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Influence of canola-olive oils, rice bran and walnut on functionality and emulsion stability of frankfurters

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ABSTRACT

Fat content of frankfurters (20 g/100 g) was replaced with canola and canola-olive oils. Rice bran (RB) and walnut (WE) were added (2.5 g/100 g) to emulsions as macronutrients. Changes in energy values, color, emulsion stability and lipid oxidation of frankfurters during storage were investigated. ANOVA model was highly significant for color parameters and energy values ($P < 0.001$). The canola-olive oil replacement led to a high capacity to hold water and fat exudates in frankfurters, reporting higher emulsion stabilization parameters than regular frankfurters. The addition of RB led to an increase of cooking and fat exudates, indicating high emulsion instability possible due to interactions between RB fiber and fat-protein binders. Walnut addition reported low cooking loss values, and a significant capacity for emulsion stabilization in comparison with regular and RB frankfurters. Lipid oxidation increased from days 0–7 in all frankfurters, declining afterwards until end of storage. TBARS was not influenced by type of emulsions control, but significant ($P < 0.05$) differences were observed in vegetable oil emulsions made with RB; as well as between RB and WE added to either vegetable oil emulsions. These results suggest the use of these natural ingredients as valuable promoters of healthy meat products.

1. Introduction

The consumer demand for healthier foods has led to the development of unsaturated fat replacements and antioxidant enriched emulsion-type meats in recent years. Some frequent diseases in developed societies such as obesity or cardiovascular disease have been associated with an excessive consumption of animal products that are high in saturated fats (O'Neil, 1993). Regrettably, consumers often associate meat with a negative image that meat contains high fat and red meat, in particular, is regarded as cancer-promoting (Ruusunen & Puolanne, 2005). This growing interest for health has led food industries worldwide to make big efforts in the development of novel products with improved functional properties, nutritional value, and product stability. Vegetable oils play an important role during emulsification process, favoring tenderness of meat products (Marquez, Ahmed, West, & Johnson, 1989). Their inclusion as fat substitutes has been related with an important increase of unsaturated fatty acids, and decreasing low density cholesterol. In addition, canola oil helps to increase the level of omega-3 fatty acids of platelet phospholipids, essential for preventing coronary heart disease (Chan et al., 1993), and is a relatively rich source of α-tocopherol (Eskin et al., 1996). Olive oil added to meat products is a good source of linoleic and linolenic acids that helps to increase the nutritional value and reduce the lipid oxidation (Ansorena & Astiasarán, 2004). Moreover, low-fat frankfurters made with vegetable oils are a valuable option for reducing saturated fatty acids, calories, and cholesterol in comparison to regular frankfurters made with pork fat (Paneras & Bloukas, 1994). However, the incorporation of vegetable oils in meat products can play an important role in the deterioration of meat quality through lipid oxidation, especially in the presence of oxygen during mechanical processing such as grinding or chopping, cooking treatments, and addition of salt during the processing procedures (Ahn, Ajuyah, Wolfe, & Sim, 1993). The oxidation of unsaturated lipids leads to rancid odors and flavors, which decreases the quality of meat and meat products. Numerous studies have been carried out on different aspects of lipid oxidation in meat products to improve their oxidative stability. Recently, scientists are utilizing antioxidants to enhance the oxidative stability and thus extend the shelf life of meat products (Lund, Hviid, & Skibsted, 2007). The addition of dietary fiber in meat products is desirable for their nutritional properties but also for their technological improvement and functional properties related with the benefits for

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Table 1
Quantities of ingredients (g) used in the formulation of meat emulsions.

Emulsion	Meat	Backfat	C	O	RB	WE	Salt	Spice	SE	STP	SN	I + W
B	2500	800	–	–	–	–	60	24	2	12	2	600
B + RB	2400	800	–	–	100	–	60	24	2	12	2	600
B + WE	2400	800	–	–	–	100	60	24	2	12	2	600
C	2500	–	800	–	–	–	60	24	2	12	2	600
C + RB	2400	–	800	–	100	–	60	24	2	12	2	600
C + WE	2400	–	800	–	–	100	60	24	2	12	2	600
CO	2500	–	600	200	–	–	60	24	2	12	2	600
CO + RB	2400	–	600	200	100	–	60	24	2	12	2	600
CO + WE	2400	–	600	200	–	100	60	24	2	12	2	600

C, canola oil; O, olive oil; RB, rice bran; WE, walnut paste; B, overall control made with 20 g/100 g backfat; B + RB (20 g/100 g backfat + 2.5 g/100 g RB), B + WE (20 g/100 g backfat + 2.5 g/100 g WE); C, overall control made with 20 g/100 g canola oil; C + RB (20 g/100 g canola + 2.5 g/100 g RB), C + WE (20 g/100 g canola + 2.5 g/100 g WE); CO, overall control made with 15 g/100 g canola and 5 g/100 g olive oils; CO + RB (15 g/100 g canola, 5 g/100 g olive oil + 2.5 g/100 g RB), CO + WE (15 g/100 g canola, 5 g/100 g olive oil + 2.5 g/100 g WE); SE, sodium erythorbate; STP, sodium tripolyphosphate; SN, sodium nitrite; I + W, ice and water (8:7).

human health (National Cancer Institute, 1984). Rice bran is rich in dietary fiber, proteins, minerals, and vitamin B components, and has been frequently used in prepared foods as a potential dietary fiber source (Lee & Moon, 1994), as well as fat substitute in low-fat meat products (Hsu & Chung, 2001). Rice bran proteins have a high water and oil binding capacities and show a good potential for producing stable emulsions under high sugar and salt concentrations (Chandi & Sogi, 2007). Several studies have reported that regular consumption of walnuts is related to the prevention of coronary heart disease (FDA, 2004). Walnut is rich in unsaturated fatty acids than typical vegetable oils. The addition of walnut extracts leads to an improvement in the nutritional profile of frankfurters, in comparison to commercial sausages made with animal fats, and contains several bioactive components that improve the sensory and physicochemical properties (Jiménez-Colmenero, Ayo, & Carballo, 2005).

In this study, fat content of frankfurter-type sausages was substituted with canola or canola-olive oil mixes (20 g/100 g), and 2.5 g/100 g of extracts (rice bran and walnut paste) were added to the sausages as macronutrients. The aim of this study was to investigate the changes in calorie and meat emulsion quality metrics (i.e. color, cooking loss and oxidative stability) of the sausages after substituting fat by vegetable oils and after adding rice bran and walnut paste in the formulation.

2. Materials and methods

2.1. Ingredients

Commercial fresh pork meat and pork backfat were obtained from a local meat purveyor (Smithfield Packing Company Inc., Grayson, KY, USA). Excess fat and connective tissue were trimmed from pork meat. Pork meat and backfat were separately ground twice through 25.4–9.6 mm (meat) and 9.6–3.2 mm (fat) orifice plates with a meat grinder (Model 4146SS; Hobart Corp., Troy, OH, USA), weighted (Metler Toledo, mod. 8140, Worthington, OH, USA), vacuum packed (Sipromac, Mod 600A, St. Germain, Canada) into individual plastic bags, and frozen at −18 °C until product formulation. All the experiments were carried out within two months. Canola and olive oils (Pompeian, Inc., Baltimore, MD, USA), rice bran, (Ener-G Foods, Inc. Seattle, WA. USA) and walnuts were obtained from a local purveyor (Kroger Co., Cincinnati, OH, USA). Walnuts were processed according to method described by Ayo, Carballo, Solas, and Jiménez-Colmenero (2008), including small modifications. Walnut halves were ground in a lab grinder (KitchenAid, Mod. KFP710, St.Joseph, Michigan USA) at 1750 rpm for approximately 1.5 min, until obtain a finely comminuted paste composed by small particles of reduced size. After grinding, the paste was heated at 80 °C for 1 h in an oven (Barnsteadt Thermolyne, model OV19225, Iowa, USA) in order to obtain a refined extract. The paste was then left at room temperature for 15 min, before weigh into plastic bags, which were vacuum sealed and stored at room temperature until use. The rest of the ingredients used during emulsion manufacturing were salt (Sysco Corp. Houston, TX, USA), spice mix blend 125, erythorbic acid (Old Plantation Seasoning, Birmingham AL, USA), sodium tripolyphosphate, (Sigma Chemical, CO. St. Louis, MO, USA) and sodium nitrite (Fisher Scientific. Fair Lawn, NJ, U.S.A.). All the ingredients of the emulsion composition were kept constant in each batch and replicate (2.5 g/100 g).

2.2. Preparation of frankfurters

Three different frankfurter formulations were prepared in a cooler room (6–8 °C) to obtain 4 kg batter (Table 1), containing 20 g/100 g backfat, 20 g/100 g canola oil, and 20 g/100 g canola-olive oils (3:1). The proximate composition (AOAC, 1996) of the trimmed pork meat was; moisture 72.9 g/100 g, fat 5.1 g/100 g, protein 21.1 g/100g and ash 0.9 g/100 g. Rice bran (RB) and walnut paste (WE) were added separately to these emulsions at an addition rate of 2.5 g/100g. Composition of RB and WE are given in Table 2. Overall control emulsions without RB and WE were also prepared in order to obtain a total of nine treatments (3 × 3 factorial design) by replicate (× 2). Before emulsion preparation, frozen meat and backfat were thawed overnight in a refrigerator at 4 °C. Partially thawed pork meat was placed in a silent cutter (Model CM-14, Mainca USA, St. Louis, MO, USA) and homogenized for 1 min. The total amount of ingredients (salt −1.5 g/100 g-, spice mix −0.6 g100/g-, erythorbic acid −0.05 g/100 g-, sodium tripolyphosphate −0.3 g/100 g-, and sodium nitrite −0.05 g/100 g-) were dissolved in water (7 g/100 ml), and kept in refrigeration (4–6 °C) before being added to the homogenized meat. This mixture was then chopped for another 2 min. Partially thawed pork fat or fat replacements (canola −20 g/100 g- or canola oil + olive oil (3:1)), ice (8 g/100 g) and rice bran (2.5 g/100 g) or walnut paste (2.5 g/100 g) were then added and the mixture was chopped for another 3 min. Total mixing time was standardized to 6 min and the final temperature of the meat emulsion was below 12 °C in all cases. The chopping speed of blades and plates were adjusted to minimal and high revolutions for the first min of chopping and the rest of the chopping procedure, respectively. The final pH of the emulsion was measured with a pHtester Oakton® (Mod. Spear, Eutech Instruments,

Table 2
Nutritional composition of rice bran and walnut paste.

	Rice bran (RB)	Walnut paste (WE)
Dietary fiber (g/100g)	28.4	6.7
Carbohydrates (g/100g)	50.7	13.4
Total fat (g/100g)	20.9	66.7
Protein (g/100g)	10.0	16.7
Energy (kcal/100g)	328.4	666.7