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Physico chemical and organoleptic characteristics of Muscovy drake meat as influenced by cooking methods

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The study was conducted to determine the effect of various cooking methods - grilling, deep frying, pan frying and roasting on quality attributes of Muscovy drake meat. A total of one hundred and eighty (180) Muscovy drakes fillets weighing between 118-130 g were used in a completely randomized design. Cooked samples were analyzed for proximate composition and physical characteristics. Organoleptic characteristics were evaluated using a nine-point hedonic scale. Deep fried meat samples had the highest (P<0.05) cooking loss (52.37%), while pan and deep fried meat samples had the highest shear force values of 4.10 and 3.91 kg/cm^3, respectively in comparison to values of 2.68 and 2.64 kg/cm^3 for roasted and grilled samples. The water holding capacity (WHC) of the meat was not affected significantly (P>0.05). The moisture content varied from 71.64% in the raw meat to 35.57% in deep fried fillets. Protein and ash content increased across the treatments after cooking. Pan fried (13.95%) and roasted duck fillets (13.92%) had higher fat than the raw sample (12.92%). Except for colour, other organoleptic parameters were not affected significantly. The use of deep frying method should be minimized since it resulted into meat with the least nutrient composition.

Key words: Muscovy drake, cooking method, organoleptic characteristics, physical attribute.

INTRODUCTION

Over the years, duck meat has been reported to be uniquely tasty and nutritious (Omojola, 2007). It has been appreciated for these qualities especially when food was in short supply. Today, duck meat is still very popular and in strong demand in many areas of the world especially Asia. Preference with regard to the breeds of duck and methods of preparation vary widely. In North America, parts of Europe, Australia and in many areas of the world roasted duck meat are a popular item in the menus of restaurants. Roasted, braised or barbecued duckling is also popular among homes and gourmets (Hird et al., 2005). More recently duck parts, such as breast and legs have become more available, which offers more options for diet conscious consumers. Pre-cooked parts which can be quickly heated in a microwave are also becoming more available in developed countries. Increased

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availability of duck meat and an increase in the available processed products prepared with duck meat is evidence of a movement to the large scale production of duck products (Hird et al., 2005).

However, duck meat consumption is reducing in Nigeria most probably because of several factors such as taboo on duck meat consumption and lack of technical know-how on duck husbandry (Oluyemi, 1979). Among people who have never tried duck or those who rarely eat it, there appears to be two concerns. The first concern seems to be lack of knowledge on how to properly prepare duck meat while the other is the somewhat higher fat content of duck, which is true of whole duck but not of leg meat and skinless breast meat (USDA, 2008).

The purpose of cooking is to make meat palatable, digestible and microbiologically safe (Tornberg, 2005). During this process, meat undergoes many changes, both physical and chemical, including weight loss, modifications of water-holding capacity, texture, muscle fibre shrinkage, colour and aroma development (Walsh et al., 2010) that are strongly dependent on protein denaturation and water loss. Quality characteristics of cooked meat products are also dependent on the composition and characteristics of the muscles, the heating method, as well as the time/temperature evolution during cooking (Christensen et al., 2000). The heating profile affects the sequence and extent of meat protein denaturation in the cooking process and, consequently, the physical and sensory properties of the final product (Riva and Schiraldi, 1994).

However, this can lead to undesirable modifications, such as a decrease in the nutritional value, mainly due to vitamin and mineral losses, and changes in the fatty acid composition associated with lipid oxidation (Rodriguez-Estrada et al., 1997). The use of different cooking methods on duck meat and its effect on the properties of the cooked product are interesting and worthy of investigation. The interaction between the raw ingredients and the cooking procedure has, however, not been studied in depth, even though heat treatment has a significant impact on the composition and physicochemical characteristics of the final food (Ratnajothi, 2010). The objective of the present work, therefore, was to determine the influence of commonly used cooking methods of - grilling, deep frying, pan frying and roasting on nutritional value and eating qualities of Muscovy drake meat.

MATERIALS AND METHODS

Sample preparation

A total of one hundred and eighty fillets weighing between 118-130 g were excised from the breast portion of eighteen (18) matured Muscovy drakes within one hour post-mortem. The meat samples were trimmed of any visible fat, ligaments and bones and kept frozen -2°C for 24 h after which the meats were properly thawed before cooking.

Cooking

After thawing, the fillets were distributed randomly to the four cooking conditions of: grilling, deep-frying, pan-frying, and roasting in a completely randomized design. Raw fillets were analyzed and served as the standard.

Cooking methods

Pan-frying

The Muscovy drake breasts were fried for 5 min per side without fat or oil in a Teflon-coated pan, which was preheated and the surface temperature was measured as 180°C.

Deep-frying

Fresh soybean oil(R) was used. The Muscovy drake breasts were fried for 10 min in a commercial stainless steel deep-fat fryer, when the temperature of oil reached 180°C.

Gas grilling

The drake breasts were grilled for 10 min per side, total cooking time was 20 min, the distance between samples and burner was about 15 cm. The surface temperature of the samples was about 200°C.

Roasting

The breasts were placed in a gas oven for roasting for 20 min at 200°C. The temperature of cooking was monitored by the thin chromium-aluminum thermocouples and cooking terminated when the core temperature of the meat reached the degree of well done (80°C). No condiment, spice or salt were applied to the fillets in each of the cooking procedure before and after cooking.

Parameters measured

Tenderness

Once fillets reached the desired internal temperature endpoint, they were cooled to room temperature for a minimum of two hours at which time an average of six 1.0 cm diameter cores were removed for shear force (tenderness) measurement using a Warner- Bratzler attachment to an Instron Universal Testing Machine.

Cooking loss

Fillets were weighed prior to and two hours post-cooking to determine cooking loss which is expressed as a percentage of raw fillet weight.

Proximate composition

After mincing the cooked samples, they were homogenized with a mixer (Moulinex 320) prior to determination of dry matter (ISO, 1997), total fat (ISO, 1973), protein (ISO, 1978) with a conversion

Table 1. Physical properties of Muscovy drake meat as affected by different cooking methods.

Parameter	Cooking method						
	Grilling	Deep frying	Pan frying	Roasting	SEM	F-Val	P-Val
Cooking loss (%)	44.40[b]	52.37[a]	43.36[b]	43.02[b]	0.94	4.61	0.003
Shear force (Kg/cm^3)	2.64[b]	3.91[a]	4.10[a]	2.68[b]	0.13	16.83	0.001
Water holding capacity (%)	21.14	21.11	17.94	18.24	0.71	2.70	0.092

[abc] Means with the same superscript along the same row are not significantly different (P>0.05).

factor of 6.25 and ash (ISO, 1998). All analyses were performed in duplicate per cooking procedure.

Water holding capacity (WHC)

This was determined using the press method as modified by Tsai and Oeckerman (1981). Approximately 0.5 g sample was taken from the differently cooked drake breast and weighed into a 9cm diameter Whatman No 1 filter paper (Model C, Carver, Inc Wabash IN, USA) and pressed between two 10.2×10.2 cm plexi glasses at approximately 35.2 kg/cm^3 for 1 min. The area of the free water was measured using a compensatory planimeter (Planix 5000, Tamaya Technics Inc, Tokyo, Japan) and percent free water calculated based on sample weight and moisture content (Tsai and Oeckerman, 1981). Percent bound water (WHC) was calculated as 100% minus free water percent. Six determinations were performed for each cooking trial.

Taste panel evaluation

Samples for sensory evaluation were taken from each of the treatment groups after cooking to the desired internal temperature. A total of 20 trained individuals aged between 22 and 35 years (40% male and 60% female) were employed to assess the cooked meat samples. Equal bite size from each treatment was coded, replicated thrice and served in odourless plastic plates. Each sample was evaluated independent of the other. The samples were evaluated on a 9-point hedonic scale for colour, flavour, tenderness, juiciness and overall acceptability.

Statistical analysis

All data obtained were subjected to analysis to variance and where statistical significances were observed, the means were compared using the Duncan's Multiple Range Test (Duncan, 1955). The SAS (1999) computer software package was used for all statistical analysis.

RESULTS AND DISCUSSION

Cooking procedures (methods) can have a dramatic effect on the final appearance and eating quality of meat, as well as its nutritional value. During cooking, meat loses approximately 20-40% of its weight (Davey and Gilbert, 1974; Martens et al., 1982; Bertola et al., 1994; Palka and Daun, 1999; Aaslyng et al., 2003). This is ascribed to a temperature-induced, structural shrinkage, which causes fluid to be expelled from the meat (Davey and Gilbert, 1974). The aspects of cooking methodology that are particularly crucial are final endpoint temperature, the time the meat spends at higher temperatures and the presence of moisture or fat.

Physical properties

Cooking loss measurement is a rapid and valid method of assessing the impact of heat treatment on meat, because it reflects the degree of its juiciness, as well as certain economic aspects (Bertram et al., 2004). Cooking loss of all samples is shown in Table 1. Deep fried meat samples had the highest (P<0.05) cooking loss (52.37%) while there was no noticeable statistical differences between values obtained for the other cooking methods. The variation observed in the percentage cooking loss especially for the high value in deep fried meat may be due to high temperature involved in deep frying which might have led to loss of fat and shrinkage in the fried meat. According to Bertram et al. (2004) the strong correlation between cooking loss and shrinkage of meat can be explained by the fact that the shrinkage appearing during cooking causes loss of meat liquid, which resulted in loss in mass.

Cooking loss is the reduction in weight of meat during cooking process. This loss of weight has been shown to consist of mainly water but a substantial loss of lipid can also occur. The degree of cooking loss will depend greatly on the cooking procedure employed. Davey and Gilbert (1974) found that the temperature at which cooking loss increased in meat corresponded to the temperature at which isolated collagen shrunk. It may therefore be reasonable to suggest that the differences in cooking loss values observed in the present study could be due to a difference in the force generated by collagen shrinkage on the myofibrils. Collagen shrinkage before its solubilization may not have been severe enough in the slow cooking methods of grilling, pan frying and roasting to generate a force able to expel water (King et al., 2003).

Shear force

Shear force measures the degree of toughness, the higher the value the tougher the meat. Tenderness is considered as the most important trait of meat quality attributes (Cross et al., 1986) that determines the perception of consumers to a particular type of meat.

Table 2. Proximate composition of Muscovy drake meat as it is affected by different processing methods.

Parameter (g/100 g)	Cooking method							
	Raw	Grilling	Deep frying	Pan frying	Roasting	SEM	F- Val	P- Val
Moisture	71.64[a]	45.89[c]	35.57[e]	38.38[d]	53.18[b]	1.68	3021.51	0.000
Protein	21.91[d]	33.43[a]	28.74[c]	30.91[b]	31.28[b]	0.55	107.97	0.000
Fat	12.92[b]	11.52[c]	8.66[d]	13.85[a]	13.92[a]	0.26	2146.94	0.000
Ash	2.12[b]	7.20[a]	7.02[a]	7.08[a]	7.02[a]	0.26	3726.86	0.000

[abc] Means with the same superscript along the same row are not significantly different (P>0.05).

Shear force results are reported in Table 1. Pan fried and deep fried meat samples had the highest shear force values of 4.10 and 3.91 kg/cm^3, respectively in comparison to values of 2.68 kg/cm^3 for roasted and 2.64 kg/cm^3 for grilled samples. The high shear force in fried samples is probably indicative of the sample surface consistency and to surface crust formation and the higher dehydration of the centre that the samples underwent during cooking. The high shear force value obtained in this study for frying methods was similar to that of Apata et al., (2012) who observed high shear force values for fried rabbit meat. Cooking temperatures and methods thus dramatically affect the tenderness of meat cuts (Combes et al., 2003).

Water holding capacity (WHC)

The WHC, which is the ability of meat to retain its water during application of external forces is important in meat processing, and the overall eating quality of meat revolves around it (Omojola, 2008). WHC is related to the denaturation of proteins that leads to different longitudinal shrinkage (Offer et al., 1984; Tornberg, 2005) and is dependent on the heating rate (Bertram, et al., 2006). The four cooking methods used in this study did not affect the WHC of the meat (P>0.05) (Table 1) probably because cooking meat for a long period of time at lower temperatures can have the same effect on water retention as does cooking at higher temperatures for short periods of time (Bertram et al., 2006).

Proximate analysis

Results in Table 2 showed the proximate composition of the raw meat, and after undergoing four cooking procedures. The moisture content significantly varied from 71.64% in the raw meat to 53.18% in roasted, 45.89% in grilled, 38.38% in pan fried and 35.57 in deep fried samples (P<0.05). Differences between dry-heat and moist heat cooking methods have previously been reported (Sainsbury et al., 2011) with higher losses of moisture in dry-heat cooking procedures. Each of the cooking procedures used in this study led to reduction in moisture compared to the raw meat (Table 2), when considering the same weight of raw and cooked meats. The percent reduction in moisture ranged from 25.77% for roasted duck meat to 35.94% for grilled, 46.43% for pan fried and 50.35% for deep fried fillets. The high moisture loss recorded for deep fried samples could be due to replacement of the water matrix by fat because deep frying is primarily a dehydration process, which means that water and water-soluble substances are extracted from the product being deep fried and transferred to the cooking fat, and at the same time the product absorbed the surrounding fat (Choe and Minutes, 1997).

The consumption of pan fried and roasted duck meat implied the intake of 7.20 and 7.74%% more fat while the consumption of grilled and deep fried meat indicated a reduction in fat consumption of 10.99 and 32.97% less fat than the composition of the raw product. Pan fried and roasted duck fillets under our cooking conditions showed a relative increase of fat in relation to the raw product, while samples that were either grilled or deep fried had lower fat contents than the raw samples.

The ash values obtained for the different processing methods did not differ from each other. The processing methods employed in this work equally increased ash content of the duck meat. This agreed with Vaclavik and Christian (2007), who stated that minerals tend to have higher heat stability and are less affected by cooking methods. No loss of ash was observed during cooking. The increase in percentage ranged from 231.13% for deep fried and roasted samples to 233.96 and 239.62% for pan fried and grilled samples respectively.

Taste panel evaluation

The results of the taste panel evaluation (Table 3) indicated that none of the cooking procedures influenced the sensory score of flavour, juiciness, tenderness and overall acceptability significantly (P>0.05). Tenderness which is regarded as the most important sensory attribute affecting meat acceptability (Cross et al., 1986; Quali, 1990; Warkup et al., 1995) was rated between a score of slightly tough (4.50) to intermediate (5.13) on a nine point hedonic scale. The panelists were however not able to

Table 3. Effect of different cooking methods on organoleptic properties of Muscovy drake meat.

Parameter	Cooking method						
	Grilling	Deep frying	Pan frying	Roasting	SEM	F- Val	P-Val
Colour	5.00[a]	3.20[c]	3.47[bc]	4.17[b]	0.24	10.28	0.004
Flavour	5.60	5.43	4.73	4.57	0.22	1.51	0.286
Tenderness	4.50	5.03	5.10	5.13	0.15	0.91	0.478
Juiciness	4.78	5.01	5.76	5.23	0.12	6.54	0.150
Overall acceptability	5.07	5.20	4.80	5.07	0.12	0.40	0.761

[abc] Means with the same superscript along the same row are not significantly different (P>0.05).

detect any difference in the tenderness of Muscovy drake meat irrespective of the cooking method employed. A similar trend was observed for flavor, juiciness and overall acceptability. Colour score for grilled duck meat was rated highest with a value of 5.00 (intermediate score on a nine point hedonic scale). Deep and pan fried samples were rated lowest with values of 3.20 and 3.47%, respectively which were significantly lower (P<0.05) compared to the value 5.00 for grilling while the colour score for roasted fillets was 4.17. There is possibility that the high temperature and the oil used in frying might have affected the colour of the product resulting to a lower score compared to the other meat products. Apata et al., (2012) stated that different cooking methods greatly affect the colour of processed rabbit eliciting the lowest scores. The low score recorded by the panelist for each of the eating quality traits is probably an indication of the level of acceptance of duck meat irrespective of the cooking method employed.

Conclusion

Cooking influenced the nutrient content of meat in different ways depending on the cooking process. In this study, it was observed that processing methods affected the physical properties of drake breast meat differently, except for water holding capacity. Grilled duck breast meat was the tenderest. Nutrient composition of processed drake breast meat was affected by different cooking methods with deep fried fillets having the lowest nutrient composition.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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