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Quality Characteristics of Whole Guinea Fowl Egg as Binder in Beef and Chevon Burgers

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ABSTRACT

This study was conducted to determine the cohesiveness of whole guinea fowl egg as a binder in chevon and beef burgers. The study also investigated the sensory characteristics, nutritional content, cooking loss, lateral shrinkage, welling and doming of the beef and chevon burgers prepared using whole guinea fowl eggs. A total of 3 kg beef and 3 kg chevon were used. The meats were assigned using complete randomized design into 3 levels. The 3 levels of inclusion of the whole guinea fowl egg per kilogram of meat were 0 g, 50 g and 100 g which corresponds to each treatment that is B1 (control), B2 (5 %) and B3 (9 %) for beef, and C1 (control), C2 (5 %) and C3 (9 %) for chevon, respectively. Thus each treatment contained 1 kg meat, 0.5 g red pepper, 1.0 g black pepper, 1.0 g white pepper, 2.0 g mixed spice (adobo®), 5 g salt and whole guinea fowl egg (0 g, 50 g or 100 g). The meat and spices were minced and moulded manually into burgers using a cylindrical tube to obtain uniform shapes and sizes. They were vacuum-packed in transparent packaging bags and stored overnight at 4 °C prior to processing. The processed samples were evaluated for their sensory, nutritional and binding properties. Sensory characteristics of beef and chevon burgers (cohesiveness, colour, juiciness, texture, taste, flavor and overall liking) showed no significant differences ($P > 0.05$). In absolute terms beef and chevon burgers with the highest inclusion level (9 %) of whole guinea fowl egg were most preferred. There were also no significant differences ($P > 0.05$) in moisture content, crude protein content, pH, cooking loss, lateral shrinkage and doming of the beef and chevon burgers. Significant difference ($P < 0.05$) occurred in the crude fat content of chevon burger but not beef burger. Welling was not observed in the beef and chevon burgers.

Key words: Binder, Burgers, Guinea fowl eggs, Nutritional, Sensory

INTRODUCTION

Meat is the edible muscle, fat and other tissues obtained from an animal after it has been slaughtered (Lawrie and Ledward, 2006). Meat obtained from cattle (beef) and goats (chevon) are red meat (Warriss 2000 and Adzitey, 2013). Red meat is important source of various nutrients. Red meat contains high amount of essential amino acids that play a major role in the growth and development of our bodies (Warriss, 2000). It is a source of long-chain omega-3 polyunsaturated fats, riboflavin, pantothenic acid, selenium and vitamin D (Williams, 2007). Red meat is an excellent source of Vitamin B6 (pyridoxine), Vitamin B12 (cobalamin), Vitamin B3 (niacin), iron, zinc and phosphorus (Williams, 2007; McAfee et al., 2010 and FOA, 2014). It is also sources of a range of endogenous antioxidants and other bioactive substances including taurine, carnitine, carnosine, ubiquinone, glutathione and creatine (Williams, 2007). The nutrient composition and importance of red meat calls for the need for Africans particularly people in rural communities to consume enough red meat. To reduce wastage, preserve and add value to red meats there is the need to process them into various meat products.

Meat processing refers to the procedures such as addition of ingredients and/or mechanical action that convert meat into specific products (Teye, 2007). Meat can be processed into different meat products such as sausages, frankfurter, bacon, meat loaf, burgers, meatballs and many more (FAO, 1991; Adzitey et al., 2014; Adu-Adjei et al., 2014; Teye et al., 2014; Adzitey et al., 2015a; Haslia et al., 2015a; Haslia et al., 2015a; Teye et al., 2015a; Teye et al., 2015b and Ossom et al., 2016). Burgers are among the meat products of importance and are prepared from minced meats with the addition of spices, additives and other ingredients, normally shaped into a circular form. There are different types of burgers on the market made from the meat of different animals. For

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instance beef burger, chicken burger and lamb burger are consumed by many people (FAO, 1991; Adu-Adjei et al., 2014; Anonymous, 2014). The characteristics and quality of burgers influence consumers' acceptability. The characteristics of burgers are influenced by the ingredients that are used to prepare the burger. When meat extenders are added they can help to improve yield, improve meat emulsification stability, improve water binding stability, enhance texture and flavour, reduce shrinkage during cooking, improve slicing characteristics and reduce formulation cost (FAO, 1991; Warriss, 2000; Adu-Adjei et al., 2014). Non-meat ingredients such as water, salt, sugar, fillers, binders and spices are used to impact flavour, slow bacterial growth and increase the yield of meat products (Tronsky et al., 2004; FAO, 2010). It has been reported that eggs are suitable as binders in burgers (Chen, 1999).

Guinea fowl meat is a favourite meat for many Ghanaians because of it nutritional value and low fat content (Gyebi, 2012). The demand for guinea fowl meat in Ghana far exceeds the supply and the implication is that guinea fowl production will continue to increase (Adzitey et al., 2015b). With the increasing production and demand for guinea fowl meats, its exploitation for use as meat products is important. Nevertheless, the effect of whole guinea fowl egg as a binder in burgers is unknown. This work investigates the effects of adding whole guinea fowl eggs to beef and chevon burgers. This was to evaluate the extent to which the use of whole guinea fowl egg to beef and chevon burgers would influence the sensory, nutritional and binding properties of the burgers.

MATERIALS AND METHODS

Study area

The study was conducted at the Meat Processing Unit of the University for Development Studies (UDS), Nyankpala, Ghana. Chemical analysis of the meat products were conducted at the Spanish Laboratory of UDS, Nyankpala, Ghana.

Preparation of guinea fowl egg, beef and chevon burgers

Table eggs from guinea fowls were cracked and whisked to ensure that the yolk and albumen were well mixed. Three kilogram each of lean beef and chevon were obtained from the UDS Meat Processing Unit and used for the experiment. The meat was thawed overnight at $4^{o}C$ and minced using table top mincer (Teller Ramon, Spain) through a 5 millimeter sieve. The minced beef and chevon were divided into three treatments per kilogram each, mixed with spices of 0.5 gram (g) red pepper, 1.0 g black pepper, 1.0 g white pepper, 2.0 g mixed spice (adobo®) and 5 g salt. Each treatment was mixed until a desired consistency was obtained. The three experimental treatments of both beef and chevon were formulated with 0 g, 50 g and 100 g inclusion level of whole guinea fowl egg per kilogram of beef and chevon which corresponded to products B1 (0g, control), B2 (50 g, 5 %), B3 (100 g, 9 %), C1 (0 g, control), C2 (50 g, 5 %) and C3 (100 g, 9 %), respectively. The mixed meat with spices was then moulded into circular shapes. The products were stored in a deep freezer for further processing and analyses.

Welling, doming, lateral shrinkage and cooking loss of beef and chevon burgers

These were done as previously described by earlier workers (Adzitey et al., 2014). Welling is the accumulation of fluid in vacuole of a burger and it is determined by observation. Doming (thickness) is the rise in height of a burger and was determined by measuring the height of burger before and after cooking. Lateral shrinkage (diameter) is the shrinkage of burger towards a central direction, that is, a circular shaped burger looking oval after cooking and was determined by measuring the diameter of the burger at different directions before and after cooking. Cooking loss was determined by weighing the burger before and after cooking.

Selection of taste panel and preparation of beef and chevon burgers for sensory analysis

Fifteen panelists were randomly selected and trained according to the British method of sensory evaluation to evaluate the product (BSI, 1993). The frozen burgers were grilled to a core temperature of $70^{o}C$ for 15 minutes by the use of a griddle oven (Turbofan, Blue seal, UK). The products were then sliced into pieces of equal sizes of $1.8cm^2$ x $2.5cm^2$ each and wrapped in a coded aluminium foil to keep it warm. Each panelist was served with the test burger in addition to a piece of bread and water to act as a neutralizer between tests. Panelists were asked to indicate the eating qualities of the various samples with the aid of the 5-point hedonic scale shown in table 1.

Nutritional/physical analyses of beef and chevon burgers

Beef and chevon burgers were analyzed for moisture, crude protein (Kjeldhal method) and fat contents (Soxtec apparatus) (AOAC, 1999). For the determination of pH, 10 g beef burger of each treatment was ground with a laboratory mortar and pestle, homogenized with 50 ml distilled water, and pH values were measured with a digital pH-meter (CRISON, Basic 20, Spain).

Statistical analysis

Data obtained was analyzed using Analysis of Variance (ANOVA) of the Genstat Edition 4. Means were separated at 5% significant level. Data obtained from beef and chevon burgers were analyzed separately. Similar data from beef and chevon have been combined in a table for convenience and to reduce the number of tables.

RESULTS

Sensory characteristics of beef and chevon burgers

Table 2 shows the sensory characteristics of beef burgers prepared using whole guinea fowl egg as a binder. From table 2 there were no significant differences (P > 0.05) in colour, juiciness, texture, taste, flavour, cohesiveness and overall liking of beef and chevon burgers. Though there were no differences, there was a trend with the cohesiveness of beef burgers prepared using 100 grams whole guinea fowl eggs being most preferred by the panelists. Table 3 shows the sensory characteristics of chevon burgers prepared using whole guinea fowl egg as a binder. From table 3 there were statistically insignificant differences (P > 0.05) in colour, juiciness, texture, taste, flavour, cohesiveness and overall liking of chevon burgers. Similarly to beef burgers, chevon burgers with the highest inclusion level of whole guinea fowl eggs were most preferred.

Nutritional/physical qualities of beef and chevon burgers

The moisture, crude fat, crude protein and pH contents of the beef burgers are shown in table 4. Table 5 shows the moisture, crude fat, crude protein and pH contents of the chevon burgers. From table 4 there were insignificant differences (P > 0.05) in moisture, crude protein and pH of beef burgers but significant difference (P < 0.001) occurred in the crude fat content. B1 (3.67) was significantly higher than B2 (2.15) and B3 (2.00). Table 5 also shows that there were insignificant differences (P > 0.05) in moisture, crude fat, crude protein and pH contents of chevon burgers prepared using whole guinea fowl eggs.

Cooking loss, doming, lateral shrinkage and welling of beef and chevon burgers

Table 6 shows the cooking loss, doming, lateral shrinkage, and welling of beef burgers, while. Table 7 shows the cooking loss, doming, lateral shrinkage, and welling of chevon burgers. From table 6 and table 7, there were no significant differences (P > 0.05) in cooking loss, doming, and lateral shrinkage of beef and chevon burgers. The trend of cooking loss, doming and lateral shrinkage was least in B3 (19.90 g), B1/B3 (0.10 cm) and B1 (0.70 cm), respectively for beef burger. In chevon burgers, cooking loss, doming and lateral shrinkage was least in C3 (27.88 g), C3 (0.87 cm) and C/C2 (0.10 cm). Welling was not observed in the both beef and chevon burgers. Figure 1 shows beef burgers before and after cooking prepared without whole guinea fowl eggs. Figures 2 and 3 show beef burgers before and after cooking prepared with whole guinea fowl eggs as a binder at various inclusion levels.

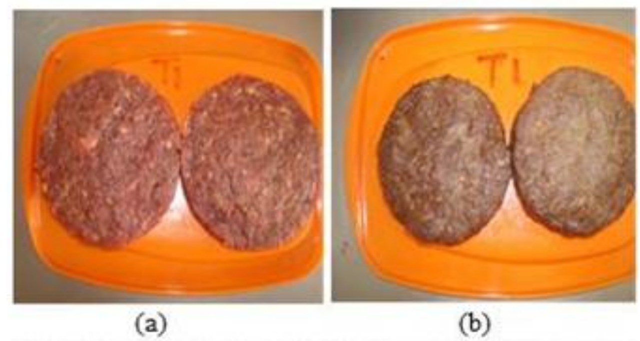

Figure 1. Beef burgers before (a) and after (b) cooking prepared without using whole guinea fowl eggs.

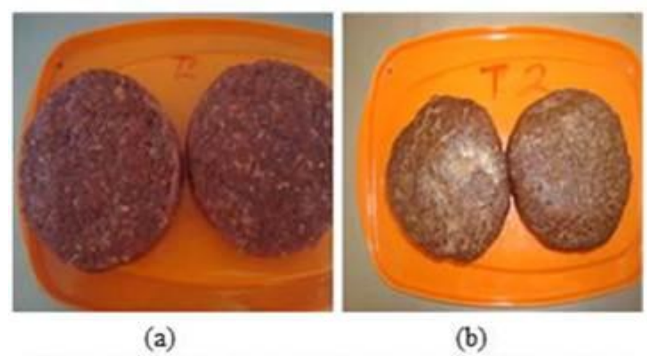

Figure 2. Beef burgers before (a) and after (b) cooking prepared using whole guinea fowl eggs at 5%.

Figure 3. Beef burgers before (a) and after (b) cooking prepared using whole guinea fowl eggs at 9%.

DISCUSSION

Sensory characteristics of the beef and chevon burgers

The incorporation of whole guinea fowl egg at 5 % and 9 % inclusion level in the beef and chevon burgers did not have any effect on the sensory quality of the burgers. Cohesiveness is the ability to hold solids and liquid together or the state of materials in a product holding together. Even though there was no significant difference in cohesiveness, beef and chevon burgers with the (9%) inclusion of whole guinea fowl eggs tended to be firmer and most liked/preferred by the panelists (Tables 2 and 3). These results agree with that of Adzitey et al. (2014) who reported that whole egg used as binder in beef burger showed no significant difference in texture, taste, juiciness, flavor, colour, cohesiveness and overall liking. The cohesive effect of the whole guinea fowl egg in both products also showed that B3 and C3 which had a 9 % inclusion level was scored lower in terms of likeness (2.40 and 2.13, respectively) as compared to the other treatments (B1=2.47, B2=2.53, C1=2.33, C2=2.53) which explains that most consumers liked the cohesive or binding effect of the whole guinea fowl egg in B3 and C3. Protein coagulates during thermal processing, resulting in the formation of gel-like structures which bind together the batter structural units (Barbut, 1995). The protein in guinea fowl eggs could have contributed to the cohesiveness of B3 and C3.

Nutritional Qualities of Beef Burger and Chevon Burgers

The beef burger, B1 had significantly higher crude fat content ($P < 0.001$) than B2 and B3. The whole guinea fowl egg could have reduced the crude fat content of the test beef burgers. Chevon burgers did not differ significantly ($P > 0.05$) in their crude fat content. USDA (1985) indicated that guinea fowl has 8.9% fats while beef contains 28.0% fat. Significant differences in moisture, crude protein and crude fat content of beef burgers prepared using whole chicken eggs at inclusion level of 5 %, 10 % and 15 % have been reported elsewhere (Adzitey et al., 2014). Moisture, crude protein, crude fat and pH contents in burgers contribute to it taste, shelf life and acceptability. Burgers with very high moisture content will have lots of drip during grilling which will have negative impact on it acceptability. Protein and fat are important nutrients needed by humans for growth, repair of worn out tissue and/or energy. Fat improve flavour and taste of meat and meat products (Warriss, 2000). pH measured the acidity and alkalinity of the burgers. The lower the pH, the less it supports the reproduction, growth and proliferation of pathogenic and spoilage microorganisms (Warriss, 2000 and MAFRA, 2011).

Table 1. Five-point hedonic scale used for the sensory evaluation

ATTRIBUTE	SCALE				
COLOUR:	1- Very light	2- Light	3- Intermediate	4- Dark	5- Very dark
FLAVOUR:	1- Like very much	2- Like	3- Intermediate	4- Dislike	5- Dislike very much.
JUICINESS:	1- Very juicy	2- Juicy	3- Intermediate	4- Dry	5- Very dry.
TEXTURE:	1- Very rough	2- Rough	3- Intermediate	4- Smooth	5- Very smooth.
TASTE:	1- Like very much	2- Like	3- Intermediate	4- Dislike	5- Dislike very much.
COHESSIVENESS:	1- Like very much	2- Like	3- Intermediate	4- Dislike	5- Dislike very much.
OVERALLIKING:	1- Like very much	2- Like	3- Intermediate	4- Dislike	5- Dislike very much.

Table 2. Sensory characteristics of beef burgers prepared using whole guinea fowl egg as a binder

Beef burger	B1 (control)	B2 (5 %)	B3 (9 %)	S.e.d	P value
Colour	2.93	2.80	3.07	0.254	0.580
Juiciness	2.60	2.20	2.13	0.317	0.293
Texture	2.93	2.80	3.07	0.339	0.736
Taste	2.53	2.40	2.53	0.352	0.909
Flavour	2.27	2.47	2.20	0.314	0.679
Cohesiveness	2.47	2.53	2.40	0.304	0.908
Overall liking	2.40	2.13	1.93	0.330	0.374

S.e.d: Standard error of difference; P value = Probability value; B1 = Beef burger containing 0 g whole guinea fowl egg; B2 = Beef burger containing 50 g whole guinea fowl egg; Beef burger containing 100 g whole guinea fowl egg.

Table 3. Sensory characteristics of chevon burgers prepared using whole guinea fowl egg as a binder

Chevon burger	C1 (control)	C2 (5 %)	C3 (9 %)	S.e.d	P value
Colour	2.80	2.67	2.87	0.345	0.841
Juiciness	2.73	2.80	2.60	0.410	0.884
Texture	2.53	2.80	3.07	0.304	0.226
Taste	2.67	2.27	1.93	0.334	0.102
Flavour	2.27	2.07	1.87	0.262	0.321
Cohesiveness	2.33	2.53	2.13	0.323	0.470
Overall liking	2.13	1.87	1.67	0.269	0.232

SED: Standard error of difference; P value = Probability value; C1= Chevon burger containing 0 g whole guinea fowl egg; C2= Chevon burger containing 50 g whole guinea fowl egg; C3= Chevon burger containing 100 g whole guinea fowl egg.

Table 4. Nutritional/physical properties of beef burgers prepared using whole guinea fowl egg as a binder

Beef burger	B1 (control)	B2 (5 %)	B3 (9 %)	S.e.d	P value
Moisture	60.40	54.70	51.30	4.030	0.221
Crude fat (g)	3.67[a]	2.15[b]	2.00[b]	0.123	0.001
Crude protein (g)	14.28	14.49	13.16	0.404	0.085
pH	5.86	5.89	5.93	0.025	0.125

SED: Standard error of difference; P value= Probability value; Means in the same row with different superscript are significantly different ($P < 0.05$).

Table 5. Nutritional/physical properties of chevon burgers prepared using whole guinea fowl

Chevon burger	C1 (control)	C2 (5 %)	C3 (9 %)	S.e.d	P value
Moisture	64.00	63.20	60.00	2.91	0.451
Crude fat (g)	3.33	5.00	4.00	0.86	0.292
Crude protein (g)	14.40	13.50	17.60	2.60	0.370
pH	6.09	6.09	6.22	0.05	0.142

SED: Standard error of difference; P value= Probability value; Means in the same row with different superscript are significantly different ($P < 0.05$).

Table 6. Lateral shrinkage, doming and cooking loss of beef burgers prepared using whole guinea fowl egg as a binder

Beef burger	B1 (control)	B2 (5 %)	B3 (9 %)	S.e.d	P value
Cooking loss (g)	20.20	21.10	19.90	2.620	0.887
Lateral shrinkage (cm)	0.70	0.87	0.90	0.228	0.662
Doming (cm)	0.10	0.20	0.10	0.125	0.670

SED: Standard error of difference; P value= Probability value.

Table 7. Lateral shrinkage, doming and cooking loss of chevon burgers prepared using whole guinea fowl egg as a binder

Chevon burger	C1 (control)	C2 (5 %)	C3 (9 %)	S.e.d	P value
Cooking loss (g)	20.20	21.10	19.90	2.620	0.887
Lateral shrinkage (cm)	0.70	0.87	0.90	0.228	0.662
Doming (cm)	0.10	0.20	0.10	0.125	0.670

SED: Standard error of difference; P value= Probability value.

Cooking loss, doming, lateral shrinkage and welling of beef and chevon burgers

Welling which is the accumulation of fluid in vacuole of a burger and determined by observation was not found in the control and the burgers prepared using whole guinea fowl egg as a binder. Accumulation of fluid in a burger after any form of cooking will make it unattractive and can be rejected by consumers. The burgers were weighed or measured before and after cooking to determine the cooking loss, the rise in height (doming) and lateral shrinkage (shrinkage towards a direction). The results obtained for the cooking loss, doming and lateral shrinkage is contrarily to earlier reports (Adzitey et al., 2014). Significant differences were observed ($P < 0.05$) in cooking loss, doming and lateral shrinkage of beef burgers prepared using whole chicken egg at 5 %, 10 % and 15 % inclusion level (Adzitey et al., 2014).

CONCLUSION

This study showed that the addition of whole guinea fowl eggs to both beef and chevon burgers at inclusion levels of 50 g and 100 g had no influence on the sensory characteristics, cooking losses, lateral shrinkages and doming of the products. Furthermore, significant effects were not observed in the nutritional qualities of the burgers except for the crude fat content of the beef burger. Though the inclusion of whole guinea fowl egg in both beef and chevon burgers had no effect on the flavour, taste, cohesiveness and overall likening of the products, consumers seem to prefer the flavour, taste and cohesiveness of both beef and chevon burgers with the 9 % inclusion level. Welling was not observed in both beef and chevon burgers.

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Competing Interests

The authors declare that they have no competing interests.

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