were in natural pasture all the year and feed with hay, pasture ensilage and barley when necessary. Twenty ewes were chosen for each breed. The ewes were balanced for age (medium age was 4.8 and 5.6, respectively for RB and OD), weight (52 kg for RB and 42.5 kg for OD) and all were in middle period of lactation. Individual milk samples were taken from each ewe third time from lactating period during spring season. Milk samples were collected at the afternoon hand milking. Milk was sampled without any preservative and analyzed within 24 h with refrigeration overnight in terms of mineral composition.

Analytical procedure: Mineral concentrations were determined on whole milk for total contents and on

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diffusible fraction for soluble contents. The soluble phase was separated by rennet coagulation (Texel-Poulenc France) followed by recovery of whey as described by De la Fuente *et al.* (1996). Each individual milk sample's was dried overnight at 103±2°C (AOAC, 1998) and ashed in a muffle furnace at 550°C for 8h (Miles *et al.*, 2001). The ash obtained was sustained to acid hydrolysis by processing it consecutively by 50% HCl, 10% HCl and deionized water; after each addition, solution was dried to appropriate volume on a hot plate placed in a fume hood according to Miles *et al.* (2001). Solutions were filtered and diluted to appropriate detection level as suggested by aforementioned authors. Macro minerals (Ca, K, Na and Mg) and trace elements (Cu, Fe, Mn) were determined by atomic absorption spectrometry (GC 107). Phosphorus and Zinc concentrations were estimated calorimetrically using colorimeter apparatus (DR/890). Three standard solutions of 0.5, 1 and 2 ppm were prepared for calibration curve by using stock standard solution ISO (1.000 ppm for each element) immediately before analysis. Deionized water with 18 MΩ cm resistance was used in the preparation of all sample and standard solutions. One percent lanthanum solution was added to overcome phosphate interference when determining Ca and Mg (Mussenden and Hiley, 1977). All analysis were performed in duplicate for every sample.

Statistical analysis: Statistical analysis was carried out using Statistical program. The significant differences between means were calculated by one-way Analysis of Variance (ANOVA) using Turkey range test. Breed was the factor studied and probability level was either 95 or 99%.

RESULTS AND DISCUSSION

Major elements: All major elements of milk samples were slightly higher in milk from RB than from OD breeds (Table 1). Results show that only Potassium and Sodium were significantly influenced by breed type.

The milk of OD and RB ewes had similar content of Ca and P. the level of Ca and P determined in this paper for ewe's milk is similar to the data found by De La Fuente *et al.* (1997), Bianchi *et al.* (2004), Bornaz *et al.* (2009) and Hilali *et al.* (2011), higher than mentioned by Miles *et al.* (2001) but lower than reported by Borys *et al.* (2006). The P content of ewe milk is lower than most values indicated by other authors (Maurer and Schaeren, 2007; Park *et al.*, 2007; Martini *et al.*, 2008; Ivanova *et al.*, 2011) however, Ca concentration is higher than established by Khan *et al.* (2006), Al-Wabel (2008), Ivanova *et al.* (2011) and Erkaya and Sengül (2012). These elements are well documented, probably because their nutritional ant technological interests. From a nutritional point of view, the role of calcium is supporting normal growth and development of the skeleton as well as its maintenance during later-life (Cashman, 2006), however, phosphorus has several functions independent of calcium, as part of the phospholipids molecules, constituent of nucleic acids and key constituent of many enzymes (Mwaura and Akinsoyinu, 2010). From a technological point of view, they play an important role in the structure and organization of casein micelle (Gaucheron, 2005) and coagulation phenomenon (Mahaut *et al.*, 2003). The mean Ca: P ratio reported in this study (1.6) is included in the interval recommended by McDowell (2003) for human nutrition and higher than the values reported by Ivanova *et al.* (2011) for sheep breeds studied in Bulgaria. Croguennec *et al.* (2008) estimate the Ca: P ratio at 1.3 for milks of all ruminant species. There has been some controversy over the role of dietary phosphorus and in particular, the dietary ratio of calcium to phosphorus, on bone health (Cashman, 2006).

Concerning monovalent ions, potassium is more abundant than sodium. This trend confirms all bibliographic data. RB milk has higher K ($p \leq 0.001$) and Na ($p \leq 0.05$) contents than OD's. The average contents of these elements are supported by Sahan *et al.* (2005) and Hilali *et al.* (2011) but lower for K and higher for Na than reported by several authors (Borys *et al.*, 2006; Khan *et al.*, 2006; Maurer and Schaeren, 2007; Erkaya and Sengul, 2012) in other breeds. Sodium in addition to K, all function in maintaining osmotic pressure and regulating acid-base equilibrium (McDowell, 2003) and are necessary for maintenance of proper water balance (Ahamefule *et al.*, 2012). Potassium helps in transmission of nerve impulses (Onibon *et al.*, 2007) and aids in proper muscle contraction (Ahamefule *et al.*, 2012). While, sodium helps in digestion (Gueguen, 2001) and it is needed for nerve and muscle function. In human nutrition high dietary K and low sodium (Na) favor lower blood pressure and less cardiovascular disease (McDowell, 2003).

Magnesium did not differ significantly between the two breeds. Similar value is observed by De Le Fuente *et al.* (1997), Sahan *et al.* (2005), Maurer and Schaeren (2007). However, this result is higher than that found by many workers (Miles *et al.*, 2001; Khan *et al.*, 2006; Erkaya and Sengul, 2012), but lower than that reported by Borys *et al.* (2006). Magnesium is vital to enzyme activity. It plays a role in the formation of bone and in carbohydrate and mineral metabolism (Ahamefule *et al.*, 2012). Magnesium deficiency has been identified as a possible risk factor for osteoporosis in humans (Cashman, 2006) and interferes with the transmission of nerve and muscle impulses, causing irritability and nervousness (Ahamefule *et al.*, 2012).

Minor elements: Although trace elements are present in very reliable quantities in milk, they are significant by their absence for some elements (such as Zn and Mn)

Table 1: Concentrations of major elements (ppm) in RB and OD ewe's milk

	Breed			
Element	*Rumbi*	*Ouled-Djellal*	P*	Average
Ca	2184.36±177.78	2039.20±164.21	ns	2103.72±181.10
P	1351.88±270.94	1226.00±103.65	ns	1281.94±200.14
K	1056.75±47.76	974.15±18.83	***	1010.86±53.84
Na	666±79.75	552.40±92.49	*	603.14±102.74
Mg	186.61±11.87	172.88±17.33	ns	178.98±16.32

P*: Analysis of variance (ns: not significant, *: $p<0.05$ ***: $p<0.001$)

Table 2: Trace elements concentrations (ppm) in RB and OD ewe's milk

	Breed			
Element	*Rumbi*	*Ouled-Djellal*	P*	Average
Zn	7.70±0.99	6.34±1.39	*	6.94±1.38
Fe	0.88±0.26	0.79±0.27	ns	0.83±0.26
Cu	0.47±0.04	0.42±0.09	ns	0.44±0.07
Mn	0.06±0.02	0.05±0.02	ns	0.05±0.02

P*: Analysis of variance (ns: not significant, *: $p<0.05$)

Table 3: Distribution of minerals between the soluble and colloidal phases

	Ca	P	K	Na	Mg	Zn	Cu	Fe	Mn
Soluble (ppm)	547	525.26	930.12	560.79	105.61	0.76	0.19	0.29	0.0035
Percentage of soluble	26	41	92	93	59	11	43	35	7
colloidal (ppm)	1557	756.74	80.88	42.21	73.39	6.18	0.25	0.54	0.046
Percentage of colloidal	74	59	8	7	41	89	57	65	93

but can be dangerous by their excess for others (such as Fe and Cu) (Bilandzic *et al*., 2011; Ogabiela *et al*., 2011) in human nutrition. But, without them the assimilation of the nutritional substances by the organism is impossible (Peichevski *et al*., 1982). Results showed that the mineral content did not vary significantly throughout the breed investigated, with the exception of Zinc (Table 2). The average contents of trace elements in this study arranged according to the following order Zn<Fe<Cu<Mn.

RB ewe's milk gave the highest values ($p \leq 0.01$) for Zn. In this study, the mean milk zinc content was 6.94 ppm. This finding coincides with the results obtained by Borys *et al*. (2006), De La Fuente *et al*. (1997) and higher than that reported by Coni *et al*. (1996), Al-Wabel (2008) and Ivanova (2011). Chronic zinc exposure results in anemia, leucopenia, gastrointestinal diseases and diarrhea (Ogabiela *et al*., 2011).

The concentration of levels of Fe in ewe milk observed in this study was lower than those observed in raw ewe milk in other areas of the world (Coni *et al*., 1996; De La Fuente *et al*., 1997; Al-Wabel, 2008; Erkaya and Sengul, 2012). Liver, kidney and cardiovascular system are the target organs for iron toxicity (Ogabiela *et al*., 2011). Zn and Fe can transfer to food from the tools and machines used in the milk collection and production (Qin *et al*., 2009).

The average content of copper in analyzed milk is within the values reported in literature (Coni *et al*., 1996; De La Fuente *et al*., 1997). Higher contents of this element in milk were observed by Al-Wabel (2008). According De La Fuente *et al*. (1995), higher copper values are frequently the result of contamination of the milk, particularly from processing equipment and storage of the milk in metal containers. Very low concentration of Cu was obtained by Borys *et al*. (2006) and Maurer and Schaeren (2007). Cu is an essential element required in the diet due to its role in vital oxidation-reduction reactions (Bilandzic *et al*., 2011). Cu content in milk is likely to be strongly influenced by environment (Qin *et al*., 2009).

Manganese is an important microelement which participates in the metabolism of carbohydrates, lipids and proteins (Ivanova, 2011), though adverse effect have been reported at higher doses (Ogabiela *et al*., 2011). The value obtained for Mn is similar than those reported by De La Fuente *et al*. (1997), Maurer and Schaeren (2007) and Ivanova (2011); lower than that established by Coni *et al*. (1996), Al-Wabel (2008) and Erkaya and Sengül (2012). The process of milk production seems to contribute to high Mn contents (Qin *et al*., 2009).

Distribution of minerals between the soluble and colloidal phases: The percentages of Ca and P found in the soluble fraction of ewe's milk (Table 3) were slightly higher than the data reported for other authors (Polychroniadou and Vafopoulou, 1985; Pellegrini *et al*., 1994; De la Fuente *et al*., 1997) but lower than that reported by Gaucheron (2005), however the content of soluble Mg coincides with the results obtained by De la Fuente *et al*. (1997) but lower than that data reported by Polychroniadou and Vafopoulou (1985) and Gaucheron (2005). Sodium and potassium are sufficiently soluble to be present almost in the dissolved phase (Gaucheron, 2005) which agrees with our finding. Also, Macedo and Malcata (1997) rapport that Na and K are usually present in the soluble fraction of cheese.

Trace elements are unevenly distributed among soluble and colloidal phases. Percentages of Zn and Mn in the soluble phase were 11 and 7%, respectively. Similar values were observed by De la Fuente *et al.* (1997). According to Brule and Fauquant (1982), 95% of both Zn and Mn and to Lonnerdal *et al.* (1983), 80% of the Mn in milk are bind with casein micelles. Significant differences were found for Zn levels between ultracentrifugation, rennet coagulation and dialysis separation procedure (De la Fuente *et al.*, 1996). Fe and Cu exist partly in soluble form and partly in insoluble or colloidal form. 43% for Cu against 35% for Fe in the soluble phase, which agree with De la Fuente *et al.* (1997) in term of tendency but higher in term of values. Copper and iron are bound to ligands of low molecular mass, largely citrate, with percentage of them are bound to serum proteins, mainly lactoferrin for iron (Brule and Fauquant, 1982). De la Fuente *et al.* (1997) attribute the lowest value of iron in soluble phase to the highest fat content in ewe's milk. Distribution of Cu and Zn between casein fraction and whey protein correspond approximately to the ratio of proteins content in each fraction (Brule and Fauquant, 1982).

Macedo and Malcata (1997) indicate that Ca, P, Mg, Zn and Cu are preferentially linked to the casein micelle (insoluble) fraction whereas significant decreases was observed in Serra cheese during ripening as consequent of pH decreases. De la Fuente *et al.* (1996) and Gaucheron (2005) attribute the difference between distributions of minerals to the separation procedure followed.

Conclusion: This study showed that the breed had a significant effect on Potassium, Sodium and Zinc. However, no significant difference was observed between the two breeds on other mineral content. The milk from *Rumbi* ewe seems to be richer than *Ouled-Djellal*'s. Algerian ewe's milk can constitute a good source of minerals, especially for child of rural population.

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