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The impact of salt and fat level variation on the physiochemical properties and sensory quality of pork breakfast sausages

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The sensory and physiochemical properties of sausages with varying fat and salt levels were investigated. Twenty eight sausages were produced with varying concentrations of fat (22.5%, 27.5%, 32.5%, 37.5% w/w) and salt (0.8%, 1%, 1.2%, 1.4%, 1.6%, 2%, 2.4% w/w). Sausages were assessed instrumentally for colour, moisture, fat, cooking loss and texture profile analysis. Consumers (n = 25), evaluated each product in duplicate for colour, texture, tenderness, juiciness, salt taste, meat flavour, off-flavour and overall acceptability using a hedonic scale.

Lowering fat produced products which consumers rated as less dark in colour, tougher, less juicy and taste less salty than higher fat products. However, no significant preferred sample was found amongst consumers. Salt reduction in products produced sausages which consumers rated as paler in colour, more tender and with greater meat flavour than higher salt containing products. The sausages containing 1.4% and 1.0% salt were significantly ($P<0.01$) found to be more acceptable to consumers than other salt levels.

1. Introduction

Studies in meat consumption in the last decade have shown that the health and nutritional value of a product is a major factor in consumer preference (Angulo & Gil, 2007; Fonseca & Salay, 2008). Cardiovascular disease (CVD) accounts for 30% of all deaths across the world (World Health Organization, 2009). Hypertension, a term which describes high blood pressure, has high global prevalence. Many studies have shown a link between a high intake of dietary sodium and hypertension (Dahl, 1972; Law, Frost, & Wald, 1991a, 1991b). The main source of sodium (75% of total dietary intake) in most of our diets has been shown by Appel and Anderson (2010) to come from processed food.

Processed meats can also contain high levels of animal fat, and high levels of fat have been associated with increased risk of promoting obesity, diabetes and also cancers especially colon cancers (Aggett et al., 2005).

Even though salt and fats are shown to impact negatively on health they are still integral parts of any meat product. Salt is a vital ingredient in processed meat as it has numerous technological benefits such as preservation, taste enhancement and water binding (Durack, Alonso-Gomez, & Wilkinson, 2008). Water holding capacity is defined as the ability of a food to enclose liquid within a three dimensional structure (Chantrapornchai & McClements, 2002). Salt is able to increase the water holding capacity of a meat product by extracting myofibrillar proteins which associate into a gel when heated (Foegeding & Lanier, 1987).

Fat also greatly contributes to the eating quality of meat (Webb, 2006; Wood, 1990). It interacts with other components present within a meat system and helps to develop what can be a more consumer acceptable product. Effecting things like texture and mouthfeel provide lubrication, as well as contribute to the overall flavour (Crehan, Troy, & Buckley, 2000; Giese, 1996; Javidipour, Vural, Ozbas, & Tekin, 2005; Wood et al., 1999).

Reduced fat foods are seen by consumers to have inferior sensory properties than regular fat products and maintain a level of scepticism that there is a need for substitutes and additives used to replace fat. It can be argued that there is a great deal more to reduced fat products than just sensory acceptance (Hamilton, Knox, Hill, & Parr, 2000). Levy and Stokes (1987) have shown evidence which also suggests than consumers are mistrustful towards product health claims, believing that companies simply use these health benefit claims as a ploy to increase product sales. However, it is still important to obtain an acceptable limit at which salt and fat can be reduced from processed meat products without negatively impacting functionality and product quality or adversely affecting sensorial acceptability, so as to enhance the health status of processed meats. Work carried out by Tobin, O'Sullivan, Hamill, and Kerry (2012a, 2012b) have shown that fat and salt reduction can be successfully reduced in processed meat products such as burgers and frankfurters.

This study aims to investigate the interactions between different salt and fat levels on the overall quality of cooked breakfast sausages and also to investigate the consumer optimisation of reduced salt and fat variants, without using fat and salt alternatives.

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2. Materials and methods

2.1. Sample preparation

Pork was selected on the basis of a high visual lean (V/L) score; pork shoulder was used with a V/L score of 99%. Pork was purchased along with pork back fat from a local supplier (Ballyburden Meats Ltd., Ballincollig, Cork, Ireland). The meat and fat were vacuum packed and stored at −18 °C until required for sausage production. The frozen meat and fat were then cut into strips and allowed to thaw slightly before being minced through a 5 mm plate (TALSABELL S. A., Spain). The meat was weighed according to the formulations shown in Table 1 and fed into the bowl chopper. The required salt and seasoning and half of the required water were added and mixed at high speed for 60 s. The required fat was then added and the mix was chopped for a further 60 s at high speed. The remaining water and rusk were then added and mixed at low speed for 15 s and high speed for 30 s. The sausage mix was then put into the casing filler and fed into collagen casings. The sausages were then sealed into laminated plastic bags of polyamide/polyethylene and chilled overnight at −4 °C.

2.2. Cooking

Oven cooking was chosen as it was the most easily repeatable and controllable cooking method. All samples were wrapped in foil and dry cooked at 150 °C in a zanussi convection oven (C. Batassi, Conegliano, Italy) for 15 min to an internal temperature of 73 °C, as measured by an internal temperature probe (Testo 110, Lenzkirch, Germany). All test samples were cooked at the same time to insure uniformity and were segregated to prevent mixing.

2.3. Sensory evaluation

Sensory analysis was carried out using 25 consumers within the age range of 20–30 years, following the method of O'Sullivan, Byrne, and Martens (2003). Panellists were chosen on the basis that they regularly consume and purchase sausage style meat products. Sensory analysis was undertaken in the panel booths at the university sensory laboratory that conforms to ISO (1988) international standard. Five samples were presented to the consumers and they were required to rinse with water before tasting each sample. Sample presentation order was randomised to prevent any flavour carryover effects (MacFie, Bratchell, Greenhoff, & Vallis, 1989; Tobin et al., 2012a,b). Consumers were asked to indicate their score on a 10 cm line scale ranging from 0 at the left to 10 at the right and rating was subsequently scored in cm from the left for each sausage presented. Consumers were required to evaluate the sausages using the following descriptors: colour, coarseness, toughness, juiciness, salt taste, meat flavour, off-flavour and overall acceptability. Off-flavour was described to consumers as off-flavour, rancid, cardboard or linseed oil-like flavour.

Table 1
Sausage formulations.

Sample	Formulation					
	% fat	% pork	% salt	% water	% rusk	% seasoning
1	37.50	26.60	2.40	20.00	12.50	1.00
2	37.50	27.00	2.00	20.00	12.50	1.00
3	37.50	27.40	1.60	20.00	12.50	1.00
4	37.50	27.60	1.40	20.00	12.50	1.00
5	37.50	27.80	1.20	20.00	12.50	1.00
6	37.50	28.00	1.00	20.00	12.50	1.00
7	37.50	28.20	0.80	20.00	12.50	1.00
8	32.50	31.60	2.40	20.00	12.50	1.00
9	32.50	32.00	2.00	20.00	12.50	1.00
10	32.50	32.40	1.60	20.00	12.50	1.00
11	32.50	32.60	1.40	20.00	12.50	1.00
12	32.50	32.80	1.20	20.00	12.50	1.00
13	32.50	33.00	1.00	20.00	12.50	1.00
14	32.50	33.20	0.80	20.00	12.50	1.00
15	27.50	36.60	2.40	20.00	12.50	1.00
16	27.50	37.00	2.00	20.00	12.50	1.00
17	27.50	37.40	1.60	20.00	12.50	1.00
18	27.50	37.60	1.40	20.00	12.50	1.00
19	27.50	37.80	1.20	20.00	12.50	1.00
20	27.50	38.00	1.00	20.00	12.50	1.00
21	27.50	38.20	0.80	20.00	12.50	1.00
22	22.50	41.60	2.40	20.00	12.50	1.00
23	22.50	42.00	2.00	20.00	12.50	1.00
24	22.50	42.40	1.60	20.00	12.50	1.00
25	22.50	42.60	1.40	20.00	12.50	1.00
26	22.50	42.80	1.20	20.00	12.50	1.00
27	22.50	43.00	1.00	20.00	12.50	1.00
28	22.50	43.20	0.80	20.00	12.50	1.00

2.4. Protein content

The Kjeldahl method (Suhre, Corrao, Glover, & Malanoski, 1982) was used to measure protein concentrations. The digestion block was pre-heated to 410 °C. Approximately 0.5 g of well homogenised sample was weighed accurately into a digestion tube. 15 ml of sulphuric acid (nitrogen free), 10 ml hydrogen peroxide and 2 "kjeltabs" were added to the sample. The tubes where then inserted in the heated digestion block. When the samples became colourless they were removed from the block. The tubes were allowed to cool in the fume hood after removal.

50 ml of distilled water was carefully added to the cooled and digested sample inside the fume-hood. The tubes and a receiver flask containing 50 ml of 4% boric acid with indicator were then placed into the distillation unit. After the sample had been distilled the contents of the receiver flask were titrated against 0.1 N hydrochloric acid until the green colour reverted back to the original red colour.

2.5. Ash content

Ash content was determined using a muffle furnace (AOAC, 1923). A muffle furnace was pre-heated to 525 °C. Approximately 5.0 g of well homogenised sample was weighed into porcelain dishes using a balance that weighs to 1 mg. The dishes containing the samples were then put in the muffle furnace for (approximately 6 h) until the colour of the samples went white. The dishes containing the samples were then removed and placed in a desiccator to cool. The dishes were then weighed and the ash content was calculated.

2.6. Moisture and fat content

A Büchi Mixer B-400 (BÜCHI Labortechnik AG, Meierseggstrasse 40, Postfach, CH-9230 Flawil 1, Switzerland) was used to homogenise a total of 200 g of sausage sample. To avoid moisture or evaporative loss the homogenised sample was then quickly transferred into a moisture proof bag Moisture and fat content were then determined using the CEM SMART (moisture) and SMART Trac (fat) systems (Bostian, Fish, Webb, & Arey, 1985).

2.7. Colour

Both raw and cooked sausages were cut down the centre and were measured for colour according to the CIE L*a*b* colour system. Cooked samples were cooled to room temperature before measuring. A Minolta CR 300 colorimeter (Minolta Camera Co. Ltd., Osaka, Japan) with an 11 mm-diameter aperture and D_{65} illuminant, calibrated by the CIE Lab colour space system using a white tile (C: Y = 93.6, x = 0.3130, y = 0.3193), (Minolta calibration plate) was used to conduct the analysis. Colour measurements (CIE L*, a* and b* values representing