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The effects of cereal additives in low-fat sausages and meatballs. Part 1: Untreated and enzyme-treated rye bran

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ABSTRACT

Rye bran was added to frankfurter-type sausages and meatballs with the aim of producing low-fat products with increased dietary fibre content. The addition of untreated rye bran to sausages was detrimental, causing a substantial increase in frying loss (20% compared to 13.2%). The addition of rye bran treated with hydrolytic enzymes reduced the frying loss to 15.2–16.4%. The firmness was also improved by the treatments (12.8–14.2 N compared to 8.8 N). Enzymatic treatment of rye bran did not however improve the water-holding capacity or the texture of sausages compared to the rye bran that had only been soaked in water. The reason could be that enzymes degraded the solubilized fraction of the dietary fibre, leaving small fragments that cannot contribute to the water-holding capacity and the texture of the sausages. The benefits of treating rye bran in water were not seen in meatballs, probably due to the more particulate structure of meatballs, which is not as sensitive to additives.

1. Introduction

There is currently a great deal of interest in new, healthy food products. A lower intake of fat, together with a higher intake of dietary fibre (DF), is one step towards a healthier diet, which may reduce the incidence of diseases such as obesity and cancer (Anderson, Smith, & Gustafson, 1994). Meat products are naturally high in fat and low in DF, and it is therefore interesting to investigate the possibility of lowering the fat content while increasing the DF content in these products (Jiménez-Colmenero, 1996).

Sausages and meatballs are two common meat products that normally contain relatively high amounts of fat. Frankfurter-type sausages are more comminuted, and have a higher salt content than meatballs, creating a strong meat protein network. This meat protein network determines the texture and sensory properties of sausages (Andersson, Andersson, & Tornberg, 1997). Meatballs, on the other hand, are a mixture of minced meat and other ingredients, leading to a more particulate structure, and the protein network does not determine the water-holding and fat-holding capacity of the product to the same degree as in sausages (Andersson, Andersson, & Tornberg, 2000; Tornberg, 2005).

There are several challenges involved in reducing the fat content of a product since fat makes a considerable contribution to the texture and taste of food. Reducing the fat content in sausages has been reported to reduce the firmness (Cofrades, Hughes, & Troy, 2000; Jiménez-Colmenero, Barreto, Mota, & Carballo, 1995) and increase cooking losses (Claus, Hunt, & Kastner, 1990; Morin, Temelli, & McMullen, 2002). Reducing the fat content in hamburgers has been reported to result in lower cooking losses, lower juiciness and increased firmness (Troutt et al., 1992). The proportion of fat can be lowered by adding water or by increasing the meat content; the latter being the more costly alternative, leading to an increase in the proportion of protein. The protein content has been shown to be more important than the fat content for the textural characteristics of sausages (Claus et al., 1990; Jiménez-Colmenero et al., 1995), and it is therefore important to maintain a constant water/protein ratio in the product when studying the influence of additives replacing fat (Bengtsson, Montelius, & Tornberg, 2011). If more water is added to the meat product it also has to be followed by an addition of an ingredient that improves the water-holding capacity (WHC). Using an additive high in DF to retain the water in the product provides an additional health aspect as not only will the fat content be decreased, but also the DF intake increased.

Rye bran is rich in DF, consisting mainly of insoluble arabinoxylans and cellulose (Andersson, Eliasson, Selenare, Kamal-Eldin, & Åman, 2003). The solubility of the DF in rye bran may be changed by treatment with hydrolytic enzymes. We have recently studied the effect of enzymatic treatment on the solubility and WHC of cereal bran (Petersson, Nordlund, Tornberg, Eliasson, & Buchert, 2013). Three of the enzymes used in that study were included in the present study to evaluate the effects of enzymatic treatment of rye bran on their suitability as additives in meat products.

Several studies have been performed, on the addition of materials rich in DF to produce low-fat meat products, for example, the addition of potato pulp and barley β-glucans to sausages (Bengtsson et al., 2011; Morin et al., 2002), and the addition of rye bran and DF from olives to meatballs (Galanakis, Tornberg, & Gekas, 2010; Yilmaz,

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2004). However, different types of low-fat meat products are not often evaluated together, and the cause of changes in important properties, such as texture, when adding DF to low-fat meat products is not yet well understood. Moreover, in most of the studies comparing different DF additives no constant water/protein ratio of the varying meat products has been considered and that can cause erroneous results (Troy, Desmond, & Buckley, 1999). In the present study, one DF source, rye bran, was used as an additive to sausages and meatballs. The rye bran was pretreated in different ways to obtain different levels of WHC and solubility. This enabled a comparison of the effects of the properties of the DF added, without having to take into account the influence of the composition of the DF source.

The aim of this study was to investigate the effects of adding untreated and treated rye bran to sausages and meatballs, concerning WHC, texture, and the acceptability of the meat products, assessed by a sensory panel. It is hoped that the findings of this study will improve our understanding of how texture and other properties are affected when adding DF to meat systems. Future studies will describe and compare the addition of rye bran, oat bran, and barley fibre to sausages and meatballs.

2. Materials and methods

2.1. Rye bran treatment

Rye bran (Lantmännen, Sweden) was used as a DF-rich additive in sausages and meatballs. Six different kinds of rye bran, one untreated (denoted RB) and 5 treated in different ways, were added to the sausage and meatball mixtures. Rye bran was ground in a mill (Retch ZM1, Germany) and passed through a 0.5 mm screen (denoted RBM). Milled rye bran was then treated with three enzyme preparations. The activities of the enzymes and the way in which they affect the physicochemical properties of the rye bran have been described previously (Petersson et al., 2013). The three enzymes used were D740, D761 (Biocatalysts Ltd, UK) and EGII (VTT, Finland), and the amounts added were based on the activities of the enzyme preparations. D740 and D761 were added to give a xylanase activity of 10,000 nkat/g bran. D740 has some endoglucanase and β-glucanase activities (11 and 126 nkat/g bran, respectively), while these are very low in D761. The amount of EGII was based on the β-glucanase activity, and was added to give an activity of 100 nkat/g bran. EGII also has some endoglucanase activity (23 nkat/g bran), but no xylanase activity. (These types of rye bran are denoted RBD740, RBD761 and RBEGII.) Rye bran (20% w/v) was subjected to water treatment at 50 °C under continuous mixing with a magnetic stirrer, with or without the addition of enzymes. The sample without any enzyme added is denoted RBW. After 4 h, beakers containing bran slurry (with or without enzymes) were placed in an ice/water bath to cool as rapidly as possible before being added to the sausage or meatball mixtures. The treatment time of 4 h was chosen based on previous studies (Petersson et al., 2013).

2.2. Reference recipes for the sausages and meatballs

Three different references were prepared for both the meatballs and sausages, in order to be able to study the effects of reduced starch and fat contents and to have a control to the samples with added fibres. The first reference samples contained normal amounts of fat and starch in these products, and are described as high fat and high starch (denoted HFHS). The second reference samples contained a low fat content and a high starch content (denoted LFHS), while the third reference samples had low levels of both fat and starch (LFLS). The various kinds of rye bran were added to the LFLS samples.

2.3. Sausage preparation

The sausages were prepared according to the recipes given in Table 1, producing 1 kg of batter. Duplicate batches of all recipes were prepared. Mixtures of low-fat pork (4.3% fat) and low- or high-fat beef (3.4 and 17.7% fat) provided by Ugglarps AB, Sweden, were used. Potato flour (containing 80.6% starch, 16% water) was obtained from Lyckeby stärkelsen (Sweden). The water/protein ratio of 7.9 was kept constant for all recipes and the salt content was 2%. The total DF content in the sausages with added rye bran was 1%. The total amount of starch added was 3.2% (low) or 6.5% (high).

The dry ingredients, including the rye bran, half meat and half water were mixed in a food processor (Braun, Germany) at high speed for 1 min. The rest of the water (as ice) and the meat were then added and mixing continued for an additional 4 min. The temperature of the meat batter was kept below 12 °C. The batter was left to rest for 30 min in a refrigerator, after which 50–60 g of batter was packed into plastic tubes with lids (Ø = 3.7 cm) under refrigerated conditions. After a total time of 2 h after batter preparation the sausages were boiled in a water bath to a centre temperature of 75 °C, which took approximately 40 min. The initial temperature of the water bath was 55 °C and was continuously increased in steps of 5 °C to a temperature at least 5 °C higher than the centre temperature of the sausages. The temperature at the centre of the sausage was measured using thin thermocouples inserted through a small hole in the plastic lid. The sausages were left to cool to room temperature before the lids were opened and water lost during cooking was poured off. The sausages were stored at 4 °C until used for texture analysis, frying loss measurements, and sensory analysis.

Table 1
Recipes for the sausages and meatballs studied (g ingredient per 100 g mixture).

Ingredient	HFHS[a]	LFHS[a]	LFLS[a]	Rye bran
Sausages				
Water/ice	41.1	43.9	46.2	45.2
Meat[b]	48.4	45.6	47.3	46.4
Spices and additives[c]	2.57	2.57	2.57	2.57
Potato flour	8.0	8.0	4.0	2.9
Rye bran	–	–	–	2.9
Meatballs				
Water	17.9	24.7	27.6	26.9
Meat[d]	51.3	44.5	46.7	46.0
Onion	11.6	11.6	11.6	11.6
Potato	9.2	9.2	9.2	9.2
Potato flour	8.7	8.7	3.6	2.8
Salt	1.3	1.3	1.3	1.3
White pepper	0.1	0.1	0.1	0.1
Rye bran	–	–	–	2.1

[a] HFHS — High Fat, High Starch, LFHS — Low Fat, High Starch, LFLS — Low Fat, Low Starch.
[b] 60% pork and 40% low- or high-fat beef.
[c] Black pepper (0.1 g), nitrite salt (0.72 g), vacuum salt (1.28 g), ascorbic acid (0.02 g), polyphosphate (0.15 g) and liquid smoke (0.3 g).
[d] Low- or high-fat beef.

2.4. Meatball preparation

The meatballs were prepared according to the recipes given in Table 1, giving 500 g of mixture. Duplicate batches of all recipes were prepared. Low- and high-fat beef were used (see Section 2.3). Potato and onion pieces (1 cm × 2 cm) were obtained from Magnihill AB (Sweden). The water/protein ratio of 7.4 was kept constant for all recipes and the salt content was 1.3%. The total DF content in the sausages with added rye bran was 1%. The total amount of starch added was 4% (low) or 8% (high).

The meat and the dry ingredients were mixed in a food processor at low speed (Braun, Germany) for 1 min. The water was added and mixing continued for an additional 2 min. The mixture was left for 30 min in a refrigerator, before forming thirty round, 15 g meatballs by hand. The meatballs were cooked in two ways. Half were deep-fat fried in sunflower oil at 160 °C until the centre of the meatballs had reached a temperature of 75 °C, which took approximately 150 s. The