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Evaluation of Eating Qualities of Ethiopian Beef of Arsi Cattle in Adama Town, Oromia, Ethiopia

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***Abstract* – The study was conducted in Adama and Bishoftu towns, on beef produced from Arsi breed cattle with objective of evaluating beef eating quality with trained sensory panellists. Beef sample was aseptically collected from longissimus dorsi chuck for sensory evaluation. Breed type was determined by phenotypic traits and age was determined with dentition. The production system being practiced by the animals selling and buying farmers were subsistence production systems. Age and production system has significant effect on tenderness of beef ($P < 0.0001$). Production systems have significant effect on beef juiciness ($P < 0.05$). The trained sensory panellists rated 5.23, 5.20 and 5.47 for beef tenderness, juiciness and flavour of beef respectively. There was no variation in proximate qualities due to age and production system effect and their interactions ($P > 0.05$). The protein and fat content of longissimus dorsi chuck of Arsi cattle were 22.10 and 6.86, respectively.**

***Keywords* – Aerobic Plate Count, Total Coliform Count, Fecal Coliform Count, E-Coli and Staphylococci Count.**

I. Introduction

These livestock play an important role in the national economy contributing to both agricultural products and national GDP (Ayele *et al.*, *2003*; Nell, 2006 and IFAD, 2010). According to MoFED (2010) report in 2009/2010 agriculture has a contribution of 43.17% to the national GDP. Livestock (animal) agriculture has 26.6% of total agricultural GDP and 11.48% of total national GDP. The contribution of livestock and livestock products export to earn foreign exchange is not too large. Thus, the country is not fully exploiting this large resource and several studies reveal that the production and productivity of the animal is low and products being produced are of low quality (Ayele *et al.*, 2003).

According to MoFED (2010) annual report, the national economy is growing in not less than double digits. This economic growth is likely to stimulate people's interest to high quality and value added products (von-Seggern, 2001). Education and economic prosperity makes people more sensitive and selective to matters they use particularly healthier consumption of foods (Gary, S. Pers.comm, US-CME, 2009). In virtue of this, meat commercialization has a great potential to become a key source of income to smallholders of Ethiopia.

In recent years feedlot firms are flourishing and getting engaged in the export of processed meat and live animals. These firms are exporting live animals and processed carcasses to various countries in close proximity of Ethiopia *i.e.* Africa and the Middle East and absorbing in foreign currency from international markets. The Middle East and North African (MENA) Countries prefer lowland live animals and meat; as a result, about 90% of live animals exported to the MENA countries are contributed by the pastoral areas (Mohammed, 2007; ESGPIP, 2011). Why meat from lowland animal is preferred? Is there eating quality difference between highland and lowland animals? These are the question that needs immediate answer to properly utilize the resource. By studying the sources of variation in meat quality, the value addition work needed and value addition processes can be enhanced to satisfy the national consumers. According to the World Bank (2004) report, Ethiopian meat production and marketing has been plagued by lack of quality and sanitation, prevalence of disease and unqualified meat production process.

Though extensive research has been and/is being done to improve production and productivity of local animals, limited and fragmented studies have focused on the meat quality characteristics (ESAP, 2006). In Ethiopia, research on meat and meat products are given lowest attention in Ethiopia (Anon, 2010a). But several scientists have indicated the importance of continuous assessment on meat eating qualities. Continuous study of meat quality is important to improve and sustain livestock production the reason being that meat should be more consistent in quality *i.e.* optimum level of eating qualities to ensure consumers have a consistently good eating experience (Kirton, 1989; CRC, 2004; von-Braun, 2010). Pethick *et al.* (2011) survey result noted that the three most important quality areas for future research are lean meat yield, eating qualities and human nutritive value (proximate composition). Mirzaei *et al.* (2011) also indicated that optimization of cattle production requires knowledge of the variation in meat quality and carcass traits and the association between them. Konishi and Kobayashi (2009) indicated the importance of making continuous study on taste, nutrition and flavour.

Hence, the major point of interest in this study is to assess and document eating qualities of the beef produced from Arsi cattle across different ages and production systems.

II. Materials and Methods

The Study Area

Adama town is the area of the study and the town is situated on the highway from Addis Ababa to Harar. Adama is on altitude of 1666m above sea level and located at 100km east of Addis Ababa capital city of Ethiopia (Google Earth, 2012). According to CSA (2012) population census report, Adama has 278000 town residents. Adama is an epicenter of different modern manufacturing industries it also hosts several East-Shoa zonal administrative offices and Oromia television station. The town is situated in the center of the country and more frequently visited by national and international tourists. The towns have also good infrastructures that facilitate and link marketing in the national and international.

The annual average minimum and maximum temperature of Adama town is 18 and 32 respectively (Anon, 2011b and Zoover, 2011). The specific geographical location of the Adama towns' abattoir is on the geographic coordinates of: 8° 33' 05.79"N and 39° 15' 34.83"E. The altitude of the abattoirs is 1639m above sea level (Google Earth, 2012).

Samples and steak preparation

Production systems and age of the animal were identified with phenotypic characteristics and dentition respectively. The sample source cattle were tagged in the abattoir on simple random sampling technique. Slaughter weight, Heart-girth, hot carcass weight was taken in the abattoir. Beef samples were collected on purchase from those who own the carcass on the next day (on panel testing day). The samples were dissected from chuck areas and were collected in clean and dry polythene bag bought from the market. The samples were marked with a code and put in an icebox and brought to hotel where it was processed and cooked. First, the necessary agreement and arrangement was made with the hotel owner and how the steak will be prepared and cooked, *i.e.*, as per guidelines prescribed in the sensory evaluation manual (Watts *et al.*, 1989). Steak preparation was done by one person and the cuttings were almost made uniform (Watts *et al.* 1989). Cuts were browned for 4 to 5 minutes on a fire-wood heated oven. The browning time was also the same for all (internal temperature of fried steaks was 71ºC). The seasoning ingredients used in broiling beef were all the same for all samples (oil, raw onion and salt).

Screening of panellists

Panellists were screened at Adami Tulu Agricultural Research Center (ATARC) through a written survey. To qualify for the test panel, consumers had to be the primary beef or other type of meat shopper, be between the ages of 20 and 45 have no meat allergies, and be willing to consume beef. Consumers were disqualified if they were not willing to taste or accept any guidelines offered on testing. A survey of demographic information, eating preferences, purchasing behaviour, and consent was made to panellists before the actual taste panel. On arrival at the host hotel, panellists were asked to complete a meat knowledge survey, as well as any incomplete paperwork. Panellists were given random three-digit numbers for identification. Panellists were paid per diem 150.4 – 224.0 ETB per head on tasting day.

Training and testing

Sensory evaluations training was conducted in ATARC on December 29, 2011. The panellists were given two hour training session according to procedures described by Cross *et al.* (1978). About thirty willing candidates participated in pre-screening training. Sixteen prospective panellists were selected based on the screening questionnaire completed by trainees (AMSA, 1995). Then four contingency, and twelve finalists were screened and contacted to prepare themselves for the tasting date (Bures *et al.*, 2007). On the testing date panellists were brought to Adama town. Panellists were placed at individual tasting tables to evaluate sensory traits of the samples.

The test samples were served on clay pans on aluminium plates. As identification, each steak samples were given an abattoir code. The panellists evaluated fried steaks for tenderness, juiciness, and beef flavour intensity on an eight-point scale (8 = extremely tender, juicy, or intense flavour to 1 = extremely tough, dry, or bland flavour respectively (Ngambu *et al.*, 2011). The beef steaks were cut almost uniform cut by one person's hand as prescribed by the panel coordinator. The batch steaks of beef were fried in uniform procedure and processes. After cooking beef were served warm to each panel member. Then panellists tasted the served beef and scored based on eight-hedonic scale or descriptive sensory attribute. But before the actual testing, a warm-up sample was served first, after which another 16 different experimental fried sample steaks were served in two separate testing sessions (Watts *et al.*, 1989).

The sensory value of each fried steak was placed on an individual score sheet that was labelled with the sample's and panellist identification number. The panellists' scoring sheets were collected. The procedure was repeated for the other samples. The serving orders were random. Water and wheat flour bread buns were provided to the panellists to cleanse their palates between samples (Wheeler *et al.*, 1999). The evaluation was conducted in two sessions, two evaluation days in a week (Wheeler et al., 2005). The averages of panellists' scores for each sample were used for statistical analyses (Bures *et al.*, 2007). In addition, a triplicate sample was served in the testing session for monitoring panellists and panel performance.

Experimental design, model and statistical analysis

The experimental design of the sensory / eating quality parameters study was 2^6 Factorial in a Completely Randomized Designed (Factorial-CRD). The production system has a two level of factor *i.e*, Highland and Lowland and the age has six levels of factors *i.e*, 5-6, 7-8, 8-9, 9-10, 10-11 and 11-12 years. Twelve (12) panellists were included in the sensory evaluation portion of the analysis. Any panellist seen outlaying from majority of the panellist was removed from the analysis. Differences in sensory panel evaluation data were analyzed using the GLM procedure of SAS 9.1 version (SAS, 2008). The model contained the fixed effects of production system and age. The eating qualities *i.e* juiciness, tenderness and flavour were considered as random effects. Mean separation was done by DMRT when the F-test was significant ($P \leq 0.05$). The model was;

$$Y_{ijk} = \mu + \alpha_i + \beta j + \gamma_k + e_{ijk}$$

III. Results and Discussion

The F-test of model and components of model are given in Appendix Table 3. The effect of age and production systems on eating quality parameters are given in Table 19. The overall F-test for tenderness, juiciness and flavor showed significant difference (P < 0.05) indicating that the model as a whole account for a significant amount of variation in tenderness, juiciness and flavor. As F-test indicates, consumers significantly detected the difference in tenderness for the two production systems, different age categories and interactions. Age and production system difference has made strongly significant variation in tenderness of beef (P < 0.0001). This implies that there is significant tenderness difference between lowland and highland animals (P < 0.0001).

The age and age by production systems interaction could not be a source of variation in juiciness. But production system was significantly a source of variation in juiciness. Age and production system are not source of variation (P > 0.05) in flavor intensity. The likely reason for lack of variation in flavor intensity is that almost all animals were mature age of ≥5 years and flavor intensity develops as age increases. For juiciness, only production system has become source of variation (P < 0.05). In other words, age by production system interaction didn't affect the juiciness of beef significantly. These findings were compared with the previously done similar or relevant studies. It is in good agreement with Shackelford *et al.* (1995) report that the juiciness, tenderness and flavour were significantly different even between ages, 1.5-1.7years and 2years old heifers. Shackelford *et al.* (1995) also reported that the juiciness and tenderness decrease as age advances and flavour increases as age advances.

The F-test of sex (of tasters) indicates that the two sexes of testers (female and male) didn't taste the meat differently (P > 0.05) in cases of tenderness and juiciness. But male and female tasters sensed flavor intensity differently (P < 0.05). Panellists rated beef of lowland origin cattle significantly (P < 0.05) higher for tenderness, juiciness and flavour. Current report is comparable with the Kerry and Ledward (2008) report that trained sensory panel rated higher tenderness for meat harvested from grain fed cattle. This would hold true since feed source of highland animals and lowland are different and may contribute to difference in flavour.

The feed source of lowland animals is mainly natural pasture whereas the highland animals mainly fed on crop aftermaths and have access to agro-industrial by-products (Amare *et al.*, 2010; CSA, 2011). Kerry and Ledward (2008) reported that concentrate fed animals also produce steaks that were more tender than forage fed animals. Bures *et al.* (2007) reported a non-significant difference in tenderness, juiciness and flavour across different breeds. Several researchers have also reported *Bos indicus* cattle produce tougher meat than *Bos taurus* cattle. Take a note that beef flavour of lowland is only numerically higher (P > 0.05) than that of highland (Table 19). Consumers placed a significantly higher (P < 0.001) value for tenderness and juiciness on lowland origin beef (Table 19). It is to mean that significant sensory difference exists between the highland and lowland origin beef was only for juiciness and tenderness.

Table 1: Effect of age and production system on Eating Qualities (LS means)

Variables	Tenderness ±SE	Juiciness ±SE	Flavor ± SE
Sex	Ns	Ns	*
Female	5.3 ±0.146	5.3 ±0.107	5.7^{a} ±0.114
Male	5.2 ±0.146	5.1 ±0.107	5.3^{b} ±0.114
Prod	***	*	Ns
Highland	4.8^{b} ±0.137	5.0^{b} ±0.107	5.4 ±0.116
Lowland	5.7^{a} ±0.137	5.4^{a} ±0.107	5.5 ±0.116
Age (year)	***	Ns	Ns
5-6	4.9^{bc} ±0.205	5.2 ±0.166	5.2 ±0.177
7-8	6.1^{a} ±0.205	5.3 ±0.166	5.3 ±0.177
8-9	5.4^{ab} ±0.199	5.2 ±0.161	5.8 ±0.172
9-10	5.0^{bc} ±0.367	4.8 ±0.298	5.6 ±0.318
10-11	5.3^{ab} ±0.247	5.4 ±0.201	5.5 ±0.214
11-12	4.2^{c} ±0.247	5.0 ±0.201	5.5 ±0.215
Age*Prod	***	Ns	*

Sex = female and male testers, Age = different age groups, Prod = production systems, Age*Prod = age by production system interaction of, SE = standard error of mean, Tenderness, Juiciness and Flavor intensity were rated on eight point scale, 1 = extremely tough, dry or bland and 8 as extremely tender, juicy or flavorful, yr = year, Ns = not significant at significance level of α = 0.05, Superscripts of different letter in the same column are significantly different at α =0.05.

The Mean values for beef eating quality parameters (sensory evaluation) of tenderness, juiciness and flavour intensity scores are given in Table 20. In overall sense, the trained sensory panellists rated 5.23, 5.20 and 5.47 for beef tenderness, juiciness and flavour of Arsi cattle respectively. These figures of beef tenderness, juiciness and flavour intensity were also compared against other relevant research papers. Accordingly, the juiciness, tenderness and flavour result of this paper is comparable with Anon's (2010) report of an average 5.93, 6.11 and 6.70 for juiciness, tenderness and flavor of beef respectively for grass fed Half-Mashona Steers. Melton *et* *al.* (1974) reported a 4.96, 5.23 and 5.40 scores for tenderness, Juiciness and flavour for Hereford bull meat on seven point hedonic scale. Jost *et al.* (1983) reported a Tenderness of 3.4, juiciness of 4.0 and flavour of 3.0 on eight point hedonic scales for carcasses from steers and heifers produced from straight-bred Angus, straight-bred Charolais and reciprocal cross cows.

Table 2 : Means of tenderness, juiciness and flavour of beef from Arsi cattle

Variables	N	Mean	S.D
Tenderness	152	5.24	1.273
Juiciness	152	5.21	0.943
Flavour intensity	152	5.47	1.013

Beef was rated on 8 point scale: Tenderness, Juiciness and Flavor intensity were rated on eight point scale, 1 = extremely tough, dry or bland and 8 as extremely tender, juicy or flavorful, S.D = standard deviation, N = number of samples examined.

The pearson correlation coefficients between tenderness, juiciness and flavor of beef are given in Table 21. Juiciness and tenderness has moderate positive correlation of 0.40 (P < 0.05). The significant positive relationship between tenderness and juiciness is also reported by Wheeler *et al.* (2005). Wheeler *et al.* (2005) also reported correlation index of 0.53 and 0.52 respectively. Flavor and tenderness has no correlation between them (P > 0.05). Wheeler *et al.* (2005) reported the weakest relationship between tenderness and flavour (r = 0.22). Thus this paper's result is in good agreement with Wheeler *et al.* (2005). Juiciness and flavor has strong positive correlation of 0.35 (P < 0.05).

The significant positive relationship between juiciness and flavor is also consistent with the early report of John *et al.* (1995) who reported correlation index of 0.47. This study report is also in agreement with John *et al.* (1995) report of existence of strong relationship between tenderness and juiciness with correlation index of 0.53. This report is also consistent with Wheeler *et al.* (2005) that reported a correlation index of 0.44 between juiciness and flavour. Lorenzen *et al.* (2003) reported a highly significant correlation between tenderness and juiciness (r =0.19, P < 0.0001) a non-significant correlation between flavour and tenderness (r = 0.08). These authors also reported the existence of a significant relationship between flavour and juiciness (r = 0.12, P < 0.001) for top-loin steaks. Jost *et al.* (1983) reported a 0.62 and 0.72 correlation coefficients between tenderness and juiciness, and between flavour and juiciness respectively.

Table 3: Correlation matrix between Eating Qualities of Arsi cattle beef

Variables	Tenderness	Juiciness	Flavour intensity
Tenderness	1	0.40	0.03
Juiciness		1	0.36
Flavour intensity			1

The pearson correlation coefficients between the proximate components and eating quality components are given in Table 25. Crude fat has no significant relationship with tenderness and juiciness (P > 0.2). Melton *et al.* (1974) also reported a non significant negative correlation (r = -0.26) between fat and tenderness. But Melton *et al.* (1974) reported a significant correlation coefficient of -0.46 between Fat and Juiciness. This research work has found out that fat and flavor has strong positive relationship (P < 0.005). But Melton *et al.* (1974) reported a non significant negative correlation (r = -0.26) between fat and flavour for Hereford American, breed, age, nutrition and general animal management difference may result in such difference.

There is no significant relationship between protein and tenderness (P > 0.2). Melton *et al.* (1974) reported a weak positive relation between tenderness and protein (r = 0.35). Again there is no relationship with protein and juiciness (P > 0.2). The correlation between protein and juiciness is in good agreement with Melton *et al.* (1974) report of a correlation coefficient of 0.20 between juiciness and protein. But protein and flavor has strong negative relationship (P < 0.005). Melton *et al.* (1974) reported a correlation coefficient of 0.50 between flavour and protein.

Jost *et al.* (1983) reported a non-significant correlation (r = 0.03) between moisture content and tenderness, (r = 0.13) between moisture content and flavour and (r = -0.17) between fat content and tenderness. Jost *et al.* (1983) reported a significant correlation(r = 0.18) between moisture content and juiciness and a correlation(r = 0.31) between protein content and tenderness. Jost *et al.* (1983) reported a significant correlation(r = 0.4) between protein content and juiciness and a correlation(r = 0.38) between protein content and flavour. Jost *et al.* (1983) reported a correlation value of -0.34, -0.26 and 0.26 between fat content and juiciness, between fat content and flavour and between protein content and moisture content respectively.

Table 4: Correlation matrix between Proximate and Eating Qualities of *longissimus dorsi* chuck of Arsi cattle beef

Variables	Protein	Fat
Tenderness	-0.18	0.19
Juiciness	0.07	-0.02
Flavour	-0.90	0.89

IV. Summary

This study was conducted to explore the eating qualities (sensory parameters) of beef in Adama town, Oromia region, Ethiopia. The study entails the specific objectives of investigating Eating Qualities of Arsi, Ethiopian beef.

Age and production system difference has made strongly significant variation in tenderness of beef (P < 0.0001). This implies that there is tenderness difference between lowland and highland animals (P < 0.0001). Interaction of age by production systems has no effect on eating qualities (P > 0.05). Juiciness of beef significantly varies between production systems (P < 0.05). There is no significant flavor intensity difference in beef between different age group and production systems (P > 0.05). Panellists rated beef of lowland origin cattle higher (P < 0.05) for tenderness, juiciness and flavour. In overall sense, the trained sensory panellists rated 5.23, 5.20 and 5.47 for beef tenderness, juiciness and flavour on eight point hedonic scale. Correlation coefficient of Eating Qualities of beef from Arsi cattle is significant ($P < 0.05$). Juiciness and flavor has strong positive correlation of 0.35 ($P < 0.05$). Juiciness and tenderness has moderate positive correlation of 0.40 ($P < 0.05$). Flavor and tenderness has no correlation between them ($P > 0.05$).

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