Camel (*Camelus dromedarius*) Meat Production Potentials and Associated Constraints in Eastern Ethiopia

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Abstract: This study was conducted to assess camels' meat production potentials and constraints hampering the production. Data were collected from 140 camels slaughtered at Dire Dawa abattoir and by interviewing 246 respondents using semi-structured questionnaire. The results show that live weight, carcass yield and dressing-out percentage were 334.7 kg, 186.4 kg and 55.5%, respectively. Consumption of camel meat ranked 1st in Shinile and 4th in Dire Dawa. Overall, the meat was preferred 1st in Shinile and 2nd in Dire Dawa. Camel meat had better preference due to its juiciness and flavour, but preferred least due to lower tenderness. About 56.1, 53.66, 46.7 and 58.53% of respondents preferred meat from young camel, camels in medium body condition, male camel and camels slaughtered in dry season, respectively. Primary reasons for more consumption and preference of camel meat include the perceived medicinal value, healthier meat source, and better flavour. Tenderness, leanness, flavour and medicinal values were perceived by respondents as descriptors of meat quality. Drying, salting, refrigeration, "Muqmad" (traditionally processed meat) preparation, and smoking were practiced to preserve camel meat. However, the camel and its meat production were constrained mainly by feed scarcity, disease, plant poisoning, marketing and management problems. Camels' high meat productivity, increasing trend in camel population, consumption and preference of camel meat by majority of respondents, and adoption of various meat preservation methods implied the high camel meat production potential. Appropriate management of rangelands, strengthening animal health service, and control of illegal market can improve the camel meat production in the study area.

Keywords: *Camel meat, Constraints, Consumption, Preference, Preservation*

Introduction

Ethiopia has 4.5 million heads of dromedary camels (*Camelus dromedarius*) (Shapiro *et al*., 2015), distributed in arid and semiarid areas that are not suitable for crop production and less proper for production of other livestock species (Bekele and Kebebew, 2002). Due to the continuing land degradation, climate change and rapid human population growth, the importance of camels is increasing because of their ability to play multipurpose roles under harsh environment (Bekele and Kebebew, 2002; Kadim *et al*., 2006). In Ethiopia, camels play vital roles mainly for milk production and transportation (Bekele and Dahlborn, 2004; CSA, 2013), but not primarily used for meat production (Simenew *et al*., 2013). Only 1.73% of the camel population aged 4 years and greater are kept as meat animals (camels reared only for meat either for home consumption and/or for sale) (CSA, 2013). However, a significant number of camels are slaughtered in Eastern Ethiopia in towns of Jijiga, Dire Dawa, Harar, Deghabur, Kebridehar, Gode, and other areas on daily basis for household consumption (Bekele and Kebebew, 2002) and during festive times (Eyassu, 2009). Camels are usually slaughtered at old ages and serve as good meat sources because they yield heavy carcasses at low cost in areas where the climate adversely affects other animals' production efficiency (Kadim *et al*., 2008; Kadim *et al*., 2013).

Demand for meat has been increasing rapidly in developing countries propelled by income, population growth, and urbanization (Jabbar *et al*., 2010). Camel meat could be a good option to meet the growing needs for meat in developing countries (Saparov and Annageldiyev, 2005). Moreover, consumers are becoming more cognizant of health-related problems of animal products (Jabbar *et al*., 2010). Camel meat is considered as healthier meat source due to its low fat and cholesterol contents (Al-Ani, 2004; Kadim *et al*., 2008). These attributes of camel meat contributed to an increase in the consumption of camel based products elsewhere (Al-Owaimer *et al*., 2014). However, information regarding the potential of camel as meat animal is scanty in Ethiopia in general and in the study area in particular. Potentials in terms of production, extent of consumption and preference, and preservation practices related to camel meat would have paramount importance to consider the camel as future meat animal.

Despite camels having the ability to survive and thrive under adverse climatic conditions (Kadim *et al*., 2006), their role as meat animal is hampered by a set of

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constraints. Constraints associated with camel husbandry have been assessed (Eyassu, 2009; Simenew *et al*., 2013). The constraints, however, were not entirely the same in all camel rearing areas and vary with time as triggered by changing climate, shrinkage of pastoral areas associated with population pressure and investment. Thus, assessment of constraints related to camel and its meat production with time interval has paramount importance to plan possible camel husbandry strategies.

Findings of this study are helpful to promote the significance of camel as meat animal in the changing global context, and to manage the niche that harbors this species. To remain competitive in the market, meat retailers must also respond to the signals of consumers. Thus, this study was undertaken with the objectives of assessing camel meat production potentials and constraints hampering the production in Shinile district and Dire Dawa administration in eastern Ethiopia.

Materials and Methods

Description of the Study Area

The study was carried out in eastern Ethiopia in particular in Shinile district of Somali National Regional State (SNRS) and Dire Dawa administration (DDA) which are major sources of camels slaughtered at Dire Dawa abattoir. A 20-year data (1996-2015) obtained from Meteorological Agency of Ethiopia indicated that the minimum and maximum temperatures were 13.5 and 31.7°C in Shinile, and 18.8 and 32.1°C in Dire Dawa. The African Rainfall Climatology (ARC) satellite data (between 1983 and 2015) showed that the overall mean annual rainfall of Shinile district was 447.5 mm and that of DDA was 680.5 mm. Both sites have bimodal rainfalls that occur between March to May and July to September.

The town of Shinile district (Shinile) has only 2 *kebeles* (the smallest administrative unit in Ethiopia), Shinile 01 and 02, and an equal number of rural kebeles (Mermarsa and Gobdin) out of the total 18 were selected for the study. Proportionally, 4 rural *kebeles* out of 38 (Gadanser, Goladeg, Lege Dini, and Mudi Anonno) and an equal number of *kebeles* in Dire Dawa town (Melka Jebdu, Megala Ch'ebt'u, Legarie, and Police Meret) out of the total 9 were selected.

Sample Size and Sampling Techniques

Previous study by Mohammed (2004) in Harar town revealed that 80% of the respondents rarely consume camel meat. Using 80% expected consumption for camel meat, 5% desired absolute precision, and 95% confidence interval (CI), sample size was determined using the formula of sample size determination in random sampling for a large population (Thrusfield, 2007):

$$n = \frac{(\frac{Z\alpha}{2})^2 P(1-P)}{d^2} = \frac{(1.96)^2(0.8)(1-0.8)}{(0.05)^2} = 246$$

where, n = required sample size; $Z\alpha/2$ = reliability coefficient or confidence interval (CI) = 1.96 for 95%; P = expected frequent consumption for camel meat; and d = desired absolute precision.

Accordingly, 246 respondents (an equal number of 20 respondents in each of the 12 selected *kebeles* and 6 butchers engaged in camel meat business in one of the selected *kebeles* in Dire Dawa town, Megala Ch'ebt'u, were randomly selected and interviewed. The rural *kebeles* were purposively selected based on accessibility provided that there is the practice of camel rearing; whereas, those in the towns were selected randomly.

Study Design and Data Collection

A pretested semi-structured questionnaire was used for field work. Enumerators that were drawn among development agents and experts were oriented before and during pre-testing the questionnaire. The actual survey was conducted using a single-visit multiple-subject survey method (ILCA, 1990). Respondents' order of consumption and preference on meat types has been rated (ranked) on a scale of 1 (consumed most frequently or most preferred) to 5 (consumed very rarely or least preferred). Moreover, focus group discussions (FGD) and key informants' interview were employed. The key informants consisted of experienced camel keepers, animal health professionals, and livestock experts.

The live body weight of 140 male Issa-Somali (Issa type) camels (94 from Shinile and 46 from Dire Dawa) that were brought to Dire Dawa abattoir for slaughter was estimated from body measurements as described by Younan *et al*. (2012): Body weight (kg) = SH × TG × HG × 50; where, SH = shoulder height measured vertically from the ground to the tip of the scapula using a graduated stick of 2.5 m height with a movable bar at right angle, TG = thoracic girth in meters using a tape around the body just behind the sternal pad, and HG = hump girth in meters using a tape along the abdomen over the midpoint of the hump.

Data Analyses

Data were analyzed using the Statistical Analysis System (SAS) 9.1 (SAS Institute Inc., Cary, NC, USA) (SAS, 2003). For ordinal data, rating of ranked data was adopted and such data were subjected to analysis using the nonparametric Kruskal-Wallis (K-W) test of SAS, with a follow-up of least significant difference (LSD) for comparison of means at $\alpha = 0.05$.

Results and Discussion

Potentials of Camel Meat Production

Camel meat sources and production: Pastoral communities of the study area slaughter camels in special occasions such as during wedding, mourning, and holidays. They rarely slaughter a camel in group. Similarly, the occasional consumption of camel meat in pastoral areas of Ethiopia has been reported in previous studies (Ahmed *et al*., 2003; Eyassu, 2009;

Yohannes *et al.*, 2009). On average, three camels were slaughtered per day at Dire Dawa abattoir for local consumption of the meat by residents in towns and the nearby pastoral communities. Of the different sources of camel meat, the butcheries contributed higher (P<0.001) amount of meat than the other sources (Figure 1). The camels produced high carcass yield. The mean live weight (LW), carcass yield (CY) and dressing-out percentage (DOP) were 334.7 kg, 186.4 kg and 55.5%, respectively (Table 1). Mohammed (2004) found a LW of 465.8 kg and CY of 252.3 kg for male mature Ogaden type camels at Jijiga abattoir. Yohannes *et al.* (2009) reported the meat production potential (CY) of male camels belonging to 12 camel types in Babile and Kebribeyah districts to be between 230.02-240.28 kg and 214.77-225.03 kg, respectively. The mean LW was 435.23 kg in Babile district and 407 kg in Kebribeyah district. The discrepancies between the current and previous studies may be due to the difference in breed or camel type, age or body condition of camels.

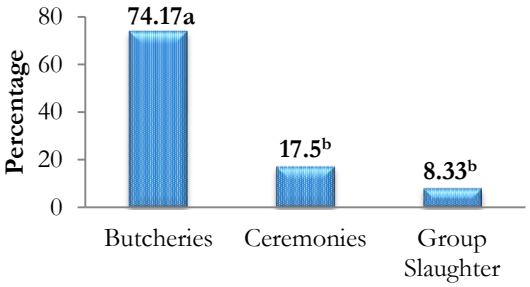

Figure 1. Major camel meat sources of respondent households in the study area

Table 1. Live weight, hot carcass weight (carcass yield), and dressing-out percentage of camels slaughtered at Dire Dawa abattoir (n = 140)

Parameter	Mean	SE	Minimum	Maximum
Live weight (kg)	334.7	5.28	145.9	544
Hot carcass weight (kg)	186.4	3.56	96.14	323.99
Dressing-out percentage (%)	55.5	0.5	44.2	69.4

SE= Standard error.

Mohammed (2004) found a comparable DOP of 54.03% (ranging from 49 to 59%) for mature male dromedary Ogaden type (Jijiga) camels. Similarly, Abebe *et al.* (2002) reported a DOP of 53.7% for male Issa type camels aged 10 years and older which was comparable to the present study; whereas, higher DOP (73.5%) has been reported for the same camel type by Mekonnen (2004). The variations in camel performances (body conditions) as a result of feed availability differences associated to climatic variability might have caused different DOP values for the same camel type as described by Abebe *et al.* (2002) and Mekonnen (2004). This implies that the determination of LW, CY and DOP at different time intervals is relevant to generate up to date information of a particular breed or type of camel.

The Dire Dawa abattoir slaughter camels sourced mainly from Shinile district and Dire Dawa administration since 2005. The meat produced was supplied through retail shops of butcheries to the local pastoral and non-pastoral communities (Table 2). The amount of meat produced in the abattoir was increasing, particularly from 2011 to 2015. There was a corresponding increase in camel population during the last decade as stated by camel owners (Table 3).

The total meat consumption of the country shows a positive trend owing to increasing income and population (AACCSA, 2015). The meat produced from camels slaughtered at Dire Dawa abattoir increased since 2011 most probably due to the same reasons. The study area was affected by drought in 2015 which might have forced camel owners to sell their animals including camels for purchase of consumable items. The increase in the number of camels slaughtered in 2015 by 63.54% compared to the 2014 slaughter may also be due to the supply of more camels to local markets that increased the slaughter volume in the abattoir. The same reasons might apply for 2009 high slaughter volume since the study area was hit by drought in 2007-2008 (Riche *et al.*, 2009). The import ban imposed by the Kingdom of Saudi Arabia in the year 2000 to 2009 on all livestock species and livestock products from the Horn of Africa due to Rift Valley Fever (RVF) has also affected the export of livestock market in the region (FEWSNET, 2010). The export ban might have caused more camels to be supplied to the abattoir for local consumption which increased the 2009 slaughter volume, followed by a decline then after with the lifting of the ban in October 2009.

Several previous studies have reported the high camel resource potential with increasing trend in different parts of the country to be associated with high capability and comparative economic importance of camels against the driving forces of rangelands ecological changes such as bush encroachment and increased drought recurrences (Solomon and Coppock, 2004; Yacob and Catley, 2011).

Consumption of camel meat: Overall, chevon received the highest rate (rank) (P<0.05) as it was consumed frequently, followed by camel meat, mutton, beef, and chicken meat. In Shinile, respondents consumed camel meat and chevon frequently (P<0.05) followed by the consumption of mutton, beef, and chicken meat. In Dire Dawa, chevon ranked first, followed in a decreasing order by mutton, beef, camel meat, and chicken meat (Table 4).

The primary reasons for consuming more of camel meat than other meats are presented in Figure 2. The reasons given by the respondents include the camel

meat is lean in nature and does not disturb the digestive system, and considered healthier meat source as the animals feed on browse plants including herbal that are not in contact with contaminated soil. Consumption of camel meat was also considered as "*Sunnah*" (religiously recommended act).

Table 2. Camels slaughtered at Dire Dawa abattoir (2009-2015) and the estimated meat production

Parameter	Year of Slaughter							Total
	2009	2010	2011	2012	2013	2014	2015	
Camels (No.)	529	35	28	20	36	57	1238	5543
Meat (kg)	285006	137004	1139	78288	99910	41105	230763	1033215

Source: Dire Dawa abattoir.

Table 3. Trends in camel population over the last decade (2004-2013) as perceived by camel-owning rural respondent (N= 120)

Trends in Camel Population	Shinile (N= 40)		DDA (N= 80)		Overall (N= 120)	
	N	%	N	%	N	%
Increasing	20	50	42	52.5	62	51.7
Decreasing	14	35	20	25	34	28.3
Almost stable	6	15	18	22.5	24	20

DDA= Dire Dawa administration; N= Number of respondent households.

The increasing trend in camel meat consumption from 11050 tons in 2000 to 19800 tons in 2012 as described by FAOSTAT (2013) would probably be associated with the reasons described in Figure 2 and the increase in camel meat consumers linked to an increase in human population. The Ethiopian livestock master plan states that projected domestic consumption requirements for red meat rises due to rapidly growing population, increasing urbanization, and rising incomes (AACCSA, 2015). Variations in individual preferences, culture, income, prices, and beliefs are the other factors that affect consumption pattern (Ahmed *et al.*, 2014).

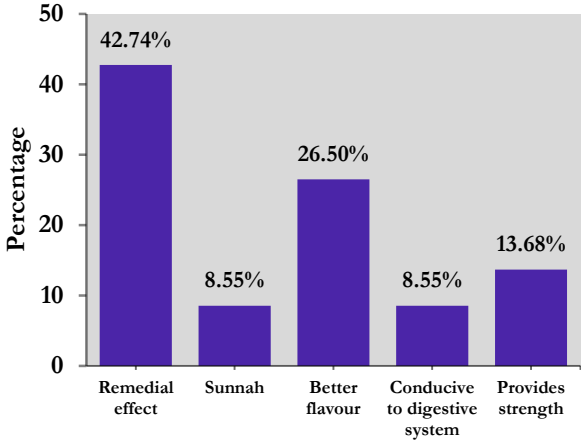

Figure 2. Primary reasons for respondents consuming more camel meat than other meats

Preferences to camel meat: Respondents expressed their preferences in relation to the meat types mentioned earlier and meat attributes (tenderness, flavour, and juiciness) (Table 5); and, age, body condition, sex and season of slaughter of camels (Table 6). The overall preference among meat types showed that camel meat ranked first and was highly preferred ($P<0.05$) to chevon in Shinile, and opposite was the case in Dire Dawa. In terms of meat attributes, camel meat was the least preferred for tenderness, but it has got better preference for flavour and juiciness (Table 5). The variations observed between the study sites in the current study imply that households dwelling even at proximity have different patterns of preference for meat. Mohammed (2004) found that camel meat ranked first followed in order by beef, chevon and mutton in Jijiga town for overall preference and flavour; whereas, beef preferred first in the nearby Harar town (100 km far from Jijiga), followed in order by chevon, camel meat, and mutton.

The perceived medicinal value of camel meat to many diseases such as cough, gastritis, malaria, tuberculosis, jaundice, and even HIV; and, the leanness and better flavour of the meat were also the major reasons for which camel meat was preferred. According to butchers, the hump and liver were preferred by consumers as they have good taste and believed to have an aphrodisiac effect and make people strong. Camel meat was claimed by the Somalis in Jijiga to have a remedial effect for at least 13 different kinds of diseases including hyperacidity, respiratory diseases, hypertension, pneumonia, and also to be an aphrodisiac (Mohammed, 2004). Respondents, however, do not practically consume more camel meat corresponding to their preference as camels are expensive and not affordable to be slaughtered at household level.

Regarding camel meat preference in relation to age, body condition, sex, and season of slaughter of camels, meat obtained from younger camels was highly preferred ($P<0.05$) by 56.1% of respondents; meat from medium-conditioned camels was preferred by the majority of the respondents (53.66%); about 46.7% of the respondents preferred ($P<0.001$) male camels' meat to that of females'; and, 58.53% highly preferred ($P<0.001$) camel meat during the dry season (Table 6).

Young camels' meat was highly preferred primarily due to its leanness, tenderness, juiciness, and fast cooking. Meat production is linked to proper herd management in terms of selection of animals to be slaughtered. Animals such as young males and females which are not kept for reproduction or other activities (Faye, 2015) can be used in feedlot fattening. Ogunwole and Adedeji (2014), however, found an increasing preference for meat with increasing age of different animals other than camel. Camels have long life span of up to 35 years (Abebe, 1991) than other meat animals and commonly slaughtered at old ages after completing a career in work or milk production (Kadim *et al*., 2013) which render them to produce meat with pronounced toughness. This is the most likely reason for the differences between the findings of Ogunwole and Adedeji (2014) and the present study.

Table 4. Consumption pattern of camel meat in comparison with other meat types

Study Site	Meat Types	Order of Consumption						NC	Mean Rank (Rating)
		1st	2nd	3rd	4th	5th	Missing (Never)		
Shinile (N = 80)	Camel	38	17	10	15	0	0	80	2.03[a]
	Beef	1	9	35	32	0	3	77	3.27[c]
	Chevon	33	29	12	6	0	0	80	1.89[a]
	Mutton	8	25	22	22	0	3	77	2.75[b]
	Chicken	0	0	0	0	6	74	6	5.00[d]
Dire Dawa (N = 166)	Camel	21	30	38	55	11	11	155	3.03[c]
	Beef	16	27	65	35	5	18	148	2.91[bc]
	Chevon	108	43	11	4	0	0	166	1.46[a]
	Mutton	18	59	32	34	7	16	150	2.69[b]
	Chicken	3	7	12	16	38	90	76	4.04[d]
Both Sites (N = 246)	Camel	59	47	48	70	11	11	235	2.69[b]
	Beef	17	36	100	67	5	21	225	3.03[b]
	Chevon	141	72	23	10	0	0	246	1.60[a]
	Mutton	26	84	54	56	7	19	227	2.71[b]
	Chicken	3	7	12	16	44	164	82	4.11[c]

[abcd]*Mean ratings with the same letter superscripts in the same column under the same study site are not significantly different (P<0.05); Missing refers to respondents who never consume meat and excluded from rating; NC= Number of consumers; Rating values are not self-explanatory whereby lower rating values implied increased regularity of consumption as the computation was based on rank of regularity of consumption.*

Table 5. Preference ratings of meat of different species based on respondents' overall perception and specific meat attributes

Meat Preference Attributes	Study Site	Meat Types				
		Camel meat	Beef	Chevon	Mutton	Chicken meat
Overall Preference	Shinile	1.54[a]	3.23[c]	2.04[b]	3.10[c]	5.00[d]
	Dire Dawa	2.07[b]	3.39[c]	1.73[a]	3.31[c]	3.30[c]
	Both	1.89[a]	3.33[b]	1.83[a]	3.24[b]	3.42[b]
Tenderness	Shinile	3.25[c]	2.56[b]	2.09[a]	2.14[a]	3.71[c]
	Dire Dawa	3.66[d]	2.85[b]	1.96[a]	2.14[a]	3.21[c]
	Both	3.53[c]	2.75[b]	2.00[a]	2.14[a]	3.29[c]
Flavour	Shinile	1.56[a]	3.11[c]	1.95[b]	3.42[d]	4.00[e]
	Dire Dawa	2.38[b]	3.35[d]	1.67[a]	3.50[d]	2.82[c]
	Both	2.11[b]	3.27[d]	1.76[a]	3.47[e]	3.02[c]
Juiciness	Shinile	2.33[a]	2.81[b]	2.43[a]	2.39[a]	4.65[c]
	Dire Dawa	2.03[a]	3.02[b]	2.87[b]	2.18[a]	4.17[c]
	Both	2.13[a]	2.95[c]	2.73[b]	2.51[a]	4.26[d]

[abcde]*Mean ratings with the same letter superscripts in the same row are not significantly different (P<0.05); Rating values are not self-explanatory whereby lower rating values implied higher preferences as the computation was based on rank of preferences.*

Respondents had no preference for meat originated from poor-conditioned camels considering it to be unhealthy meat source. On the other hand, consumers of camel meat are well accustomed to consumption of male camels' meat which could be attributed to the more frequent slaughtering of males than females camel consequently resulting in the highest proportion of respondents to prefer such meat. Female camels are primarily kept for reproduction and slaughtered too rarely in cases when they are confirmed infertile, physically damaged, or too old. In Shinile, preference for female camels' meat was comparable to males' since

respondents considered it as softer (tender) due to the restricted exercise where the females are not engaged in heavy duties like transportation. The slaughtering rate is obviously higher in male than in female camels (Faye, 2015). According to Melaku and Fesseha (2001), up to 90% of the slaughtered camels in eastern Ethiopia are males and only unproductive females are slaughtered. In both the study sites, camel meat was preferred in the dry season when shortage of milk and other food sources encounter. Respondents further noted that meat has longer shelf life and better flavour during the dry season, but it has shorter shelf life and appears watery in wet season.

Table 6. Respondents' preference to camel meat in relation to age, body condition, sex, and season of slaughter

Parameters	Shinile (N= 80)	Dire Dawa (N= 166)	Both Sites (N= 246)
	N (%)	N (%)	N (%)
Age			
Young (≤ 9 years)	45 (56.25)[a]	93 (56.02)[a]	138 (56.1)[a]
Medium (10 to 18 years)	25 (31.25)[b]	46 (27.71)[b]	71 (28.86)[b]
Old (≥ 19 years)	9 (11.25)[c]	17 (10.24)[c]	26 (10.57)[c]
Equally any age	1 (1.25)[d]	2 (1.21)[d]	3 (1.22)[d]
No idea	0	8 (4.82)[cd]	8 (3.25)[d]
Body Condition			
Poor	0	0	0
Medium	36 (45)[a]	96 (57.83)[a]	132 (53.66)[a]
Good	44 (55)[a]	62 (37.35)[b]	106 (43.09)[a]
No idea	0	8 (4.82)[c]	8 (3.25)[b]
Sex			
Male	28 (35)[a]	87 (52.4)[a]	115 (46.7)[a]
Female	31 (38.8)[a]	39 (23.5)[b]	70 (28.5)[b]
Equally both sexes	21 (26.2)[a]	31 (18.7)[b]	52 (21.1)[b]
No idea	0	9 (5.4)[c]	9 (3.7)[c]
Season			
Dry	56 (70)[a]	88 (53)[a]	144 (58.53)[a]
Wet	16 (20)[b]	12 (7.2)[b]	28 (11.38)[c]
Equally both seasons	8 (10)[b]	59 (35.5)[a]	67 (27.24)[b]
No idea	0	7 (4.2)[b]	7 (2.85)[d]

[abcd]*Mean values with the same letter superscripts in a column and under the same parameter are not significantly different (P<0.05).*

Preservation practices and perception to quality of camel meat: Meat preservation by drying tops the list as it was practiced by majority of respondents in Shinile (36.79%) and Dire Dawa (30.75%) (Table 7). Drying involves cutting or thinning of lean meat into slices to which salt and sometimes red pepper (*Capsicum spp.*) powder (RPP) is added and the slices let to dry under the direct sunlight or at room. The application of RPP on meat has antimicrobial effect (Careaga *et al*., 2003). Dried meat can be stored up to 3 years with frequent checkup for moisture. Drying after frying was the other form of drying involving partial frying of lean meat until much of the water dripped off, followed by sun or open air drying. This method enables the meat to have good flavour with maximum shelf life of 6 months. The third form of drying is drying after partial cooking, which involves cooking the meat to drip much of the water, cutting the meat into thin slices, application of salt and sometimes ginger, and finally drying. "*Darreein*" is a meat product processed by drying on direct sunlight in Afder zone of Somali region especially during drought catastrophes when large numbers of animals are dying (Ahmed *et al*., 2003).

Finely ground salt alone or being mixed with RPP is applied on top of the sliced meat. Salting is mostly followed by drying or *Muqmad* preparation. *Muqmad* is a traditional meat preservation which involves cooking fresh or dried lean meat slices in a dish without or with little water and added RPP and salt until much of the water dripped off. The fat initially separated from the lean is melted in a dish where the liquid that comes out from the fat (known as camel butter) is mixed with the cooked lean meat. Garlic (*Allium sativum*) and other spices are added to improve the product's flavour and shelf life, and finally the product is stored in a special container made of stainless steel for 2 to 3 months. It is prepared in occasions during marriage, for treating bone fracture, and for home consumption. *Muqmad* is prepared commonly from camel meat, beef, and chevon in the order listed. "*Olobe*" is a traditionally processed meat product in Afder zone of Somali region (Ahmed *et al*., 2003) which is similar to *Muqmad*. Refrigeration is practiced in towns. The availability of various meat preservation methods is vital for pastoralists of the study area especially when drought occurs and enables pastoralist communities to slaughter their animals and preserve the meat for several months rather than losing animals due to mortality catastrophe.

Respondents have good knowledge about the relevance of preservation practices. Majority of

respondents (170 or 69.1%) stated that preservation prolongs the shelf life of meat, 15 (6.1%) appreciated improvement of eating quality (flavour and tenderness), while 61 (24.8%) mentioned that both shelf life and eating quality improved (Table 7).

Table 7. Meat preservation methods commonly practiced in the study area

Preservation Methods and their Relevance	Shinile (N= 80)		Dire Dawa (N= 166)		Overall (N= 246)	
	Freq.	%	Freq.	%	Freq.	%
Types of Preservation						
Drying	71	36.79	107	30.75	178	32.9
Salting	45	23.32	76	21.84	121	22.37
Refrigeration	19	9.84	86	24.71	105	19.41
"*Muqmad*"	57	29.53	57	16.38	114	21.07
Smoking	1	0.52	11	3.16	12	2.22
Drying after frying	0	0	7	2.01	7	1.29
Drying after partial cooking	0	0	4	1.15	4	0.74
Importance of Preservation						
Prolongs shelf life	53	66.25	117	70.48	170	69.1
Improves eating quality	2	2.5	13	7.83	15	6.1
Improves both shelf life and eating quality	25	31.25	36	21.69	61	24.8

N= Number of respondents; Freq.= Frequency of respondents response; Percentage values are calculated using total column frequency of an attribute with in study site as a denominator.

Higher proportion of respondents perceived that tender and lean meat to be high in quality (Figure 3). Meat originated from healthy camels was considered to have better medicinal value. Camel meat is conducive (does not disturb the digestive system unlike mutton) during consumption due to its leanness. Meat leanness is linked to a healthy life (Kerry *et al*., 2002). The quality perception in terms of fat content differed among respondents in that 11.37% were accustomed to consumption of hump fat and considered fatty meat as high quality, while 21.11% claimed leanness to describe meat quality. Leanness and tenderness are linked to age of camel. There are ample studies that have noted meat from younger camels to be of high quality (Kadim *et al*., 2006; Kadim *et al*., 2008). Improvement in tenderness and flavour of meat are also linked to fat content (Miller, 2004). Lean meat with optimum fat level can be a compromise for many of the respondents to consider it as quality product.

Respondents reflected their perception regarding camel meat quality without giving them any definition or meaning of 'quality' to know how their perceptions matched the standard concepts of meat quality. The quality perceptions defined by respondents for camel meat revealed that even in the absence of scientifically based official standards, consumers have ways of identifying quality of a meat product.

Constraints to Camel and Camel Meat Production

Focus group discussants pointed out that rainfall variability, recurrent drought, and deforestation for firewood and charcoal production altered the vegetation composition. Invasion of rangelands by non-native species such as *Prosopis juliflora* and bush encroachment caused feed scarcity as the primary constraint on productivity of camels (Table 8). *Prosopis juliflora,* especially in Shinile district*,* invaded vast area of rangelands, and restricted movement of animals. Its thin and spiny thorns penetrate and wound feet pads of camels. The sharp, strong, and poisonous thorns of *P. juliflora* caused wounds to livestock and human beings in Dire Dawa (Jema and Abdu, 2013).

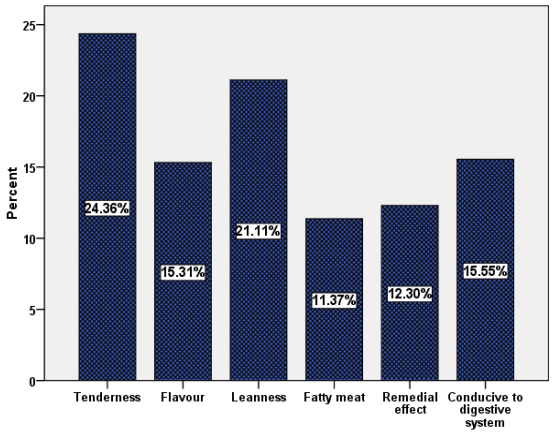

Figure 3. Attributes used to define quality of camel meat as perceived by respondents

Deaths of livestock related to drought are common. Camels tolerate drought better than other species, but they are not drought-proof (Yacob and Catley, 2011). The Shinile district Office of Agriculture reported that about 18.95, 31.8, 40.4 and 63.63% mortality rates were recorded in camels, cattle, goats and sheep, respectively during the 2015 drought. The death rate of animals was high which is indicative of the severity of the drought. Drought impacts include decreased feed and water availability, overgrazing, mobility to distant areas, loss

of body condition and poor resistance to disease and death of animals (Riche *et al*., 2009). The district Office of Agriculture and NGOs were supplying feed to mitigate the catastrophe.

Trypanosomiasis, cough, pasteurellosis, paralysis, liver infection, lung worm, and wound due to transportation or cannibalism during rutting were the major health problems of camels reported from respective offices of agriculture of the study sites. Occasional lack of drugs and vaccines limited the veterinary health service. Mortality of calves was a common problem. Newborn mortality in camels is very common and calf losses as high as 50% have been reported in different parts of eastern Africa (Kamber *et al*., 2001). Diseases hamper the export market as a result of frequent bans imposed by importing countries (Belachew and Jemberu, 2003).

Table 8. Major constraints to camel and its meat production in the study area

Constraints	Shinile (N= 40)		Dire Dawa (N= 80)		Overall (N= 120)	
	Freq.	%	*Freq.*	%	*Freq.*	%
Feed scarcity	30	18.07	54	18.75	84	18.50
Invasive weeds and thorns	31	18.67	51	17.71	82	18.06
Drought	18	10.84	45	15.62	63	13.88
Diseases and parasites	23	13.85	37	12.85	60	13.22
Plant poisoning	21	12.65	26	9.03	47	10.35
Calf mortality	19	11.45	26	9.03	45	9.91
Marketing problem	13	7.83	18	6.25	31	6.83
Management problem	9	5.42	12	4.17	21	4.63
Attack by predator	1	0.60	15	5.201	16	3.52
Animal loss in the field	1	0.60	4	1.39	5	1.10

N= Number of respondents; Freq.= Frequency of respondents response; Percentage values are calculated using column frequency of study site as a denominator.

Toxicity by poisonous plants was the other serious problem on camels' production and productivity. Cactus (*Opuntia ficus indica*) caused bloating and diarrhoea in camels probably due to the high water content in the plant. The lack of proper feeding management and high water content of cactus (*Opuntia ficus indica*) were reported as major causes for bloat and diarrhoea (Firew *et al*., 2008). During feed scarcity, camels consume the leaves and pods of *Prosopis juliflora,* with more preference to the pods. According to a key informant from Dire Dawa town veterinary clinic, excess consumption of the pods causes colic in the digestive system where the rate of passage of the digesta reduced highly due to twisting of the intestine and the animals cannot defecate and may die unless the blockade is removed. Pods of *P. juliflora* consumed along with *Opuntia ficus indica* also cause bloating. However, the detrimental effects of *P. juliflora* leaves on camels are not clearly noticed. Camels consuming the poisonous plant locally known as *gemour* (*Acacia oerfota*) cease feeding and in severe cases they may die of toxicity. Eyassu (2009) noted *gemour* (*Acacia oerfota*), *gumar* (*Acacia nubiaca*), and *Irgin* (*Euphorbia tirucalli*) as major poisonous plants affecting camels in Jijiga and Shinile zones.

Attack by predators (particularly hyena attack on calves), theft, and raiding or death of animals during conflicts was some of the problems affecting camel production. Inaccessibility of market sites, sale of camels based on visual observation rather than on live weight, and bargaining of camel prices through brokers were some of the marketing problems reported by households and butchers in the study area. According to butchers, the low supply and high price of camels at local markets due to competitive and attractive price fetched through illegal (contraband) trade limited the local camel meat supply despite the high demand. Butchers reported that frequent power interruption has negatively influenced meat preservation using refrigeration.

Conclusion

Under the existing ecological changes, the camel population is increasing and they could produce considerable amount of meat vital for future generation. The regular slaughter of camels at Dire Dawa abattoir increased the meat consumption of respondents. The consumption and preference for camel meat were higher in Shinile than in Dire Dawa. The major reasons for respondents to consume and prefer camel meat were the food value, perceived medicinal value, healthier meat source, and better flavour of camel meat. The variations in preferences to camel meat in relation to age, body condition, sex, and season of slaughter dictate the need for designing strategy to supply camels as demanded by the market.

The camel meat preservation methods are important to prolong shelf life and eating quality during normal periods and when catastrophes such as drought occur. The quality perceptions defined by respondents revealed the indigenous knowledge to identify meat quality in the absence of scientific standards. However, the existing set of constraints has detrimental effect to camels and their meat production potential. Appropriate management of rangelands will improve

the camel husbandry and camel meat production of the study area.

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Conflict of Interests

The authors declare that they have no competing interests.

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