Potential of Rice Bran Wax and Soybean Oil Oleogels as Pork Fat Replacements in Frankfurter-type Sausages

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Summary and Implications

This study demonstrated the technological potential of rice bran wax/soybean oil oleogels as animal fat replacers in frankfurter-type sausages while maintaining acceptable product sensory properties. These results complement those of recent studies that utilized ethylcellulose/canola oil oleogels as partial fat replacements in beef frankfurters and breakfast sausage. In addition, the evaluation of rice bran wax as a lower-cost and faster-melting gelator contributes useful practical knowledge to the application of this novel technology in processed meats.

Introduction

Animal fat is essential in many sausage products due to its organoleptic contributions. However, its high saturated fat content and atherogenic potential has led to some consumer wariness of these products. As a result, attempts have been made to replace animal fat with liquid oils of vegetable origin in comminuted meat products. This strategy, however, may result in products with increased hardness and chewiness, as well as lighter and less red color. It is obvious, then, that maintenance of the product's organoleptic attributes necessitates replacement of animal fat with a material of similar rheological properties and functional behavior. One approach, oil hydrogenation, can unfortunately result in saturation and cis-trans isomerization of unsaturated fatty acids, which negate any potential health benefits of the oil. The new technology of oleogelation, the structuring of liquid oils into gels that possess solid-like rheological properties without the need for hydrogenation, has emerged as a potential new approach to accomplish this. Manufacturing of an oleogel involves melting a gelling material (gelator) into liquid oil, followed by cooling to form a three-dimensional gel network. This study's objective was to evaluate the effects of oleogels made of soybean oil (SBO) and two levels (2.5%, 10%) of rice bran wax (RBW) as gelator on the physicochemical and organoleptic attributes of frankfurter-type comminuted sausages, when used as full-fat replacements.

Materials and Methods

Frankfurters (21% target lipid) were made with pork knuckles (r. femoris, v. intermidius, v. lateralis, v. medialis) that were trimmed of visible fat to provide the source of lean meat (this enabled pork fat replacement of approx. 94.6%). Treatments utilized one of five lipid sources: 1) pork back fat (PF), 2) soybean oil (SBO); 3) 2.5% RBW/SBO oleogel, 4) 10% RBW/SBO oleogel, and 5) 2.5% RBW/SBO added later in the comminution step to reduce shear. Other ingredients were water/ice (21.99%), salt (1.80%), dextrose (0.76%), sodium tripolyphosphate (0.38%), sodium erythorbate (0.04%), sodium nitrite (0.01125%) and seasonings (1.73%). In a bowl chopper, knuckles and non-lipid ingredients were comminuted under vacuum to 4.4°C (10°C in treatment 5), lipid source added, and vacuum comminution continued to 13°C. At this point, batter samples were collected for emulsion stability analysis. Batters were stuffed into 25-mm cellulose casings and cooked to 72°C. Samples were chilled for 18 h at -1.1°C, vacuum-packaged and stored at 1.1°C for 98 d. Instrumental texture (texture profile analysis [TPA]; incisor puncture probe), internal and external color (CIE L*a*b*; illuminant D65, 2.54-cm aperture, 10° observer angle) and lipid oxidation (thiobarbituric acid-reactive substances), were analyzed on days 0, 14, 28, 42, 56, 70, 84, and 98. Sensory evaluation by a trained panel was conducted on days 42, 56, 70 and 84. Microstructure was analyzed by light microscopy and image data analyzed by AxioVision Microscopy LE software. The study was replicated three times and data were analyzed using SAS PROC MIXED (v 9.4, SAS Institute, Cary, NC, USA) with treatment, replication, time, and treatment x time as fixed effects, and replication x treatment as random effect.

Results and Discussion

Raw batter emulsion stability and cook/chill yields were unaffected by treatment ($P < 0.05$) (Table 1). Instrumental color was redder for PF than for all other treatments and darker than all except 2.5 RBW/SBO LS. PF had darker external color, and darker and pinker internal color by sensory analysis than all ($P <0.05$) except 2.5% RBW/SBO LS. In terms of texture (Table 2), PF offered less resistance to puncture by incisor probe than all other treatments except 2.5% RBW/SBO low-shear, and lower incisor force area than all treatments ($P < 0.05$). TPA showed 10RBW and PF to be firmer than SBO ($P < 0.05$); however, according to the sensory panel (Fig. 1), PF was less firm than all other treatments, which did not differ among each other (P < 0.05) (Table 2). This discrepancy between instrumental and sensory texture can most likely be attributed to differences in test temperatures (ambient vs. warm, respectively). Sensory "cured frankfurter aroma" did not differ among treatments, but PF had a stronger "frankfurter flavor" than all others (P < 0.05). TBARS values for all treatments were < 0.20 and remained constant throughout the entire study, indicating there is enough antioxidative capacity in the system to keep lipid oxidation under control. The TBARS was slightly higher in 10% RBW/SBO than in all other treatments at every sampling time point (P < 0.05), which was likely due to the longer heating time required to dissolve the higher amount of RBW in the SBO, and no oxidation-related off-flavors were reported by the sensory panelists. Microstructural analysis showed that PF had larger average fat globule size than all other treatments (P < 0.05). PF and 10% RBW/SBO both had a significantly greater (P < 0.05) proportion of fat globules larger than 100 μm^2 when compared to all other treatments, indicating that a stronger oleogel may be necessary in order to more closely resemble pork fat after frankfurter processing

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Table 1. Means for proximate composition (%), emulsion stability (%), total (cook/chill) yield (%), and internal color as affected by lipid source.

Lipid type	Moisture	Lipid	Protein	Emulsion Stability	Total Yield	Internal color L*	Internal color a*	Internal color b*
PF	60.25^{a}	21.27^{a}	14.05^{c}	98.51^{a}	87.9^{a}	74.38^{a}	7.81^{b}	13.27^{ab}
SBO	59.35^{a}	20.65^{a}	14.63^{a}	98.38^{a}	86.6^{a}	78.73^{a}	6.51^{a}	12.95^{a}
2.5 RBW	59.48^{a}	20.69^{a}	14.54^{ab}	98.92^{a}	88.7^{a}	79.84^{b}	6.08^{a}	13.00^{a}
10 RBW	59.68^{a}	20.48^{a}	14.27^{bc}	98.76^{a}	88.2^{a}	78.86^{b}	6.24^{a}	13.31^{ab}
RBW/LS	59.64^{a}	19.86^{a}	14.32^{bc}	99.08^{a}	88.1a	77.39^{ab}	6.73^{a}	13.45^{b}
SEM	0.58	3.09	0.03	0.42	1.6	0.08	0.20	0.08

$^{a-c}$ Different superscripts within columns indicate significant differences ($P < 0.05$)

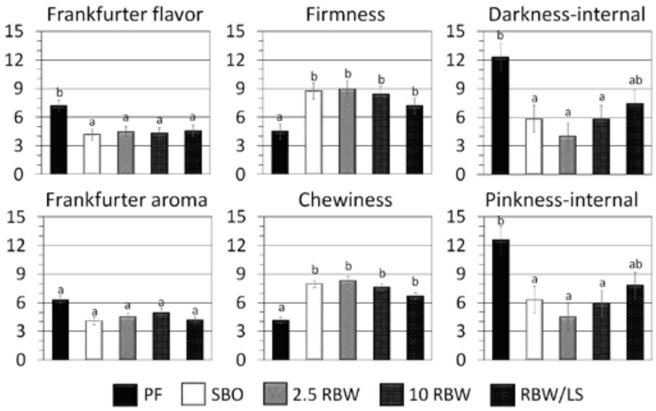

Figure 1. Sensory characteristics (scored on 15-cm line scale) of frankfurters as affected by lipid type. Treatments with different letters differ significantly (P < 0.05). Error bars = SEM.

Table 2. Means for effect of lipid type on TPA parameters of frankfurters.

Lipid type	Firmness (g)	Resilience (%)	Cohesiveness (%)	Chewiness	Springiness (%)
PF	7099^{e}	39.73^{e}	72.79^{bc}	4908^{ab}	94.94^{ab}
SBO	6330^{a}	39.07^{d}	74.08^{c}	4510^{a}	96.08^{c}
2.5 RBW	6893^{ab}	38.22^{c}	73.00^{bc}	4789^{ab}	95.20^{b}
10 RBW	7650^{c}	35.56^{a}	70.42^{a}	5076^{b}	94.16^{a}
RBW/LS	6617^{ab}	37.37^{b}	72.46^{b}	4541^{a}	94.73^{ab}
SEM	147	0.13	0.27	109	0.17

$^{a-c}$ Different superscripts within columns indicate significant differences ($P < 0.05$)