academicJournals

Vol. 10(1) pp. 12-16, January 2016
DOI: 10.5897/AJFS2015.1349
Article Number: 4455F1256939
ISSN 1996-0794

http://www.academicjournals.org/AJFS

African Journal of Food Science

Full Length Research Paper

Influence of means of transportation on the quality of beef from three indigenous cattle breeds in Cameroon

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Received 18 July, 2015; Accepted 12 November, 2015

The influence of transportation conditions on the quality of beef was evaluated on carcasses from three indigenous cattle breeds in Cameroon. Twenty bulls of similar age (3 to 5 years inclusive) from the Gudali, Red Mbororo and White Fulani breeds transported by train and by truck from the same production zone to the abattoir were investigated. Beef samples were used to evaluate technological and chemical properties. Gudali bulls transported by train produced beef with the highest proportion of bright red colour (85%). Beef from Gudali bulls transported by truck had the highest drip loss (9.87±2.82%), White Fulani bulls transported by truck produced beef with the highest freezing and cook-out losses (19.40±3.02 and 28.37±1.90% respectively). Means of transportation did not significantly (p>0.05) influence chemical properties. These results indicate that in Cameroon, animals transported by truck give poor quality beef. Therefore, measures should be taken to minimize animal stress especially during truck transportation.

Key words: Beef quality, indeginouscattlebreed, technological properties, chemical properties, Cameroon.

INTRODUCTION

Livestock production is a rapidly fast growing agricultural subsector in developing countries. Its share of agricultural gross domestic product (GDP) in Cameroon is about 35% and increasing (ECA/SRO-CA, 2012). The growth is driven by rapidly increasing demand for livestock products due to population growth, urbanization and increasing incomes in developing countries (Gebresenbet et al., 2004). There is a steady rise in demand for meat in Cameroon as the national population increases. Cattle contribute approximately 28% of the total animal protein produced in the country with the Gudali, Red Mbororo and White Fulani contributing 45 to 54% of meat consumed in the cities (FAO, 2008).

Transportation of cattle from the production areas to the slaughter house is always accompanied by some degree of stress which subsequently influences the overall quality of the beef. Swanson and Morrow-Tesch (2001) identified the main factors involved with "transport stress" to include pre-transport management, noise, vibration, novelty, social regrouping, crowding, climatic

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factors (temperature, humidity and gases), restraint, loading and unloading, duration oftransit, resting during transport, feed and water deprivation and waiting time after arrival before slaughter. These factors compromise the welfare of the animals and reduce meat quality: lean colour, drip and cook-out losses (Warriss et al., 1995; Grandin, 2000). Incidences of dark-cutting beef provide information about the welfare of cattle during handling, transport and lairage (Broom, 2003). Furthermore, the intensity of stress varies depending on the means of transportation employed. Cattle transported by railcar reportedly were less stressed and lost 4% less liveweight than those shipped through equivalent distance in trucks (Friend et al., 1981).

Putting knowledge into evidence concerning the transportation of animals destined for slaughter can be of assistance in reducing mortality during transportation, reducing skin and carcass damage, increasing the quality of meat supplied to consumers and consequently reducing economic losses to the beef industry (Ljungberg et al., 2007). The main objective of this research was thus to investigate the possible influence of different means of transportation on the technological and chemical properties of beef from the three main indigenous cattle breeds reared in Cameroon.

MATERIALS AND METHODS

Selection of animals and sample collection

Sixty bulls of similar slaughter age (3 to 5 years inclusive) from the three predominant breeds: 20 Gudali, 20 Red Mbororo and 20 White Fulani from the Guinea high savannah agro-ecological zone and reared under the transhumance production system were sampled at the Yaoundé SODEPA abattoir for investigation during May to June, 2014. Among the 20 animals selected from each breed, 10 had been transported to the abattoir by truck and the other 10 by train. An inclined wooden platform supported by a heap of grass is used for on and off loading of the animals. However, cattle movement on and off the train is easier because the angle of inclination is lower than the truck. Averagely, 20 animals are loaded in each train wagon of 24 m^2 area while the same number of animals is loaded on trucks each having an average area of $18m^2$. The distance covered by the animals from production site to slaughter house was 673 km by road (duration in transit was 3.5 days) and 622 km by train (duration in transit was 2 days). Most of the road is not tarred, with many potholes. During transit, the animals transported by truck are off loaded once to rest and graze while those in the train are provided water only and do not get off the train until the final destination. All the animals were slaughtered between 12 and 15 h after arrival; they were provided forage and water during this period.

Following slaughter and immediately after carcass dressing, a sample (approximately 1000 g) of *Longissimusdorsi* muscle (between 12^{th} and 13^{th} rib) was removed from the left side by cutting a three-centimetre thick chop from the section dividing the thoracic and lumbar parts of the muscle of each animal. Approximately, 500 g from each sample was used for the evaluation of technological (drip, freezing and cook-out losses) properties and the remaining 500 g was used for chemicalanalysis. Lean colour was assessed on the pelvic region and on the section of the semi-membranous muscles exposed by tail removal immediately after carcass dressing (Nfor et al., 2014).

Evaluation of technological properties

Using a three-point scale, lean colour was assessed visually and graded as pink, bright red or dark red (Baublits et al., 2005). After 24 h storage of meat samples at 4°C, drip loss was calculated as the difference between initial and final weights and expressed as a percentage. Cook-out-loss was evaluated using the method described by Piasentier et al. (2003). 6 h after slaughter, meat samples in ziploc bags were immersed in a thermostatic water bath at 75°C for 15 min. Cook-out-loss was obtained as the difference between the initial and the final weights and expressed as a percentage. Freezing loss was evaluated using the method described by Piasentier et al. (2003). Meat samples were frozen at -20°C for 14 days, then thawed to room temperature (2°C) and reweighed. Freezing loss was calculated as the difference in weight loss before and after freezing and expressed as a percentage.

Evaluation of chemical properties

Meat samples were minced and dried in a ventilated oven at 60°C for 20 to 24 h when a constant weight was attained. Moisture content was calculated as the difference in weight before and after drying. Crude protein, crude lipid and ash contents were estimated on dry matter basis as described (AOAC, 2000). The results were expressed as percentages.

Statistical analysis

Lean colour was expressed in percentage. The effects of transportation means on technological and chemical properties of beef irrespective of breed was evaluated using the Student t-test at a significance level of $p<0.05$. The effects of transportation means on the technological and chemical properties of beef with respect to breed were evaluated using ANOVA (General Linear Model approach; SPSS version 19.0). Means were separated for significant differences ($p<0.05$) using Duncan's multiple range test (Steel and Torrie, 1980).

RESULTS

Technological properties of beef

Lean colour

Lean colour carcass distribution as affected by means of transportation is presented in Figure 1. Within breed analysis revealed, most (85%) of Gudali bulls transported by train gave carcasses with a bright red lean colour compared to only 54% transported by truck. The same trend was observed in carcasses from the other breeds. Between breeds comparison revealed for animals transported by train, the highest percentage bright red colour was found in carcasses from Gudali bulls (85%), pink colour was most predominant in carcasses from White Fulani bulls (22%) while dark red colour was greatest in carcasses from Red Mbororo bulls (22%). For transportation by truck, the highest proportion of lean with bright red colour was recorded in carcasses from Gudali bulls (54%), pink colour was greatest in carcasses from Red Mbororo bulls (67%) while the dark red colour was most predominant in carcasses from White Fulani bulls

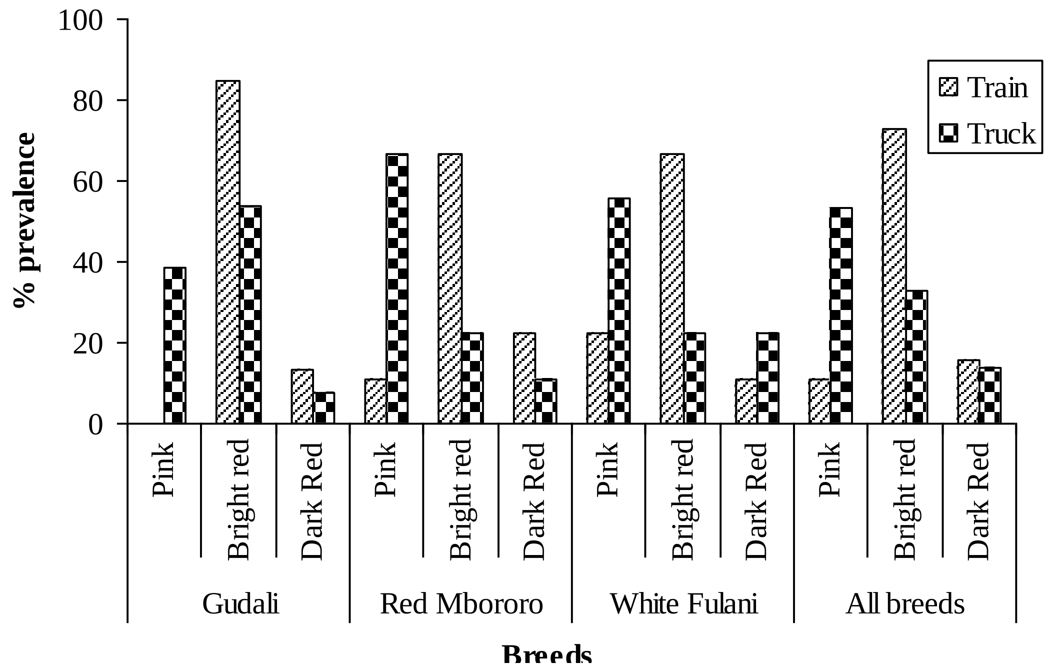

Figure 1. Lean colour distribution of beef from three indigenous cattle breeds in Cameroon.

Table 1. Influence of means of transportation on technological properties of beef with respect to cattle breed (for each breed, n=10 per means of transportation).

Technological property (%)	Transportation means	Gudali	Red Mbororo	White Fulani	All breeds
Drip-loss	Train	$8.63\pm2.65^{a\mu}$	$4.16\pm2.37^{a\mu}$	$6.60\pm5.45^{a\mu}$	6.23 ± 1.89^{a}
	Truck	$9.87\pm2.82^{a\$}$	$4.52\pm2.19^{a\mu}$	$7.09\pm4.79^{a\mu\$}$	8.13 ± 2.51^{a}
Freezing-loss	Train	$10.38\pm5.34^{a\mu}$	$11.38\pm7.45^{a\mu}$	$13.57\pm2.91^{a\mu}$	12.27 ± 2.59^{a}
	Truck	$16.92\pm3.22^{a\mu\$}$	$13.54\pm2.73^{a\mu}$	$19.40\pm3.02^{b\$}$	16.12 ± 6.71^{a}
Cook-out loss	Train	$23.04\pm0.58^{a\mu}$	$24.14\pm2.25^{a\mu}$	$23.44\pm1.28^{b\mu}$	23.19 ± 1.43^{a}
	Truck	$24.19\pm6.72^{a\mu}$	$22.69\pm5.31^{a\mu}$	$28.37\pm1.90^{a\mu}$	24.74 ± 4.91^{a}

$^{a,\ b}$: Means with different superscript letter on same column for the same technological property are significantly different at 5 %$^{;\ \mu,\ \$:}$ Means with different superscript letter on same row for the same technological property are significantly different at 5%.

(22%). Irrespective of breed, bright red lean colour was dominant in carcasses from cattle transported by train (73%) while this colour was present in only 33% of carcasses from animals transported by truck. More than half (54%) of all the animals transported by truck were lean with a pink colour.

Drip, cook-out and freezing losses

In general, drip, freezing and cook-out losses were greater in carcasses from animals transported by truck than by train, (Table 1) although the differences were not significant ($p>0.05$). Drip loss was highest in carcasses from Gudali bulls transported by truck (9.87±2.82%) and lowest in Red Mbororo transported by train (4.16±2.37%). For truck transportation, drip loss of carcasses from Red Mbororo bulls (4.52±2.19%) was significantly lower ($p<0.05$) than in carcasses from Gudali bulls (9.87±2.82%). Freezing loss was greatest in carcasses from White Fulani transported by truck (19.40±3.12%) and lowest in carcasses from Gudali transported by train (10.38±5.34%). Freezing loss was significantly higher ($p<0.05$) in carcasses from White Fulani bulls transported by truck (19.40±3.12%) than by train (13.57±2.91%). Furthermore, freezing loss was significantly higher ($p<0.05$) in carcasses from White Fulani bulls (19.40±3.12%) than in carcasses from Red Mbororo bulls (13.54±2.73%) transported by truck. Influence of transportation means on cook-out loss was observed only

Table 2. Influence of means of transportation on chemical properties of beef with respect to breed.

Chemical property (%)	Transportation means	Gudali	Red Mbororo	White Fulani	All breeds
Moisture	Train	$67.74\pm7.69^{a\ \mu}$	$69.25\pm5.42^{a\ \mu}$	$70.01\pm7.35^{a\ \mu}$	69.02 ± 10.29^{a}
	Truck	$69.36\pm4.87^{a\ \mu}$	$73.35\pm4.14^{a\ \mu}$	$66.75\pm7.85^{a\ \mu}$	$69.74\pm.8.84^{a}$
Crude ash	Train	$1.54\pm0.33^{a\ \mu}$	$1.41\pm0.48^{a\ \mu}$	$1.25\pm0.17^{a\ \mu}$	1.40 ± 0.48^{a}
	Truck	$1.47\pm0.44^{a\ \mu}$	$1.13\pm0.12^{a\ \mu}$	$1.45\pm0.41^{a\ \mu}$	1.35 ± 0.59^{a}
Crude protein	Train	$24.06\pm5.29^{a\ \mu}$	$21.85\pm4.58^{a\ \mu}$	$20.19\pm3.17^{a\ \mu}$	21.98 ± 4.07^{a}
	Truck	$23.02\pm2.70^{a\ \mu}$	$19.95\pm2.68^{a\ \mu}$	$25.83\pm6.87^{a\ \mu}$	22.93 ± 2.18^{a}
Crude lipid	Train	$3.61\pm1.95^{a\ \mu}$	$3.08\pm0.42^{a\ \mu}$	$4.04\pm1.73^{a\ \mu}$	3.57 ± 1.04^{a}
	Truck	$2.54\pm1.39^{a\ \mu}$	$2.52\pm0.87^{a\ \mu}$	$3.96\pm2.22^{a\ \mu}$	3.00 ± 2.18^{a}

$^{a,\ b}$: Means with different superscript letter on same column for the same chemical property are significantly different at 5 %$^{;\ \mu,\ \$:}$ Means with different superscript letter on same row for the same chemical property and for the same means of transportation are significantly different at 5%.

in carcasses from White Fulani bulls where the loss was significantly higher ($p<0.05$) in carcasses transported by truck (28.37±1.90%) than by train (23.44±1.28%).

Chemical properties of beef

Moisture and crude protein were slightly higher in carcasses transported by truck than by train (Table 2). Conversely, crude ash and crude lipid were slightly higher in carcasses from animals transported by train than by truck. However, no significant differences ($p>0.05$) were noted in the chemical properties with respect to means of transportation. Between breeds comparison, it showed that moisture content was highest in carcasses from Red Mbororo animals transported by truck (73.35±4.14%) and lowest in carcass from White Fulani animals transported by truck (66.75±7.85%). Crude ash was highest in Gudali transported by train (1.54±0.33%) and lowest in bright red Mbororo transported by truck (1.13±0.12%). Crude protein was highest in White Fulani transported by truck (25.83±6.87%) and lowest in bright red Mbororo transported by truck (19.95±2.68%). Lipid was highest in White Fulani transported by train (4.04±1.73%) and lowest in bright red Mbororo transported by truck (2.52±0.87%). Again, there were no significant differences ($p>0.05$) observed between breeds.

DISCUSSION

Technological properties of beef

Lean colour distribution

Irrespective of breed, cattle transported by train produced beef with a better colour (bright red) than those transported by truck. This is because the animals transportation by truck were subjected to many more stress inducing factors such as banging of the animals, more vibrations, changes in velocity, sudden starts and stops due to the poor state of the road, higher stocking density, more difficulties encountered during on and off loading as well as longer transportation time. These same stress factors have been identified by Kadim et al*.* (2007). In an earlier study during which steers were transported for 3 or 16 h, Gallo et al. (2003) reported that the longer journey was associated with a significantly greater increase in the proportion of "dark-cutter" carcasses (reduced bright red colour of lean). Stress promotes accumulation of intracellular water which reflects less light and causes the muscle to appear dark (Page et al., 2001).

Drip, cook-out and freezing losses

Drip, cook-out and freezing losses were higher in animals transported by truck than by train irrespective of breed. This might have been due to differences in the pHu of the carcasses (not measured in this study). Animals that experience more stress will produce carcasses with a higher pHu because very little lactic acid will produced post mortem (Knowles and Warriss, 2000). A high pHu increases drip, freezing and cook-out losses (Grandin, 2000). Gallo et al. (2003) and Awantu (2015) reported high pHu as well as high drip and cook-out losses in carcasses from stressed cattle. Freezing damages cell membranes; and the degree of damage is influenced by the severity of ante mortem stress (Rahelić et al*.,* 1985; Wheeler et al*.,* 1990). The results obtained in this study suggest that in Cameroon, transportation of animals by truck is more stressful than by train. White Fulani bulls transported by truck produced carcasses with higher freezing losses than carcasses from Red Mbororo and Gudali bulls. This implies differences in stress tolerant levels between breeds. Irrespective of breed, average cook-out loss in carcasses from cattle transported by truck was higher than for those transported by train. This again affirms that transportation of cattle by truck is more stressful than by train within the Cameroonian context. Kadim et al. (2007) obtained similar results with Omani sheep which were subjected to different levels of transportation stress. Increase in drip, freezing and cook-out losses lead to increased loss in organoleptic (texture, juiciness) and nutritive properties (Wheeler et al*.,* 1990; Knowles and Warriss, 2000) and consequently the overall quality of the beef is reduced.

Chemical properties of beef

The chemical properties of beef did not significantly vary either with respect to breed or means of transportation. Maybe the sample size was not sufficiently large. However, the higher average lipid content was recorded in carcasses transported by train than by truck maybe due to the longer time involved in truck transportation. During this period, feed and water supplied to the cattle is grossly inadequate. In such situations, the animals will resort to mobilizing their fat reserves for energy production (Knowles and Warriss, 2000). Loss in lipid results in a lower selling price of the bull as well as reduced organoleptic qualities of the meat especially its taste and flavour (Zhong et al., 2011).

Conclusion

Irrespective of breed, cattle transported by train produced more carcasses with a brighter red colour and better technological properties than those transported by truck. With respect to breed, the breed with the highest proportion of bright red lean colour was Gudali. Lean colour is the primary criterion that most Cameroon consumers use to evaluate beef quality. Therefore, the results from this study imply that bulls transported by train produce better quality beef and that Gudali gives the best beef. Carcasses fromGudali bulls transported by train gave the best quality beef after freezing, while carcasses from White Fulani bulls transported by train gave the best quality after cooking. The findings of this study have shown that ante mortem stress during transportation negatively affects beef quality, and that the stress is more severe when bulls are transported by truck than by train. Therefore, appropriate measures should be taken to minimize animal stress during transportation by improving transportation conditions and/or reducing the duration of transit.

Conflict of Interests

The authors have not declared any conflict of interest.

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