The effects of added high gelling whey protein/carrageenan gels with tapioca starch on the eating quality and acceptability of low fat fresh pork sausages using response surface methodology.

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Introduction

Reduction of fat content in comminuted meat products to more acceptable levels (<20%) can result in an unpalatable product with an unacceptable flavour and texture (Claus *et al.*, 1989; Claus & Hunt, 1991; Ahmed *et al.*, 1990). Fat replacement with non-meat proteins, especially dairy proteins, has received much attention due to their excellent functional and nutritional properties. Dairy proteins have been incorporated as fillers, acting as water and fat binders with the ability to modify the final textural properties of low-fat comminuted meat products (Comer *et al.*, 1986; Girard *et al.*, 1990; Ellekær *et al.*, 1996). Dry addition of milk proteins has been reported to have an adverse effect on the texture of comminuted meat products, which change from springy at lower protein concentrations to cakey and less juicy at higher concentrations (Comer & Allan-Wojtas, 1988; Baardseth *et al.*, 1992). The use of carbohydrates, especially hydrocolloids, as fat replacers in reduced and low-fat meat systems, have been shown to modify both the texture and sensory attributes of these products (Skrede, 1989; Berry & Wergin; 1990, Knight & Perkin, 1991). The objectives of this study were; to incorporate high gelling 35% WPC/carrageenan gel blends with dry addition of tapioca starch, as a 100% replacement for pork backfat; to statistically assess the textural and organoleptic properties of these final low-fat sausages using response surface methodology (Cochran & Box, 1957); and to compare these optimum combinations to full-fat commercial sausage controls.

Materials and Methods

35% WPC (0-4%) and carrageenan (0-3%) were hydrated with various levels of water presented in the experimental design. Ingredients were mixed and poured into water impermeable casings, heated at 80°C x 2h and stored at 4°C x 16h prior to being used. Minced frozen pork (9[illegible] V/L), together with seasonings, residual water and tapioca starch were chopped for 1.0 min. Diced preformed gel was added as 100% replacement for the pork backfat with further chopping for 30 sec. Rusk was finally added, and the batter was chopped for 30 secs. Sausage batter was stuffed into edible casing and stored at 4°C x 16h. Sausages were assessed for cook (frying) losses, water holding capacity, (Lianji and Chen, 1991), purge-loss, mechanical texture (Warner-Bratzler Shear) and organoleptic analysis using a ten member taste panel.

Results and Discussion

Analysis of variance (ANOVA) show that % cooking losses and mechanical texture properties were significant ($p<0.05$), with very high R² values (Table 1). Sensory properties (Fig 1) of low-fat pork sausage were also found to be significant ($p<0.05$) with the exception of overall tenderness and acceptability. % Cook losses (Fig. 2) for low-fat sausages were found to be similar (9 - 11%) compared to the commercial full-fat control (7.5 - 8.5%). Added Preformed 35% WPC gel was found to have a significant ($p<0.05$) positive linear effect on the shear force values. The texture of low-fat sausages ranged from very soft, through to grainy and dry with increasing protein addition (Fig. 1). Increased concentration levels of 35% WPC were found to have a negative influence on flavour intensity ($p<0.05$) and overall flavour ($p<0.01$). Addition of carrageenan to 35% WPC protein gel solutions, reduced the levels of both ingredients required to give an acceptable preformed gel. Carrageenan gave both a significant negative linear effect ($p<0.01$) and interactive effect ($p<0.01$) in combination with tapioca starch, for % cook losses. % Cook losses increased with increasing carrageenan additions, however, losses for carrageenan decreased when used in combination with tapioca starch. % Cook losses for-low fat sausages decreased from 12 to 3% using combinations of carrageenan and tapioca starch. In this study, carrageenan addition was shown to increase gel elasticity, resulting in sausages with higher shear force values. Although no significant interactive effect was observed between 35% WPC and carrageenan (Table 1), the trend from the graphs (Figure 1) indicates that there was an increase in shear force values with increasing concentrations of both ingredients. The change in gel texture and final product texture show combinations of 35% WPC (3% protein) and carrageenan (1.5% powder) as a preformed gel, gave similar texture results to that of the full-fat commercial control sausage. Sensory analysis gave similar results, with combinations of 35% WPC and carrageenan giving significant values for flavour intensity ($p<0.05$) and juiciness ($p<0.001$).

Conclusions

Results showed that by using preformed gels containing blends of 35% WPC (3-4%) and carrageenan (1-1.5%), an improvement in the final texture of the low fat sausage was observed. The 'cakey' texture which is often associated with the addition of dairy ingredients as fillers was not observed using the preformed gel. The gel gave a more elastic homogenous mix similar to the full-fat commercial control sausage. Synergies between the 35% WPC/carrageenan preformed gel and tapioca starch (dry addition) was evident throughout the trial. Combinations of 35% WPC/carrageenan preformed gel and 3% tapioca starch resulted in a low-fat sausage with similar mechanical and organoleptic properties to that of a full-fat control sausage.

References

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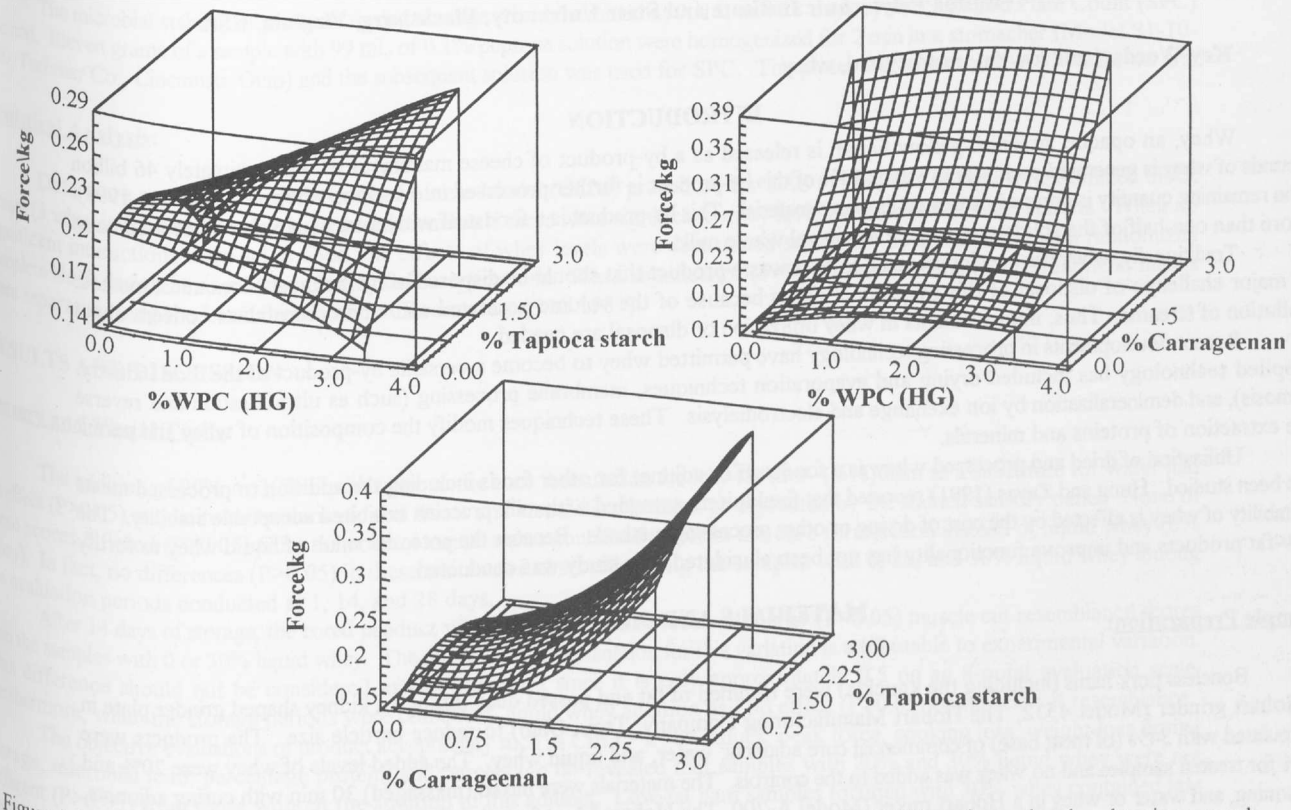

Figure 1. Effects of high gelling 35% whey protein concentrate (0-4%), carrageenan (0-1.5%) preformed gel and tapioca starch powder (0-3%) addition, as a function of shear force values (kg) using the warner bratzler shear cell.

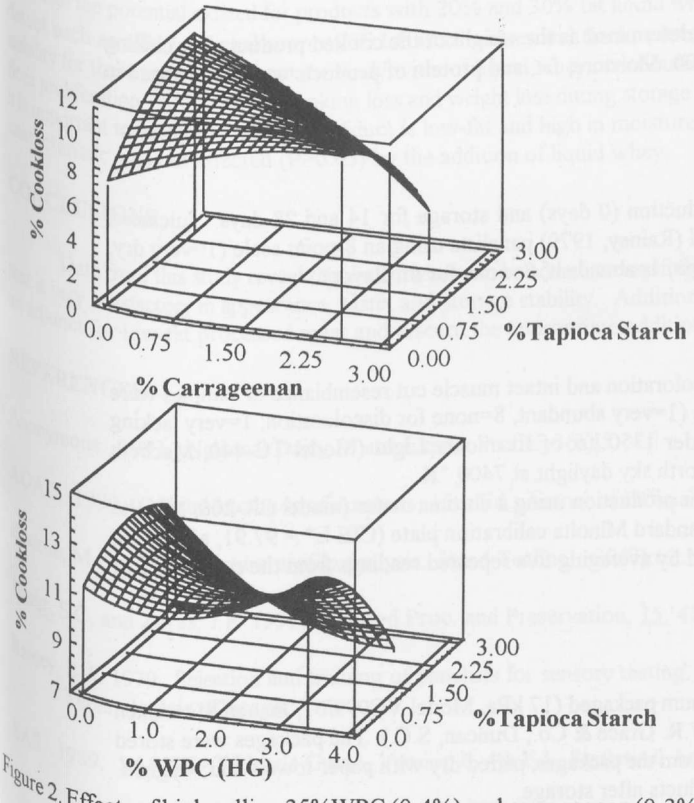

Figure 2. Effects of high gelling 35%WPC (0-4%) and carrageenen (0-3%) preformed gel addition with tapioca starch (0-3%) powder on % Cook (frying) losses.

Table 1

Analysis of variance of regression models for cooking properties, mechanical texture properties and sensory properties of low fat pork sausages.

	Model	R^2_y
Cooking Properties		
Cooking losses	**	0.748
Water holding Capacity	*	0.570
Purge loss	*	0.515
Mechanical Texture Properties		
Warner-Bratzler peak force	***	0.949
Flat Blade peak force	***	0.900
Sensory Properties		
Flavour Intensity	*	0.486
Overall flavour	*	0.715
Overall tenderness	NS	0.000
Juiciness	***	0.867
Overall Acceptability	NS	0.000