APR -27

Sensory Acceptability and Microbial Load of Partial, Combined and Total Replacement of Sodium Chloride in Beef Sausage

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Abstract
Sodium chloride is an essential nutrient but is needed by the body only in small quantities, it inhibits the growth of microbes. High intake of sodium in sodium chloride (NaCl) has been identified as one of the main contributing factors in the development of specific diseases, such as; high blood pressure, cardiovascular disease, coronary heart disease, stroke, end-stage renal disease and diabetes. This study evaluates the effects of NaCl partial, combined or total replacement on sensory and microbial load of beef sausage. Beef sausage was prepared ((g/100g: beef 65.0, corn flour 10.0, oil 10.0, others 13.0). Sodium chloride (SC) was replaced with potassium chloride (PC), potassium lactate (PL) or calcium ascorbate (CA) at 25, 50 and 100%, then stored for 15 days. Sausage was subjected to sensory evaluation and microbial load using the standard procedure. Data were analysed using descriptive statistic and ANOVA at $\alpha_{0.05}$.The most preferred sausage colour was obtained with a salt combination of 50% SC and CA each (5.60±0.2) with least colour in a salt combination of 50% SC, 25% PL and CA (2.60±0.1). In tenderness, a salt combination of 50% SC and CA each was significantly tender (6.60±0.3) with least tenderness in 100% PL total replacement. Salt combination of 25% SC, PC, PL and CA each was most juicy (6.30±0.3) while 100% PC total replacement was dry (3.80±0.1). The panelists rated salt combination of 50% SC and CA as the most overall accepted salt combination (6.8±0.3) with least overall acceptability recorded for salt combination of 50% PL and CA (3.20±0.1).Sodium chloride replacement with Calcium Ascorbate at 50% enhanced the most preferred sausage for overall acceptability and aerobic bacteria count lower than the international standard limit.

Keywords: Sodium chloride, beef sausage, potassium chloride, potassium lactate, calcium ascorbate

Introduction

A link between salt consumption, or increased sodium intake, and increased blood pressure has been verified in several studies. The Global Strategy on Diet, Physical Activity and Health passed by the WHO (World Health Organization) in 2004, identified increased salt consumption as one of the main contributing factors in the development of specific, non-transmittable diseases, such as, high blood pressure and related secondary diseases. Most sodium comes from salt added during food processing. Many types of processed foods contribute to the high intake of sodium. Consumers will rate taste very highly and accept healthier products only as long as they do not have to sacrifice palatability. Furthermore, in many applications, the total exclusion of salt is not possible for technical reasons.

Therefore, adequate salt substitutes must feature essential functionalities in taste, preservation, texture and the color of end products. Firstly, sodium chloride could be replaced by potassium chloride. This is in fact, the most commonly used salt to date (Weiss *et al.,* 2010). However, potassium chloride has a slightly bitter taste and to prevent the product from having unacceptable sensory properties, masking substances are added as additives to the product, flavour enhancer may also be added to the meat product. The flavour enhancers themselves do not have a salty taste, but may in combination with salt increase the saltiness of the product. For example, carboxymethylcellulose and carrageenan in combination with sodium citrate have been shown to enhance saltiness in frankfurters (Ruusunen *et al*., 2003; Weiss *et al.,* 2010).

This study seeks to evaluate the effects of partial, combined and total replacement of sodium chloride on sensory acceptability of beef sausage.

Materials and Methods

The experiment was undertaken at the Animal Product and Processing (Meat Science) Laboratory of the Department of Animal Science, Faculty of Agriculture, University of Ibadan, Ibadan. Beef sausage was prepared (g/100g: beef 65.0, corn flour 10.0, oil 10.0, others 13.0). Sodium chloride (SC) was replaced with potassium chloride (PC), potassium lactate (PL) or calcium ascorbate (CA) at 25, 50 and 100% stored for 15 days**.** Microbial count was carried out using the pour plate water method (Harrigan and Macanee, 1976). A sterile pipette was used to measure 1ml out to the $10^{-2,}$ 10^{-4} and 10^{-6} dilution and this was pipetted into sterile

Petri dishes and molten agar at 45 °C was poured into it. It was swirled gently for even distribution; the plate was inverted and incubated in an incubator at 30 °C. The total plate count was carried out after 48 hours. A nine-point hedonic scale was used by twenty panelists to assess colour (1-4 dark, 5- intermediate, 6-9 light), tenderness (1-4 tough, 5- intermediate, 6-9 tender), juiciness (1-4 dry, 5- intermediate, 6-9 juicy), hotness (1-4 less, 5- intermediate, 6-9 high) and overall acceptability, OA (1-4 low, 5- intermediate, 6-9 high) according to (Mahendraker *et al.,* 1988).

Data were subjected to analysis of variance using SAS (2002). Means were separated using Duncan's Multiple Range Test option of the same software.

Results

Effects of different salts on sensory evaluation are shown on Figure I to V. The most preferred sausage colour was obtained with a salt combination of 50% SC and CA each (5.60±0.2) with least colour in a salt combination of 50% SC, 25% PL and CA (2.60±0.1). For tenderness, a salt combination of 50% SC and CA each was significantly tender (6.60±0.3) with least tenderness in 100% PL total replacement. Salt combination of 25% SC, PC, PL and CA each was most juicy (6.30±0.3) while 100% PC total replacement was dry (3.80±0.1). The panelists rated salt combination of 50% SC and CA each as the most overall accepted salt combination (6.8±0.3) with least overall acceptability recorded for a salt combination of 50% PL and CA (3.20±0.1).Table 1 shows the effects of different salts on the microbial count. There was no significant difference in all the treatments across the storage days.

Table 1: Interaction effect of different salt and storage days on microbial count of beef sausage

Parameter	DayS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Aerobic bacteria count (log/CFU)	Day 0	0.0 0	0.2 0	0.2 0	0.7 0	0.9 0	0.2 0	0.0 0	0.0 0	0.1 0	0.2 0	0.0 0	0.1 0	0.0 0	0.1 0	1.0 0
	Day 5	0.0 0	0.1 0	0.3 0	0.2 0	0.5 0	0.9 0	0.0 0	0.0 0	0.0 0	0.1 0	0.1 0	0.2 0	0.3 0	0.1 0	1.2 0
	Day 10	0.0 0	0.3 0	0.8 0	0.8 0	0.8 0	0.3 0	0.8 0	0.7 0	0.3 0	0.0 0	0.0 0	0.6 0	0.0 0	0.3 0	1.0 0

A= 100% Sodium chloride, B = 50% Sodium chloride & Potassium chloride, C = 50% Sodium chloride & Potassium lactate, D= 50% Sodium chloride & Calcium ascorbate, E = 25% sodium chloride, potassium chloride, Potassium lactate & Calcium ascorbate each, F= 50% Sodium chloride and Potassium lactate each, G= 50% potassium chloride & Calcium ascorbate each and H = 50% sodium chloride, 25% Potassium lactate & Calcium ascorbate, I= 25 % potassium chloride, Calcium ascorbate & 50 % Potassium lactate, J = 25 % potassium chloride, Potassium lactate & 50% Calcium ascorbate, K = 100% potassium chloride, L= 100% Potassium lactate, M= 100% Calcium ascorbate, N= 50% Potassium lactate & Calcium ascorbate, O= NO salt.

Discussion

The panelists were able to distinguish a difference in colour, tenderness and overall acceptability among the treatment (Figure II - V). The effects of replacing NaCl by KCl, potassium lactate and glycine on physicochemical, microbiological, and sensory properties of fermented sausages were studied. In this study, the combination of 50% sodium chloride and calcium ascorbate was rated high which could be attributed to calcium ascorbate ability to fix colour and the synergy between sodium chloride and calcium ascorbate reduced spiciness of the breakfast sausage thus making the product tenderer. There were no significant differences in the microbial load. This could be due to the ability of salt to reduce or inhibit the growth of microbes.

Gelabert*et al.*(2003) reported that replacement of 50% of the NaCl with KCl in frankfurter provided acceptable flavour without excessive bitterness, while Hand *et al.* (1982a) observed similar results by replacing 35% of NaCl with KCl. Hand *et al.* (1982b) investigated the effects of chloride salts of potassium and magnesium by replacing all (100%) or part (35%) of NaCl in mechanically deboned turkey frankfurters. At substitution levels, higher than 30% with potassium lactate and higher than 50% with glycine, a loss of cohesiveness was noticed by the sensory analysis in fermented sausages.

Conclusion

Sodium chloride replacement with calcium ascorbate at 50% enhanced the most preferred sausage for overall acceptability and aerobic bacteria count lower than the international standard limit.

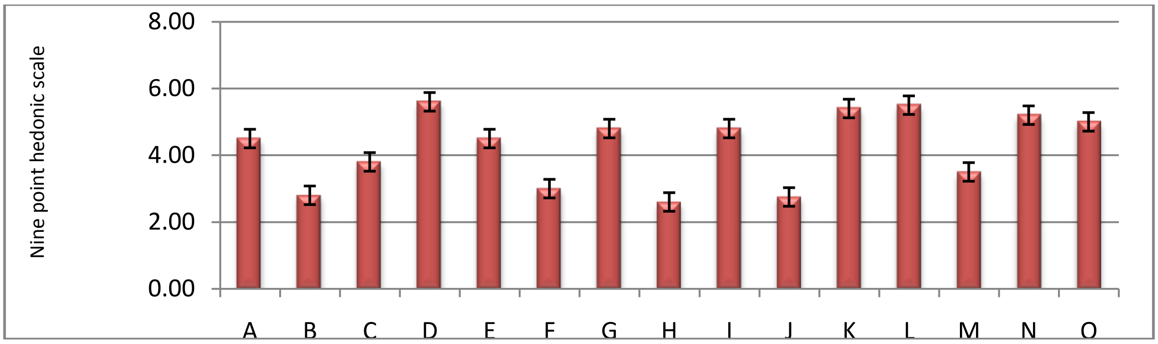

Fig. II: Effect of different salts on sausage colour

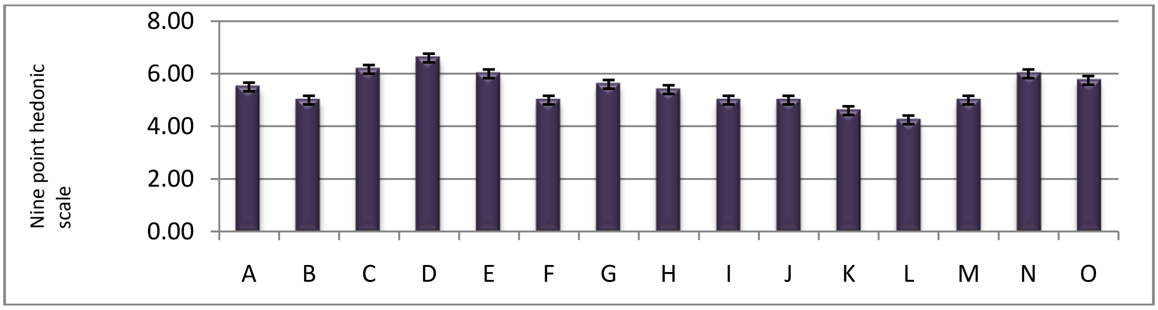

Fig. II: Effect of different salts on sausage tenderness

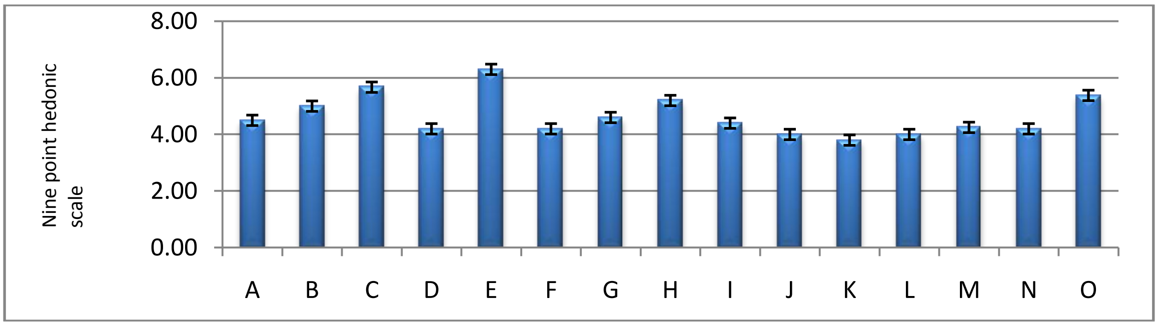

Fig. III: Effect of different salts on sausage juiciness

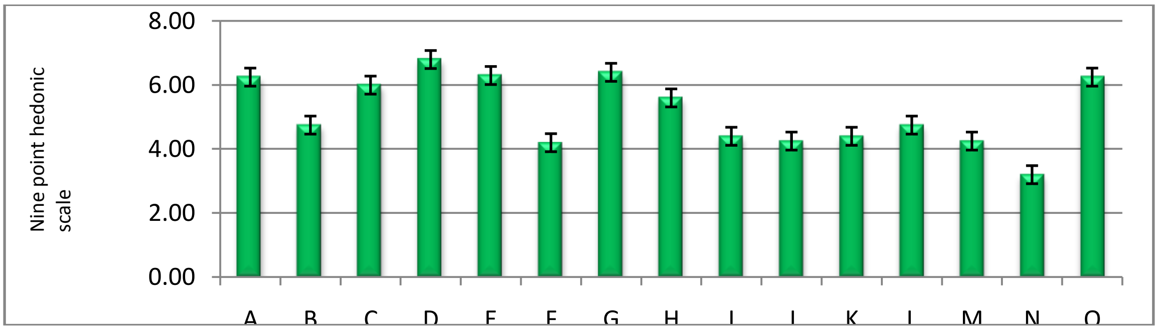

Fig. V: Effect of different salts on overall acceptability

A= 100% Sodium chloride, B = 50%Sodium chloride & Potassium chloride, C = 50% Sodium chloride & Potassium lactate, D= 50% Sodium chloride & Calcium ascorbate, E = 25% sodium chloride, potassium chloride, Potassium lactate & Calcium ascorbate each, F= 50% Sodium chloride and Potassium lactate each, G= 50% potassium chloride &Calcium ascorbate each and H = 50% sodium chloride, 25% Potassium lactate & Calcium ascorbate, I= 25 % potassium chloride, Calcium ascorbate& 50 % Potassium lactate, J = 25 % potassium chloride, Potassium lactate & 50% Calcium ascorbate, K = 100% potassium chloride, L= 100% Potassium lactate, M= 100% Calcium ascorbate, N= 50% Potassium lactate & Calcium ascorbate, O= NO salt.

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