Physico-chemical, microbiological, textural and sensory properties of dahi prepared from Vechur cow milk

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Abstract

Vechur cow is a rare breed of Bos indicus cattle of Kerala, India listed under the category of Critical Breeds in 'The World Watch List of Domestic Animal Diversity' published by Food and Agriculture Organisation of the United Nations (FAO).The present study reports the quality parameters of a product prepared from Vechur cows' milk. Physico-chemical, microbiological, textural and sensory properties of dahi prepared from Vechur cow milk was assessed and compared with that of standard dahi prepared from cross-bred cow milk. Dahi prepared from Vechur cow milk exhibited significantly ($p<0.01$) lower syneresis, a* , b* values, cohesiveness, adhesiveness and higher hardness than the cross- bred cow milk dahi. Vechur cow milk dahi scored significantly higher values for the sensory attributes body and texture and color and appearance. However no significant differences were observed in terms of overall acceptability, flavor scores and microbiological parameters. This is one of the first reports elaborating the quality characteristics of a fermented product prepared from Vechur cow milk. The data generated is expected to contribute significantly to the currently available database on this subject matter. This study also opens up the possibilities of exploring fermentation as a highly economical and suitable process for value addition of Vechur cow milk which could effectively support the efforts towards the conservation of this rare indigenous cattle breed.

Keywords: Vechur cow milk, dahi, syneresis, color characteristics, textural attributes

Introduction

Vechur cow is an indigenous cattle breed named after the Vechur village in Kottayam district of Kerala state in India. Owing to their extremely small size, low feed requirement, good adaptation and high disease resistance, Vechur cows were very popular in Kerala till 1960s, but became rare when the cross breeding policy was adopted in the state [1]. This indigenous cattle breed of Kerala is listed by Food and Agriculture Organisation of the United Nations (FAO) in their Domestic Animal Diversity Information System and also under the category of Critical Breeds in 'The World Watch List of Domestic Animal Diversity' published by FAO [2]. The Vechur cow is also placed in the breed map of cattles published by the National Bureau of Animal Genetic resources, ICAR, India [3]. Vechur cow milk is considered to be very ideal for infants and convalescents due to its high digestibility which is attributed to the smaller fat globules [4]. High antimicrobial properties are also reported for Vechur cow milk lactoferrin [5]. A recent report on the characterization of the Toll like receptor2 (TLR 2) gene of this native cattle suggested greater immune response of this native cattle compared to exotic cattle [6]. Though studies are being conducted on the genetic diversity, population structure, and relationship between native Vechur cattle and Crossbred Cattle of Kerala State, India [7] so far no concerted efforts have been taken towards the use of Vechur cow milk for product preparation. Considering that this breed is considered as a critical breed, it is essential to find ways to conserve and popularize their rearing. The major hindrance towards this is the less productivity of these animals thereby resulting in huge economical limitations. Development of traditional high – quality products from the milk of indigenous cattle breeds is recognized as one of the means for compensating their lower milk yield [8]. Preparation of dahi, the most popular fermented product of the Indian subcontinent which applies fermentation, one of the age old methods practiced by mankind for the preservation of milk is an ideal choice in this direction. It is also vital that the various properties of the developed product are thoroughly characterized as they are having a high bearing upon consumer acceptance and thus its marketability. This aspect is of particular relevance in the case of development of products using Vechur cow milk as so far no efforts have been taken towards assessing the attributes of products prepared from milk of these cows or even its suitability for product preparation. In view of this scenario the present study attempts to evaluate the physico-chemical, microbiological, sensory and textural properties of dahi prepared from Vechur cow milk.

Materials and Methods

Preparation of dahi:

Fresh, pooled milk samples of Vechur and cross-bred cow's were ob-

tained from University cattle farm, Kerala Veterinary and Animal Sciences University, Mannuthy, Kerala, India. Vechur cow milk dahi was prepared from homogenized standardized Vechur milk according to the optimized production parameters (rate of inoculation, incubation temperature and incubation period) derived through Response Surface Methodology (RSM). In brief, standardized (3% fat and 8.5% SNF) and two stage homogenized (2500psi and 500psi) milk was heat treated at (90°C/5min), cooled to the incubation temperature, inoculated with the culture Lactococcus lactis subsp.lactis NCDC 91 (National Collection of Dairy Cultures, Karnal) at the rate of 3% of milk and incubated at 37°C/5 h 30 min. The control dahi was prepared from standardized (3% fat and 8.5% SNF) and two stage homogenized (2500psi and 500psi) cross-bred cow milk in the same way except that the rate of inoculation was 2 % and the incubation period was 8h [9]. Six independent batches of both the types of dahi were prepared and assessed for various attributes as detailed below.

Physico - chemical parameters:

Fat content of dahi was measured by standard Gerber method [10]. Protein content of dahi samples was determined by semi-micro Kjeldahl method described by Menefee and Overman [11] and the total solids by the standard method [12]. Lactose contents of dahi samples were determined by Lane Eynon method [13] and titratable acidities by the standard method [14]. Syneresis of dahi samples were determined by centrifuging (30-40g) of dahi sample at 1100 rpm for 10 minutes. Weight of the supernatant was determined and the syneresis percentage was calculated as per the equation given below [15].

$$\%\ syneresis = \frac{weight\ of\ the\ supernatant}{weight\ of\ the\ sample\ taken} \times 100$$

Color of the dahi samples were measured using a Color flex colorimeter (Hunter Associated Laboratory, Inc., VA, USA, software version 4.10). The color characteristics of product was expressed in terms of L* (luminance or lightness component, ranging from 0 to 100) and a* (from green to red), b* (from blue to yellow) values (International Commission for Color Measurement (CIE) system). As per the color scale adopted in the current study, at L (lightness) axis – 0 is black and 100 is white, a axis – positive values are red; negative values are green and zero is neutral, and b – positive values are yellow; negative values are blue and zero is neutral.

Microbiological analysis:

Total viable count of the dahi samples were determined by pour plating appropriate dilutions on nutrient agar and incubation at 37°C for 48 h [16]. Coliform counts of dahi samples were determined as per the standard procedure [17] using violet red bile agar (VRBA, HiMedia, Mumbai) and incubation at 37±0.5°C for 24 h. Yeast and mold counts in dahi samples were determined as per the standard methods for analysis of dairy products of American Public Health Association (APHA) using potato dextrose agar (PDA) and incubation at 25±1°C for 5 days [18]. M17 agar was used for the enumeration of lactococci and the incubation was done at 37°C for a period of 48 h [18].

Texture Analysis:

Textural characteristics such as hardness, adhesion, and cohesiveness were measured using Texture Analyzer (Stable Micro Systems, Model TA.HD plus, fitted with 50 kg load cell). Experiments were carried out by compression tests that generated plot of force (N) versus time (s). A 25 mm perplex cylindrical probe was used to measure texture of dahi samples at a temperature of 5±0.5ºC. The texture analyzer was calibrated in terms of compression height and the texture analyzer parameters were set such that the speed of the probe is 0.5 mm/s during the compression and 2 mm/s during pre-test and relaxation of the samples. The samples were loaded to the analyzer ensuring that the coagulum is not disturbed and the tests were run. The typical graphs obtained were analyzed using Texture Expert Exceed Software provided with the instrument.

Sensory Analysis:

The dahi samples were subjected to sensory analysis (color and appearance, flavor, body and texture and overall acceptability) by a panel of six trained judges. The panelists were presented with the coded dahi samples and were instructed to score the coded samples based on the 9-point hedonic scale score card with scores ranging from 1 to 9 (9=extremely like, 8=very much like, 7=moderately like, 6=slightly like, 5=neither like nor dislike, 4=slightly dislike, 3= moderately dislike, 2=very much dislike, and 1=extremely dislike).

Statistical analysis:

Paired t-test was used for comparing physico-chemical, microbiological and textural parameters of samples. Changes in sensory parameters between the samples in each period were compared using Wilcoxon test. Data analyses were carried out using the Statistical Package for Social Sciences (SPSS, Version 24) and the results are presented as mean with standard error of six replications.

Results and Discussion

Physico- chemical properties:

Physico-chemical attributes of dahi prepared from Vechur cow milk is summarized in Table 1. Significantly higher ($p<0.01$) protein and lactose contents were observed in Vechur cow milk dahi (4.35% and 4.1% respectively) than cross-bred cow milk dahi (3.91% and 3.20% respectively). It is quite understandable as raw milk samples of Vechur cow had significantly higher protein and lactose contents than cross-bred cow milk (data not shown). No significant differences were observed between the fat, SNF, total solids and acidity percentages of the samples. Both the types of dahi exhibited titratable acidity of 0.73 ± 0.01 per cent. The developed Vechur cow milk dahi met all the stipulated Food Safety and standards Authority of India (FSSAI) standards of fermented milk products i.e. 'should have the minimum percentage of fat and solids-not-fat as the milk from which it is prepared and minimum titratable acidity of 0.45 per cent' [19]. Wheying-off or syneresis, an

Table 1: Physico-chemical properties of Vechur and cross-bred cow milk dahi samples

Parameter	Vechur cow milk dahi	Cross-bred cow milk dahi	t –value
Fat (%)	3.13±.033	3.15±.00	0.542^{ns}
SNF (%)	8.56±.033	8.54±.033	0.000^{ns}
Total solids (%)	11.67±.067	11. 69±.033	0.523^{ns}
Protein (%)	4.35±.01	3.91±.067	5.543**
Lactose (%)	4.1±.024	3.20±.025	11.521**
Acidity (% lactic acid)	0.72±.033	0.73±.033	1.430^{ns}
Syneresis (%)	9.05±.05	11.95±0.00	14.97**
Color characteristics			
L*-Lightness axis	89.12 ± 0.067	89.22 ± 0.017	2.079^{ns}
a*-Red-green axis	-3.91 ± 0.0	-3.48 ± 0.050	12.277**
b*-Blue-yellow axis	11.42 ±0 .033	12.10 ± 0.067	17.994**

Figures are the Mean ± Standard Error of six replications, ns: non-significant at 5% level ($p>0.05$), **: significant at one per cent levels ($p<0.01$),*: significant at five per cent levels ($p<0.05$)

Table 2: Microbiological parameters of Vechur and cross -bred cow milk dahi samples

Microbial parameter	Vechur cow milk dahi	Cross-bred cow milk dahi	t-value
Total viable count (log10CFU/g)	7.64±0.048	7.65±0.056	0.807^{ns}
Coliform count (log10CFU/g)	0	0	-
Yeast and mold count (log10CFU/g)	0.54±0.123	0.60±0.085	0.325^{ns}
Lactococcal count (log10CFU/g)	7.63±0.007	7.62±0.009	1.042^{ns}

Figures are the Mean ± Standard Error of six replications, ns: non-significant (p>0.05) at 5% level

undesirable aspect for fermented milk products is attributed to the unsteadiness of the gel grid and its reduced capacity to entangle all the serum phase [20]. Syneresis % of dahi prepared from Vechur cow milk (9.05%) was significantly (p<0.01) lower than that of the dahi (11.95%) prepared from cross-bred cow milk. The reduced level of syneresis observed for Vechur cow milk dahi could be attributed to the higher protein content as reported by Lee and Lucy [21].

The color character values expressed in terms of L*, a* and b* values are presented in Table 1. The L* value of Vechur cow milk dahi was 89.12 which was lower than (p <0.05) that of cross-bred cow milk dahi having L* value of 89.22 though not statistically significant. As the L* values were lower than 100 it could be conceived that they have relatively dark color compared with standard white color (L*=100). Whiteness in fluid milk results from the presence of colloidal particles, such as milk fat globules and casein micelles, capable of scattering light in the visible spectrum [22]. The difference observed between the samples might be due to any of these factors as the milk from different breeds of cattle was used in this study. Significant differences (p<0.01) were observed in a* value, measure of redness of both the types of dahi.

Table 3: Textural parameters of Vechur and cross-bred cow milk dahi samples

Parameters	Vechur cow milk dahi	Cross-bred cow milk dahi	t-value
Hardness(g)	176.1±0.99	159.7±0.27	10.16**
Cohesiveness	0.36±0.001	0.38±0.002	9.37**
Adhesiveness	84.8±0.61	93.3±0.67	10.34**

Figures are the Mean ± standard error of six replications **: Significant at one per cent levels (p<0.01)

The a* value of Vechur cow milk dahi was found to be lower (-3.91) than cross-bred cow milk dahi (-3.48). The negative a* value obtained indicates the inclination of the product color towards greenness. The b* value which measures yellowness was found to be 11.42 for Vechur cow milk dahi and was significantly lower (p < 0.01) lower than that of cross-bred cow milk dahi (12.10). Positive b* values referring yellowness exhibited by both the types of dahi could be attributed to the presence of β-carotene, a colored carotenoid pigment responsible for the red, yellow and orange color in dairy products. The observed greenish-yellow discoloration could be attributed to the presence of colored nutrients such as riboflavin (vitamin B2) in milk [23]. Such colorimetric observations of greenish-yellow colored fermented milk products are reported by other authors also [23, 24]. So based on the L*, a* and b* values, both types of dahi could be regarded as relatively dark greenish yellow in color.

Microbiological Analysis:

Dahi prepared from Vechur cow milk did not differ from cross-bred cow milk dahi in any of the microbiological parameters tested (Table 2). The FSSAI stipulated starter culture count (lactic acid bacteria) of more than 10^7 CFU/g was present in both the types of dahi. Coliforms were not detected in both the samples throughout the shelf life. The fact that the FSSAI specified process hygiene parameters: coliform count as well as yeast and mold count conforms to the standards is suggestive of good practices followed during preparation of products.

Textural and Sensory characteristics:

Texture is one of the primary characteristics that decides the quality of fermented milk products. Texture has a direct influence on the sensorial properties like appearance, mouth feel and overall acceptability. Textural properties of the dahi prepared from both types of milk are presented in Table 3. Hardness is regarded as the force required to attain a certain deformation and is considered as a measure of firmness. It is viewed as the most important parameter for evaluation of texture. Dahi prepared from Vechur cow milk exhibited significantly (p<0.01) higher values for hardness and lower cohesiveness and adhesiveness values (p<0.01) than the cross-bred cow milk dahi. The higher hardness observed for Vechur cow milk dahi could be attributed to its higher protein content as higher protein content results in increased extent of cross-linkage of gel network and thereby a much denser structure [25]. Cohesiveness is the "ability to adhere to itself under some compressive or tensile stress" or it is the level to which a material can be deformed before it is ruptured and is a measure of the strength of internal bonds [26]. Lower cohesiveness value was observed for Vechur cow milk dahi than the cross-bred milk dahi. Adhesiveness is regarded as the force required to remove the adhered material in the mouth while eating. In the case of fermented milk products both the fat and protein content influence adhesiveness. Despite the significantly high protein content Vechur cow milk dahi, exhibited lower adhesiveness than the cross-bred cow milk dahi. Cohesive and adhesive yoghurts can possibly be pulled into threads and they may possess a larger degree of stickiness in mouth and thereby can defectively influence consistency and texture of the product [27]. Accordingly Vechur cow milk dahi with its significantly lower cohesiveness and adhesiveness values could be graded as superior in terms of textural attributes. The sensory scores obtained (8.5 and 8.0 respectively) underpin this observation. Both the types of dahi samples scored values higher than or equal to 'eight' qualifying them to be graded as 'Liked very much' in terms of all the sensory parameters tested: flavor, body and texture, color and appearance and overall acceptability. Among the sensory parameters assessed, significant differences in between the samples were observed only for body and texture (p<0.05) and color and appearance (p<0.01) with the Vechur cow milk dahi scoring higher than the other (Table 4). So the sensory scores obtained were agreeing with the significant differences observed in terms of the color characteristics a* and b*, protein, lactose contents and syneresis %; the major factors contributing towards the above mentioned sensory attributes. Despite the significant differences observed in the protein and lactose contents of the two types of dahi samples, no significant differences (p> 0.05) were observed in between them in terms of their overall acceptability: a measure of consumers' degree of preference in relation to the control sample or samples of the same category. The sensory evaluation of the dahi samples indicated that highly acceptable dahi could be produced from

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Table 4: Sensory parameters of Vechur and cross-bred cow milk dahi samples

Parameter	Vechur cow milk dahi	Cross-bred cow milk dahi	Z-value
Flavour	8.5±0.22	8.3±0.21	0.625^{ns}
Body and Texture	8.5±0.22	8.0±0.0	2.236*
Color and Appearance	8.7±0.21	8.0±0.0	40.0**
Overall Acceptability	8.0±0.0	8.0±0.0	0.00^{ns}

Figures are the Mean ± Standard Error of six replications, ns: non-significant (p>0.05) at 5% level, **: significant at 1% levels (p<0.01), *: significant at 5% levels (p<0.05)

Vechur cow milk.

Conclusion

Value addition is considered as an effective approach to address the economic drawbacks related to rearing of low yielding animals. Fermentation is already recognized as an economically viable way of value addition of milk especially while handling small volumes due to the low capital investment required. Moreover, health benefits attributed to fermented products increases the demand for these nutritionally superior products. The Vechur cow milk dahi was found to be more or less similar or even superior to crossbred cow milk dahi in some attributes. Thus observations in this study highly support exploration of fermentation as a way to develop products from Vechur cow milk, specifically targeting the elite consumers. Such attempts can compensate the economic issues associated with lower milk yield and thereby indirectly contribute towards conservation of this rare breed by encouraging rearing of this indigenously unique breed.

References

1. Iype S. Vechur cattle – from extinction to sustainability. Anim Genet Resour,2013; 52:105–110.
2. DAD-IS. Domestic Animal Diversity Information System. Food and Agriculture Organization of the United Nations, Available: http://www.fao.org/dad-is/, 2012.
3. NBAGR [National Bureau of Animal Genetic Resources]. Breeds; cattle .Available http://www.nbagr.res.in/regcat.html, 2001.
4. Venkatachalapathy RT, Iype S. Fat globule size and distribution in milk and iodine value of milk fat of Vechur cattle of Kerala. Ind J Anim Sci. 1996; 67: 10–12.
5. Anisha S, Bhasker S, Mohankumar C . Recombinant lactoferrin (Lf) of Vechur cow, the critical breed of Bos indicus and the Lf gene variants. Gene. 2012; 495: 23-8.
6. Shivakumara PN, Aravindakshan TV, Thomas N, Anilkumar R, Uma R. Molecular characterization and differential mRNA expression profiling of Toll-like receptor-2 gene in Vechur (*Bos indicus*) and crossbred (*Bos indicus* X *Bos taurus*) cattle of Kerala in response to anthrax vaccination. Meta Gene .2016; 16:15-20.
7. Radhika G, Aravindakshan TV, Jinty S, Ramya K. Evaluation of Genetic Diversity, Population Structure, and Relationship Between Legendary Vechur Cattle and Cattle of Kerala State, India. Anim Biotechnol. 2018; 29:50-58. Doi: 10.1080/10495398.2017.1297719. E.pub 2017 Mar 30
8. Petrera F, Catillo G, Napolitano F, Malacarne M, Franceschi P, Summer A, Abeni F. New insights into the quality characteristics of milk from Modenese breed compared with Italian Friesian. Ital J Anim Sci. 2016; 15: 559-567
9. Nahar A, Al-Amin M , Alam SMK, Wadud A, Islam MN. A Comparative Study on the Quality of Dahi (Yoghurt) Prepared from Cow, Goat and Buffalo Milk. Int J Dairy Sci. 2007; 2: 260-267.
10. IS: (SP: 18), "ISI Handbook of Food Analysis, Part XI: Dairy Products, 1981; Indian Standards Institution, New Delhi, 175 -250.
11. Menefee SG, Overam OR. A semi micro Kjeldahl method for determination of total nitrogen in milk. J Dairy Sci. 1940; 23:1177-1183
12. IS: 12333. Milk, Cream and Evaporated Milk –Determination of total solids content. 1997;Bureau of Indian Standards, Manak Bhavan, 9- Bahadur Shah Zafar Marg, New Delhi -1.
13. IS: SP: 18.PART XII. 1981. Handbook of food analysis. Dairy products.1981; Indian standard institution, Bahadur Shah Zafar Marg, Manak Bhavan, New Delhi-1. 15.
14. IS: 1166. Specification for condensed milk, partly skimmed and skimmed condensed milk.1986; Indian standards Institution, Manak Bhavan, New Delhi -1.
15. Goncalvez D, Cecilia PC, Reolon G, Segura N, Lema , P., Gambaro, et al. Effect of thickeners on the texture of stirred yogurt. Alim Nutr Araraquara. 2005;16: 207-211.
16. American Public Health Association. Standard Methods for the Examination of Dairy Products, 1978;14th Ed., Washington D.C.
17. IS: 5401. Methods for detection and estimation of coliform bacteria in food stuffs. 2002; Indian standards Institution, Manak Bhavan, New Delhi-1.
18. Downes FP, Ito K, Editors, Compendium of Methods for the Microbiological Examination of Foods. 2001; 4th Ed., APHA, Washington, D.C.
19. Food Safety and Standards Authority of India. Food safety and Standards (Food Product Standards and Food Additives) Regulations. 2017; Available: https://www.fssai.gov.in/upload/uploadfiles/files/Compendium_Food_Additives_Regulations_29_03_2019.pdf.
20. Lucey JA, Singh H. Formation and physical properties of acid milk gels: a review. Food Res Int. 1997; 30: 529–542.
21. Lee WJ, Lucey JA. Formation and physical properties of yogurt. Asian- Aust J Anim Sci. 2010; 23 t: 1127–1136.
22. Fox PF, McSweeney PLH 1998. Physical properties of milk, In: Fox PF, McSweeney PLH, editors Dairy Chemistry and Biochemistry, Blackie Academic and Professional, London; 1998. p. 437-462.
23. Akeem SA, Yerumoh O, Leigh O, Bamgbala K, Okeke G, Sokunbi F, Olayiwola I. Physicochemical properties, colour characteristics, and sensory evaluation of full cream cow-coconut milk yoghurts. Croat J Food Sci Technol. 2018;10:226-233.
24. Deb M, Seth D. Studies on the Physico-Chemical and Microbiological Analysis of Plain Dahi of Assam (India). J Bioresour Eng and Technol. 2014; 1:27-32
25. Paseephol T, Small DM, Herkat F. Rheology and texture of set yogurt as affected by inulin addition. J of Texture Stud. 2008; 39: 617-634.
26. Yilmaz-Ersan L, Ozcan T, Akpinar-Bayizit A, DelikanlKiyak B. The characterization of the textural and sensory properties of buffalo milk yogurts. Proceedings of 68th the IRES international conference, 2017; Lisbon, Portugal.
27. Kailasapathy K. Survival of free and encapsulated probiotic bacteria and their effect on the sensory properties of yoghurt. Lebensm-Wiss Technol. 2006; 39:1221–1227.