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The Impact of dietary garlic powder additive on quality of *Asun*: An intermediate moisture meat product of West African dwarf rams

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Abstract
The study was conducted to determine the characteristics of *asun* an intermediate moisture meat product produced from West African Dwarf (WAD) rams fed garlic powder as an additive. A total number of forty WAD rams of under a year old of average weight of 15kg, were randomly allocated into five treatment groups in a completely randomized design. Garlic powder was included in diets at 0% (control), 2%, 4%, 6% and 8% respectively. Animals were fed for the period of 90 days, three WADS rams of weight of 25kg were randomly selected from each treatment, slaughtered and carcass dissected to obtain rib with skin cut. *Asun* was produced by grilling and pan frying of meat samples. Samples were analyzed for proximate composition and organoleptic properties were score using a nine-point hedonic scale. Thiobarbituric acid (TBA) value of *asun* was evaluated to express the oxidative stability. The dietary treatments significantly influenced ($p<0.05$) the proximate composition of *asun*. Moisture content of *asun* was significantly high revealing that *asun* is a typical moisture meat. The organoleptic properties and shear force values were not significantly influenced ($p>0.05$) by treatments but TBA value was greatly reduced in *asun* produced from diet 5 fed rams after 21 days of storage. Feeding garlic powder as source of natural dietary antioxidant significantly reduced fat content and inhibits lipid oxidation in *asun*. Organoleptic properties evaluated for flavor, aroma, texture, tenderness, juiciness and overall acceptability of all tasted *asun* were much liked across dietary treatments.

Keywords: A*sun*, antioxidants, intermediate moisture meat

Introduction
Asun (Yoruba Language for a grilled meat) is a popular spicy, grilled, or barbecued meat with spices that gives it irresistible suitable smell. It is a delicacy that could be prepared from varieties of animals such as goat, sheep, pig and chicken by individuals at home. *Asun* is a tropical moisture meat product. It is otherwise known as ready to eat meat (Akharaiyi and Isunu, 2015) [1]. *Asun* is very popular in the Southern part of Nigeria especially among the south west and south east regions. *Asun* is usually prepared during festive periods, ceremonies and as delicacies at eateries, hotels and restaurants. The highest number of West Africa Dwarf goats and sheep were predominantly found in Southern part of Nigeria used majorly to produce *asun* as a major product of goat meat delicacy apart from goat pepper soup. *Asun* is a tropical moisture meat product. Because of the contained water activity (aw), it cannot be kept for long at room temperature without deterioration (Akharaiyi and Isunu, 2015) [1].
Meat is an excellent source of protein (Komba *et al*., 2012) [2]. Meat makes a valuable contribution to diets in developing countries because of its nutritional importance, as a source of protein, and having high biological value (Fakolade, 2011) [3]. In Nigeria there is the preferential consumption of different types of meat by communities and this may be due to a combination of a number of factors bordering on religious belief, culture, adaptability, food habits, age, sex, socio-economic facts and individual differences (Obanu, 1986; Ajiboye *et al*., 2011) [4, 5]. In order to ameliorate the problems associated with consumption of red meat, by the introduction of dietary natural antioxidants in raising livestock in order to produce affordable and acceptable red meat and meat products that are not detrimental to the health, this will assist to meeting the need of daily protein requirements per an average Nigerian. Therefore, the study was geared to investigate the effect of feeding dietary garlic powder on the quality of *asun* an intermediate moisture meat product of West African Dwarf ram.

Materials and Methods
Location of the study
The study was conducted at small ruminant unit of the Teaching and Research Farm and the analytical study took place at Laboratory of Department of Animal Science both located in Ekiti state University, Ado-Ekiti, Nigeria.

Experimental design and treatments
Forty yearling West African Dwarf (WAD) rams of average weight 15 kg were randomly allocated into five treatment

groups of which garlic powder was supplemented at 0% (control), 2%, 4%, 6% and 8% in the diets respectively in a Completely Randomized design.

Table 1: Composition of experimental diets (%)

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Level of garlic inclusion	0%	2%	4%	6%	8%
Ingredients					
Soybean meal	10.0	10.0	10.0	10.0	10.0
Maize	35.0	35.0	35.0	35.0	35.0
Rice bran	15.0	15.0	15.0	15.0	15.0
Brewer's dry grain	37.5	37.5	37.5	37.5	37.5
Bone meal	1.0	1.0	1.0	1.0	1.0
Salt	1.0	1.0	1.0	1.0	1.0
Vitamin/mineral	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated protein (%)	16.07	16.07	16.07	16.07	16.07
Calculated Energy(kcal/kg)	2605.7	2605.7	2605.7	2605.7	2605.7

Experimental animals and their management

Experimental animals were labelled, weighed to obtain initial body weight, housed individually in the pen and acclimatized for the period of three weeks during which they were quarantined. Feeds and water were provided *ad-libitum*. Feeding trial lasted for 90 days and weighed for final body weight prior slaughtering.

Slaughter procedures

Three rams were randomly selected from treatment group after 18 hr of feed withdrawal, stunned mechanically and exsanguinated. Carcasses were dissected by the procedure of Garcia-Valverde *et al*. (2008) [6]. The head was separated at the atlanto-occipital joint, fore and hind feets detached at the carpal-metacarpal and tarsal-metatarsal joints, respectively. The left and right side half carcasses were separately through the mid-plane weighed then stored in room temperature for 8 hours and chilled at 4ºC overnight prior analysis.

Sample preparation

Rib cut- part of WAD ram was selected, cut to small sizes of about 50-60g, wrapped in polythene and cooked in a water bath of temperature of 80°C to internal temperature of 65°C. Meat samples were cooled and salted. Meat samples were placed in an oven heated to 100°C and grilled for 15 minutes. Grilled meat samples were cooled to room temperature and further chopped into smaller size of about 10g. About 100 cm^3 of olive oil was placed in a frying pan, allowed to heat up to temperature of 85°C, thereafter the ingredients (Table 2) were added gradually into the hot oil and stirred gently, grilled meat samples were introduced to sauce bit by bit, stirred until ingredients are evenly distributed on the meat and cooked for 2-3 minutes. Cooked samples were allowed to cool, packed into a polythene plastic bowl and kept chilled at 4°C prior to analysis.

Table 2: Composition of ingredients used for *Asun* (g100 g^{-1})

Ingredients	Composition
Dry ground pepper	15.00
Red pepper	10.0
Bonnet pepper	10.0
White pepper	2.50
Ginger	2.50
Onions	20.0
Curry powder	2.50
Thyme	2.50
Salt	1.10
Stock cubes	8.90
Vegetable oil	25.00
Total	100.0

Determination of proximate composition of samples

Determination of moisture content

Moisture content was determined by modification of the methods of Akharaiyi and Isunu (2015)[1]. 25g of *asun* sample was dried in an oven at 85ºC to a constant weight, cooled in the desiccator and reweighing the sample. The moisture content was evaluated by the difference in weight between the fresh sample and the oven-dried sample. Moisture content was expressed as percentage (%) of the total weight of the sample.

Determination of crude protein

Crude protein of the samples was determined by the procedure of AOAC (2010) [7] as described by Akharaiyi and Isunu (2015) [1]. 25g of dried ground samples were used for the determination of crude protein by kjeldahl method to obtain the nitrogen content which was multiplied by a constant factor of 6.25 for conversion to crude protein.

Determination of ash content

Ash content was determined by the method of Pearson (1976) [8] by heating 25 g of sample at 560°C in muffle furnace for 18 hours.

Determination of ether extracts

Ether extract was determined by hydrolysis method using soxhlet apparatus according to method of AOAC (2010) [7].

Determination of TBARs

Lipid stability of samples were assessed for lipid oxidation by measuring the thiobarbituric acid reactive substances (TBARS) at 7, 14 and 21 days' storage described by Wattanachant, *et al. (*2008) [9]. The TBARS were calculated from a standard curve of malondialdehyde (MDA) and expressed as mg MDA/kg sample

Sensory evaluation of products

Samples were evaluated by un-trained sensory panel for flavour, aroma, tenderness, juiciness, texture and overall acceptability. Panelists were instructed to cleanse their palates between samples using water. The meat samples

were evaluated using a 9-point descriptive scale. Scores were assigned with 9 being "like extremely" and 1 "dislike extremely" (Dhanda *et al.*, 1999) [10].

Statistical analysis

All data were collected in triplicate and statistically analyzed using SAS (2008) [11].

Results and Discussion

The mean crude protein of *asun* was significantly different ($p<0.05$) between dietary treatments with value ranged from 31.46 to 33.51%. The mean crude protein obtained in the study was lower than (54%) lamb, (51.51%) mutton and (59.24%) beef jerky respectively reported by Sutton *et al*. (1993) [12] and the range values from 46.51% and 39.19% reported by Eke *et al*. (2012) [13] in *dambu-nama* (traditionally dried-smoked meat). Akharaiyi and Isunu (2015) [1] reported higher crude protein for *asun* from goat than those obtained in the study. The crude protein values obtained disagreed with the findings of Eyeson and Ankrah (1975) [14] who reported 16.20%, 21.0% and 14.70% crude protein for smoked grasscutter, smoked mutton and smoked salted beef respectively. The mean crude protein values obtained for *asun* were high this might have been due to the contributions of garlic inclusion in the diets as well as ingredients used for the production.

The mean ash content of *asun* was significantly different ($p<0.05$) among dietary treatments. The ash content of *asun* was lower than the range value of 5.76% and 4.90% obtained by Eke *et al*. (2012) [13] in dried smoked meat. The ash content of *asun* obtained from rams fed control (diet 1) and diet 2 were found to be within the range from 2.70% and 3.54% reported by Huda *et al*. (2014) [15] in mutton nugget. Fat content of *asun* obtained fell within the range of 10.9 and 29.6 % reported by Venia *et al*. (2006) [16] and range from 10.15% and 13.00% reported by Huda *et al*. (2014) [15] for mutton nugget. The fat content obtained from the study was comparable with those reported by Sutton *et al*. (1993) [12] for lamb and mutton jerky. Moisture content of *asun* of WAD rams ranged from 41.71 and 46.54% among dietary treatments. The moisture value for *asun* was extremely higher than the values of 11.29 to 14.39% reported by Tettey *et al*. (1997) [17]. Moisture content of *asun* from WAD rams fed experimental diets were extremely high and therefore, not too suitable for shelf stability of the product this is in conformation with the assertion of Akharaiyi and Isunu (2015) [1] that asun is moisture meat product due to its high water activity (aw) that can facilitate microbial deterioration, on the contrary the presence of high moisture could contribute immensely to eating qualities of the products.

The results of the sensory evaluation of *asun* were not significantly influenced ($p>0.05$) by dietary treatments but average score values varied numerically. Aroma was moderately intense in diets 4 and 5 products. Flavour scores had the highest perception in diet 4 products while similar values were obtained from diets 1, 2, 3 and 5. The values obtained for flavour for *asun* among test diets were similar to scores observed by Ribeiro *et al*. (2011)[18] in roasted lamb. The flavour was perceived to be strongly intensed for *asun* in all samples evaluated this was strongly in support of the opinion of Sañudo (2008)[19] that flavour is of primary importance among the attributes that make consumers buy and consume lamb. More so, Forrest *et al*. (1975)[20] opined that the perception of flavour involves the detection of four basic sensations by the nerve endings on the surface of tongue. *Asun* produced from diets 4 and 5 were moderately tendered while diet 3 was much tenderer than other dietary treatments. Studies revealed that tenderness of meat is correlated with the amount and quality of collagen, this depends on its total content in muscle tissue and the amount, which transforms into soluble form during heat treatment (Listrat and Hocquette 2004; Chang *et al.*, 2011)[21,22].

Asun produced from diets 2 and 4 were juicier than those produced from diets 1, 3 and 5. The Juiciness of *asun* was moderate in diets 1 and 3. Diets 2 and 4 products had similar scores for juiciness and this indicates that increase in the level of garlic powder in the diets did not impose any negative trait on the water holding capacity and fat contents of the carcasses. The mean score for texture of *asun* were moderately fine in garlic fed rams than those fed diet 1(control). The highest over-all acceptability score for texture was found in diet 3 by the panelist. The overall assessment of sensory properties of *asun* produced from experimental animals revealed that diet 3 products was very much liked while diets 1, 2, 4 and 5 were moderately liked by the panelists. The sensorial properties of *asun* as obtained in the study were similar to those reported by Akharaiyi and Isunu (2015) [1] for asun made from goat.

There was no significant difference ($p>0.05$) in shear force values of *asun* prepared from muscles of WAD rams fed experimental diets. This corroborates with the values reported by Karami *et al.* (2010) [23] in chevon of goat fed dietary supplementation of herbal antioxidants. The shear force value of asun obtained from diets 2 to 5 ranged from 3.96 and 4.70kg/cm^2 these were within 4.0 and 4.6 kg/cm^2 reported by Babiker *et al*. (1990); Huffman *et al*. (1996) [24, 25] and Dhanda *et al*. (1999) [10] for chevon. Shear force values in the study were higher than value of 3.59 kg/cm^2 reported by El-Waziry *et al*. (2011) [26]. However, shear force values of *asun* were slightly above the standard value of 3.0 kg/cm^2 for mutton tenderness (Bickerstaffe, 1996) [27] but fell within shear force range of 4.6 and 5.5kg/cm^2 for acceptable limit for red meat (Shackelford *et al*., 1991) [28]. The shear force values of *asun* observed in the current study was found within acceptable limit for meat tenderness this indicated that the muscle type, dietary treatments as well as pre-slaughter handling of animal did not constitute stress that could result into shrinkage of muscle that could lead to losses and denaturation of myofibrillar protein this conformed with the report of Webb *et al*. (2005) [29]. More so, the processing method used in making *asun* may have increased collagen solubility and level of intramuscular fats in carcasses that enhanced tenderness (Devine *et al.*, 2002) [30]. This implies that *asun* product of WAD rams fed dietary garlic powder diets had highly acceptable degree of tenderness.

The TBARS values of *asun* derived from WAD ram is shown on figure 1.0. The TBARS values of *asun* differs significantly ($p>0.05$) among dietary treatments. The TBARS values of *asun* samples obtained from control (diets 1) increased significantly while diets 2, 3, 4 and 5 products decreased significantly during storage. The TBARS value behaviour of *asun* samples were similar to the pattern reported by Zapata *et al.* (1990) [31] in dry salted lamb. The spices and other ingredients used in processing of *asun* samples might have probably contributed to the reduction in TBARS values, an indication that natural dietary antioxidant

source can promote oxidative stability in intermediate moisture meat products produced from WAD rams fed experimental diets. This is concomitant to the findings of Wattanachant *et al*. (2008) [9] who observed lower TBARS value in stored goat meat processed with massaman curry and Gonulalan *et al*. (2004) [32] reported lower TBARS values in smoke meat after 5 to 30 days of storage. Berges (1999) [33] reported that both the composition and the quality of dietary fat influence the oxidative stability of meat during storage. The reducing effect of garlic powder on MDA levels of *asun* at interval of days agrees with Valesco and Williams (2011) [34] who reported that plant extracts had potentiality to delay lipid oxidation by the reduction of 2-thiobarbituric acid (TBARS) on different muscle types during storage. Values for TBARS of *asun* obtained in the study for meat samples were much lower than value of 2 mg MDA/ kg reported by Vatansever *et al*. (2000) [35] in burger stored for 3 days. The lowest TBARS values in *asun* products of the best anti-oxidative effect were found in WAD rams fed diet 5 (8% garlic powder) and this resulted into better oxidative stability and it suggested that garlic powder could be a good source of natural antioxidant in WAD ram's diet because garlic powder has an antioxidant effect that lowers the thiobarbituric acid reactive substance (TBARS) value and protect lipid oxidation (Hanieh *et al*., 2010) [36]. This is also supported by the assertion of Eke *et al*. (2012) [13] that oxidative stability of meat may be attributed to the antioxidant properties of the phenolic substances in plants used as spices.

Table 3: Proximate composition of *asun* of WAD rams fed experimental diets (%)

Items	Diet 1 0% garlic	Diet 2 2% garlic	Diet 3 4%garlic	Diet 4 6% garlic	Diet 5 8% garlic
Crude protein	33.51±1.06^{a}	32.57±0.60^{b}	32.87±0.60^{b}	31.98±1.61^{b}	31.46±0.81^{b}
Ether extract	10.27±0.76^{b}	11.10±0.47^{a}	10.48±0.22^{b}	9.89±0.33^{b}	9.49±0.88^{b}
Ash	3.48±0.20^{b}	3.52±0.23^{b}	3.73±0.14^{b}	3.69±0.72^{b}	3.83±0.07^{a}
Moisture content	42.28±1.62^{c}	41.71±1.22^{c}	41.76±1.26^{c}	46.54±1.33^{a}	44.14±1.27^{b}

Mean ± standard deviation, a, b, c- means with different superscripts on same row are significantly different (P<0.05)

Table 4: Sensory quality and shear force value of *asun* of WAD rams fed garlic powder additive diets

Items	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
		Level of garlic inclusion			
	0%	2%	4%	6%	8%
Aroma	6.80±0.10	6.20±0.45	7.00±0.23	7.00±0.23	6.60±0.55
Flavour	7.40±0.34	7.40±0.34	7.00±0.01	7.40±0.89	7.60±0.34
Tenderness	6.40±0.55	6.00±0.87	7.20±0.92	7.00±0.87	7.00±0.23
Juiciness	6.80±0.84	7.60±0.14	6.80±0.84	7.60±0.14	7.20±0.10
Texture	7.40±0.55	7.60±0.89	6.00±0.23	7.00±0.23	7.40±0.89
Overall acceptability	7.20±0.10	7.40±0.89	8.00±0.71	7.80±0.84	7.40±0.89
Shear force(kg/cm^2)	4.54±0.35	4.64±0.09	4.66±0.12	.42±0.19	4.30±0.14

Mean ± standard deviation,

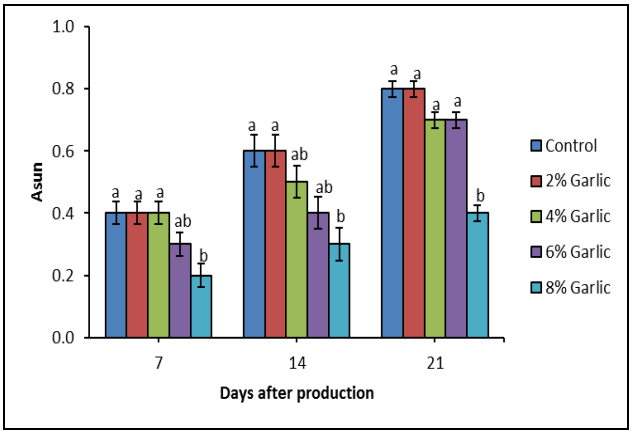

Fig 1: TBARS (mg MDA/Kg meat) of *asun* derived from cut-parts of WAD ram fed experimental diets at different storage days Diet 1 0% garlic, Diet 2- 2% garlic, Diet 3- 4% garlic, Diet 5- 8% garlic

Conclusion

The findings from the study showed that *asun* had high moisture contents that confirm its characteristic as an intermediate moisture meat product. It was revealed that 8% garlic powder supplementation (diets 5) had lowering effects on fat content and TBARS value of *asun* during storage. The addition of garlic powder in the diets led to the oxidative stability of *asun* during storage. The overall acceptability of sensory properties of *asun* was much liked by the panelist irrespective of the dietary treatments.

References

1. Akharaiyi FC, Isunu EL. Microbiological safety and proximate composition of grilled barbecued goat meat (*asun*), Annals. Food Science and Technology, 2015; Volume 16, Issue 2, 247-487
2. Komba EVG, Komba EV, Mkupasi EM, Mbyuzi AO, Mshamu S, Luwumbra D, *et al*. Sanitary practices and occurrence of zoonotic conditions in cattle at slaughter in Morogoro Municipality, Tanzania: implications for public health. Tanzania J Health Res., 2012, 14:2.
3. Fakolade PO. Relevance of Dried Meat Product (Kundi), an Intermediate Moisture Meat, for Food Security. Journal of Agricultural Science and Technology A. 2011; 1/:563-569.
4. Obanu ZA. A Survey of the meat preference, of the Ibos of East Central Nigeria. J. Sci. Food Agriculture. 1986, 20:903-908.
5. Ajiboye EA, Sani AA, Majekodunmi R, Kolawole MO, Oladosu OT. Physicochemical properties and microorganisms isolated from dried meat obtained in Oja- Oba market in Ilorin, Nigeria Adv. Appl. Sci. Res. 2011; 2(4):391-400.
6. Garcia-Valverde R, Barea R, Lara L, Nieto R, Aguilera

JF. The effect of feeding level upon protein and fat deposition in Iberian heavy pigs. Liv. Sci., 2008; 114(2-3):263-273.
7. AOAC. Official Methods of Analysis of AOAC International (eds. W. Horwitz).18th edition, 2010, Gaithersburg, MD.
8. Pearson D. The chemical analysis of foods (7th ed). Churchill Livingstone, London. 1976, 6 – 25.
9. Wattanachant S, Sornprasitt T, Polpara Y. Quality characteristics of raw and canned goat meat in water, brine, oil and Thai curry during storage, Songklanakarin J. Sci. Technol., 2008, 227(2): 337-344.30.
10. Dhanda JS, Taylor DG, Murray PJ, McCosker JE. The influence of goat genotype on the production of Capretto and Chevon carcasses. 2. Meat quality. *Meat Sci*., 1999, 52, 363-367.
11. SAS (Statistical Analysis System User's Guide). SAS 2008, Institute Inc., Cary, N.C. 27513 U.S.A.
12. Sutton DS, Hand LW, Fitch GQ. Physical and Sensory Properties of Jerky made from Lamb, Mutton and Beef, Animal Science Research Report, Oklahoma Agricultural Experiment Station, 1993:83-88.
13. Eke MO, Arihau CC, Okonkwo TM. Production and Quality Evaluation of *Dambu-Nama* - A Nigerian Dried Meat Product. Nigerian Food Journal. 2012; 30(2):66-72.
14. Eyeson, KK, Ankrah EK. Composition of foods commonly used in Ghana. Food Res. Inst and UNDPI-FAO Project. Food Res. Insti. 1975, CSIR Pub.
15. Huda AB, Parveen S, Sajad AR, Akhter R, Hassan M. Effect of incorporation of apple pomace on the physico-chemical, sensory and textural properties of mutton nuggets. International Journal of Advanced Research. 2014; 2(4):974-983.
16. Venia F, Joana B, Sandra V, Ana M, Fatima S, Maria JM, Tim H, Paul G, Paula T. Chemical and microbiological characterization of alheira: Atypical Portuguese fermented sausage with particular reference to factor relating to food safety. Meat Sci Journal. 2006; 73(4):570-575.
17. Tettey ECT, Osei-Yaw A, Hodari-Okae M. Studies on the quality of traditionally smoked-dry snail meat (*Achatina achatina*) in Ghana, Ghana Journal of agric. Sci., 1997, 30,
18. Ribeiro RDX, Oliveira RL, Macome FM, Bagaldo AR, Silva MCA, Ribeiro CVDM, *et al*. Meat Quality of Lambs Fed on Palm Kernel Meal, a By-product of Biodiesel Production Asian-Aust. J. Anim. Sci. 2011; 24(10):1399-1406.
19. Sañudo CA. Carcass and meat lamb and kid quality and development of consumer acceptability. Rev. Bras. Zootecn. 2008; 37(Suppl.):143-160.
20. Forrest JC, Aberle ED, Hedrick HB, Judge MD, Merkel RA. Principles of Meat science. 1st edition. W. H. Freeman and Co. San Franscico, 1975.
21. Listrat A, Hocquette JF. Analytical limits of total and insoluble collagen content measurements and of type I and III collagen analysis by electrophoresis in bovine muscles. Meat Science, 2004, 68, 127-136.
22. Chang HJ, Xu XL, Li CB, Huang M, Liu DY, Zhou GH. A comparison of heat-induced changes of intramuscular connective tissue and collagen of beef semitendinosus muscle during water bath and microwave heating. Journal of Food Process Engineering, 2011, 34, 2233-2250.
23. Karami M, Alimon A, Goh YM, Sazili AQ, Ivan M. Effects of Dietary Herbal Antioxidants Supplemented on Feedlot Growth Performance and Carcass Composition of Male Goats, *American* Journal of Animal and Veterinary Sciences, 2010; 5(1):33-3.
24. Babiker SA, Ei Khider IA, Shafie SA. Chemical composition and quality attributes of goat meatand lamb. Meat Sci. 1990; 28:273-279.
25. Huffman KL, Miller MF, Hoover LC, Wu CK, Brittin HC, Ramsey CB. Effect of beef tenderness on consumer satisfaction with steaks consumed in the home and restaurant. J. Anim. Sci. 1996; 74:91-97.
26. El-Waziry AM, Al-Owaimer AN, Suliman GM, Hussein ES, Abouheif MA. Performance, Carcass Characteristics and Meat Quality of Intact and Castrated Ardhi Goat Kids Fed High Energy Diet. J. Animal and Veterinary Advances. 2011; 10(16):2157-2161.
27. Bickerstaffe R. Proteases and meat quality. Proc. N. Z. of Anim. Prod. 1996, 56: 153-156.
28. Shackelford SD, Morgan JB, Savell JW, Cross HR. Identification of threshold levels for Warner-Bratler shear force in beef top loin steak. Journal of Muscle Foods, 1991, 2(4) 289-296.
29. Webb EC, Casey N, Simela L. Goat meat quality. Small Rumin. Res., 2005, 60: 153-166.
30. Devine CE, Payne SR, Wells RW. Effect of muscle restraint on sheep meat tenderness with rigor mortis at 18°C. *Meat Sci*., 2002, 60, 155-159.
31. Zapata JFF, Ledward DA, Lawrie RA. Preparation and storage stability of dried salted mutton. Meat Sci., 1990, 27: 109-118.
32. Gonulalan, Z, Kose A, Yetim H. Effects of liquid smoke on quality characteris- tics of Turkish standard smoked beef tongue. Meat Science, 2004, 66(1): 165-170.
33. Berges E. Importance of vitamin E in the oxidative stability of meat: Organoleptic qualities and consequences. In: Brufau J. (ed.), Tacon A. (ed.). Feed manufacturing in the Mediterranean region: Recent advances in research and technology. Zaragoza : CIHEAM,. 1999, 347-363 (Cahiers Options Méditerranéennes; n. 37).
34. Velasco V, Williams P. (2011). Improving meat quality through natural antioxidants, Chilean Journal of Agricultural Research, 2011, vol. 71, pp. 313–322.
35. Vatansever L, Kurt E, Enser M, Nute GR, Scollan ND, Wood JD, R.I. Richardson RI. Shelf life and eating quality of beef from cattle of different breeds given diets differing in n-3 polyunsaturated fatty acid composition. Animal Science, 2000, 71, 471–482
36. Hanieh H, Kiyoaki N, Mingzi P, Chaogetu G, Asaki A, Yasuhiro K. Modulatory effects of two levels of dietary alliums on immune response and certain immunological variables, following immunization, in White Leghorn chickens. Anim. Sci. J., 2010, 81:673-680.