EFFECT OF TWO COOKING METHODS AND TEMPERATURE ON OXIDATION AND MICROBIOLOGICAL PROPERTIES OF BREAKFAST SAUSAGE

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ABSTRACT
Sausages were prepared from 65% meat, 20% lard, 3.5% binder, 2.01% curing salt, 1% sugar, 0.30% phosphate, 4% ice water, 2% dry spice, and 2.19 wet spices. A set of five samples were boiled in a water bath while another set were baked at temperatures of 80, 90, 100, 110 and 120 °C. The effect of cooking method and temperature was tested on oxidative and microbiological properties of breakfast sausage. The oxidative properties were evaluated using iodine value, acid value and thiobarbituric acid reactive substances (TBARS) assays. Three culture media were used to measure the microbial status of product using Nutrient Agar (NA) for total aerobic count, Potato Dextrose Agar (PDA) for yeast and mould count and Ethyl Methanesulfonate (EMS) for coliform bacteria count. Significant differences were observed for all the parameters measured at a significant level of 5%. Iodine value measures the level of unsaturated fatty acid, Iodine value ranged from 2.54 to 6.86 mg/g. Baking at 90°C gave the highest value, while boiling at 100°C and baking at 120°C had the lowest values. Acid value had boiling at 100°C giving the highest value and baking at 80°C giving the least. TBARS value showed that boiling at 120°C had the highest value, while boiling at 90°C gave the lowest value. Total aerobic count was high at 110°C for baking and boiling at 100°C. Total coliform bacteria count was high at boiling at 90°C. Fungi growth in the sausage was generally low, baking at 80°C had the highest count and least count was observed for boiling at 80°C and baking at 90°C. In conclusion, the oxidative and microbiological properties of breakfast sausage as influenced by cooking method and temperature showed the best cooking method and temperature interaction to be baking at 90°C and 100°C.
Key words: breakfast sausage, microbiological properties, oxidative rancidity, iodine value

INTRODUCTION
Oxidation of lipid fraction is one of the major causes of quality decrease during the shelf-life of sausage (Garcia and Astiasaran (2002). In processing technology the additive used in the dough formation and the poly unsaturated fatty acids of the lipid fraction are the cause of development of unpleasant odours and tastes and thus a decrease in the nutritional value of the product due to a lowering of polyunsaturated fatty acids content (Awod *et al.*, 1996). Livsmedelsrerket (2004) reported that meat and meat products vary greatly in their fat content according to the animal species, age of the animal and part of the carcass used. Younthan *et al.* (1980) reported that rancidity increased with increasing storage time. Gada (2008) stated that unsaturated fatty acids are very prone to oxidation, even in meat where most of the fat is saturated as the cell membranes contain phospholipids.

As the main objective is to prevent microbial spoilage and food poisoning, several hurdles are used minimally to obtain the optimum combination to give good sensory qualities, safety and stability as well as savings of energy and money (Das & Radhakrishna, 2001; Grijspaardtvink, 1994; Karthikeyan, Kumar, Anjaneyulu, & Rao, 2000). Shelf stable meat products could be processed by thermal processing which could be dry or moist cooking method in a sealed container or by adjusting hurdles such as pH, water activity (aw) and food preservatives (Kanatt, Chawla, Chander, & Bongirwar, 2002) and/or irradiation (Leistner, 2000; Leistner, Vukovic, & Dresel, 1980) and can be stored without refrigeration.

The aim of this study was to assess the influence of baking and boiling cooking methods and temperature on the oxidative and microbiological properties of breakfast sausage.

MATERIALS AND METHODS

Experimental Site: The study was carried out at the Meat Science laboratory of the Department of Animal Science, University of Ibadan.

Experimental Procedure and Treatments: The muscles used for preparation of sausage were the *Semitendinosus* and *Semimembranosus* muscles obtained from a freshly slaughtered bull from the slaughter house of the University of Ibadan. The meat was cleaned of fat and dirt, and chilled over the night. Meat was chopped into small bits before grinding. The back fat from pig was cleaned and frozen to solidify for easy grinding. The natural sausage casing used was the pig's intestine. It was washed by allowing water run through it. After thorough washing, the intestine was then soaked in brine solution, (9% NaCl) until ready for use. After grinding, salt and sugar solution were added to the meat emulsion so as to maintain the natural colour of the ground meat. The dry and wet spices were then added and properly mixed. The binder was added afterwards. Crushed ice was used to lower the temperature, further mixing was done on the emulsion until consistency was obtained. The sausage was then pushed into the casings using a stuffer. Sausages were linked using twines, weighed and packed into 20 different Ziploc bags and kept in the freezer. Table 1 shows the sausage formulation

Cooking method: Two cookery methods were used, boiling in a water bath, for moist heat cookery method and baking in an electric oven for dry heat cookery method.

Iodine Value and Acid Value: This was carried out according to **IUPAC (1979)** using titration technique against alkali (1 - 10 gm dissolved fat).

Thiobarbituric acid reactive substances: Thiobarbituric acid value (TBA) was estimated by modified methods of Buege and Aust (1978).

Microbial Analysis: Using the pour plate count method (Harrigan and Macanee, 1976). Three agar types were used on samples, Nutrient agar (NA), Potato Dextrose agar (PDA), and Ethyl methanesulfonate (EMS). NA was used to determine the total anaerobic count, PDA for fungi and mould count, and EMS for coliform bacteria.

RESULTS AND DISCUSSION

Microbial Analysis: Table 2 shows the microbial count for each cooking temperature and methods for breakfast sausage. There were significant differences in the mean values of samples subjected to the three culture media. For coliform, the highest count was recorded for boiling at 90°C and the least by boiling at 110°C and baking at 120°C. For fungi, the highest count was recorded for boiling at 80°C followed by baking at 90°C, boiling at 80°C and 100°C, showed no significant difference in their means ($P>0.05$). For total anaerobic count, the highest count was recorded for baking at 110°C and the least by boiling at 100°C. Microbiological organisms could be pathogenic or spoilage organisms. These are dangerous to the health and safety of the consumers and also of economic importance to producers. It is for this reason that the microbial analysis was done to determine what spoilage organisms pose a threat to the producers as well as the consumers. Generally, it was observed that counts decreased with boiling method and this may be due to the moist heat penetrating the sausage more. This finding is in accordance with the results obtained by Sharma *et al.* (2005).

Oxidative properties: Table 2 shows the iodine and acid values for each cooking temperature and method for breakfast sausage. The iodine values showed that there were significant differences among all the mean values ($P<0.05$) with the 90°C baked sausage giving the highest iodine value followed by baking at 100°C and boiling at 80°C, the least was that subjected to boiling at 100°C and 120°C baked sausages. Iodine values are often used to determine the amount of unsaturation in fatty acids. Thus baking at 90°C which had the highest iodine value had a higher level of unsaturated fatty acids and this is safe for human health as too much saturated fatty acids could cause heart diseases. Also there was a significant difference among all mean values in the acid value determination ($P<0.05$). Boiling at 100°C gave the highest mean value, followed by baking at 120°C and the least mean value recorded by baking at 80°C. Acid value is a measure of the free fatty acids present in fats and oils and it is an indication of hydrolysis of triglycerides (Chemprime, 2010). In this study, boiling at 100°C had more of its triglycerides hydrolysed. Figure 1 shows the TBARS for each cooking temperature and method for breakfast sausage. There were significant differences ($P<0.05$) in the mean values of the

TBARS assay. Boiling at 80°C yielded the highest mean value and the least was recorded for boiling at 90°C. Oxidative rancidity (TBA value) is one of the major causes of decrease in quality during the shelf life of sausage. (Gracia and Astiasaran, 2002). It was observed that baking had higher TBARS value and this may be due to lower cooking loss recorded for baking – the dry heat cookery method.

CONCLUSION

From the study, it can be concluded that baking at 90°C and 100°C yielded the best results. The iodine and acid values of these samples showed that baking at these two temperatures gave high unsaturated fat levels which infers that sausages contained lower levels of saturated fats which are dangerous to health

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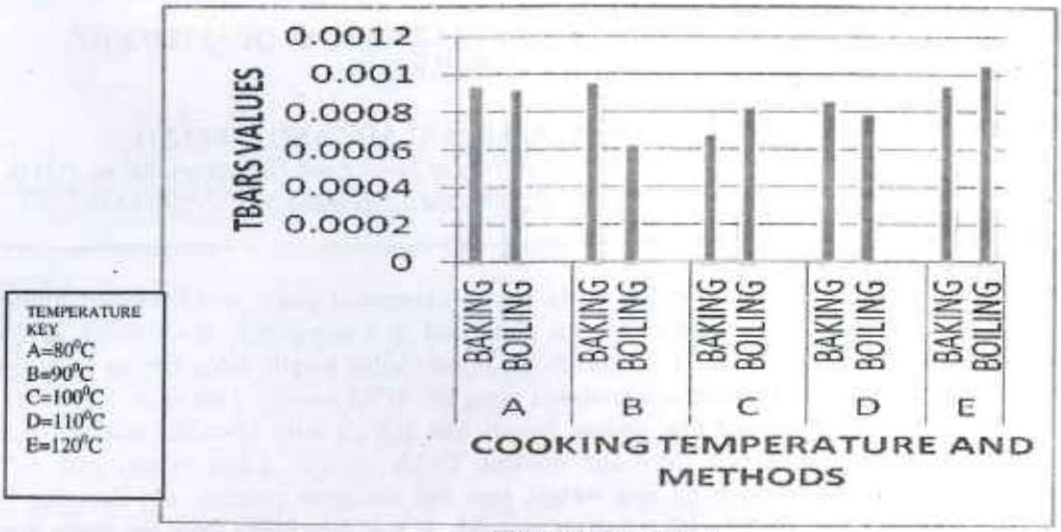

Fig 1: T Bars values

Table 1: SAUSAGE FORMULATION

INGREDIENT	COMPOSITION %
Beef	65
Lard	20
Binder	3.5
Curing salt	2.01
Sugar	1
Phosphate	0.3
Ice water	4
Dry spices	2
Green spices	2.19
Total	100

Table 2: Microbiological Analysis of total aerobic count, fungi, coliform bacteria iodine and acid values.

TEMP °C	Methods	Coliform (Log $_{10}$ cfu/g)	Fungi (Log $_{10}$cfu/g)	Total aerobic count (Log $_{10}$cfu/g)	Iodine value (mg/g)	Acid value (mg/g)
80	BAKING	0.60^{b}	0.48^{a}	1.98^{i}	2.85^{f}	6.16^{j}
	BOILING	0.81^{i}	0.30^{b}	2.54^{d}	5.72^{b}	21.32^{g}
90	BAKING	1.36^{c}	0.30^{b}	2.37^{g}	6.86^{a}	20.31^{h}
	BOILING	1.72^{a}	0.00^{c}	2.00^{h}	4.45^{c}	25.58^{e}
100	BAKING	1.60^{b}	0.00^{c}	2.67^{b}	5.72^{b}	26.03^{d}
	BOILING	1.28^{e}	0.30^{b}	1.70^{j}	2.54^{g}	29.73^{a}
110	BAKING	1.29^{d}	0.00^{c}	2.81^{a}	3.56^{e}	27.38^{c}
	BOILING	0.00^{j}	0.00^{c}	2.41^{f}	3.81^{d}	19.07^{i}
120	BAKING	0.00^{j}	0.00^{c}	2.62^{c}	2.54^{g}	29.06^{b}
	BOILING	0.78^{g}	0.00^{c}	2.46^{e}	4.45^{c}	21.54^{f}
	SEM	0.11	0.03	0.06	0.26	1.21