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Physicochemical Characteristics of Raw Milk from Farm to End User in Urban Area of Oromia Special Zone Surrounding Finfinne, Ethiopia

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ABSTRACT

Unadulterated milk has the semi-perfect food for humans and animals. The study was aimed to analyze the quality of milk by evaluating the physicochemical characteristics of milk in the urban area of Oromia special zone around Finfinne, central highland of Ethiopia. A total of 90 cow raw milk was collected from Burayu, Sabeta, and sululta. 30 milk samples from each urban area, 10 from farm/producer, 10 from milk collectors, and 10 from the cafeteria for physical property and chemical composition analysis. The General Linear Model (GLM) was used for variance analyses of data. The result of (mean±SE) percentage of added water, PH, and Specific gravity were a significant difference ($p<0.05$) between the study town but there was no significant difference between the study town in the finding of Titratable acidity and freezing point. All the physical parameters of milk quality obtained from farms, milk collectors, and cafeterias were significantly different ($p<0.05$) except freezing point. The mean result of protein, lactose, fat, and TS were significantly different ($p<0.05$) between Burayu, Sabeta, and Sululta but no statistical difference between study town in the result of SNF and ash percentage. Except for ash, all the chemical compositions of milk were significantly different ($p<0.05$) among the critical point of milk quality. From this result, most of the physicochemical property of milk sample obtained from farm fulfill the minimum requirement of Ethiopia quality standard but when it was camas to the milk collectors and cafeterias, the physicochemical content was below the limits of Ethiopia quality standard, this indicated that the adulteration of milk in the study area increased from producer to end-user. The finding of this study provided recent information on milk physicochemical

quality from farm to the cafeteria which can be an important input for regulatory bodies (FMCA) of Ethiopia.

Keywords: Physicochemical, Milk quality, Fat, Protein, Lactose, Ash, Solid-not-fat and Total Solid, pH specific gravity, Freezing point.

INTRODUCTION

Milk a white advanced biological fluid secreted by the mammary glands of female mammals. It is a vital supply of nutrients needed for the growth, maintenance, production, and correct functioning of the bodies of mammals. Most milk consumed by humans is typically obtained from 5 totally different species of mammals as cows' buffalo, sheep, goats, and camels. It's consisting of an alimentary substance that contains macro and micronutrients of fats, proteins, carbohydrates, vitamins, minerals, and active compounds having a task in health protection. Milk could be an advanced mixture of fats, proteins, carbohydrates, minerals, vitamins, and alternative miscellaneous constituents spread in water. Milk protein, fat, and lactose are an important source of energy. One gram of milk fat gives 9.3 Cal and one gram of protein and lactose gives 4.1cal. In Ethiopia, 95% of milk has occurred from cattle, and Cow milk is the utmost used up in the world followed by that of goat, camel, and donkey. Cattle is an associate degree economically necessary farm artifact and investment possibility for smallholder farmers within the country [1]. The Ethiopian per capita consumption was abundant lower (17 kg) compared to it of different African nation average that was regarding 62.5 kg counseled as a minimum level to satisfy the necessity for a diet and therefore the world's per capita average that was regarding 100 L/year.

The composition of cows' milk is most important for the dairy farm trade, since, its quality is highly influenced by composition. In order that physical properties and chemical compositions of milk were the symptoms of qualities of milk with the hygienically normal. In Ethiopia most milk assortment centers and milk shade area unit inspecting the standard of milk victimization physical properties of alcohol check and relative density for its freshness throughout milk assortment. Additionally, pH scale and treatable acidity were helped to check the standard of milk for process in milk plant. For this reason, identifying the physical characteristics and chemical composition of milk helps to assure the quality of milk for the consumers/dairy industry processers. In this study area, the limited stud has been reported on the physical characteristic and chemical composition of raw milk. Therefore, the authors were initiated to examine the physical characteristics and chemical composition of raw milk from farm to cafeteria to assure the quality for the consumers. The laboratory analysis result was compared with Ethiopia quality standard agency and EU/FAO.

MATERIALS AND METHODS

Description of the study areas

The study was conducted in Oromia Special Zone around Finfinne, in the central high lands of Ethiopia. The Oromia Special Zone has seven administrative towns, Out of seven cities/towns from Oromia Special Zone around Finfinne/Addis Ababa, three cities/towns, namely Burayyu, Sebata, and Sululta were purposively selected for this study due to their high potential for urban dairy production.

Physicochemical analysis

Analyses of physicochemical properties of milk were performed at Dairy Laboratory of the Ethiopia meat and dairy industry development institute using a Lacto scan to determine the percentage composition Added water, specific gravity/density, titratable acidity/lactic acid, freezing points, pH, lactose, protein, fat, SNF Ash and total solid (ST). Percent Solids-not-fat was calculated by this formula: %SNF=%Total solids–% Fat.

Statistical analysis

The acquired data was arranged and analyzed using the General Linear Model (GLM) procedure of the Statistical Analysis System version 9.1. Mean separation was administered using the Least Significant Difference (LSD) method once the associate Analysis of Variance (ANOVA) shows significant differences between means. The results were expressed as mean ± standard mean error [2]. Differences were considered statistically significant at 5, and 1% significance levels. The following models were used for the milk physicochemical statistics:

$Yijk=\mu+\alpha i+\beta j+eijk$

Where Yijk=individual observation for each sample

μ=the overall mean

αi=the ith milk sources sites effects (i.e

Burayu, Sabeta, and Sululta)

βj=the jth milk sample type effect (farm, collectors, cafeteria).

RESULTS

Raw milk physical characteristics

The mean ± (SEM) of the added water of milk sampled urban areas. The current study indicated that there was an adulteration of milk in all study areas. The added water of milk samples collected was significantly varied ($P<0.05$) among the three towns. The average mean values of added water content in the farm (producer), milk collectors, and the cafeteria was 0.58 ± 1.017, 2.31 ± 1.203, and 5.68 ± 2.19, respectively. The result revealed that there was a statistically significant difference ($P<0.05$) of added water among dairy farms, milk collectors, and cafeteria (value chain point).

PH-Value

The mean (± SE) pH of milk from Burayu, sabeta, and sululta was 6.4 ± 0.127, 6.24 ± 0.041, and 6.28 ± 0.032 respectively. The result indicated that there was a significant difference between Burayu and the other two towns, but no significant difference between sabeta and sululta at the level of ($p>0.05$). The pH of all the milk samples collected from farms, milk collectors, and cafeterias were found to be 6.41 ± 0.048, 6.28 ± 0.036, and 6.24 ± 0.0303, respectively. Milk samples collected from the farm were significantly higher in pH than the other types of samples, however, slightly below the required standard, but milk sampled from collectors and cafeteria was more acidic.

Titratable acidity

The overall mean (± SE) of Titratable Acidity of sampled milk 0.198 ± 0.006, 0.179 ± 0.0033, and 0.176±0.01 respectively. The mean Titratable Acidity/lactic acid percentage of raw milk sampled were not significantly different ($P >0.05$) among the three towns. The overall mean (± SE) of Titratable Acidity milk sample collected from the farm, collectors, and cafeterias were 0.176 ± 0.0034, 0.187 ± 0.0084, and 0.189±0.004 respectively. The result revealed showed that there were significant differences ($P<0.05$) in milk from farm to collectors and cafeteria.

Specific gravity

The specific gravity of milk obtained 1.035 ± 0.01, 1.028 ± 0.001, and 1.027 ± 0.0011 respectively. The result revealed that the specific gravity of milk sampled from Burayu was higher than the specific gravity of milk obtained from Sabeta and Sululta. Therefore, Significant differences ($P<0.05$) were perceived for density between Burayu town to the other study towns. The specific gravity/density of collected samples from farms, collectors, and cafeterias were 1.029 ± 0.00039, 1.026 ± 0.0091, and 1.026 ± 0.0023 respectively. The study revealed that the specific gravity of milk sample in value chain point was significantly different ($P<0.05$) between milk sampled from farm to the other collectors and cafeteria, but there was no significant difference ($p>0.05$) between collectors and cafeterias.

Freezing point

The Mean ± (SE) freezing point of milk sampled in table 1. The result indicated that there was no critical distinction ($p>0.05$) among the 3 study cities. Average and commonplace error mean of the temperature of milk from the farm (milk producers), milk assortment, and cafeterias were evaluated. The freezing point of milk samples collected was considerably varied ($P<0.05$) among the worth chain points (Table 1).

Table 1: Physical quality of raw milk.

Parameter %	Burayu	Sabeta	Sululta
Added water	4.42 ± 1.302	3.9 ± 1.19	3.59 ± 1.24
PH-value	6.4 ± 0.127	6.24 ± 0.041	6.28 ± 0.032
Titratable acidity	0.198 ± 0.006	0.179 ± 0.0033	0.176 ± 0.01
Specific gravity	1.035 ± 0.01	1.028 ± 0.001	1.027 ± 0.0011
Freezing point	-0.525 ± 0.078	-0.475 ± 0.053	-0.541 ± 0.009

Parameter %	Farm	Collector	Cafeterias
Added water	0.58 ± 1.017	2.31 ± 1.203	5.68 ± 2.19
PH-value	6.41 ± 0.048	6.28 ± 0.036	6.24 ± 0.0303
Titratable acidity	0.176 ± 0.0034	0.187 ± 0.0084	0.189 ± 0.004
Specific gravity	1.029 ± 0.00039	1.026 ± 0.0091	1.026 ± 0.0023
Freezing point	-0.56 ± 0.0035	-0.553 ± 0.009	-0.43 ± 0.126

Chemical composition of raw milk

The laboratory result for chemical composition of raw milk sampled such as protein, lactose, fat, ash, solid nonfat (SFN), and total solid.

Protein content

The mean ± SE protein content obtained was (3.16 ± 0.0551, 3.31 ± 0.098, and 3.14 ± 0.095) respectively [3]. There was a significant difference ($P < 0.05$) between the Sabeta and the other two towns but there is no statistical difference between Burayu and Sululta. The average protein contents of milk sampled from Farm, milk collectors and cafeteria were (3.45 ± 0.051, 3.34 ± 0.086, and 2.84 ± 0.111) respectively. Statistical analysis showed that there was a significant difference ($P<0.05$) in protein percentage among the three value-chain points.

Lactose contents

The mean ± SE lactose contents of raw milk samples collected 3.55±0.133, 3.69±0.154, and 3.75 ± 0.164 respectively. These results showed that there was a significant difference ($p<0.05$) among the study town. The average lactose content of raw milk collected from Farm (producer), milk collectors, and cafeteria were (3.83 ± 0.127, 3.72 ± 0.148, and 3.45 ± 0.176) respectively. Statistical analysis showed that there was significant difference ($p<0.05$) between producer, collectors, and cafeteria.

Fat contents

The overall average and standard error of fat composition of raw milk sampled 3.64 ± 0.204, 4.11 ± 0.179, and 4.13 ± 0.371, severally. The statistical analysis revealed that there was a significant difference ($P< 0.05$) among the study areas. The mean value ± standard means an error of fat content in milk samples collected from Farm, Collectors, and cafeteria were 4.33 ± 0.253, 3.45 ± 0.314, and 4.103 ± 0.186 respectively. The result revealed that there were significant difference ($p<0.05$) among the milk channels point.

Solid not Fat (SNF)

The average SNF content of raw milk samples collected were 7.46 ± 0.153, 7.71 ± 0.172, and 7.603 ± 0.197, correspondingly. It was found that there was no significant difference between the study towns. The overall mean values of solid, not fat (SNF) content of raw milk samples collected from producers, collectors, and cafeterias were 7.99 ± 0.126, 7.77 ± 0.184, and 6.99 ± 0.212 correspondingly.

Statistical analysis showed that there were significant differences (P<0.05) within the SNF content of milk collected in the different milk Value chain points.

Total Solid (TS)

The overall average ± SE result of TS content in raw milk sampled were 11.097 ± 0.307, 11.83 ± 0.252 and11.73 ± 0.507 respectively. Statistical analysis showed that there were no significant differences (P>0.05) within the TS content of milk collected from the study town. The mean value of total solid contents of milk samples collected from farms, collectors, and cafeterias were 12.34 ± 0294, 11.88 ± 0.315, and 10.44 ± 0.46 respectively. The result revealed that there were significant differences (p<0.05) within the milk value chain point.

Ash contents

The overall mean value ± SE result of ash content in raw milk sampled were 0.74 ± 0.101, 0.713 ± 0.022, and 0.713 ± 0.11 respectively. The result showed that there were no significant differences (P>0.05) within the ash content of different types of raw milk samples collected from study towns. The average ± SE ash contents of raw milk samples collected from Farm, Milk collectors, and cafeteria were 0.73 ± 0.187, 0.74 ± 0.0187, and 0.697 ± 0.026 respectively [4]. Statistically, it was found that there were no significant differences within the different types of raw milk samples collected from the different value chain points (Table 2).

Table 2: Chemical composition of milk.

Parameter %	**Burayu**	**Sabeta**	**Sululta**
Protein	3.16 ± 0.0551	3.31 ± 0.098	3.14 ± 0.095
Lactose	3.55 ± 0.133	3.69 ± 0.154	3.75 ± 0.164
Fat	3.64 ± 0.204	4.11 ± 0.179	4.13 ± 0.371
SNF	7.46 ± 0.153	7.71 ± 0.172	7.603 ± 0.197
Total solid	11.097 ± 0.307	11.83 ± 0.252	11.73 ± 0.507
Ash	0.74 ± 0.101	0.713 ± 0.022	0.713 ± 0.11
Parameter %	**Farm**	**Collector**	**Cafeterias**
Protein	3.45 ± 0.051	3.34 ± 0.086	2.84 ± 0.111
Lactose	3.83 ± 0.127	3.72 ± 0.148	3.45 ± 0.176
Fat	4.33 ± 0.253	3.45 ± 0.314	4.103 ± 0.186
SNF	7.99 ± 0.126	7.77 ± 0.184	6.99 ± 0.212
Total solid	12.34 ± 0294	11.88 ± 0.315	10.44±0.46
Ash	0.73 ± 0.187	0.74±0.0187	0.697±0.026

DISCUSSION

The study was aimed to test the physiochemical characteristics of raw milk in the urban area of Oromia special zone around Finfine, central highland of Ethiopia. This was due to the very fact that

milk produced in Ethiopia by several dairy farms to finish shoppers isn't well regulated and such milk is also exposed to adulteration. Generally, it was found that the overall mean of added water was similar to findings, higher than the results and contrast with the result. The addition of water to milk not only reduces the nutritional value of milk but also contaminated water may also pose a health risk and if contaminated, it poses a health risk to consumers. The remains of the rinse water in the milk container prior to milking and the addition of the wash water to the tank after the milking might have subsidized the presence of added water in milk.

The milk pH gives an indication of milk hygiene and freshness; the pH value of this study was below the normal pH of fresh cow milk. According to O'Connor, fresh cow milk has a pH value that ranges from 6.6 to 6.8 when milk temperature is 20℃. In the current study milk, PH-value was out of the normal fresh milk. This might be due to the increased acidity of milk by bacterial multiplication. The result of this study was comparable with the result.

In the current study, the milk samples collected from three towns had a titratable acidity value of greater than 0.17% which indicates that the milk samples were kept at room temperature for a longer period and under poor handling practices until they were sold and/or consumed. According to the Ethiopian Standards Agency, the titratable acidity of ordinary fresh milk is between 0.14 and 0.17%. The current study is comparable with the result and lower than the finding reported. In this study milk sampled from collectors and cafeteria high percent of titratable acidity than milk sampled from the farm, maybe due to the high bacterial growth and multiplication during transportation of the milk to the vending sites and longer storage of the milk before consumption.

The specific gravity of normal milk ranges from 1.027 and 1.035 with an average value of 1.032 at 16°C. In this finding, the specific gravity of raw milk samples obtained from collectors and cafeteria in a milk supply chain was lower than that obtained from producers and also below the acceptable limit. These variations might be due to the different sources of milk mixed together that might have been adulterated with water. A similar result was also reported. The specific gravity of milk can be affected by various factors. For instance, the specific gravity of milk decreases by the addition of water and addition of cream; while it is increased by the removal of fat and reduction of temperature.

According to the Ethiopia standard agency, the normal freezing point of milk is between -0.55oC to -0.525°C. The current study was not within the range of normal milk freezing point, however, this finding was slightly similar to the average milk freezing points reported of -0.55 ± 0.03°C and less than the results of -0.941 ± 1.40°C reported with milk collected from the study conducted in Addis Ababa. For dairy farmers and consumers, the freezing point of milk cans an indicator of milk quality, especially adulteration with water. The environmental difference, breed, and management can all influence the freezing point of milk. The season, time, type of feed, and the amount of water the animal consumes can affect milk's freezing point.

Raw milk chemical composition

In this study, the finding of protein content was like the result, (3.2 ± 0.22), (3.2±0.22%), and (3.21 ± 0.06). However, it is lower than the finding of (3.94 ± 0.07), 3.67, 3.4, and 3.34 % reported by cow milk of Western Shewa, Southern Ethiopia and Western Amhara region respectively. The current result was slightly higher than the result of 3.12 ± 0.32. From the result, the protein content of milk decreased starting from the producer to the end consumer. This may due to the adulteration of milk by the cheap material. According to the Ethiopian standards Agency, the minimum percent protein content of whole milk should be 3.2 percent. Hence, the average protein content for the current study was within the recommended standard.

In this study, the result of lactose contents was lower than the finding of (4.34 ± 0.13) Belay and who reported the lactose content of raw milk samples collected from different urban dairy farms located in Jimma town and 5.39 ± 0.31 reported. According to European Union Quality Standards for unprocessed whole milk, lactose content should not be less than 4.2%. Therefore, the current result was below the recommended standards [5]. This might be due to the action of lactose hydrolyzing enzymes produced by microorganisms as a result of storage temperature variation. In general, the composition of milk can vary depending on the breed of the animals, management practices such as feeding management, and environmental factors that influenced the milk composition.

The current result of fat contents was higher than the report of who found (3.60 ± 0.53) fat from Milk Value Chain and Quality in Regional State, Ethiopia. However, this finding was less than the report of who found (4.28 ± 0.05) fat from raw cow's milk produced and marketed in Shashemene town, Southern Ethiopia. This result was comparable with the result of 3.9% raw milk reported on smallholder of dairy farmers in the Lusaka Province of Zambia. The subordinate fat content of milk may be due to high milk-producing crossbreeds' cows which reduces the fat content of the milk samples or water may be added with milk or partly skimming the milk or due to the feed, they offered. According to the Ethiopian standard agency, the minimum fat content of raw milk should not be less than 3.5% (ESA, 2009). Accordingly, the mean (± SE) fat content (3.96 ± 0.25) observed from the three value-chain points milk samples was in the range of recommended standards.

The current finding of SNF content of raw milk was slightly similar with who report the average SNF (7.98 ± 0.98) of raw cow milk and who report the average SNF (7.78 ± 0.41) Milk Value Chain and also reported the minimum (8.3 ± 0.36) and maximum (8.7 ± 0.36) SNF content of raw cow's milk obtained from street-vendors and milk producers in and around Addis Ababa. According to Food and Drug Administration (FDA) as well as European Union (EU) quality standards, a minimum solid not fat (SNF) content of whole milk is 8.25%. The current result is not found in the recommended range. This may due to a variety of factors including the feed, genetics, season of the year, stage of lactation and disease.

The Total Solids (TS) content of this result was lower who report average total solid (12.78%) milk production, marketing practices, and qualities along milk supply chains of Haramaya District, Ethiopia. But the current result was agreed with who report the average total solid content (11.38%) Milk Value Chain and Quality in Regional State. According to the Ethiopia standard agency, the total solid

contents of cow milk should not be less than 12.80%. Therefore, the result of this study was less than the recommended standard. The lower total solid content found from this study may be due to adulteration of milk (addition of water to milk) and removal of fat content.

The ash content of the current study was higher than the result of 0.62 ± 0.05 reported and also the result who observed that the means of ash in cow's raw milk collected from different locations were 0.64 ± 0.07and 0.68 ± 0.16, respectively. But an agreement with the finding who reported the ash content (0.78 ± 0.00) for the raw cow's milk collected from produced and marketed in Shashemene town, Southern Ethiopia.

CONCLUSION

From the laboratory analysis of this study, it was concluded the adulteration of raw milk were increase along with the milk chain in Oromia special zone around Finfinne. As results of physiochemical properties analysis indicated that, most of the quality parameters of sampled milk were not fulfilling the required quality of Ethiopia standard agency/FAO/EU. Milk chemical composition was an indicator of the quality, these decreased from producer to end consumer. Finally, it is concluded that the current condition of quality of milk in the study site in terms of physicochemical compositional aspect is at an alarming state, so it requires urgent action to reverse the situation.

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