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EFFECT OF LEMON JUICE CONCENTRATION ON PROXIMATE COMPOSITION OF CHEESE PRODUCED FROM COW'S MILK

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ABSTRACT

The quality and composition of cheese produced in Ethiopia may vary due to the quality and composition of the milk, method of manufacture, and the process passed from parents to children by observation and practical experiences. In view of this, the effect of lemon juice concentration on the proximate composition of cheese produced from cow's milk was investigated. The treatment consisted of three lemon juice concentrations (20 mL, 30 mL, and 40 mL) and two milk sources (Menelik and Yigezu dairy farms). The experiment was laid out as a Complete Randomized Design (RCD) in factorial arrangements (2×3=6 treatments) and replicated three times per treatment. Proximate composition (moisture, ash, crude protein, and crude fat) of cheese samples were analyzed using standard methods and sensory quality (aroma, taste, color, and overall acceptability) of cheese were determined using a 10-member panel. Lemon juice concentration has a significant ($P< 0.05$) effect on proximate composition and sensory characteristics of cheese. The proximate composition result showed that the highest moisture content was 56.23% in the Menelik milk sample treated at 20 mL lemon juice concentration, ash, and crude protein content were highest, 2.88%, and 16.31% in the Menelik milk sample treated at 30 mL lemon juice concentration. A significantly high crude fat (24.99%) content was observed in cheese processed with a 20 mL lemon juice treated milk sample. So, significantly high protein (16.31%), crude fat (24.99%), and moisture (56.23%) contents were observed in cheese, processed using lemon juice. The sensory quality result showed that the highest overall acceptability was 6.00 in the Menelik milk sample treated at 30 mL lemon juice concentration. The sensory quality of the cheese sample has average values of aroma, taste, color, and overall acceptability of 5.12, 5.35, 6.00, and 5.48 on a 7-point hedonic scale, respectively, and was liked slightly. The study concluded that lemon juice concentration had a significant effect on the proximate composition and sensory quality of cheese.

Key words: Cheese, Milk source, Lemon juice, Proximate composition, and Sensory quality

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INTRODUCTION

Cheese is one of the most widely used ingredients in ready foods for imparting taste, texture, and nutritional qualities [1]. Cheese-making evolved centuries ago as a means of concentrating raw milk via acid precipitation [2]. Fermentation of the milk sugars would cause the acidified milk to curdle and the swaying motion would break up the curd and give solid curd and drinkable whey. The curds would be removed, drained, and lightly salted to give a tasty and nourishing high protein food [3].

Cheese is a product that is made from the curd obtained from milk by coagulating the casein with the help of rennet or similar enzymes in the presence of lactic acid microorganisms [4]. Cheese is the fresh or ripened product obtained after coagulation and whey separation of milk, cream, or partly skimmed milk, buttermilk, or a mixture of these products [5]. It can also be made from the milk of cows, sheep, goats, and camels or a mixture of two of these [6]. Cheese-making aims to get the best composition concerning moisture, acidity, pH, fat, protein, and minerals. Each type of milk imparts the characteristic quality of cheese made from it and the resulting cheese will differ in its properties, body texture, and flavor [7]. There are many varieties of cheese, some of which are perishable and must be consumed within few days while others can be stored for years [6]. White cheese is the only type of cheese available to the public in large quantities on the markets of Sudan. The method of its production was introduced through Egypt, from Mediterranean countries such as Syria and Greece [8]. Sudanese white cheese falls into the family of soft and semi-soft pickled cheese of east European countries, the East Mediterranean region, and North Africa [9].

Cheese is a dairy product with high nutritional value and health benefits, popular in many countries of the world for its good taste and diverse flavor [3]. In general, cheese is rich in fat and casein, constituents of milk, which are retained in curd manufacturing. Cheese is also a rich source of minerals, protein, vitamins, fat, and carbohydrate [5]. Sudanese white soft cheese has 47.8% total solids, 14.0% fat, 15.9% protein, and 6.2% ash, and it is locally known in Sudan as (Gibna Bayda) or Gibbna which is the most famous name [10], and it is usually stored in containers filled with whey [11]. Natural cheese should be stored at suitable temperatures to ensure good quality. Storage of cheese at high temperatures leads to evaporation of moisture and the growth of unwanted bacteria and other faults [4]. The quality and composition of cheese may vary due to the quality and composition of the milk, method of manufacture, quality of salt added, and the storage of cheese [12]. Therefore, the effect of lemon juice concentrations (20, 30, and 40 mL) on proximate composition (moisture, ash, crude fat, and crude protein) and sensory characteristics of cheese made from cow's milk from two different sources, Menelik and Yigezu dairy farms were studied.

MATERIALS AND METHODS

Location of the Study

The experiment of the cheese production process was conducted at Dire Dawa University in Chemical Engineering laboratory, Ethiopia. Determination of proximate

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composition and sensory quality evaluation of the product was conducted in Haramaya University, Food Technology and Process Engineering laboratory.

Experimental materials

The raw milk sample was acquired from two Dire Dawa private dairy farms and was processed into cheese soon after arrival. Fully mature lemons were procured from the Dire Dawa market.

Experimental design

The sample was divided into three groups: (1) with the addition of lemon juice in three different proportions; (2) two different milk sources. The two milk sources were MDF (Menelik Dairy Farm) and YDF (Yigezu Dairy Farm). The three lemon juice concentrations were L1 (20 mL), L2 (30 mL), and L3 (40 mL). The experiment was laid out as a Completely Randomized Design (RCD) in a factorial arrangement (2 x 3 = 6 treatments) and replicated three times per treatment.

Extraction of Lemon Juice

Lemons were washed thoroughly with water to remove dirt and waste, then cut into halves. The juice was extracted by pressing the half lemons manually and filtering the juice using a muslin cloth. Lemon juice was diluted with an equal quantity of clean, fresh water and stirred to mix.

Cheese production by lemon juice addition

Fresh whole milk was used. The fat content of the fresh milk was reduced. To reduce the fat content, the milk selected for cheese making was allowed to stand for about one hour, then the cream was skimmed off the top layer.

The milk was heated to about 85 ºC to destroy most of the bacteria present and increase yield through precipitation of the whey proteins, then 20, 30, and 40 mL lemon juice was added per liter of milk. The milk was stirred while carefully adding the lemon juice and the curd precipitated almost immediately. Stirring continued for about three minutes after adding the lemon juice before the curd was allowed to settle for 15 minutes. The curd was separated from the whey by draining through a sieve or muslin cloth and salt was added to the curd at a rate of about 4 g for every 100 g of curd and mixed properly. The quantity of salt might be varied to cater to consumer taste preferences. The curd was pressed overnight by placing metal weights on top of the wooden follower and finally coated with a thin film of butter to enhance the appearance [13].

Proximate composition

The protein content was determined by the Kjeldahl method and the fat content was determined by soxhlet extraction, the moisture and ash content were determined according to AOAC [14].

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Sensory evaluation

A ten-member panel was used to evaluate the organoleptic properties of cheese samples. Cheese samples were placed in white plastic cups, labeled, and placed on benches in a way that there was no interference among the panelists. Water was provided to the panelists to rinse their mouth after each taste. The products were assessed for aroma, taste, color, and overall acceptability on a seven-point Hedonic scale (7-excellent; 6-Very good; 5-good; 4-average; 3-fair; 2-poor; 1- very poor) and the attribute mean score was calculated.

Statistical Analysis

Data collected were analyzed with Analysis of Variance (ANOVA) using the statistical analysis system (SAS Institute and Cary, NC), and means significant differences were separated using Duncan's multiple range tests at $p < 0.05$.

RESULTS AND DISCUSSION

Effect of lemon juice concentration on proximate composition of cheese

Table 1 shows the moisture content of the various types of cheese. The high moisture content (56.23±1.04 %) was recorded in the Menelik milk sample treated at 20 mL of lemon juice and the lowest (40.90±2.39) was recorded in the Yigezu milk sample treated at 20 mL lemon juice concentration. The moisture content of the Menelik milk sample treated at 20 mL lemon juice, cheese was lower than the value of 65.3% [15]. The low moisture content of cheese may partly contribute to better shelf life. The moisture content of local cheese, processed with *Carica papaya* and *Caltropis Procera* reported was greater than 62.50% and 61.70% [16]. All the above-reported values were lower than 70.75% [17]. These differences may be attributed to different processing methods adopted by these scientists. The differences could also be due to variations in the quantity of coagulants used. Furthermore, the variation in the moisture content of the cheese could also be attributed to the coagulating strength (concentration of enzymes responsible for coagulation). It must be noted, however, that the higher moisture content is not preferred because it could favor the growth and proliferation of microorganisms, thus reducing the shelf-life of cheese [18].

The fat content of the cheese sample ranged from 8.99-24.99% as illustrated in Table 1. The high-fat content (24.99%) was recorded in the Yigezu milk sample treated at 20 mL lemon juice and the lowest (8.99%) was for Menelik milk treated at 40 mL lemon juice concentrate, but the difference was the source of milk. The fat content of the milk sample treated at 20 mL of lemon juice was higher than the value obtained by Sameen *et al*. [19]. The fat content of cheese reported by other scholars was found to be 16.5±2.3% [20]. The difference in fat content may be a result of the good curdling, which reserves a great amount of fat and other milk components in the cheese curd.

The ash content of the cheese samples in the present study is also higher than the ash content (1.16%) obtained by Kassa [21]. The highest ash content was recorded in Menelik milk samples treated at 30 mL of lemon juice (2.88%) and the lowest was recorded in the Yigezu milk sample treated at 20 mL and 30 mL lemon juice concentrations, (1.92% and 1.97%). The high protein content of cheese was recorded in

the Menelik milk sample treated at 40 mL lemon juice (16.67±0.01%) and the lowest was in the Yigezu milk sample treated at 20 mL lemon juice (11.02±0.06). The protein content of the cheese samples in the present study is lower than the values 23.33±2.12 and 22.1±0.1% obtained by Sameen *et al*. [19]. The higher protein and ash contents of cheese samples suggest that it could serve as an important source of amino acids and minerals for human beings. Analysis of the amino acid and mineral composition of cheese could give an insight into the major types of amino acids and minerals that it has and thus its real nutritional value. The increase in ash content during pickling may be due to the decrease in moisture content.

Effect of main factors on proximate composition of cheese

Lemon juice concentrations had a significant effect ($P < 0.05$) on moisture contents of cheese products (Table 2). The high moisture content of (56.23%) was observed in the 20 mL lemon juice treated sample while the lowest was the 40 mL lemon juice treated cheese sample (45.38%). The low moisture contents of formulations are required for convenient packaging and transport of products [22]. Reduced moisture content ensures the inhibition of microbial growth and it is an important factor in food preservation [23]. This indicates that if the moisture content is higher it is favorable for the growth of micro-organisms.

Statistical analysis showed that there was a significant difference ($P < 0.05$) within the ash content of cheese samples (table 2). The ash content of the cheese samples was highest in milk treated with 30 mL lemon juice (2.40%) and lowest in milk treated with 20 mL lemon juice (2.10%). Ash content represents the total mineral content in foods. There were significant differences in the crude protein and crude fat among the sources of milk and different treatments. The fat content of the cheese samples was highest in milk treated with 20 mL of lemon juice (17.54%) and lowest in milk treated with 30 mL of lemon juice (9.77%). The crude fat content of the cheese samples in the present study is lower than the value of 23.5% obtained by Ahmed [24]. Crude protein, crude fat, and ash contents of cheese from this study are lower than the results obtained from most literature [25]. The crude fat obtained from this study was higher than what was reported for cheese treated with different concentrations of honey [26].

Table 2 shows the protein content of various types of cheese. The high protein content of the cheese sample was recorded in the milk sample treated at 30 mL lemon juice (15.53%) and the lowest in the milk sample treated at 20 mL of lemon juice (12.47%). The crude protein content of the cheese samples in the present study is lower than the value of 22% obtained by Ahmed [24]. The significant difference in moisture and protein content of cheese samples may be due to variation in the initial composition of milk as reported by Ahmad *et al*. [27]. Therefore, the variations in protein contents between the cheese samples in the present study could have occurred due to the hydrolytic activity of the coagulant used in the cheese-making.

Effect of lemon juice concentration on sensory quality of cheese

The scores obtained for the sensory attributes: aroma, taste, color, and overall acceptability demonstrated significant ($P < 0.05$) differences among lemon juice concentrates of cheese produced (Table 3). Lemon juice concentration had a significant

effect on the color of cheese samples. The color of the cheese treated at 20 mL lemon juice was the most preferred (like very much) by the panelists, while the cheese samples, Yigezu milk treated at 30 mL and 40 mL lemon juice concentrations were least preferred (like slightly). The highest cheese color (6.10±0.31) was observed in 20 mL of lemon juice concentration cheese sample.

Lemon juice concentrations affected the aroma of cheese samples (Table 3). The highest value of cheese aroma (5.50±0.84) was recorded in the Menelik milk sample treated at 30 mL lemon juice concentration and the lowest 4.70 was recorded in the Yigezu milk sample treated at 20 mL (like slightly). Also, lemon juice concentration affected the taste of cheese samples. The highest value of cheese taste (6.20) was recorded in the Menelik milk sample treated at 30 mL of lemon juice concentration and lowest (4.90) in the Yigezu milk sample treated at 40mL. The panelists, however, noted that color, taste, and overall acceptability of the cheese processed were highly acceptable. Regarding the smell attribute, the sensory response of the tasters could be minimally influenced by the increase in acidity as the concentration of the coagulant used in the coagulation process increases, taking into account that these variations were very slight [28]. Regarding the aroma, it should be noted that the differences between the cheeses in terms of acceptance of these sensory attributes were remarkably close in quality, and in addition, vegetable coagulants generally cause bitter tastes (bitter peptides) in cheeses due to their proteolysis.

Also, the overall acceptability of cheese samples was affected by lemon juice concentration (Table 3). The highest value of cheese overall acceptability 6.00 (like very much) was recorded in the Menelik milk sample treated at 30 mL of lemon juice concentration and lowest 5.20 (like slightly) in 20 mL lemon juice concentrate of Yigezu milk sample cheese.

Effect of main factors on sensory quality of cheese

The mean sensory scores for the cheese sample are summarized in Table 4. The sensory scores for color, flavor, taste, and overall acceptability of all the products had a mean value greater than 4.95, indicating that they were well-liked by the panelists. The differences in fat level and protein to fat ratio, which occur in milk, have a marked influence on the composition, yield, rheology, flavor, and sensory attributes of cheese [29]. The ANOVA of Hedonic scores for the sensory attributes revealed that there is no significant difference ($P < 0.05$) between cheese samples.

Lemon juice concentration affected the color of cheese shown in Table 4. The highest value of color (5.85) was in 20 mL lemon concentration (like very much) and the lowest 5.25 (like slightly) was in the 40 mL lemon juice concentration cheese produced. The value of color in 20 mL, 30 mL, and 40 mL processed cheese samples were 5.85, 5.40, and 5.25, respectively. Vision plays a major role in sensory analysis and the appearance of food can have a major effect on its acceptability [30].

The lemon juice concentrations affected the aroma of cheese shown in Table 4. The highest scores were obtained for cheese prepared from 40 mL lemon juice concentration (5.20) and lowest (4.95) in 20 mL lemon juice concentration. Typical

cheese aroma is the result of volatiles formed by lipolysis, proteolysis, and metabolism of lactose, lactate, and citrate [31]. The improvement in flavor was probably attributed to the effect of lactic acid which controls the growth of undesirable organisms [32]. The improvement in flavor might be due to the natural flora initially present in milk which participates in flavor production.

CONCLUSION

The result of this study has revealed that adding the different concentrations of lemon juice much enhances the proximate composition (moisture, protein, ash, and fat) and sensory quality of cheese samples. Lemon juice concentration (20 mL, 30 mL, and 40 mL) improves the proximate composition and sensory quality of the cheese sample. The ash and crude protein contents of cheese produced increase with lemon juice concentration since the moisture content of cheese decreases. Cheese sample produced at 30 mL lemon juice has the highest consumer acceptability among the treatments. Cheese sample made by the addition of 30 mL lemon juice concentration has good protein, fat, and ash content than other treatments.

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Table 1: Effect of lemon juice concentration on proximate composition of cheese

Sample Source	Lemon Juice concentration	Proximate composition of cheese			
		Ash %	Protein %	Moisture %	Fat %
Menelik Dairy Farm	20 mL	2.32±0.00^{ab} c	13.93±0.74 c	56.23±1.04 a	10.08±1.52^{bc}
	30 mL	2.88±0.00^{a}	16.31±0.86 a	48.92±0.55 b	9.52±0.60^{bc}
	40 mL	2.56±0.06^{ab}	16.67±0.01 a	49.25±0.07 b	8.99±3.52^{bc}
Yigezu Dairy Farm	20 mL	1.88±0.46^{bc}	11.02±0.06 d	40.90±2.39 d	24.99±11.56^{a} b
	30 mL	1.92±0.40^{bc}	14.75±0.94 b	44.36±0.23 c	10.02±1.82^{bc}
	40 mL	1.97±0.01^{bc}	14.30±0.18 c	41.50±1.51 d	13.11±0.45^{abc}
Mean		2.26±0.43	14.50±1.98	46.86±5.60	12.79±6.94
CV		11.12	4.21	2.68	7.61

Note: Values are means ± standard deviation. Mean Values followed by different superscript letters within a column indicate a significant difference (P < 0.05): Note CV=Coefficient of variation

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Table 2: Effect of main factors on proximate composition of cheese

Factors				
Lemon Juice Concentration	Ash %	Moisture %	Protein %	Fat %
20 mL	2.10±0.36^{ab}	48.57±8.97^{b}	12.47±1.73^{b}	17.54±3.93^{a}
30 mL	2.40±0.60^{a}	46.64±2.65^{b}	15.53±1.16^{a}	9.77±1.14^{c}
40 mL	2.26±0.34^{ab}	45.38±4.56^{b}	15.49±1.37^{a}	11.05±3.14^{b}
Milk Sources				
Menelik Dairy Farm	2.12±0.53^{a}	57.78±9.63^{a}	15.24±1.27^{a}	8.09±0.79^{b}
Yigezu Dairy Farm	2.02±0.44^{a}	52.97±12.32^{a}	15.51±2.69^{a}	18.05±11.21^{a}
CV	*21.83*	*11.93*	*10.98*	*7.34*

Note: Values are means ± standard deviation. Mean Values followed by different superscript letters within a column indicate a significant difference (P < 0.05): Note CV=Coefficient of variation

Table 3: Effect of lemon juice concentration on sensory quality of cheese

Sample Source	Lemon juice Concentration	Aroma	Taste	Color	Overall acceptability
Menelik Dairy Farm	20 mL	5.20±1.39^{abc}	5.60±0.84^{abcd}	6.10±0.31^{abc}	5.50±0.97^{ab}
	30 mL	5.50±0.84^{abc}	6.20±0.42^{a}	5.70±1.05^{abcd}	6.00±0.66^{a}
	40 mL	5.40±1.07^{abc}	5.00±1.15^{cd}	5.20±0.91^{cd}	5.30±0.94^{ab}
Yigezu Dairy Farm	20 mL	4.70±1.25^{bc}	5.30±0.82^{bcd}	5.60±1.42^{abcd}	5.20±1.22^{b}
	30 mL	4.90±1.37^{bc}	5.10±1.10^{bcd}	5.10±0.99^{d}	5.50±0.97^{ab}
	40 mL	5.00±1.15^{abc}	4.90±0.87^{d}	5.30±1.05^{cd}	5.40±0.69^{ab}
Mean		5.12	5.35	6.00	5.48
CV		17.58	13.49	15.68	13.14

Note: Values are means ± standard deviation. Mean Values followed by different superscript letters within a column indicate a significant difference (P < 0.05): Note CV=Coefficient of variation

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Table 4: Effect of main factors on sensory quality of cheese

Factors				
Lemon Juice Concentration	Aroma	Taste	color	Overall acceptability
20 mL	4.95±1.31^{b}	5.45±0.82^{a}	5.85±1.03^{abc}	5.35±1.08^{b}
30 mL	5.20±1.15^{ab}	5.65±0.98^{a}	5.40±1.04^{bc}	5.75±0.85^{ab}
40 mL	5.20±1.10^{ab}	4.95±0.99^{b}	5.25±0.96^{c}	5.35±0.81^{b}
Milk Source				
Menelik Dairy Farm	5.41±0.92^{a}	5.65±0.75^{a}	5.96±0.86^{a}	5.70±0.72^{a}
Yigezu Dairy Farm	5.30±1.01^{a}	5.36±0.82^{b}	5.61±1.05^{b}	5.51±0.79^{a}
CV	23.41	16.85	18.51	17.03

Note: Values are means ± standard deviation. Mean Values followed by different superscripts letters within a column indicate a significant difference (P < 0.05): Note CV=Coefficient of variation

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