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Technological strategies to produce functional meat burgers

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ABSTRACT

This research was focused on the development of different strategies in order to produce beef burgers enriched with fructo-oligosaccharides (FOS), inulin and an oat bran loaded protein foam. The various formulations of functional beef burgers were optimized from a sensory point of view by means of a panel of ten trained members. Once the formulation has been optimized, the influence of the prebiotic ingredients on chemical, physical, nutritional and technological characteristics of meat burgers was assessed. From the results, it was found that combinations of both FOS and inulin, respectively combined with oat bran loaded foam are an interesting way to minimize the loss of prebiotic compounds during cooking. The concentration of fibers was found to be much higher than the minimal imposed level (3 g of dietary fiber for 100 g of food product) for prebiotic food, in all meat samples. Results also suggest that prebiotic addition to meat also improved the technological and sensory characteristics of investigated burgers.

1. Introduction

In the food guide pyramid, meat is categorized as a protein food group along with poultry, fish and eggs (USDA). Undoubtedly, meat is a major source of proteins with high biological value and an excellent source of some valuable nutrients such as minerals and vitamins (Biesalsky, 2005). Some of these nutrients (e.g., iron, vitamin B12, and folic acid) are either not present or have inferior bioavailability in other foods. Unfortunately, consumers often think of meat as highly rich of fat and red meat is seen as a cancer-promoting food. For these reasons, meat products are often avoided to reduce the risk of cancer, obesity and other diseases. Recently, it became possible to develop new meat products with potential health benefits. There are different strategies for developing healthier meat products (Jimenez-Colmenero, Carballo, & Cofrades, 2001), for example by incorporating functional ingredients. Well-documented studies acknowledge that diets enriched with dietary fiber play a significant role in the prevention of several disorders such as colon cancer, constipation, obesity and cardiovascular diseases (Rodrıguez, Jimenez, Fernandez-Bolanos, Guillen, & Heredia, 2006). Among the components of dietary fiber we can find the fructo-oligosaccharides (FOS), a general name for all non-digestible oligosaccharides composed mainly of fructose, recognized as a natural food ingredient. FOS and inulin have been extensively studied for providing the best evidence of prebiotic effects in humans (Crittenden, 1999). Inulin is heterogeneous with respect to polymer chain length and its degree of polymerization (DP) that ranges from 3 to 60, but it primarily consists of DP 20–25. Moreover, FOS has been used for processed foods (soft drinks, cereals and candies, ice creams and dietetic products) because of their low caloric value and the formation of viscous solutions that simulate fat (Rodriguez et al., 2006). They are also suitable for use in meat products as a good fat replacer and have been successfully used in meat emulsion products with positive sensory results, due to their neutral flavor and their ability to retain water during cooking, thus also determining low cooking loss (Caceres, Garcia, Toro, & Selgas, 2004). These prebiotics have been used for several meat products such as dry fermented sausages and sliced ham products (Arihara, 2004) but there are no works on the use of prebiotics in fresh meat products such as burgers, and on the influence of these components on the sensory and nutritional properties of meat. Natural sources of prebiotics also include cereals. Oat, among other cereals, has received considerable attention for its high soluble and insoluble fibers content that may promote several beneficial physiological effects. Oat fiber is a source of β-glucan and has been generally added to different meat products to counteract the problems caused by fat reduction (Inglett, Peterson, Carriere, & Maneepun, 2005; Pinero et al., 2008; Yang, Choi, Jeon, Park, & Joo, 2007), because fiber is not only desirable for its nutritional properties but also for its viscosity and then for its ability to improve rheological properties and stability. Hence, the development of new functional oat-based food products, that

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combine the beneficial effects of oat fiber with its technological properties, is a challenging issue.

Considering that the research was aimed also to understand the effect of the prebiotic addition on meat texture, all these substances were combined with whey protein, which are a by-product of cheese and casein manufacture, which contains approximately 20% of the original milk protein. Such proteins include a-lactalbumin, b-lactoglobulin, lactoferrin, lactoperoxidase, immunoglobulins, glycomacropeptide, and a variety of growth factors. Whey proteins have the ability to form a thermally induced gels when heated above 70 °C, which can positively affect meat products stability and texture. Whey proteins contain a few proline amino acids, and numerous disulphide bonds, for this reason they are surface-active globular proteins and can be absorbed at water/fat interface stabilizing the water binding and the final texture (Shie, 2004). There is no consensus among researches concerning the minimum FOS consumption that is needed to ensure prebiotic activity but according to some studies few amounts are sufficient to stimulate growth of bifidobacteria (Roberfroid & Slavin, 2000). The most important consideration that must be taken into account during the development of a functional meat product is not only the achievement of a perfect final prebiotic retention but also the maintenance of good textural and sensory properties in the final product. FOS and inulin have a neutral taste and are stable over a wide range of pH and temperature; therefore, they have great potential to be used for food applications. Even if some studies have been conducted on the use of different ingredients to low fat ground beef to improve texture and palatability (Desmond, Troy, & Buckley, 1998; El-Magoli, Laroia, & Hansen, 1996; Pszczola, 1991; Serdaroglu, 2006; Trout et al., 1992; Ulu, 2004; Ylmaz & Dağlıoğlu, 2003), a more thorough research needs to be conducted on how prebiotics should be used to functionalize ready to cook beef burgers and on the technological implications of their addiction on texture and palatability properties of beef burgers.

Hence, on the basis of the above considerations, the current study is focus on the development of technological strategies in order to produce functional beef burger loaded with FOS, inulin and oat bran loaded protein foam. To this aim, the influence of functional addition on cooking quality, nutritional and sensory properties of meat burgers has been studied.

2. Materials and methods

Beef as boneless rounds was obtained from the flank of an adult beef medium fat for slaughter in order to produce the hamburgers. Meat was purchased from the farm Cucugliato S.r.L (Vernole, Lecce, Italy) and transported to the laboratory vacuum packaged in a frozen state (−20 °C). Once arrived to the laboratory, meat has been thawed for 24 h at 2 °C and minced with a mincer (Everest, Sbarlati and C., s.n.c Rimini, Italy) equipped with a 4 mm grinding plate. The burger dough was immediately divided into seventeen equal batches (1200 Kg each), each one of them was formed by twelve burgers of 100 g respectively. The dough were immediately shaped (1.0 cm thick and 10 cm diameter) by mean of a metal shaper. Meat burgers weighed approximately 100 g each. All experimental batches were immediately subjected to each analyses including sensory evaluation. Hereinafter each experimental batch was described.

2.1. Cooking procedure

The experimental burgers were cooked according to the American Meat Science Association methodology (AMSA, 1995, pp. 1–48) in an oven (Moulinex Activys, Milano, Italy) to an internal end point temperature of 71 °C, recorded at the geometrical centre of each patty by using hypodermic probe-type thermocouple (Model HVP-2-21-V2-TO-48-OCT-M Omega, Stanford, Connecticut). The weight and diameter of meat burgers per batch were measured at room temperature before and after cooking to calculate cook loss and reduction in diameter.

2.2. Production of meat burgers with FOS and inulin

FOS (Beneo Orafti, Oreye, Belgium) and inulin (Beneo Orafti, Oreye, Belgium) were added to minced meat containing salt (1 g) and oregano (0.3 g), in the form of powder (6 g and 9 g) (FOS6-P (first batch); FOS9-P (second batch); IN6-P (third batch); IN9-P (fourth batch)) and in the form of water solution. The water solutions were obtained dissolving 6 g of FOS and Inulin powder in 15 mL of distilled water (FOS6-WS (fifth batch); IN6-WS (sixth batch)) and 9 g of FOS and Inulin powder in 22.5 mL of distilled water (FOS9-WS (seventh batch); IN9-WS (eighth batch)). Hamburgers with sole minced meat with salt and oregano were also produced as control sample (CNTR) (ninth batch). The experimental burgers were cooked as previously described.

2.3. Production of meat burgers with oat bran

The formulations with oat bran were prepared by adding to the minced meat, containing salt (1 g) and oregano (0.3 g), oat bran soaked either in water or in oil. In particular, for the first sample, 5 g of oat bran powder (Di Minno Dario and c.s.r.l., Milano, Italy) were soaked with 15 mL of distilled water (Oat-H) (tenth batch) and for the second meat sample, 5 g of oat bran powder were soaked with 8 mL of olive oil (Oat-O) (eleventh batch). Hamburgers with sole minced meat with salt and oregano were also realized as control sample (CNTR). The experimental burgers were cooked as previously described.

2.4. Production of meat burgers with the whey protein foams

The formulations realized with the addition of foams were prepared by adding to the minced meat, containing salt (1 g) and oregano (0.3 g), different kinds of protein foams: a simple whey protein foam (WPF) (twelfth batch) (Farmalabor, Canosa di Puglia, Italy) and 3 whey protein foams with different quantities of oat bran (20 g, 30 g and 40 g) (Oat20-WPF (thirteenth batch); Oat30-WPF (fourteenth batch) Oat40-WPF (fifteenth batch)). The foams were prepared according to a previous work of Conte, Mastromatteo, Cozzolino, Lecce, and Del Nobile (2011), briefly described as follows. The foams with and without the desired amount of oat bran were prepared by mixing 60 g whey protein, 4 g NaCl, 10 g Na_2CO_3 and 110 mL distilled water. This mixture was cooked at 160 °C for 40 min in the oven (Moulinex Activys, Milano, Italy). After cooking the foam was minced by a Sterilmixer (PBI International, Washington, USA), reduced to crumb, soaked with oil (7.5 mL) and added to the minced meat. Control samples based on sole minced meat with salt and oregano were also realized (CNTR). The experimental burgers were cooked as previously described.

2.5. Production of meat burgers with FOS, inulin and oat bran loaded foam

The two formulation previously described with (FOS6-WS and IN9-WS) FOS and Inulin added in the form of water solution were combined with oat bran loaded foam with 40 g of oat bran (Oat40-WPF) in order to obtain the last two experimental batches: FOS6-WS-Oat40-WPF (sixteenth batch) and IN9-WS-Oat40-WPF (seventeenth batch). The experimental burgers were cooked as previously described.