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Impact of varying salt and fat levels on the physicochemical properties and sensory quality of white pudding

Susann Fellendorf, Maurice G. O'Sullivan, Joseph P. Kerry *

The Food Packaging Group, School of Food and Nutritional Sciences, University College Cork, Ireland

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ABSTRACT

Twenty-five white pudding formulations were produced with varying fat contents (20%, 15%, 10%, 5%, 2.5% w/w) and varying sodium contents (1.0%, 0.8%, 0.6%, 0.4%, 0.2% w/w). Compositional analysis, cooking loss, colour and texture profile analysis were determined. Sensory acceptance testing using untrained assessors (n = 25–30) was performed in duplicate on products for liking of appearance, flavour, texture, colour and overall acceptability, followed by ranking descriptive analysis using the descriptors grain quantity, fatness, spiciness, saltiness, juiciness, toughness and off-flavour. Puddings containing higher sodium levels (1.0%, 0.8%) were the most accepted, with the exception of those with the lowest fat content. Lower fat and salt puddings were tougher, less juicy, less spicy, lighter and had a more intense yellow colour ($P < 0.05$). However, the pudding sample containing 15% fat and 0.6% sodium was highly accepted ($P < 0.05$), thereby satisfying the sodium target (0.6%) set by the Food Safety Authority of Ireland (FSAI, 2011).

1. Introduction

White pudding meat products are popular in Ireland and in the United Kingdom and contribute particularly a special feature of the traditional Western European breakfast. In general, it is manufactured from lean pork meat, pork fat, grains, onions, salt and seasonings, and is similar in nature to black pudding products, but lacks the blood component present in the latter form. The fat content of commercial available white puddings range from 6.0% to 22.4% though the majority of the products contain between 12% and 18% fat (unpublished data, 2013). Additionally, the level of sodium concentrations determined in these products has been reported to range from 520 mg/100 g to 1190 mg/100 g, with an average level of 867 mg/100 g (FSAI, 2014).

Meat and meat products play an important role in the human diet providing a great source of minerals like iron and zinc, B-vitamins and proteins which contain all nine essential amino acids. Conversely, over-consumption of meat and meat products has been linked with obesity, cancer and cardiovascular diseases primarily due to the high amounts of sodium chloride and saturated fat present in processed products (Cross et al., 2007; Halkjaer, Tjønneland, Overvad, & Sørensen, 2009; Li, Siriamornpun, Wahlqvist, Mann, & Sinclair, 2005; Micha, Wallace, & Mozaffarian, 2010). Generally, 75% to 80% of salt is added during product manufacture, 10% of the dietary salt occurs naturally in foods and the remaining percentages are added during cooking or at the table by the consumers themselves (Mattes & Donnelly, 1991; OMS, 2002). The demand for healthier food has increased in the last two decades. Consequently, food and regulatory bodies have targeted issues like salt and fat reduction in processed products. Organizations like the World Health Organization (WHO) and Food Safety Authority of Ireland (FSAI) are driving measures to reduce salt and saturated fat content in foods by raising the consumers' awareness and setting guidelines around ingredient usage for companies. Currently WHO recommends a daily salt consumption of less than 5 g (WHO, 2012) and furthermore they suggest a daily intake of polyunsaturated fatty acids (PUFAs) between 6% and 11% based on daily energy intake (WHO, 2003). Recently, the FSAI agreed a guideline with the Irish meat industry to reduce the sodium level in white and black pudding to 600 mg/100 g (FSAI, 2011). However, there are several compromises to achieve this such as using leaner meat, less fat and salt, more water, replacing parts of animal fat with plant oil, or the application of fat and salt replacers. Previous studies have already investigated fat and salt reduced meat products in frankfurters, ground beef and pork patties, cooked bologna type sausages, and pork breakfast sausages (Jeong et al., 2007; Ruusunen et al., 2005; Tobin, O'Sullivan, Hamill, & Kerry, 2012a, 2012b, 2013; Ventanas, Puolanne, & Tuorila, 2010). Significant differences in physicochemical properties and sensory qualities were found in all these reports. These effects are caused by the functional roles of salt and fat in processed meat. Fat interacts with other ingredients, and induces mouth-feel, texture and lubrication. In turn, salt is important for the water holding capacity and

* Corresponding author. Tel.: +353 490 3798; fax: +353 21 42 70001.
E-mail address: joe.kerry@ucc.ie (J.P. Kerry).

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acts as a preservative and flavour enhancer (Chantrapornchai, McClements, & Julian, 2002; Giese, 1996; Gillette, 1985; Hutton, 2002; McCaughey, 2007; Wood & Fisher, 1990).

From research conducted to date, it has become clear that successful salt and fat reduction in processed meats is product specific and no research has been carried out on salt and fat reduction in meat pudding products. Therefore, the objective of this study was to optimize the effects of reducing fat and salt levels on the physicochemical and sensory properties of white pudding products without using fat and salt replacers, to produce highly accepted end products.

2. Materials and methods

2.1. Sample preparation

Lean pork trimming (visual lean score of 95%) and pork fat were obtained from a local supplier (Ballyburden Meats Ltd., Ballincollig, Cork, Ireland) and were minced to a particle size of 10 mm and 5 mm, respectively (TALSABELL SA., Valencia, Spain). Afterwards, the minced meat and fat were vacuum packed and stored at −20 °C. Required portions of frozen meat and fat were taken out to defrost at 4 °C for 12 h before white pudding production commenced. The ingredients were weighed in accordance with formulations shown in Table 1. The required meat, fat, seasoning, salt and three quarters of the water were fed into a bowl chopper (Seydelmann KG, Aalen, Germany) and chopped at high speed (3000 rpm) for 45 s, followed by the addition of the remaining water and mixed again at high speed for 30 s. The required pinhead oatmeal and dried onions were then added and chopped at a low speed (1500 rpm) for 15 s. Finally, added boiled pearl barley and rusk were chopped at low speed for 30 s. The white pudding batter was transferred into the casing filler (MAINCA, Barcelona, Spain) and loaded into polyamide casings. The white puddings were then cooked in a Zanussi convection oven (C. Batassi, Conegliano, Italy) using 100% steam at 85 °C until the internal temperature reached 75 °C, as measured by a temperature probe (Testo 110, Lenzkirch, Germany). This temperature was held for 15 min. Following the cooking process, the white puddings were immediately put in the chiller to cool down and stored there at 4 °C. All sausage batches were produced in replicate.

2.2. Reheating procedure

Before serving white pudding at home, usually the cut slices are cooked in a frying pan. For experimental purpose the reheating step was standardized with all samples cut into 1.2 cm thick slices, placed on aluminium plates and dry cooked at 100 °C for 7 min in a Zanussi convection oven (C. Batassi, Conegliano, Italy). The slices were then turned and heated up again at 100 °C for 7 min to reach a core temperature of 74 °C.

2.3. Sensory evaluation

The sensory acceptance test was conducted using untrained assessors (n = 25–30) (Stone, Bleibaum, & Thomas, 2012a; Stone & Sidel, 2004) in the age range of 18–60. They were chosen on the basis that they consumed white pudding products regularly. The experiment was conducted in panel booths which conform to the International Standards (ISO, 1988). The sensory test was split into five sessions, whereby five reheated samples (coded and presented in a randomised order) were served to the assessors. The assessors were asked to assess, on a continuous line scale from 1 to 10 cm, the following attributes: liking of appearance, liking of flavour, liking of texture, liking of colour and overall acceptability (hedonic). Samples were presented in duplicate (Stone, Bleibaum, & Thomas, 2012b). The assessors then participated in a ranking descriptive analysis (RDA) (Richter, Almeida, Prudencio, & Benassi, 2010) using the consensus list of sensory descriptors including grain quantity, fatness, spiciness, saltiness, juiciness, toughness and off-flavour, which was also measured on a 10 cm line scale. All samples were again presented in duplicate (Stone et al., 2012b).

2.4. Fat and moisture analysis

Approximately 1.0 g of each of the homogenised vacuum packed white pudding samples was measured before and after reheating in triplicate using SMART Trac system (CEM GmbH, Kamp-Lintfort, Germany) for analysing moisture and fat, respectively (Bostian, Fish, Webb, & Arey, 1985).

Table 1
White pudding formulations.

Sample[a]	Formulation [%]								
	Meat	Fat	Salt	Water	Seasoning	Oatmeal	Onion	Boiled barley	Rusk
F 20 Na 1.0	18.44	30.77	2.54	27.00	1.00	11.00	2.50	4.35	2.40
F 20 Na 0.8	18.95	30.77	2.03	27.00	1.00	11.00	2.50	4.35	2.40
F 20 Na 0.6	19.46	30.77	1.52	27.00	1.00	11.00	2.50	4.35	2.40
F 20 Na 0.4	19.96	30.77	1.02	27.00	1.00	11.00	2.50	4.35	2.40
F20 Na 0.2	20.47	30.77	0.51	27.00	1.00	11.00	2.50	4.35	2.40
F 15 Na 1.0	26.13	23.08	2.54	27.00	1.00	11.00	2.50	4.35	2.40
F15 Na 0.8	26.64	23.08	2.03	27.00	1.00	11.00	2.50	4.35	2.40
F15 Na 0.6	27.15	23.08	1.52	27.00	1.00	11.00	2.50	4.35	2.40
F 15 Na 0.4	27.66	23.08	1.02	27.00	1.00	11.00	2.50	4.35	2.40
F 15 Na 0.2	28.17	23.08	0.51	27.00	1.00	11.00	2.50	4.35	2.40
F 10 Na 1.0	33.83	15.38	2.54	27.00	1.00	11.00	2.50	4.35	2.40
F 10 Na 0.8	34.33	15.38	2.03	27.00	1.00	11.00	2.50	4.35	2.40
F 10 Na 0.6	34.84	15.38	1.52	27.00	1.00	11.00	2.50	4.35	2.40
F10 Na 0.4	35.35	15.38	1.02	27.00	1.00	11.00	2.50	4.35	2.40
F 10 Na 0.2	35.86	15.38	0.51	27.00	1.00	11.00	2.50	4.35	2.40
F 5 Na 1.0	41.52	7.69	2.54	27.00	1.00	11.00	2.50	4.35	2.40
F 5 Na 0.8	42.03	7.69	2.03	27.00	1.00	11.00	2.50	4.35	2.40
F 5 Na 0.6	42.53	7.69	1.52	27.00	1.00	11.00	2.50	4.35	2.40
F 5 Na 0.4	43.04	7.69	1.02	27.00	1.00	11.00	2.50	4.35	2.40
F 5 Na 0.2	43.55	7.69	0.51	27.00	1.00	11.00	2.50	4.35	2.40
F2.5 Na 1.0	45.36	3.85	2.54	27.00	1.00	11.00	2.50	4.35	2.40
F 2.5 Na 0.8	45.87	3.85	2.03	27.00	1.00	11.00	2.50	4.35	2.40
F 2.5 Na 0.6	46.38	3.85	1.52	27.00	1.00	11.00	2.50	4.35	2.40
F 2.5 Na 0.4	46.89	3.85	1.02	27.00	1.00	11.00	2.50	4.35	2.40
F 2.5 Na 0.2	47.40	3.85	0.51	27.00	1.00	11.00	2.50	4.35	2.40

[a] Sample code: F = fat, Na = sodium.