THE EFFECTS OF VARYING LEVELS OF TAPIOCA STARCH, OAT FIBRE AND WHEY PROTEIN ON THE EATING QUALITY OF LOW-FAT BEEF BURGERS.

E.M. Desmond[1], D.J.Troy[1] and D.J.Buckley[2]

[1]Teagasc, The National Food Centre, Dunsinea, Castleknock, Dublin 15, Ireland.
[2]Department of Food Science and Technology, University College, Cork, Ireland.

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BACKGROUND

Concern about the role diet plays in general health and development of certain diseases has mounted in the last number of years. Red meat in the diet, in particular, has been the focus of interest in modification of dietary patterns. The aim in producing low fat meat products is to give the consumers products similar to full fat meat products while maintaining a healthy diet.
Fat plays an important role in determining the quality of meat products. It has a profound effect on the rheological and structural properties of meat products. The flavour of meat products is highly influenced by the amount and type of fat. It is a known precursor of a large number of flavour compounds that contribute too desired as well as undesired tastes and aromas. There is evidence that reducing the fat level from approximately 20% to between 5 and 10% in beef burgers results in reductions in tenderness, juiciness, flavour intensity and overall product palatability (Berry *et al.* 1996; Troutt *et al.* 1992a,b; Egbert *et al.* 1991).
Consequently, today there are many meat products containing fat substitutes or mimics that act as water binding and texture modifying agents. These fall under three categories: (1) Non-meat Proteins e.g soya and milk proteins (2) Carbohydrate based e.g. carrageenans, starches, oat fibre and gums and (3) Functional blends which contain various ingredient blends. Several studies (El-Magoli *et al.* 1996; Bullock *et al.* 1995; Troutt *et al.* 1992a,b; Egbert *et al.* 1991) have shown that some of these fat replacers have improved the overall palatability of low fat beef burgers.

OBJECTIVES

Few studies deal systematically with identification of the most appropriate combinations for producing low fat beef burgers or any other processed meats. The aim of this work was to assess the effects of varying levels of tapioca starch, oat fibre and whey protein on the physical, texture and sensory characteristics of low fat beef burgers. Response Surface Methodology (Cochran and Cox, 1987) was used for the simultaneous analysis of the effects of the added ingredients. The experimental design also allows evaluation of the possible existence of any interactive effects between the ingredients mentioned. The low fat beef burgers were examined in terms of cook yield, water holding capacity (WHC), sensory and mechanical texture analysis.

METHODS

Experimental Design: The experiments were designed according to a central composite rotatable design (CCRD) (Cochran and Cox, 1957). Five levels of each factor (variable) were chosen in accordance with the principles of the CCRD. The factors studied were; level of tapioca starch (ranging from 0 to 3%), level of oat fibre (ranging from 0-2%) and whey protein (ranging from 0-2%). For the experiment, twenty combinations of three variables were performed following the designs of Cochran and Cox, (1957). Assessment of error was derived from replication of one treatment combination as suggested in the design.
Beef burger Manufacture: Lean beef (90%) was coarsely ground through a 10mm plate. Water salt and the blends of ingredients were then added to the meat. The resulting mixture was finely ground through a 5mm plate. Beef burgers (113g) were formed and frozen in a blast freezer at -20°C. When frozen the burgers were packaged and then vac-packed. The burgers were stored at -20°C until required.
% Cook Yield and Dimensional Changes: These were determined by calculating weight and dimensional changes in beef burgers before and after cooking.
Water-Holding Capacity: The WHC was determined using centrifugation (9000×g at 4°C for 10 min) using a modification of the method of Lianji and Chen, (1991).
Sensory Analysis: A ten member in-house taste panel evaluated the cooked beef burgers for a number of textural, flavour and overall quality attributes.
Mechanical Texture Analysis: Beef burgers were sheared using the Warner-Bratzler and Kramer shear attachments using modifications of the methods of Berry (1996) and Millar *et al*, (1993) respectively. Beef burgers were also analysed using Texture Profile Analysis (TPA) using a variation of the method of Millar *et al*, (1993).

RESULTS AND DISCUSSION

Multiple regression analysis showed that models were significant ($P<0.05$) for cooking properties (yield and WHC), the sensory attributes of tenderness and moistness/juiciness and all mechanical texture attributes such as Warner-Bratzler and Kramer shear forces and energies and the TPA measurements e.g hardness. There were no significant effects ($P>0.05$) for percent reduction in diameter and thickness, sensory attributes of meaty flavour, non-meat flavour, overall flavour, texture and acceptability. Where significant, the effect of the variables tapioca starch, oat fibre and whey protein levels on each property was divided into first-order (linear), second-order (quadratic) and interactive (interaction between pairs of variables). A response surface was fitted for the effect of each pair of variables on each parameter evaluated.
The concentration of tapioca starch (TS) influenced the regression models, for the various parameters evaluated, to the greatest extent. And its effect on cooking properties (yield (Fig.1) and WHC) of the beef burgers was highly significant ($P<0.001$), positive and linear.

In general, the more TS added the higher the yield after cooking. The relationship between TS and cook yield is consistent with the findings of Hart and Price, (1993), who found recipes of low fat beef burgers containing TS substantially improved cook yields of burgers compared to both low and high fat controls. The presence of TS had a highly significant (P<0.001), negative linear effect on Warner-Bratzler and Kramer shear forces (Fig.2). Therefore, in general as more TS is added the lower the force or energy required to shear the sample. TS had a significant (P<0.001) positive linear effect on both the sensory attributes of tenderness and juiciness. Therefore as TS was increased the juiciness of the low fat beef burgers was increased i.e. aiding in retention and subsequent release of moisture giving increased succulence. Hart and Price, (1993) also found that TS gave the desired juiciness of reduced fat beef burgers. Oat fibre (OF) had a limited influence on the parameters measured, it significantly (P<0.05) influenced WHC in a positive linear fashion and the sensory attribute of juiciness in a negative linear fashion (p<0.05). Therefore as OF was increased the WHC increased also giving a product more water retention. However, the opposite was found for the juiciness rating, as OF increased juiciness scores decreased. This is most likely due to the presence of the other ingredients, even though there was on interaction between them. Pszczola, (1991) reported that the advantages of oat barn or fibre included its ability to retain moisture and keep meats from drying out. Whey protein (WP) had the least influence of the variables analysed, affecting only two parameters. WP affected Kramer shear peak force in a negative linear manner (P<0.05), while affecting the TPA trait of hardness in a positive linear manner (P<0.05). El-Magoli *et al.* (1996) found similar results, as whey protein was increased from 0 to 3% hardness increased while at 4% hardness decreased.

CONCLUSIONS

Of the variables studied, tapioca starch was the most influential. For each model that was significant, tapioca starch exerted a linear effect and in some cases a quadratic effect also. Both oat fibre and whey protein had a very limiting influence, only having a linear effect on two parameters. The lack of any interactive effects between the variables shows that the contribution made by any one ingredient to the characteristics of the low fat beef burgers was not generally affected by the other two.

The response surface methodology (RSM) showed that as tapioca starch, the most significant variable, was increased to a maximum level of 2-3% the low fat beef burgers had better cook yield and better water retention giving a more tender and juicy product. Similarly, tapioca starch was highly significant in influencing the mechanical texture parameters, as it was increased the force required to shear the sample decreased. More research is needed on how these ingredients, in particular tapioca starch are affecting the comminuted meat system at the molecular level.

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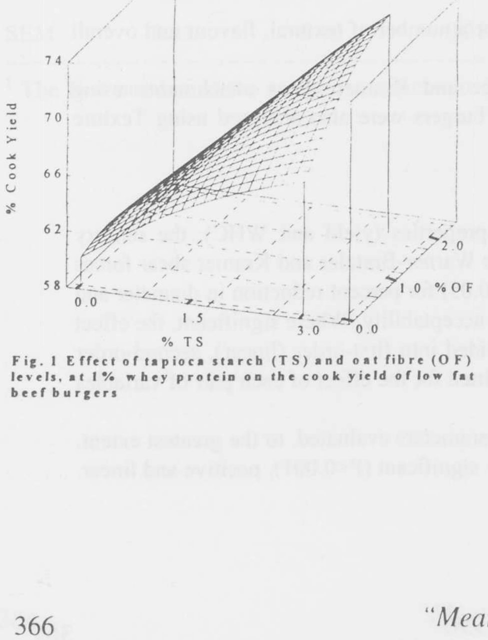

Fig. 1 Effect of tapioca starch (TS) and oat fibre (OF) levels, at 1% whey protein on the cook yield of low fat beef burgers

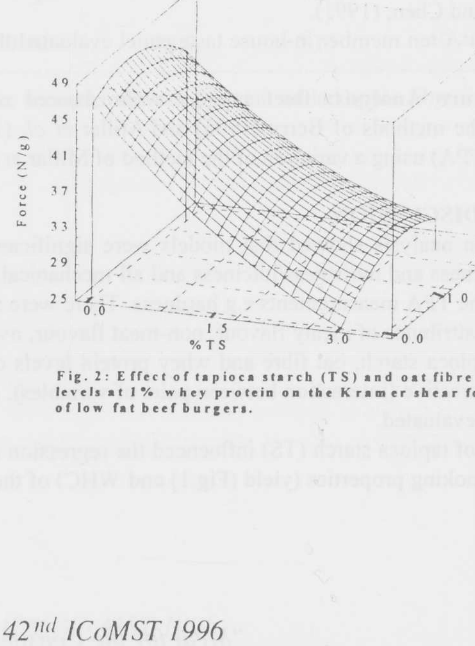

Fig. 2: Effect of tapioca starch (TS) and oat fibre (OF) levels at 1% whey protein on the Kramer shear force of low fat beef burgers.