POTENTIAL OF RICE BRAN WAX AND SOYBEAN OIL OLEOGELS AS PORK FAT REPLACEMENTS IN FRANKFURTER-TYPE SAUSAGES

Taylor L. Wolfer[1], Nuria C. Acevedo[2], Kenneth J. Prusa[1,2], Joseph G. Sebranek[1,2] and Rodrigo Tarté[1*]

[1]Department of Animal Science, [2]Department of Food Science and Human Nutrition, Iowa State University, Ames, Iowa, United States

*Corresponding author email: rtarte@iastate.edu

Abstract – The potential of oleogels made with rice bran wax (RBW; 2.5%, 10%) and soybean oil (SBO) to replace most of the pork fat (PF) in comminuted frankfurter-type sausages was investigated. Replacement of PF resulted in a less redness and darkness. PF- and 10% RBW/SBO oleogel-containing frankfurters were firmer than all others, although PF frankfurters were softer than all oil-containing treatments when evaluated warm by a sensory panel. Sensory "cured frankfurter aroma" did not differ among treatments, but PF had stronger "frankfurter flavor." Lipid oxidation was low in all samples (TBARS < 0.2) throughout the 98-day duration of the study. RBW/SBO oleogels exhibit good potential as partial or total fat replacements in these types of products.

Key Words – Fat replacement, frankfurter, oleogel, rice bran wax

I. 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 [1, 2], as well as lighter and less red color [1, 3]. It is obvious, then, that maintenance of the product's organoleptic attributes necessitates replacement of animal fat with a material of similar rheological properties. One approach could be through oil hydrogenation but, unfortunately, this can result in saturation and potential *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.

II. 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 consisted of 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 [4]. Batters were stuffed into 25-mm cellulose casings and cooked according to a stepwise protocol 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*) 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 the random effect.

III. RESULTS AND DISCUSSION

Raw batter emulsion stability and cook/chill yields were unaffected by treatment ($P < 0.05$). 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, 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, PF was less firm than all other treatments, which did not differ among each other ($P < 0.05$). 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.

IV. CONCLUSION

This study demonstrated the technological potential of RBW/SBO oleogels to replace all of the animal fat in frankfurter-type sausages while maintaining acceptable product organoleptic properties, despite some measurable organoleptic differences. These results complement those of recent studies that utilized ethylcellulose/canola oil oleogels as partial fat replacements in beef frankfurters [5] and breakfast sausage [6]. In addition, the evaluation of RBW as a lower-cost and faster-melting gelator contributes useful practical knowledge to the application of this novel technology in processed meats. Future research should focus on optimizing this technology by examining the behavior of other types of oleogels under different comminution conditions, and on evaluating its potential for fat replacement in other processed meat applications.

ACKNOWLEDGEMENTS

The authors thank Christine A. Fedler, McKenna J. Powell, and Elaine M. Larson for their technical support.

REFERENCES

1. Youssef, M. K. & Barbut, S. (2010). Physicochemical effects of the lipid phase and protein level on meat emulsion stability, texture, and microstructure. Journal of Food Science 75(2): S108–S114.
2. Zetzl, A. K., Marangoni, A. G., & Barbut, S. (2012). Mechanical properties of ethylcellulose oleogels and their potential for saturated fat reduction in frankfurters. Food & Function 3: 327–337.
3. Álvarez, D., Delles, R. M., Xiong, Y. L., Castillo, M., Payne, F. A. & Laencina, J. (2011). Influence of canola-olive oils, rice bran and walnut on functionality and emulsion stability of frankfurters. LWT-Food Science and Technology, 44(6), 1435–1442.
4. Rongey, E. H. (1965). A simple objective test for sausage emulsion quality. In Proceedings Meat Industry Research Conference (pp. 99-106), 25–26 March 1965, Chicago, IL, USA.
5. Barbut, S., Wood, J., & Marangoni, A. (2016). Potential use of organogels to replace animal fat in comminuted meat products. Meat Science 122: 155–162.
6. Barbut, S., Wood, J., & Marangoni, A. (2016). Quality effects of using organogels in breakfast sausage. Meat Science 122: 84–89