SUMMARY

Obesity is a significant risk factor for lifestyle related diseases. Foods capable of suppressing hunger and decreasing energy intake could be an efficient tool in obesity prevention. Numerous randomized controlled trials report a beneficial effect of diets high in protein on appetite regulation. Also, dietary fiber has been suggested to enhance satiety. A combination of dietary fiber and protein could therefore be beneficial in the formulation of satiety enhancing foods.

Denmark is one of the world’s leading exporters of pig meat. Although pork is an important source of dietary proteins, some pork products are also characterized as high fat products containing more than 10 g fat per 100 g. In this context, the Danish meat industry puts a lot of effort into developing meat products with a healthier nutritional profile. Thus, it is relevant to provide scientific evidence of the satiating effects of new formulations of pork products. Different strategies can be applied to potentially enhance the satiating properties of pork. Processed meat products such as meatballs can serve as a matrix for the addition of fiber ingredients. Based on their high protein and fiber contents, high-fibre meatballs could provide a dual mechanistic action that would lead to greater satiety. For whole muscles, cooking is known to induce structural, physical and chemical changes of the meat proteins, which in turn may affect protein digestibility and potentially affect satiety.

The overall aim of this PhD thesis was to investigate the effects of fiber addition to meatballs and the effects of cooking methods of pork on appetite regulation. The PhD thesis is based on three human meal test studies and one analytical study related to the characteristics of fiber meat products.

In paper I, the objective was to investigate dose-response effects of rye bran and pea fiber addition to meatballs with regard to sensory quality and subjective appetite sensations. A trained sensory panel (n=9) evaluated the sensory quality of meatballs containing rye bran or pea fiber. Our results showed that rye bran and pea fiber addition affected the sensory quality of meatballs differently. The addition of rye bran primarily increased grain-related attributes, whereas pea fiber addition resulted in a more crumbly, firm and gritty texture. In the same paper, 27 healthy men completed a semi-controlled cross-over meal test study, in which appetite sensations were assessed over a period of four hours. The subjects consumed five test meals consisting of meatballs, wheat bun with butter, cucumber and a glass of water. The meatballs contained three different fiber doses: 0, 3 and 6 g dietary fiber from rye bran or pea fiber. We did not find any differences in appetite sensations...
between the meals with varying rye bran or pea fiber doses. In paper I, a semi-controlled design including free-living participants was used. Our findings indicate that the expected satiating effects of rye bran and pea fiber meatballs diminish in a more free-living setting.

The objective of paper II was to investigate whether ad libitum energy intake, appetite sensations and metabolic markers in a meal context were affected by 1) rye bran and pea fiber addition to meatballs, 2) the food matrix of fiber ingredients (fiber meatballs vs. fiber bread) or 3) the protein source (animal vs. vegetable protein patties). In a controlled cross-over design, 40 healthy men consumed four meals with similar weight, energy and macronutrient composition (13 g fiber in the three fiber meals) that consisted of meatballs/vegetable patties, bread with butter, a dipping sauce and a glass of water. Four-hour postprandial concentrations of glucose, insulin, glucagon-like peptide-1(GLP-1), peptide YY (PYY) and plasma amino acids were measured. We found that meals based on meatballs and bread with differences in fiber content, food matrix of fiber and protein source had similar effects on ad libitum energy intake. However, the addition of a combination of rye bran and pea fiber to meatballs favorably affected appetite sensations, but without changes in hormonal and metabolic responses. The satiating properties of rye bran and pea fiber meatballs were unlikely to be explained by the viscous properties of the fiber ingredients. Moreover, our results suggest that animal and vegetable protein-based, fiber-matched meals had similar effects on appetite regulation.

Paper III compared the physico-chemical, orosensory, and microstructural properties of meatballs and sausages containing either rye bran, pea fiber, or a combination of rye bran and pea fiber. Viscosity and water-holding capacity (WHC) were determined in vitro in a simulated digestion model. Fourteen subjects assessed chewing time. Microstructural characteristics were determined by CT-scanning. Sausages had a longer chewing time but lower WHC than meatballs. Results on viscosity were generally low and no differences were observed between the meat products or fiber types. Moreover, sausages contained fiber aggregates of a larger size than those found in meatballs. The observed differences could be of importance for satiety.

Finally, in paper IV, we investigated the effects of 1) cooking method (LTLT sous vide cooking at 58°C vs. oven cooking at 160°C), 2) LTLT holding time (17 hours vs. 72 min) and 3) pork structure (minced vs. roast) on ad libitum energy intake, three-hour appetite sensations and in vitro protein digestibility. In this cross-over study, 37 healthy men consumed four meals consisting of pork, rice, sauce and a glass of water. In vitro protein digestibility was determined in a simulated digestion
model mimicking gastric and duodenal conditions. Our results showed that LTLT cooking, LTLT holding time and pork structure did not affect appetite regulation. Protein aggregation of meat proteins during long time cooking and a heterogeneous temperature gradient in the meat from oven cooking may explain the lack of effects between the different cooking practices. However, we found that LTLT cooking at 58°C for 72 min enhanced protein digestibility during gastric in vitro digestion compared to LTLT cooking at 58°C for 17 hours and oven cooking.

Taken together, the present PhD thesis suggests that meatballs with rye bran and pea fiber enhance satiety, although this is limited to subjective measures of appetite. Furthermore, the satiating properties of pork muscles remained unaffected by LTLT sous vide cooking.