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Chemical Quality of Raw Cow's Milk Detection and Marketing system in Walmera District of Oromia Regional State, Ethiopia

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Abstract

The objective of this study was to evaluate the chemical quality of raw cow's milk in Walmera district of Oromia Regional state. A total 60 samples of raw cow's milk, 30 from local and 30 from crossbred cows were collected in the morning and evening from purposively selected eleven kebeles. The data generated from laboratory result were analyzed using General Linear Model of SAS. The means for Total Solids, Fat, Solid Not fat (SNF), Protein, Ash and Lactose of local and crossbred raw cow's milk were 14.71% ± 1.51 and 13.03%±1.24; 5.46%±0.51 and 4.04%±0.29; 9.26%±1.38 and 9.01%±1.16; 3.07%±0.56 and 2.70%±0.37; 0.72%±0.08 and 0.73%±0.07 and 5.47%±1.25% and 5.85±1.29, respectively. Significant differences ($p<0.05$) were found for Total Solid, Fat and Protein between raw cow's milk of local and crossbred. Therefore, it could be conclude that the chemical quality of the collected raw cow's milk were within recommend levels.

Keywords: Chemical quality, raw cow's milk, Walmera District

1. Introduction

Milk is used throughout the world as a human food in at least one or more form. Because of its high nutritional value, milk is considered as one of the most important diet items of many people (Mehari, 1988). Nutritionally, milk has been defined as "the most perfect foods". The demand of consumers for safe and quality milk has placed a significant responsibility on dairy producers (Menane et al., 2007). Hygienic control of milk and milk products in Ethiopia is not usually conducted on routine bases. Apart from this, door-to-door the raw milk delivery in the urban and peri-urban areas is commonly practiced with virtually quality control at all levels of production level (Godefay and Molla, 2000). Moreover, most of the studies conducted yet concerning the bacteriological quality raw and pasteurized milk on milk collecting center and processing plants in Addis Ababa and its vicinity (Alehegne, 2004).

However, there is no adequate work that has been conducted on the chemical quality of raw cow's milk produced and sold in Walmera distract. Besides, there is no documented information on the chemical quality and safety of raw milk in the study area. Therefore, this study was designed to evaluate the chemical quality of raw cow's milk produced and sold in the study area.

2. Materials and Methods

2.1. Study area

The study was carried out in Walmera District of West Shoa Zone of Oromia, which is located 30km to the west along the main road to Ambo. Geographically, the district is found 9^o 0' 0''-9^o 10' 0' N latitude and 38^o 25' 0''- 38^o 30' 0'' E longitudes. The study area has an altitude of 2400m.a.s.l and receives an average annual rainfall of about 1000mm.The mean minimum and maximum temperatures are 6 and 22°C, respectively (WDLDFO, 2017). The mean relative humidity is 59%. The study area obtains short rainy season (March to May), long rainy season (June to September) and dry season (October to February) (HARC, 2008). The total human population of the district is 104,932 and cattle are the dominant livestock of the smallholder farmer in the area, although limited number of small ruminants and equines are kept (WDLDFO, 2017). Animals largely depend on natural grazing, which were supplemented with crop residues late in the dry season.

2.2. Research design

The study involved a laboratory-based investigation intended to evaluate the chemical quality of raw cow's milk produced in Walmera Distract of Oromia regional state. A total of 60 samples of raw cow's milk were collected in the morning and evening from purposively selected eleven kebeles. In addition, 102 respondents were selected from each kebeles for gathering the data required for practicing dairy products marketing in the study area.

2.3. Sources of data and Sampling procedure

Milk samples were collected from local and crossbred cows of small scale dairy producers. From purposively selected eleven kebeles by lottery random sampling method based on the research schedules, morning and evening milk were collected by mixing, leveling and then transported using icebox to Holleta Dairy Research Laboratory center to analyze chemical quality of raw cow's milk by using SAS computer package version 8.2 (SAS, 2009) .

2.4. Chemical Quality of raw cow's milk

2.4.1. Total Solids (TS)

For the determination of total solids content, fresh cow milk sample was mixed and five grams transferred to a pre-weighed and dried flat bottom crucible (AOAC, 1990). The milk samples dried in a hot air oven at 102^0C for 3 hours. Finally, the dried samples has taken out of the oven and placed in desiccators to cool to room temperature. Then samples weighed again and total solids calculated by the following formula according to (Richardson, 1985).

$$\mathbf{TS} = \frac{\mathbf{CWt + Oven\ dried\ Sample - CWt}}{\mathbf{Sample\ weight}} \mathbf{x\ 100}$$

Where, CWt = Crucible Weight
TS = Total solid

2.4.2. Crude Protein Determination

Total protein content of the milk samples were determined by the Kjeldahl method [20] according to the following procedures:

Digestion: Five gram of milk sample warmed in a water bath at 38°C and poured into a Kjeldahl flask. 15-gram potassium sulphate, 1.0 ml of copper sulphate solution and 25 ml of concentrated sulpharic acid added into the flask and mixed gently. The digestion carried out in a digestion block until a clear solution appeared. Then it allowed cooling at room temperature.

Distillation: The digestion flask was placed in the distillation equipment and then 30 ml of distilled water and 75 ml of 50% sodium hydroxide solution were added into it. Then, ammonia distilled and 50 ml of 40% boric acid solution using bromo-cresol green indicator added until blue color appeared. Finally, the sample was titrated with 0.1 N hydrochloric acid solution from a burette until a faint pink color solution was formed and the burette reading was taken to the nearest 0.01 ml. Blank test was carried out using the above procedure except that water was used instead of test sample. The percentage of nitrogen in the milk samples calculated as follows:

$$\mathbf{N\ (\%)} = \frac{\mathbf{(Vs - Vb)HClConsumed \times NHCl \times 1.4007}}{\mathbf{Sample\ weight}} \mathbf{X\ 100}$$

$$\mathbf{CP\ (\%) = N\ (\%) * 6.3}$$

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

2.4.3. Fat Content

The Gerber method was used to determine the milk fat content. Ten ml of sulfuric acid dispensed into a butyrometer. Then, 11 ml of milk and one ml of amyl alcohol added into a butyrometer having the sulfuric acid. The butyrometer closed with rubber cork and the sample was shaken and inverted several times until all the milk digested by the acid. Then the butyrometer placed in a water bath at 65ºC for five minutes. The sample has centrifuged for five minutes at 1100 rpm. Finally, the sample was returned back to the water bath, and kept for 5 minutes at 65ºC and fat percentage was read from the butyrometer scale (O'Connor, 1995). Those samples having higher or lower percentages beyond the normal fat range is rejected.

2.4.5. Ash Content

Total ash content was determined by igniting the dried milk samples used for determination of TS content in a muffle furnace in which the temperature slowly raised to 550°C (Richardson, 1985). The sample was ignited until carbon (black color) disappears and a light grey or white ash remains. Total ash was calculated as:

$$\text{Ash} = \frac{\text{Residue weigt} * 100}{\text{Sample weiht}}$$

2.4.5. Solids-Not-Fat Determination

Solids-not-fat (SNF %) content was determined by subtracting percent fat from TS present (O'Mahony, 1998).

Percent of Solids-non-Fat = % Total Solid- % Fat

2.4.6. Lactose Content

Percent lactose was determined by subtracting the fat, protein and total ash percentages from the percentage of the total solids (O'Mahony, 1998).

Percent Lactose = Percent total solids – (% fat + % protein + % ash)

2.5. Method of Data Analysis and Interpretation

Data generated from laboratory result were analyzed using General Linear Model of SAS (SAS, 2009). Mean separation was performed using the least significance difference (LSD) when analysis of variance showing significant differences.

3. Results and Discussion

3.1. Milk Composition

3.1.1. Total Solid% (TS)

The overall mean TS of local and crossbred cow milk were 14.71% ± 1.51 and 13.03%±1.24. The current result is lower than 15.47% reported by (Gurmessa et al., 2015) in Yabelo, (Rehrahie and Andinet, 2007) who reported 16.02% for Borana cows' milk at Holleta Research Center.

In addition, 14.8% and 14.31% reported for Boran and Horro cows' milk (Workneh, 1997) and Alganesh, 2002) in east Wollega, respectively. According to European Union recognized quality standards for total solids, content of cow milk should not be less than 12.5% (FAOSTAT, 2007). In view of that, the total solid content obtained from both local and crossbred cow's milk in the current study meet the standard.

3.1.2. Fat %

Fat of milk is unquestionably the most valuable constituent of milk. Milk having a fair amount of fat is more valuable as a food than milk, which is poor in fat (Kearson, 2005). The fat content significantly affected by the factors like feed, parity, breed and stage of lactation. The mean fat content in the study areas was 5.46%±0.51 for local cow and 4.04%±0.29 for crossbred cow, which is lower compared with the average fat content of milk obtained in Yabelo with 6.01% fat as reported by (Gurmessa et al., 2015). But the local cow milk fat content in the study area was greater than the report of (Asaminew , 2007) for Bahir Dar milk shed which was 4.71% fat for local cows. It is slightly similar with local cow milk with 5.6% fat content for Zebu cows as reported by (O'Connor, 1995). The Food and Drug Administration (FDA) requires not less than 3.25% milk fat for fluid whole milk similarly to the U.S. public health service (USPHS) Milk Ordinance and Code also recommended a minimum of 3.25% butterfat in farm milk (Raff, 2011). The fat content obtained in the current study fulfills the criteria set by both FDA and USPHS.

3.1.3. Solid Not fat% (SNF)

The SNF content of both local and crossbred cows' milk was 9.26%±1.38 and 9.01%±1.16, respectively. This is almost equal with (Gurmessa et al., 2015) (9.46%) which was reported in Yabelo and lower than the result obtained by (Helen and Eyassu, 2007) who reported SNF contents of 10.7% for cow milk in Kombolcha district. Yet, this value was greater than the finding reported by Teklemichael, 2012) for milk obtained from dairy farms (8.75%) in Dire Dawa town. Debebe (2010) 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 solids-not fat (SNF) content of whole milk is 8.25% (Raff, 2011). In view of that, the result obtained in the present study area was in the range of quality standards given by FDA and EU.

3.1.4. Protein%

The protein content of the raw milk was 3.07%±0.56 local cow was higher than 2.70%±0.37 milk samples from crossbred cows. This is due to breed difference of local and crossbred cows. According to (Sendros et al., 2003), indigenous cow breeds characterized by high values for milk composition. Low milk yield (hardly exceeds 600 liters in a short lactation of less than 200 days). The overall mean protein content 3.07±0.56% local and 2.70±0.37% crossbred cows obtained in the current study was lower than that reported by (Gurmessa et al., 2015) 3.94% in Yabelo and 3.1 % reported for Zebu cows' milk (O'Connor, 1995). Similarly, (Debebe, 2010) also reported higher protein content (3.46 %) for milk samples collected from households producing local and crossbred cows. However, (Rehrahie and Andinet, 2007) reported higher protein content of 4.05% for Borana cow milk at Holleta research center. According to Food and Drug Administration (FDA), a minimum protein content of whole milk is 2.73% (Raff, 2011). The value of protein content obtained in the current study fulfills the criteria developed by FDA for the consumers.

3.1.5. Ash%

The overall mean ash content obtained in this study for local and crossbred dairy cows milk were 0.72%±0.08 and 0.73%±0.07, respectively. This value is lower than the one reported by (Gurmessa et al., 2015) 0.80% in Yabelo and the findings of (Workneh, 1997) who reported an average ash content of (1.0 %) for Borana cow's milk. Almost equal with (Asaminew, 2007) reported ash content of 0.73% for the local cow milk in the Bahir Dar milk shed.

3.1.6. Lactose %

The overall mean and standard deviation of lactose content of the current study for local cow 5.47%±1.25 was lower than that for crossbred cow 5.85±1.29. In addition, the crossbred cow milk contain higher than the 5.52%±1.71 estimated in Yabelo by (Gurmessa et al., 2015) confirm that the local breed cow characterized by high values for milk composition. As to by (WDLFRDO, 2017) indigenous cows in Ethiopia is characterized by high values for milk composition. Lactose content may be affected by the presence of bacteria in raw milk as result of storage temperature differences (Ballou et al., 1995). Therefore, the overall mean percentage crossbred of lactose found in the current study was 5.52±1.71 percentage was above that reported by (O'Connor, 1995).

The crossbred dairy cow's milk is liquid than local cow milk. That is why the local cow milk is more test than crossbred cows and the total solid content is greater than crossbred. It could clearly understood from the current result that the milk composition of crossbred cows were greater than that of local cows only by lactose content. However, for milk processing high percentage of total solid in the milk composition is recommended for milk products like butter and cheese yield. Better milk product yield of dairy cow depends on the amount of constituents' content in the milk composition. Then local dairy cow produce more milk product like butter and cheese. As the statically analysis of SAS result confirmed, in the study area, there were highly significant difference between local and crossbred for Total solid%, Fat%, and Protein%. However, there were no significant difference of Lactose%, Ash% and SNF, but statistical difference. The lactose percentage of crossbred is greater than local breed. But, local dairy cows protein%, Fat%, Total solid, Ash% and Solid not Fat% milk composition content were greater than crossbred dairy cows. According to (O'Connor, 1995) indicated the greater the amount of fat and protein in milk the greater the yield of cheese and milk with a high fat content gives more butter than milk with a lower fat content.

General for milk processing (butter and cheese production) local breed were preferred, whereas the crossbred milk composition in the study area was fulfill all the international standard criteria and highly greater milk yield, by tolerating the genetic merits of local breed, crossbred (up graded) dairy cow were selected in the study area for milk yield and quality (composition).

Table 1: Local and Crossbred dairy cows milk composition (%) in Walmera District

Milk chemical Composition				
	Local (N=30)	Crossbred (N=30)		
Variable	**Mean ±SD**	**Mean ±SD**	**CV**	**LSD**
Protein	3.07±0.56 [a]	2.76 ±0.37[b]	16.15	0.24
Fat	5.46 ±0.51[a]	4.04±0.29[b]	8.77	0.21
TS	14.71±1.51[a]	13.03±1.24[b]	9.63	0.69
Ash	0.72±0.08[a]	0.72 ±0.07[a]	10.38	0.63
Lactose	5.47±1.25[a]	5.52 ±1.71[a]	22.02	0.04
SNF	9.26±1.38[a]	9.01 ±1.16[a]	13.94	0.66

Values in the same row with different superscripts are significantly different at $P < 0.05$

3.2. Milk and milk product marketing in the study area

In and around the study area, there is high potential for milk and milk products marketing because of the proximity of the area to the capital city, Addis Ababa. Like other parts of the country, in the study area, there are two basic marketing systems: one is the formal system in which the milk were collected at the roadside through milk collection centers, and then taken to the processing plants. While the other form of marketing system is the informal system, in which the smallholders sell their surplus milk to neighbors or in the local market.

The interview result of 102 respondents on the milk market channels, outlets and value chains in the study area were:

- Producer → Milk collector (Retailer) → consumer or processing center 82.4% respondents sold milk at roadside and at their home.
- Producer → Collector, cooperative and consumers respondents 13.7%
- Producer →consumer respondents 3.9%. Home consumer (by monthly rent). Almost similar milk market channel in and around Burie town was reported by (Haile et al., 2016).
- Producer→ consumer (P-C) channel: These marketing channels were accounted 10.8% of the total milk marketed per day. This channel is common for both rural and urban areas.
- Producer → Retailer → Consumer: These channels were accounted 38.4% of the total market i.e. hotels and restaurants.
- Producer → Cooperative → Retailer →Consumer: these channels accounted 10.8% of the total market
- Producer → Cooperative →Consumer: these channels were accounted 40%.

Generally as the current study result showed the percentage of producer and consumer directly buy and sale milk were only 3.9% in study area. Because of this, most of the producer cannot get fair price. Majority of the producers (84.7%) sold one litter of milk with 10-12birr and price of the milk was determined by milk collectors. In addition, in the current study area, as the report of field observation, informal discussion with milk consumer, Key informant interview and focus group discussion clearly showed the price of 1liter of milk was ranging 10-12birr. The price of dairy products is varying depending on season, holy days, festivals and wedding ceremonies. However, there were no milk price difference between local and crossbred dairy cows' milk. All respondent dairy producers in the study area agreed that the local cow milk was more tasteful than that of crossbred cow milk.

Table 2: Milk and milk product market channels, outlets and value chain in the study area

Variance		Frequency	Percent
Milk sold to	milk collectors	84	82.4
	CCC	14	13.7
	Consumer	4	3.9
	Total	**102**	**100**
Current milk price Per litter	10-12 ETB	86	84.3
	Above 12 ETB	16	15.7
	Total	**102**	**100**
Processed milk	No	89	87.3
	Yes	13	12.5
	Total	**102**	**100**
Current price of Milk products	Not processing	89	87.3
	B130 and C 80birr of 1kg HM	7	6.9
	B140-180 and C100birr1kg AAM	6	5.9
	Total	**102**	**100**
Variation of milk price among CLB	No	100	98.0
	Yes	2	2.0
	Total	**102**	**100**
Classify test of Milk CLB	Yes	92	90.2
	No	10	9.8
	Total	**102**	**100.0**

CCC =Collector, cooperative and consumer HM =Holleta Market, AAM Addis Ababa Market, B=Butter, and C= Cheese CLB=Cross, Local Breed

4. Conclusion and Recommendation

To sum up, according to the current result, the chemical quality of the collected raw cow's milk were within recommend levels of European Union, FAO and Food and Drug Administration (FDA) established quality standards. This may be helpful for the responsible government regulatory bodies to keep an eye on the quality of the commercial milk and milk products in the market. Cornering milk and milk products marketing, there were high milk price differences between producer, consumer and milk collectors in the study area in which the producers were the least benefited from the market share. This would be potential weapons to enlist the support and cooperation of commercial dairy industry and government in order to successfully develop and support advanced milk production and invite investors in modern dairy production in the study area.

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References

Alehegne W (2004). Bacteriological quality of Bovine milk in small holder dairy farms in Debare Zeit, Ehiopia, 34pp.

Alganesh Tola. 2002. Traditional milk and milk products handling practices and raw milk quality in Eastern Wollega. M.Sc. Thesis, Alemaya University. Dire Dawa, Ethiopia. 108p.

AOAC (Association of Official Analytical Chemists). 1990. Official Methods of Analysis, *15th Edition*, Association of Official Analytical Chemists. Washington, D.C

Asaminew Tassew. 2007. Production, handling, traditional processing practices and quality of milk in Bahir Dar milk shed area, Ethiopia. M.Sc. Thesis, Haramaya University of Agriculture, Dire Dawa, Ethiopia

Ballou, L.U., Pasquini M. and Bremrl R.D. 1995. Factors affecting herd milk composition and milk plasma at four levels of somatic cell counts. *Journal of Dairy Science*, 78(10): 2186-2195.

Debebe Worku. 2010. Physicochemical Properties and Safety of Streetvended Milk in and Around Addis Ababa City (Kotebe, Bishoftu and Chancho), M.Sc.Thesis. Haramaya University, Ethiopia.

FAOSTAT (Food and Agricultural organization of the United Nations Statistics). 2007. Online database on food and agricultural products and producers, FAO, Rome. Feed resources and its utilization practices by smallholder farmers in Meta-Robi District, West Shewa Zone, Oromiya Regional State, Ethiopia

Godefay B, Molla B (2000). Bacteriological Quality of raw milk from four dairy farms and milk collection center in and around Addis Ababa. Beri Munch. Tierarztl.Wschr.113:1-3

Gurmessa Terfa Gurmessa, Mitiku Eshetu and Alemayehu Regassa. 2015. Physico-chemical qualities of raw cow milk in Ethiopia. The case of Borana zone, Yabello District Yabello Pastoral and Dry Land Agriculture Research Center, Yabello, Ethiopia. *Global Journal of Dairy Farming and Milk Production*, ISSN: 2449-1861 Vol. 3 (2), pp. 086-091

Haile Mikael Mossie, MitiKu Eshetu and Negasse Ameha. 2016. Monitoring Dairy Production, Marketing and Milk Quality in and Around Burie Town: Case of Dairy Cooperatives. *International Journal of science and technology* vol. 4 (12).

Helen Nigussie and Eyassu Seifu. 2007. Effect of the lactoperoxidase system and container smoking on the microbial quality of cows' milk produced in Kombolcha woreda, eastern Ethiopia. *Livestock Research for Rural Development, 19,* p.157.

Holeta Agricultural Research Center, 2008.

Kearson, D. 2005 .The Chemical Analysis of Food. Seventh Edition. Chemical Publishers Co., Berlin, pp. 9-11.

Mehari T (1988). Thermoduring and Pyschrophilic Bacteria from raw milk. MSc. Thesis, Addis Ababa University, Ethiopia

Menane Z, Ouhssine M, Khedid K, Elyachioui M (2007). Hygienic Quality of Raw Cow's Milk Feeding from Domestic. In.J.Agri.Biol. 9(1):1560-8530

O'Connor, C.B. 1995. Rural Dairy Technology ILRI Training Manual I, International Livestock Research Institute, Addis Ababa, Ethiopia.

O'Mahony, F. 1998. Rural Dairy Technology-Experiences in Ethiopia. ILCA manual No 4. Dairy Technology Unit. ILCA, Addis Abeba, Ethiopia. 64pp.

Raff, H. 2011. Market implications of changing fat content of milk and dairy products, fat content and composition of animal products. *Journal Food Science Technology*, 5 (2): 6 - 17.

Rehrahie Mesfin and Andinet Getachew. 2007. Evaluation of grazing regimes on milk composition of Borana and Boran-Friesian crossbred dairy cattle at Holeta Research Center, Ethiopia. *Journal of Livestock Research for Rural Development*, 19 (12)

Richardson, H.G. 1985. Standard Methods for the Examination of Dairy Products. 6thSixth (edit) American Public Health Association, Washington DC. pp. 133-150.

SAS(Statistical Analysis System). 2009. SAS'users' guide, SAS Institute, Inc. Cary, NC.

Sendros, D., Neser, F. W. C. and Schoeman, S. J. 2003. Early growth performance of *Bostaurus x Bosindicus* cattle crosses in Ethiopia. Estimation of individual crossbreeding effects. *Animal Breeding and Genetics*, Volume120, 245-257

Teklemichael, T. 2012. Quality and Safety of Raw and Pasteurized Cow Milk Produced and Marketed in Dire Dawa Town, M.Sc. Thesis. Haramaya University, Ethiopia

Walmera District Livestock Development and Fishery Office (2017): Annual work report: Unpublished

Workneh Abebe. 1997. Assessment of nutritive value and consumer preferences for some varieties of cheese made from goat milk. M.Sc. Thesis, Alemaya University, Ethiopia.

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