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Full Length Research Paper

Influence of sex and processing methods on physicochemical and organoleptic quality of rabbit meat

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The objective of this study was to determine the influence of sex and processing (cooking) methods on physicochemical and organoleptic properties of rabbit meat. Thirty two matured rabbits of different breeds (16 males and 16 females) were used for this study. The rabbits were purchased from Abeokuta and transported to Olabisi Onabanjo University, Yewa Campus, Ayetoro, where this study was conducted. The rabbits were rested for 2 weeks, starved for 16 h, then slaughtered and dressed conventionally. Their carcasses were assigned randomly to four cooking treatments viz: frying, broiling, roasting and stewing. 100 g of meat samples were excised from leg cuts of rabbit carcasses from each treatment and cooked for 20 min after which physical, chemical and sensory attributes of rabbit meat were determined. Data generated were subjected to analysis of variance (ANOVA) for completely randomized design with 4 × 2 factorial arrangement (P = 0.05). The results showed that cooking loss, thermal shortening and shear force values were higher (P < 0.05) in fried rabbit meat, while water holding capacity and cooking yield were higher (P < 0.05) in stewed rabbit meat. Moisture and protein contents were higher (P < 0.05) in stewed rabbit meat while, they were lower (P < 0.05) in fried rabbit meat. Meat from female rabbits had higher (P < 0.05) proximate components values except nitrogen free extract values that were higher (P < 0.05) in male rabbit meat. The results revealed that colour and flavour scores were higher (P < 0.05) in fried rabbit meat, followed by broiled ones also, fried rabbit meat were accepted more than broiled, roasted and stewed ones. Also, male rabbit meat was highly relished than female rabbit meat in this study. It was suggested therefore, that frying and broiling methods be employed, also male rabbits be preferred if rabbit meat is to be processed since fried and broiled rabbit meat as well as meat from male rabbits were accepted more than those from female rabbits, in this study.

Key words: Rabbit meat, sex, processing methods, physicochemical, organoleptic, quality.

INTRODUCTION

Animal protein intake is dismally low in less developed countries below the recommended minimum daily requirement of 35 g (FAO, 2006). In order to bridge this gap, necessary and practical initiatives should be taken (Abu et al., 2008). One of such steps is the utilization of micro-livestock which are unconventional protein sources (Adesope, 2000). The rabbit (*Oryctolagus cuniculus*) appears to be the most sustainable means of supplying high quality animal protein for the growing populations of the developing countries since it has favourable attributes such as low cost of production, small body size, short generation interval, high fecundity, rapid growth rate, genetic diversity, ability to utilize forage and agricultural

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by-product and easy adaptability among others (Nodu et al., 2003). However, rabbits have not been fully integrated into animal farming system and this could be due to apathy on the farmers as well as inadequate information on rabbit farming, nonetheless, rabbit meat is still relished by many consumers (Medubari, 2002). Production, processing and consumption of meat have tremendous economic, social, ecological and political importance, but the overall acceptability of meat is dependent on both processing and general qualities which can be physical, chemical or organoleptic (Omojola and Adesehinwa, 2006). These attributes of meat are largely based on the cooking method(s) employed in processing the meat. Processing methods (cooking) includes dry and moist methods. Dry method includes frying, roasting, and boiling, while the moist method involves stewing and braising among others (Apata et al., 2005). These cooking methods could have some effects on nutritional quality of rabbit meat which may render it unacceptable to consumers (Dal Bosco et al., 2001; Apata and Akinfemi, 2010). It has been reported (Bhuyan et al., 1999) that sex affected meat composition of pigeon as well as broilers (Omojola et al., 2004). Sexual dimorphism can also have some influence on rabbit meat. This study is conducted therefore, to investigate the dual effects of sexual differences and processing (cooking) methods on physicochemical and organoleptic characteristics of rabbit meat.

MATERIALS AND METHODS

Thirty two matured rabbits of mixed breed (16 males and 16 females) were used for this study. They were purchased from Ogun State Ministry of Agriculture Rabbitory Unit Abeokuta and were transported to the Rabbitory Unit of the Teaching and Research Farm Olabisi Onabanjo University, Yewa Campus, Ayetoro where they were rested for two weeks and fed tridax procumbens and commercial grower concentrate feed. The rabbits were fasted for 16 h but with access to clean and enough water. They were moved into the Meat Science Laboratory, Department of Animal Production where they were weighed, stunned, exsanguinated and properly bled. The rabbits' carcasses were randomly assigned into 4 treatment groups with 8 carcasses in a group as follows:

Treatment 1 = Meat Samples from this group were cooked with frying.
Treatment 2 = Meat Samples were cooked with broiling.
Treatment 3 = Meat Samples were cooked with roasting (charcoal fire).
Treatment 4 = Meat Samples were cooked with stewing.

Carcass dressing and fabrication

Rabbits' carcasses were dressed conventionally, eviscerated and split into primal cuts leg, loin, rack and shoulder.

Cooking of meat

100 g of meat samples were excised from leg cut of carcasses from each treatment group, washed and cooked with 4 different methods: frying, broiling, roasting (on charcoal fire) and stewing, for 20 min (Apata et al., 2005).

Cooking loss and thermal shortening

Cooking loss and thermal shortening of meat samples were determined following the procedures of Allen et al. (1998). Each 100 g and 10 cm of meat sample was cooked using each of the cooking method. The meat samples were reweighed after cooking for 20 min to an internal temperature of 72°C, cooled to room temperature (27°C) and wiped with tissue paper to remov e the red water or oil from the meat surface. Cooking loss determined thus:
Thermal shortening of meat samples was measured with the same meat samples used for determining cooking loss. The final lengths of the meat samples were taken after each cooking:

Cooking yield

This was obtained by difference between 100% and percentage cooking loss of each meat samples according to Omojola (2008). Thus:

Cooking yield = 100% - % cooking loss

Water holding capacity (WHC)

Approximately 1 g of cooked meat samples from each treatment was wiped clean with tissue paper and placed between two Whatman No. 1 filter papers (Model C, Caver Inc Wabash USA). The meat sample was pressed between two 10.2 × 10.2 cm^2 plexiglasses at about 34.6 kg/cm^3 absolute pressure for 1 min with a vice (Suzuki et al., 1991). The meat sample was removed and oven dried at 100 to 105°C for 24 h to determine its moisture content. The amount of juice released from the meat sample was measured indirectly by taking the area of filter paper wetted relative to the area of pressed meat sample. Thus:
Where: Aj = Area of juice released from meat sample (cm^2); Am = Area of meat sample (cm^2); Wm = Weight of meat sample (g); Mc = Moisture content of meat sample (%); 9.47 = A constant factor.

Shear force

Meat sample weighing 10 g from each cooking treatment was cut and cooled to room temperature, and about 1.20 cm diameter core parallel to muscle fibre orientation was removed using a manual coring device according to Qiaofen and Da-Wen (2005). Each meat sample was sheared at three locations with Warner Bratzler V-notch blade shearing instrument (Honikel, 1998) and average value of the three shearings was taken.

Proximate Composition

This was evaluated according to the procedures of AOAC (2000) Moisture content of the cooked meat samples was determined by oven drying 2 g of the meat at 100 to 105°C for 24 h until a constant weight was obtained. Crude protein of the meat was obtained with Kjedahl method which consisted of digestion of the meat sample, distillation of the digest and titration of the distillate. The actual crude protein values of meat samples were obtained by converting nitrogen (N%) content with a constant (6.25) and crude protein was obtained thus (6.25 × N%). Fat of the cooked meat samples was determined with soxhlet extraction method using petroleum ether; while ash content was obtained by igniting 2 g of cooked meat

Table 1. Physical properties of rabbit meat as influenced by sex and processing methods.

Treatments	CL (%)	CY (%)	TS (%)	WHC (%)	SF (kg/cm^3)
Frying					
M	38.70^{ab}	61.30^{da}	35.70^{ab}	21.30^{db}	4.30^{ab}
F	41.50^{aa}	58.50^{db}	39.40^{aa}	23.90^{da}	5.52^{aa}
Broiling					
M	36.50^{bb}	63.50^{ca}	33.40^{bb}	25.40^{cb}	3.60^{bb}
F	38.40^{ba}	61.60^{cb}	37.10^{ba}	27.60^{ca}	4.75^{ba}
Roasting					
M	26.30^{cb}	73.70^{ba}	26.10^{cb}	31.30^{bb}	2.45^{cb}
F	29.50^{ca}	70.50^{bb}	28.70^{cb}	34.70^{ba}	3.55^{ca}
Stewing					
M	25.50^{db}	74.50^{aa}	23.60^{db}	42.70^{ab}	1.30^{db}
F	27.40^{da}	72.60^{ab}	25.50^{da}	45.90^{aa}	2.42^{da}
SEM	3.40	1.60	6.70	4.70	8.35

abcd: Means on the same column with different superscripts and for the same variable are statistically significant ($P < 0.05$). CL = Cooking loss, CY = cooking yield, TS = thermal shortening, WHC = water holding capacity, SF = shear force, M = male, F = FEMALE.

samples in a muffle furnace set at 550 to 600℃ for 4 h until the ash was formed and was weighed.

Sensory evaluation of meat samples

This was conducted using a 10-member semi-trained taste panel according to the procedures of AMSA (1995). Cooked meat samples were coded after cooling to room temperature (27℃) and were presented sequentially to the panelists on clean saucers and each meat sample was evaluated independently. The panelists were provided unsalted biscuit and clean water for use in-between treatments meat samples. The panelists rated cooked meat samples on a 9-point hedonic scale on which 1 equals dislike extremely and 9 equals like extremely for colour, flavour, tenderness, juiciness, texture and overall acceptability.

Experimental design and statistical analysis

Completely randomized design with 4 × 2 factorial arrangement was employed for this study.

Data collected were subjected to analysis of variance (ANOVA) using (SAS, 2002). Significant differences among the means were separated with Duncan Multiple range test of the same analytical system.

RESULTS AND DISCUSSION

Cooking loss, thermal shortening and shear force values were higher ($P < 0.05$) in rabbit meat that were fried, followed by meat that were broiled and least ($P < 0.05$) in rabbit meat that were stewed (Table 1). Cooking yield and water holding capacity (WHC) were higher ($P < 0.05$) in stewed rabbit meat followed by those roasted, while fried rabbit meat had the least ($P < 0.05$) values of these variables. Meat from female rabbit carcasses had the highest ($P < 0.05$) values for all the physical variables evaluated in this study, while meat from male rabbit carcasses gave the least ($P < 0.05$) values. There were inverse relationships between WHC, cooking yield, cooking loss, thermal shortening as well as shear force. As WHC and cooking yield increased, cooking loss, thermal shortening and shear force values decreased. The temperature at which rabbit meat was fried was higher than, the temperature at which the meat was broiled roasted and stewed, respectively. The stewing temperature was the least between 90 to 100℃, that of frying was between, 150 to 180℃ while that of broi ling and roasting were little below that of frying, when meat is cooked juices are lost depending on the intensity of heat due to shrinkage of connective tissues (Apata et al., 2005). The results obtained on physical variables in this study agreed with the report of these authors. The results of this study revealed that samples of meat from female rabbits had higher values for all the physical variables tested except for cooking yield. This could be that female rabbits' meat lost more juice during cooking processing. Perhaps heat was able to weaken the connective tissues in female rabbit meat than it did to meat samples from male rabbits which toughed the meat and raised the shear force values than meat from male rabbits. Table 2 shows the results of proximate composition of differently

Table 2. Proximate composition of rabbit meat as affected by sex and processing methods.

Treatments	MC (%)	CP (%)	Fat (%)	Ash (%)	NFE (%)
Frying					
M	35.50^{db}	61.20^{db}	1.30^{c}	1.20^{b}	45.80^{aa}
F	38.20^{da}	17.43^{da}	1.45^{c}	1.22^{b}	41.80^{ab}
Broiling					
M	45.70^{cb}	17.13^{cb}	1.60^{c}	1.40^{b}	34.17^{ba}
F	47.00^{ca}	18.30^{ca}	1.72^{c}	1.42^{b}	31.56^{bb}
Roasting					
M	52.20^{bb}	19.05^{bb}	2.50^{b}	2.10^{a}	24.15^{ca}
F	54.60^{ba}	20.10^{ba}	2.70^{b}	2.23^{a}	20.37^{cb}
Stewing					
M	57.05^{ab}	21.15^{ab}	3.45^{a}	1.10^{b}	17.25^{da}
F	59.13^{aa}	22.18^{aa}	3.15^{a}	1.15^{b}	14.03^{db}
SEM	10.90	1.30	0.50	0.40	2.60

abcd: Means on the same column with different superscripts and for the same variable are statistically significant ($P < 0.05$). MC = Moisture content, CP = crude protein, NFE = nitrogen free extract, M = male, F = female.

cooked male and female rabbit meats. Moisture and protein contents were higher ($P < 0.05$) in stewed rabbit meat followed by roasted meat and lower ($P < 0.05$) in fried rabbit meat. Fat content was higher ($P < 0.05$) in stewed rabbit meat followed by roasted meat, while broiled and fried meats had the same fat content ($P > 0.05$). The ash content was higher ($P < 0.05$) in roasted meat, while those fried, broiled and stewed had the same ($P > 0.05$) ash content values. Nitrogen Free Extract (NFE) was higher ($P < 0.05$) in fried meat, while it was least ($P < 0.05$) in stewed rabbit meat. The results revealed further that meat from female rabbits had higher ($P<0.05$) proximate component values than in male rabbit meat except for NFE. It has been reported (Apata and Akinfemi, 2010) that moisture and crude protein were higher in stewed rabbit meat while fried rabbit meat had the least, and opined that high heat from frying processing could be responsible for burning of protein and draining of juices due to shrinkage of meat during frying which probably was minimal in stewing. Stewing coagulates fat, while cooking with higher heat melts it. This was observed in this study, fried and broiled rabbit meat had lower fat content probably fat in the meat might have melted during frying and boiling while roasted and stewed coagulated fat, hence higher values of fat for meat cooked with these methods. Colour, flavour and overall acceptability scores were higher ($P < 0.05$) in fried rabbit meat (Table 3), while tenderness, juiciness and texture scores were higher ($P < 0.05$) in stewed rabbit meat. Meat samples from male rabbits were highly ($P < 0.05$) accepted than meat from female rabbits. This could be due to lower ($P < 0.05$) colour, flavour, tenderness, juiciness and textural scores of meat samples from female rabbits. Similar report was given by Apata and Akinfemi (2010) that colour and flavour constitute the most cherished attributes of meat that attract consumers to accepting any type of meat. Despite the fact that tenderness, juiciness and texture scores were high in stewed rabbit meat, its acceptability was lower compared with fried rabbit meat. Acceptability of fried rabbit meat was high probably due to its high colour and flavour which might have been partly contributed by oil used in frying the meat. Omojola (2007) reported sexual dimorphism of some carcass and organoleptic characteristics in duck. This condition could also happen in rabbits and could be responsible for differences, observed in attributes of male and female rabbit meat processed (cooked) differently in this study.

Conclusion

In order to bridge the gap of dismally low protein intake in developing countries, pragmatic steps should be taken. One of such necessary steps is the utilization of micro-livestock like rabbit. This is because it can supply high quality animal protein and attracts low cost of production, has small size, short generation interval, high fecundity, rapid growth rate and ability to utilize forage. Production and consumption of meat have tremendous economic and socio-political importance, but the overall acceptability of meat depends on the processing (cooking) method which can affect the physicochemical and sensory qualities of meat. Sexual dimorphism is reported to have influence on the carcass, meat and organoleptic characteristics of some animals and birds. In

Table 3. Sensory characteristics of Rabbit meat as influenced b y sex and processing methods.

Treatments	Col.	Flv.	Tdn	Jcn	Tex	OA
Frying						
M	6.70^{aa}	7.50^{aa}	4.40^{da}	3.30^{d}	5.50^{ba}	7.60^{aa}
F	5.50^{ab}	6.30^{ab}	3.30^{db}	3.20^{c}	4.40^{bb}	6.30^{ab}
Broiling						
M	5.40^{ba}	6.30^{ba}	5.20^{ca}	4.40^{ca}	5.20^{ba}	6.40^{ba}
F	4.30^{bb}	5.20^{bb}	4.10^{cb}	3.30^{cb}	4.20^{bb}	5.10^{bb}
Roasting						
M	3.80^{d}	4.20^{d}	6.70^{ba}	5.30^{ba}	4.70^{c}	4.30^{d}
F	3.50^{c}	4.00^{d}	5.50^{bb}	4.10^{bb}	4.20^{b}	4.00^{c}
Stewing						
M	4.70^{c}	5.40^{c}	7.80^{aa}	6.70^{aa}	6.50^{aa}	5.70^{c}
F	4.50^{b}	5.00^{c}	6.60^{ab}	5.50^{ab}	5.30^{ab}	5.30^{b}
SEM	0.78	0.71	1.10	1.00	0.84	0.50

abcd: Means on the same column with different superscripts and for the same variable are statistically significant ($P < 0.05$). Col = Colour, Flv = flavour, Tdn = tenderness, Jcn = juiciness, Tex = texture, O.A. = overall acceptability, M = male, F = female. Sensory scores were analysed on a 9-point Hedonic scale on which 1 = dislike extremely and 9 = like extremely.

this study, it was observed that rabbit meat processed with stewing had higher cooking yield and water holding capacity, moisture, protein and fat contents which conferred on it higher tenderness and juiciness. However, fried rabbit meat was highly accepted than those from other treatments due to high colour and flavour. Meat from male had higher cooking yield and overall acceptability. It is recommended that frying and broiling methods be employed, also male rabbits be preferred if rabbit meat is to be processed since fried and broiled rabbit meat as well as meat of male rabbit were accepted more in this study.

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