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INFLUENCE OF CINNAMON AND GARLIC ON CHEMICAL AND MICROBIAL PROPERTIES OF BEEF MINCED MEAT

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ABSTRACT

The study was conducted to determine the influence of cinnamon and garlic on proximate and microbiological properties of beef minced meat (Dambun nama). Dambun nama was produced using three different spices (Cinnamon powder 10g/kg, Garlic powder 10g/kg, Cinnamon plus Garlic powder10g/kg at 1:1, including control). The meat was cooked at 60°C for 60-140 minutes during which preferred seasonings were added. The meat was then pounded with mortar and pestle until the matrix was formed. It was then dried in a hot air oven for 30minutes at 60°C and fried for 20 minutes with little oil. All samples were subjected to proximate and microbial analyses. The proximate analysis revealed significant difference (P<0.05) across the beef minced meat samples on moisture and ash content. Dambun nama made from T4 (Garlic plus Cinnamon powder) had the lowest (5.14%) moisture content, highest value of protein (44.03%) and ash (5.33%) content. On microbiological analyses, significant difference (P<0.05) was observed on E. coli with highest count of (0.90 x10^2 cfu/g) in T3 (Cinnamon powder), while the lowest count (0.01 x10^2 cfu/g) was found in T4. Staphylococcus aureus (0.81 x10^3 cfu/g) and Salmonella spp. (0.66 x10^{3}cfu/g) were all recorded higher count in T1, while least count was found in T4. It was concluded that addition of cinnamon and garlic either individually or in combination, significantly influenced both the proximate and microbial quality of the experimental beef minced meat. The sample treated with a combination of garlic and cinnamon (T4), showed the most favorable results such as lowering the moisture content which enhances the shelf life, high protein and ash content indicating improved nutritional value. Low microbial counts were also observed, particularly in total viable bacteria, E. coli, Salmonella spp., and Staphylococcus aureus, proving better microbial safety and longer shelf life stability.

Keywords: Beef minced meat, Spices, Microorganisms, Garlic, Proximate analysis

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INTRODUCTION

Meat and meat products play an important role in human nutrition; it is an excellent source of protein and rich in minerals and vitamins (Haytowitz & Pehrsson, 2018). Meat belongs to one of the six major classes of food that provides the body with high quality essential proteins, minerals, vitamins and nutrients (Oh *et al.,* 2016), as well as minerals and vitamins in order for the body to remain strong and healthy (Tsegay *et al.,* 2015). Meat is a rich source of protein, it can also be a potential vehicle of human food borne diseases if it not properly processed and stored (FAO, 2010). In developing countries food borne infection leads to death of many

children and resulting diarrheal disease and can also cause a long term effect on children's growth, physical and cognitive development (Adak *et al.,* 2005; Clarence *et al.,* 2009). Meat obtained from cattle is usually referred to as beef (Piatti-Farnell, 2013). Meat deterioration begins soon after the meat has been slaughtered due to chemical changes, enzymatic action and the action or presence of micro-organism (bacteria, fungi) which may result in the oxidative rancidity, discoloration, mouldiness, off flavour, slimness etc. (Gurunathan *et al.,* 2015).

The major source of these deteriorative changes is the micro-organism and these render the meat unacceptable and unfit for human consumptions. Shelf life and maintenance of meat quality are influenced by a number of inter-related factors including holding temperature, which can result in detrimental changes in the quality attributes (Nychas *et al.*, 2008). In many developing countries, meat is widely consumed either in a freshly cooked form, or processed into other products in order to improve taste and palatability, and also to avoid associated spoilage (Apata *et al.*, 2013).

Minced meat (*Dambun-nama*) a shredded fried meat product, prepared from the animal's skeletal muscle is a ready-to-eat meat product, produced mainly with the aim of extending the shelf life of meat, providing variety, and developing its individual distinct texture and flavor (Yusuf *et al.,* 2020). Due to its low moisture content, meat floss can be kept without refrigeration and will not drastically change in room temperature for long storage period of time (Huda *et al.*, 2012). Spices (cinnamon, cloves, ginger and garlic, etc.) have achieved some commercial importance as antioxidants. Beneficial influence of certain ground herbs and spices in fat stability has been known (Schuler, 1990).

Cinnamon has a wide variety of phenolics compounds that exhibit antimicrobial activities, the most important phenolic compounds in cinnamon plants are Cinnaaldehyde, Cinnamate and Cinnamic acid except that, the presence and concentration of each compound vary depending on the plant part, trans-cinnamaldehyde in bark was shown to be responsible for antimicrobial activity in cinnamon extracts (Rao & Gan, 2014). On the other side, Garlic is a strong antibacterial material against the bacterial species such as *Staphylococcus aureus, Streptococcus spp., Escherichia coli, Shigella senteriae, Salmonella spp., Klebsiella spp., Proteus mirabilis,* and *Helicobacter pylori* (Indu *et al.,* 2006). Also, it is effective against most of enteric genera of *Enterobacteriaceae* family and even against even those strains that have become antibiotics resistant (Ross *et al.,* 2001).
The main objective of the study is to determine effect of cinnamon and garlic on proximate and microbiological properties of beef minced meat.

MATERIALS AND METHODS

Study area

The research was carried out at the Laboratory of Animal Science of Faculty of Agriculture Federal University of Kashere. Kashere is located in Akko Local Government Area of Gombe State. Its coordinates lie between latitude 10^0 30N and longitude 10^0 52E, on the Northern fringes of the Sudan Savanna belt of Nigeria. The area has tropical climate with a distinct wet and dry seasons. The area records about three to four months of annual rainfall and is concentrated in July, August and September with an average annual rainfall of 951mm per annum. The mean annual temperature ranged from 30 – 37^0 C, while the months of March, April and May are observed to be dry/hot months of the year. (ZASTAL Kashere, 2024).

Sources of experimental materials

Fresh beef meat, ingredients (Cinnamon, Garlic seasonings and spices) and other equipment used in the study were obtained at Gombe metropolitan market.

Preparation of the experimental materials

This was carried out according to the method described by (Balarabe *et al.,* 2016). About 6 kg of fresh beef of good grade was cut into pieces of approximately 4 cm by 2.5 cm dimensions and washed with water, mixed with spices and seasoning, boiled for about 90 minutes and pounded into shreds using a mortar and pestle. This would then be shallow fried using groundnut oil in a stainless steel pot to obtain minced meat (*dambun-nama*) which is usually brownish in colour.

The Cinnamon was oven dried and grinded into fine powder and the Garlic too was cleaned and the peeled off the papery skin without cutting the garlic cloves, it was also oven dried and grinded with pestle and mortar, and sieved using a 0.002 mm mesh sieve. The experiment was laid in a Completely Randomized Design (CRD) with a four experimental treatments (Control, T1), (Cinnamon powder 10g/kg, T2), (Garlic powder 10g/kg, T3) and (Cinnamon plus Garlic powder 10g/kg, T4) and replicated three times.

Proximate analysis of an experimental beef minced meat

Determination of total protein, fat ash and moisture were performed according to the methods described by the AOAC (2006). Crude protein of the minced meat samples was determined by Kjeldahl methods while fat was obtained by Soxhlet extraction method using petroleum ether. Ash content of minced meat was obtained by igniting 1g of minced meat sample in a Muffle furnace at 500 °C for 5 - 6 hours until ashes were produced.

Microbial analysis of an experimental beef minced meat

This was done according to the procedure described by Buhari (2012). 10g of the sample was collected and transferred aseptically into 90ml of 0.1% sterile peptone water (Stock solution). It was allowed to sock to about 10 minutes after which 1ml was transferred into a bottle containing 0.1% sterile peptone water (10^{-1}) dilution. This was severally diluted with 10-7 dilution and obtained with the aid of a sterile pipette. 0.1ml of 10-5 dilution was aseptically transferred onto a surface of an agar (PCA) Eosin methylene blue agar (EMB). *Salmonella* and Shigella agar (SSA) Manito salt agar (MSA) Macconkey agar, blood agar base and potato dextrose agar plates and were spread evenly on the surface by using a spreader respectively. The plates were then incubated at 37˚C for 24 hours. At the end of incubation period the bacterial colony grown on the both of the media were counted and the result was express as colony forming unit per gram (CFU/g) by using the formula:

$$\text{CFU/g} = \frac{\text{Total number of colonies counted}}{\text{Volume of inoculate}} x \text{ Dictation factor}$$

Statistical analysis

The data generated from proximate and microbial analysis were subjected to analysis of variance (ANOVA) using (SPSS), version 23. Difference among means were separated using least significant difference (LSD).

RESULTS AND DISCUSSION

Proximate Composition of the Beef Minced Meat (*Dambun nama*) Produced from Cinnamon and Garlic Powder

The proximate composition of the beef minced meat (*dambun nama*) produced from Cinnamon and garlic powder are presented in Table 1. The result showed significant difference (P<0.05) across the beef minced meat samples on moisture and ash content. While no significant differences (P>0.05) were recorded on protein, fat and carbohydrate contents. *Dambun nama* made from combined Garlic Cinnamon powder had the lowest value (5.14%) of moisture content, the highest value of protein (44.03%) and ash content of (5.33%) respectively. While *dambun nama* produced from in treatment 2 (garlic) had the highest value of fat content (22.98%). The moisture content values obtained in this study are higher than 9.87% reported by (Apata *et al.,* 2013) and 10.00% by (Olusola *et al*., 2017).

Table 1: Proximate composition of the beef minced meat produced from cinnamon and garlic powder

Parameter	T1 (%)	T2 (%)	T3 (%)	T4 (%)	LSD
Moisture	7.54^{a}	5.37^{c}	5.67^{b}	5.14^{d}	0.39
Protein	42.70	43.48	42.97	44.03	2.68
Fat	21.36	22.98	22.30	22.07	1.10
Ash	4.43^{d}	5.33^{a}	5.17^{c}	5.24^{b}	0.18
Carbohydrate	23.97	22.83	22.89	23.52	2.24

abcd Means in the same row with different superscripts are significantly difference (P<0.05), LSD: Least Significant Difference, T1 = Control, T2 = Garlic powder, T3 = Cinnamon powder, T4 = Garlic + Cinnamon powder

Microbial Quality of Beef Minced Meat (Dambun nama) Produced from Cinnamon and Garlic Powder

The results of microbial analysis of the beef minced meat (*dambun nama*) produced from cinnamon and garlic powder samples are presented in Table 2. The findings indicated significant differences (P<0.05) among *Escherichia coli, Staphylococcus aureus* and *Salmonella spp* (cfu/g) across the all the samples. While no significant differences (P>0.05) were recorded on the total viable bacterial counts (TVBC), coliforms and fungi. TVBC indicated in this study recorded ranges from 2.25 $x10^3$ -2.94 $x10^3$ cfu/g and the highest count (2.94$x10^3$, 2.31 $x10^3$, 2.45 $x10^3$, 2.25 $x10^3$ cfu/g) of total viable bacteria, *E. coli, coliforms,* fungi*, Salmonella* and *staphylococcus* were found in treatment 1 (control) *dambun nama* while the lowest count (2.25$x10^3$, 0.01 $x10^2$, 0.08 $x10^2$, 0.22 $x10^2$, 0.18 $x10^3$, 0.62 $x10^3$ cfu/g) of total viable bacteria, *E. coli, coliforms,* fungi*, salmonella* and *staphylococcus* were found in treatment 4 (cinnamon plus garlic powder) *dambun nama* respectively. Microbial quality and safety of meat products are very important in ensuring consumer health and food security (Shamsuddeen, 2009).

The range value of *Staphylococcus*, coliform and *fungi* counts in this study were low compared to the range value (3.0$x10^4$-7.0 $x10^4$, 1.04$x10^4$-3.0$x10^4$ and 2.4$x10^4$-5.9$x10^4$ cfu/g) of reported by Olusola *et al*. (2017) respectively, However, the total viable vacteria counts(TVBC) in this study is lower compared to range value of 4.07$x10^4$ - 4.67$x10^4$ and 3.71$x10^4$ - 4.28$x10^4$ (cfu/g) reported by Iyiola *et al.* (2021; 2023*)* respectively. The range value of microbial counts observed is within the recommended range of less than 10^6 cfu/g as satisfactory limit, and 10^6 to <10^7 cfu/g as acceptable range (London Health Protection Agency, 2009) and a range limit

between 2.5 x 10^5 to 1.0 x10^8 cfu/g for consumable meat products (ICMSF, 1996). Spices have been reported to play a role in microbiological quality of a product by inhibiting the growth and multiplication of microorganisms through its antimicrobial and antioxidant activity (Jackson *et al*., 2002, Botsoglou *et al*., 2003, Brandi *et al*., 2006, Munekata, 2021). Therefore, the result indicated that *dambun nama* samples are fit for consumption and do not pose any health risk to the public.

Table 2: Microbial quality of the of the beef minced meat produced from cinnamon and garlic powder

Parameter	T1 (cfu/g)	T2 (cfu/g)	T3 (cfu/g)	T4(cfu/g)	LSD
TVBC	2.94x10^3	2.31 x10^3	2.45 x10^3	2.25 x10^3	4.98
E. coli	0.70 x10^{2b}	0.38 x10^{2c}	0.90 x10^{2a}	0.01 x10^{2d}	3.18
Coliform	0.26 x10^2	0.10 x10^2	0.13 x10^2	0.08 x10^2	0.67
Fungi	0.34 x10^2	0.28 x10^2	0.26 x10^2	0.22 x10^2	2.08
Salmonella	0.66 x10^{3a}	0.25 x10^{3c}	0.27 x10^{3b}	0.18 x10^{3d}	1.53
Staphylococcus	0.81 x10^{3a}	0.71 x10^{3b}	0.51 x10^{3d}	0.62 x10^{3c}	3.54

abcd Means in the same row with different superscripts are significantly difference (P<0.05), LSD: Least Significant Difference. T1 = Control, T2 = Garlic powder, T3 = Cinnamon powder, T4 = Cinnamon + garlic powder, TVBC =Total Viable Bacterial Count

CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study, it was concluded that addition of cinnamon and garlic either individually or in combination, significantly influenced both the proximate and microbial quality of the experimental beef minced meat. The sample treated with a combination of garlic and cinnamon (T4), showed the most favorable results including lowering the moisture content which enhances the shelf life and high protein and ash content indicating improved nutritional value. It was also showed low microbial counts, particularly in total viable bacteria, *E. coli, Salmonella spp.,* and *Staphylococcus aureus.* Thus, proving better microbial safety and longer shelf life stability. These findings suggest that the incorporation of spices like cinnamon and garlic can enhance the nutritional quality, microbial safety and shelf life of ready- to- eat products like minced meat. The combination of cinnamon and garlic is highly recommended as natural preservative and flavor enhancer in the processing of beef minced products to extend shelf life and ensure food safety.

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