ASSESSMENT OF THE EFFECTS OF β-LACTOGLOBULIN, TAPIOCA STARCH AND ADDED WATER ON THE PHYSICAL AND TEXTURAL PROPERTIES OF LOW-FAT FRESH PORK SAUSAGES USING RESPONSE SURFACE METHODOLOGY.

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Background
Growing awareness of the need to reduce dietary fat intake has led to a consumer driven demand for low-calorie type meat products. Reduced-fat meat products while healthier than their full-fat counterparts, usually possess a less desirable flavour and texture. Non-meat proteins and polysaccharides may be employed as fat substitutes in processed foods successfully reducing caloric content while simulating the viscosity, mouthfeel and sensory attributes of natural fats (*Barbut, and Mittal, 1995*). An important property of any functional adjunct employed in low-fat meat production is its ability to retain or entrap water. This ability can significantly influence the cookloss, texture and perceived juiciness of low-fat meat products (*Lyons et al., 1998*). The objectives of this study were therefore, to determine using Response Surface Methodology (RSM), the optimum ratio of added water (AW) : β-lactoglobulin (β-Lg) preformed protein gel required to produce a gel texture with similar properties to that of pork backfat. To assess the effects of β-Lg protein gel addition in combination with tapioca starch (TS) on low-fat sausage texture and determine if these test ingredients could improve product quality.

Materials and methods
RSM was used to study the simultaneous effects of three compositional variables namely 55% β-Lg protein level (0 – 14% protein), TS addition (0 – 3% powder) and % added water level : protein gel ratio (0 – 44%) on the physical properties of low-fat (<3% fat) pork sausages. Experiments were based on a central composite rotatable design (Cochran and Cox, 1957). 55% β-Lg (Dairygold Co operative Society Ltd., Mitchelstown, Cork, Ireland.) gels were prepared as suggested by the RSM design. β-Lg solutions were filled into plastic casings and heated to 80°C x 2 h in a Sümann steam oven (Sümann Walzbachtal 2, Germany), cooled and held at 4°C x 16 h. Pork sausages were prepared using frozen *M. semimembranosus* (97 V/L) muscles tempered to -4^{0}C and pre-minced through a 4mm plate (Mainca, Maquinaria Industria, Barcelona, Spain). TS, seasonings (Redbrook Ingredient services Ltd., Santry, Dublin, Ireland), meat and free water were chopped in a 15 L Mainca bowl cutter for 1 min. Preformed gel was diced into 3cm cubes and added to the mix as 100% replacement for the pork backfat, chopping for 30 sec. Rusk was added with chopping for a further 30 sec. Sausage batter was stuffed into 10mm diameter collagen casing (Devro Casings, Moodiesburn, Scotland) using a 15 L Mainca piston filler. Sausages were stored at 4°C x 16 h allowing the rusk to fully hydrate prior to product testing. Cook –frying- losses were calculated by weight difference on frying at 100°C x 15min. A texture analyser (Stable Micro-Systems Model TA-XT2I) with a 5kg load cell in compression mode was used to determine the textural parameters of final product. Cooked samples were cored (12mm x 2.5cm) and tempered (25°C x 1 h) prior to testing. Samples (n=6) were sheared using a Warner Bratzler shear rig fitted with either a flat or v-shaped blade. Textural properties of gels were determined as described by Bourne (1978). Sausages were assessed for freeze/thaw stability and for water holding capacity (WHC) as calculated according to the method of Liangi and Chen, (1991).

Results and discussion
% Cook loss data showed a negative linear effect for both β-Lg ($p<0.01$) and TS ($p<0.05$). However, as β-Lg and TS levels increased, cookloss decreased from 20% to 13% (Fig 1). β-Lg showed a highly significant ($p<0.001$) positive linear effect on WHC, where increasing levels of β-Lg increased WHC (Table 1). Data also showed a highly significant ($p<0.001$) quadratic effect for AW:β-Lg gel ratio. This suggested that as preformed gel levels were replaced with increasing levels of added free water in test sausages more water was lost, thus decreasing WHC. Therefore, entrapment of water within a protein gel matrix enhanced the WHC of test sausages. WHC results also showed a significant ($p<0.05$) positive interactive effect between β-Lg with TS and TS with AW:β-Lg gel ratio. Increased water addition to the sausage mix, which conversely reduced the level in the preformed gel matrix, resulted in improved WHC at higher levels of TS (e.g. 99.5% at 3% addition). Textural analysis gave a negative quadratic effect ($p<0.001$) for β-Lg and TS using both the Warner Bratzler flat and V shaped blades (Fig 2). At low β-Lg concentrations (0-7%) shear force values increased from 0.3 kg to 0.7 kg. However, at protein levels >7%, shear forces decreased to 0.4kg. Moreover, as the amount of water added to the β-Lg gel increased there was an increase in the shear force. TS displayed a predominantly positive linear ($p<0.05$) effect on shear force values, where an increase in shear force from 0.4kg to 0.67kg was observed with increasing levels of TS addition from 0 to 1.5% (Fig 2). Freeze thaw data showed that β-Lg had a significant ($p<0.05$) negative linear effect, decreasing purge from 5% to 2%. Freeze/thaw stability data was in agreement with WHC data, where increased gel addition levels combined with TS addition similarly decreased purge losses.

Conclusion
Addition of a 10% protein β-Lg preformed gel at a rate of 18 - 22% on its own, or at a 12% level in combination with 3% TS gave optimum results in test low-fat (<3%) sausage products when compared with commercial full-fat (22%) control sausages in terms of cook losses, texture and product stability. In summary, the use of protein preformed gel as an alternative fat source in low-fat comminuted meats can improve water holding and overall product texture and is a improved mode of protein inclusion when compared with dry powder addition.

References

Barbut, S. and Mittal, G.S. (1995) *J. Muscle Foods* **6** 47-62; Bourne, M.C. (1978) *J. Food Sci*, **28** 385-389; Cochran, W.G. and Cox, G.M., (1957) In: *Experimental Design* Ed. Wiley. J., J. Wiley & Sons, N.Y.; Liangi M. and Chen, N. (1991) *Proc. 35th Int. Congress Meat Sci and Tech* Copenhagen, Denmark 781. Lyons, P.H., Kerry, J.F. and Buckley, D.J. (1998) *Meat Science* **51** 43-52;

Table 2 Analysis of variance of regression models for physical and mechanical texture properties of low-fat fresh pork sausages.

Model		R_{2y}
Cook loss	**	0.654
Water holding Capacity	***	0.836
Freeze/Thaw Stability	*	0.515
WBS V blade peak force	**	0.680
WBS Flat Blade peak force	*	0.584

***, **, *, = significant at $p< 0.001$, $p<0.01$, $p<0.05$, respectively; NS = not significant; **WBS** = Warner Bratzler Shear

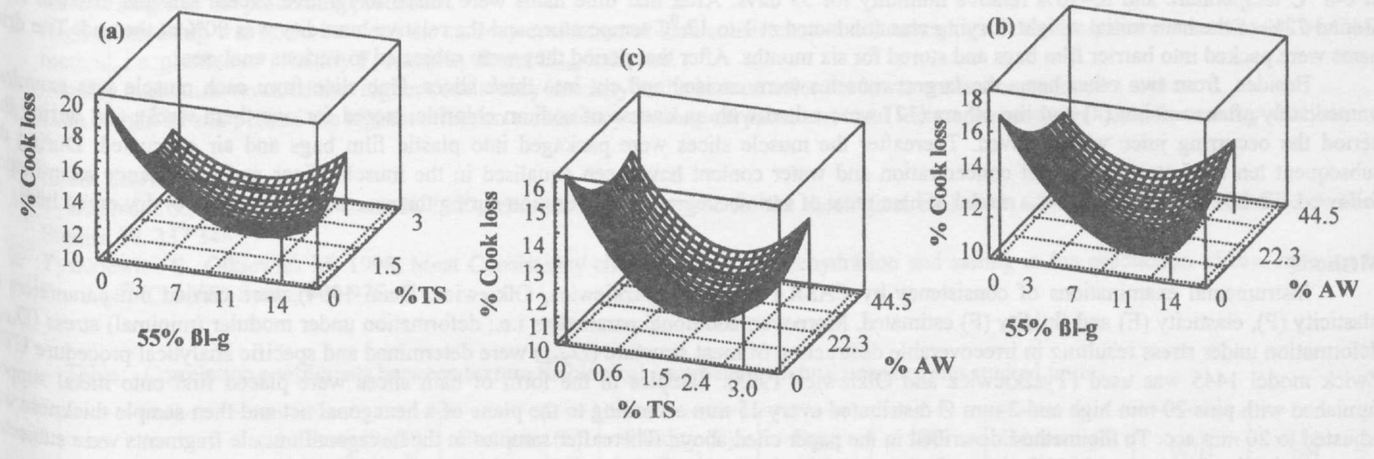

Fig 1 Results of cook loss (%) values for low-fat pork sausages (a) Effect of 55% ß lactoglobulin (ßlg) and tapioca starch (TS) levels, at 22.3% gel/added water (AW) (b) Effect of 55% ßlg and AW levels at 1.5% TS addition and (c) Effect of TS and AW at 7% ßl-g addition

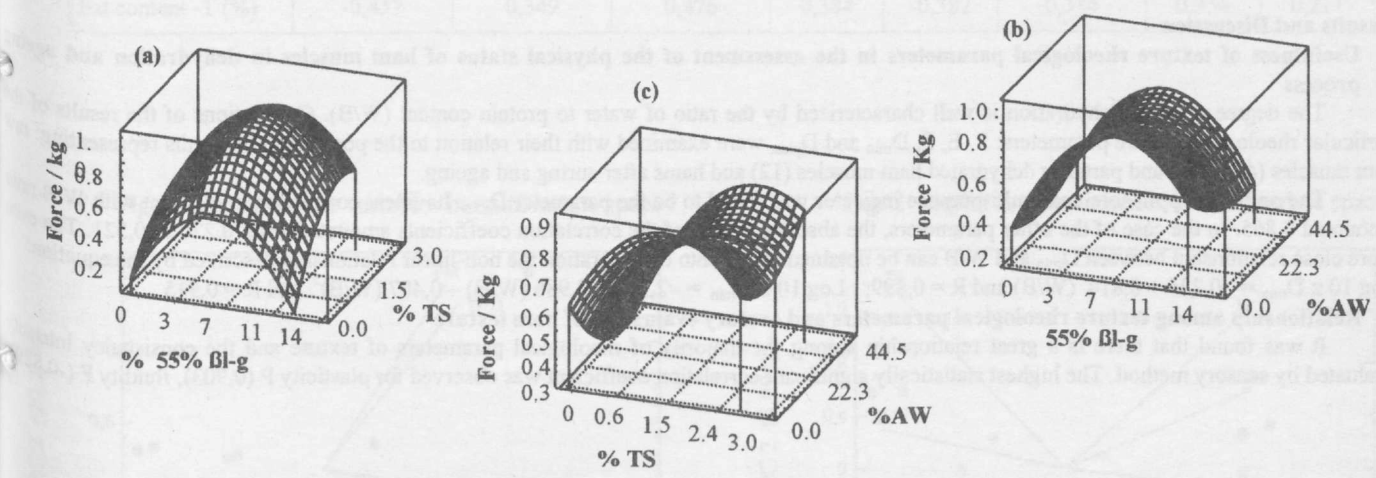

Fig 2 Results of shear force (KgF) values of low-fat pork sausages using a Warner Bratzler V blade (a) Effect of 55% ß lactoglobulin (ßl-g) and tapioca starch (TS) levels, at 22.3% gel/added water (AW) (b) Effect of 55% ßlg and AW levels at 1.5% TS addition and (c) Effect of TS and AW at 7% ßl-g addition