FAT REPLACERS AND EATING QUALITY OF LOW FAT BEEFBURGERS

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SUMMARY

Twenty three commercially available ingredients such as Danagel GB1, Maltrin MO40, Tapiocaline EX533, Alacen 152, Advanced Oat Fibre, Slendid, Soyamin 90 (containing functional ingredients such as soya, milk and blood proteins, starches, carrageenans, maltodextrin, oat fibre, alginate), which may have the potential to offset eating quality deterioration associated with low fat meat products were assessed in low fat beefburger formulations. Beefburgers formulated to have 10% fat were tested for water holding capacity (WHC), cook yield, retention of shape, sensory and mechanical textural analysis. There were significant differences($p<0.05$) in cook yields between the different ingredients used. The Manugel/CaL beefburger had the best cook yield at 74% and had good textural qualities, but scored low in overall flavour. Most additives tested did increase the WHC by comparison with the full fat control, which had a WHC of 30.1%. Sensory analysis showed that beefburgers containing Tapiocaline Ex533, Carbelac 35, Slendid and Avicel RCN-30 scored high in flavour and overall quality. In contrast the beefburger with Plasmapowder U70 had poor overall quality and flavour attributes.

INTRODUCTION

The nutritional quality of food has emerged as a major concern of todays consumer. Many consumers are currently limiting the amount of fat and calories in their diets, they select food products that contain less fat. These attitudes are also reflected in their meat selections. Of all the nutritional concerns with food, American consumers rank fat and cholesterol first on their list (Bruhn *et al.*, 1992). In this study health concerns and dieting were the main reasons given by respondents for eating less red meat.

It is not a simple matter of using less fat in formulations. Fat greatly influences the sensory properties of the finished product. Humans have an in-built recognition for fat which plays a role in food acceptance (Mela, 1990). Fat has a profound effect on the rheological and structural properties of meat products. It effects hardness, softness, juiciness and chewiness of the finished product. Fat also effects flavour, it is the precursor of a large number of flavour compounds. Also, many volatile aroma compounds are fat soluble rather than water soluble and the relative amounts of these two media in the food will affect the way the volatiles are released, both before eating (odour) and during chewing. Several studies (Cross *et al.*, 1980; Egbert *et al.*, 1991; Berry, 1992; Troutt *et al.*, 1992; Millar *et al.*, 1993) have shown that production of low fat ground beef through simple fat reduction would substantially decrease product palatability, flavour intensity, juiciness and tenderness.

Therefore, many low fat meat products contain fat substitutes which act as texture modifying and water binding agents. These fall under three categories:

(a) Non-meat proteins e.g. soya and milk proteins(whey proteins and caseins).
(b) Carbohydrate based e.g. carrageenan, maltodextrin, starches, oat fibre.
(c) Functional blends.

A number of studies(Egbert *et al.*, 1991; Troutt *et al.*, 1992; Berry and Wergin; 1993) have shown that some of these ingredients have improved the eating quality of low fat beefburgers. The aim of this study was to compare a range of commercially available ingredients in the production of low fat beefburgers with regard to physicochemical, mechanical and sensory properties.

MATERIALS AND METHODS

Beefburger Manufacture: Appropriate amounts of lean beef(90%) flank and fat trimmings from Hereford Cross heifers were used to manufacture batches of low fat beefburgers with fat levels of 8-12%, each containing the following fat replacing ingredients, Danagel GB 1 containing carrageenan (FMC Corp.), Genugel MG 11 containing carrageenan and locust bean gum and Slendid containing pectin (Copenhagen Pectin), Maltrin MO40 containing maltodextrin (Grain Processing Corp. USA), Leanbind containing modified food starch (National Starch & Chemical USA), Tapiocaline EX533 containing tapioca starch (Tipiak), Soyamin 70 containing soya protein concentrate and Soyamin 90 containing soya protein isolate (Lucas Meyer), Carbelac 35 containing whey protein concentrate 35% (Carbery Milk Products), Alacen 152 containing whey protein concentrate 80%, Alanate 195 containing sodium caseinate and MPC 195 containing milk protein concentrate (New Zealand Milk Products), Plasmapowder U70 and Protoplus U70 containing blood proteins (Harimex Biochemical Products), Avicel PH101 containing microcrystalline cellulose, Avicel RCN-30 a coprocessed mixture of microcrystalline cellulose, maltodextrin and xanthan gum, MicroQuick WC-595 a combination of microcrystalline cellulose, dried whey and sodium carboxymethylcellulose (FMC Corp.), Advanced Oat Fibre #770 (Williamson Fibre Products) Fat Replacer #786 a functional blend containing carbohydrates (maltodextrin, vegetable fibre), egg albumin, stabiliser (E407) and flavour (Vassen-Schoemaker, Chemische Industrie B.V.), Manugel\CaL* containing sodium alginate and calcium lactate (Kelco International), Collagen Fibre (Stork), Raftiline ST containing inulin (Raffinerie Tirlemontoise S.A.). Two controls,

* subject to U.S. patent owned by Colorado State University Research Foundation (CSURF)

a full fat control(23% fat) and a low fat control(10% fat) were also manufactured similarly. Once formed the beefburgers (113g) were immediately blast frozen at -20°C. They were stored at this temperature until required.

Water Holding Capacity: The WHC was determined using centrifugation (9000×g at 4°C for 10 min) using modifications of the method of Liangi and Chen (1991).

Cooking Protocol: Beefburgers were cooked from a frozen state in a preheated setting 5 electric Trinity grill for 10 min and turned over every 2 mins until an internal temperature of 71°C for each burger was reached.

%Cook Yield: This was determined by calculating weight differences in beefburgers before and after cooking by equation (Berry, 1992). Both percent change in beef burger diameter and thickness were determined by calculating difference for beefburgers before and after cooking by equation (Berry, 1992).

Sensory Analysis: Beefburgers were cooked to procedures previously described. A 8-10 member in-house taste panel evaluated the beefburgers for a number of textural , flavour and overall quality attributes as described by Jeffery and Lewis (1983). Tenderness, crumbliness, moistness\juiciness and meat flavour were evaluated by means of eight-point structured scales (8=extremely tender, crumbly, juicy and intense; 1= extremely tough, cohesive, dry and bland respectively). Overall flavour and texture were ranked on five point structured scales (5=very good: 1=very poor). Musty\earthy(non-burger flavour) and overall acceptability (6=none and extremely acceptable; 1=extremely intense and not acceptable respectively). Fatty flavour was ranked on a four point scale (4= none; 1=very fatty).

Mechanical Texture Analysis: Each cooked beefburger was compressed in 5 locations with a punch and die (Jones *et al.*, 1985), attached to an Instron Universal Testing Machine, Model 1140. The punch travelled at 10 cm\min, 1.0 cm into the die and then returned to the starting position 2.5 cm above the die. Instrumental values from the compression test included resistance to deformation (N\cm), compressive strength (N\cm^2) and residual strength (N\cm^2).

RESULTS AND DISCUSSION

There were significant differences ($p<0.05$) in cook yields between the different ingredients used. Beefburger cook yields (Table 1) were highest for burgers containing Manugel\CaL (73.9%), Advanced Oat Fibre (66.5%) and Tapiocaline EX533 (64.4%). The majority of beefburgers including both controls had cook yields between 60-65%. In contrast, the beefburger containing Maltrin MO40 had the lowest cook yield (54.8%).

Both reduction in diameter and thickness (Table 1) were significantly different ($p<0.05$) between the various ingredients. The Manugel\CaL beefburger retained its shape to the highest degree with a reduction in its diameter of 16%. Most burgers including both controls had a reduction between 18-22% in their diameter, the beefburger containing Maltrin MO40 had a reduction of 24.5% in its diameter.

Most of the additives tested resulted in an increase in WHC (Table 1) by comparison to the full fat control, which had a WHC of 30.1%. Beefburgers containing Manugel\CaL, Tapiocaline EX533 and Leanbind

had the highest WHC values of 41-46%. Most beefburgers, including the low fat control, had WHC values between 33-40%. However, beefburgers containing Maltrin MO40, Soyamin 90 or Slendid had the lowest WHC values between 22-30%.

The sensory panel (Table 2) detected no differences ($p>0.05$) in crumbliness and meaty flavour. However, there were significant differences ($p<0.05$) in tenderness, moistness\juiciness, fatty flavour, musty\earthy(non-burger flavour), overall flavour, acceptability and texture. Beefburgers containing Manugel\CaL and Fat Replacer #786 were found to be the most tender and juicy (Table 2). The low fat control was found to be one of the least tender and driest of the beefburgers examined. Millar *et al.* (1993) found a similar result for the low fat treatments without added water, the beefburgers being lower in juiciness, texture and overall palatability. For overall quality, panelists ranked burgers containing Carbelac 35, Danagel GB 1, Slendid or Advanced Oat Fibre with best overall flavour while burgers containing Plasmapowder U70, Maltrin MO40 or Fat replacer #786 were ranked the lowest.

Many instrumental methods attempt to imitate some aspect of mastication. The action of the commonly used devices has been analysed by Voisey (1976). The punch and die takes the engineering approach recommended by Mohsenin (1970) to measure the failure properties of beefburgers (Jones *et al.*, 1985). Jones *et al.* (1985) showed that beefburgers with higher compressive strength i.e. tougher burgers had more protein and particularly more collagen. They found that they were coarse, more rubbery and overall their texture was more acceptable if not comminuted excessively. The low fat beefburger containing Alacen 152 had the highest compressive strength at 7.15×10^4 N\m^2 (Table 3) and the highest overall texture (Table 2). In this study compressive strength had a high negative correlation($r = -0.81$) with the tenderness attribute. However, the other two parameters measured by the punch and die, the resistance to deformation and the residual strength had very low correlations with any of the textural attributes measured in the sensory analysis.

CONCLUSIONS

The study showed that there was no ideal fat replacer but some have the potential for improving the palatability of low fat beefburgers. Best results were obtained with Tapiocaline EX533, Carbelac 35, Slendid, Danagel GB1 and Advanced Oat Fibre which compared well to the full fat control. Some ingredients such as Manugel\CaL and Plasmapowder U70 had good functional properties but were ranked low by panelists in flavour attributes . Further work is required to determine a mechanical test for determining the textural attributes perceived by taste panels of low fat beefburgers.

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