



Birmaduma Gadisa^{1*}, Yesihak Yusuf² and Mohammad Yousuf²

¹Mechara Agricultural Research Center P. O. Box 19, Mechara, Ethiopia

²Haramaya University P.O. Box 138, Dire Dawa, Ethiopia

Received: 18 February, 2019

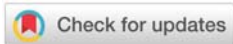
Accepted: 14 May, 2019

Published: 15 May, 2019

***Corresponding author:** Birmaduma Gadisa, Mechara Agricultural Research Center P. O. Box 19, Mechara, Ethiopia, Tel: +251910462545, +251986330181; E-mail: birmaduga@gmail.com

Keywords: Beef; Breeds; Ethiopia; Instrumental tenderness; Sensory panel testing

<https://www.peertechz.com>



Research Article

Evaluation of Eating Quality in Sensory Panelist and Instrumental Tenderness of Beef from Harar, Arsi and Bale Cattle Breeds in Oromia, Ethiopia

Abstract

Meat is one of the most nutritious animal products that humans can consume, particularly in terms of supplying high-quality protein, minerals and essential vitamins. Hence, the demand for meat is not only quantity wise, but also quality wise. The objective of this study was evaluate eating qualities of beef produced at public abattoirs from Arsi, Bale and Harar cattle breeds with semi-trained sensory panel evaluation and instrumental tenderness. To know the status of meat produced for domestic market in relation with globally demands. The samples were collected from the longissimus dorsi region between 12th and 13th ribs within 45 min after slaughters. The samples were packed in vacuum-seal and aged for 14 days to evaluate instrumental tenderness using Warner Bratzler Shear Force Device and eating quality using panel testing. Mean values of 33.12 N, 7.12, 7.2 and 7.24 were determined in instrumental tenderness, sensory tenderness, juiciness, and flavor of beef respectively. The parameters were significantly affected by age, breeds and season interactions ($P < 0.01$). Breed interaction with age and season exhibited significant variation ($P < 0.05$) on water holding capacity. Beef pH was significant affected by season. The instrumental tenderness had negative medium relationship with sensory attributes conducted for tenderness and juiciness, but positive with flavor. From this study, it was concluded that quality of beef produced in study areas was relatively tender which internationally competent but becomes tough as cattle gets older. It is recommended that strategy should be developed to encourage premium payment for young cattle marketing that is not exposed to draft service and creating awareness among stakeholders on quality beef production. As Ethiopia is planning to in the beef market in the Middle East Countries, it is highly needed to promote Ethiopian beef at international markets.

Introduction

Ethiopia has long been recognized the center of origin of diverse livestock genetic resources in both Africa and the world at large [1]. However, livestock and its products are underutilized compared to its potential in Ethiopia [2]. The annual meat per capita consumption is 8.5 to 10 kg/year and annual milk per capita consumption is 19 liters/years [3]. Meat is one of the most nutritious animal products that humans can consume, particularly in terms of supplying high-quality protein (essential amino acids), minerals (iron) and essential vitamins [4]. Hence, the demand for meat is increasing not only quantity wise but also quality wise. Consumers satisfaction is primarily based eating quality [5,6].

The most important aspect of eating quality is the function of combined effects of tenderness, juiciness, flavor, appearance and color. These eating qualities are affected by nutrition, slaughter ages, seasons, breeds, live weight, sexes, pre- and

postmortem handling [7]. In particularly, tenderness has been linked to animal's age, marbling, muscle location and aging [8]. The older animals are the tougher meat source in general [9]. The greatest tenderness and quality of beef is achieved with cattle less than 36 months of age; thereafter the meat becomes tougher [10]. Marbling (intramuscular fat) is complex trait, which is obtained from many genes, because no single factor determines a large proportion of the trait variations in the population [11,12]. It rises from white flecks of fat within the meat muscle. Beef cuts with high levels of marbling are more likely to be tender, juicy and flavorful than cuts with low levels of marbling [8].

However, mostly as age of cattle increased development of fat is increased flavors [10]. The breed of animals for slaughter is one of the key factors determining the quality of meat. In recent years, feedlots are prosperous and being engaged in the export of processed meat and live animals in Ethiopia [13]. However, different cattle breeds have different demand for

international and domestic beef consumption, especially for international market. Is there different eating quality across ages, breeds and seasons? These are the questions that need answer to properly utilize, plan to breed improvement and promote our resource for international market.

Seasonal variation affects the quality of beef cattle due to feed resources availability is closely relate with season of year [14]. Diet is the major factor influenced beef quality like sensory, physical and proximate composition [15]. Finishing diets changed ruminal biohydrogenation of polyunsaturated fatty acids without affecting the concentrations of conjugated linoleic acid in the meat. Various constituents in tissues are influenced by diet to affect flavor, but the most important are the fatty [16].

Quality of beef is associated with stress. Animal can be stressed by improper pre-slaughter handling during transport and stunning that could result in undesirable pH, which causes for pale soft excudative (PSE) and dark firm dry (DFD) meat, poor water-holding capacity and end up in poor cooking loss [17]. The DFD meat has a high ultimate pH, which exposes meat for high microbial contamination [18]. The high water-holding capacity of meat described as the ability of the post-mortem muscle to retain water.

Quality of meat can be analyzed through both instrumental and panel testing [19]. Only scant studies were conducted on eating quality of beef produced in Ethiopia using sensory panel testing. However, eating quality of beef using instrumental tenderness was not evaluated before in Ethiopia. The correlation between sensory evaluation and instrumental tenderness was not determined for Ethiopian cattle breeds. This study was design to investigate eating quality of beef produced at public abattoirs using trained sensory panelist and instrumental tenderness methods to evaluate PSE, DFD and water holding capacity (WHC) of beef from different breeds and ages of cattle slaughter for local consumption.

Materials and Methods

Meat samples collection and aging

In total 118 (48 during dry and 70 during wet season) samples were collected during dry and wet seasons from end of October to early November 2017 and mid to end June 2018, respectively. Daily slaughtered cattle were divided into age groups and breeds. Breeds and ages of cattle were deliberately selected. Breeds were identified using the phenotypic traits in combinations of coat color, confirmation, dewlap structure, ear, horn and hump type according to Rege and Tawah and DAGRIS [1,20]. The samples were collected from three breeds; *Arsi*, *Bale*, and *Harar* cattle. The *Arsi* and *Bale* breeds were collected from Adama city municipal abattoir while the samples from *Harar* breeds were collected from Haramaya community service abattoir. Age of cattle was determined using dentition according to Verification Guidelines [21,22]. For purposive of this study the age was stratified into four groups < 5, 5-7, 7-9, and > 9 years old.

The sample source cattle were tagged in the abattoir using simple random sampling technique before entering into lairage

from 2 pm to 3 pm in Adama municipality abattoir. At Haramaya University, using phenotypical traits slaughtered cattle were given identification number in hundred days staying barn prior upcoming to abattoir. The samples were collected during night time (10:00 pm to 4:00 am) from Adama abattoir and at morning (6-7 am), in Haramaya University. The samples were collected from specific location of *longissimus-dorsi* (LD) muscle between 12th and 13th ribs in abattoirs before rigor mortis. For a time the samples were store in refrigerators at respective abattoirs unfortunately both abattoirs had facilities for samples only. Then, collected samples were packed into plastic bag, sealed into vacuum packed, stored in the icebox and then transported to Oda Bultum University (OBU) laboratory at Chiro town. Vacuum-sealed samples were stored in deep freeze for 14 days before steaks were prepared for sensory and instrumental analysis.

Screening and training sensory panelists

Panelist screening: The panelists were selected from Oda Bultum University 3rd year Dairy and Meat Technology (DMT) students based on their interest, familiarity with the product and ability to understand the scales rate used in the evaluation procedures. The panelists were excluded if they were not willing to follow or accept any guidelines offered on testing methods. Based on the criteria, twelve panelists were selected. The panelists' age was between 22 and 32 years old of both sexes. The selected panelists were also checked for absence of meat allergies as well as a willingness to consume beef. Ten panelists participated directly while two were placed on reserve.

Steak preparation and sensory panelist testing

The samples were analyzed in batches. After 14 days aged samples were thawed for 24 hrs and steaks were prepared that have served for both sensory and instrumental tenderness evaluation. The steak preparation was done according to Warner-Bratzler Shear Force procedures protocol developed by AMSA [19]. Sensitive precision balance (power 2204/50Hz) model -yp10002 (China) were used for eight steaks before and after cooking. Cooking loss was calculated based on the following formula.

$$\text{Cooking loss calculate (CL)} = \frac{(\text{Initial weight} - \text{final weight})}{\text{Initial weight}} * 100$$

Sample presentation: Similar sample presentation procedures were conducted for all panelists at room temperature (24-25 °C) on metal pans plates with panelists receiving cuts from various locations. The steaks were cut uniformly to reduce any bias related to serving position and presented in white color plate randomly. Each assessor has evaluated three most important eating quality (tenderness, juiciness, and flavor) parameters. The evaluators scored each sample on a 9-point hedonic scale for tenderness, flavor, and juiciness. They were filled in three-digit of sensory codes, which indicated panelists codes, treatment codes, and sensory variables. Before actual testing, a warm-up sample was served first, and then proceeded to experimental samples steak in the next testing sessions. Between each sample tasted, biscuit and clean water were served for calibration of the panelist taste [19].

Determination of instrumental tenderness

The steak was prepared based on the procedures of AMSA [19] and cooled at room temperature for one hour prior to determine tenderness by Warner Bratzler Shear force (WBSF) apparatus as following:

1. After samples were cooled, connective tissue was removed across the long axis of the steak to expose the fiber direction.
2. Six cores of 1.27 cm diameter were removed from each sample parallel with the muscle fibers using of WBSF device.
3. The shear force was measured across the middle (center) on each core using WBSF value in kg for each core.
4. The WBSF values for each core were averaged for the determination of a single value

Determination of Water Holding Capacity (WHC)

Water-holding capacity of meat was measured using the gravimetric method. A 50 gram of meat sample weighed and placed in a plastic bottle for 24 hours being suspended by tying to the bottle cover. The fat part of the sample was removed and weighed before the hanging, then reweighed after stored for 24 hrs in a deep freezer [23–25]. Water holding capacities (WHC) expressed, in percentage from a total of meat water contents (75%) was calculated as follows;

$$\text{Water holding capacity (WHC)} = \frac{(\text{Weight of sample at first} - \text{Weight after 24hrs})}{\text{Weight of initial}} * 75$$

Determination of pH in Meat

The initial and final pH of meat samples were measured after slaughter at 45 min and 24 hrs, respectively. This pH values was conducted using portable instrumental battery drive and glass electrodes digital pH meter. The pH meter probe was calibrated by inserting into distilled water and a buffer solution, then touch a probe with meat and read the value of pH after about 30 seconds [26].

Statistical analysis

General leaner model (GLM) procedure of SAS 9.0 version software was used for analysis of samples collected. The model contained the fixed effects of breed types, age groups and seasons. The eating quality parameters (Tenderness, Juiciness, flavor and instrumental tenderness), water holding capacity, pH, and cooking loss were evaluated from the meat samples collected. Where significance difference between fixed effects was observed mean, separation was done by Duncan's Multiple Comparison Range n Test (DMCRT) at $P \leq 0.05$.

The model was; $Y_{ijkl} = \mu + \alpha_i + \beta_j + C_f + \gamma_k + e_{ijkl}$

Where; Y_{ijkl} = the response variable

μ = Overall mean common to all observation (α_i , β_f , C_f)

α_i = Effects of breed (Harar, Arsi, Bale)

β_j = Effect of age (<5, 5-7, 7-9, > 9)

C_f = Effects of season (Dry and Wet)

γ_k = Interaction effect (Breed, Season and Age)

e_{ijkl} = Random error

Results and Discussion

Mean value of eating quality, WHC, pH, and cooking loss (CL) of beef samples are presented in table 1. The overall mean value of sensory panelists and WBSF (N) rated 7.29, 7.16, 7.35, 42.94 N at the wet and 7.12, 7.23, 7.13 and 23.3 N at the dry season for sensory tenderness, juiciness, flavor and instrumental tenderness of studied beef cattle, respectively. The mean value of WBSF for all beef cattle breeds evaluated in this study was equivalent to 33.12 N (7.51 lb). This indicated that the instrumental tenderness of meat in current finding were mainly tender (58.47% tender followed by 12.71% moderate and 28.81% tough beef) based on categories described by Calkines and Sullivan who grouped beef muscles into three tenderness groups. These were instrumental tenderness <37.31 N (8.46 lb) tender, 37.49 – 44.54 N (8.5 – 10.07 lb) intermediate and > 44.98N (10.1 lb) as tough meat. The present result is comparable with Giusti *et al.* [27], who reported that shear force values for the Canchim (37.71 N) and Nellore (41.67 N) animals after seven days of aging (42.66 N) at zero days age of three beef cattle breed in Brazil. As Ethiopia is planning to in the beef market in the Middle East Countries, it is highly needed to promote Ethiopian beef at international markets.

The mean values of instrumental tenderness indicated that there were enormous difference between dry 23.3 N (tender) and wet season 42.94 N (intermediate). This might be due to good conformation of cattle during the onset dry season because of availability both quantity and quality feed resource, rest of draft cattle for a long time without physical work, less cold and warm weather stress. Farmer in mixed crop livestock system feed their bulls for sale on at the onset of dry season. In contrast to the general fact that cattle fatten well in wet season, particularly, short rainy, cattle were in poor body condition during this time in the study areas. During this short rainy season from March to June, cattle had passed sever long dry season (December to February), further emaciated due to stressed from physical work (ploughing) and loss their body condition. Bulls in mixed crop livestock system serve for draft purpose from March to June of the year. The current finding is in line with Pannier *et al.* [28], who report that energy source feed is used to activating Leptin protein production that regulates marbling and fat deposition.

The sensory panelist evaluation in current finding is comparable with Adhikari [29], on flavor for prime meat cuts (7.42) and choice cuts (7.24) and tenderness for prime cuts (8.66). However, the figure in this findings was good compared with Gebeyehu *et al.* [4], using trained sensory panelists rated (5.23) and (5.20) for beef tenderness and juiciness of Arsi cattle breed, respectively. Difference in sensory tenderness between the present findings in the study from Arsi cattle breed might be due to postmortem aging and personal difference between

Table 1: Overall, mean value of eating quality, WHC, pH, and CL of three beef cattle.

Variable	Wet season (N= 70)				Dry season (N =48)				Overall Mean
	Min	Max	Mean	SD	Min	Max	Mean	SD	
WBSF (N)	20.57	75.38	42.94	13.82	8.66	47.33	23.3	11.30	33.12
Tenderness	5.57	8.50	7.29	0.63	5.20	8.10	7.12	0.57	7.21
Juiciness	5.78	8.00	7.16	0.51	5.87	8.10	7.23	0.53	7.20
Flavor	6.20	8.45	7.35	0.48	5.50	8.30	7.13	0.78	7.24
WHC	67.07	74.37	71.95	1.56	69.30	74.37	73.82	1.43	72.89
CL	11.96	33.95	21.07	5.70	2.42	22.73	9.99	5.17	15.53
Initial pH	5.90	6.96	6.55	0.23	6.00	7.10	6.50	0.26	6.52
Ultimate pH	5.24	6.20	5.81	0.24	5.30	6.40	5.62	0.23	5.72

WBSF= Warner Bratzler Shear Force in Newton, WHC= Water Holding Capacity, N= Number of animal considered in respective season.

evaluators. The result supported by Calkines and Sulivan who reported that aging is the most important ways to improve meat tenderness.

The overall, mean value of WHC, initial pH, ultimate pH, and cooking loss were obtained 71.95, 6.55, 5.81, and 21.07 in the wet season and 73.82, 6.5, 5.62 and 9.99 in the dry season for beef of studied cattle, respectively. The result of WHC being low in wet than dry season might be due to lower WHC related lower body conformation in wet season than dry season in the present study. The overall mean cooking loss of current finding was comparable with the finding by Jama *et al.* [30], who reported that 23.9% cooking loss or Angus beef cattle at South Africa. It was better than report of Muchakilla *et al.* [31], which had reported 26.7% Tanzania Shorthorn Zebu for a different type of muscle and diet 26.97%. These differences might be due to cooking procedure, feeding region before slaughter and breeds difference.

Effects of breeds and age on sensory evaluation and instrumental tenderness

Effects of ages, breeds and seasons on beef eating quality and instrumental tenderness are presented in table 2. The analysis of variance indicated that breeds, ages and seasons interaction had highly significant source of variation ($P < 0.01$) on instrumental tenderness, juiciness and flavor. The age interaction within breeds showed highly significant ($P < 0.001$) on juiciness, flavor, sensory tenderness and instrumental tenderness. The body condition of beef cattle at end of wet season and beginning of dry season had good performance due to taking care of bulls by farmers in the region (September to December). This might be due to availability of good feeds and exposed to less physical work, however at entrance of wet season (February to May) scarcity of feed resource and exposed to the physical work might emaciate cattle, resulting in increased the value of instrumental tenderness, juiciness and sensory tenderness were shown in this finding.

The mean value of WBSF (N) had high significant difference ($P < 0.001$) on breeds type. Harar breed had good instrumental tenderness than Bale and Arsi breeds. This result might be due to the genetic or environmental difference or combination of two factors. As age of cattle increased value of instrumental, tenderness also increased. This might be due to the presence of more cross-link of collagen in older animal than younger once,

Table 2: Effects of breeds, ages, and seasons on beef sensory quality and instrumental tenderness.

Factor	WBSF± SE	Sensory tenderness± SE	Juiciness ± SE	Flavor ± SE
Overall	34.51±1.50	7.21±0.06	7.19±0.05	7.25±0.06
Breed	***	Ns	**	**
Harar	24.72 ^b ±1.42	7.10±0.11	7.40 ^a ±0.08	6.97 ^b ±0.11
Arsi	41.32 ^a ±2.68	7.23±0.09	7.02 ^b ±0.09	7.37 ^a ±0.09
Bale	40.61 ^a ±2.92	7.32±0.11	7.09 ^b ±0.09	7.51 ^a ±0.11
Age	***	***	Ns	***
<5	23.15 ^a ±1.72	7.74 ^a ±0.08	7.40±0.08	6.69 ^a ±0.11
5-7	28.70 ^b ±2.60	7.17 ^b ±0.08	7.21±0.10	7.23 ^b ±0.11
7-9	38.25 ^c ±2.49	7.13 ^b ±0.12	7.13±0.08	7.44 ^{ab} ±0.09
>9	50.22 ^d ±2.59	6.74 ^c ±0.11	7.00±0.14	7.69 ^a ±0.11
A*B	***	***	***	***
Season	***	Ns	Ns	Ns
Dry	23.02 ^b ±1.63	7.12±0.08	7.23±0.08	7.13±0.11
Wet	42.38 ^c ±1.72	7.29±0.09	7.16±0.07	7.35±0.06
A*B*S	***	Ns	***	**

*($p < 0.05$), ** ($P < 0.01$), *** ($P < 0.001$), A= age, B= breed, S= season, SE = Standard error

which was less soluble during cooking. The current finding is in line with Guiusti *et al.* [27], who reported that younger animals produced tender meat with lower value of instrumental tenderness. The difference in result of instrumental tenderness across breeds might be as a result of expose to the different feed resource before slaughter. Harar breed at Haramaya University was managed in feedlots for few days. However, the others breeds were finished on roughage after being kept on extensive grazing system. The current finding is in line with the finding of Muchakilla *et al.* [31], who reported that beef from feedlot had the goods instrumental tenderness value compared to beef from grazing animals.

The ANOVA result indicated that age was shown strong significant difference ($P < 0.001$) on sensory tenderness. Breeds and seasons were not indicated statistically difference ($P > 0.05$), on sensory tenderness, however, numerically the least square mean values were showed difference. In general, the numerical mean value of Harar breed had good tenderness than other breeds. Kerry and Ledward [32], reported that concentrate fed animals had produced more tender steak than forage-fed

animals. The ANOVA result among different breeds was shown strong significant difference ($P < 0.01$) on juiciness, however, ages and seasons were not shown significant difference ($P > 0.05$). As the age of cattle advanced, the juiciness has decreased. The highest numerical mean value of juiciness was recorded from age of less than 5 years. This might be due as age advanced muscle become fiber. Similarly during wet season, the lowest average juiciness was obtained due to lower body condition animal were supplied for market.

The ANOVA result indicated that ages and breeds were shown significantly difference ($P < 0.01$) on flavors. The age variation on meat flavors may be due to as cattle gets matured fats developed. The current finding is in line with Tran and Thu (2006) who reported that beef from older animal could produce a greater flavor due to having a high concentration of linoleic acid. The result indicated that the flavor from Harar breed had the lowest score. This might be due to the stay of the Harar breed in a feedlot for few days before slaughter at Haramaya University compared to their breed counterparts. Muchakilla *et al.* [31], reported that natural pasture grazed animal had good aroma score than animal finished in feedlot.

Effects of breeds and ages on water holding capacity, pH and cooking loss

Effects of ages, breeds and seasons on WHC, pH, and cooking loss of beef are presented in table 3. The ANOVA result on breeds, ages and seasons interaction were shown strong significant difference ($P < 0.001$) on WHC. The breed types were highly significant variation ($P < 0.01$) on WHC. This may be due to different breeds had different muscle structures. Seasons had shown strong significant difference ($P < 0.001$) on WCH. This might be happened due to cattle had different body condition at different season in case of feed resource availability. Lower body condition during upcoming wet season resulted stress

Table 3: Effects of breeds, age and seasons on WHC, pH, and cooking loss of beef.

Factor	WHC \pm SE	Initial pH \pm SE	Ultimate pH \pm SE	Cooking loss \pm SE
Overall	72.71 \pm 0.16	6.53 \pm 0.02	5.73 \pm 0.02	16.56 \pm 0.71
Breed	**	Ns	Ns	***
Harar	73.26 ^a \pm 0.17	6.50 \pm 0.04	5.70 \pm 0.03	12.31 ^b \pm 0.87
Arsi	71.81 ^b \pm 0.35	6.57 \pm 0.03	5.76 \pm 0.04	18.60 ^a \pm 1.31
Bale	72.94 ^a \pm 0.29	6.51 \pm 0.04	5.76 \pm 0.05	20.21 ^a \pm 1.20
Age	*	Ns	Ns	***
<5	72.14 ^b \pm 0.38	6.51 \pm 0.05	5.65 \pm 0.04	16.47 ^a \pm 1.00
5-7	72.94 ^a \pm 0.24	6.50 \pm 0.04	5.74 \pm 0.04	16.93 ^{ab} \pm 1.42
7-9	72.55 ^{ab} \pm 0.37	6.58 \pm 0.04	5.76 \pm 0.06	19.06 ^b \pm 1.73
>9	73.24 ^a \pm 0.27	6.53 \pm 0.05	5.78 \pm 0.05	13.30 ^c \pm 1.23
A*B	*	*	Ns	***
Season	***	Ns	***	***
Dry	73.82 \pm 0.21 ^a	6.50 \pm 0.04	5.62 ^b \pm 0.03	9.99 ^b \pm 0.75
Wet	71.95 \pm 0.19 ^b	6.55 \pm 0.03	5.81 ^a \pm 0.03	21.07 ^a \pm 0.68
A*B*S	***	*	*	***

*($P < 0.05$), ** ($P < 0.01$), *** ($P < 0.0001$), A= age, B= breed, S= season, SE= Standard error.

animals to search feed and water while compared with end of wet season, consequently influenced carcass and meat quality characteristics [33]. The age had shown significant difference ($P < 0.05$) on WHC. As the age of the cattle increased, WHC also increased. This might be due to as animal gets older the sarcolemma was contracted and extracellular muscle was decreased (Calkins and Sullivan, 2006). This result was in line with Warner *et al.* [34], who reported that the water holding capacity of meat is influenced by genetic, age and pre-slaughter animal stress. The season had shown strong significant difference ($P < 0.001$) on WHC. This happened due to cattle had different conformation at different season which commonly related to feed availability and exposed to physical work. This result was supported by Jorge and Rodrigo who reported that different feed types have a major influence on meat quality due to mainly affected animal conformation and fat content.

The result of analysis variance indicated that ages, breeds and seasons interaction were not shown significant difference ($P > 0.05$) on initial pH. However, numerically least mean square value were showed different number on seasons, breeds and ages groups. Generally, the mean value of initial pH was increased as age of animal increased. This might be due to the better body condition of the young cattle at slaughter than aged once. This lower body condition implicated that lower energy reserve, which exposed them for faster exhaustion of glycogen consequently resulting in relatively lower initial pH [17]. The season had shown strong significance difference on ($P < 0.001$) on ultimate pH. This might be happened due to environmental difference made chronic stress on beef cattle during beginning of wet season due to passing through in long dry periods, water scarce and physical work [17].

The ANOVA results for ages, breeds and seasons interaction were indicated strong significant difference ($P < 0.01$) on cooking loss. This finding was indicated that cooking had decreased by ages of cattle. The decrease in cooking loss as aging increased was expected since enzymatic reactions by endogenous enzymes, such as collagenase, which are produced by bacterial within beef or by ionic solubilisation, progresses at faster rates aging increases. This might be also due to muscle (sarcomere) from a young animal was easily fragmented during cooking (Calkins and Sullivan, 2006). The current finding coincides with Jama *et al.* [30], who reported that endogenous enzymatic reactions, such as collagenase disintegrated the myofibrillar proteins and made connective tissue thereby improving cooking loss.

Correlation of sensory evaluation with instrumental tenderness

Pearson correlation of sensory evaluation with instrumental tenderness, WHC, pH and cooking loss are presented in table 4. There was a negative strong correlation ($r = -0.48$; $P < 0.05$) on an instrumental tenderness with sensory tenderness and negative correlation ($r = -0.27$) on juiciness with instrumental tenderness. Similarly, the negative correlation was reported by Caine *et al.* [35], on juiciness and instrumental tenderness ($r = -0.61$). The strong positive correlation ($r = 0.6$; $P < 0.001$) was detected on flavor and instrumental tenderness (WBSF),

Table 4: Pearson Correlation between sensory eating qualities with instrumental tenderness, WHC, pH, and cooking loss.

Variable	WBSF	ST	JC	FVL	pHi	WHC	pHu	CL
WBSF	1							
ST	-0.48*	1						
JC	-0.27	0.10	1					
FVL	0.60**	-0.66**	-0.22	1				
pHi	0.14	-0.24	0.04	0.24	1			
WHC	-0.33	0.23	0.23	-0.21	-0.26	1		
pHu	0.56**	-0.57**	-0.05	0.58**	0.37	-0.40*	1	
CL	0.42*	-0.31	-0.68*	0.38	0.23	-0.58**	0.62**	1

*** (P<0.0001), ** (P<0.001), * (P<0.05), NS= non-significant, WBSF= Warner Bratzler shear force, WHC= water holding capacity, above diagonal = Dry season, Below diagonal= Wet season, CL= Cooking loss, pHi= initial pH, pHu= Ultimate pH

however negative correlation between flavor and sensory tenderness ($r = -0.66$; $P < 0.01$). This value was happened due to behaviors of data between flavor and sensory tenderness. Instrumental tenderness had positive weak correlation with pHi ($r = 0.14$) and moderate with pHu ($r = 0.56$; $P < 0.01$). The cooking loss had positive correlation with instrumental ($r = 0.42$; $P < 0.05$). Puente *et al.* [36], reported similar result on cooking loss was correlated to WBSF ($r = 0.44$). However, instrumental tenderness had negative moderate correlation with water holding capacity ($r = -0.33$).

Analysis of result revealed that there were moderate relation between instrumental and sensory evaluation. The moderate/weak relationship between sensory evaluation and instrumental measurements of meat tenderness is generally accept. The first is the lack of precision arising from the use of sensory panelists because of the subjective nature of the measurements, e.g. the ability of panelist differing scales of perception for tenderness due to lack of exposure for meat in their daily food menu. In Ethiopian, there were no specialist meat sensory panelists as coffee quality panelist. Therefore, the moderate/weak correlation relation between sensory panelist and instrumental tenderness were expected. This finding is in line with Savell *et al.* [37], who reported that a weak relationship between instrumental measurements and sensory evaluations. Similarly, Van Wezemaal *et al.* [38], reported the reason for weak correlations between sensory evaluations and instrumental tenderness as panelists experience, personal preferences, eating habits, social influences or available information give the subjective frame of reference [39-43].

Conclusion

This study was conducted with the objective of evaluating eating quality of beef produced in wet and dry seasons at public abattoirs in Adama municipality and Haramaya University. Sensory analysis was also conducted using trained panelists. Warner Bratzler-Shear Force device was used to determine instrumental tenderness. The data were analyzed by using statistical software tools by SAS version (9.0).

The overall mean value of WBSF (N), sensory tenderness, juiciness, and flavor were rated 33.12, 7.12, 7.2 and 7.24,

respectively in both seasons. The interaction of age, breed, and season were a highly significantly affected ($P < 0.01$) on instrumental tenderness, juiciness and flavor. Harar breed has better instrumental tenderness than others all breeds considered in this experiment across all ages and both seasons. The result of two ways ANOVA for age and breed interaction were shown strongly significance variation ($P < 0.01$) on sensory tenderness, juiciness and flavor. The beef from Harar breeds had exhibited good eating quality based on tenderness and juiciness than other breeds but lower flavor. This might be due to finishing feed difference. As the age of animal increases the sensory tenderness and juiciness is decrease but instrumental tenderness and flavor increase.

The overall mean value of WHC, ipH, upH, and Cl in the current study was 72.89, 6.52, 5.72 and 15.53, respectively in both seasons. The result of three ways analysis was showed that interaction of age, season and breed were the of source variation ($P < 0.05$) on WHC. The result of interaction season, age and breed did not showed significant difference ($P > 0.05$) on pH for both initial and ultimate. Interaction of age, breed and season produced significant difference ($P < 0.01$) on cooking loss. Instrumental tenderness and sensory tenderness had negative relation ($r = -0.48$; $P < 0.05$). Juiciness had weak negative relationship with WBSF ($r = -0.27$; $P > 0.05$). Flavor had strong positive relationship with WBSF ($r = 0.6$; $P < 0.01$)

Recommendations to improve the quality of beef in Ethiopia.

1. Strategy that encourage premium payment for young cattle not served for draft purpose should be developed.
2. Breed improvement strategy should be developed for Harar cattle breeds to produced tender meats.
3. Instrumental based quality evaluation technique will be more appropriate to evaluate beef in the future.

Further research work will need on:

- ✓ Investigate whether the eating quality difference between Harar, Arsi and Bale breeds was due to environment or genetics.

Acknowledgment

This research project was supported by Oromia Agricultural Research Institute (IQOO) and United States Agency for International Development (USAID) for which the authors are highly grateful. The authors have also like to thanks for Mr. Dinku Sime, Adama abattoir associate manager; Dr. Sabona Feyisa and Dr. Girma Kiltu, Adama abattoir meat inspectors and Dr. Abdisa Chala, abattoir meat inspector at Haramaya University for their assistance in meat samples collection. Lastly but not least authors wish to thanks for Mr. Nasir Abdurahaman and Ms. Maza Dajene whose laboratory technicians at OBU Department of Dairy and Meat technology for their professional and friendly assistance during evaluation of sensory and instrumental tenderness of beef samples.

References

- DAGRIS (2011) Breed in Ethiopia, International livestock resource information system, Addis Ababa, Ethiopian. [Link: https://tinyurl.com/y634376c](https://tinyurl.com/y634376c)
- Bekele, Abraham (2016) Review on live animal and meat export marketing system in Ethiopia: challenges and opportunities. Scientific and innovative Research Journal 5: 59-64. [Link: https://tinyurl.com/y6e85nnq](https://tinyurl.com/y6e85nnq)
- EMDIDI (Ethiopian Meat and Dairy Industry Development Institute) (2016) Ethiopian Agro-Industry Strategy Meat Industry Sub-Sector Strategic Plan (2015-2025). Addis Ababa-Ethiopia. [Link: https://tinyurl.com/y3o63zg3](https://tinyurl.com/y3o63zg3)
- Gebeyehu A, Yousuf M, Sebsibe A (2013) Evaluation of eating qualities of Ethiopian beef of Arsi cattle in Adama town, Oromia, Ethiopia. International Journal of Agriculture Innovations and Research 1: 177-182. [Link: https://tinyurl.com/yy8povzu](https://tinyurl.com/yy8povzu)
- Troy DJ, Kerry JP (2010) Consumer perception and the role of science in the meat industry. Meat Sci 86: 214-226. [Link: https://tinyurl.com/yykfh3vz](https://tinyurl.com/yykfh3vz)
- Lee SH, Choe JH, Choi YM, Jung KC, Rhee MS, et al. (2012) The influence of pork quality traits and muscle fiber characteristics on the eating quality of pork from various breeds. Meat Science 90: 284-291. [Link: https://tinyurl.com/y4yhtom8](https://tinyurl.com/y4yhtom8)
- Purwin C, Wyżlic I, Nogalski Z, Sobczuk-Szul M, Pogorzelski, et al. (2016) The effect of grass silage quality and supplementary concentrate levels on feed intake and fattening performance of crossbred steers. Journal of Elementology 21: 1103-1113. [Link: https://tinyurl.com/y67teet6](https://tinyurl.com/y67teet6)
- Farzad S (2014) Prediction of beef Tenderness using hyperspectral imaging. Thesis submitted to the Graduate and Postdoctoral Studies Office in partial fulfillment of the requirements for the degree of Master in. McGill University, Sainte-Anne-de-Bellevue, Quebec, Canada.
- Berit C (2012) The effect of biochemical parameters on tenderness in beef. MSc thesis. Norwegian University of life science, Germany.
- Semler ML, Woerner DR, Belk KE, Enns KJ, Tatum JD (2016) Effects of United States Department of Agriculture carcass maturity on sensory attributes of steaks produced by cattle representing two dental age classes. Journal of Animal Science 94: 2207-2217. [Link: https://tinyurl.com/y5njjyss](https://tinyurl.com/y5njjyss)
- Hwang S, Son SW, Kim SC Kim, Jeong YJH, Lee D (2008) A protein interaction network associated with asthma. Journal of Theoretical Biology 252: 722-731. [Link: https://tinyurl.com/y2jt8now](https://tinyurl.com/y2jt8now)
- Lim D, Kim NK, Lee SH, Park HS, Cho YM, et al. (2014) Characterization of Genes for Beef marbling Based on Applying Gene Coexpression Network. International Journal of Genomics, lume. [Link: https://tinyurl.com/y3tv8mqz](https://tinyurl.com/y3tv8mqz)
- Mummad YY, Webb EC (2015) Carcass quality audit-A strategy to improve beef sector in Ethiopia. African Journal of Agricultural Research 10: 2731-2737. [Link: https://tinyurl.com/y2nn4vou](https://tinyurl.com/y2nn4vou)
- Knee B, Cummin L, Walker P, Warner R (2004) Seasonal variation in muscle glycogen in beef steers. Animal Production 44: 729-734. [Link: https://tinyurl.com/y56mlh9p](https://tinyurl.com/y56mlh9p)
- Džinić N, Puvača N, Tasić T, Ikončić P, Okanović Đ (2015) How meat quality and sensory perception is influenced by feeding poultry plant extracts. World's Poultry Science Journal 71: 673-682. [Link: https://tinyurl.com/y4l465zf](https://tinyurl.com/y4l465zf)
- da Costa DPB, de Oliveira Roça R, da Costa QPB, Duarte Lanna DP, da Silva Lim E, et al. (2013) Meat characteristics of Nellore steers fed whole cottonseed. R Bras Zootec 42: 183-192. [Link: https://tinyurl.com/y2oeh646](https://tinyurl.com/y2oeh646)
- Adzitey F, Nurul H (2011) Pale soft exudative (PSE) and dark firm dry (DFD) meats: causes and measures to reduce these incidences - A mini review. International Food Research Journal 18: 11-20. [Link: https://tinyurl.com/y6lgbdmg](https://tinyurl.com/y6lgbdmg)
- Węglarz A (2012) Meat quality defined based on pH and colour depending on cattle category and slaughter season. Czech. Journal of Animal Science 55: 548-556. [Link: https://tinyurl.com/yyll7rgc](https://tinyurl.com/yyll7rgc)
- AMSA (American Meat Science Association) (2015) Research Guidelines for Cookery, Sensory Evaluation, and Instrumental Tenderness Measurements of Meat. Second Edition Version 1.0. [Link: https://tinyurl.com/y5nrxrbc](https://tinyurl.com/y5nrxrbc)
- Rege JEO, Tawah CL (1999) The state of Africa cattle genetics resource, II: Geographical, characteristics and uses of present day breed and strain. Animal Genetic Resource Information 26: 1-25. [Link: https://tinyurl.com/y37cznll](https://tinyurl.com/y37cznll)
- Torrell R (1998) Methods of determining age in cattle. Cattle Producer's Library: CL712. University of Nevada, Reno, NV, USA. [Link: https://tinyurl.com/y5fxw786](https://tinyurl.com/y5fxw786)
- MLA (2011) Tropical Beef Production Manual. Module 2 Cattle nutrition for beef production. [Link: https://tinyurl.com/yy6upgn4](https://tinyurl.com/yy6upgn4)
- Honikel KO (1998) Reference methods for the assessment of physical characteristics of meat. Meat Science 49: 447-457. [Link: https://tinyurl.com/yycxtx6p](https://tinyurl.com/yycxtx6p)
- Wilborn BS, Kerth CR, Owsley WF, Jones WR, Frobish LT (2004) Improving pork quality by feeding super nutritional concentrations of vitamin D3. Journal of Animal Science 82: 218-224. [Link: https://tinyurl.com/yyqh7odh](https://tinyurl.com/yyqh7odh)
- Filho RAT, Henrique Pereirab Cazedey HP, Fontes PR, Ramos ALS, Ramos EM (2017) Drip loss assessment by different analytical methods and their relationships with pork quality classification. Journal of Food Quality 1-8. [Link: https://tinyurl.com/yxwkbybu](https://tinyurl.com/yxwkbybu)
- ESVLDM (Ethiopian standard Veterinary Laboratory Daigoinastic Manual) (2005) Food and Hygienic public health V VI. Addis Ababa University, Faculty of medicine, Ethiopia.
- Giusti J, Castan E, Dal Pai M, Baldin SR, De Oliveira HN (2013) Expression of genes related to quality of Longissimus dorsi muscle meat in Nellore (Bos indicus) and Canchim (5/8 Bos taurus × 3/8 Bos indicus) cattle. Meat Science 94: 247-252. [Link: https://tinyurl.com/y5phf2er](https://tinyurl.com/y5phf2er)
- Pannier L, Sweeney T, Hamill RM, Ipek F, Stapleton PC, et al. (2009) Lack of an association between single nucleotide polymorphisms in the bovine leptin gene and intramuscular fat in Bos taurus cattle. Meat Science 81: 731-737. [Link: https://tinyurl.com/y4jwxcfn](https://tinyurl.com/y4jwxcfn)
- Adhikari K (2013) Sensory flavor analysis of beefsteaks. Kansas State University and J. C. Brooks Texas Tech University, 156.
- Jama NV, Muchenje M, Chimonyo P, Strydom E, Dzama K, et al. (2008) Cooking loss components of beef from Nguni, Bonsmara and Angus steers. African Journal of Agricultural Research 3: 416-420. [Link: https://tinyurl.com/y598w766](https://tinyurl.com/y598w766)

31. Muchakilla MB, Asimwe L, Kimambo AE, Mtenga LA, Laswa GH (2014) Effect of diet and muscle type on meat quality characteristics of Tanzania Shorthorn Zebu. *Livestock Research for Rural Development* 26. [Link: https://tinyurl.com/yxyu25le](https://tinyurl.com/yxyu25le)
32. Kerry JP, Ledward D (2008) Improving the sensory and nutritional quality of fresh meat. CRC press, New York, US. [Link: https://tinyurl.com/y472jmmt](https://tinyurl.com/y472jmmt)
33. Yesihak Y (2015) Beef carcass quality, yield and cause of condemnation in Ethiopia. Faculty of Natural and Agricultural science. SouthAfrica, Pretoria. [Link: https://tinyurl.com/y34t7gfv](https://tinyurl.com/y34t7gfv)
34. Warner RD, Kerr M, Kim YHB, Gee sink G (2014) Pre-rigor carcass stretching counteracts the negative effects of high rigor temperature on tenderness and water-holding capacity using lamb muscles as a model. *Animal Production Science* 54: 494-503. [Link: https://tinyurl.com/y47m98ym](https://tinyurl.com/y47m98ym)
35. Caine WR, Aalhus JL, Best DR, Dugan MER, Jeremiah LE (2003) Relationship of texture profile analysis and Warner-Bratzler shear force with sensory characteristics of beef rib steaks. *Journal of Meat Science* 64: 333-333. [Link: https://tinyurl.com/y64d35wa](https://tinyurl.com/y64d35wa)
36. Puente J, Samanta SS, Bruce HL (2015) Instrumental meat quality characteristics associated with aged m. longissimus thoracis from the four Canadian beef quality grades. *Canadian Journal of Animal Science* 96: 143-153. [Link: https://tinyurl.com/yysg6xq](https://tinyurl.com/yysg6xq)
37. Savell JW, Hale DS, Griffin DB, Kerth CR, Belk KE, et al. (2011) National beef quality audit. In-plant survey phase. Funded in part by the beef checkoff, USA.
38. Van Wezemael L, De Smet S, Ueland Ø, Verbeke W (2013) Relationships between sensory evaluations of beef tenderness, shear force measurements and consumer characteristics. *Meat Science* 97: 310-315. [Link: https://tinyurl.com/yyhqe825](https://tinyurl.com/yyhqe825)
39. Calkins CR, Sullivan G (2007) Ranking of beef muscles for tenderness. Beef Facts, National Cattlemen's Beef Association. [Link: https://tinyurl.com/y547u6ba](https://tinyurl.com/y547u6ba)
40. Ramírez-Retamal J, Morales R (2013) Influence of breed and feeding on the main quality characteristics of sheep carcass and meat: A review. *Chilean Journal of Agricultural Research* 74. [Link: https://tinyurl.com/yxltjv9s](https://tinyurl.com/yxltjv9s)
41. Muchenje V, Dzama K, Chimonyo M, Raats JG, Strydom PE (2009) Meat quality of Nguni, Bonsmara and Aberdeen Angus steers raised on natural pasture in the Eastern Cape, South Africa. *Meat Science* 79: 20-28. [Link: https://tinyurl.com/y4sg5muw](https://tinyurl.com/y4sg5muw)
42. Tran D, Thu T (2006) Meat quality: Understanding of meat tenderness and influence of fat content on meat flavor. *Science and Technology Development* 9: 65-70. [Link: https://tinyurl.com/y3kpt37z](https://tinyurl.com/y3kpt37z)
43. Warris P (2010) Meat science. An introductory text. 2nd edition. CABI, UK. [Link: https://tinyurl.com/y3l54v63](https://tinyurl.com/y3l54v63)

Discover a bigger Impact and Visibility of your article publication with Peertechz Publications

Highlights

- ❖ Signatory publisher of ORCID
- ❖ Signatory Publisher of DORA (San Francisco Declaration on Research Assessment)
- ❖ Articles archived in worlds' renowned service providers such as Portico, CNKI, AGRIS, TDNet, Base (Bielefeld University Library), CrossRef, Scilit, J-Gate etc.
- ❖ Journals indexed in ICMJE, SHERPA/ROMEO, Google Scholar etc.
- ❖ OAI-PMH (Open Archives Initiative Protocol for Metadata Harvesting)
- ❖ Dedicated Editorial Board for every journal
- ❖ Accurate and rapid peer-review process
- ❖ Increased citations of published articles through promotions
- ❖ Reduced timeline for article publication

Submit your articles and experience a new surge in publication services
(<https://www.peertechz.com/submission>).

Peertechz journals wishes everlasting success in your every endeavours.

Copyright: © 2019 Gadisa B, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.