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ASSESSMENT OF SENSORY ATTRIBUTES IN CHEDDAR CHEESE MADE FROM THE MILK OF DEONI AND CROSSBRED COWS

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Abstract– Present study aimed to assess the sensory properties between the Cheddar cheese made from the milk of Deoni (DMCC) and Crossbred cows (CMCC). Deoni milk had total solids content of 14.12 % and contents of protein, fat, lactose and ash were 3.28, 5.2, 4.64 and 0.75, respectively. The DMCC and CMCC were prepared and analysed for proximate composition The overall acceptability score for DMCC was significantly ($p<0.05$) higher and was well-balanced flavour with smooth body and texture. However, total viable bacterial count was significantly higher ($p<0.05$) in DMCC than in CMCC from 6th month of ripening.

INTRODUCTION

Fermented milk constitutes as one of the most important dairy based functional foods and is vital components of the human diet. The components of milk not only deliver nutrients to the body, but also enhance their absorption, even if they are present with food products. Milk products that belong to the category of functional food are endowed with bioactive peptides, probiotic bacteria, antioxidants, highly absorbable calcium and other biologically active components.

Cheese has been a part of dietary culture since the dawn of history and is produced using unique food processing procedures, such as fermentation and ripening. Cheese is a source of biologically active elements, especially its protein and it is known that, its peptide fraction comprises numerous health-promoting impacts. Through the action of proteinases and peptidases, various peptides are released in the course of secondary proteolysis, which not only contribute for flavour and texture in the ripened cheese but also show a considerable bioactivity (Saito *et al*., 2000). Cheddar cheese is a ripened variety of cheese where fermentation takes place by lactic acid bacteria and hydrolysis of protein and fat occur with residual coagulating enzymes and various other enzymes produced by bacteria and native milk enzymes. Milk from which cheese is made, has great role for its basic dietary role and bio-functional activities in relation to health benefits.

Cheese is most popularly consumed dairy products with an increasing consumer demand. While most cheese varieties mature fast, some varieties require prolonged maturation time to improve the colour, texture, taste and aroma attributes of mature cheese, particularly in varieties of low moisture like Cheddar. Traditional cheese maturation includes a series of biochemical and microbiological events that happens at a very slow rate. The sensory attributes of cured cheese are greatly influenced by proteolysis and lipolysis. The key proteolytic elements of cheese are proteinases of indigenous milk, rennet proteinases and starter, non-starter, and secondary starter bacterial proteinases and peptidases (McSweeney, 2004)

There are not many studies reported on comparison of ripening and sensory properties between the cheese made from indigenous and Crossbred milk. Therefore, present attempt would be focussed to compare sensory properties of the Cheddar cheese made from Deoni and Cross breed milk.

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MATERIALS AND METHODS

Materials

Cheddar cheese was made from Crossbred and Deoni cow milk obtained from dairy plant of ICAR-National Dairy Research Institute, Bengaluru. Cheddar cheese DVS culture was procured from Chr. Hansen, Denmark. Microbial rennet (FROMASE 2200 TL Granulate; derived from *Rhizomucor miehei*; milk clotting activity ≥ 2200 IMCU/g) was obtained from M/s DSM, Mumbai. All the chemicals and reagents used for chemical analyses were of AR grade.

Cheddar cheese manufacture

Cheddar cheese was prepared according to the standard protocol (Kosikowski and Mistry, 1997). Whole milk of Crossbred and Deoni milk with 50 litres each were standardized to casein to fat ratio of 0.68- 0.70 with their respective skim milk and it was Pasteurised at 63 °C for 30 min. The milk was cooled to 30-31 °C and DVS culture of 0.9 g was added and kept for 30 min. Microbial rennet of 1.5 gwas added for 50 litres of milk. After 45 min of coagulation, the curd was cut with cheese knives and cooked at 38-39 °C for 40 min. Whey was drained and curd was cheddared at 39 °C till reached to 0.45-0.50% lactic acid. The milled curd was salted and hooped in cheese moulds, dressed and pressed overnight. The cheese blocks were turned next day and pressed further for 24 h. After pressing, cheese blocks were removed and placed in ageing room for 2 days. These surface dried cheese blocks were paraffined and aged for 12 months at 7± 2 °C. Cheese samples were collected at two months interval for analysis.

Analysis of Cheddar cheese

Percent fat, protein, ash and acidity were determined as per the method described in AOAC (2005). The pH was measured as described by Awad *et al.* (2005). Moisture content in cheddar cheese was analysed by gravimetric method (IS, SP: 18 Part XI, 1981). Total chloride was measured as described in AOAC (2012) known as Volhard method.

Titratable Acidity

Acidity in Cheddar cheese was determined by titration method as described in AOAC 920.124 (2005).

Microbiology of Cheddar cheese

Enumeration of Total bacterial count in Cheddar cheese

Reagent

(a) *Preparation of Plate count agar: Plate* count agar of 30 g was dissolved in 1000 ml distilled water. The mixture was heated to boiling temperature to dissolve the medium completely. The medium was autoclaved at 15 psi pressure (121 °C) for 15 min.

(b) *Tri sodium citrate (2% w/v):* Tri sodium citrate of 20 g was dissolved in 1000 ml of water.

Procedure: Enumeration of Total bacterial count was assessed during ripening period for cheese made from Crossbred and Deoni milk for 12M and Cheddar cheese with and without hydrolysed cheese slurry for 6M. Cheese samples (11 g) were diluted in 99 ml of sterile 2% (w/v) tri-sodium citrate solution. The sample was macerated in a mortar and pestle to obtain slurry for the first dilution and subsequent serial dilutions were made in sterile 2% (w/v) tri-sodium citrate solution. Appropriate dilutions were pour-plated. Total bacterial count during ripening were enumerated on Plate count agar and incubated at 37 °C for 24-48 hrs. Spherical colonies with off white coloration were counted and results were expressed as CFU/g.

Sensory evaluation of cheese

The sensory quality of Cheddar cheese was evaluated by an expert panel of minimum 6 judges as per 9-point Hedonic scale score card. The samples were tempered at 25-28 °C and coded before subjected to the judgement. The evaluation was carried out under proper lighting. The parameters of flavour, body and texture, finish and appearance, colour and overall acceptability were judged on the basis of liking.

Statistical analysis

The statistical analysis was executed using the statistical software SPSS 16.0. (Stat Soft Polska Sp. Z o. o., Kraków, Poland) and Prism Graph-pad version 8.1.2 was used for graphical representation of data.

RESULTS AND DISCUSSION

Compositional analysis of cheddar cheese

Moisture content between Deoni milk Cheddar cheese (DMCC) and Crossbred milk Cheddar cheese (CMCC) did not differ significantly ($p > 0.05$) (Table 1).

Table 1. Compositional parameters of cheddar cheese made from Crossbred and Deoni milk

Parameters (%)	Crossbred	Deoni
Moisture	40.47 ± 0.71[a]	39.06 ± 1.06[a]
Protein	22.41± 0.59[a]	23.55± 0.97[a]
Fat	32.66± 0.71[a]	34.14± 0.93[a]
Ash	2.47± 0.12[a]	2.49± 0.14[a]
Salt	0.87±0.04[a]	0.88±0.04[a]
Lactose	0.62±0.01[a]	0.64±0.04[a]
Yield	10.43 ± 0.22[a]	11.20± 0.19[a]

Mean ± S.D, n=3; same small letter (a) superscripted not differ significantly ($p < 0.05$)

The higher protein content in DMCC was due to the higher concentration of casein in Deoni milk. Significant differences in the amount and type of casein content of milk between different species are expressed in the characteristics of the cheeses made from them. Its milk mimics buffalo milk in composition because of higher content of fat, protein, lactose and total solids than cross bred milk, which makes it a highly suitable for manufacturing of various milk products, especially cheese. The fat imparts a characteristic flavour to cheese upon ripening, it also gives characteristic texture to cheese by filling intracellular vacuoles among protein and mineral complexes of cheese.

Changes in titratable acidity of Cheddar cheese during maturation

The titratable acidity in DMCC was significantly ($p < 0.05$) higher than the acidity in CMCC at all stages of maturation (Fig. 1).

Results are expressed as Mean ± S.D.; means with different Capital letter superscripts (A,B,..) differ significantly ($p<0.05$) between the Cheddar cheeses (columns); means with different small letter superscripts (a, b,..) differ significantly ($p<0.05$) across the ripening months (rows); n=3.

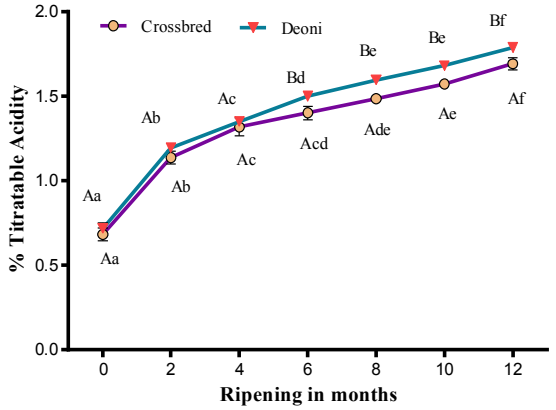

Fig. 1. Effect of type of Milk on titratable acidity of Cheddar cheese during maturation

The titratable acidity elevated continuously during the maturation period. The initial titratable acidity increased from 0.68 to 1.69 % in CMCC and 0.71 to 1.78 % in DMCC at the end of 12 months of maturation and values differed significantly ($p < 0.05$) for each two months of ripening. The acidity in cheese is associated to the production of lactic acid by the starter culture during cheese making (Amarita *et al.*, 2006) and to other acids produced by microorganisms due to their metabolic action and biochemical alteration of components in the course of maturation period. As cheese cures, hydrolysis produces many end products with carboxyl groups carrying water soluble peptides, amino acids and fatty acids, promoting an increase in % titratable acidity (Marth and Steele, 2001; Lau *et al.*, 1991).

Changes in total viable bacterial count of Cheddar cheese prepared from Crossbred and Deoni milk during maturation.

The changes in the total viable bacterial count of both type of Cheddar cheese in the course of maturation are shown in Fig. 2.

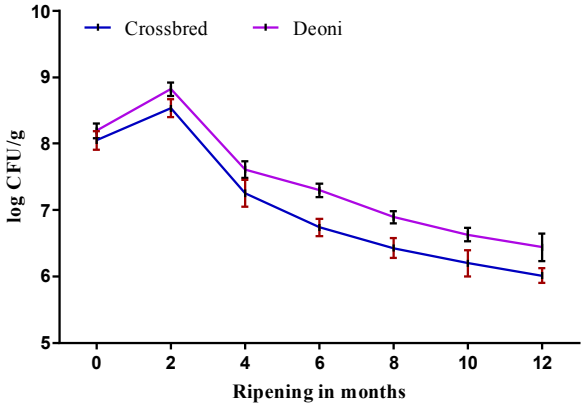

Fig. 2. Effect of type of Milk on total viable bacterial count (expressed as log CFU/g) of Cheddar cheese during maturation

Results are expressed as Mean ± S.D.; means with different Capital letter superscripts (A,B,..) differ significantly ($p<0.05$) between the Cheddar cheeses (columns); means with different small letter superscripts (a, b,..) differ significantly ($p<0.05$) across the ripening months (rows); n=3.

The total viable bacterial count was non significantly higher ($p>0.05$) in both cheeses till second month of maturation and its population in CMCC and DMCC were of 8.59 and 8.81 log CFU/g respectively at 2nd month, thereafter decrease in the

count to 6.10 and 6.42 log CFU/g, respectively at the end of 12 months of maturation. However, the DMCC showed a significantly ($p<0.05$) higher count than the CMCC after fourth month of maturation. This might be attributed to higher proteolysis lead to formation of peptides and amines that are favoured as growth substrates to the microorganism during maturation when the lactose is depleted by starter bacteria initially. In support to our results, lactobacilli growth was promoted by peptides and protein hydrolysates (Peterson and Marshall, 1990) and many strains can actually oxidize peptides (Thomas, 1986) (Williams and Banks, 1998). A wide variety of amino acids were catabolized by NSLAB, indicating that proteolysis provide an essential growth substrate for bacteria in cheese curd when lactose is no longer obtained. Total viable bacteria are not constant throughout maturation and changes in response to the nutrients obtained.

Sensory evaluation of Cheddar cheese prepared from Crossbred and Deoni milk during maturation

Cheese samples of CMCC and DMCC were subjected to sensory evaluation with a jury of six judges and assessed for flavour, body and texture, colour and appearance, finish and appearance and overall acceptability (Table 2). There was no detectable difference was observed in both fresh cheeses.

Results are expressed as Mean ± S.D.; means with different Capital letter superscripts (A,B,..) differ significantly ($p<0.05$) between the Cheddar cheeses (columns); means with different small letter superscripts (a, b,..) differ significantly ($p<0.05$) across the ripening months (rows); n=3

As the maturation advanced, the flavour profile increased. Development of flavour enhanced for both the cheeses up to 2nd month of maturation and the flavour scores were 7.56 and 7.76 for CMCC and DMCC, respectively, which was significantly ($p<0.05$) different from 4th month onwards of ripening. The flavour scores were then significantly improved ($p<0.05$) from (7.56 to 7.89) and (7.76 to 8.14) in CMCC and DMCC at the end of 12-month maturation period, respectively. Our results are like that of the reports of Deeth and Touch, (2000) FFA, especially short chain fatty acids, are highly flavoured and at increased concentration of short chain fatty acids have been correlated with the lipolysed flavor defect or rancidity in Cheddar cheese. Singh *et al.* (2003) showed that during maturation, the distinctive taste, aroma, texture and appearance of cheese evolve and these changes are predetermined by the composition. There was non-significantly difference ($p>0.05$) in the development of body and texture for both the cheeses up to the 4th month of maturation. Further, from 6th month onwards of maturation significant ($p<0.05$) difference was observed for CMCC and DMCC

Table 2. Effect of type of milk on sensory attributes of Cheddar cheese during maturation

Sensory	0M	2M	4M	6M	8M	10M	12M
				Flavour			
CMCC	7.26 ± 0.05^{Aa}	7.33 ± 0.05^{Aa}	7.56 ± 0.06^{Ab}	7.82 ± 0.03^{Ad}	8.15 ± 0.05^{Ad}	8.01 ± 0.06^{Ad}	7.89 ± 0.03^{Ad}
DMCC	7.31 ± 0.07^{Aa}	7.37 ± 0.04^{Ab}	7.76 ± 0.03^{Bc}	8.08 ± 0.08^{Bd}	8.37 ± 0.08^{Be}	8.25 ± 0.03^{Bf}	8.14 ± 0.04^{Bg}
				Body and texture			
CMCC	7.39 ± 0.02^{Aa}	7.42 ± 0.03^{Aa}	7.56 ± 0.01^{Ab}	7.64 ± 0.02^{Ac}	7.76 ± 0.02^{Ad}	7.78 ± 0.04^{Ad}	7.70 ± 0.03^{Ad}
DMCC	7.34 ± 0.01^{Aa}	7.38 ± 0.01^{Aa}	7.66 ± 0.03^{Ab}	7.78 ± 0.02^{B}	7.91 ± 0.07^{Bd}	7.98 ± 0.10^{Bd}	7.84 ± 0.03^{Bd}
				Colour			
CMCC	7.38 ± 0.02^{Aa}	7.45 ± 0.02^{Aa}	7.66 ± 0.03^{Ab}	7.85 ± 0.08^{Ac}	8.09 ± 0.06^{Ad}	7.85 ± 0.07^{Ae}	7.81 ± 0.08^{Af}
DMCC	7.43 ± 0.02^{Aa}	7.47 ± 0.01^{Aa}	7.76 ± 0.11^{Bb}	7.97 ± 0.03^{Bc}	8.20 ± 0.05^{Bd}	8.01 ± 0.03^{Be}	7.97 ± 0.03^{Bf}
				Finish and Appearance			
CMCC	7.67 ± 0.03^{Aa}	7.73 ± 0.02^{Aa}	7.83 ± 0.01^{Ab}	7.94 ± 0.02^{Ac}	8.09 ± 0.03^{Ad}	7.97 ± 0.02^{Ae}	7.90 ± 0.02^{Ae}
DMCC	7.66 ± 0.01^{Aa}	7.72 ± 0.02^{Aa}	7.88 ± 0.02^{Ab}	8.00 ± 0.07^{Ac}	8.15 ± 0.04^{Ad}	8.04 ± 0.05^{Ae}	7.95 ± 0.02^{Ae}
				Overall Acceptability			
CMCC	7.57 ± 0.04^{Aa}	7.63 ± 0.02^{Aa}	7.72 ± 0.02^{Ab}	7.89 ± 0.03^{Ac}	8.01 ± 0.04^{Ad}	8.16 ± 0.04^{Ae}	8.06 ± 0.06^{Af}
DMCC	7.66 ± 0.03^{Aa}	7.70 ± 0.07^{Aa}	7.87 ± 0.03^{Bb}	8.05 ± 0.05^{Bc}	8.17 ± 0.02^{Bd}	8.41 ± 0.10^{Be}	8.23 ± 0.06^{Bf}

were 7.64 and 7.77, respectively. This might be due to higher proteolysis contributes cheese with firm, close with softer body. These attributes are evident in the actual body and texture development (Nelson and Trout, 1981). The process of metabolizing casein produces textural changes of the cheese to creamy smooth surface from rubbery hard curd (Clark *et al*., 2009). The score for body and texture, increased up to 10 months of maturation, thereafter, decreased at the end of the maturation in both types of cheeses. Colour of cheese was not affected significantly ($p>0.05$) by the milk type. Consequently, while ripening, significant differences ($p<0.05$) were noted. Colour development occurred after the second month of maturation in both samples of the cheese. Scores were maximum in the eighth month of maturity. There was no significant difference in the finish and appearance of cheeses influenced by the type of milk. Both cheeses have negligible variations. As maturation progressed, the overall acceptability of cheeses improved with respect to flavour and body and texture. There was no significant ($p>0.05$) difference for both the cheeses up to 2nd month of maturation. Subsequently, from the 4th month onwards the overall acceptability scores for DMCC were significantly ($p<0.05$) higher as compared to CMCC. However, the scores for CMCC and DMCC were significantly improved ($p<0.05$) from (7.72 to 8.16) and (7.87 to 8.41) at the end of the 10th month of maturation, respectively. However, at the end of the tenth month of maturation, for both cheeses samples highest scores were achieved and thereafter decreased.

CONCLUSION

Substantial differences were observed during ripening as well as bio-functionalities activities in the Cheddar cheeses made from Deoni and Crossbred milk. DMCC had optimum well balanced pleasant flavor with compact body without any objectionable odour than CMCC.

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