

INFLUENCE OF PLANT OILS ON CERTAIN PHYSICO-CHEMICAL CHARACTERISTICS OF FRANKFURTERS

Daniela BELICHOVSKA^{1*}, Zlatko PEJKOVSKI², Katerina BELICHOVSKA², Aleksandra SILOVSKA-NIKOLOVA³

¹Department of Food Safety, Faculty of Environmental Resources Management, MIT University, Skopje, Republic of Macedonia

²Institute of Animal Biotechnology, Faculty of Agricultural Sciences and Food, Ss. Cyril and Methodius University, Skopje, Republic of Macedonia

³Department of Quality Control, Rimes MS Group, Skopje, Republic of Macedonia

*Corresponding author: daniela.belichovska@gmail.com

Abstract

With the aim the effect of pork adipose tissue substitution with plant oils and fats in poultry frankfurters production to be investigated, six variants of frankfurters were produced: control – with pork fat, with olive oil, rapeseed oil, sunflower oil, palm fat and a mixture of 12% rapeseed oil and 8% palm fat. Cooking loss, pH-value and basic chemical composition were tested on the final product. It was found that palm and pork fat, as well as sunflower oil significantly ($P < 0.01$) influenced the reduction of cooking loss of frankfurters. Frankfurters with palm fat, a mixture of 12% rapeseed oil and 8% palm fat and those with rapeseed oil had a lower pH than the other three variants ($P < 0.01$). Regarding the content of water and ash there were no significant differences, while in the content of protein there was significant difference ($P < 0.01$) only between variants with pork fat and sunflower oil. Frankfurters with olive oil and those with pork fat had significantly ($P < 0.01$) higher fat content than all the other variants. Frankfurters with palm fat contained significantly ($P < 0.01$) lower fat percentage compared to other variants, except that with a mixture of 12% rapeseed oil and 8% palm fat. Total pork fat replacement with plant oils and fats in poultry frankfurters production is possible.

Keywords: *frankfurters, plant oils, cooking loss, pH, chemical composition*

Introduction

Fats play an important role in meat products. Historically, meat rich in fats was used mainly for the production of sausages which increased the value of used meat (Bishop *et al.*, 1993). However, diets rich in animal fats is associated with obesity, hypertension, cardiovascular and coronary heart disease (Özvural and Vural, 2008; Vural and Javidipour, 2002). The recommended dietary intake of fat should be no more than 20 to 35 % of total caloric intake (National Academy of Science, 2011). As a result of this, the popularity of meat products with high content of animal fat is reduced (Vural and Javidipour, 2002). Consumers are becoming increasingly aware of the nutritional quality and health effects of the food they consume. Lipid composition, particularly of the products from animal origin, has become the primary area of interest to consumers. This is due to the increased awareness regarding the link between the quantity and composition of fats in the human diet and increased coronary heart disease as well as certain forms of cancer (Arihara, 2006; Pike, 1999).

One approach to develop healthier meat products is through reformulation of meat products during processing (Jiménez-Colemenero, 2007). Modification of the fats is mainly based on the replacement of animal fat with oils that meet dietary recommendations (Fernández-Ginéset *al.*, 2005). Vegetable oils are free of cholesterol and have a high content of

unsaturated fatty acids. Thus, vegetable oils have positive effects for the cardiovascular system (Özvural and Vural, 2008).

Frankfurters are non-fermented, emulsion type sausages (Gonzalez-Vinaset *et al.*, 2004). They are very popular, frequently-consumed meat products with significant economic importance worldwide (Jiménez-Colmenero *et al.*, 2010). However, their consumption has negative health effects regarding the amounts and types of animal fats that they contain (Bloukas and Paneras, 1993).

This was an occasion to perform replacement of pork fat with several plant oils in chicken frankfurters and to examine their influence on certain physico-chemical characteristics of the product.

Material and Methods

Frankfurters made from chicken (boneless breast and thigh) were used in the present research. As an alternative to pork fat plant oils were used as: olive, rapeseed and sunflower oil, as well as palm fat. Six different frankfurters were produced which compositions are given in Table 1. The control frankfurters were prepared with pork backfat (Po). The other five treatments were prepared with olive oil (O); rapeseed oil (R); sunflower oil (S); palm fat (Pa), and a mixture of 12 % rapeseed oil and 8 % palm fat (Mi).

Table 1. Frankfurter formulation (%)

Ingredients	Treatments					
	Po	O	R	S	Pa	Mi
Chicken breasts without skin	23	23	23	23	23	23
Chicken thighs without skin	23	23	23	23	23	23
Pork backfat	20					
Olive oil		20				
Rapeseed oil			20			12
Sunflower oil				20		
Palm fat					20	8
Nitrite curing salt	1.7	1.7	1.7	1.7	1.7	1.7
Ice	32	32	32	32	32	32
Sodium tripolyphosphate	0.2	0.2	0.2	0.2	0.2	0.2
Mixture of spices	0.2	0.2	0.2	0.2	0.2	0.2
Sodium isoascorbate	0.075	0.075	0.075	0.075	0.075	0.0705
Soy protein isolate	2	2	2	2	2	2

Artificial collagen edible casings, 23 mm in diameter, product of Naturin GmbH, Weinheim, Germany were used for stuffing the batter.

Heat treatment was performed in smokehouse at a temperature of 78°C until achieving an internal temperature of 72°C.

pH value was measured by pH meter Testo 230. The cooking loss during heat processing of frankfurters represents the difference in weight before and after heat treatment, expressed as a percentage of the initial weight.

Chemical composition was determined using AOAC (1997). The water content according to official method 950.46; protein according to 928.08; fat according to 991.36 and ash according to 920.153.

The program package SAS/STAT (SAS Software. Version 8.01, 1999) was used for statistical processing of data and significance, means were separated using the Duncan test.

Results and Discussion

Cooking loss and pH

During heat processing and chilling of frankfurters the lowest cooking loss (9.04%) was established in frankfurters produced with pork backfat (Po), and the highest (10.21%) in those with rapeseed oil (R). Palm and pork fat, as well as sunflower oil significantly ($P<0.01$) influenced the reduction of cooking loss in the heat treatment of frankfurters (Table 2). Cooking losses during thermal processing of low-fat frankfurters with vegetable oils were high, whereby the type of oil did not influence the loss, while the amount of fat had a major impact (Paneras and Bloukas (1994). Somewhat lower values for cooking loss of chicken frankfurters were obtained by Kratovalieva (2007).

Cooking loss during thermal processing is influenced by cooking method (Yoo *et al.*, 2005), cooking temperature and time (Kim and Chin, 2007; Vasanthiet *al.*, 2007; Banonet *al.*, 2008), the type and the amount of fat (Choi *et al.*, 2010; Choi *et al.*, 2009; Hong *et al.*, 2004; Fernández-Ginéset *al.*, 2004), ingredients (Huang *et al.*, 2005), the casing (Choi *et al.*, 2008). Great number of factors affecting the amount of cooking losses during thermal processing of meat products is a reason for diversity of the data published in the literature.

Table 2. Cooking loss during thermal processing and pH of frankfurters (mean \pm standard deviation)

Parameters	Treatments					
	Po	O	R	S	Pa	Mi
Cooking loss, %	9.04 \pm 0,31 ^b	10.18 \pm 0.17 ^a	10.21 \pm 0.35 ^a	9.38 \pm 0.09 ^b	9.38 \pm 0,09 ^b	10.18 \pm 0.17 ^a
pH	6.38 \pm 0,01 ^a	6.38 \pm 0.01 ^a	6.37 \pm 0.01 ^b	6.38 \pm 0.01 ^a	6.36 \pm 0,00 ^b	6.36 \pm 0.01 ^b

^{a,b}– Means within a row with different superscript letters are significantly different ($P<0.01$)

Po – Pork back fat (control);

O – Olive oil;

R –Rapeseed oil;

S – Sunflower oil;

Pa – Palm fat;

Mi – Mixture of 12% rapeseed oil and 8% palm fat.

Frankfurters with palm fat (Pa), a mixture of 12% rapeseed oil and 8% palm fat (Mi) and those with rapeseed oil (R) had a lower pH than the other three variants ($P<0.01$). Kratovalieva (2007) reported similar results (6.34 – 6.38 %) for chicken frankfurters. According to Paneras and Bloukas (1994) pH in frankfurters produced with vegetable oils is usually in the range of 6.30 to 6.46 and in those with pork fat is higher. In Turkish type beef frankfurter with different percentage of sunflower oil (12.5 – 20%) pH ranged from 6.02 to 6.07, and in those with 20 % beef fat pH accounted 6.21 (Yilmaz, 2004). The pH value of beef frankfurters produced with 10 % beef fat (control treatment) or 10 % interesterified oils or oil blends was ranged from 6.28 to 6.38, although there were found significant differences between the treatments (Özvural and Vural, 2008).

Chemical composition

The water content in all variants of frankfurters was almost equivalent (60.06 – 60.85 %), so the differences between variants were statistically insignificant (Table 3). In terms of protein content significant difference ($P<0.01$) was found only between Po (with pork backfat) and S (with sunflower oil) variants. Higher differences were observed in the fat content. Frankfurters of the variant Po (pork fat) and O (olive oil) contained significantly ($P<0.01$) more fat than the other variants. Furthermore, variant S (sunflower oil) contained significantly ($P<0.01$) more fat than variant R (rapeseed oil). The ash content was approximately the same in all variants (2.71 – 2.81%).

Table 3. Chemical composition of frankfurters (mean \pm standard deviation)

Parameters (%)	Treatments					
	Po	O	R	S	Pa	Mi
Water	60.18 \pm 0.73 ^a	60.18 \pm 0.44 ^a	60.06 \pm 0.37 ^a	60.35 \pm 0.46 ^a	60.85 \pm 1.26 ^a	60.55 \pm 0.34 ^a
Protein	13.08 \pm 0.38 ^a	12.65 \pm 0.19 ^{ba}	12.73 \pm 0.20 ^{ba}	12.28 \pm 0.47 ^b	12.72 \pm 0.56 ^{ba}	12.81 \pm 0.58 ^{ba}
Fat	25.34 \pm 0.40 ^a	25.45 \pm 0.18 ^a	23.88 \pm 0.17 ^{cb}	24.13 \pm 0.07 ^b	23.38 \pm 0.35 ^d	23.62 \pm 0.27 ^{cd}
Ash	2.79 \pm 0.10 ^a	2.71 \pm 0.07 ^a	2.75 \pm 0.27 ^a	2.81 \pm 0.12 ^a	2.74 \pm 0.07 ^a	2.77 \pm 0.13 ^a

^{a-d} – Means within a row with different superscript letters are significantly different ($P<0.01$)

Po – Pork back fat (control);

O – Olive oil;

R – Rapeseed oil;

S – Sunflower oil;

Pa – Palm fat;

Mi – Mixture of 12% rapeseed oil and 8% palm fat.

Similar content of water and ash, and slightly lower of protein and fat in chicken frankfurters were found by Kratovalieva (2007). Jiménez-Colmenero *et al.* (2010) reported that there were no differences in the water content (range from 60.6 to 62.3 %) of the different frankfurters formulations. This is consistent with the fact that the amount of added water was similar in all the treatments. Addition of interesterified oil and oil blends affected the moisture (56.98 – 60.85 %) and fat (19.55 – 24.08 %) content of frankfurters (Özvural and Vural, 2008). Frankfurters with pork fat contain more protein than that with vegetable oils (Stevanović, 1993).

Future developments will be dictated by the marketplace and the ability of the meat industry to deliver products with high nutritional value (Barbut, 2011).

Conclusion

In terms of cooking loss during thermal processing, pH and basic chemical composition, total pork fat replacement with plant oils and fats in poultry frankfurters is possible. In order to produce low fat frankfurters, further research is needed to reduce the total amount of fat.

References

- AOAC. (1997). Official Methods of Analysis of AOAC International, 16th Edition. Washington, USA: Association of the Official Analytical Chemists International.
- Arihara K. (2006). Strategies for designing novel functional meat products. *Meat Science*, 74, 219-229.
- Banon S., Diaz P., Nieto G., Castillo M., Alvarez D. (2008). Modeling the yield and texture of comminuted pork products using color and temperature. Effect of fat/lean ratio and starch. *Meat Science*, 80, 649-655.

- Barbut S. (2011). In Reducing saturated fats in foods: Saturated fat reduction in processed meat products. Woodhead Publishing Limited, 211-233.
- Bishop D.J., Olson D.G., Knipe C.L. (1993). Pre-emulsified Corn Oil for Pork Backfat Affects Quality of low-fat Frankfurters. *Journal of Food Science*, 58, 484-487.
- Bloukas J.G. and Paneras E.D. (1993). Substituting olive oil for pork backfat affects quality of low-fat frankfurters. *Journal of Food Science*, 58, 705-709.
- Choi J.H., Jeong J.Y., Han D.J., Choi Y.S., Kim H.Y., Lee M.A., Lee E.S., Paik H.D., Kim C.J. (2008). Effects of pork/beef levels and various casings on quality properties of semi-dried jerky. *Meat Science*, 80, 278-286.
- Choi Y.S., Choi J.H., Han D.J., Kim H.Y., Lee M.A., Kim H.W., Jeong J.Y., Kim C.J. (2009). Characteristics of low-fat meat emulsion systems with pork fat replaced by vegetable oils and rice bran fiber. *Meat Science*, 82, 266-271.
- Choi Y.S., Choi J.H., Han D.J., Kim H.Y., Lee M.A., Kim H.W., Lee J.W., Jeong J.Y., Chung H.J., Kim C.J. (2010). Effects of replacing pork back fat with vegetable oils and rice bran fiber on the quality of reduced-fat frankfurters. *Meat Science*, 84, 557-563.
- Fernández-Ginés J.M., Fernández-López J., Sayas-Barberá E., Pérez-Alvarez, J.A. (2005). Meat products as functional foods: A review. *Journal of Food Science*, 70, 37-43.
- Fernández-Ginés J.M., Fernández-López J., Sayas-Barberá E., Sendra E., Pérez-Álvarez J.A. (2004). Lemon albedo as a new source of dietary fiber: Application to bologna sausages. *Meat Science*, 67, 7-13.
- Gonzalez-Vinas M., Caballero A., Gallego I., García Ruiz A. (2004). Evaluation of the physico-chemical, rheological and sensory characteristics of commercially available frankfurters in Spain and consumer preferences. *Meat Science*, 67, 633-641.
- Hong G.P., Lee, S., Min S.G. (2004). Effects of Substituted Level of Added Water for Fat on the Quality Characteristics of Spreadable Liver Sausage. *Food Science and Biotechnology*, 13, 397-402.
- Huang S.C., Shiau C.Y., Liu T.E., Chu C.L., Hwang D.F. (2005). Effects of rice bran on sensory and physico-chemical properties of emulsified pork meatballs. *Meat Science*, 70, 613-619.
- Jiménez-Colmenero F. (2007). Healthier lipid formulation approaches in meat-based functional foods. Technological options for replacement of meat fats by non-meat fats. *Trends in Food Science and Technology*, 18, 567-578.
- Jiménez-Colmenero F., Herrero A., Pintado T., Solas M., Ruiz-Capillas C. (2010). Influence of emulsified olive oil stabilizing system used for pork backfat replacement in frankfurters. *Food Research International*, 43, 2068-2076.
- Kim S.H., Chin K.B. (2007). Physico-chemical properties and changes of sarcoplasmic protein bands of chicken meat cuts with or without salt during cooking temperature. *Korean Journal of Animal Science and Technology*, 49, 269-278.
- Kratovalieva M. (2007). Possibilities of nitrite, phosphate and pork fat substitution in poultry frankfurters. Master of Science thesis. Ss. Cyril and Methodius University, Faculty of Agricultural Sciences and Food, Skopje (in Macedonian).
- Liu M.N., Huffman D.L., Egbert W.R. (1991). Replacement of beef fat with partially hydrogenated plant oil in lean ground beef patties. *Journal of Food Science*, 56, 861-862.
- National Academy of Science. (2011). Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Institute of Medicine of the National Academies. The National Academies Press, Washington, D. C.
- Özvural E.B., Vural H. (2008). Utilization of interesterified oil blends in the production of frankfurters. *Meat Science*, 78, 211-216.
- Paneras E.D., Bloukas J.G. (1994). Vegetable oils replace pork backfat for low-fat frankfurters. *Journal of Food Science*, 59, 725-733.

- Pike H.W. (1999). Health benefits from feeding fish oil and fish meal: the role of long chain omega-3 polyunsaturated fatty acids in animal feeding. *Infoma*, 28, 1-18.
- SAS/STAT (1999). Version 8.01. Cary, SAS Institute Inc. Software.
- Stevanović M. (1993). Sensory, chemical and instrumental properties of dietary frankfurters. Master of Science thesis. University of Ljubljana, Biotechnical Faculty, Ljubljana (in Slovenian).
- Vasanthi C., Venkataramanujam V., Dushyanthan K. (2007). Effect of cooking temperature and time on the physico-chemical, histological and sensory properties of female carabeef (buffalo) meat. *Meat Science*, 76, 274-280.
- Vural H., Javidipour I. (2002). Replacement of beef fat in frankfurters by interesterified palm, cottonseed, and olive oils. *European Food Research and Technology*, 214, 465-468.
- Yilmaz I. (2004). Quality characteristics and fatty acid composition of turkish type frankfurter made with sunflower oil addition. *Fleischwirtschaft International*, 1, 52-54.
- Yoo S.S., Kook S.H., Park S.Y., Shim J.H., Chin K.B. (2005). Evaluation of curing and flavor ingredients, and different cooking methods on the product quality and flavor compounds of low-fat sausages. *Food Science and Biotechnology*, 14, 634-638.