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Research Article

Evaluation of Milk Composition in Zebu × HF Crossbred Dairy Cows in Different Seasons and Stage of Lactations in Amanuel Town, Ethiopia

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ABSTRACT

A study was carried out on lactating crossbred dairy cows with the objectives of evaluating the effect of season and stage of lactation on milk quality in East Gojjam Zone of Amanuel town, Ethiopia. Milk quality was analyzed by profiling major components; protein, fat, lactose, solid-not-fat (SNF) and ash. Milk samples were collected from a total of 60 crossbred dairy cow's (30 milk samples in winter and 30 milk samples in summer seasons) and immediately analysed using milk analyzer machine. Based on laboratory result average milk composition of fat, SNF, TS, protein, lactose and ash percentage of milk in winter season were 4.45 ± 0.26, 7.47 ± 0.38, 11.92 ± 0.40, 2.7 ± 0.05, 4.3 ± 0.07 and 0.6 ± 0.01, respectively. In summer season the milk composition were 3.58 ± 0.23, 8.08 ± 0.13, 11.66 ± 0.36, 3.01 ± 0.06, 4.44 ± 0.07 and 0.66 ± 0.01, respectively with overall average value of 4.12 0.26% fat, 7.77 0.14% SNF, 11.89 0.40% TS, 2.83 0.06% protein, 4.28 0.08% lactose and 0.63 0.01% ash. There were significant differences in all compositions of milk except in TS content of milk between seasons. But there is no significant difference ($p \geq 0.05$) in all compositions of milk among different lactation stages except in protein content during winter season i.e., during winter season, higher protein content result was recorded in 3rd stage of lactation (2.84 0.06) than 2nd stage of lactation (2.59 0.10). Therefore, the qualities of milk from the Zebu × HF crossbred cows met the required standard. It was revealed that the Zebu × HF crossbred animal was the best performer regarding the milk composition and quality.

Keywords: Cross breed dairy cows; Milk composition; Season; Stage of lactation

INTRODUCTION

Milk is considered as nature's single most complete food and it is definitely one of the most valuable and regularly consumed foods [1]. In other case it is the lacteal secretion, practically free from colostrums, obtained by the complete milking of one or more healthy cows, five days after and 15 days before parturition, which contains not less than 8.5 percent milk solids-not-fat and not less than 3.5 percent milk fat [2]. Milk chemical composition and production are the interaction of many elements within the cows and her external environment.

High milk yield of satisfactory composition is the most important factor ensuring high economic returns. If the composition of milk varies widely, its implication is that nutritive value and its availability as a raw material will vary; normally milk composition and quality are important characteristics that determine the nutritive value and consumer acceptability. According to Alphonsus report, milk composition (fat, protein and lactose contents) is an important trait in dairy cattle and considerable selection pressure is placed on these traits [3]. This author further stated that milk composition traits determine the quality of milk produced by dairy cows and have economic value since dairy producers are paid premium value for milk of higher than average quality or composition. Milk component levels and characteristics are important factors that have a significant effect on dairy product quality and yield [4].

It has high value proteins (casein, lactalbumin and lacto globulin providing essential amino acids), fat providing energy (9.3 kcal /g) and small globules stimulating an easy assimilation and vitamin A and D that playing a special role in Calcium and Phosphorus fixation in bones [5]. The composition of milk is not constant, sometimes the composition might even change during milking the first milk drops differs from the last milk drops [6]. According to O'Connor the chemical quality of milk may be ascertained by measuring its content of fat, protein and total solids, which is affected by genetic and environmental factors, breed, feeding, individuality within the breed, stage of lactation, age, health and

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interval between milking are among the factors responsible for variation in milk composition of cows [6,7].

Generally, the composition of cows' milk is also of greatest importance for the dairy industry. Since, its process ability is highly influenced by composition. Knowing the composition of milk also helps to assess adulteration and the quality of the milk for consumers and milk processing industries.

To put in place appropriate remedial interventions that would lead to enhanced milk composition of the dairy subsector, understanding the prevailing overall milk composition is very vital. This necessitates the need for generating site specific database under specific production scenarios. In this regard, little research has been done so far to identity the overall milk quality in East Gojjam Zone. In this research, it is endeavored to fill this existing information gap. Hence, the aim of this study was to evaluate the effect of season and stage of lactation on milk quality in East Gojjam Zone of Amanuel town, Ethiopia.

MATERIALS AND METHODS

Location and description of the study area

The study was conducted in Machakel district Amanuel Town, East Gojjam zone, Amhara National Regional State. The district is located 236 km far south west from Bahir Dar and 316 Km North West from Addis Ababa. The area is located at 100 40' N latitude and 370 20' E longitudes at an altitude of 1200-3200 meter above sea level (masl). Its annual rain fall ranges from 900-1800 mm. The area has two seasons, the wet season from June to September in which the area gets its majority of rainfall and the dry season from October to May which receives small and erratic rainfall. The mean annual temperature is 17.5 °C [8].

The major feed sources for livestock in the district are natural pasture, crop residues, local brewery by- product (Briniti and Atella), agro-industrial by-products and others. Cows in the study area largely depend on local brewery by- products throughout the year and crop residues late in the dry season. Agro-ecologically the district covers 5% lowland, 54% midland and 41% high land. Major crops grown in the district are wheat, teff, maize, barely, bean, noug (Guizotia abyssinica) and oat. The livestock population of the district accounts as: 91, 343 cattle, from this 1,700 were crossbred cows, sheep 47,222, goats 5215, equine 15,608, chicken 61,431 and 9,883 bee colony.

All farms found in Amanuel town have no access to grazing land. Hence, mainly they depend on local brewery by product and crop residue. Birinti (local brewery by product) was purchased daily along with crop residue which was purchased immediately after the end of harvesting season and stored in straw shed. However, some producers purchased hay as additional feed source for feeding throughout the year. In addition locally prepared concentrate feeds (maize and oat grain) and milling factories by - products, were given to animals.

Methodology

A laboratory-based investigation designed to determine the chemical properties of raw crossbred dairy cow's milk.

Sampling method and data collection

The study animals were classified according to lactation stage. Those cows between 1 to 3 months of delivery were classified as early, between 4 to 6 months as mid and those in between 7 to 9 months under late stage of lactation.

Prior to the laboratory analysis sampling glass bottles were prepared sterilized and disinfected with detergent. Approximately a total of 60 sample size about 100 ml per sample raw crossbred dairy cow milk samples from each morning were aseptically collected for 2 (two) days from a producer's milking Jog immediately after the end of total milking of cow from each season summer (August, 2017) and winter (January, 2018) and placed into sterile glass bottles. Consequently, samples were labeled and put in ice box (4°C) and transported as early as possible to Elemtu integrated milk industry axion cooperative for analysis of milk composition by Ekomilk. The laboratory analyses were performed within 36 hours after collecting the sample [8].

Data analysis

Milk composition was analyzed using General Linear Model (GLM) procedure of Statistical Analyzed (SAS Version 9.1). Mean comparisons was done using the Least Significant Difference (LSD) for variables whose F-values showing a significant difference at P-value 0.05, 0.01 and 0.001. The model employed was as follows:

$Yik = \mu + Ai + eik$

Where: yik = Response variables (raw milk composition),

μ = Overall mean,

Ai = treatments: seasonal effect, lactation stage effect (early, mid and late) and

eijkl = residual effect.

RESULT AND DISCUSSION

Milk composition

The overall mean of milk chemical composition in summer and winter season and among lactation stage were indicated in Table 1 below. Average fat, SNF, TS, protein, lactose and ash contents of milk in winter season were 4.45 ±0.26, 7.47 ± 0.38, 11.92 ± 0.40, 2.7 ± 0.05, 4.3 ± 0.074 and 0.6 ± 0.01, respectively, while in summer season it were 3.58 ± 0.23, 8.08 ± 0.13, 11.66 ± 0.36, 3.01 ± 0.06, 4.44 ± 0.07 and 0.66 ± 0.01, respectively with overall average value of 4.12 ± 0.26% fat, 7.77 ± 0.14% SNF, 11.89 ± 0.40% TS, 2.83 ± 0.06% protein, 4.28 ± 0.08% lactose and 0.63 ± 0.01% ash.

Except TS content of milk, the compositions of milk were significantly ($P<0.01$) affected by seasons. Apart from the protein content all major compositions of milk were not significantly affected by stages of lactation. Protein content during winter season was significantly higher in 3rd stage of lactation (2.84 ± 0.056) than 2nd stage of lactation (2.59 ± 0.102).

Total solid content

In the current study the overall mean of TS contents of milk were 11.89 ± 0.40%. The TS content of milk was not significantly affected by seasons. However, it was significantly ($P<0.01$) affected by stages of lactation. It was less than the finding of Bille, Mirzadeh and Tekelemichael as they reported that, 12.33% in Namibia, 12.57% Lordgan region in Iran and 12.58% in Dire Dawa area, respectively [9-11]. According to European Union recognized quality for total

Table 1: Milk composition in different season and stage of lactation.

Variable	N		Fat	SNF	TS	Protein	Lactose	Ash
				Mean ±SE				
				Season				
Winter	30		4.45 ± 0.26[a]	7.47 ± 0.38[b]	11.92 ± 0.40	2.7 ± 0.05[b]	4.3 ± 0.07[b]	0.60 ± 0.01[b]
Summer	30		3.58 ± 0.23[b]	8.08 ± 0.13[a]	11.66 ± 0.36	3.01 ±0.06[a]	4.44 ± 0.07[a]	0.66 ± 0.00[a]
Average	30		4.12 ±0.26	7.77± 0.14	11.89 ± 0.40	2.84 ± 0.06	4.28 ± 0.08	0.63 ± 0.01
Significant			0.01	0.001	NS	0.001	0.001	0.001
Ls					Season			
First	10	Winter	4.44 ± 0.55	7.57 ±0.20	12.01± 0.75	2.76 ± 0.07[ab]	4.164 ±0.11	0.62 ±0.02
Second	11	Winter	4.88 ± 0.46	7.15 ±0.26	12.03 ± 0.72	2.59 ± 0.10[b]	3.94 ± 0.14	0.57 ±0.02
Third	9	Winter	5.26 ± 0.66	7.78 ±0.14	13.05 ± 0.80	2.84 ± 0.06[a]	4.18 ± 0.08	0.62 ±0.02
Average	10		4.86 ± 0.55	7.48 ±0.23	12.34 ± 0.77	2.74 ± 0.09	4.12 ± 0.12	0.59 ± 0.02
Significant			NS	NS	NS	0.05	NS	NS
First	11	Summer	3.56 ±0.58	8.13 ± 0.16	11.7 ± 0.74	2.74 ±0.28	4.47 ±0.09	0.66 ± 0.02
Second	10	Summer	3.65 ±0.39	7.92 ± 0.23	11.57 ± 0.64	2.92 ±0.09	4.34 ±0.14	0.65 ± 0.03
Third	8	Summer	4.59 ±0.54	8.22 ±0.30	12.81 ± 0.85	2.99 ±0.11	4.52 ±0.17	0.67 ±0.03
Average	9.66		3.86 ±0.52	8.18 ±0.23	11.94 ± 0.74	2.87 ±0.20	4.44 ±0.13	0.66 ±0.02
Significant			NS	NS	NS	NS	NS	NS

Note: NS = non-significant, TS = total solid, SNF = solid not fat, Ls = lactation stage, N = sample size and SE = standard error
Means in the same column with different subscript letters were significantly different and summer includes (June, July and August), Winter includes (December January and February)

solid content of cow's milk not less than 12.5% [13]. Therefore, the average TS content of milk sample in this study area was slightly lower than the recommended standard. This variation might be due to difference in feeding and management practices which have important effect on milk composition quality [7].

Fat content

In the current study fat contents of milk were 4.45 ± 0.26% and 3.58 ± 0.23% in winter and summer season, respectively with overall mean of 4.12 ± 0.26%. The fat content of milk was significantly (P<0.01) affected by seasons. However, it was not significantly affected by stages of lactation. This finding was greater than the previous study report of Teklemickeal who reported that fat content of milk in Dire Dawa area was 3.86% and Janstora as they reported that, 3.79% of fat in Czech Republic [11,14]. But comparable results were reported by Deresse 4.27% in West Shoa Zone Oromia region and Shibru and Mekasha 4.10 ± 0.77% in peri urban area and slightly greater result 4.58 ± 1.21% in urban area in Awas district Oromia region [15,16].

The fat contents of milk might be affected by feed, seasons and other managemental practice. According to European Union quality standard for unprocessed whole milk fat content should not be less than 3.5%. Similarly, the Food and Drug Administration (FDA) requires not less than 3.25% milk fat for fluid whole milk. Therefore fat content of this result was within the recommended standard [17].

Solid not fat contents

Solid not fat contents of milk were 7.47 ± 0.38% and 8.08 ± 0.13% in winter and summer seasons, respectively, with overall mean 7.77 ± 0.14%. The solid not fat content of milk was significantly (P<0.01) affected by seasons. However, it was not significantly affected by stages of lactation. Solid not fat contents of milk in this study was less than the report of from all crossbred dairy cows by Debebe who reported that, a minimum of 8.3 ± 0.30% and a maximum of 8.7 ± 0.36% from street-vendors and milk producers in and around Addis Ababa, Deresse 8.89% in West Shoa Zone Oromia region and Teklemicheal 8.75% in Dire Diwa [11,15,18]. According to European Union quality standard for unprocessed whole milk solid-not-fat content should not less than 8.59% [19]. The current result was slightly less than the EU quality standard. The difference might be different in feeding practices, season, milking method and lactation period exerted.

Protein contents

Protein contents of milk were 2.7 ± 0.052% and 3.01 ± 0.058% in winter and summer season, respectively with overall average 2.83 ± 0.06%. The protein content of milk was significantly (P<0.01) affected by seasons. It was also significantly (P<0.05) affected by stages of lactation in winter season. The current result was lower than the previous study report by O'Connor and Deresse 3.1% and 3.67% respectively [6,15]. According to Food and Drug Administration (FDA) protein contents of whole milk is 2.73% [17]. Similarly, European Union quality standard for unprocessed whole milk, total protein content should not be less than 2.9% [19]. The difference might be variability among breed of cow, with in a breed, feeds and stage of lactation. Therefore the average protein content in this study was within the recommended standards set.

Lactose content

Lactose content in this study was 4.3 ± 0.074% and 4.44 ± 0.071% in winter and summer season, respectively with overall average result 4.28 ± 0.08%. The lactose contents of milk was significantly (P<0.001) affected by seasons. However, it was not significantly affected by stages of lactation as shown in Table 1. This result was much less than the previous study report of Bekele 5.07% obtained from urban and peri- urban area of Dangila town Amhara region

but, in some extent comparable with the report of Derese (2008) 4.52% and 4.37% in urban and peri- urban area, respectively in west Shoa zone Oromia region [15,20].

Ash contents

The Ash contents milk in this study was 0.6 ±0.014% and 0.66 ± 0.012% in winter and summer season respectively, with overall mean 0.63 ± 0.01%. The ash contents of milk was significantly ($P<0.001$) affected by seasons. However, it was not significantly affected by stages of lactation as shown in Table 1. This result was lower than the previous study report of Deresse 0.70% and Asamnew 0.70 in Bahir Dar milk shed [15,21]. But, it was slightly greater than Shibru and Mekasha (2016) 0.59 + 0.09% and Nigusu and Yoseph 0.6% [16,22].

CONCLUSION

The results obtained in this study indicate high variability in most milk composition traits indifferent season. However, most milk composition traits were not significantly affected by stages of lactation. In general, many factors besides nutrition and management can influence milk composition and quality. This is an important point to remember when evaluating the milk quality and in the improvement of milk yield and composition. Therefore, the qualities of milk from the Zebu × HF crossbred cows met the required standard. Hence, it was revealed that the Zebu × HF crossbred animal was the best performer regarding the milk composition and quality.

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