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How Does Replacement of Beef with Agushie Impact the Nutritional and Eating Quality of Beef Burgers?

Akwetey WY* and Ibrahim Z

Department of Animal Science, Kwame Nkrumah University of Science and Technology, Ghana

***Corresponding author:** Worlah Yawo Akwetey, Department of Animal Science, Kwame Nkrumah University of Science and Technology, Ghana, Tel: +233501349018; Email: wyakwetey.canr@knust.edu.gh

Research Article

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Abstract

The main research objective was to study the influence of using agushie on proximate composition and eating quality of beef burgers. Cooking yield and pH of burgers produced with or without agushie were also studied. Boneless beef was used as the meat ingredient and portions of the beef were replaced with ground agushie at 0% (control), 13%, 26% and 39% to obtain four treatments namely T1, T2, T3, and T4 respectively. Proximate analysis of the burgers was determined as well as cooking yield, pH and sensory evaluation was by 30 untrained consumers using a 9-point Hedonic scale. Increasing levels of "agushie" significantly ($p<0.05$) reduced moisture content from 49.49 (T2) to 46.77 (T4) in the burgers. Crude protein contents increased significantly ($p<0.05$) from T1 (20.49%) to T4 (27.48%). There were significant ($p<0.05$) differences in fat content with T2 recording the lowest (12.38%). Ash content also increased significantly ($p<0.05$) from 2.41% (T1) to 3.77% (T4) while the contents of fibre significantly ($p<0.05$) increased from 0.24% (T1) to 0.98% (T4). There were also significant differences ($p<0.05$) in pH (6.14 - 6.55) and cooking yield (60.66%-79.06%) from T1 to T4 respectively. Fibre contents increased significantly ($p<0.05$) with increasing levels of agushie in burgers. Sensory evaluation revealed no significant ($p>0.05$) differences across treatments for appearance, taste, flavour, juiciness, texture and acceptability. The results suggest that agushie has beneficial potentials in beef burger production at 26% without any adverse effects on nutritional composition and eating characteristics.

Keywords: Agushie; Beef Burger; Proximate Composition; Fibre Content; Eating Characteristic; Consumer Panel

Introduction

Meat is said to be one of the most valuable animal products, containing protein, fat, vitamins and minerals, with relatively very little amounts of carbohydrates. Xiong YL [1] reported that meat is considered the highest source of quality protein not only due to its nutritional characteristics, but also due to its appealing taste and as an essential part of several mixed diets. Meat consumption ensures adequate delivery of essential micro nutrients and amino acids involved in regulatory processes of energy metabolism, however the consumption of meat is frequently associated with a negative health effect due to its presumably ''high'' fat contents [2].

But the eating quality of a meat product is influenced by several factors, including the variety of ingredients incorporated, degree of mixing, cooking method and the appearance, taste, flavour and juiciness perceptions of the consumer. Consequently, meat processors have concerned themselves increasingly to satisfy health concerns raised by consumers using different meat analogues [3], and different vegetables Akwetey WY, et al. [4] in product formulations.

A meat analogue has been defined as an ingredient or compound that is structurally similar to another but differs slightly in composition and approximates to the aesthetic qualities (primarily, texture, flavour and appearance) and or chemical characteristics of specific types of meat [5].

Agushie (white melon seed) is a species of melon native to tropical Africa where it is grown as a food crop and as a source of cooking oil. Lokou AL, et al. [6] described its agushie fruits as egg-shaped, or elongated ovate-shaped, up to about 19cm long, 8cm wide and cream in colour. The seeds are ground and used in soups or as a vegetable, and could also serve as an ingredient for seasoning baked meat and fish. It contains appreciable quantities of sulphur, calcium, iron, potassium and magnesium which play very important roles in human nutrition [7]. However, information on the use of agushie in meat product formulations is not readily available in the scientific literature.

The main objective of this research was to study the influence of using agushie in beef burger production.
Specific objectives included determination of:

i. Proximate components (moisture, protein, fat, ash and fibre)
ii. Cooking yield and pH
iii. Eating characteristics (sensory properties) of beef burgers produced with and without fresh ground agushie.

Materials and Methods

Study Location and Experimental Materials

The experiment was conducted at the Meat Science and Processing Unit of the Department of Animal Science, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. Beef (boneless) was purchased from the Kumasi Abattoir Company Limited and stored in a freezer at -18°C prior to usage. Agushie and other non-meat ingredients used were obtained from the Kumasi central market.

Experimental Procedure

Preparation of Burgers: All undesirable particles in agushie were removed by hand picking and discarded, after which it was washed thoroughly with distilled water and blended with a kitchen blender. The frozen beef was cut into smaller pieces and minced using a table top meat grinder (MADO Superwolf, Germany) through a 5mm grinder disc. The minced beef and blended agushie were allotted to four treatments namely, T1 (Control), T2, T3 and T4 in which agushie was included at 0% 13% 26% and 39% respectively. All spices used were not varied for each treatment and each was formed into burger. Five (5) kg of burgers were produced per treatment and the four treatments produced were replicated three times, vacuum packaged after overnight chilling, labelled appropriately and frozen at -18°C for further analysis.

Parameters Measured

Cooking Yield and PH (Acidity): Cooking yield of burgers were determined as described by Akwetey WY, et al. [8] using the following formula:

Acidity (pH) of blended burger treatment samples were directly determined using an electronic pH meter with a probe (Mettler, Toledo).

Proximate Composition

Moisture, protein, fat, ash and fibre contents were determined according to the methods described by Association of Official Analytical Chemists [9].

Eating (Sensory) Attributes

Nine (9) samples (100g each) per treatment were taken out of the freezer at random and thawed at 2°C overnight, fried in vegetable oil, cut into four equal parts and served to thirty (30) consumers made up of students of KNUST and Teaching Assistants of the Department of Animal Science for sensory evaluation. The vegetable oil used was changed after frying each treatment sample and the sensory evaluation was based on appearance, taste, flavour, juiciness, texture, mouth feel and acceptability of burgers produced with and without agushie. A 9-point Hedonic scale (1=dislike extremely, 2 = dislike very much, 3= dislike moderately, 4=dislike slightly, 5= neither like nor dislike, 6= like slightly, 7= like moderately, 8= like very much, 9= like extremely) was used for the evaluation. Treatments samples were coded with three-digit random numbers in order to ensure fairness in assessment and to ensure realization of sincere results from the panel. Water was provided to each panel member to rinse his/her mouth between tasting and scoring the profiles of the burgers in order the prevent carry-on effects from one sample to another. The sensory area was adequately lighted with white fluorescence lamps and there was no awful odour that could possibly detract the attention of panel members.

Statistical Analysis

All data generated from the study were subjected to One-way Analysis of variance (ANOVA) using SPSS [10] and significant differences between treatment means ($p<0.05$) were determined by Duncan's test of homogeneity.

Results and Discussion

Proximate Composition, PH and Cooking Yield

Results obtained for percentage moisture, protein, fat, ash, and fibre of the burgers with and without agushie are shown in Table 1. There were significant differences ($p<0.05$) between moisture content of the control (T1) and agushie-treated burgers. Moisture content reduced significantly ($p<0.05$) from T1 (53.73%) to T4 (46.77%). Adebayo OF, et al. [11] also reported reduced moisture contents in 'agushie-treated 'ogri' condiment, but Akofur SDH [12] observed increasing moisture levels (50.30-54.60%) in agushie-treated meatloaves. The difference in moisture content in this study compared to what was reported by Akofur SDH [12] could be attributed to the fact his study was about emulsified products (meatloaf) which involved the addition of relatively more water during formulation compared to beef burgers in this study.

From Table 1 the levels of protein increased with increasing levels of agushie in burger formulations and the control (without agushie) recorded significantly ($p<0.5$) lower protein contents (20.49%) compared to all the agushie-treated burgers. Akofur SDH [12] reported that agushie has 30% protein whiles FAO [13] stated that beef has up to 22% protein. The increasing levels of protein with increased use of agushie in this study confirm the findings of Dzadu L [14] when agushie was used in frankfurter-type sausage formulations. Thus suggesting that, agushie could be used in meat formulations in order to increase protein contents.

There were also significant differences ($p<0.05$) between fat contents of T1 (control) and the agushie-treated burgers. It was observed that fat contents increased significantly ($p<0.05$) from T1 (13.66%) to T4 (17.95%); however, the fat contents of T1 and T2 were not different. Agushie has been reported to have lower fat content Bankole SA, et al. [15] compared to beef AAC [16], hence the observed increased fat contents in the agushie-treated burgers in study were not readily understood. But Akofur SDH [12] also reported increasing levels of fat in agushie-treated meatloaf. It could probably be due to the fact that agushie, being a vegetable, might have higher affinity for the vegetable oil used in frying the burgers compared to beef.

Ash contents in the control (T1) and T2 were not significant different ($p>0.05$), but the contents of ash observed in both T1 and T2 were significantly ($p<0.05$) lower than T3 and T4.

Parameter (%)	Type of burger				P-value	SEM
	T1	T2	T3	T4		
Moisture	53.73^{c}	49.49^{b}	48.05^{a}	46.77^{a}	<0.01	0.999
Crude Protein	20.49^{a}	25.22^{b}	26.52^{b}	27.48^{b}	0.02	1.064
Fat	13.66^{a}	13.66^{a}	17.22^{b}	17.95^{c}	<0.01	0.895
Ash	2.51^{a}	2.56^{a}	3.48^{b}	3.77^{c}	<0.01	0.217
Crude fibre	0.24^{a}	0.27^{a}	0.82^{b}	0.98^{c}	<0.01	0.248
*Acidity	6.14^{a}	6.33^{b}	6.33^{b}	6.55^{c}	<0.05	0.654
Cooking yield	60.66^{a}	66.76^{b}	71.86^{c}	79.06^{d}	>0.01	1.374

Table 1: Proximate composition, cooking yield and pH of burgers produced with and without agushie.
^{abc} Means in the same row with different superscripts are significantly different ($p<0.05$). T1=100% ground beef (or 0% agushie), T2, T3 and T4 contained 13%, 26%, and 39% agushie respectively in place of ground beef. Mixed spice comprised of powdered red pepper (10g/kg), black pepper (5g/kg) and powdered ginger (10g/kg) meat. *pH (no unit).

reatment T1 recorded lower ash contents of 2.41% while values in the agushie-treated burgers increased from 2.56% (T2) to 3.77% (T4). These observations are similar to the report by Egbebi AO [17] (3.70%), but lower than what was reported by Akofur SDH [12] (4.60% to 5.53%). Akofur SDH [12] reported that agushie has 3% ash content whiles beef has 1.2% ash [13].

The contents of crude fibre showed significant differences ($p<0.05$) between the control (T1) and the agushie-treated burgers. Treatment T1 and T2 were similar in fibre contents but their values were significantly lower ($p<0.05$) compared to T3 and T4; both of which were also similar. Fibre contents in this study ranged from 0.24% (T1) to 0.98% (T4). Contrarily Akofur SDH [12] and Egbebi AO [17] reported higher values of 4.54% in agushie-treated 'ogri' and 5.53% in agushie-treated meatloaf respectively. The higher levels of fibre in agushie-treated burgers could help alleviate diet-related constipations by improving bowel movements in consumers.

The results obtained for cooking yield and acidity

(pH) are also shown in Table 1. Significant differences ($p<0.05$) existed in the pH values across treatments. All the pH values observed in the agushie-treated burgers were higher compared to the control. The reported values of pH ranged from 6.14(T1) to 6.55(T4). These increases in pH with increased use of agushie resulted in significantly ($p<0.05$) higher cooking yields in all the agushie-treated beef burgers compared to the control because pH in meat and meat products increase with water holding capacity [18], which also is positively correlated with cooking yield. Also, the cooking yield of meat is dependent on contraction of myofibrillar proteins that form the muscle matrix, leading to expulsion of water and, to a lesser extent fat. However, the proportion of these losses will depend on the type of cooking; which was similar for all burger treatment types in this study. The cooking yields observed in this study ranged from 60.66% (T1) to 79.06% (T4), indicating that all things been equal, meat processors could benefit more when they produce and sell agushie-treated burgers since meat products are sold on weight basis.

Eating Characteristics of Burgers Produced With or Without Agushie

Table 2 shows the results for the sensory properties of burgers produced with and without agushie. No significant differences ($p>0.05$) were found across treatments in terms of appearance, flavour, taste, juiciness, texture and acceptability. Though T2 and T3 seemed to be more acceptable to the panel, the observed differences in the scores were not statistically different.

Attribute	Type of burger					
	T1	T2	T3	T4	P-value	SEM
Appearance	6.13	6.57	6.93	6.77	0.15	0.13
Flavour	6.63	6.63	6.87	6.57	0.9	0.127
Taste	7.1	6.52	6.9	6.17	0.18	0.163
Juiciness	6.17	6.1	6.17	6.37	0.94	0.156
Texture	6.43	6.4	6.7	6.63	0.83	0.134
Acceptability	7.07	6.77	6.77	6.6	0.74	0.15

Table 2: Effects of using agushie on eating characteristics of burgers.
T1=100% ground beef (or 0% agushie), T2, T3 and T4 contained 13%, 26%, and 39% agushie respectively in place of ground beef. Mixed spice comprised of powdered red pepper (10g/kg), black pepper (5g/kg) and powdered ginger (10g/kg) meat. (Sensory scale,1=dislike extremely to 9= like extremely).

Conclusions and Recommendation

Burgers produced with agushie were higher in crude protein, ash, fat and fibre contents with reduced moisture and higher cooking yields. The eating characteristics of the burgers produced with or without agushie were not different during consumer panel evaluation. The result of this research suggests that agushie has very desirable potentials to be included in burgers. Consequently, 26% fresh ground agushie could be used to replace ground beef in burger production to increase nutritional and fibre contents without any adverse effects on sensory and eating characteristics.

It is recommended in future study to determine the influence of shelf life storage on burgers produced with and without agushie.

Author Contributions

This work was carried out by equal author contributions, and all authors read and approved the final manuscript.

Conflict of Interest

Authors have no conflict of interest to declare.

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