EFFECTS OF FAT LEVEL, TAPIOCA STARCH AND WHEY PROTEIN ON FRANKFURTERS FORMULATED WITH 5 AND 12% FAT

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Key-words: Low-fat, frankfurter, tapioca starch, whey protein

Background/Objectives

Potential fat replacers in frankfurters include whey protein and tapioca starch. Whey protein has been used in a variety of meat products (Thompson, 1982; Ensor *et al.*, 1987; Skrede, 1989; Chen & Ockerman, 1995; El-Magoli *et al.*, 1995, 1996). However, none of these authors investigated the interactive effects of fat and the ingredient. Modified tapioca starch can improve flavour and reduce cook losses (Knight & Perkin, 1991; McAuley & Mawson, 1994). However, to the authors' knowledge, no research has been published on its use in frankfurters. Given the lack of detailed studies on the effects of tapioca starch and whey protein on frankfurters, their effects on textural, sensory and hydration/binding characteristics were investigated. In addition, the interactive effects of fat with the added ingredients were examined.

Materials and Methods

Six different frankfurter formulations were prepared in two separate trials according to Hughes *et al.* (1997). Two products were prepared containing 5 and 12% fat. Modified tapioca starch and whey protein concentrate were added separately to these emulsions at an addition rate of 3%. Two controls (5% and 12% fat) without the functional ingredients, were also formulated to give a total of 6 treatments (3 x 2 factorial design). For each product, moisture, fat and protein were determined (Bostian *et al.*, 1985; Sweeny & Rexford, 1987). Cook losses and emulsion stability were also recorded. Texture profile analysis (TPA) was applied to the cooked products based on a method described by Bourne (1978). An 8-member panel evaluated the sensory characteristics of the frankfurters. The trial was performed twice and the data from both was combined prior to statistical analysis. One-way analysis of variance (ANOVA) was carried out on the proximate data and the results of the remaining experiments were compared using two-way ANOVA with fat content and ingredient as factors. Interactions were considered significant when $P<0.05$.

Results and Discussion

Reducing the fat content increased cook losses and decreased emulsion stability. The addition of tapioca starch and whey protein improved both cook losses and emulsion stability. Other workers have also reported reduced cook losses from frankfurters with added whey protein (Correia *et al.*, 1991; Ker & Toledo, 1992) but no comparative data is available for tapioca starch in frankfurters. Both tapioca starch and whey protein significantly altered the fat : water ratio of the expressible fluid. Products containing tapioca starch released fluid with a higher fat content compared with the controls. This implies that this ingredient is better at retaining water than fat in a meat batter. In contrast, whey protein apparently binds fat in the emulsion. The ANOVA indicated that there was a two-factor interaction between fat level and ingredient for one of the hydration/binding characteristics examined: tapioca starch has no effect on the volume of fluid expressed from products containing 12% fat. When fat content was reduced to 5%, this ingredient reduced the amount of expressible fluid by approximately 50%. This implies that tapioca starch works best at the lowest fat level when added water is high. Whey protein in contrast works well at both fat levels.

Reducing the fat content decreased cohesiveness and gumminess of the frankfurters as measured by TPA (Table 1). The addition of either tapioca starch or whey protein significantly increased hardness, adhesiveness, gumminess and chewiness but had no effect on springiness or cohesiveness. This is in agreement with previous studies which showed an increase in hardness and chewiness of knockwurst with whey protein but no effect on cohesiveness (Ensor *et al.*, 1987). An increase in firmness was also noted in frankfurters with added whey protein (Ker & Toledo, 1992). No interactive effects between fat content and ingredient were observed for any of the TPA values examined.

Table 1. Influence of fat, tapioca starch and whey protein on TPA values. Different letters in the same column (within each main effect) indicate significant differences ($P<0.05$). SL = Significance level. NS = Not significant.

	Hardness	Springiness	Adhesiveness	Cohesiveness	Gumminess	Chewiness
A : Fat Level						
5	27.4	8.2	0.056	0.649^{a}	17.8^{a}	146.1
12	30.7	8.1	0.057	0.672^{b}	20.4^{b}	165.0
SL	NS	NS	NS	0.0191	0.0096	NS
B : Ingredient						
No ingredient	23.9^{a}	8.3	0.046^{a}	0.668	15.7^{a}	131.9^{a}
Tapioca Starch	33.1^{b}	8.2	0.067^{c}	0.650	21.6^{b}	176.2^{b}
Whey protein	30.1^{b}	8.0	0.056^{b}	0.664	19.9^{b}	158.6^{b}
SL	0.0004	NS	0.0007	NS	0.0001	0.0025

The sensory characteristics of the frankfurters were affected by fat reduction (Table 2). Low-fat products were more smoky, more spicy, more salty and had increased overall flavour intensity. Other studies have also shown an increase in spice (Yang *et al.*, 1995; Hughes *et al.*, 1997) and smoke (Hughes *et al.*, 1997) intensities in low-fat frankfurters. Juiciness increased when fat content was decreased to 5%. Panellists were unable to detect differences in texture or acceptability between products regardless of fat content. The addition of whey protein to the products did not significantly alter their flavour profile although tapioca starch increased the overall flavour intensity of the frankfurters. The latter may not be desirable in a low-fat meat product. It is known that reduced fat frankfurters release flavour compounds more rapidly than the higher fat products (Hughes *et al.*, 1997). Therefore, an ideal fat replacer should retain flavour compounds within the food matrix and release them at a rate comparable to that of their full-fat counterparts. Using this criterion, tapioca starch may not be an effective fat-replacer in low-fat frankfurters. The ANOVA indicated that there was a two-factor interaction between fat content and ingredient for two of the sensory parameters examined. Tapioca starch has no effect on spice intensity at 5% fat but at 12% fat the presence of the ingredient significantly increased the spiciness. Similarly, juiciness is unaffected by the addition of tapioca starch at 5% fat but is significantly increased at 12% fat. This indicates that tapioca starch increases juiciness in products where added water is low and fat level is high compared with lower fat frankfurters with higher added water.

Table 2. Influence of fat, tapioca starch and whey protein on sensory characteristics of frankfurters. OA = Overall acceptability.

	Smoke Intensity	Spice Intensity	Salt Intensity	Other Flavour Intensity	Juiciness	Overall Flavour Intensity	Texture	OA
A: Fat Level								
5	3.2^b	3.7^b	3.5^b	2.2	5.0^b	4.2^b	4.0	3.9
12	2.8^a	3.0^a	3.0^a	2.3	4.7^a	3.7^a	4.1	3.9
SL	0.0181	0.0	0.0004	NS	0.0004	0.0	NS	NS
B: Ingredient								
No ingredient	2.9	3.3	3.2	2.3	4.8	3.9^a	3.9	3.8
Tapioca Starch	3.2	3.5	3.4	2.3	4.9	4.2^b	4.1	3.9
Whey protein	2.9	3.1	3.2	2.1	4.9	3.8^a	4.0	3.9
SL	NS	NS	NS	NS	NS	0.0212	NS	NS
Interactions								
AxB								
SL	NS	0.0275	NS	NS	0.0194	NS	NS	NS

Conclusions

Reducing the fat content significantly alters the hydration/binding properties of frankfurters. In addition, fat reduction increases the flavour intensity of the products and alters their texture. Whey protein did not decrease the rate of flavour release from the low-fat products (i.e., flavour intensities were unaffected). However, tapioca starch increased the flavour intensity of the 12% fat products above those of the controls. This characteristic may not be an advantage for low-fat meat products where flavour release is more rapid. Both ingredients altered the texture of the products but these changes were not detected by trained panellists. The addition of tapioca starch and whey protein can partially offset some of the changes that occur in low-fat products when fat is replaced with water. They improve emulsion stability, cook losses and texture but their effects on flavour are minimal.

References

Bostian, M. L., Fish, D. L., Webb, N. B. & Arey, J. J. (1985). *J. Assoc. Off. Anal. Chem.*, **68** (5), 876.

Bourne, M. C. (1978). *Food Technology*, July, 62.

Chen, P. H. & Ockerman, H. W. (1995). *Proceedings : 41st International Congress of Meat Science and Technology*, San Antonio, Texas, USA, D-4, 429.

Correia, L. R. & Mittal G. S. (1991a). *Meat Sci.*, **29**, 335.

El-Magoli, S. B., Larola, S. & Hansen, P. M. T. (1995). *Food Hydrocolloids*, **9** (4), 291.

El-Magoli, S. W., Larola, S. & Hansen, M. T. (1996). *Meat Sci.*, **42** (2), 179.

Ensor, S. A., Mandigo, R. W., Calkins, C. R. & Quint, L. N. (1987). *J. Food Sci.*, **52** (5), 1155.

Hughes, E., Cofrades, S. & Troy, D. J. (1997). *Meat Sci.*, 45 (3), 273.

Ker, Y. C. & Toledo (1992). *J. Food Sci.*, **57** (1), 82.

Knight, M. & Perkin, J. (1991). *Meat Manufacturing and Marketing*, **5** (4), 29.

McAuley, C. & Mawson, R. (1994). *Food Australia*, **46** (6), 283.

Skrede, G. (1989). *Meat Sci.*, **25**, 21.

Sweeny, R. A. & Rexford, P. R. (1987). *J. Assoc. Off. Anal. Chem.*, **70** (6), 1028.

Thompson, L. U., Reniers, D. J. & Baker, L. M. (1982). *J. Dairy Sci*, **65**, 1715.

Yang, A., Trout, G. R. & Barry, B. J. (1995). *Proceedings : 41st International Congress of Meat Science and Technology*, San Antonio, Texas, USA, D-7, 435.