The Pharma Innovation Journal 2018; 7(11): 132-135

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(11): 132-135

www.thepharmajournal.com
Received: 01-09-2018
Accepted: 05-10-2018

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Study on the effect of heat treatment on chemical composition of milk among native and cross bred cows

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Abstract
An experiment was conducted to study the milk composition of native breeds (Sahiwal, Ongole & Punganur) and cross bred cows (HF & Jersey). Milk samples of eight healthy cows each of five cattle breeds, each breed were divided into four groups based on heat treatment as group I – Control (Raw milk); group II – Heating milk at 60^0 C /30 min. (LTLT); group III - Heating milk at 72^0 C/15 sec. (HTST) and group IV - Heating milk at 135^0 C/5 sec. (UHT), and analyzed for chemical composition (fat %, SNF %, Lactose and Protein). The results showed that, the milk of Punganur, Ongole and Sahiwal breed cows is superior in terms of its chemical composition and has potential to withstand for heat treatment when compared to Jersey and HF cross bred cows. The results of the study further demonstrated that heating the milk beyond 60^0C will denature the proteins, lactose and reduced the fat and SNF % in cross bred when compared to native breeds. Hence, it is concluded that, among all the experimental breeds, Punganur cow milk is superior in terms of Fat %, SNF %, Lactose content and protein profile then followed by Ongole breed and least was observed in Jersey cross bred and HF cross bred at room temperature or even at higher temperatures.

Keywords: milk composition, punganur breed, ongole breed, pasteurization, UHT, protein and lactose

Introduction
Livestock in India contributes 7% national income and milk output account for 5.6% to GNP (Prasad, 2013) [16]. India the world's second largest producer of milk and has ever growing market for milk and milk products (NDDB, 2017) [14]. Cow milk contains on an average 87.25 % of water, 3.80 % of fat, 3.50 % of protein, 4.80% of lactose and 0.07% of minerals. Besides, milk contains considerable quantity of fat soluble vitamins (Vit-A, D, E & K) and water soluble vitamins (Vitamin - B complex and Vitamin -C) (Eckles *et al.*, 1981) [7]. Composition of milk is mainly influenced by many genetic and environmental factors such as parity, breed, stage of lactation and agro-climatic conditions (Sudhakar. K *et al.*, 2013) [22]. The chemical composition of Indian native cow milk and the effect of heat treatment or pasteurization on native milk in comparison with cross bred cow milk is of much significance in the present scenario.
Several investigations have been carried out on the composition of milk with reference to fat %, SNF %, in many native and cross bred cows, but a detailed study on the chemical composition and effect of different heat treatment (60 ^{0}C, 72 ^{0}C and 135 ^{0}C) among native (Sahiwal, Punganur and Ongole) and cross bred (HF and Jersey) milk was lacking. Hence, the present study was undertaken to investigate the chemical composition such as fat%, SNF %, Protein and Lactose content and effect of heat treatment on milk among native in comparison with cross bred.

Materials and Methods
Milk samples were collected from randomly selected eight healthy cows each of five cattle breeds comprising of two exotic cross bred cows (Holstein Friesian & Jersey) and three indigenous cows (Sahiwal, Ongole and Punganur). The milk samples of each breed were divided into four groups based on heat treatments. The group I – Control (Raw milk); group II – Heating the milk sample at60 ^{0}C /30 min. (LTLT); group III - Heating the milk sample at 72 ^{0}C/15 sec. (HTST) and group IV - Heating the milk sample at 135 ^{0}C/5 sec. (UHT) and subjected to above mentioned heat treatments and analyzed for chemical composition (pH, specific gravity, fat, SNF, Protein & Lactose) of milk samples. Milk samples were collected from eight cows of each breed from organized dairy farms.

All the lactating cows selected in the present study were in second or third stage of lactation. All the hygienic principles were followed to procure clean milk. The raw milk samples were collected in a sterile beaker separately and closed with lid aseptically. The samples were kept in ice boxes and brought immediately to laboratory for further analysis.

All the milk samples at room temperature and at different heat treatments are subjected for determination of pH using digital pH meter, fat % as per AOAC (2000) [1], SNF % with Lactometer (Richmond's formula as per BIS, 1982), Benedict's method was used for estimation of lactose content and Biuret method for quantification of proteins in milk at different heat treatments and the data was analyzed for significance among the breeds and treatments using standard statistical procedures. (Snedecor and Cochran, 1994) [21].

Results and Discussion

Milk fat %

The mean fat % in the milk of HF and Jersey was 4.36±0.085 and 3.81±0.085 respectively, whereas in Sahiwal, Ongole and Punganur was 4.52±0.085, 4.52±0.085 and 5.07±0.085 (table 1). The fat percentage in Punganur breed was significantly (p<0.01) higher when compared to all other experimental breeds under study. Further, the fat percentage values in the milk of Sahiwal, Ongole did not differ with each other and similar observations was recorded between HF and Jersey cross bred also. The results of present study indicate, a significantly (p<0.01) higher fat percentage in native breed than cross bred cow milk, which may be due to variation in genotype and adaptability of breed in particular region. Similar trend of results were observed by Islam *et al.*, (2008) [9] and Bindya and Gayathri (2015) [2]. The study further indicated that fat% in punganur is higher when compared to all other breeds.

In the present study, the mean values of fat % did not differ significantly between 60 ^{0}C and 72 ^{0}C in all the experimental native and cross bred cow milk. The highest fat % was observed at 60 ^{0}C and 72 ^{0}C when compared to RT, this might be due to the coalescence of fat globules in the milk matrix of present study (Jose *et al.* 2015) [10]. Heat treatment of milk mainly affects the milk fat globule membrane (MFGM) and a number of heat-sensitive MFGM protein components and thus altering the structure of fat globules (Raynal-Ljutovac *et al*., 2007) [18]. When the milk was subjected to >100 ^{0}C sulphydryl compounds, H_2S and phospholipids were released. According to Van Boekel and Walstra, (1995) [23] the thermal degradation of milk fat was observed in UHT milk due to oxidation reactions of milk via release of reactive oxygen species (ROS). However, at more intense heating (>120), fat underwent autoxidation and formed antioxidants in the Maillard reaction (Van Boekel and Walstra, 1995) [23] which is said to be protective. The findings of present investigation along with the previous work, suggests that the milk fat % varies with breed, exotic inheritance and heat treatment.

Table 1: Mean values of Fat (%) of milk treated with different temperatures among experimental cows of native and cross bred.

S. No.	Heat Treatments	Cow breeds				
		HF	Jersey	Sahiwal	Ongole	Punganur
1	**Room Temperature**	4.36^b ±0.063	3.81^b ± 0.438	4.52^b ± 0.204	4.52^b ± 0.238	5.07^b ± 0.195
2	**60^0 C**	4.56^a ± 0.061	4.05^a ± 0.345	4.70^a ± 0.211	4.70^a ± 0.253	5.27^a ± 0.165
3	**72^0 C**	4.58^a ± 0.059	4.09^a ± 0.321	4.75^a ± 0.207	4.75^a ± 0.278	5.31^a ± 0.208
4	**135^0 C**	4.05^c ± 0.067	3.67^c ± 0.359	4.23^c ± 0.208	4.43^c ± 0.253	4.92^c ± 0.203

* Means with in column with different superscripts vary significantly (P<0.01)

Milk SNF %

The mean SNF % in present study was estimated as 8.28±0.105, 8.20±0.199, 8.67±0.147, 9.42±0,121 and 8.06±0.185 in HF, Jersey, Sahiwal, Ongole and Punganur cow milk respectively (table 2). The mean SNF % of Ongole was significantly higher as compared to all other breeds and followed by Sahiwal and it was significantly (p<0.01) differed as compared to other breeds. Similar findings were reported by Yadav *et al.* (1991) [25] in Sahiwal and F2-Friesian-Hariana breed milk, whereas While, Nigam and Bector (1991) [15] higher mean SNF %in purebred Sahiwal cows (9.12) compared to cross bred milk. Venkatachelapathy and Iype (1998) [24] recorded SNF % as 8.89 ± 0.12 in native breed of Vechur cow milk. The results of the present study indicates that the highest SNF % was recorded in native cow milk than cross bred milk, it could be influenced by breed, inheritance and genetic makeup of breeds.

Table 2: Mean values of SNF (%) of milk treated with different temperatures among experimental cows of native and cross bred.

S. No.	Heat Treatments	Cow breeds				
		HF	Jersey	Sahiwal	Ongole	Punganur
1	Room Temperature	8.28^d ± 0.219	8.20^d ± 0.241	8.67^d ± 0.196	9.42^d ± 0.125	8.06^d ± 0.287
2	60^0 C	8.39^c ± 0.190	8.17^c ± 0.494	8.78^c ± 0.234	9.51^c ± 0.109	8.30^c ± 0.277
3	72^0 C	8.54^b ± 0.161	8.31^b ± 0.502	9.07^b ± 0.503	9.64^b ± 0.116	8.71^b ± 0.394
4	135^0 C	9.57^a ± 0.295	9.93^a ± 0.316	10.52^a ± 0.165	10.70^a ± 0.239	10.25^a ± 0.358

* Means with in column with different superscripts vary significantly (P<0.01)

The study showed that the variations in SNF percentages were directly proportional to temperature i.e. as temperature increased the SNF % also increased significantly, it might be due to evaporation of water content in milk at high temperatures resulting in concentration of salts and other substances subsequently contributing to an increase in SNF percentage.

Lactose in milk

The Lactose content in the milk samples of the experiment was recorded as 5.17±0.059, 5.15±0.036, 4.89±0.077, 4.41±0.030 and 4.43±0.031 being highest in breeds of Ongole & Punganur followed by Sahiwal, Jersey and HF respectively and it is significantly (P<0.01) lower in crossbreds than in native breeds. The highest lactose content was observed in Ongole & Punganur cow milk which did not differ

significantly between these two breeds and least was in Jersey cross bred cow milk. Schmidt G.H *et al.*, (1971) [20] reported lactose content in Sahiwal cow milk as 5.04 g/dL and Puranik *et al.*, (2000) [17] in HF cross bred as 4.40 g/dL of lactose in milk. Whereas, Kulshreshtha and Razdan *et al.* (1970) [11] reported higher lactose content in the Ongole breed was higher than in Sahiwal and Tharparkar breeds. Bindiya and Gayathri (2015) [2] reported that, the highest milk lactose values are noticed in Vechur cow (4.99%) and least was in cross bred milk. The results of the study indicated that, Ongole and Punganur breed cow milk has higher Lactose content than cross bred cow milk.

Table 3: Mean values of Lactose (g/dL) content of milk treated with different temperatures among experimental cows of native and cross bred.

S. No.	Heat Treatments	Cow breeds				
		HF	Jersey	Sahiwal	Ongole	Punganur
1	Room Temperature	$4.43^a \pm 0.128$	$4.41^a \pm 0.122$	$4.89^a \pm 0.127$	$5.17^a \pm 0.045$	$5.15^a \pm 0.048$
2	60^0 C	$4.47^a \pm 0.122$	$4.40^a \pm 0.151$	$4.92^a \pm 0.130$	$5.17^a \pm 0.039$	$5.15^a \pm 0.033$
3	72^0 C	$4.45^b \pm 0.130$	$4.39^b \pm 0.112$	$4.83^a \pm 0.097$	$4.94^a \pm 0.086$	$4.92^a \pm 0.057$
4	135^0 C	$3.70^c \pm 0.480$	$3.36^c \pm 0.192$	$3.21^b \pm 0.250$	$3.02^b \pm 0.129$	$4.26^b \pm 0.212$

***** Means with in column with different superscripts vary significantly ($P<0.01$)

The mean lactose content in cross bred (HF and Jersey) cow milk did not differ significantly between RT and 60 ^{0}C treated milk samples, but a significant ($p<0.01$) difference was observed at 72 ^{0}C and 135 ^{0}C heat treatment. The lactose content in native breeds like Sahiwal, Ongole and Punganur cow milk did not differ significantly at room temperature, 60 ^{0}C and 72 ^{0}C whereas, at 135 ^{0}C there was a significant ($p<0.01$) reduction in lactose content.

The reduction of lactose content in milk at higher heating temperatures (UHT) may be due to heat treatment of milk causes the transfer of soluble salts to colloidal state and changes in lactose which includes its interaction with proteins and its conversion into formic acid. Heating of milk above 120 ^{0}C (UHT) affects the quality and functional properties of milk. These effects include degradation of lactose to organic acids and formation of lactulose, denaturation of whey proteins, destruction of vitamins andenzymes, hydrolysis of proteins and lipids and disturbances in calcium-phosphorus equilibrium. Similarly, heating temperature increased further to 140 ^{0}C the lactose undergone Lobry De Bruyn Van Ekenstein reaction and transformed to lactulose via 1-,2-enediol intermediates. The results of present findings are in accordance with results of Godson *et al.*, (2003) [8] and Mc Carthy and Singh (2009) [13] Sakkas *et al*. (2014) [19], Lan X.Y *et al.*, (2010) [12]. The results of present study revealed that, lactose content in milk was decreased in cross bred cow milk at 72 ^{0}C onwards but lactose content in native breed like Punganour and Ongole cow milk was not degraded and retained the quality of lactose even at 72 ^{0}C which clearly indicated that, the Punganur breed cow milk has better quality and superior breed performance than other cross bred and other native breeds.

Milk Proteins (g/dL)

The mean milk protein content varied from 3.16 to 3.51 and differed significantly ($p<0.01$) among the experimental groups. However, no significant difference was observed between cross bred HF milk (3.16) and Jersey milk (3.17), but significant ($p<0.01$) difference was observed in Sahiwal (3.32), Ongole (3.51) and Punganur (3.45) cow milk. Ongole breed cow milk had the highest milk protein content whereas, least was in Jersey crossbred cow milk. It might be due to variations in genetic makeup of breed, indicating the Ongole and Punganur breed cow milk appeared to be superior in terms of protein content over the cross bred cow milk.

Table 4: Mean values of Protein (g/dL) content of milk treated with different temperatures among experimental cows of native and cross bred.

S. No.	Heat Treatments	Cow breeds				
		HF	Jersey	Sahiwal	Ongole	Punganur
1	Room Temperature	$3.16^b \pm 0.037$	$3.17^b \pm 0.055$	$3.32^b \pm 0.053$	$3.51^b \pm 0.032$	$3.45^b \pm 0.046$
2	60^0 C	$3.37^a \pm 0.085$	$3.41^a \pm 0.043$	$3.58^a \pm 0.057$	$3.79^a \pm 0.030$	$3.85^a \pm 0.049$
3	72^0 C	$2.84^c \pm 0.052$	$2.89^c \pm 0.048$	$3.04^c \pm 0.088$	$3.70^c \pm 0.056$	$3.78^c \pm 0.049$
4	135^0 C	$2.49^d \pm 0.046$	$2.54^d \pm 0.127$	$2.56^d \pm 0.094$	$3.02^d \pm 0.110$	$2.99^d \pm 0.127$

* Means with in column with different superscripts vary significantly ($P<0.01$)

The protein content in the milk of native and cross bred cows was significantly ($p<0.01$) higher at 60 ^{0}C when compared with room temperature and there was a significant ($p<0.01$) decrease in protein content with increase in temperature to 72 ^{0}C and 135 ^{0}C. it might be due to heating of milk causes unfolding of proteins. After unfolding of proteins, the whey proteins are capable to interact with themselves and k-casein to form heat-induced protein aggregates it might be the reason for high protein content at 60 ^{0}C, further heating of milk above 70 ^{0}C induces changes at molecular level which may have an impact on protein functionality. On heating above 70 ^{0}C causes unfolding of protein structure, cleavage of disulphide bonds, formation of intra/inter molecular interactions and rearrangement of disulphide would take place at 80–90 ^{0}C and formation of protein aggregates was seen at 90-100 ^{0}C. The present findings are in accordance with Donato, *et al.*, (2007) [6], Singh *et al*, (1992), Davis and Willams (1998) [5] and Croguennec *et al*., (2004) [4]. The present investigation indicated that, significantly higher protein concentration in the milk was observed in Ongole and Punganur breed milk and least was in cross breeds and suggest that, heating the milk upto 60 ^{0}C will not affect the protein quality of milk in Punganur and Ongole breed over cross bred cow milk.

Conclusion

The results of the experiment concluded that the milk of native cow breeds of Punganur, Ongole and Sahiwal are superior in terms of its chemical composition and the milk has potential to withstand for heat treatment indicating its

superiority over cross bred cows of Jersey and HF. Further, heating the milk beyond 60^0C will denature the useful proteins, lactose and reduced the fat and SNF %, with much higher rate in cross bred when than in native breeds. Further, Punganur cow milk is superior in terms of Fat %, SNF %, Lactose content, and proteins profile followed by Ongole breed and least was observed in Jersey cross bred followed by HF cross bred at room temperature or at high temperatures.

Acknowledgement
The authors are grateful to Sri Venkateswara Veterinary University, Tirupati and P.V. Narsimha Rao Telangana Veterinary University for providing funds to execute this research work. Special thanks to Dr. P. Eswara Prasad, Professor and University Head, Department of Veterinary Biochemistry, Tirupati for his courtesy.

References

1. AOAC. Official methods of analysis of Association of Official Analytical Chemists, 20th Edition. International Gaithersburt, Washington DC; USA, MD Sec. 2000; 33(2):27.
2. Bindya Liz Abraham, Gayathri SL. Milk composition of crossbred and desi cattle maintained in the sub-tropical high ranges of kerala. Ind. J Vet. & Anim. Sci. Res. 2015; 44(1):53-55.
3. Bureau of Indian Standards (BIS). Method of test for determination of SNF in milk by the use of lactometer. Indian Standards Institution, New Delhi, 1982, 4-8.
4. Croguennec T, Kennedy BT, Mehra R. Heat-induced denaturation/aggregation of β-lactoglobulin A and B: kinetics of the first intermediates formed. International Dairy Journal. 2004; 14:399-409.
5. Davis PJ, Williams SC. Protein modification by thermal processing. Allergy. 1998; 53:102-105.
6. Donato L, Guyomarc'h F, Amiot S, Dalgleish DG. Formation of whey protein/k-casein complexes in heated milk: preferential reaction of whey protein with k-casein in the casein micelles. International Dairy Journal. 2007; 17:1161-1167.
7. Eckles CH, Conbs WB, Maey H. Milk and milk products. Fourth edition. Mc Grow-Hill Book company, New York. USA, 1981.
8. Godson DL, Acres SD, Haines DM. Failure of passive transfer and effective colostrum management in calves. Large Animal Veterinary Rounds 3: Montreal, Canada, 2003.
9. Islam MR, Hassan MN, Siddiki MSR, Khan MAS, Islam MA. Determination of quality of milk from different genotype of dairy cows. Bang. J Anim. Sci. 2008; 37(1):53-56.
10. Jose MP, Adriano Gennari, Bruna Wissmann Monterio, Daniel Neutzling Lehn, Claucia Fernanda Volken de Souza. Effects of pasteurization and ultra-high temperature processes on proximate composition and fatty acid profile in bovine milk. American J of food tech. 2015; 10(6):265-272.
11. Kulshreshtha VV, Razdan MN. Indian J Dairy Sci, 1970; 23:50-54.
12. Lan XY, Wang JQ, Bu DP, Shen JS, Zheng N, Sun P. Effect of heating temperatures and addition of reconstituted milk on the heat indicators in milk. Journal of Food Science. 2010; 75(8).
13. McCarthy, Singh H. Advanced Dairy Chemistry, Lactose, Water, Salts and Minor Constituents. Chapter 15, Springer Science Business Media, LLC, 2009.
14. National Dairy Development Board. 2017. Annual report – 2016-17. Available at http://www.nddb.org/English/Statistics /Pages/Milk-Production.aspx.
15. Nigam S, Bector BS. Effect of milking and stage of lactation on the composition of milk of crossbred (Karan-Swiss and Karan-Fries) and Sahiwal cattle. Indian J. Dairy Sci. 1991; 44:431-434.
16. Prasad J. Importance of bovines in Indian agriculture, livestock industry vs. socio-economic life. National seminar on role of livestock in Indian agriculture held at Mahatma Gandhi Chitrakoot Gramodya Viswavidyalaya, Chitrakoot, Madhya Pradesh, during, 2013, 20-23.
17. Puranik DB, Nagabhushana V, Appannavar MM. Effect of Breed and stage of lactation on the milk composition in HF x Deoniand Jersey x Deoni crossbred cows. Indian J Anim. Prod. Mgmt. 2000; 16:18-19.
18. Raynal-Ljutovac K, Pirisi A, de Crémoux R, Gonzalo C. Somatic cells of goat and sheep milk: Analytical, sanitary, productive and technological aspects. Small Ruminant Research. 2007; 68:126-144.
19. Sakkas L, Moutafi A, Moschopoulou E, Moatsou G. Assessment of heat treatment of various types of milk. Food Chem. 2014; 159:293-301.
20. Schmidt GH. Biology of Lactation. San Francisco: W. H. Freeman, 1971.
21. Snedecor WG, Cochran GW. Statistical methods. 8th Edition, IOWA State Univeristy Press, Ames, USA, 1994
22. Sudhakar Krovvidi S, Panneerselvam AK, Thiruvenkadan J, Johnson Rajeswar K, Sivakumar R, Vinoo. Lactation Performance and Milk Constituents of Ongole Cattle in Its Breeding Tract. RR Jo VST, 2013, 8-11 © STM Journals.
23. Van Boekel MA, Walstra P. Effect of heat treatment on chemical and physical changes to milk fat globules. International Dairy Federation, 1995, 51-65.
24. Venkatachelapathy RT, Iype S. Fat, total solids and solids-not fat percentage of milk in Vechur cattle. Indian J Anim. Sci. 1998; 68:570.
25. Yadav PL, Nautiyal PL, Saxena MM, Sanyal MK, Dubey PC, Pandey HS *et al*. Quality characteristics of milk from Holstein Friesian and Hariana x Exotic cattle. Indian Vet. J. 1991; 68:963.