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Bio-Chemical and Textural Changes in Pre-Ripening Stages During Manufacture of Cheddar Cheese from Different Blends of Doe and Ewe Milk

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Abstract: Whole Doe and Ewe milk and their mixtures in different proportions (75:25; 50:50; 25:75) were used to study bio-chemical and textural changes during ripening of milk, cooking of curd and cheddaring process used for cheddar cheese production. The Doe and Ewe milk used, had fat, protein and Total solids – 4.30, 2.89 and 12.62 and 6.00, 4.82 and 17.40 percent, respectively. Their mixtures in the ratio of 75:25; 50:50 and 25:75 showed fat, protein and total solids- 5.60, 4.41 and 15.89; 5.1, 4.13 and 15.00; 4.80,3.85 and 13.90 percent, respectively. The starter culture consisting of *Lactococcus lactis* and *Lactococcus cremoris* were used. At the end of milk ripening, cooking and cheddaring process, the pH of samples ranged from 6.3 to 5.9; 5.3 to 5.5 and 4.8 to 4.7, respectively. The milk composition exhibited direct correlation with the body and texture of the green cheese samples which is exhibited by fractability. Samples made from 100% Doe and Ewe milk exhibited highest (0.65 N/g) and lowest (70.297 N/g) hardness, respectively. As the proportion of Doe milk decreased in the mixtures, the hardness increased steadily being highest (0.569 N/g) and lowest (0.333 N/g) in 75:25 and 25:75 proportions of Doe and Ewe milk cheese samples, respectively. Standard Plate Counts and Yeast and Mould counts in all the cheese samples were below the standard limits irrespective of types of milk and their mixtures used. Doe and Ewe milk mixed in the ratio of 50:50 found most suitable for making Cheddar cheese with highest sensory characteristics.

Key words: Doe milk · Ewe milk · Milk ripening · Texture profile

INTRODUCTION

Cheese, the natures wonder food and the classical product of bio technology, is a highly nutritious with good keeping quality, enriched pre-digested food with fat, calcium, phosphorus, riboflavin and other vitamins, available in concentrated form. Besides, it is the only concentrated and balanced milk food for lactose in tolerance Persons. The supremacy of cheese technology strongly lies in the fact that it not only retains the original biological value of milk, but further enhances it by virtue of its bio-available beneficial microflora and Probiotic. In view of above, cheese has become major food product and getting much attention throughout the world and also in developing countries [1-3]. Cheddar cheese is generally made from cow milk but due to unavailability of cow milk during lean season, milk from other breeds such as Doe and Ewe may be used for cheese making.

Doe and Ewe milk has played a very important role in the economic viability of many developing countries of the world, as well as in Mediterranean, Middle East and eastern European countries, through its utilization to manufacture cheeses and other products [4, 5]. Doe and Ewe produce approximately 2% of the world's total annual milk [6] and its milk products also have gained increasingly popularity among curtain ethic groups due to its nutritional and medicinal significance [7] and the cheese producers in the united states [8].

Large numbers and many different varieties of Doe and Ewe milk cheeses are produced worldwide, depending on diversity of locally, milk composition and manufacturing techniques. These cheeses vary in composition due to the high variation in the seasonal composition of milk, modifications of manufacturing procedures and multitude of aging time and conditions [9, 10].

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Cheese making in Africa is largely dictated by tradition. The cheese produced is generally consumed very soon after manufacture, primarily because of the poor shelf-life at ambient temperature. The composition and flavor of cheese is affected by milk composition, milk ripening, and cooking of cheese curd cubes and cheddaring process during manufacture. The manufacturing conditions are pre-requisites, which are utmost essential to impart balanced glycolysis, proteolysis and lipolysis bio chemical reactions to develop characteristic flavor, body and texture in green as well as ripened cheese [2, 11]. In view of above, the Doe and Ewe milk alone and in combination were used to study its effect on milk ripening, cooking and cheddaring process on flavor, body and texture of green cheddar cheese.

MATERIALS AND METHODS

Materials: Doe and Ewe milk procured from a village 'Ashoka' and immediately transported to Addis Ababa University Food engineering Laboratory, Addis Ababa Institute of Technology for experiments in chilled condition in Ice boxes.

Chemical Analysis: Doe (D) and Ewe (E) milk and its blends in different proportion (75D:25E; 50D:50E and 25D: 50E) were analysed for pH and viscosity, total solids, fat, protein and pH by the methods suggested by O'Connor [12]. The viscosity of raw milk was measured using viscometer model SV-10 at 25°C and expressed in m Pas. Cheddar cheese samples with analyzed for moisture [13] Fat [13] and protein [13] and pH by standard procedures.

Starter Culture: FD-DVS YF-LF811 Yo-Flex^{R} starter culture used in this investigation was procured from Chr. Hansen Laboratory, Denmark.

Clotting Agent: Chy-MaxR Powder, nature^{s} enzyme for clotting milk and a 100% pure chymosin coagulant produced by fermentation was supplied by Chr Hansen Laboratory, Denmark and used in this investigation.

Cheddar Cheese Technology: Doe and Ewe milk and its blends in different proportion (100D:0E;75D: 25E; 50D: 50E and 25D: 75E;0D:100E) were used to manufacture cheddar cheese as per procedure described by Kosikowaski [14].

Microbiological Analysis: The standard plate counts, staphylococcus aureus and y and m counts with enumerated in cheese samples by standard procedures. Standard Plate counts, *Staphylococcus aureus* and Yeast and Mould Counts were enumerated in cheese samples by standard procedures described in AOAC [13].

Texture Profile: Texture analysis of green cheese samples was performed for hardness and fracturability using T S texture analyzing equipment LLOYD instrument, TA plus Ametek, UK. The test method used was compression and the sample size was 50g load of hardness measurement was zero N, cross head speed was 20 mm/min. The result was expressed as N/g and probe used was cheese cutting jig.

Sensory Analysis: Sensory characteristic and overall acceptability of cheese samples were evaluated by panel of nine trained panelist consisting of post-graduate students and faculty members of the Food Engineering Programm, Addis Ababa Institute of Technology on the basis of 9-point hedonic scale (1=dislike extremely;5=neither like nor dislike and 9=Like extremely).Sensory characteristics studied included flavor, body and texture, appearance and overall acceptability. Sensory characteristics for the cheese samples scoring 6 and above rated acceptable [15].

Statistics Analysis: The data obtained was statistically analyzed by using Statistical Package for Social Scientists (SPSS 17thversion) and completely randomized Block design [16].

RESULTS AND DISCUSSION

Composition: Doe milk (D) had lower percent of protein (2.89), fat (4.3) and T.S (2.62) than Ewe (E) milk (4.82), 6.0, 17.40%). As proportion of D milk increased with E milk (25D:75E; 50D: 50E; 75D:25E), the protein (4.41, 4.13 and 3.85%), fat (5.65, 5.1 and 4.01%) and T.S. (15.09,15.0 and 13.90%) decreased, respectively. Ewe milk exhibited higher viscosity (3.4mPas) than Doe milk (1.66 m Pas) and followed increasing trend as proportion of Doe milk increased in the mixture. The cheddar cheese samples mode from 100% D and E milk and their mixtures, (25 D:75E; 50 D:50E and 75 D: 25E) had moisture, fat, protein -27.77,54.8 and 21.6%; 35.29, 30.1 and 23.7%; 34.06, 25.3 and 22.80; 35.76, 35.4 and 23.9% and 34.79, 443.5 and

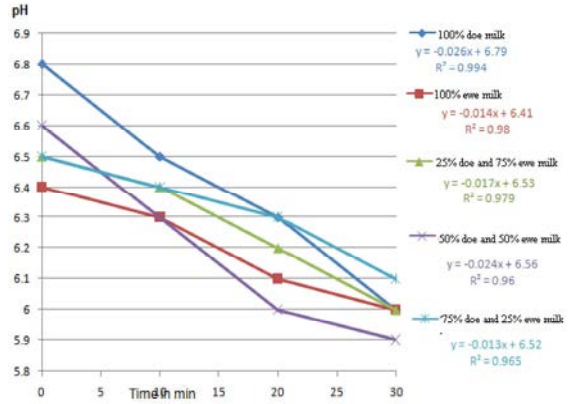

Fig. 1: Effect of different blends of Doe and Ewe milk on pH changes during ripening of milk for cheddar cheese making

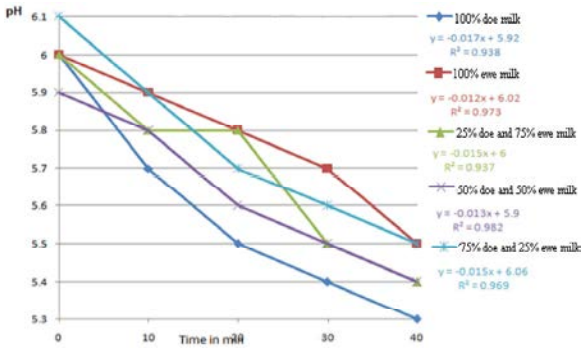

Fig. 2: Effect of different blends of Doe and Ewe milk on pH changes during cooking of curd during manufacture of Cheddar cheese.

21.1 percent, respectively. As the proportion of Doe milk increased in the mixtures, the moisture and fat percent is the cheese sample increased whereas protein percent decreased. The average protein of cheese samples made from different blends did not differ significantly. The protein content of all the cheese samples ranged in between 21.1 to 23.9 per cent. The cheese made from 100% Ewe milk had highest 17.6% and minimum (13.2%) yields in samples made from 100% Doe milk.

Bio-Chemical Changes: The pH changes during milk ripening at 28±1°C are exhibited in Fig. 1. The pH at initial stage ranged from 6.0 to 6.4 which changed to 6.1 to 5.9, after 30min of ripening. The milk mixed in 75 D: 25 E ratio, showed maximum decrease (6.6 to 5.9) but lowest in 100% Ewe milk (6.4 to 6.0). This could be attributed to buffering action of milk. The linear change in pH during milk ripening was observed in all the milk samples irrespective of type and blends of milk (Fig 1).

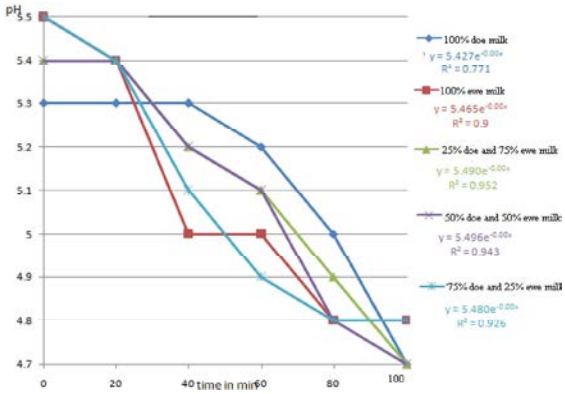

Fig. 3: Effect of different blends of Doe and Ewe milk on pH changes during Cheddaring process

The periodic measurements of pH change at 0,10,20,30 and 40min intervals in the five type of samples during cooking of curd is shown in Fig.2 The maximum (pH 6 to5.3) and minimum (pH 6.0 to 5.5) decrees in pH observed in 100% Doe and Ewe milk curd samples. The pH change in all the samples of curd during cooking is linear with time in all the samples irrespective of milk types. R^2 value ranged from 0.937 to 0.982.

During cheddaring process, pH at the beginning and end after 100 min ranged from 5.5 to 5.3 and 4.8 to 4.7, respectively in all the cheese samples (Fig. 3). The drop of pH during 100 min of cheddaring in all the five types of cheese samples was non linear. The pH change profile during cheddaring process was different than that of milk ripening and cooking process (Fig 1-3).The pH changes during cheddaring process decreased at faster rate in comparison to during milk ripening and cooking stages.

It is observed that there was a decrease in the pH of all the samples starting from milk ripening, cooking of curd and cheddaring process. A similar trend in the pH of cow milk used for cheddar cheese was reported by Walstra [17]. The decrease in pH was comparatively faster in 100% Doe milk than 100% Eve milk. This difference could be attributed due to lower buffering action of 100% Doe milk due to its lower protein content compared to Eve milk [18].

Table 1. shows the texture profile of cheddar cheese samples. It is apparent that cheese made from 100% Doe milk required higher compression for fracture in comparison to other cheese samples. The cheese samples differed significantly in hardness, being maximum (0.65 N/g) in cheese samples made from 100% Doe milk and minimum (0.297 N/g) in Eve milk. The other cheese samples exhibited hardness in the range of 0.569 to 0.333

Table 1: Textural Profile of cheese samples made from different blends of milk

Results	100%Doemilk	100%Ewe milk	25D:75E	50D:50E	75D:25E
Load (N)	32.5	14.85	28.45	22.65	16.65
Hardness(N/g)	0.65	0.297	0.569	0.453	0.333
Fractrability (N/g)	0.1565	0.078	0.1489	0.1186	0.087
Stiffness(N/m)	5189.7	4053.7	4233	4579	5076
Young's Modulus(Mpa)	0.14828	0.13512	0.1378	0.14224	0.1467
Tensile Strength(Mpa)	0.02407	0.019237	0.02004	0.02256	0.0234
Stress at maximum load(Mpa)	0.02407	0.019237	0.02004	0.02256	0.0234
Stress at maximum Extension(Mpa)	0.011979	0.016098	0.01564	0.01489	0.0122
Strain at maximum load	0.28641	0.26294	0.27645	0.279882	0.28134
Strain at maximum Extension	0.87614	1.0019	0.9564	0.91238	0.86592

Table 2: Sensory characteristic of green cheddar cheese samples made from different blends of milk.

	Sensory characteristics						
Samples	Appearance	Taste	Flavor	Texture	Color	Saltiness	OAA
100%Doe	6.28[a]	4.18[a]	6.74[a]	6.82[a]	4.18[a]	3.83[a]	7.18[a]
100% Ewe	6.08[a]	4.76[a]	7.09[a]	6.76[a]	4.41[b]	3.46[b]	6.84[a]
25D:75E	6.79[a]	4.69[a]	6.81[a]	8.60[a]	5.53[a]	3.48[a]	6.58[a]
50D:50E	7.25[b]	5.53[a]	8.81[a]	8.94[b]	4.40[b]	3.33[a]	8.98[a]
75D:25E	6.39[a]	4.99[a]	6.81[a]	7.01[a]	4.30[a]	3.25[a]	6.38[b]

[a-b] Means bearing the same letters in the same column are not significantly different at $P < 0.05$,OAA-Overall acceptability.

N/g being highest and lowest in cheese samples made from 25 D: 75 E and 75 D: 25 E mixtures of milk samples. This could be attributed to the different protein to fat (P/F) ratio in cheese samples. Those cheese samples had higher P/F ratio exhibited more hardness in comparison to cheese samples had lower values. Our results are in agreement of previous workers who showed that P/F ratio is responsible for the body and texture of the cheese which in turn control the flavor of the ripened cheddar cheese.

The results of sensory assessment of different cheese samples are depicted in Table 2. Statistical analysis showed the mean scores for flavor, body& texture, appearance and OAA for cheese samples differed significantly irrespective of type of milk and their mixture used. With regards to flavor, taste and texture and OAA, cheese samples made from 50 D: 50 E milk exhibited highest sensory scores, without significant difference but showed significant difference with respect to texture. These cheese samples had chicken breast texture which is the requirement for the best quality of cheddar cheese made from cow milk. The cheese samples made from 25D: 75E combinations of milk were rated second highest with regards to sensory characteristics.

It was concluded that Cheddar cheese made from 50:50 blends of Doe and Eve milk exhibited highest sensory characteristics with respect to flavor,texture snd overall accepatability followed by cheese made from 25:75 blends ration hence doe and Ewe milk mixed in the ratio 50:50 is recommended for making Cheddar cheese.

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