



Proximate Composition and Sensory Characteristics of Low-Fat Meatloaf with Shredded Cabbage

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Abstract

The portions of pork fat in meat loaf were replaced with shredded fresh cabbage at 0% (control), 50% and 100% in the production of low-fat meatloaves which were coded as CAB₀, CAB₅₀ and CAB₁₀₀ respectively. Proximate compositions of the meatloaves were determined as well as water holding capacity, fat and moisture retentions and pH. Sensory analysis was performed to evaluate the appearance, taste, flavor, tenderness, juiciness, texture, mouth feel and acceptability of the meatloaves. There were significant ($p < 0.05$) increases in moisture, protein, ash and fiber contents of the meatloaves as the level of cabbage used increased. Fat content reduced significantly ($p < 0.05$) from 48.50% (control) to 10.67% (CAB₅₀) and pH significantly reduced ($p < 0.05$) with increasing levels of cabbage. Moisture and fat retentions reduced significantly ($p < 0.05$) from 40.84% (control) to 31.16% (CAB₅₀) and 94.60% (control) to 61.42% (CAB₅₀) respectively. There were no significant differences ($p > 0.05$) between the control (CAB₀) and the cabbage-treated meatloaves in terms of appearance and taste. Significant differences ($p < 0.05$) were observed in flavour, tenderness, juiciness, texture, mouth feel and acceptability of meatloaf produced with or without shredded cabbage. But the overall acceptability of meatloaf without cabbage was not significantly different ($p > 0.05$) from those produced with 50% shredded cabbage. The results of this study suggest that cabbage has promising potential in the production of low-fat processed meats.

Keywords: Shredded cabbage; Low-fat meatloaf; Water holding capacity; Sensory attribute

Introduction

Meat processing is the manufacture of meat products from muscle meat, animal fat and certain non-meat ingredients [1]. Value addition, variety, convenience, portion control and improved incomes are some of the reasons that inform meat processors to produce different kinds of processed meats. Meat consumers on the other hand keenly consider product safety and health benefits before making a decision to purchase and consume meats that have been changed from their natural states (processed meats). Some typical examples of processed meats are hams, bacons, patties, sausages and meatloaves. Meatloaf is a meat dish consisting of seasoned ground meat (usually ground beef or a combination of ground beef with veal, lamb and pork), which is formed into a loaf shape and baked or smoked. The shape of the loaf is formed by either cooking it in a loaf pan or forming it by hand in an ordinary baking pan.

Consumers are becoming very concerned about the contents of fat in the meats they consume due to health issues that have been attributed to meat fat. Fats in lean meats supply essential fatty acids and vitamins and play an important role in the sensory perception of juiciness, flavour and texture. Nevertheless, there is a perception among consumers that, processed meats in general are excessively high in fats considered to cause a variety of human diseases including high cholesterol levels; a risk factor for heart disease, obesity and certain cancers. Due to these health concerns, consumers are now demanding low-fat products even at premium prices. Non-meat ingredients would have to be explored to substitute animal fats in processed meats in order to satisfy the health concerns and demands of consumers. Cabbage is a green leafy vegetable that is used in food in many ways; in salads and as a raw or cooked vegetable. Munro [2] indicated that, the leaves of cabbage are stuffed with various meats, sauces and other vegetables to make tasty cabbage rolls. Cabbage also has medicinal purposes and is an excellent source of vitamins K and C which are necessary for blood clotting and are required for protein metabolism in living tissues. According to EB [3] cabbages can also provide some special cholesterol-lowering benefits if cooked by steaming. It is also a good source of molybdenum, vitamin B6, potassium, thiamin (vitamin B1) and calcium. Cabbage is a very good source of fiber, manganese and folate required for efficient digestion of meats. However,

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the use of cabbage in processed meats has not been widely reported in the scientific literature. The most commonly reported non-meat ingredients include soy protein concentrate, texturized vegetable protein, and vegetable oils which are used to replace either animal fat or meat during meat processing [4].

This study was undertaken to explore the possibility of using shredded fresh cabbage as a non-meat ingredient in the manufacture of low-fat meatloaf, which could satisfy consumer demands for reduced fat foods and offer better health benefits to them. The proximate composition (protein, ash, fat, moisture and crude fiber), moisture and fat retention, and pH, water holding capacity, and sensory attributes of meatloaf with and without fresh shredded cabbage were also determined.

Materials and Methods

Experimental materials

The experiment was conducted at the Meat Science and Processing Laboratory of the Department of Animal Science, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. Fresh cabbage and other non-meat ingredients used were obtained from the central market in Kumasi, Ghana. Frozen boneless beef and pork fat were obtained from the Kumasi Abattoir Company Limited. Cabbage, boneless beef and pork fat were stored in a chiller at 0°C prior to use.

Meatloaf production

The beef and pork fat were cut separately and minced using a table top meat grinder (MA[®] Superwolf, Germany) with a grinding sieve diameter of 5.00mm. Five (5) kg of the minced beef was used as the portion for each treatment. Minced beef and pork fat were used in the ratio of 7:4 respectively to produce the control treatment (CAB₀) while the portion of pork fat in (CAB₀) was replaced with fresh shredded cabbage at 50% (CAB₅₀) and 100% (CAB₁₀₀) in order to obtain three different treatments. Each treatment was chopped separately using a horizontal table top bowl cutter (MADO Garant, Germany) to obtain a batter of desirable consistency at 16°C. The outer leaves of the fresh cabbage were removed and the remaining ball was washed under running tap water to remove any dirt and unwanted materials. The washed cabbage ball was shredded and incorporated into the meat batter. 2 kg of each treatment meat batter was manually filled into a baking pan and cooked using an air convection electric oven which was pre-heated to 180°C. Each treatment was replicated three times and the cooked loaves were allowed to cool to room temperature under a ceiling fan after cooking. The treatments were then packaged separately in zip-lock bags and labeled for frozen storage and further studies.

Parameters measured

Acidity (pH), percentage Water Holding Capacity (WHC) and costs of production: The procedure used in the determination of pH was as described by Hack-Youn *et al.* Five (5) g of mashed samples of each treatment was mixed thoroughly with 10ml distilled water in separate centrifuge tubes. The mixtures obtained were stirred for 5 m and allowed to stand for 15 minutes after which the electrode of a pH meter (Synthex SP-701, Mettler, Toledo) was dipped into each to read and record the pH. The procedure of Lin and Haung was used to determine the water holding capacity of the meatloaves [5]. Approximately 5g of each treatment was taken and mixed thoroughly with 10ml distilled water in separate 50ml centrifuge tubes. After centrifuging at 15°C for 10 minutes at 2000g the supernatant

obtained was decanted and the final weight of the pellet obtained was determined. WHC was calculated as follows:

$$\%WHC = \frac{B-A}{B} \times 100$$

Where B = Initial weight of sample and A = weight of sample after centrifuging.

The costs of producing meatloaf with and without shredded fresh cabbage were calculated based on the prevailing retail prices in of all ingredients used in the product formulation in Kumasi.

Proximate composition, fat and moisture retentions: Samples of each treatment were analyzed to determine their contents of protein, ash, fat and fibre using Association of Official Analytical Chemists (AOAC, 2002) procedures for proximate analyses [6]. Moisture and fat retentions were calculated according to the following equations [7]:

$$\text{Fat retention (\%)} = \frac{\text{Cooked weight} \times \text{percent fat in cooked loaf}}{\text{Raw weight} \times \text{Percent fat in raw loaf}} \times 100$$

$$\text{Moisture retention (\%)} = \frac{\text{percentage yield} \times \text{percentage moisture in cooked loaf}}{100}$$

Sensory attributes: Thirty-five (35) untrained consumer panelists made up of twenty-eight (19) males and seven (16) females evaluated the meatloaves. The test meatloaves were coded with three-digit random numbers in order to ensure uniform and independent sampling and also to avoid biased assessments. The attributes evaluated by the panelists were appearance, taste, flavor, tenderness, juiciness, texture, mouth feel and acceptability on a 5-point hedonic scale where 1 = like extremely, 3 = neither like nor dislike and 5 = dislike extremely. Water was provided to the panelists to rinse their mouths after testing each sample in order to nullify the influence (or carry-ons) of the sensory attribute of one sample on the other.

Statistical analysis: SPSS [8] version 16.0 statistical package was used to analyze all data generated using a one-way Analysis of Variance (ANOVA). Duncan's test of homogeneity was used to determine significant differences between treatment means at 5% ($p < 0.05$).

Results and Discussion

Acidity (pH), WHC, fat and moisture retentions and costs of production

Results obtained for pH, water holding capacity and production cost of meatloaf with and without using cabbage are shown in Table 1. It was observed that the control (CAB₀) had significantly higher pH in both raw (6.05) and cooked (6.25) meatloaves respectively. No significant differences were observed ($p > 0.05$) between the pH of CAB₅₀ and CAB₁₀₀ for both raw and cooked meatloaves. The high acidity of CAB₁₀₀ resulted in a reduced water holding capacity compared to CAB₀ and CAB₅₀. Also, the lower pH in CAB₁₀₀ implies it is more likely to record a higher cooking loss compared to CAB₀ and CAB₅₀ because the FAO (1999) stated that a lower pH in meats result in lower water holding capacity and higher cooking losses. The lower pH among the cabbage-treatments could possibly be attributed to the lower pH of cabbage (5.90) which replaced pork fat (6.91). Since most bacteria require pH close to neutral for optimum growth and proliferation, it is possible to safely suggest that the observed reduction in the pH of cabbage-treated meatloaf is likely to result in antimicrobial benefits and hence extended shelf storage.

Both fat and moisture retentions reduced significantly ($p < 0.05$) with increasing use of shredded cabbage in the meatloaves. The

Table 1: Acidity (pH), WHC, Fat and moisture retentions and costs of production.

Parameter	Meatloaf type			P-value	SEM
	CAB ₀	CAB ₅₀	CAB ₁₀₀		
pH (raw)	6.05 ^b	5.34 ^a	5.39 ^a	0.001	0.12
pH (cooked)	6.25 ^b	5.86 ^a	5.84 ^a	0.001	0.07
WHC (raw)	57.93 ^c	42.36 ^b	24.06 ^a	0.001	4.85
WHC (cooked)	90.83 ^b	81.05 ^a	60.70 ^a	0.002	4.75
Fat retention (%)	94.60 ^c	69.46 ^b	61.42 ^a	0	5.41
Moisture retention(%)	40.83 ^c	38.44 ^b	31.16 ^a	1.74	0.029
Cost (GH¢/kg)	8.2	5.7	4.9		

Abc Means in the same row with different superscripts are significantly different (p<0.05) Control (CAB0) = sample without cabbage, (CAB50) =50% Cabbage + 50% Pork fat, (CAB100) =100% cabbage; pH of cabbage = 5.88, pH of beef= 6.29, pH of pork fat= 6.91.

Table 2: Sensory characteristics of low-fat meatloaf with and without fresh cabbage.

Parameter	Type of meatloaf			P-value	SEM
	CAB ₀	CAB ₅₀	CAB ₁₀₀		
Appearance	1.83	1.97	1.6	0.065	0.081
Taste	1.51	1.89	1.6	0.169	0.084
Flavour	1.57 ^a	2.00 ^b	1.46 ^a	0.008	0.076
Tenderness	1.51 ^a	1.97 ^b	1.57 ^a	0.029	0.077
Juiciness	1.37 ^a	2.34 ^b	1.71 ^a	0	0.082
Texture	1.63 ^a	2.00 ^b	1.57 ^{ab}	0.075	0.084
Mouth feel	1.57 ^a	2.03 ^b	1.49 ^a	0.028	0.09
Acceptability	1.47 ^a	2.17 ^b	1.43 ^a	0	0.085

Abc Means in the same row with different superscripts are significantly different (p<0.05); Sensory scale: 1=like very much; 2=like moderately; 3=neither like nor dislike; 4=dislike moderately; 5=dislike very much.

moisture retention decreased from 40.83% (control) to 31.16% (CAB₁₀₀) while fat retention reduced significantly from 94.60% (control) to 61.42% (CAB₁₀₀) with increased usage of shredded fresh cabbage. Again, this suggests that the cabbage-treated meatloaves are more likely to lost more weight during cooking, resulting in less juicy products. But the sensory attribute evaluation (Table 2), the juiciness of meatloaf without shredded fresh cabbage was not significantly different from CAB₅₀.

A simple arithmetic of costs of ingredients used in producing meatloaf with and without shredded fresh cabbage resulted in appreciable reductions in the production costs from C/kg 8.20(CAB₀) to C/kg 4.90(CAB₁₀₀) which translated into 30.49% and 40.24% respectively for producing CAB₅₀ and CAB₁₀₀ compared to CAB₀. These cost reductions could possibly result in increased consumption levels among meatloaf consumers when manufacturers adopt cabbage-treated meatloaf production [9].

Proximate compositions

Results obtained for percentage moisture, crude protein, crude fat, ash and crude fibre contents of meatloaf are shown in Table 3. The moisture content of the different meatloaves increased significantly (p<0.05) from 50.25% to 75.42% with increasing levels of cabbage used. CAB₁₀₀ recorded the highest moisture content, with an increase of 25.17% moisture compared to the control. The significantly higher (p<0.05) moisture recorded in cabbage-treated meatloaf could probably be due to the inherently high moisture content of fresh cabbage which replaced portions of pork fat used in meatloaf

Table 3: Proximate compositions of cooked meatloaf with and without fresh cabbage.

Parameter (DM) %	Meatloaf type			P-value	SEM
	CAB ₀	CAB ₅₀	CAB ₁₀₀		
*Moisture	50.25 ^a	55.73 ^b	75.42 ^c	0	3.827
Crude protein	33.45 ^a	34.15 ^b	37.85 ^c	0	3.643
Crude fat	56.17 ^b	51.33 ^b	11.67 ^a	0	7.049
Ash	3.50 ^a	3.67 ^b	7.17 ^c	0	0.601
Crude fibre	1.24 ^a	1.33 ^b	2.15 ^c	0	0.144

Abc Means in the same row with different superscripts are significantly different (p<0.05) Control (CAB0) = meatloaf without cabbage, (CAB50) = 50% Cabbage + 50% pork fat, (CAB100) =100% cabbage; *%Moisture 'as-is'.

production.

There were significant differences (p<0.005) between the fat content of the control and the meatloaves produced with 100% cabbage as shown in Table 3. It was observed that the fat levels decreased significantly (p<0.05) with the use of cabbage in meatloaf formulations. Korch (2011) reported that cabbage has low fat content (how low?); therefore, the reduction in crude fat content with increasing fresh cabbage in meat could be due to the very low fat content of cabbage which replaced part of the fat in the meat batter. The meatloaves produced with 100% cabbage in place of pork fat recorded a significant reduction of 44.5% fat compared to the control. This significant reduction in fat is likely to result in a reduction in auto-oxidation rancidity in the cabbage-treated meatloaves, and hence improve upon their storage life compared to those without shredded fresh cabbage [10].

Crude Protein: It was reported by FAO (2007) that protein of a lean beef should be 22.3% of which all the treatments were within the acceptable level. From Table 3, the protein content of the control (CAB₀) was lower than that of the cabbage-treated meatloaves. It was also observed that, the protein levels increased significantly (p<0.05) with the use of cabbage in meatloaves formulation. The differences in protein content could be attributed to addition of cabbage which replaced some amount of pork fat in the meatloaves. But there was significant increase in crude protein level with high inclusion level (100%) of cabbage.

Ash: There were significant differences (p<0.05) between the control (CAB₀) and cabbage treated meatloaves as shown in Table 3. The treatments with the highest level of cabbage recorded the highest ash content while the treatment with pork fat recorded the lowest ash content. Therefore, as the levels of cabbage increases, the ash content of the meatloaves increases. This agreed with the work done by Abaka (2009), there was a significant (P<0.05) increase in the ash content of products as the roasted cowpea flour level increased respectively. The higher ash content recorded in the product could attribute to the high mineral content of the cabbage.

Crude Fibre: There were significant differences (p<0.05) in the crude fibre content of the treatments. The treatments with the highest level of cabbage recorded the highest crude fibre content and this could be attributed to higher fibrous nature of the cabbage and a high fibre diet may reduce the risk of hemorrhoid and constipation. Fibre in diet also lower the cholesterol, helps to control diabetes and plays a role in the prevention of colon cancer.

Sensory attributes: The results of the organoleptic test of meatloaf appearance, flavour, taste, texture, mouth feel and acceptability with

and without fresh cabbage are shown in Table 2. There were no significant differences ($p>0.05$) between the control (CAB_0) and the cabbage treated meatloaves in terms of appearance and taste. For flavour, tenderness, juiciness, texture, mouth feel and acceptability, there were no significant differences between the control (CAB_0) and meatloaf products with 100% cabbage in place of pork fat (CAB_{100}). This could be attributed to the inclusion of fresh cabbage and the pork in the meatloaves [11].

Conclusion

The results of this experiment suggest that cabbage has promising potential to replace portions of pork fat in processed meats. The crude fat contents of the meatloaf reduced with increasing amounts of cabbage usage in the products. Thus, cabbage could be used as filler in meatloaves for consumers with preference for low fat meatloaves. Therefore, consumers who have preference for low-fat meatloaf are likely to patronize cabbage-treated meatloaf.

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