Chemical Composition, Mineral Profile and Sensory Properties of Traditional Cheese Varieties in selected areas of Eastern Gojjam, Ethiopia

Mitiku Eshetu[1*] and Aleme Asresie[2]

[1]School of Animal and Range Sciences, Haramaya University, P.O. Box 138, Dire Dawa, Ethiopia
[2]Department of Animal Production and Technology, Adigrat University, Adigrat, Ethiopia

Abstract: This study was conducted to evaluate the chemical composition, mineral profile and sensory properties of Metata, Ayib and Hazo traditional cheese varieties in selected areas of Eastern Gojjam. The chemical composition and mineral content of the cheese varieties were analyzed following standard procedures. Sensory analysis was also conducted by consumer panelists to assess taste, aroma, color, texture and overall acceptability of these traditional cheese varieties. Metata cheese samples had significantly (P<0.05) lower moisture content and higher titratable acidity than Ayib and Hazo cheese samples. The protein, ash, fat contents of Metata cheese samples were significantly (P<0.05) higher than Ayib and Hazo cheese samples. Moreover, phosphorus, calcium, magnesium, sodium and potassium contents of Metata cheese samples were significantly (P<0.05) higher than that of Ayib and Hazo cheese samples. Metata cheese samples had also the highest consumer acceptability scores compared to Ayib and Hazo cheese samples. In general, the results of this work showed that Metata cheese has higher nutritional value and overall sensory acceptability. This could be due to the fermentation of the product for several months and use of different types of spices.

Keywords: Chemical composition; Consumer acceptability; Mineral profile

1. Introduction

The major fermented milk products in Ethiopia produced by smallholder farmers using traditional methods include *Ergo* (fermented sour milk), *Ititu* (fermented milk curd), *Kibe* (traditional butter), *Neter Kibe* (clarified butter), *Ayib* (cottage cheese), *Arerra* (defatted sour milk), *Aguat* (whey) (Gonfa *et al*., 2001) and *metata* (fermented cottage cheese variety) (Eyassu, 2013). Traditional cottage cheese (Ayib) is made from defatted sour milk obtained from churning of sour whole milk and then by heating the product on a slow flame until distinct curd forms. The shelf life of *Ayib* is limited to few days and therefore, it is either consumed at home or marketed as quickly as possible (Assefa *et al.,* 2008). There are also some more traditional dairy products known in the mixed and pastoral production systems of the country. *Metata, Hazo* and *Zureshekefign* are the traditional fermented cottage cheese varieties produced in Northwestern highlands of Ethiopia (Eyassu, 2013; and Geremew *et al*., 2015).

Awabal, Gozamin, Machakel and Dejen districts of East Gojjam Zone are important milk producing areas in Amhara National Regional State of northwestern highlands of Ethiopia. In these areas milk is produced from cows under traditional conditions and processed into different traditional cheese varieties such as *Ayib*, *Metata*, *Hazo* and *Zureshekefign*. These dairy products differ from the traditional cottage cheese. Metata cottage fermented cheese production involves the use of various spices, spontaneous fermentation for about 25 days coupled with continuous removal of whey. These products are more shelf stable compared to the most common *Ayib* (which can be kept only for a few days) and properly made *Metata Ayib* could be kept for more than 10 years if tightly sealed and stored in a cool place. *Metata* valued by the community for its medicinal and cultural values (Tegegne *et al*., 2013).

These products could be of significant nutritional importance for the community with substantial contribution to the country's economic development. However, there is no adequate information available on their chemical composition, mineral profile as well as sensory properties. Nevertheless, it is essential to understand such properties of these traditional dairy products in order to improve manufacturing procedures, standardize the processing parameters, and to provide basic information necessary to improve the quality of these dairy for households use and commercial purpose. The aim of this study was therefore, to evaluate the chemical composition, mineral profile and sensory properties of *Metata, Ayib* and *Hazo* traditional cheese varieties along the cheese value chain in selected areas of Eastern Gojjam, northwestern highlands of Ethiopia.

2. Materials and Methods

2.1. Description of the Study Areas

East Gojjam is one of the Zones in the Amhara National Regional State of Ethiopia. It borders the Oromia National Regional State in the south, West Gojjam Zone in the west, South Gondar in the north, and South Wollo in the east. The bend of the Abay

*Corresponding Author. E-mail: mitikuguya@yahoo.com

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River defines the Zone's northern, eastern and southern boundaries. The Zone has seventeen districts of which four districts namely, Gozamin, Awabal, Dejen and Machakel districts were purposively selected based on dairy potential, history of dairy development interventions and number of crossbred dairy cattle.

2.2. Cheese Sampling Procedures and Layout

A total of 216 samples (of ≈ 300g each) of the three traditional cheese varieties namely *Metata*, *Ayib* and *Hazo* were collected from dairy producers (120), dairy products retail shops and kiosks (60), and dairy cooperatives (36) from the four selected districts (Table 1; Figure 1). The samples were placed in sterile bottles (300 g) aseptically and stored in an icebox having ice packs, and delivered to the Ethiopian Food, Medicines and Health Care Administration and Control Authority (EFMHACA) and Bless Agrifood Laboratory Services for analysis. Total number of samples collected for each cheese variety was 72 (Table 1). Each sample was analyzed in duplicate for chemical composition, mineral profile and consumer acceptability tests.

Fig 1. *Ayib* (A), *Metata* cheese variety (B) and *Hazo* cheese variety (C)

Table 1. Cheese sampling procedures and layout

Districts	Sampling sources and cheese varieties									
	Producers			Cooperatives			Dairy PRSK			
	Metata	Ayib	Hazo	Metata	Ayib	Hazo	Metata	Ayib	Hazo	Total
Awabal	10	10	10	3	3	3	5	5	5	54
Gozamin	10	10	10	3	3	3	5	5	5	54
Machakel	10	10	10	3	3	3	5	5	5	54
Dejen	10	10	10	3	3	3	5	5	5	54
Total	40	40	40	12	12	12	20	20	20	216

Note: Dairy PRSK=Dairy product retail shops and kiosks.

2.3. Determination of Chemical Composition

2.3.1. Fat Content

The Soxhlet fat extraction method was used to determine the fat content of traditional cheese (*Metata, Ayib* and *Hazo*) varieties as described by AOAC (1995) method 933.05. Three grams for each of the traditional cheese varieties was fed into a Soxhlet apparatus fitted with a 1-L round-bottom flask and condenser. The extraction was carried out for 8 hours using n-hexane (boiling point of 68-70°C). The solvent was removed by heating at 70°C in a hot dry oven (PN9410.GL. Britain). The recovered oil was then weighed and expressed as fat percentage.

$$\%Fat = [(Wa + Wb) - (Wc) X 100$$

Where: Wa = thimble weight; Wb = sample weight before extraction; and Wc = sample weight after extraction

2.3.2. Moisture Content

The moisture content of the traditional cheese (*Metata, Ayib* and *Hazo*) varieties was determined by drying three grams cheese samples in a forced draft oven (EDSC, 99H207: England) at 102±2°C for 3 hours. The moisture content of these traditional cheese samples was calculated according to Bradley *et al.* (1993).

$$\%\ Moisture = \frac{Loss\ in\ weight}{weight\ of\ cheese\ sample} x\ 100$$

2.3.3. Ash Content

The ash content of cheese samples was determined according to the method described in AOAC (1995) method No. 935.42 by igniting the pre-dried cheese samples (≈ 2.0 g) that were used for moisture determination in a Muffle Furnace (Lindberg/Blue M

Crucible furnace, top loading 100-1200 Serious, Fisher Scientific) at 550℃. Then, it was placed in desiccators while cooling and reweighed. The initial and final weights of the cheese samples were taken. The obtained ash weight was divided by original sample weight and expressed in percent. The ash content was calculated according to the following formula.

$$\% \text{ Ash} = \frac{Weight\ of\ residue}{weight\ of\ cheese\ sample} x100$$

2.3.4. Protein Content

The total nitrogen content of the traditional cheese-varieties (1 g) was determined by the Kjeldahl method as described by the International Dairy Federation (IDF, 1993). The crude protein content of these traditional cheese samples was determined by multiplying the nitrogen content by the factor 6.38.

$$\% \text{ N} = \frac{(1.4007 * (Vs - Vb) * NHCl * 100}{weight\ of\ cheese\ sample}$$

Where: % N= Percentage nitrogen by weight, Vs = Volume of HCl used for titration of sample Vb = Volume of HCl used for titration of the blank
%CP = Percentage of crude protein
%CP= %N *F; F = 6.38 was used as conversion factor

2.3.5. pH Determination

The pH of the traditional cheese varieties was measured using a digital pH meter (Crison, Barcelona, Spain).

2.3.6. Titratable Acidity

The titratable acidity of the traditional cheese varieties was determined by measuring 10 g of finely grounded traditional cheese samples and adding water (40℃) to a volume of 105 mL. After vigorous shaking, the mixture was filtered and an aliquot of the filtrate (25 mL) was titrated with 0.1 N sodium hydroxide solution using phenolphthalein as indicator. The titratable acidity was expressed as % lactic acid and calculated according to the procedure of AOAC (1995) method 920.124.

$$\% \text{ Lactic acid } = \frac{\text{ml of 0.1 N NaOH used} * 0.99}{ml\ of\ filtrate\ cheese\ sample\ used}$$

2.4. Determination of Mineral Profile

The mineral profile (phosphorus, calcium, magnesium, sodium and potassium) of the traditional cheese varieties were determined according to the procedure of AOAC (1995) method 999.10 using Atomic Absorption Spectrophotometer (Model Phillip Pu9100x) with a hollow cathode lamp and a fuel rich flame (air-acetylene). Ten gram of each cheese sample were incinerated to a white ash at 550℃ in a muffle furnace for 4 hours, cooled and the ash was washed into 250 ml beaker with 30 ml of concentrated trioxonitrate acid evaporated to dryness on steam bath, the residue was further heated for 30 minutes, there after the sample was dissolved in 40 ml of hydrochloric acid (HCl) at a ratio of 1:1 and digested for about 2 hours on a hot plate magnetic stirrer. 1 ml of dilute hydrochloric acid was further added to the sample and boiled for about 1 hour, filtered with whatman number four filter paper, washed with HCl and the volume made up to 100 ml with distilled water. Samples were aspirated and the mean signal responses were recorded at each of the element respective wavelength.

2.5. Sensory Analysis

Sensory evaluation of the traditional cheese (*Metata, Ayib* and *Hazo*) varieties was conducted by consumer panelists according to the method described by Resurrecin (1998). A total of fifty-eight adult consumers took part in the sensory analysis and they were requested to evaluate the sensory attributes of the cheese samples and fill the prepared questionnaire. Consumer panelists were selected based on the following criteria: age between 18-40 years old and they have to be “consumers” of fermented milk products. *Metata, Ayib* and *Hazo* traditional cheese samples (20 g) were placed in three-digit coded white plastic plates and served in a bright well-ventilated room. Bottled water was provided to the panelists to rinse their mouth after each taste. The taste, color, aroma, texture, appearance and overall acceptability of *Metata, Ayib* and *Hazo* traditional cheese samples were evaluated using a 5-point Hedonic scale (5 = like very much, 4 = like moderately, 3 = neither like nor dislike, 2 = dislike moderately and 1 = dislike very much). These traditional cheese samples were presented in a random fashion. The sensory evaluation was conducted at the Ethiopian Food, Medicines and Health Care Administration and Control Authority (EFMHACA).

2.6. Data Analysis

Data related to chemical composition, mineral profile and sensory properties of the traditional cheese varieties (*Metata, Ayib* and *Hazo)* were analyzed using the General Linear Model procedure of the SAS (Version 9.1, 2008). Means were separated by Duncan Multiple Range Test. Significant differences were declared at 5% significance level. The model used;

$$Y_{ijk} = \mu + \alpha_i + \epsilon_{ijk}$$

Where: Y_{ijk} = chemical composition, mineral profile and sensory properties of cheese varieties
μ = overall mean; α_i = cheese varieties; and ϵ_{ijk} = random error.

3. Results and Discussion

3.1. Chemical Composition of Traditional Cheese Varieties

The moisture content of *Metata* cheese samples was significantly (P<0.05) lower than that of *Ayib* and *Hazo* cheese varieties regardless of their sources (Table 2). The lower moisture content of *Metata* cheese as compared to *Ayib* and *Hazo* cheese varieties might be due to continuous loss of water from the curd as a result of lactic acid development which causes curd contraction and syneresis during the production process and ripening period (Terzic-Vidojevic *et al.*, 2007). The moisture content of *Metata* cheese observed in the current study is in agreement the finding of Eyassu (2013) who reported 42.3% moisture content for metata cheese variety, and with the moisture content of Halloumi cheese made from goat milk, cow milk and their mixture which was found to be 41.33% (Elgaml *et al.,* 2017).

Table 2. The chemical composition of the traditional cheese varieties (Mean ± SE) (n=216).

		Cheese varieties		
Variables	Sampling sources	*Metata*	*Ayib*	*Hazo*
Moisture (g/100 g)	DP	38.53±0.69[b]	78.33±0.69[a]	77.15±0.55[a]
	DC	38.59±1.22[b]	78.71±1.26[a]	76.35±1.26[a]
	DR	41.27±0.95[b]	78.49±0.98[a]	78.18±0.98[a]
Fat (g/100 g)	DP	31.89±0.41[a]	1.42±0.47[b]	1.43±0.34[b]
	DC	30.86±0.91[a]	1.40±0.86[b]	1.42±0.62[b]
	DR	30.19±0.70[a]	1.44±0.67[b]	1.41±0.48[b]
Ash (g/100 g)	DP	4.55±0.93[a]	1.17±0.11[b]	1.16±0.31[b]
	DC	4.57±0.17[a]	1.16±0.24[b]	1.15±0.22[b]
	DR	4.52±0.13[a]	1.15±0.14[b]	1.17±0.12[b]
Crude protein (g/100 g)	DP	41.54±6.29[a]	16.78±0.28[b]	15.03±2.88[b]
	DC	40.82±3.21[a]	14.59±1.61[b]	14.94±2.61[b]
	DR	41.44±1.24[a]	14.53±1.24[b]	14.40±6.24[b]
pH	DP	4.18±0.05[b]	4.49±0.04[a]	4.44±0.06[a]
	DC	4.12±0.15[b]	4.53±0.14[a]	4.54±0.16[a]
	DR	4.26±0.11[b]	4.48±0.12[a]	4.47±0.14[a]
TA (% lactic acid)	DP	0.73±0.02[a]	0.44±0.02[b]	0.45±0.02[b]
	DC	0.72±0.03[a]	0.43±0.03[b]	0.44±0.03[b]
	DR	0.74±0.02[a]	0.44±0.02[b]	0.46±0.02[b]

Note: DP = Dairy producers, DC = Dairy cooperatives, DR = dairy product retail shops and kiosks, TA = Titratable acidity, n = sample size and [a,b] Means with different superscript letters in a row for each variables under the three sampling sources and cheese varieties are significantly different (P<0.05).

The fat, ash and crude protein content of *Metata* cheese samples were significantly (P<0.05) higher than that of *Ayib* and *Hazo* cheese samples collected from different sources (Table 2). However, there was no significant (P>0.05) difference in fat, ash and protein content between *Ayib* and *Hazo* cheese samples. The fat content of *Metata* cheese (30.19 - 31.89 g/100 g) obtained in the present study is slightly higher than the fat content of Metata cheese (28.7±8.4 (g/100 g) reported in Western Gojjam zone of Amhara region, Ethiopia (Eyassu, 2013). However, the fat content of *Ayib* (1.16-1.52 (g/100 g) reported by Regu *et al.* (2016) is much lower than Metata *Ayib* obtained from the present study. The higher fat content of *Metata* cheese compared to *Ayib* and *Hazo* cheese varieties means that it could serve as an important source of energy and essential fatty acids in human nutrition. Fat has many important functions in food; it contributes to the taste, texture and appearance of the cheese (Manson and Willet, 2001).

The average ash content of *Metata* cheese recorded in the present study is similar to the ash content of cheese made from cow milk (4.53%) and buffalo milk (4.67%) (Masud *et al.*, 1992). The higher ash content of *Metata* cheese compared to *Ayib* and *Hazo* cheese varieties might be due to the effect of spices, the reduction of moisture content and absorption of salt by cheese curd during ripening.

Metata cheese had more or less similar protein content with the findings of Eyassu (2013) who reported protein content of *Metata Ayib* to be 43.0±6.9% (g/100 g). The higher protein content of *Metata* cheese samples might be due to an increase in soluble protein contents during storage as a result of continuous proteolysis of protein and a decrease in moisture content during ripening. The higher crude protein content observed in *Metata* cheese samples in the present study could serve as an important source of amino acids in human nutrition and its consumption will help to ameliorate protein deficiencies. Cheese contains biologically valuable proteins that are almost 100% digestible, as the ripening phase of the manufacturing process involves a progressive breakdown of caseins to water soluble peptides and free amino acids (Lopez-Expsito *et al*., 2012).

The pH values of *Metata* cheese samples was significantly (P<0.05) lower than that of *Ayib* and *Hazo* cheese samples collected from different sources (Table 2). The pH value observed in the present study is similar with the findings of Kassa (2008) who reported a pH value of 4.34 for Ethiopian traditional cottage cheese (*Ayib*) samples collected from a local market in Shashemene area, southern Ethiopia. The lower pH values observed in *Metata* cheese samples might be associated with the fermentation of lactose to lactic acid resulted in reduction of pH and rise in acidity. Cheese pH directly influences chemical changes in the protein network of the cheese curd, with high pH leads to increased interactions among proteins (Floury *et al*., 2009). The variation in pH values most probably originated from acidifying activities of lactic acid bacteria (LAB) present in cheese (Prodromou *et al*., 2001). In contrary to this, an increase in pH value may occur during cheese ripening which might be as a result of yeast metabolic activity which uses lactic acid as a source of carbon or a result of great amounts of alkaline compounds released during proteolytic activities (Volken de Souza *et al*., 2003).

The titratable acidity of *Metata* cheese samples was also significantly (P<0.05) higher than that of *Ayib* and *Hazo* cheese samples (Table 2). The present result is not in agreement with the finding of Eyassu (2013) who reported titratable acidity of 0.43±0.07 for *Metata* cheese samples collected from northwestern Gojjam. The higher titratable acidity observed in *Metata* cheese samples in the current study might be associated with the growth of lactic acid bacteria that increased the level of lactic acid and consequently resulted in the low pH values of the cheese. Titratable acidity is regulated by the amount of lactose fermented to lactic acid and the buffering capacity of the curd during manufacturing of the cheese (Kafili *et al*., 2009). Lactobacilli may utilize the residual lactose in cheese during ripening and contribute to increased titratable acidity of the cheese (Arenas *et al*., 2004).

3.2. Mineral Profile of *Metata*, *Ayib* and *Hazo* Cheese Varieties

The mineral contents of *Metata, Ayib* and *Hazo* varieties collected from different sources are presented in Table 3. The mineral content of *Metata* cheese samples was significantly (P<0.05) higher than that of *Ayib* and *Hazo* cheese varieties for all the three sampling sources. However, there was no significant (P>0.05) difference observed in mineral content between *Ayib* and *Hazo* cheese varieties. The value of phosphorus in *Metata* cheese samples observed in the current study is in line with the finding of Adetunji and Babalo (2011) who reported phosphorus content of 179 (mg/100 g) for *Wara,* a traditional West African soft cheese. Phosphorus is the second most abundant mineral in human body with many important biological functions such as acid-base balance, bone and teeth formation, development and maintenance and energy metabolism. (Cashman, 2002). Although phosphorus is the most important structural component of bones and teeth, excessive intake of phosphorus combined with reduced calcium intake may have negative effects on bones (Cashman, 2006).

The calcium content of *Metata* cheese samples observed in the current study is in agreement with the finding of Gonzalez *et al.* (2009) who reported 50.26±2.30 (mg/100 g) calcium content in semi-hard cheese during six month of ripening period. The higher calcium content of *Metata* cheese is quite possibly as a result of firmer curd in fermented *Metata* cheese with higher number of calcium phosphate molecules. Research showed that insufficient intake of calcium raises the risk of obesity (Parikh and Yanovski, 2003), hyperlipidemia and insulin-resistance syndrome (Teegarden, 2003; Zemel, 2004). On the contrary, a diet rich in daily calcium intake enhanced weight reduction in type two diabetic patients (Shahar *et al*., 2007). Moreover, calcium is responsible for many regulatory functions, such as normal cardiac rhythm maintenance, blood clotting, hormone secretion, muscle contraction and enzyme activation (Cashman, 2002).

The magnesium content of *Metata* cheese samples observed in the current study is in agreement with Kailas and Kapadnis (2015) who reported 49.6 mg/100 g magnesium content of soft cheese samples in Nashik region. Magnesium plays an important role in many physiological processes, such as metabolism of proteins and nucleic acids, neuromuscular transmission and muscle contraction, bone growth and blood pressure regulation (Zamberlin *et al*., 2012).

The sodium content of *Metata* cheese samples observed in the current study is not in agreement with Mian *et al.* (2014) who reported 678 (mg/100 g) sodium content for cheddar cheese made from buffalo milk and their mixture with cow milk. The higher values of sodium in *Metata* cheese samples might be attributed to multiple additions of sodium chloride during the cheese production. Cheese is perceived as containing high levels of sodium, which discourages some consumers from eating cheese (Johnson *et al*., 2009; Saint-Eve *et al*., 2009). Consumption of too much sodium is associated with high blood pressure and increased risk of heart attack and stroke (Smith-Spangler *et al*., 2010; USDA, 2010).

The potassium content of *Metata* cheese samples observed in the current study is in agreement with Slacanac *et al*. (2011) who reported 202.43±2.44 (mg/100 g) potassium concentration in cheese made from a mixture of Croatian goat and cow milk. The higher value of potassium in *Metata* cheese samples could be attributed to the release of this mineral from the caseins due to the heat denaturing effect, different processing method employed and the numerous spices used. The high mineral content of *Metata* cheese is of significant importance from nutritional point of view in that it can be used to combat malnutrition (mineral deficiency) which is prevalent among the general public in developing countries such as Ethiopia.

Table 3. The mineral profile of traditional cheese varieties (Mean±SE) (n=216).

Minerals	Sampling sources	Cheese varieties		
		Metata	*Ayib*	*Hazo*
Phosphorus (mg/100 g)	DP	174.99±1.47^{a}	126.48±1.64^{b}	126.15±2.42^{b}
	DC	175.68±1.63a	126.74±2.64^{b}	125.22±2.44^{b}
	DR	175.60±1.02^{a}	125.17±2.04^{b}	124.26±3.04^{b}
Calcium (mg/100 g)	DP	52.44±2.40^{a}	40.47±0.30^{b}	40.65±0.70^{b}
	DC	51.46±1.28^{a}	39.68±1.18^{b}	41.73±1.28^{b}
	DR	52.28±1.99^{a}	41.23±2.99^{b}	43.91±0.99^{b}
Magnesium (mg/100 g)	DP	43.75±0.36^{a}	8.27±0.36^{b}	8.24±0.26^{b}
	DC	44.21±0.46^{a}	8.17±0.66^{b}	8.19±0.26^{b}
	DR	43.59±0.51^{a}	8.29±0.11^{b}	8.12±0.71^{b}
Sodium (mg/100 g)	DP	338.73±2.34^{a}	42.97±2.64^{b}	41.03±1.65^{b}
	DC	348.15±4.22^{a}	42.71±4.82^{b}	42.87±3.42^{b}
	DR	348.36±4.74^{a}	41.88±3.74^{b}	43.60±3.75^{b}
Potassium (mg/100 g)	DP	200.83±3.34^{a}	81.58±4.33^{b}	80.75±4.54^{b}
	DC	201.05±1.25^{a}	83.91±4.27^{b}	82.65±4.45^{b}
	DR	200.31±2.34^{a}	82.66±4.31^{b}	81.28±3.31^{b}

Note: DP = Dairy producers, DC = dairy cooperatives, DR = dairy product retail shops and kiosks, n = sample size, ^{a,b} Means with the different superscript letters in a row for each mineral under the three sampling sources and cheese varieties are significantly different (P<0.05).

3.3. Sensory Evaluation of *Metata*, *Ayib* and *Hazo* Cheese Varieties

Consumer acceptability of *Metata, Ayib* and *Hazo* traditional cheese are presented in Table 4. *Metata* cheese samples had significantly (P<0.05) higher taste, color, aroma, texture, appearance and overall acceptance score than *Ayib* and *Hazo* cheese varieties. The average taste score for *Metata* cheese samples observed in the current study is in agreement with the findings of Regu *et al.* (2016) who reported that inclusion of one percent garlic powder treated cottage cheese samples had a taste scores of 4.62. The higher taste score of *Metata* cheese samples observed in the present study could be attributed to various spices added during processing that resulted in strong flavor and acceptable taste. Flavor perception is critically influenced by type of starter culture, level and proteolytic activity of coagulating enzyme, curd washing, ripening condition and rate of curd cooling (Guinee and Kilcawley, 2010).

The average color score of *Metata* cheese samples found in the present study is comparable with the report of Marilda *et al.* (2013) who reported color score of 4.41 for Marajo cheese manufactured from buffalo milk and cow milk. This might be due to colour change from white to blue mold during ripening of *Metata* cheese. According to Carpino *et al.* (2004) cheese color depends on milk fat colour and the content of fat itself. The aroma value of *Metata* cheese variety observed in the present study is in agreement with the findings of El-Aziz *et al.* (2012) who reported that cheese made from buffalo milk fortified with ginger extract had the lowest aroma scores. Soryal *et al.* (2004) reported that the concentrations of free fatty acids mostly short chain fatty acids in cheese significantly influence cheese flavor and aroma. Too much free fatty acid causes a nasty, sour and unpleasant taste to cheese. The higher aroma score in *Metata* cheese might be attributed to the inherent property of different spices used during processing, which might have imparted pleasant aroma to the cheese.

Texture of cheeses is related to a complex interaction between chemical composition and ripening parameters. The differences in moisture content may be the possible reason for the differences in cheese hardness (Anka *et al*., 2016). Texture is an essential feature of food as it influences processing, handling and shelf life as well as customer preferences for the product (Karadbhajne and Bhoyarkar, 2010). Kumar and Srinivasan (2011) reported that texture of cheese might be affected by water binding capacity due to the nature of protein. However, Karadbhajne and Bhoyarkar (2010) reported that fat, cheese yield, storage period and moisture content as well as coagulants plays an important role in cheese texture.

The appearance scores of *Metata* cheese samples observed in the present study is in agreement with Gehan and Samah (2014) who reported appearance scores of Kareish cheese manufactured by various ways as 4.3-4.7. The overall acceptability of *Metata* cheese samples observed in the present study agrees with Bandyopadhy *et al.* (2007) who reported that a Sandash (antioxidant enriched dairy product) fortified with ginger had good acceptability scores. The higher acceptability of *Metata* cheese might be attributed to the various spices used during its preparation. The high consumer acceptability of *Metata* cheese is important in that it will facilitate the scaling-up of *Metata* cheese production to commercial level in the future.

Table 4. Consumer acceptability of traditional cheese varieties (Mean ± SE) (n = 58).

		Cheese varieties		
Variables	Sampling sources	*Metata*	*Ayib*	*Hazo*
Taste	DP	4.46 ± 0.24^{a}	3.50 ± 0.25^{b}	3.62 ± 0.15^{b}
	DC	4.48 ± 0.23^{a}	3.48 ± 0.21^{b}	3.58 ± 0.29^{b}
	DR	4.47 ± 0.17^{a}	3.46 ± 0.37^{b}	3.56 ± 0.37^{b}
Color	DP	4.56 ± 0.14^{a}	3.65 ± 0.35^{b}	3.58 ± 0.35^{b}
	DC	4.31 ± 0.29^{a}	3.76 ± 0.19^{b}	3.58 ± 0.24^{b}
	DR	4.31 ± 0.14^{a}	3.65 ± 0.17^{b}	3.56 ± 0.27^{b}
Aroma	DP	4.74 ± 0.33^{a}	3.48 ± 0.22^{b}	3.41 ± 0.55^{b}
	DC	4.85 ± 0.26^{a}	3.45 ± 0.31^{b}	3.44 ± 0.36^{b}
	DR	4.75 ± 0.15^{a}	3.46 ± 0.45^{b}	3.48 ± 0.42^{b}
Texture	DP	4.84 ± 0.15^{a}	3.58 ± 0.35^{b}	3.54 ± 0.22^{b}
	DC	4.86 ± 0.19^{a}	3.54 ± 0.41^{b}	3.55 ± 0.24^{b}
	DR	4.83 ± 0.17^{a}	3.53 ± 0.27^{b}	3.56 ± 0.33^{b}
Appearance	DP	4.57 ± 0.37^{a}	3.37 ± 0.21^{b}	3.39 ± 0.45^{b}
	DC	4.49 ± 0.35^{a}	3.35 ± 0.11^{b}	3.34 ± 0.67^{b}
	DR	4.47 ± 0.39^{a}	3.38 ± 0.14^{b}	3.36 ± 0.68^{b}
Over all acceptability	DP	4.27 ± 0.25^{a}	3.53 ± 0.34^{b}	3.51 ± 0.55^{b}
	DC	4.31 ± 0.39^{a}	3.49 ± 0.48^{b}	3.48 ± 0.65^{b}
	DR	4.33 ± 0.17^{a}	3.48 ± 0.49^{b}	3.47 ± 0.77^{b}

Note: DP = Dairy producers, DC = Dairy cooperatives, DR = dairy product retail shops and kiosks, $^{a, b}$Means with the different superscript letters in a row for each variable (sensory attribute) under the three sampling sources and cheese varieties are significantly different ($P<0.05$), n = Total number of panelists.

4. Conclusions

This study we found that *Metata* cheese variety is rich source of fat and crude protein as well as minerals (calcium, phosphorous, magnesium, sodium and potassium). Moreover, lower moisture content of this cheese variety attributed to its longer shelf life. The consumer acceptability value of *Metata* cheese variety was also significantly higher than that of *Ayib* and *Hazo* cheese varieties. In general *Metata* cheese variety is highly nutritious and acceptable by the consumer than *Ayib* and *Hazo* cheese varieties due to its good gross chemical composition, high-mineral profile and acceptable organoleptic properties. Therefore, nutritional value and acceptability of *Metata* cheese variety calls for scaling-up of this cheese production to commercial level by developing standardized manufacturing protocols.

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