IJPSR (2024), Volume 15, Issue 11 **(Research Article)**

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 08 June 2024; received in revised form, 29 June 2024; accepted, 17 July 2024; published 01 November 2024

A COMPARATIVE STUDY ON NUTRITIVE VALUE AND PHYSICO-CHEMICAL PARAMETERS OF ANDALUSIAN BREED OF DONKEY MILK WITH OTHER RUMINANT MILKS IN KAMAREDDY DISTRICT

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Keywords:

Donkey milk, Buffalo milk, Cow milk, Goat milk, Physico-chemical composition

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ABSTRACT: Recently, there has been increasing interest in donkey's milk. Donkeys' milk is a good alternative source for infant nutrition in the case of cow milk protein allergy and substitute to human milk. The main aim of this study was to evaluate and compare the proximate composition and physico-chemical properties of Andalusian breed donkey milk with different species mainly buffalo, cow and goat milk obtained from Kamareddy district of Telangana state. The milk samples were analyzed for proximate composition like fat, protein, carbohydrate, ash and total solids, physico-chemical properties such as pH, specific gravity, titratable acidity and viscosity. It was observed from the results that among all the species buffalo and goat milk showed higher levels of all the constituents than that of cow and donkey milk. The specific gravity, titratable acidity, ash, and protein content of buffalo milk showed higher than donkey milk, but had a lower lactose level than donkey, goat and cow milk. All the tested parameters were similar in buffalo and goat milk except lactose which was higher in donkey milk.

INTRODUCTION: Milk is the characteristic secretion of all mammals. All species of mammal's secrets milk from mammary gland to feed mammalian infant. Milk is a highly nutritious nearly a complete food and is a good source of various nutrients and hence important for growth, repairs and provides energy. Milk antibodies play an important role in protecting the young one against infectious diseases [1]. In recent times, interest in consumption of donkey milk (DM) has been increased due to its nutritive value, which has a close resemblance to human milk.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.15(11).3291-96

This article can be accessed online on www.ijpsr.com

DOI link: https://doi.org/10.13040/IJPSR.0975-8232.15(11).3291-96

When the breast feeding is not possible or the infants affected by cow milk protein allergy (CMPA), donkey milk is the best substitute [2]. Donkeys were used as a working animal since from ancient times. Donkeys belong to the family Equidae. But from last few decades the donkey milk is gaining a growing interest in human nutrition due to its distinctive composition and physiological aspects.

The literature evidence suggests that DM contains less fat, less protein but more lactose similar to human milk when compared to cow's milk, and therefore, it is easily digestible, palatable and rich in nutrients. Donkey milk was characterized by low casein and high lysozyme content (1.0 mg/mL) in comparison to other kinds of milks [3]. DM is known for its biological activities such as antioxidant, anti-microbial, anti-inflammatory, anti-viral and

antiproliferative activity. The donkey milk has numerous health benefits, but there is no much scientific data available on its production, biochemical and nutritional properties of milk. Also, most of the consumers hesitate to accept the DM, because of lack of legislations on food product [4].

The lack of comprehensive evidence regarding the nutritional value of DM with other species has been the main aim for this study. Hence, the objective was to study the proximate composition and physico-chemical parameters of Andalusian breed of donkey milk and to compare with other ruminant milk.

MATERIALS AND METHOD:

Collection of Milk Samples: A total of 30 Andalusian breed of donkey milk and goat samples were randomly collected from local villages of kamareddy. All the animals selected for milk sampling were thoroughly examined for any signs of clinical disease, and there was no medication administered. The milk samples of buffalo (Murrah) and cow milk (Sahiwal) was obtained from dairy farm, College of Dairy Technology, Kamareddy.

Compositional Analysis: All the milk samples were analysed by applying the ISO 2446:2008 for the determination of fat, using the electric Gerber centrifuge (REMI ELEKTROTECHNIK Ltd, Maharashtra, India), Protein content in milk samples was estimated by Kjeldahl method as per IS: SP-18, Part XI, (1981) using Kjeldhal digestion unit (Gerhardt Analytical Systems, Germany) and the AOAC 984.15-1985 for lactose, using a UV–vis spectrophotometer (Systronics, model 166), Ash content was measured using muffle furnace (Biotech) while total solids were measured by hot air oven (Kemi).

Physico-chemical Properties:

pH: pH of milk samples was determined by potentiometric method using digital pH meter (Eutech Instruments PH510). The pH meter was first calibrated using standard buffers of pH 4.0 and 9.2 and standardized using pH buffer of 7.0 at 20.0 ± 0.1°C.

Specific Gravity: The milk samples were warmed to about 40°C for 5 min by placing in hot water bath. The samples were removed from water bath and mixed gently by inverting and rotating it (bottle) taking care to avoid frothing. Then cooled to a temperature close to that of the lactometer calibration temperature. The milk was poured into the cylinder and adjusted the level of the milk in the measuring cylinder so as to allow slight overflow when the lactometer is inserted. The lactometer reading was noted carefully avoiding parallax and calculated the specific gravity of milk.

Specific gravity of milk = CLR/1000 + 1

Titratable Acidity: Titratable acidity of milk samples was determined as per IS: SP-18, Part XI, (1981).

Viscosity: Viscosity (cP) of milk samples at 27^{o}C was measured using Ostwald viscometer. The density of samples at 27^{o}C was analysed using pycnometer. Temperature was maintained exactly at 27^{o}C in thermostatically controlled water bath. The specific gravity, relative viscosity and absolute viscosity were calculated according to equation,

Specific gravity = wt. of pycnometer fill with sample – wt of empty pycnometer / wt. of pycnometer fill with water – wt. of empty pycnometer

Relative viscosity = Specific gravity x Time taken by sample / Time taken by water

Absolute viscosity = Relative viscosity x viscosity of water at 27°C

Statistical Analysis: The statistical analysis was carried out using SPSS program (Statistical Package for Social Sciences version 16). The significant differences between means were calculated by one-way Analysis of Variance (ANOVA).Quantitative data are presented as mean with standard deviation (SD).

RESULT AND DISCUSSION:

Proximate Composition of Milk:

Total Solids: The concentration of total solids in milk samples collected from donkey, buffalo, cow and goat were given in the **Table 1**. These results illustrated that the concentration of total solids was in the range of 17.19-19.11%, 13.62-15.16%, 10.86-11.95% and 16.82-18.18% in Buffalo, Cow, Donkey and goat milk respectively. From the results it was observed the concentration of total solids in buffalo milk was higher than that of

donkey and goat milk at significant (P<0.001) level. The total solids of milk samples collected from goat milk was also found higher than that of cow and donkey milk at significant (P<0.001) level. Statistical analysis showed non- significant (P>0.05) difference between the concentration of total solids in buffalo and goat milk. The amount of total solids found in buffalo milk was similar to that other reports [5]. Total solids content in milk of various species of cow like Ayrshire, Brown Swiss, Holstein, Jersey and Zebu were found to be 13.1%, 13.3%, 12.2%, 15.0% and 14.7%, respectively [6]. The cow milk samples were found slightly lower and goat milk was found similar to other research findings [7].

Fat Content: Fat content in milk samples collected from buffalo, cow, donkey and goat were given in the **Table 1**. Results revealed that fat content was found in the range of 6.98-8.89% in buffalo milk, 3.39-3.98% in cow milk, 0.81-1.85% in donkey milk and 6.10-6.82% in goat milk. The amount of fat content in buffalo milk was higher than the milk of other species at highly significant (P<0.001) level. The fat content in goat milk was significantly (P<0.001) higher than donkey and cow milk but found lower than buffalo milk. Buffalo milk is almost twice as rich in fat as compared to cow milk [8], the range of fat content was reported between 6.57% and 7.97% in buffalo milk. The average value of buffalo milk fat was 8.3% and reaches high in normal healthy condition [9]. The fat content in cow milk was slightly higher than the findings [10-11] but in agreement with the findings [12, 13]. Mixed southern milk has better nutritious contents than western milk [14]. The amount of fat content found in goat milk during this investigation was found similar [15-16]. The variation in fat content might be due to quality and quantity of the feed, genetical variation and stage of lactation.

Protein Content: From the **Table 1** it was observed that the protein concentration of the milk samples was in the range of 3.82-4.57%, 3.19-3.78%, 1.57-1.89% and 4.56-5.62% for buffalo milk, cow milk, donkey milk and goat milk respectively. The amount of protein content in goat milk was significantly higher than (P<0.001) buffalo, cow and donkey. Buffalo milk showed higher protein concentration than cow milk [17]. The buffalo milk protein content was in support with [10] to our findings. The protein content of goat milk is quite similar to that of cow milk [3]. Donkey milk was characterized by low casein and high lysozyme content (1.0 mg/ml) in comparison to other kinds of milk [18]. The donkey milk protein content was found lower than that reported [11], the lower protein content in DM will help to avoid excessive load on renal system. The donkey milk has great demand and arousing popularity in worldwide. It is available as a commercial product to the benefit of newborn infants affected with cow's milk protein allergy and older people [19-20]. Goat milk protein content range was found higher than the research findings [21]. The variation in the protein content might be due breed difference, stage of lactation and health status of the udder.

TABLE 1: PROXIMATE COMPOSITION OF DIFFERENT SPECIES OF MILK

Species	Total solids (%)	Fat (%)	Protein (%)	Lactose (%)	Total Ash (%)
Buffalo	18.38±0.96^{c}	7.62±0.50^{c}	4.53±0.25^{b}	4.57±0.19^{c}	0.81±0.03^{c}
Cow	14.14±1.13^{b}	3.91±0.72^{a}	3.39±0.16^{a}	4.81±0.37^{c}	0.69±0.09^{b}
Donkey	11.23±0.18^{a}	0.82±0.72	1.82±0.13^{a}	5.85±0.21^{a}	0.41±0.08^{a}
Goat	17.92±0.30^{c}	6.73±0.22^{b}	5.21±0.37^{b}	5.07±0.24^{b}	0.76±0.07^{c}

The values bearing different alphabets significantly differ (P<0.001) among the rows.

Lactose Content: Lactose content in milk samples collected from buffalo, cow, donkey and goat milk were given in the **Table 1**. Results illustrated that lactose content was in the range of 4.21-4.91% in buffalo milk, 5.56-6.27% in donkey milk and 4.47-5.31% in goat milk. The amount of donkey milk lactose content was significantly (P<0.01) higher than buffalo, cow and goat milk. A non- significant difference (P<0.05) was found between the amount of lactose content in buffalo, cow and goat. The lactose content in donkey milk was found higher that that reported [22] (4.70%). The high lactose content in DM is a good of source of energy for body activities particularly of brain. It also facilitates the intestinal calcium absorption, which plays an important role in development of nervous system and bone mineralization in infant's [23-24]. Moreover, the higher lactose content in donkey

milk can be utilized for preparation of probiotic beverages because it is the ideal substrate for a perfect development of intestinal lactobacilli [25].

Total Ash: Ash content in milk samples collected from buffalo, cow, donkey and goat were shown in the **Table 1**. The ash level was found to be in the range of 0.78-0.81%, 0.67-0.72%, 0.39-0.45% and 0.75-0.78% in buffalo, cow, donkey and goat milk respectively. Amount of ash content in donkey milk was lower than in goat, cow and buffalo milk at highly significant level (P<0.001). There was significant difference found between (P<0.01) between the amount of ash content in cow and donkey milk. No significant difference (P>0.05) was found between the ash content in the milk samples collected from goat and buffalo milk samples. The amount of ash content present in the buffalo milk was in line and in support with the findings [4, 26].

Physico-chemical Properties:

pH Value: At the time of sampling itself milk samples from different species of animal pH was determined. The results showed that the pH values were in the range of 6.61-6.99 in buffalo milk, 6.59-6.67 in cow milk, 7.0-7.2 in donkey milk and 6.55 -6.70 in goat milk samples. pH values of donkey milk were significantly (P<0.001) higher than that of buffalo, cow, and goat milk **Table 2**. The level of pH in Donkey milk was in agreement with [27], the pH of donkey milk is neutral or slightly alkaline, which might be due to low content of caseins and phosphates, in comparison to cow milk [22]. The results showed that the pH values of cow and goat were non significantly (P>0.05) different from each other.

Specific Gravity: The values of specific gravity of milk samples collected from buffalo, cow, donkey and goat samples were given in the **Table 2**. It was observed from results that the specific gravity was found in the range of 1.034-1.038 in buffalo milk, 1.028-1.031 in cow milk, 1.023-1.025 in donkey milk and 1.033-1.036 in goat milk. Specific gravity of buffalo and goat milk was higher than that of cow and donkey milk at highly significant level (P<0.001). There was non-significant (P>0.05) difference between cow and donkey milk, buffalo and goat milk. The research findings regarding specific gravity are in line with the present findings (1.035) for the specific gravity of normal buffalo milk [28]. Buffalo milk had a lower specific gravity of in some clinical and subclinical cases, 1.014 and 1.028 respectively. The increase specific gravity in goat milk than cow and donkey milk might be due to stage of the lactation or the basal diet.

Titratable Acidity: The titratable acidity values of fresh milk samples from all species were calculated immediately after they were collected and the data is shown in the **Table 2**. Titratable acidity was found in the range of 0.16-0.19% in buffalo milk, 0.14-0.17% in cow milk, 0.063-0.071 % in donkey milk and 0.16-0.18% in goat milk. The values of titratable acidity of buffalo and goat milk was found significantly (P<0.001) higher than cow and donkey milk. Difference between the values of buffalo and goat milk; cow milk were non-significant (P>0.05). Lactic acid accounted for 25% of total acidity in fresh milk. In buffalo milk, acidity was correlated with fat and solid-to-fat ratios, but not in cow milk. The values of the buffalo milk titratable acidity were in accordance with the findings [29]. The values of titratable acidity in cow and goat milk were in support and found higher acidity in buffalo and goat milk might be due to the more caseins, phosphates, citric acid, and phosphoric acid which contribute the natural acidity of milk [26].

TABLE 2: PHYSICO-CHEMICAL PROPERTIES OF DIFFERENT SPECIES OF MILK

Species	pH values	Specific gravity	Titratable Acidity (%LA)	Viscosity (Cp)
Buffalo	6.85 ± 0.11^{c}	1.036 ± 0.02^{b}	0.16 ± 0.01^{b}	1.78 ± 0.05^{c}
Cow	6.63 ± 0.02^{b}	1.029 ± 0.01^{a}	0.17 ± 0.01^{a}	1.50 ± 0.01^{b}
Donkey	7.15 ± 0.01^{a}	1.024 ± 0.01^{a}	0.067 ± 0.01^{a}	0.75 ± 0.01^{a}
Goat	6.64 ± 0.05^{b}	1.036 ± 0.01^{b}	0.16 ± 0.01^{b}	1.75 ± 0.01^{c}

The values bearing different alphabets significantly differ (P<0.05) among the rows.

Viscosity: The determined viscosity of the buffalo and goat milk samples showed a remarkable similarity. The result showed that, the viscosity value of buffalo, cow, donkey and goat milk was in the range of 1.75-1.78, 1.47-1.52, 0.73-0.77 and 1.68-1.78 cp respectively **Table 2**. The viscosity of

cow milk was found significantly higher than donkey milk. The lower viscosity in donkey milk might be due to the lower fat and protein content when compared with other ruminant's milk. These results were in consonance with reports by other authors and also there were considerable variations when compared to the values reported from different parts of the world. This discrepancy may be ascribed to various factors as breed, milking system, feeding, milking frequency, lactation stage and age of the animal [30].

CONCLUSION: Collectively our results indicated that physico-chemical properties of buffalo and goat milk were higher than donkey and cow milk. It implies that buffalo and goat milk could act as complete source of nutritive value in comparison with cow and donkey milk. However, DM has been successfully used in various clinical studies, in children suffering with cow's milk protein allergy and has good palatability. Its composition is similar and close resemblance to human milk than other ruminant milk. The donkey milk is a best substitute to human milk with respect to its composition and bio-functional properties.

ACKNOWLEDGEMENT: The authors are highly thankful to the Heads of the departments to the concerned disciplines for providing facilities to conduct this research.

Ethics Standards: Manuscript does not involve any biological studies, the use of any animal or human data or tissue ''Not applicable''.

CONFLICT OF INTEREST: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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How to cite this article:
Swarnalatha G and Kumar SS: A comparative study on nutritive value and physico-chemical parameters of Andalusian breed of Donkey milk with other ruminant milks in Kamareddy District. Int J Pharm Sci & Res 2024; 15(11): 3291-96. doi: 10.13040/IJPSR.0975-8232.15(11).3291-96.

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