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Enhancement of the nutritional status of beef patties by adding flaxseed flour

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ABSTRACT

Flaxseed flour was used as a functional ingredient in the production of beef patties. Beef patties were produced with five different formulations; the addition of 3%, 6%, 9%, 12% and 15% flaxseed flour. Control samples were formulated with 10% and 20% fat addition. Raw and cooked beef patties were analyzed for moisture, protein, fat, ash, pH, color parameters and fatty acid profiles. Beef patties were evaluated for cooking loss and sensory properties. Fat and ash content of raw patties increased, while moisture and protein content decreased with increased flaxseed flour. The same trend (except fat content) was also observed after cooking. The addition of flaxseed flour did not affect pH values of raw and cooked beef patties. The addition of flaxseed flour improved the cooking loss but, increased the energy value (as kcal/100 g). *L* and *a* values of raw beef patties containing flaxseed flour were close to controls with 10% fat. α-linolenic acid content of raw and cooked beef patties increased as the level of flaxseed flour increased. The PUFA/SFA ratio increased from 0.04 in the control with 10% fat to 0.62 in the raw beef patties with 15% flaxseed flour. The n-6/n-3 ratio decreased from 5.76 in the control with 10% fat to 0.36 in the raw beef patties with 15% flaxseed flour. The nutritional status of beef patties was enhanced with minimal composition and sensory changes with 3% or 6% flaxseed flour addition.

1. Introduction

Meat is a major source of food proteins with high biological value. It is also an excellent source of some valuable nutrients such as minerals and vitamins. Some of these nutrients (e.g., iron, vitamin B12, and folic acid) are either not present or have inferior bioavailability in other foods (Arihara, 2006). Meat and meat products also contain elements which in certain circumstances and in inappropriate proportions have a negative effect on human health (Jimenez-Colmenero, Carballo, & Cofrades, 2001). This unfortunate situation derives mainly from the content of fat, saturated fatty acids, and cholesterol and their association with cardiovascular diseases, some types of cancer and obesity (Fernandez-Gines, Fernandez-Lopez, Sayas-Barbera, & Perez-Alvarez, 2005). To achieve healthier meat and meat products, two methods can be applied: avoiding undesired substances or reducing them to appropriate limits, and increasing the levels (naturally or by programmed addition) of other substances with beneficial properties (Arihara, 2006; Fernandez-Gines et al., 2005; Jimenez-Colmenero et al., 2001; Jo, Son, Son, & Byun, 2003). Currently, a series of ingredients such as vegetable oils (Pelser, Linssen, Legger, & Houben, 2007; Valencia, O'Grady, Ansorena, Astiasaran, & Kerry, 2008), fish oils and natural extracts with antioxidant properties (Valencia et al., 2008), vegetable products (Serdaroglu & Degirmencioglu, 2004; Turhan, Temiz, & Sagir, 2007) and fiber (Jo et al., 2003; Mansour & Khalil, 1997; Turhan, Sagir, & Ustun, 2005) are added to raw or cooked meat products to improve functional properties.

Flaxseed has recently gained attention as a "functional food" because of its unique nutrient profile and potential to affect the risk and course of cardiovascular disease and some cancers, particularly hormone-dependent cancers such as prostate and breast. The main components of flaxseed, expressed on a moisture-free basis, are protein (21%), dietary fiber (28%), and fat (41%). Flaxseed has a unique fatty acid profile. It is high in polyunsaturated fatty acids (73% of total fatty acids), moderate in monounsaturated fatty acids (18%), and low in saturated fatty acids (9%). Linoleic acid, an omega-6 fatty acid, constitutes about 16% of total fatty acids, whereas α-linolenic acid constitutes about 57%, the highest of any seed oil (Ramcharitar, Badrie, Mattfeldt-Beman, Matsuo, & Ridley, 2005). There is more information on the use of flaxseed in bakery products (Conforti & Davis, 2006; Koca & Anil, 2007; Ramcharitar et al., 2005; Shearer & Davies, 2005) and flaxseed oil has also been used in bakery (Shearer & Davies, 2005) and meat products (Pelser et al., 2007; Valencia et al., 2008). Pelser et al. (2007) studied the effect of addition of flaxseed oil, canola oil, encapsulated fish oil and encapsulated flaxseed oil in Dutch style fermented sausages and suggested it is possible to replace part of the animal backfat by health promoting oils giving fermented sausages a "healthy" image. According to Valencia et al. (2008) linseed

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oil can be used successfully as enhancer in the manufacture of healthier functional meat products. To the best of our knowledge, there are no reports on the use of flaxseed flour as a functional ingredient in beef patties.

The objective of the present study is to investigate the effect of the addition of flaxseed flour to raw and cooked beef patties on proximate composition, energy value, pH, cooking loss, color, fatty acid composition and sensory properties.

2. Materials and methods

2.1. Materials

Ground beef (moisture 69.20%, fat 6.78%), beef fat (moisture 7.45%, fat 88.54%) and flaxseed (moisture 6.97%, fat 37.13%) were used as raw materials. Ground beef and beef fat were purchased from a butchers shop. Flaxseed was purchased from a local market and used in the form of flour after being ground with a mill (IKA A 11, Germany). The fatty acid composition (g/100 g fatty acids) of beef fat and flaxseed flour was determined by gas chromatography (see Section 2.6). Beef fat contained C10:0 (0.18), C12:0 (0.15), C14:0 (2.75), C14:1 (0.30), C15:0 (0.50), C15:1 (0.30), C16:0 (24.12), C16:1 (1.60), C17:0 (1.25), C18:0 (22.96), C18:1n-9 (33.09), C18:2n-6t (0.42), C18:2n-6c (1.56), C18:3n-6 (0.22), C18:3n-3 (0.26), C20:0 (0.20), C20:1n-9 (0.16) and C20:3n-3 (0.07). Flaxseed flour contained C12:0 (0.03), C14:0 (0.03), C16:0 (5.46), C16:1 (0.06), C18:0 (4.71), C18:1n-9 (17.54), C18:2n-6 (14.49), C18:3n-3 (54.88), C18:3n-6 (0.19), C20:0 (0.13) and C20:1n-9 (0.13). All chemicals used were of analytical grade.

2.2. Preparation of beef patties

Ground beef was divided into 7 batches. The first and second batches were used as controls and adjusted to fat contents of 10% and 20% by the addition of beef fat. The other batches were adjusted to a fat content of 10% by the addition of beef fat and supplemented with different levels of flaxseed (3% flaxseed for 3rd batch; 6% flaxseed for 4th batch; 9% flaxseed for 5th batch; 12% flaxseed for 6th batch; 15% flaxseed for 7th batch). In addition, 1.5% salt and 1% garlic were added to each batch. Batches of 1 kg of each formulation were mixed by hand for 5 min, weighed into 40 g portions, and shaped by hand. Analyses of the beef patties were started on the day of production and were stored at 4 ± 1 °C throughout.

2.3. Proximate composition, energy value, pH and cooking loss

Moisture, protein *(N x 6.25)*, fat, ash and salt contents were determined according to AOAC (1990) procedure. Carbohydrate contents were calculated by difference. Total energy estimates (kcal) for raw and cooked beef patties were calculated on the basis of a 100 g sample using Atwater values for fat (9 kcal g^{-1}), protein (4.02 kcal g^{-1}) and carbohydrate (3.87 kcal g^{-1}) (Mansour & Khalil, 1997).

pH values of raw and cooked beef patties were measured using a digital pH-meter (Cyberscan PC 510, Singapore) equipped with a combination pH electrode (Sensorex, S175CD Spear Tip, USA) calibrated in buffers at pH 4.01 and 7.00 (Mettler Toledo, USA) at 25 °C. The average of six measurements was used.

The beef patties were cooked in a preheated electrical grill (Arcelik Midi Firin, Turkey) for a total of 10 min, 6 min one side and 4 min the other side. The weight of six beef patties per batch was measured at room temperature, before and after cooking to calculate cooking loss.

2.4. Color

The color of raw beef patties was measured using the Hunter Lab system with a colorimeter (Minolta CR 300), calibrated with a white tile (Minolta calibration plate, No. 21733001, $Y = 92.6$, $x = 0.3136$, $y = 0.3196$) at 2° observation angle with a C illuminant. Four beef patties per batch were randomly selected and three readings were taken from each patty. Hunter L (lightness; 100 = white, 0 = black), a (redness; +, red; −, green), b (yellowness; +, yellow; −, blue) values were recorded.

2.5. Fatty acid composition

Total lipids were extracted by the method of Bligh and Dyer (1959). Fatty acid composition was determined after methylation (ISO, 1978) using a Shimadzu (Model GC-2010, Shimadzu Corporation, Kyoto, Japan) gas chromatograph with a DB-23 column (60 m × 0.25 mm ID, 0.25 μm) (J & W Scientific, Folsom, CA, USA). The temperature of the injector port and detector was held at 270 °C and 280 °C, respectively. The injected volume was 1.0 μl. The carrier gas was helium at a pressure of 150 kPa. The split used was 1:100. The temperature of the column was held at 130 °C for 2 min, raised to 170 °C at 6.5 °C/min and to 215 °C at 2.75 °C/min, held at 215 °C for 6 min, raised again to 240 °C at 40 °C/min and finally held at 240 °C for 10 min. Fatty acids were identified by comparison of their retention times with those of authentic standards (Supelco 37 Components FAME Mixture, Cat. No. 18919-1AMP, Bellefonte PA, USA) and reported as the percentage of total fatty acids determined.

2.6. Sensory evaluation

Beef patties were cooked as previously described and served warm to a trained consumer panel of 8–10 volunteers from the Department of Food Engineering at Ondokuz Mayis University in Turkey. Each sample was coded with randomly selected 3-digit numbers. The sensory evaluations were performed by the panelists under fluorescence lighting. Panelists were instructed to cleanse their palates between samples using water. Each treatment from each replication was evaluated in one separate session given a total of three sessions. Appearance evaluation was performed only on raw samples, while flavor, tenderness and juiciness were done on cooked samples. The appearance, flavor, tenderness and juiciness of the beef patties were scored using an 8 point Hedonic scale, where 1 represented dislike extremely and 8 represented like extremely. Each attribute was discussed and tests were initiated after the panelists were familiarized with the scales. The overall acceptability was calculated taking into account appearance, flavor, tenderness, and juiciness (each with 25%).

2.7. Statistical analysis

The data obtained from three replications were analyzed by ANOVA using the SPSS statistical package program, and differences among the means were compared using Duncan's Multiple Range test (SPSS, 1999). A significance level of 0.05 was chosen.

3. Results and discussion

3.1. Proximate composition, energy value, pH and cooking loss

The proximate composition, energy value, pH and cooking loss of beef patties formulated with different levels of flaxseed flour are given in Table 1. As can be seen, the moisture content of the control with 10% fat was 65.45% which was higher ($P < 0.05$) than