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EFFECT OF GENOTYPE ON THE PROXIMATE COMPOSITION AND SENSORY PROPERTIES OF RABBIT MEAT

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ABSTRACT

The effect of genotype on the proximate composition and sensory properties of rabbit meat was evaluated using eighteen male and female California white, New Zealand white and Havana black rabbits. The rabbits were raised under the same feeding and housing management system and slaughtered at 12 weeks. They were properly bled and dressed. Proximate analysis was carried out on the meat samples. Cooked samples were evaluated on a 9-point scale for colour, flavour, taste, juiciness, tenderness, texture and overall acceptability. Data obtained was subjected to analysis of variance (SAS, 2010). California white had the highest mean value for crude protein (24.41±1.26%), moisture content (70.18±0.77%), ash content (3.65±0.66%), nitrogen free extract (7.56±0.05%) while it had the least mean value for fat (8.26±4.88%). Havana black rabbit had the highest fat content (18.49±2.74%) but had the least mean value for crude protein (15.05±2.85%) and ash content (0.91±0.10%) New Zealand breed had the least mean value for nitrogen free extract (2.59±0.51%). The genotype of rabbit also had significant ($P<0.05$) influence on the flavour, tenderness, juiciness and overall acceptability of the meat samples. Meat samples from Havana black rabbit had the best ranking for flavour, tenderness, juiciness and overall acceptability. However, the influence of breed was not significant ($P>0.05$) on the colour and texture of rabbit meat. In conclusion, genotype had significant influence on the chemical composition of rabbit meat. California white had better nutritive value and should be preferred to New Zealand and Havana black rabbit.

Key words: rabbit, meat, proximate composition, sensory properties

INTRODUCTION

Rabbits provide an excellent source of protein for human consumption and may play a significant role in solving the problem of meat shortage in developing countries (Abdel-Azeem *et al.*, 2007). The meat of rabbit is characterized by high protein and low fat. It has relatively high concentrations of polyunsaturated fatty acids (Dalle Zotte, 2002). According to Polak *et al.* (2006), rabbit meat contains monounsaturated fatty acids of 34.15%, polyunsaturated fatty acids of 25.10%, and saturated fatty acids of 40.9%. Another indicator of rabbit meat good quality is its exceptionally low cholesterol level that ranges between 45 and 85 mg/100 g of fresh meat (Dalle Zote, 2002; Polak *et al.*, 2006). Rabbit meat has about 1380 to 1820 calories per kilogram. It is rich in phosphorus, iron, calcium and iodine while potassium is the most abundant of its elements (Tarnauceanu, *et al.* 2010). Potassium content of rabbit meat is the highest compared with beef, pork, mutton and chicken meat . The meat also has a low sodium content and is also a good source of B vitamins (Hernandez and Gondret, 2006).

Colour and flavour constitute the most cherished attributes of meat that attract consumers to accepting any type of meat (Apata and Akinfemi 2010). The first criterion of rabbit meat attractiveness for the consumers is appearance, which is primarily given by the colour of meat (Combes *et al.,* 2008). Meat colour can be affected by many factors. One of the most important factors is the content of pigment myoglobin, which is dependent on primary production factors such as species, nutritional status and age of animal. Pre-slaughter period and the slaughter process, stress immediately before and during the slaughtering also affect meat colour (Bizkova and Tumova, 2010). As in all slaughter animals, the colour of rabbit meat may be indirectly influenced by environmental factors related to management conditions (Dal Bosco *et al.*, 2002), pre-slaughter stress (Maria *et al*., 2004) as well as the housing system (Dalle Zotte, 2009) . The characteristic flavour of meat of a particular species is determined, however, by the proportions of different fatty acids which contribute to the aroma of meat. Phospholipids, which are rich in polyunsaturated fatty acids, also play a fundamental role in the flavour of meat (Beriain *et al*, 2000)

The chemical composition of rabbit meat is extremely variable, especially regarding fat content, depending on the part of the carcass studied (Pla *et al*., 2004). Meat chemical composition of broiler rabbits are influenced by breed (Singh and Prasad, 2005). Hernandez *et al*. (2008) also reported the influence of genetic origin of rabbits on the lipid content, lipolytic activity and fatty acid composition of meat. However, Baiomy and Hassanien (2011) reported that there was no significant difference in moisture content, crude protein, fat and ash of meats in New Zealand white and California rabbits. This study was therefore carried out to investigate the chemical composition of the meat of Californian, New Zealand white and Havana black rabbits when raised in a humid tropical environment.

MATERIALS AND METHODS

Experimental site : The experiment was carried out at the rabbitry unit of the Department of Animal and Environmental Biology, Adekunle Ajasin University Akungba-Akoko, Ondo state.

Experimental animals and management: Eighteen male and female California white, New Zealand white and Havana black rabbit were used for the study. Californian white rabbits are rounded in body and have short smooth coat. New Zealand white are multipurpose breed because they can be raised for meat, pets and laboratory purpose. The Havana black rabbit was first discovered in the Netherland. The experimental animals were kept in a wooden cage and were fed with commercial pelleted diet; the diet used contained 15% crude protein, 7% fat, 10% crude fibre, 1.0% calcium, together with available phosphorus of 0.35% and 2550Kcal/kg metabolisable energy. They were also supplied with forages. Clean water was also supplied to the rabbits *ad-libitum*.The rabbits were raised under same management system and slaughtered at 12 weeks. They were properly bled and dressed.

Data Collection : Meat samples were collected from the carcass of the rabbits and taken to the Central Research Laboratory , Faculty of Science of the University. Proximate analysis was carried out on the meat samples to determine the crude protein, fat content, moisture content ash content and the nitrogen free extract using AOAC (2005). Samples for sensory evaluations were taken from the thigh muscle and cooked to an internal temperature of 75°C. Adult individuals aged between 25 and 40 years were used to assess the cooked meat samples. Equal bite size from each genotype was coded and served in an odourless plastic plate. Each sample was evaluated independent of the other. The samples were evaluated on a 9-point hedonic scale for colour, flavour, taste, juiciness, tenderness, texture and overall acceptability. Data obtained was subjected to analysis of variance (SAS, 2010) for statistical analysis.

RESULTS

California rabbit had the highest crude protein (24.41 ± 1.26%) followed by New Zealand white (21.12 ± 2.50%) while Havana black had the least crude protein (15.05 ± 2.58%) as presented on Table 1. Havana black had the highest fat content (18.49 ± 2.74%) followed by New Zealand (14.53 ± 5.30%) while the least was found in California white meat (8.26 ±4.88%). The proximate analysis also showed that the California white had the highest moisture content (70.18 ±0.77%) followed by New Zealand (60.65 ± 2.67%). There was no significant difference in the moisture content of meat from New Zealand and Havana black rabbit as shown in Table 1. Meat samples obtained from California rabbit also had the highest nitrogen free extract (7.56 ± 5.00%) followed by Havana black (6.28±0.10%) while the least was found in New Zealand rabbit (2.59±0.51%). Havana black had the least ash content (0.91±0.10%) followed by New Zealand while the highest ash content was found in California rabbit.

TABLE 1: Proximate composition of rabbit meat as affected by genotype (Mean ± SEM)

Composition %	California	New Zealand	Havana Black
Crude Protein	24.41 ±1.26[a]	21.12± 2.50[b]	15.05 ±2.85[c]
Fat Content	8.26± 4.88[c]	14.53±5.30[b]	18.49±2.74[a]
Moisture	70.18±0.77[a]	60.65±2.67[b]	59.27 ± 5.64[b]
Ash	3.65± 0.66[a]	1.11 ±0.34[b]	0.91± 0.01[c]
Nitrogen free extract	7.56±5.00[a]	2.59±0.51[c]	6.28±0.10[b]

[abc]Means on the same row with the different superscript are significantly different ($p<0.05$).

The proximate composition of rabbit meat as affected by sex is presented on Table 2. Meat samples from female rabbits had higher crude protein (21.62±1.69%) than male rabbits (18.27±4.36%). However, male rabbit meat contains more nitrogen free extract compared to female. The fat content in the meat of male and female rabbit were statistically similar. The effect of sex was also significant ($p<0.05$) on the moisture content. Higher moisture content was found in male rabbits compared to female rabbits. In this study, male rabbit meat also contained higher ash content than the female rabbit meat.

TABLE 2: Proximate composition of rabbit meat as affected by sex (Mean ± SEM)

Composition %	Female	Male
Crude Protein	21.62±1.69[a]	18.27±4.36[b]
Fat Content	13.31±3.41	12.99±5.75
Moisture	61.21±2.69[b]	70.67±0.65[a]
Ash content	1.98±0.63[b]	2.27±1.00[a]
Nitrogen free extract	4.05±1.01[b]	9.51±5.63

[a b c]Means on the same row with the different superscript are significantly different ($p<0.05$).

The sensory properties of rabbit meat as affected by genotype is presented in Table 3. The effect of breed was not significant ($p>0.05$) on the meat colour. The mean values for colour of meat from New Zealand white, California, and Havana black rabbits were statistically similar. However the effect of genotype was significant ($p<0.05$) on the flavour of rabbit meat. Meat samples from Havana black rabbit had the highest mean value for flavour (8.23±0.05) followed New Zealand white (7.77±0.01) while the California breed had the least value for flavour (6.69± 0.19). In this study, Havana back meat was the most tender meat. This was followed by meat samples from New Zealand white. Californian breed also had the least value for tenderness (5.88±1.23).

The highest grade for juiciness (7.85±0.21) was also recorded for Havana black rabbit. The effect of genotype was not significant ($p>0.05$) on the texture of the rabbit meat samples in this study. Meat from Havana black rabbit had the best overall acceptability (6.87±0.21). This was followed by New Zealand white (5.94±0.17) Meat samples from California white breed had the least overall acceptability (5.22±0.31). Table 4 shows the least square means of the sensory properties as affected by sex. The effect of sex was significant on all the sensory properties studied. Meat samples of male rabbit had better colour, flavour, tenderness, juiciness, texture and overall acceptability than meat samples from their female counterparts.

TABLE 3: Sensory properties of rabbit meat as affected by genotype (Mean ± SEM)

Parameters	New Zealand	California	Havana black
Colour	6.54±0.12	6.34±0.35	6.48±0.33
Flavour	7.77±0.01[b]	6.69± 0.19[c]	8.23±0.05[a]
Tenderness	8.33±1.67[b]	5.88±1.23[d]	8.68±0.07[a]
Juiciness	7.34±0.34[b]	5.11±0.62[c]	7.85±0.21[a]
Texture	4.65±0.35	4.67±0.51	4.96±0.15
Acceptability	5.94±0.17[b]	5.02±0.31[c]	6.87±0.21[a]

[a b c] Means on the same row with different superscripts are significantly ($p<0.05$) different

TABLE 4: Sensory properties of rabbit meat as affected by sex (Mean ± SEM)

Parameters	Female	Male
Colour	6.56±0.07[b]	7.21±0.05a
Flavour	7.01± 0.12[b]	7.77±0.38[a]
Tenderness	6.33±1.67[b]	7.55±0.89[a]
Juiciness	5.89±0.34[b]	7.19±0.43[a]
Texture	4.77±0.35[b]	4.86±0.24[a]
Acceptability	5.54±0.17[b]	6.02 ±0.38[a]

[b] Means on the same row with different superscripts are significantly ($p<0.05$) different

DISCUSSION

Rabbit meat fat content was influenced by the genotype of rabbits. This is in line with the report of Polak *et al.* (2006) that the intramuscular fat content of meat is influenced by the genotype of rabbits. The effect of genotype found in the protein content of New Zealand white and California meat samples in this study was contrary to the observation of Maj *et al*. (2008) that there were no significant difference in protein content and ash content of New Zealand White, California and their backcrosses. However slight difference was observed with regards to fat and moisture content between the two breeds. Male rabbit meat contained more nitrogen free extract compared to female. The fat content in the meat of male and female rabbit were statistically similar. Higher moisture content was found in male rabbits compared to female rabbits. This is similar with the report of Kuzelov *et al.* (2011) reported that male rabbit contained more moisture and mineral substances. According to Polak *et al*. (2006) males had higher contents of water, proteins and mineral substances in comparison with female rabbits while female rabbits had a higher fat content than male rabbits. However, Baiomy and Hassanien (2011) found that the meat from female rabbit had more moisture than males but less protein and fat. In this study, male rabbit also contain higher ash content than the female rabbit. According to Murshed *et al.* (2014), ash content was higher in meat of male than female rabbit but no significant difference was found in crude protein of male and female rabbit meat.

The effect of genotype was not significant on the meat colour in this study. The colour of meat predominantly depends on the chemical state of myoglobin (Brewer, 2004; Mancini and Hunt, 2005), which is affected by the partial pressure of O_2, the concentration of hydrogen ions (pH), temperature, light access, tissue structure, the presence of substrates and co-factors, the activity of reducing enzymes and lipid oxidation (Mancini and Hunt, 2005). Meat colour, one of the most important criteria in initial selection by the consumer, is related to the concentration of pigments, mainly myoglobin, and the chemical state of the myoglobin on the surface of the meat, the structure and physical state of muscle proteins (Beriain *et al*, 2000). Meat tenderness is one of the most important physical and sensory characteristic of meat (Bizkova and Tumova, 2010). Meat tenderness depends mainly on the post-mortem changes affecting myofibrillar proteins and on the connective tissue that represents the toughness (Arino *et al*., 2006). Stress does not only influence the pH and colour of meat, but also affects tenderness (Liste *et al.*, 2009). The study of Arino et al. (2006) indicated an influence of the genetic type and selection on meat tenderness. In this study, Havana back meat was the most tender meat. This was followed by meat samples from New Zealand white. Small amounts of intramuscular fat, which are necessary to lubricate the muscle fibres, affect the flavour and juiciness of cooked meat.

The effect of genotype was not significant on the texture of the rabbit meat samples in this study . This corroborates the report of Gasperlin *et al.* (2006) that the effect of genotype is not significant on the meat texture. Meat texture mainly depends on the post mortem changes and on the structure of the muscle (Bizkova and Tumova, 2010). Elevated hardness is linked with lower fatness and higher collagen level in meat (Łapa *et al.*, 2008). However, Łapa *et al*. (2008) estimated texture parameters and shears force of meat from New Zealand White and California rabbits and stated that meat from California breed had lower shear force and texture compared to New Zealand white rabbit. Larzul *et al*. (2005) also observed an influence of genotype (different genetic lines of rabbits) on shear force values and meat texture. Meat from Havana black rabbit had the best overall acceptability. This was followed by New Zealand white while the meat samples from California genetic line had the least overall acceptability. The overall acceptability of meat is dependent on both processing and general qualities which can be physical, chemical or organoleptic (Omojola and Adesehinwa, 2006).

Meat samples of male rabbit had better colour, flavour, tenderness, juiciness, texture and overall acceptability than meat samples from their female counterparts. This may be due to their ability to consume and utilize feed better than the female rabbits. Apata *et al* (2012) reported that meat from male rabbit had better colour, flavour, tenderness, juiciness, texture, and overall acceptability than female rabbit meat. Omojola (2007) also observed sexual dimorphism of some organoleptic characteristics in duck. The author reported that in terms of flavour, tenderness and juiciness, the taste panelist has higher preference for meat from male duck. However, no effect of sex on meat tenderness was found out by Carrilho *et al*. (2009) and Pla (2008). According to Larzul *et al.* (2005) there is no influence of sex on shear force and texture of rabbit meat.

CONCLUSION

The meat of California rabbit contains more crude protein, moisture, nitrogen free extract and ash than New Zealand. The Havana black had the highest fat content when compared with California and New Zealand white. The New Zealand rabbit had lesser nitrogen free extract than the Havana black rabbit. Male rabbit meat contains more nitrogen free extract, moisture and ash compared to female. Crude protein is higher in female rabbit meat than that of male rabbit. The fat content in the meat of male and female rabbit were similar.

The genotype of rabbit influenced the flavour, tenderness, juiciness and overall acceptability of the meats. Meat samples from Havana black rabbit had better ranking for flavour, tenderness, juiciness and overall acceptability compared with meat from New Zealand white, and Californian rabbit. The influence of genotype was not found in the colour and texture of the meat samples. Male rabbit meat was preferred to female rabbit meat in colour, flavour, tenderness, juiciness, texture and overall acceptability.

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