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Physicochemical properties and consumer acceptability of soft unripened cheese made from camel milk using crude extract of ginger (*Zingiber officinale*) as coagulant

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This study was conducted to analyze the quality attributes of soft unripened cheese (SUC) made using ginger (*Zingiber officinale*) crude extract (GCE) by comparing it with cheese made using camel chymosin (CC). SUC made using GCE had higher acidity and ash but lower fat, total solids and protein as compared to cheese made using CC. The camel chymosin resulted in higher cheese yield as compared to cheese made using GCE. Although, lower than the values for cheese made using CC, sensory scores of cheese made using GCE is in line with literature values for camel milk cheese. The results indicated that GCE can be used to coagulate camel milk and thus help make cheese from camel milk.

Key words: Camel milk, cheese, ginger crude extract, physicochemical properties, sensory properties.

INTRODUCTION

Dromedary camels (*Camelus dromedarius*) produce more milk of high nutritional value that can be kept for a longer period of time as compared to other species in a hostile environment (Khan and Iqbal, 2001). Although camel milk has been consumed fresh in traditional pastoral systems for several centuries, processing of camel milk into more shelf stable value added milk products is not well developed and camel milk products are not common (Mehaia, 2006; Farah and Bachmann, 1987). Although coagulation of camel milk is reported to be difficult without addition of commercial milk clotting enzymes (FAO, 2001), possibilities of cheese-making from camel milk were reported by several authors (Khan et al., 2004; Mehaia, 2006; Ahmed and El Zubeir, 2011).

Recently, camel chymosin was developed using recombinant DNA technology by Danish scientists (Kappeler et al., 2006). However, it is not easily available for pastoralists or small camel milk processers; when available, it is not affordable. Generally, cheese making is reportedly curtailed by factors such as high cost and limited availability of calf rennet (Jacob et al., 2010; Hashim et al., 2011a). This calls for the need to search for alternative coagulants from easily available and cheap

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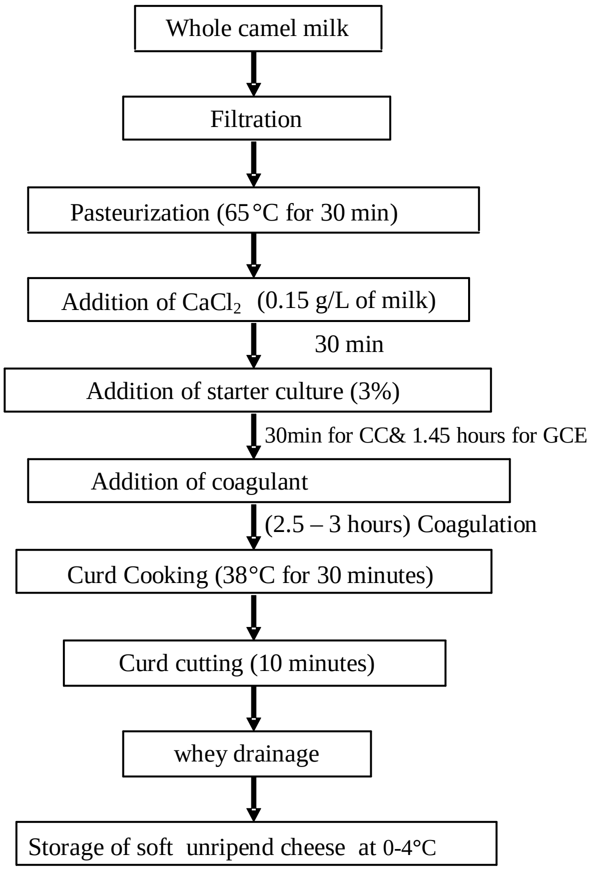

Figure 1. Flow diagram for the manufacture of soft unripened cheese from camel milk.

resources such as plant extracts to coagulate camel milk and make cheese out of it. Ginger extract was used to coagulate cow milk in which the milk clotting activity was caused due to the proteolytic activity of protease enzymes (Huang et al., 2011; Hashim et al., 2011a, b). Further, Hashim et al. (2011a) revealed that ginger extracted enzyme had high specificity for *α*-casein followed by *β*-casein and κ-casein and exhibited a similar affinity for κ-casein, α-casein and *β*-casein. Its higher specificity for κ-casein with increasing temperature was also reported (Huang et al., 2011). The milk clotting activity of ginger crude extract was reported to be higher than that of calf rennet and papain but lower than mucor rennet (Hashim et al., 2011a). This study was, therefore, conducted to assess the physicochemical properties and consumer acceptability of soft unripened cheese made by coagulating camel milk using ginger crude extract.

MATERIALS AND METHODS

Sample collection and physicochemical properties of camel milk

Camel milk samples were obtained from pastoralists living in the Erer valley in Eastern Ethiopia and delivered to Haramaya University Dairy Technology Laboratory by placing it in an ice box. The milk was collected by directly milking into sterile bottles. The extraction of ginger crude extract was performed according to the procedure described by Hashim et al. (2011a) with some modification as follows. Briefly, fresh ginger rhizomes were peeled, chopped, washed with de-ionized water and frozen at -23°C, then homogenized using a blender (Model 38BL40, Blender 8010E, Christiano Scientific Equipment, USA) with five parts of cold acetone (w/v) (-23°C) and kept at 4°C for about 15-20 min. The homogenate was filtered through cotton cloth and the precipitate was further washed with cold acetone followed by air drying. The air dried material was made into powder using a food grinding mill (Model M20, KIKA®WERKW, Germany). The powder was then homogenized in 20 mM phosphate buffer (pH 7.0) for 2.4 minutes (Hashim et al., 2011b) and the extract was filtered using a muslin cloth. The filtrate was centrifuged at 12,000 g for 20 min (Model 1020, D Centrifuge, Centrurion Scientific LTD) and the supernatant was considered as crude extract. Liquid camel Chymosin (Chy-Max® M, Christian Hansen, Denmark) with an activity of 1000 IMCU/ml at a concentration of 0.1 ml/L was also used for manufacturing of soft unripened cheese for comparison purpose. A yoghurt culture (*Streptococcus thermophilus*) (Micro-Milk, Italy) was used for acidification of milk. The physicochemical properties (pH, titratable acidity, total solids, ash, protein and fat) of raw camel milk were analyzed using standard procedures (AOAC, 1995).

Manufacturing of soft unripened cheese

Soft unripened cheese was manufactured from camel milk according to the method described by Mehaia (2006). Three different batches of cheese were made. At the end of each manufacturing process, the cheese samples were collected in sterile containers and kept in refrigerator at 4°C for further analysis. Ten liters of camel milk brought to the laboratory was divided into two lots of five liters each (ginger crude extract was used to coagulate one of the lots, added at a pH value of 5.2 and camel chymosin was used to coagulate the second lot and added at a pH value of 6.2, which served as a control). Both lots were inoculated simultaneously with the yoghurt starter culture, *S. thermophilus* (3%). Calcium chloride (0.15 g/L of milk) was added into the milk 30 min prior to the addition of the coagulants as recommended by FAO (2001). The other subsequent steps were maintained the same during cheese-making for both treatments (Figure 1).

The physicochemical properties (pH, titratable acidity, total solids, ash, protein and fat) of soft unripened cheese (SUC) were analyzed following standard procedures (AOAC, 1995). pH and titratable acidity were measured in the same day the cheese was manufactured; however, the other parameters were analyzed within 48 h of manufacture of the cheese. The cheese yield was calculated as suggested by Mehaia (2006) and was expressed as kg/100 kg of milk. Cheese yield = weight of cheese/weight of the milk sample.

Sensory evaluation

Thirty voluntary panelists were selected based on the criteria suggested by Hashim (2002): age between 18 and 34 years, and usual consumers of camel milk or fermented camel milk and cheese from milk of other species to rate the acceptability of the cheese based on its color, appearance, aroma, taste, texture and overall acceptability using a 7-point hedonic scale (1 = dislike extremely, 2 = dislike moderately, 3 = dislike slightly, 4 = neither like nor dislike, 5 = like slightly, 6 = like moderately and 7 = like extremely). Each batch of cheese was coded with three digit numbers and provided to panelists after 24 h of manufacturing. Fifteen grams of soft

Table 1. Physicochemical properties of camel milk samples used for making soft unripened cheese.

Variables	Values
pH	6.64 ± 0.02
Titratable acidity (% lactic acid)	0.15 ± 0.01
Total solids (%)	11.6 ± 0.27
Ash (%)	0.94 ± 0.03
Fat (g/100ml)	3.0 ± 0.10
Protein (g/100 ml)	2.9 ± 0.13

Table 2. Physicochemical properties of soft unripened cheese made from camel milk using crude extracts of ginger and chymosin as coagulant.

Variables	Cheese made using ginger crude extract	Cheese made using chymosin
pH	4.87 ± 0.04[b]	5.27± 0.02[a]
Titratable acidity (% lactic acid)	0.81 ± 0.06[a]	0.57 ± 0.06[b]
Total solids (%)	35.40 ± 0.03[b]	39.90 ± 1.76[a]
Ash (%)	2.10 ± 0.04[a]	1.98 ± 0.00[b]
Fat (g/100 g)	12.90 ± 0.14	13.40 ± 0.59
Protein(g/100 g)	16.40 ± 0.54[b]	19.70 ± 0.89[a]
Actual yield (kg/100 kg milk)	8.70 ± 1.22[b]	11.4 ± 0.36[a]

Means with the same superscript letters within a row are not significantly different (P > 0.05); Values in the table are mean ± SD of three replications.

unripened cheese was allotted to each judge. Sensory evaluation was conducted in a well-ventilated and illuminated room.

Data analysis

The physicochemical and sensory score data were analyzed using the ANOVA technique of completely randomized design. Means were separated using least significant difference method.

RESULTS AND DISCUSSION

Physicochemical properties of soft unripened cheese made from camel milk

The whole camel milk used for cheese making had pH 6.64 ± 0.02, titratable acidity 0.15± 0.01, percent total solids 11.6 ± 0.27, percent ash 0.94 ±0.03, fat 3.0 ± 0.10 g/100ml and protein 2.9 ± 0.13 g/L (Table 1). Significant difference (P<0.05) was observed in physicochemical properties of cheese samples made from camel milk using ginger crude extract (GCE) and camel chymosin (CC) (Table 2).

In the present study, lower pH values were observed for SUC made from camel milk as compared to values reported in literature. As indicated by El-Aziz et al. (2012), pickling of cheese from buffalo milk using ginger extract resulted in a reduced pH (from pH of 5.86 to 4.94). Inayat et al. (2003) reported a comparable pH value (5.23) for SUC made from camel milk as that made using CC in the present study. The higher titratable acidity recorded in the present study for SUC made using GCE, might be due to the type of coagulant added, temperature used and the time that elapsed in the cheese-making process that has an effect on the acidification process.

Higher total solids were observed for SUC made using CC as compared to SUC made using GCE (Table 2). Khan et al. (2004) and Mehaia (1993) indicated higher values of total solids (44.4 and 45.5% respectively) for cheese made from whole camel milk as compared to the results of the present study. Lower ash content was observed for SUC made using CC when compared with SUC made using GCE (Table 2). Lower values of ash content were reported for soft white cheese manufactured from camel milk by Khan et al. (2004) (1.53%), Ahmed and El Zubeir (2011) (1.53%) and Mehaia (1993) (1.85%) when compared with that observed in the current study.

Several factors can be responsible for these differences that, among others, include the nature of ingredients used in the cheese-making process and the ash content of the raw material used. Mehaia (2006), for instance, indicated that addition of salt during cheese manufacturing resulted in higher ash content of Domiati cheese.

Higher protein and cheese yield values were observed for SUC made using CC as compared to SUC made using GCE (Table 2). Inayat et al. (2003) reported a

Table 3. Mean sensory scores of camel milk cheese made using crude extract of ginger and camel chymosin as coagulants (n= 30).

Sensory attributes	Cheese made using ginger crude extract	Cheese made using camel chymosin
Color	5.20 ± 0.96[b]	6.50± 0.68[a]
Appearance	4.70± 1.26[b]	6.17± 0.83[a]
Aroma	5.93± 0.79 [a]	5.20 ±1.27[b]
Taste	5.00± 1.34 [b]	5.70± 1.09[a]
Texture	4.83± 1.12 [b]	5.67 ± 1.47[a]
Overall acceptability	5.23 ± 0.94 [b]	6.47± 0.68[a]

Means with the same superscript letters within a row are not significantly different (P > 0.05); n = total number of sensory panelists.

comparable value of protein (19.64%) for soft unripened cheese made from camel milk as to the cheese made using chymosin in the present study. Hashim et al. (2011a) and Huang et al. (2011) indicated high proteolytic activity of ginger extracts on milk casein. Therefore, the variations in protein contents between the cheese types in the present study could have occurred due to the hydrolytic activity of the coagulant used for the cheese-making. Bansal et al. (2009), for example, reported that Cheddar type cheese made from camel chymosin resulted in low proteolysis as compared to cheese made with calf chymosin. El-Aziz et al. (2012) also reported that cheese proteolysis could be enhanced by the use of ginger crude extract as a coagulant for cheese making from buffalo milk.

Weak firmness of curd was observed for milk treated with crude extracts of ginger and resulted in smaller curd particles, which were not well coagulated; thus escaped out with the whey through the pores of the muslin cloth. This might be the reason for low cheese yield observed for milk treated with GCE. According to the report of Kamoun and Bergaouin (1989), cheese yield of 12 kg was obtained from 100 kg of camel milk. Cheese yield of 13.22 and 14.9% were also reported by Khan et al. (2004) and Mehaia (2006), respectively for fresh white cheese made from camel milk.

Sensory evaluation of soft unripened cheese made from camel milk

Significant differences (P<0.05) were observed for all sensory attributes between cheeses made using GCE and CC (Table 3). Cheese made using GCE had lower score for color than that made using CC (Table 3). According to Delahunty and Drake (2004), appearance of cheese is a function of the interaction between cheese color and texture, and coagulant type used.

On the other hand, in the present study, cheese made using GCE had higher score for aroma as compared to cheese made using CC (Table 3). This variation in cheese aroma might be attributed to the inherent property of the crude extract of ginger rhizome (aromatic plant used as a spice) that provides a pleasant aroma and enhances the flavor of the cheese (El-Aziz et al., 2012).

In the present study, cheese made using CC had higher scores for texture and overall acceptability than cheese made using GCE (Table 3). Bansal et al. (2009) suggested the less primary proteolysis by camel chymosin to be a possible reason for acceptable texture of Cheddar cheese made using camel chymosin. Proteolytic activity of ginger contributed to textural softening during ripening of Iranian ultra-filtrate white cheese (Fathollahi et al., 2010). El-Aziz et al. (2012) indicated that fortification of buffalo milk with ginger extract caused an increase in cohesiveness and a decrease in firmness of the curd, which resulted in more softness and smoothness during storage of cheese but high score for overall acceptability of cheese.

Although, the sensory score values for most of the sensory attributes were lower for cheese made using GCE than that made using CC, the values for sensory attributes observed in cheese made using GCE are higher than sensory scores reported by earlier researchers for camel milk cheese. Benkerroum et al. (2011) reported mean sensory scores of 4.30, 4.15, 4.25 and 4.50 for color, texture, flavor and acceptability for camel milk cheese obtained using chymosin (Chy.Max™) as a clotting agent.

Conclusions

The results of the current study revealed the possibility of making SUC from camel milk by coagulating it using locally available ginger crude extract. Although, the values for most of the quality parameters of SUC made using GCE were lower than the corresponding values for cheese made using the commercial camel chymosin, the observed result is promising and shows possibilities of improving the quality of such cheese in the future. Production of cheese from camel milk using easily available and cheap coagulants such as ginger crude extract is of paramount importance in adding value to camel milk. Further studies are needed to confirm the result and improve the outcomes using pure enzyme from ginger.

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