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Proximate Composition and Fatty Acid Profile of Beef from Arsi, Borana and Harar Cattle Breeds in Oromia National Regional State, Ethiopia

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Abstract

This study was conducted to determine proximate composition and profile of fatty acid of beef from Arsi, Borana and Harar Cattle breeds in Ethiopia. A total of 39 bulls with three age categories were used for the study. The bulls were purchased from mixed crop livestock system (Arsi and Harar cattle breeds) and Ranch (Borana cattle breed). Complete randomized design was used for the study. *Longissimus dorsi* muscle was used to evaluate proximate composition and profile of fatty acid. The result of the study indicated that mean of percentage of dry matter, ash, crude fat and crude protein were ranging 22.43 - 24.26, 0.32 - 1.28, 4.32 - 7.88, 17.21 - 22.76, respectively. At age younger than 3 years, Harar bulls contain more crude fat compared to Arsi bulls while the vice versa was true for crude protein. The concentration of polyunsaturated fatty acid (PUFA) was higher than saturated fatty acid (SFA) in the three breeds studied across all age categories. However, significantly higher ($P < 0.01$) PUFA and lowest ($P < 0.05$) SFA found in Harar breed whereas the opposite hold true for Arsi bulls. Ratio of n-6: n-3 in the muscle of bulls under the study was ranged from 2.10 to 2.57. Concentration of PUFA and MUF in muscle of the three breeds were significantly affected ($P < 0.05$) by age. From the study it was concluded that Arsi, Boran and Harar bulls under the three age categories contained more than 3% minimum crude fat that is required to insure palatability of the beef. The higher concentration of PUFA over SFA in all breeds across age categories indicated that the meat from these cattle breeds has less risk hazard to human health. However, a

strategy needs to be developed to increase the ratio of n-6: n-3 to the nutritional recommendations by the World Health Organization which is 4:1 to 5:1. Moreover, the cause of the difference in proximate composition and profile of fatty acid between breeds under the study at different age categories needs to be investigated.

Keywords

Crude Fat, Fatty Acid Profile, Beef

1. Introduction

Beef is the best source of animal proteins, micronutrients, and B-complex vitamins in the human diet. The chemical composition of meat is an important factor determining both its nutritional value and its suitability for processing meat products [1]. The amount of fat in beef is the source of juiciness and marbling which are some of basic parameter that determines the eating qualities of meat. However, excessive fat content is undesirable by consumers as it is associated with the risk of cardiovascular problems. Fat deposits in meat can be categorized as saturated fatty acids (SFAs) and unsaturated fatty acids (PUFA). The proportion of these two categories of fat has human health implications. SFAs are related to the increased level of cholesterol in blood stream and, consequently, with coronary heart disease and cardiovascular disease [2]. The higher fatty acid in meat is accompanied by a higher proportion of SFAs and a lower PUFA percentage [3]. Polyunsaturated (PUFA) or monounsaturated fatty acids (MUFA) are known to have cholesterol-lowering properties, thereby limiting the risk of coronary problems [4].

Fatty acid profile and proximate composition of meat vary can be influenced by breed, feed, age and sex of animal [4] [5]. Age of animal and breed in particular influence the concentration of MUFA in beef by affecting Stearoyl-CoA Desaturase (SCD) gene expression and activity [6]. In ruminants, the fatty acid profile is not only a reflection of FA composition in the feed but also the result of complicated reactions of bio-hydrogenation precipitated via rumen microorganisms [7] [8]. The dominating SFAs in cattle fat are myristic (C14:0), palmitic (C16:0), and stearic (C18:0) acids (Lawrie, 2005; Antunes de Lemos *et al.*, 2017). The ratio of n-6:n-3 fatty acids is the most essential nutritional indices regularly used to describe fatty acid composition of ingredients [9]. The optimum ratio required in human diet was reported as 2 - 5:1 [10].

Few studies were conducted to evaluate qualities of beef in Ethiopia and reported difference in instrumental tenderness and sensory characteristics of beef from Arsi, Bale, Boran and Harar cattle breeds [11] [12]. However, the cause for the difference in eating quality was not investigated. The role of fatty acid composition and profile on the quality of beef and a healthy diet was well documented. Therefore, this study was conducted to determine proximate composition and fatty acid profile of beef from Arsi, Borana, and Harar cattle breeds un-

der different age categories.

2. Materials and Method

2.1. Description of the Study Areas

The animals were purchased from West Arsi Zone (Kofelle), Borena Zone (Yabello), and West Hararge Zone (Chiro), Ethiopia. West Arsi Zone is located 250 km south of Addis Ababa/Finfinnee, the capital city of Ethiopia and is found in the Rift Valley Region (**Figure 1**). The mean annual temperature ˚C of the zone is found between 20˚C - 25˚C. Kofale district is located 280 km south of Addis Ababa/Finfine, the capital city of Ethiopia and located at 7˚19'N to 7˚40'N and 38˚30'E to 38˚53'E. It has an erratic type of bimodal rainfall. West Hararge zone is found 326 km east of Addis Abab/Finfinnee, the capital city of Ethiopia. West Hararge zone is located at 8˚40'0''N, 40˚30'0''E and altitude between 970 and 1410 meters above sea level. The annual rainfall ranges (include from or between) 650 - 950 mm and means temperature range (include from or between) 17.5˚C - 27˚C. Mixed crop livestock production is practiced in Arsi and Hareghe regions. Grazing and crop residue are the major feed resource in these regions.

Borana Zone of Yabello district and is situated about 550 km south of Addis Ababa/Finfinnee, the capital city of Ethiopia and 20 km north of Yabello town. Borana zone is semi-arid with an average rainfall ranging (include from) 300 - 600 mm and an average daily temperature of 19˚C to 26˚C. The zone is located at 4˚53'N 38˚5'E. Extensive grazing on natural pasture dominated by perennial grasses (*Cenchrus*, *Pennisetum*, and Chrysopogoies) species is practiced in this area. The area has a bimodal rainfall distribution with the long rains extending from March to May and short rains from September to November.

2.2. Experimental Animals

A total of 39 bulls from three breeds of cattle namely, Harar, Arsi and Borana were used for the study. Bulls were purchased from their niche market. Harar and Arsi bulls were purchased from Chiro and Kofale local markets, respectively. Borana bulls were purchased from Yabello (Didu Tiyura) Ranch. The bulls were categorized into three age groups that include <3, 4 - 6 and 7 - 9 years. Ages of the bulls were determined based on dentition. After purchased individual bulls were ear tagged and transported by vehicles to Elfora abattoir at Bishoftu for slaughter in May 2018.

2.3. Slaughter Procedure and Sampling

After lairage rest pre-mortem examinations were taken immediately before slaughter. Bulls were slaughtered by enervation method. After bleeding, flying of the hide, and removing the viscera. Postmortem examinations were made by veterinarians at the abattoir to identify whether the carcass was diseased, influenced with a condition that may display a risk to human wellbeing and remains that might be unpleasant to the buyer. After sawed into right and left half, the

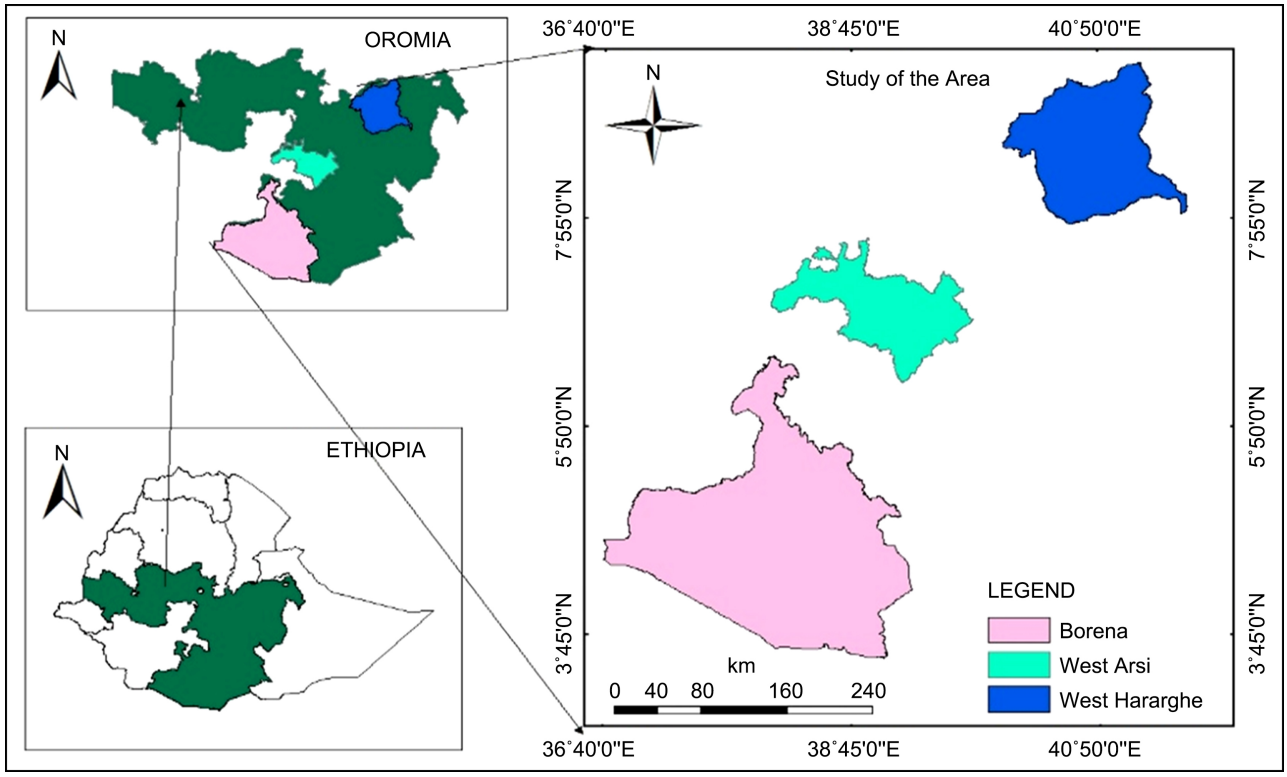

Figure 1. Map of the study area.

carcass was chilled for 24 hours at 4˚C. After chilling, the left sides of each carcass were sawed at the 12th and 13th ribs to take beef samples for fatty acid profile and proximate composition determination from the *Longissimus dorsi* muscle.

2.4. Determination of Fatty Acid Profile and Proximate Composition

2.4.1. Fatty Acid Profile Determination

The meat was dried at temperature of 60˚C for 72 hours using an oven according to the standard meat drying method [13]. After drying, the meat size was reduced by grinder followed by fat extraction [14]. Ten g of sample was homogenized with 75 mL of dichloromethane: methanol (2:1, v/v). The mixture was centrifuged (10 min, 3000 rpm) and filtered. This procedure was repeated three times. The three filtrates were transferred to a graduated cylinder and a volume of about 50 mL KCl 0.88% in distilled water was added. The mixture was shaken vigorously. The final biphasic system was decanted, and the upper aqueous phase was eliminated. The lower organic phase was filtered through anhydrous sodium sulphate and collected. Lipid content was then recovered after solvent was evaporated with a rotary evaporator under vacuum.

The esterification reactions of the fatty acids were carried out according to the methodology of [15]. Primarily, about 100 mg of lipid extract was weighed in a test tube, after that 4 mL of NaOH/MeOH 0.5 mol was added. Then, the tube was heated in a water bath for 5 min with subsequent cooling under running

water. About 5 mL of esterifying reagent (NH_4Cl/H_2SO_4/MeOH) was added to the same tube, and the system was once again heated in a water bath for 5 min and cooled under running water. The mixture was transferred to a separatory funnel, then it was added 4 mL of saturated NaCl solution and vigorously shaken for 30 s. After that, 5 mL of hexane was added and vigorously shaken for 30 s. Finally, the internal standard (23:0 Me) was added, and after phase separation the supernatant was collected at Adama Science and Technology University.

The Gas Chromatography (GC) was operated based on the standard procedure [16]. The injector was held at 250˚C fitted with sitlek deactivated split/splitless liner packed with glass wool (Restek, Bellefonte, PA). The column head pressure was 195.6 kPa and a total flow rate of 129.1 mL/min (Column flow: 2.47 mL/min and Purge flow: 3.0 mL/min). One microliter of the sample was injected with a split ratio of 50:1. The oven method was as follows: 35˚C held for 2 min, increased to a temperature of 170˚C at the rate of 4˚C/min, held for 4 min, then increased to a temperature of 240˚C at the rate of 3.5˚C/min, held for 7 min. Hydrogen was used as the carrier gas. The FID was operated at 250˚C. Fatty acids were identified based on the similarity of retention times with the GC reference standards (Nu-chek Prep, Inc., Elysian, MN). Finally, 39 beef samples were analyzed for fatty acid profile both at Addis Ababa University and Ethiopian leather development institute.

2.4.2. Determination of Proximate Composition

Samples from *L. dorsi* muscle were thawed for 24 - 48 hours at 4˚C - 8˚C. All exterior muscles, connective tissue and external fat were removed leaving only the *Longissimus thoracis* muscle. Samples were cubed, submerged in liquid nitrogen for rapid freezing, placed in a blender (VITA-MIX Corp, Cleveland, OH; model # VM0100A) and ground to form beef homogenates. Grinded/powdered samples were double packed in VWR sample bags (BPR-4590 VW1, Radnor, Pennsylvania) and stored at −80˚C for subsequent analysis [17]. A total of 39 beef samples were analyzed for proximate analysis in National Veterinary Institute (NVI) Bishoftu. For each parameter approximately 5 g of lean meat was taken from *Longissimus dorsi* muscle (eye rib area).

1) Fat content

Soxhlet method of solvent extraction of fat was determined according to AOAC standard procedure [18]. About 2 g milled samples were measured into an extraction thimble lined with fat free cotton. Then the thimbles with the samples were attached to the extraction apparatus. The aluminum cup with a boiling cheep was placed in the oven at 100˚C for 30 minutes and cooled to room temperature in the desiccators for 30 minutes then the cup weight was measured using a digital balance and recorded as W1 (weight of cup), then 50 ml of diethyl ether was added into each cup, after which set up of the extraction apparatus was done.

The samples contained in the thimbles were soaked for about 1 hour by lifting the thimble down into the cup, started from the apparatus hot plate temperature

reached 55˚C, after soaking the thimbles were lifted up and the extraction process takes place for 5 hours. Then the recycling process made by the diethyl-ether was stopped to let the solvent evaporate from the aluminum cup with the extract, in the process the evaporated solvent was recovered in the apparatus. Then aluminum cup and the content were dried in the oven for 30 minutes at 100˚C to evaporate the remaining solvent in the cup. After drying, it was removed from the oven and cooled in the desiccators for 30 minutes then weighed and recorded as W_2 (cup + fat).

The percentage of fat was calculated using the following formula

$$\text{Fat}(\%) = \frac{[\text{W2} - \text{W1}]}{\text{Sample Weight}} \times 100$$

2) Dry Matter

Pre-weighted muscles from the left sides were dried at 55˚C for 72 hours for the ease of grinding. After recording partial dry matter (PDM), the meat samples were grinded to pass a 1 mm sieve screen and stored in air tight plastic bags and put at 4˚C pending chemical analysis. From a partially dried ground sample, 3 g was weighed into a pre-weighed crucible dish and then dried overnight at 105˚C in a forced draft oven for determination of laboratory dry matter. Then the DM was calculated as:

$$\text{DM} = \frac{\text{PDM}}{100} \times \frac{\text{Lab.DM}}{100} \times 100$$

where, DM is Dry matter, Lab.DM is Laboratory Dry Matter.

3) Ash

Ash was determined according to the AOAC standard procedure [19]. Two gram ground meat sample was placed into a dried crucible with known weight. The crucible was placed inside a muffle furnace at 150˚C. Temperature was increased gradually till it reached 600˚C and heated at that temperature for 3 hrs. Then the crucible was taken out, cooled into a desiccator and weighed. The ash percentage was calculated as

$$\text{Ash}(\%) = \frac{\text{Crucible weight containing incinerated meat} - \text{empty crucible weight empty}}{\text{Meat sample weight before incineration}} \times 100$$

4) Crude protein

For determination of crude protein Kjeldhal method of AOAC standard procedure [19], Crude protein was obtained by multiplying the amount of nitrogen by 6.25. The sample was weighed in a Kjeldhal flask. Half a tablet of catalyst mixture (10 parts) of K_2SO_4 to 1 part of $CuSO_4$ was added (10 ml). 25 ml Concentrated H_2SO_4 was added. The content of the flask was digested under boiling at maximum heat for 2 hours. The flask was cooled and transferred to the distillation unit. The sample was distilled using 40% NaOH solution and received in 4% Boric acid. The content was titrated against 0.1 M HCl.

$$\text{Crude protein\%} = \frac{(\text{mL HCl for sample} - \text{mL HCl for blank})}{\text{Weight of sample}} \times 0.1 \times 14 \times 3.38 \times 100$$

2.5. Experimental Design

A factorial arrangement with two factors (age and breed) in the CRD (Completely Randomized Design) was used for the study. The treatment composition was indicated in Table 1.

2.6. Statistical Analysis

The data were analyzed by the procedure of General Linear Model (GLM) using SAS software [20]. When the GLM showed the presence of significant difference between the different parameters, the Duncan's multiple range tests were used for mean separation.

The model used for the analysis was:

$$Y_{ijk} = \mu + \beta_{1i} + \beta_{2j} + (\beta 1\beta 2)ij + e_{ijk}$$

where,

Y_{ijk} = the response variables,

μ = the overall mean,

β_{1i} = the effect of age,

β_{2j} = the effect of breed,

$(\beta 1\beta 2)ij$ = The effect of interaction between age and breed and,

E_{ijk} = Random error.

3. Results and Discussion

3.1. Proximate Composition of Beef from Arsi, Borana and Harar Cattle Breeds

Proximate composition of beef from Arsi, Borana and Harar cattle breeds across different age categories are presented in Table 2. Mean of DM, Ash, CF and CP ranged from 22.43 - 24.26, 0.32 - 1.28, 4.32 - 7.88, 17.21 - 22.76, respectively. DM content was comparable across age categories of the three breeds under the study. The DM percentage in the present study was comparable to some other studies [21] [22] who reported mean DM percentage of 24.2% and 25.51%,

Table 1. Treatment composition.

Cattle Breeds	Age (Years)			Total
	<3	4 to 6	7 to 9	
Arsi	5	3	3	11
Borana	5	5	4	14
Harar	5	5	4	14
Total	15	13	11	39

Table 2. Proximate composition of beef from Arsi, Borana and Harar cattle breeds across different age categories.

Parameters (%)	Age (year)	Breeds			P value
		Arsi	Borana	Harar	
		Mean ± SD	Mean ± SD	Mean ± SD	
DM	<3	23.26 ± 0.71	22.43 ± 0.35	22.27 ± 1.16	NS
	4 - 6	23.44 ± 0.36	22.93 ± 0.63	23.61 ± 0.55	NS
	7 - 9	23.35 ± 0.29	23.06 ± 1.87	24.26 ± 1.65	NS
Ash	<3	1.1 ± 0.07	0.67 ± 0.26	0.63 ± 0.33	NS
	4 - 6	1.28 ± 0.14^{a}	0.90 ± 0.47^{a}	0.32 ± 0.02^{b}	**
	7 - 9	1.28 ± 0.21^{a}	0.67 ± 0.22^{b}	0.56 ± 0.13^{b}	**
CF	<3	4.32 ± 0.14^{b}	4.81 ± 0.59^{ab}	5.58 ± 0.45^{a}	*
	4 - 6	6.48 ± 0.32	5.82 ± 0.58	6.27 ± 0.30	NS
	7 - 9	6.97 ± 0.11^{b}	7.79 ± 0.24^{a}	7.88 ± 0.10^{a}	***
CP	<3	22.76 ± 1.04^{a}	20.88 ± 0.54^{b}	20.52 ± 0.53^{b}	*
	4 - 6	19. 27 ± 0.87	19.31 ± 0.51	19.32 ± 0.05	NS
	7 - 9	17.21 ± 0.26^{b}	18.46 ± 0.35^{a}	18.73 ± 0.38^{a}	**

^{abc}Means bearing different superscripts are significantly different, ***p < 0.0001, **P < 0.01, *P < 0.05, NS = Non Significant, SD = Standard deviation, DA = Dry Matter, CF = Crud Fat, CP = Crud Protein.

respectively. Difference in ash composition was observed for bulls above 4 years of age. Beef from Harar bulls above 4 years of age contains lower (P < 0.05) ash percent compared to ash content in beef from Arsi and Borana bulls. Similar to the present study, higher (0.997) value of ash composition was reported for Arsi breeds at 5 - 6 years of ages [22].

The amount of ash, crude fat (CF) and crude protein (CP) were significantly different between breeds. Similarly, a study had reported the presence of significant difference in protein, fat, ash and moisture content of beef across the breeds [23]. Besides, another study had reported difference in fatty acid compositions between breeds [24]. The CF content of beef of all the breeds under the study can be considered as a good contributor to palatability of the beef as minimum of 3% fat is suggested to ensure acceptable palatability of beef [25]. The increase in CF in all breeds under the study as the age of the bulls increase can be explained by the well accepted fact that fat accumulation increase as the animal advanced in age. CF in age categories between 4 and 6 years was similar in all breeds. However, the significant difference in CF was observed below 3 and above 7 years of age. Harar bulls less than 3 years of age deposited higher (P < 0.05) CF percentage in its meat compared to CF of meat from Arsi bulls. Meat from Arsi bulls at age 7 - 9 years contained lower (P < 0.05) mean fat percentage

compared to the CF of meat from Borana and Harar bulls. Similar fat percentage for Arsi breed in age categories between 7 - 8 years which was 6.86% was similarly reported in another study [22]. But, in contrast to the present fining, a study had reported 5.4% mean fat percentage for Arsi breeds [26].

CP content was similar for the three breeds in an age category between 4 and 6 years. However, at age less than 3 years, Arsi bulls contained higher ($P < 0.05$) CP compared to the CP of meat from Borana and Harar bulls in the same age categories. The higher protein content of Arsi bulls was similar to another finding [28] [37] who reported 22.64% and 22.06% for Brazil cattle and Nellore steers, respectively. The result of the present study in respect to CP implied that Arsi breed is better for red meat production at an age younger than 3 years as the percentage protein decreased with advance in age. The higher protein content in the meat of Borana and Harar bulls was comparable with another finding which was reported as 18.1% [29].

3.2. Fatty Acid Profile of Beef from Bulls of Arsi, Borana and Harar Cattle Breeds

Fatty acid profile of beef from bulls of Arsi, Borana and Harar cattle breeds is presented in **Table 3**. The concentration of PUFA was higher than SFA in all breeds across age categories. This indicated that consumption of meat from these cattle breeds has less health hazard to human. This might be as a result of genetic or environmental factors. Breeds had significantly ($P < 0.01$) affected the PUFA in the present study. The muscle of Harar cattle breed had significantly ($P < 0.01$) higher (52) PUFA in longissimus muscle while the muscle from Arsi bulls had the lowest (32). Despite the less health risk of fat from beef from the three breeds under the study, the abundance of PUFA in Harar cattle breed compared to Arsi indicate that fat from Harar cattle breeds has more cholesterol-lowering properties compared to Arsi breeds. However, the breed cannot directly be implicated for the difference in PUFA as the three breeds were managed under different environments before slaughter. Harar cattle breed was managed under Hararghen fattening system where forage based on cut and carry was the major source of feed while Arsi breed depends on grazing and Boran under ranch condition. The difference in PUFA among breeds can also be explained by genome expression. Variations amongst breeds seem to be linked or associated with differences in the genome and expression of proteins, which intervene in the extent and kinds of fat deposition [30]. The higher PUFA over SFA in the three breeds under the study indicated that the beef from breeds of cattle under the study had positive impact on human health. The probable reason for higher PUFA content in tissues of beef from the studied breeds might be the dependence of these bulls mainly on pasture as a feed resource. Since 25% increase in polyunsaturated fatty acids (PUFA) has been linked as the response of grass feeding [31] [32]. On the other hand, more abundant PUFA in beef is located in the phospholipids of muscle membranes [31] [32] which indicate most of their beef were lean meat.

Table 3. Fatty acid profile of beef from bulls of Arsi, Borana and Harar cattle breeds.

Factors	Fatty Acid					
	PUFA	MUFA	SFA	n-3	n-6	n-6:n-3
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Breed	**	***	***	NS	**	NS
Arsi	32.87 ± 22.41^{b}	20.15 ± 11.1	22.79 ± 11.13^{a}	18.65 ± 4.39	37.41 ± 11.39	2.17 ± 1.01
Borana	40.77 ± 17.89^{ab}	17.08 ± 28.88	20.15 ± 8.79^{ab}	17.31 ± 2.12	35.99 ± 16.57	2.10 ± 0.95
Harar	52.20 ± 18.52^{a}	12.37 ± 6.74	16.03 ± 7.98^{b}	18.61 ± 1.94	48.28 ± 14.70	2.57 ± 0.65
Age	***	*	NS	*	NS	NS
A × B	NS	***	NS	***	***	***

^{abc}Means bearing different superscripts are significantly different, ***P < 0.0001, **P < 0.01, *P < 0.05, NS = Non Significant, SD = Standard deviation, PUFA = Poly-Unsaturated Fatty Acid, MUFA = Mono-Unsaturated Patty Acid, SFA = Saturated Fatty Acid, n-3 = Omega three fatty acid and n-6 = Omega six fatty acid, A × B = Age × Breed.

In all cattle breeds studied there was no significant difference (P > 0.05) in MUFA content across the age categories. The highest and lowest mean SFA accumulations were 22.79 and 16.03, respectively. Muscle tissue from Arsi bulls has significantly higher (P < 0.05) SFA accumulation than muscle tissues from Harar bulls. The ratio of n-6: n-3 fatty acids is the most essential nutritional indices regularly used to describe fatty acid composition of ingredients [33]. There were no variations (P > 0.05) in n-3, n-6 and n-6: n-3 across breeds of cattle under the study. Ratio of n-6: n-3 ranged from 2.10 to 2.57 in the present study. Similarly, studies reported a ratio of n-6: n-3 to range from 2.28 to 2.68 [35] and a ratio of about two for animals fed grass containing high levels of PUFA n-3 [34]. The optimum ratio required in human diet was reported as 2 - 5:1 [10]. However, the ratio of n-6: n-3 in the present study was lower than the nutritional recommendations by the World Health Organization [36] that was suggested to increase consumption of n-3 PUFA, ideally to achieve an n-6:n-3 ratio between 4:1 and 5:1. The lower concentrations ratio of n-6:n-3 for Borana breed may be associated with the grass and pasture feed available in the ranch where the breed was managed. Similarly, a study reported lower (2.1) concentration of n-6: n-3 ratio in muscle of cattle depend on grass and pasture as feed resources [37]. Arsi bull was found to contain more SFA than Borana and Harar. PUFA and MUF were significantly affected (P < 0.05) by Age. This might be as a result of genetic or environmental factors. Although SFA from beef contributes significantly to increased circulating cholesterol concentrations in humans, fats rich in stearic acid do not have this characteristic. Soon after its ingestion, this fatty acid may be converted rapidly into oleic acid (C18:1), preventing an increase in serum cholesterol [38].

3.3. Types of Saturated and Unsaturated Fatty Acid in Beef from Arsi, Borana and Harar Bulls

Saturated, mono unsaturated and poly unsaturated fatty acid composition of

beef in Arsi, Borana and Harar bulls are presented in **Table 4**. Myristic acid, palmitic acid, stearic acid and pentadecanoic acid were the major SFA in the beef of cattle under the study. Similarly, a study reported the dominant SFAs in cattle fat as myristic (C14:0), palmitic (C16:0), and stearic (C18:0) acids [39]. The age and breeds of cattle had a significant influence ($P < 0.05$) on fatty acid profiles in the present study. Beef from Harar bulls in age categories 3 - 6 years exhibited significantly low ($P < 0.05$) myristic acid compared to Arsi bulls and Borana bulls of the same age categories. In the same age categories, beef from Boran bulls had significantly lower myristic acid over beef from Arsi bulls. However at later age (7 to 9 years) Borana had contained higher ($P < 0.05$) Myristic acid content than Arsi and Harar. The difference can be explained by the feeding system the breeds were managed. Harar cattle was managed under Hararge fattening system where farmers utilized maize and sorghum Stover as a dominant feed resource for cattle fattening both in dry and wet seasons [40]. The less Myristic acid concentration of Harar breed implied that its consumption has less risk in raising serum cholesterol concentration in human beings, since the presence of Myristic acid concentration in beef associates with human health with cardiovascular disease and obesity, by influencing cholesterol blood levels [41].

The Palmitic acid concentration in beef cattle in the present study ranges from 19.18 to 11.75. Less value was reported (18.42 mg/g) for grass fed crossbred steers and higher value was reported (26.9 mg/g) for mixed cattle production [42] [43]. Proportion of Stearic acid was similar between breeds except in age categories between 4 and 6 years. At 4 - 6 years age category Arsi breeds deposited higher ($P < 0.05$) Stearic acid than Borana breeds. In agreement to the present finding a study reported lower (19.47) concentrations of Stearic acid for young Simmental bulls [44]. Stearic acid is a neutral fatty acid in affecting blood cholesterol levels because it is converted into Oleic acid in the organism without affecting the blood cholesterol levels [45] [46]. Oleic acid depositions of the three cattle breed ranged from 3.67 to 33.91. Across all age categories Arsi deposited higher ($P < 0.05$) Oleic acid than Borana and Harar while there was no variation observed between Borana and Harar across all age categories. The higher Oleic acid concentration of Arsi breeds is in line with the finding who reported 30.86 for Simmtental cattle breed [47]. The lower Oleic acid concentration of Borana (4 - 9 years) might be related to feeding system practiced with the breed as the breed was foraging in the ranch. Increasing dietary forage decreases Oleic acid concentration [6] [48]. On the other hand the variation in Oleic acid concentration among bulls might be due to genes (Stearoyl-CoA desaturase and its activity) since Stearoyl-Coa desaturase (SCD) is genes associated with fatty acid composition of beef [8]. Further investigation need to be conducted to specifically identify the cause of the difference in the oleic acid in fat of the three cattle breeds.

Pentadecanoic acid was observed in fat from Arsi and Borana bulls at an age younger than 3 years of age and in all breeds older than 7 years of age. Petroselinic acid was only deposited in Borana at 4 - 6 years category.

Table 4. Saturated, mono unsaturated and poly unsaturated fatty acid composition of beef in Arsi, Borana and Harar bulls.

Type of Fatty Acid	Fatty acid (mg/g)	Age (year)	Breed			P value
			Arsi	Borana	Harar	
			Mean ± SD	Mean ± SD	Mean ± SD	
SFA	Myristic acid	<3	27.61 ± 4.34[a]	21.40 ± 1.05[b]	12.04 ± 2.36[c]	***
		4 - 6	34.13 ± 0.30[a]	26.40 ± 0.47[b]	11.86 ± 2.77[c]	***
		7 - 9	14.71 ± 0.67[b]	31.41 ± 0.61[a]	17.53 ± 4.41[b]	**
	Palmitic acid	<3	19.18 ± 10.54	12.98 ± 5.09	12.63 ± 0.49	NS
		4 - 6	16.80 ± 6.87	11.75 ± 1.21	13.42 ± 1.97	NS
		7 - 9	16.46 ± 1.76	16.19 ± 3.99	14.85 ± 1.78	NS
	Stearic acid	<3	27.76 ± 7.61	29.81 ± 12.44	19.04 ± 9.83	NS
		4 - 6	42.51 ± 0.73[a]	21.64 ± 2.70[b]	32.90 ± 11.00[ab]	*
		7 - 9	23.98 ± 6.08	19.60 ± 7.37	13.95 ± 1.59	NS
	Pentadecanoic acid	<3	4.79 ± 5.63	1.27 ± 2.20	ND	NS
		4 - 6	ND	ND	ND	NS
		7 - 9	1.0. ± 1.78	2.37 ± 4.10	1.39 ± 2.41	NS
MUFA	Oleic acid	<3	11.55 ± 1.26[a]	5.51 ± 0.70[b]	3.67 ± 2.40[b]	**
		4 - 6	28.51 ± 4.00[a]	9.95 ± 2.49[b]	12.21 ± 1.40[b]	**
		7 - 9	33.91 ± 9.33[a]	12.04 ± 1.67[b]	20.74 ± 0.60[b]	**
	Palmitoleic acid	<3	8.51 ± 7.94	3.80 ± 6.58	ND	NS
		4 - 6	4.63 ± 8.03	ND	ND	NS
		7 - 9	6.93 ± 7.46	45.32 ± 58.89	8.71 ± 7.55	NS
	Petroselinic acid	<3	ND	ND	ND	NS
		4 - 6	ND	12.75 ± 11.07	ND	NS
		7 - 9	ND	ND	ND	NS
	Elaidic acid	<3	7.06 ± 2.23	7.71 ± 0.32	7.38 ± 0.31	NS
		4 - 6	13.13 ± 0.24[b]	19.28 ± 0.81[a]	18.44 ± 0.78[a]	***
		7 - 9	9.43 ± 0.75[b]	14.37 ± 0.61[a]	15.17 ± 0.30[a]	***
PUFA	Linolenic acid	<3	23.07 ± 0.93[a]	18.85 ± 0.76[b]	20.10 ± 1.50[b]	**
		4 - 6	14.14 ± 0.51[b]	17.75 ± 0.42[a]	18.93 ± 1.41[a]	**
		7 - 9	18.74 ± 4.02	15.32 ± 2.73	16.80 ± 1.57	NS
	Arachidonic acid	<3	36.43 ± 2.5[c]	53.70 ± 0.85[b]	61.66 ± 5.24[a]	***
		4 - 6	25.21 ± 5.19[a]	15.77 ± 1.61[b]	30.37 ± 0.81[a]	**
		7 - 9	50.59 ± 0.81[a]	38.50 ± 1.31[b]	52.80 ± 7.54[a]	**
	Linoleic acid	<3	11.44 ± 0.89[c]	24.60 ± 4.33[b]	36.54 ± 5.52[a]	***
		4 - 6	25.81 ± 2.98[b]	45.49 ± 5.57[a]	47.83 ± 2.78[a]	***
		7 - 9	67.76 ± 5.77[b]	66.58 ± 6.68[b]	83.99 ± 2.26[a]	**

[abc]Means bearing different superscripts are significantly different, ***P < 0.0001, **P < 0.01, *P < 0.05, NS = Non Significant, SD = Standard deviation, ND = Not Detected.

Elaidic acid is an unsaturated trans fatty acid, with code C18:1 trans-9. This compound has trans fats which have been implicated in heart disease. It is the trans isomer of oleic acid. It is more similar to the saturated stearic acid than it is to oleic acid. The proportion of the acid was significantly lower ($P < 0.05$) Arsi bulls in age over 4 years compared to the same age categories of Borana and Harar breeds.

Linolenic acid concentrations of three breeds ranged from 14 to 23. Age of the bulls significantly affected the concentration of Linolenic acid except for the age group above 7 years of age in the present study. A study reported higher (29.5) Linolenic acid concentration compared to the present study [49]. At a lower age category (<3 years) Arsi breed deposited higher ($P < 0.05$) Linolenic acid than Borana and Harar. In addition, Arsi breed (4 - 6 years) deposited less ($P < 0.05$) Linolenic acid than Borana and Harar.

Arachidonic acid belongs to the omega-6 (n-6) polyunsaturated fatty acids (PUFA) and one of the important fatty acids that form an important constituent of cell membranes [50]. At lower age category (<3 years) Harar deposited higher ($P < 0.05$) Arachidonic acid than Arsi and Borana breeds. At 4 - 6 and 7 - 9 years Borana deposited less ($P < 0.05$) Arachidonic acid than Arsi and Harar. The less deposition of Arachidonic acid in Borana breed might be due to consumption of n-3 PUFA.

Harar bulls younger than 3 years and age categories from 7 - 9 years deposited higher ($P < 0.05$) Linoleic acid than Arsi and Borana breeds in similar age categories. At 4 - 6 and 7 - 9 years, Harar showed significantly higher ($P < 0.05$) Linoleic acid concentration than Arsi breed. The higher concentration of linoleic acid content in beef from Harar bulls might be associated with the the feeding practice in Hararghen fattening system where vegetable products incorporated into their feed. The abundance of this acid in beef of Harar bulls can contribute in reduction of carcinogenic effect of conjugated linoleic acid in human compared to the concentration of the acid in beef of bulls from Arsi and Borana.

4. Conclusion and Recommendations

From the study it was concluded that Arsi, Boran and Harar bulls under the three age categories contained more than 3% minimum crude fat that is required to insure palatability of the beef. The higher concentration of PUFA over SFA in all breeds across age categories indicated that the meat from these cattle breeds has less risk hazard to human health. Age and breeds of cattle had significant influence ($P < 0.05$) on proximate composition and fatty acid profiles. However, a strategy needs to be developed to increase the ratio of n-6:n-3 to the nutritional recommendations by the World Health Organization which is 4:1 to 5:1. Moreover, the cause of the difference in proximate composition and profile of fatty acid between breeds under the study at different age categories needs to be investigated. Proximate composition and fatty acid profile of bulls in the present study were the sum effect of production systems and genetics. Evaluation for the

same parameter is suggested after finishing the breeds under similar feeding conditions. The absence of females and steers for the same breeds in the present study can be considered as some of the limitations of this study.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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