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Comparative Physical and Organoleptic Properties, Nutritional Composition, and Safety of Charcoal and Oven Smoked Noiler Meat Spiced *Asun*.

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Abstract

Five Matured Noiler chickens 3 months old weighing 3kg±120g were used for the experiment. The birds have fasted for 16 hours without food but with a supply of fresh cool water. The birds were slaughtered and dressed conventionally. The breast meat was excised within one-hour post-mortem and used for the preparation of *Asun* using charcoal and oven smoking. The breast meats were cut into fillets of average weight without bone; the fillets were spiced, rubbed with vegetable oil, and smoked using charcoal and oven to an internal temperature of 720C for 20 minutes with regular turning. The result shows a significant difference ($p<0.05$) in the nutritional and chemical composition of raw and smoke Noiler meat. The charcoal and oven-smoked *Asun* were not different, but both differ from the raw. The organoleptic properties show no significant difference ($p>0.05$) in color, aroma, and texture while flavor, juiciness, and overall acceptability differ. There was a significantly different ($p>0.05$) in WHC, cooking loss, and cooking yield. Preparation of *Asun* using charcoal and oven smoking contributed to the nutritional component except for the moisture content. The cholesterol, SFA, MUFA, PUFA, and amines were also increased. The value obtained shows that charcoal and oven-smoked Noiler meat *Asun* is safe for consumption and has no negative effect, also impacts positively on both the physical and organoleptic properties of the prepared product and therefore, recommended for the preparation of *Asun* using Noiler meat.

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Introduction

Asun is a smoked grilled or barbecued spiced goat meat. However, based on choice or availability, *Asun* could also be prepared from other animal types. As a delicacy, *Asun* could be prepared at home by individuals. It is also available as ready-to-eat meat in nightclub centers, hotels, and relaxation centers (Akharaiyi and Isunu, 2015). Meat and meat products are very important sources of nutrients in human diets. From farm to table, the whole process of obtaining meat and its products includes animal handling, transportation, and slaughtering process, followed by preservation techniques aimed at extending the shelf life of fresh meat and processing aimed at converting meat into desirable meat products (Pal and Dervani, 2018). The effort to preserve and make meat more desirable for consumption has increased the demand for meat processing. Consumption of processed meat products has greatly increased due to the availability and accessibility of ready-to-eat meat products. The food safety implication of processed ready-to-eat meat products calls for global concern, despite increased patronage (Sofos, 2008). The awareness of consumers about the influence of what they consume on their health has led to the concept of functional food; this has inspired investigation into functional meat development and also in conserving the nutritive values of the product (Eze *et al*., 2017). Meat processing plays an important role if fully utilizes meat resources; including nearly all edible livestock parts that can be processed for human food consumption. Meat processing is the transformation of animal muscle, fat, and non-meat additives into meat products. Consumers' perception of a meat product is enhanced by meat additives. Meat additives can be used to increase product value for specific meat preparation. Animal by-products such as internal organs, slain, and blood is also well suited for meat processing. Meat processing creates different types of product compositions that optimize the usage of edible livestock parts making it tasty, attractive, and nourishing (Chen *et al*., 2018).

The nutritional quality of *Asun* is primarily determined by the chemical composition of the muscle tissue used, post-mortem biochemical changes that lead to the conversion of muscle to meat and the additive used in the preparation. Muscle and connective tissues are the most abundant tissues in meat; their properties and the relative proportion of each tissue are responsible for the leanness and quality of meat (Astruc, 2014).

Asun is made from meat and meat is considered rich to be in essential amino acids, mineral contents to a lesser extent, essential fatty acids, and vitamins (Eze *et al*., 2017). Meat can be smoked using different sources of smoke and smoking materials using a smoker and outdoor grill, oven grill, and saucepan (no grill no smoke) (Ahmed *et al*., 2020). Smoking is an aged-old preservation technique, where meat is subjected to smoking; it affects the sensory and nutritional composition of the meat products. Smoking impacts positively on the flavor, color, odor, and overall acceptability of meat products. Effect of smoking, on meat, increases with the time of exposure, type of smoke and intensity of smoking. Hot smoking, cold smoking, electrostatic smoking, condensates smoke aromas and liquid smoke are commonly used smoking treatments. Meat is smoked at 20-250C at a relative humidity of 70-80% and 75-800C during cold and hot smoking respectively (Beriain *et al*., 2011). Smoking reduces the water activity of meat, which affects the hardness and protein stability of the products. One of the advantages of meat processing is the integration of certain animal tissues such as muscle trimming, bone scraps, skin parts, and internal organs which are usually not sold in fresh meat marketing, into the food chain as valuable protein-rich ingredients (Eze *et al*., 2017).

Smoking is considered an effective treatment and a preservative measure against pathogenic micro-organisms, it also reduces lipid oxidation which usually causes undesirable flavors and oxidative rancidity in stored processed meat (Dieguez *et al*., 2010). The study will provide accessible information on the influence of charcoal and oven smoking on nutritional safety, consumers' perception, and physical attributes of *Asun* (spiced smoked meat) made from Noiler chicken.

Materials and Methods

Experimental location

The experiment was conducted in the Meat Science Laboratory, Department of Agricultural Technology, Institute Applied Science, Kwara State Polytechnic Ilorin, Nigeria.

Sample Collection

The breast muscles of five mature Noiler chickens aged 3 months were used. The Noiler chickens were acclimatized and conditioned for slaughtering and processing. The Noiler chickens were fasted overnight for 16 hours without feed but were supplied with cool fresh water. Slaughter and dressed conventionally within one-hour post mortem. The muscle of the breast was excised and cut into fillets of average weight without bone, but with fat, skin, and connective tissues (Omojola *et al*., 2012). The meat fillets were cool in ice-packed containers and transferred to the meat laboratory for *Asun* production.

Preparation of Spice Mixture

The ingredients in table 1 were used for the species formulation, each of the species was dried, ground, sieved, and weighed separately, and other species were weighed and used as bought. The species were combined, mixed thoroughly, and stored in an airtight container for further use.

Table1. Composition of formulated recipe used for *Asun* production

Ingredients	Scientific Names	Quantity (g)
Salt	Sodium chloride	7.0
Maggi	Monosodium glutamate	12.0
Thyme	Thymus vulgaris L.	6.0
Curry	Murraya koenigii L.	6.0
Pepper	Piper Nigrum L	25.0
African nutmeg	Mobogora myristica	3.0
Ginger	Zingiber afficinale	3.0
Garlic	Allium sativum L	3.0
Clove	Syzyjim aromaticum L	2.0
Onions	Allium cepa L	23.0
Total		90.00g

Source: experimental research (2022).

The recipe was added in the ratio 1:25 (40g recipe to 1000g meat). The recipe was made into a broth solution. The fresh onions were peeled, sliced, weighed, and added to other weighed ingredients and blend in an elective blender with 200ml water to form a broth solution. The broth solution was refrigerated for subsequent use.

Cooking of meat

500g Noiler breast meat fillet each was weighed rinsed in cool water and blotted dry wrapped in foil paper. 20g of the prepared broth recipe solution was rubbed separately on each meat, wrapped and steam cooked separately at 100^{0C} for 30min, then cool down to 28^{0}C room temperature before smoking (Omojola *et al*., 2012).

Smoking of Cooked Meat

Smoking was done in an electric oven according to a modified method by Soepamo *et al*. (2015). The oven was preheated to an internal temperature of 100 degrees. The meat was rubbed with vegetable oil (cholesterol-free) to prevent the meat from having a dry crack surface. The meat was smoked for 20min, with regular turning for the meat to be evenly smoked. Smoke was generated in the oven by dropping drops of oil on the electric filament of the oven. Smoking was done using the open charcoal grilling (locally made charcoal pot) method. The charcoal was heated to cherry red with wire gauze placed in the charcoal grill pot. The meat was placed on the wire gauze and covered allowing the meat to be smoked for 20min at regular turning intervals.

Analytical methods

Proximate analysis: proximate composition of the raw Noiler meat and the prepared *Asun* was conducted using the method described by AOAC, (2005). The total cholesterol composition of *Asun* was carried out as described by Weyant *et al*. (1976). Polycyclic Aromatic Hydrocarbons (PAH) were determined using gas chromatography-mass spectrophotometry (GCMS) according to Duedal-Olesen *et al*. (2010). Heterocyclic Aromatic Amines (HAAs) were determined using a gas chromatography-mass spectrophotometer (GCMS) according to Duedahl-Olesen *et al*. (2010). The fatty acids composition of the freshly prepared

Asun was assessed using the method described by Lowry and Tinsley, (1976).

Cooking loss: loss in weight during smoking was measured by weighing the cooked meat samples before smoking for 20min until the meat reaches an internal temperature of 72^{o}C. The *Asun* was allowed to cool down to room temperature of 28^{0}C and reweighed again to calculate cooking loss (Omoloja *et al*., 2014)

Cooking loss (%) = initial weight of meat - cooked weight of meat / Initial weight of meat ***** 100

Cooking yield: increase in weight due to smoking of *Asun* was calculated using the method described by Omoloja *et al*. (2014).

Cooking (Product) yield (%) = Weight of Asu/ weight of raw meat * 100

Water holding capacity (WHC) was assessed using a slightly modified method described by Suzuki *et al*. (2001). 1g each of differently smoke *Asun* sample was sandwiched between two 9cm Whatman No1 filter papers separately. The *filter papers* were placed in between two 12 X 12 cm^2 Plexiglass and then pressed at about 35.2 kg/cm3 absolute pressure for 1 minute using a vice. The meat samples were removed and oven dried at 80℃ for 24 hours to determine the moisture content. The amount of water released from the samples was measured indirectly by measuring the area of filter paper wetted relative to the area of pressed meat samples. The procedure was carried out separately for oven and charcoal smoke *Asun* and replicated thrice. Thus, the water holding capacity was calculated as follows:

WHC=100-{(Aw- Am * 9.47)} / Wm-Mo
Where:
Aw= Area of water released from meat samples (cm^2)
Am= Area of meat sample (cm^2)
Wm= weight of meat sample (g)
Mo= moisture content of meat sample (%)
9.47 = a constant factor

Organoleptic Properties

Forty semi-trained panelists of mixed gender, different backgrounds, and ages, were used for the sensory evaluation. The panelists were made to rate each of the different smoke *Asun* replicates. Equal bite sizes from each processed *Asun* were served in a separate coded odorless plate. The panelist rated each sample on a nine-point hedonic scale with a maximum score of 9 for the extremely high condition while the lowest score of 1 was assigned to the poorest condition. The parameters evaluated include flavor, aroma, juiciness, texture, and overall acceptability (Omojola *et al*., 2014).

Data Analysis

All data obtained were subjected to analysis of variance (ANOVA), and the treatment means were compared using Duncan's multiple range test (Duncan, 1995). SAS 2000 computer software package was used for the statistical analysis.

Results and Discussion

The moisture content of differently smoke *Asun* and the raw meat of Noiler differs significantly (P<0.005). The moisture content of raw meat was higher than the differently smoke *Asun*, while the charcoal-smoked *Asun* had more moisture than the oven-smoked. The loss in moisture may be due to the high oven temperature. The result also shows that oven smoking reduces moisture content compared to charcoal smoking. The result is within the range reported by Alfaia et al. (2010) who stated that maximum moisture content of 74.42% was found in cooled samples of chicken meat and a minimum of 54.4% was found in a charcoal-roasted sample of chicken meat. Omojola *et al*. (2014) reported that the higher the cooking temperature the more moisture will be lost. The protein, ether extract, ash, and total cholesterol content in raw meat was lower (p<0.05) compared to differently smoked *Asun*. The protein, ether extract, ash, and total cholesterol content were not affected by smoking methods.

Both the oven and charcoal smoke *Asun* had the same percentage of crude protein, crude ether extract, crude ash, and total cholesterol content which was higher than the raw meat. Juaraz *et al*. (2010) reported an increase in the nutritional content of Buffalo meat after cooking. With the highest obtained in fried meat samples. Nobrega et al. (2006) indicate that all smoking treatments increase the proximate content of processed meat. There were only slight differences ($p>0.05$) in the cholesterol content of raw meat and Noiler meat processed into *Asun*. Alina *et al*. (2012) results show that all cooking treatments caused as an increase in cholesterol content except microwave cooking. Omojola *et al*. (2014) reported that the processing method increased the physicochemical properties of differently processed Muscovy drake breast meat. The fatty acid concentration was lower ($p<0.05$) in raw Noiler breast meat as compared to the processed *Asun* using charcoal and oven smoking. Saturated fatty acids, monounsaturated fatty acids, and polyunsaturated fatty acids contents were lower in raw Noiler meat but higher in processed meat. There was no statistical difference ($p>0.05$) in the fatty acids content of both charcoal and oven smoked *Asun*. Alina *et al*. (2012) reported an increase in the fatty acid composition of raw, grilled, boiled, fried, and microwave roasted samples (18.5, 29.4, 30.2, 24.8 and 30.0% respectively). The unsaturated fatty acids mainly PUFA were affected by cooking methods, considering the parts of the membrane structure (Gerber *et al*., 2009).

THAAs (total heterocyclic aromatic amines) and TPHA (total polycyclic heterocyclic amine) were not detected in raw Noiler meat. Charcoal smoking increases the THAAs in Noiler *Asun* to 26.96ng/g and oven smoking to 24.88ng/g which were not significantly different. Charcoal smoking increases the TPHAs in *Asun* to 2.82ng/g and oven smoking to 4.180ng/g in the processed *Asun*. Reports have suggested that amines are formed when meat is cooked at high temperatures (Sinha *et al*., 1995). The value of HAA obtained in this study was lower than that obtained by Liao *et al*. (2009) and Omojola *et al*. (2014) who reported 53.3ng/g total HAAs in processed duck breast meat. Different smoking materials did not increase THCAs broiler meat beyond the daily recommended dose (Ahmed *et al*., 2020). The values obtained in this study were lower than 32ng/g obtained for charcoal grilling of duck breast meat by Solyakov, (2012). Liao *et al*. (2009) suggested that poultry meat prepared under different cooking conditions contains variable levels of HAAs. Total heterocyclic aromatic amine concentration in cooked meat ranges from less than 1ng/g to about 500ng/g, but usually less than 100ng/g (Sinha *et al*., 1995). Smoking, Grilling, and barbecuing which are categorized as dry heat cooking methods are the most common methods for the preparation of fatty meat, this usually requires higher temperatures (above 200 °C) that promote HAAs formation

Table 2. Nutritional and chemical composition of raw, charcoal, and oven smoked Noiler chicken *Asun*

Nutritional and chemical composition	Raw unsmoked	Charcoal smoked	Oven smoked	MSE	Sig
Moisture %	70.88^{a}	57.01^{b}	51.18^{c}	1.059	0.000
Protein %	22.64^{b}	32.58^{a}	32.84^{a}	1.008	0.000
Ether extract %	9.93^{b}	12.62^{a}	12.41^{a}	315	0.000
Ash %	2.36^{b}	5.36^{a}	5.20^{a}	0.15	0.000
Total cholesterol mg/g	50.06^{b}	56.61^{a}	56.42^{a}	0.253	0.000
S.F.A ng/g	1.27^{b}	2.06^{a}	1.98^{a}	0.01	0.000
MUFA ng/g	1.87^{b}	2.56^{a}	2.49^{a}	0.01	0.000
PUFA ng/g	0.52^{b}	0.85^{a}	0.75^{a}	0.201	0.000
THAAs ng/g	0.00^{b}	26.96^{a}	24.88^{a}	0.257	0.000
TPHA ng/g	0.00^{c}	2.82^{b}	4.180^{a}	0.007	0.000

Mean values having the same superscripts were not significantly different $p<0.05$.

Mean values having different superscripts were significantly different p>0.05.
S.F.A (saturated fatty acid), MUFA (monounsaturated fatty acid), PUFA (polyunsaturated fatty acid), THAAs (total heterocyclic aromatic amines), TPHA (total polycyclic heterocyclic amine).

The result of taste panelist perception towards the differently smoked *Asun* made from Noiler breast meat is presented in table 3 below. Three of the parameters; color, aroma, and texture did not differ significantly (p>0.05) while the other three parameters; flavor, juiciness, and overall acceptability were rated differently (p<0.05) by the taste panelist. The color which is the first point of attraction of consumers to a particular product (Omojola *et al*., 2014) was not affected by the two different smoking methods employed in the study. The aroma and texture were not impacted by the charcoal and oven smoking. The color, aroma, and texture were equally perceived and rated by the taste panelist. The flavor which is the response of the taste buds of the tongue to a particular foodstuff (Beriain *et al*., 2011) was rated differently by the panelist. The flavor was rated high in charcoal smoked Noiler *Asun*. This might be a result of the wood the charcoal is made from. Smoking foods by conventional wood or charcoal smoke condensate flavors. The juiciness and overall acceptability of charcoal and oven-smoked Noiler *Asun* were also affected by a high-value score for oven-smoked *Asun* compared to charcoal-smoked *Asun*. The use of different smoking materials increases the palatability and consumers' perception of broiler meat (Ahmed *et al*., 2020). Smoking affects the eating qualities, consumers' perception, and nutritional information of meat products. Smoking impacts desirable effects on flavor, color, and odor in lamb meat. Changes in the characteristics of meat increase with the time of exposure to smoking temperature (Ahmed et al. 2020; Beriain *et al*., 2011).

Table 3. Organoleptic properties of charcoal and oven smoked Noiler chicken *Asun*

Organoleptic properties	Charcoal smoked	Oven smoked	MSE	Sig
Colour	4.00[a]	3.00[a]	2.125	0.231
Flavour	8.00[a]	5.00[b]	1.792	0.004
Aroma	7.00[a]	7.00[a]	2.646	0.137
Texture	7.00[a]	7.00[a]	4.125	0.201
Juiciness	4.00[b]	5.00[a]	2.000	0.001
Overall	6.00[b]	8.00[a]	0.625	0.000

Mean values having the same superscripts were not significantly different p<0.05
Mean values having different superscripts were significantly different p>0.0

The result of the physical properties of *Asun*; spiced smoke meat made from Noiler, and processed using oven and charcoal smoking methods are shown in table 4 below. The result shows that there was a significant difference (p<0.05) in the water holding capacity, cooking yield, and cooking loss of *Asun* therein produced. Water holding capacity (WHC) is the amount of moisture meat can retain after subjecting to heat treatment for a particular period. The water holding capacity was high in *Asun* prepared from Noiler meat using the charcoal smoking method compared to the oven smoking method. The result revealed that different smoking methods impacted the WHC while oven smoking causes more water loss. Charcoal smoking was able to retain water in the final products (69.70 and 73.58 respectively). Cooking loss refers to weight loss when meat is subjected to heat treatment at a particular temperature for a particular period (Alina *et al*., 2012; Ahmed *et al*., 2020). Cooking loss is a determinant of meat fat content and leanness of the meat. There was a significantly different (p<0.05) in the shrinking of meat in Noiler during processing using an oven and charcoal. Cooking loos was low in charcoal smoked Noiler and high in oven smoked Noiler respectively (18.68 and 21.05 respectively). Cooking yield is the opposite integral of cooking loss, the lower the cooking loss the higher the cooking yield (Omojola *et al*., 2014). There was a significantly different

($p<0.05$) in the yield of meat in Asun made from Noiler during processing using oven and charcoal. The cooking yield was high in charcoal smoked Noiler while it was least in oven processed Noiler (81.32 and 78.95 respectively). The change in yield of the differently processed Asun might be due to temperature and time combination effects, as reported by Omojola *et al*., 2014; Beriain *et al*., 2011 and Dieguez *et al*., 2010).

Table 4. Physical properties of charcoal and oven smoked Noiler chicken *Asun*

Physical properties	Charcoal smoked	Oven smoked	MSE	Sig
WHC %	73.58[a]	69.70[b]	7.933	0.002
Cooking loss %	18.68[a]	21.05[ab]	0.253	0.000
Cooking yield %	81.32[a]	78.95[ab]	0.253	0.000

Mean values having the same superscripts were not significantly different $p<0.05$.
Mean values having different superscripts were significantly different $p>0.05$.

Conclusion

Investigation into the healthiness, safety, and wholesome of processed meat products plays an essential function in maintaining the health status of humans. Wood smoking is one of the ancient methods of meat processing, charcoal, and the oven is relatively new and gaining prominence in outdoor meat processing. The result of the experiment concluded that smoking poultry meat using charcoal and an oven increases the nutritional content of the *Asun* made from Noiler chicken meat as compared to raw meat. Other components such as cholesterol, saturated fatty acid, monounsaturated fatty acids, and polyunsaturated fatty acid also increased with charcoal and oven smoking. Other aromatic amines were also generated due to temperature and the smoking effects involved in the processing of Noiler chicken meat into *Asun* but below the daily recommended doses. The processing methods also impacted positively on both the physical and organoleptic properties of the prepared product and therefore, recommended for the preparation of *Asun* using Noiler meat.

Conflict of Interest

The above research work has no conflict of interest whatsoever with any completed findings, before, during, and after the collection of data and writing of this paper**.**

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