GRIND SIZE, PROCESS TEMPERATURE, AND MIXING TIME EFFECTS ON BEEF PATTY TEXTURE AND COOK YIELD

Swan, J.E., Cooper, R.J., Hall, W.K.
Department of Materials and Process Engineering, University of Waikato, Private Bag 3105, Hamilton, New Zealand

Background

Patties and hamburgers are considered convenience foods and this market is a large sector of the meat industry in countries such as the United States of America and United Kingdom. For instance, patties comprise 16% of the meat in meals eaten away from home in the United Kingdom (Fisher, 2001). Japan is also an emerging market for patties. The traditional patty is made from beef and can contain up to 30% fat. Usually low-cost meat cuts and trimmings are used in patty formulations but other ingredients such as mechanically separated beef and/or partially defatted beef fatty tissue may also be incorporated. Ingredients such as non-meat proteins, binders, extenders, and water may be used for their functional properties and/or to reduce raw material costs. Seasonings may be added. Many major fast food restaurants use hamburgers made solely from meat, without any binders or extenders.

The general processing method is to coarsely grind (hole plate size of 8-12 mm) chilled and/or frozen meat. Flaked meat can also be used. The fat content of the patties and hamburgers is regulated by combining meat and trimmings. Any non-meat ingredients are then blended in and the mixture may then be reground through a finer plate before being formed into patties. These patties may be stored chilled or frozen, may be raw or pre-cooked. Factors that consumers consider important are composition, colour, texture, appearance and microbial quality. The manufacturer is interested in bind, cook yield (especially when providing pre-cooked patties that need to meet minimum net weight specifications), shrinkage, and loss of shape. Recent literature reports on the effect of factors such as boning method (Farouk *et al*., 2000), processing method (Liu and Berry, 1998), fat and fat substitutes (Ju and Mittal, 1999), cooked colour (Berry, 1998; Berry and Bigner-George, 2000), storage method (Bigner-George and Berry, 2000), cook temperatures (Berry *et al*., 2001) and porosity and pore size distribution (Ngadi *et al*., 2001) on patty characteristics.

Objectives

Most of the manufacturing beef produced in New Zealand, after being hot or cold boned, is boxed, frozen and exported to markets in North America and Asia. Much of this beef is used in hamburger and patty formulations, where it helps standardize the fat content of the mix and/or maintain lower processing temperatures during the grinding. The objectives of this research were to investigate the effect of initial processing temperature (-2, 4, 10°C), grind size (4- or 8-mm) and mixing time (1, 3 or 5 min) on cook yield and objective texture of standardized beef patties.

Methods

Boxes of frozen 70% chemical lean (CL) beef trimmings in 27.2-kg cartons were obtained from a commercial hot boning meat packer. The cartons were transported to the laboratory and stored at -20°C. When required, the frozen cartons were tempered at 0°C for 24 h and then at 10°C for a further 12 h. Subsequent processing was done in a 10°C processing room. The meat was cut into strips, chunked through a three-hole kidney plate and then minced through a 4- or 8-mm plate. Batches (2.45-kg) of mince were packed into polyethylene bags and stored at -2, 4 or 10°C for 20 h to temper the meat to its pre-processing temperature.

The patties were produced by mixing the ground meat, 30 g salt and 17.5 g of seasoning mix for 1, 3 or 5 min in a model A200 Hobart mixer (Hobart Corp., Troy, OH) fitted with a paddle blade on speed 1. The salt was added gradually during the first 10 sec to ensure even distribution. The mixture was then loaded into a patty former (Nippon-Career CF15, Japan) and formed into oval patties with dimensions of 90-mm x 75-mm x 10-mm (average weight, 57 g). A single layer of patties was put onto non-stick plastic sheeting on metal trays and frozen and -20°C for 24 h.

The chemical composition of the patty mix was determined by mincing about 400 g of the mix through a 6-mm plate and then remincing it twice through a 3-mm plate. Random samples were then analysed in duplicate for moisture (AOAC, 1990) and fat (Lambden and Chadwick, 1986). The protein content of the meat was determined by difference. The ash content was assumed to be 0.5% of protein content. To determine cook yield, six raw frozen patties per treatment were weighed together. The patties were then cooked on a Hayman hotplate (Model PG30, Dishmaster Manufacturing Ltd, New Zealand) set at 170°C, for 5 min on each side. Immediately after being cooked, the patties were blotted gently on each side with paper towels and reweighed together while still hot. Cook yield was the mean of the cooked weight expressed as a percentage of the raw weight. The objective patty texture was measured as compressive strength at failure using the punch and die apparatus described by Jones *et al*. (1985). The apparatus was mounted on a Model 4301 Instron Universal Testing Machine (Instron Limited, High Wycombe, England). Immediately after cook yield was determined, a 20-mm punch, mounted on a Model 4301 Instron (Instron Ltd, High Wycombe, England), was lowered through the die and patty at a crosshead speed of 100 mm min^{-1}. The peak force (N) required to drive the punch through the patties was recorded. Three holes were punched in three of the six cooked patties from each treatment.

The effect of process temperature, grind size and mixing time on average cook yield and texture of patties was replicated five times. Data were analysed by simple analysis of variance using Genstat (1993). The project was a completely random design. Means were separated using least significant differences.

Results and discussion

Meat temperature increased an average of 4°C during mincing and 2°C during mixing and patty forming, regardless of initial meat temperature. The raw patty mixes had a final composition of approximately 61.5% moisture, 7.2% protein, 29.4% fat and 1.3% ash.

Cook yield and peak force were similar to those of patties with similar fat contents reported in previous work (Farouk *et al*., 1999; Farouk *et al*., 2000). There was a significant (P=0.007) interaction between grind size and processing temperature for both cook yield and peak force but no other significant interactions. Means for the effects of process temperature, grind size and mixing time on cook yield and peak force are presented in Table 1.

Patties made from meat processed at lower temperatures had similar cook yield and tenderness (Table 1). Cook yield and peak force decreased (more tender patties) if processing temperature increased to 10°C. Higher processing temperatures tend to increase shear of fat cells and therefore increase fat cook-out. Spadaro and Keeton (1996) reported that macroscopic observations indicated products with fat smeared surfaces and little or no particle definition tended to have lower tensile resistance than patties with normal and clear particle definition. Patties made from 8-mm mince had a significantly ($P<0.05$) higher cook yield and were significantly ($P<0.05$) less tender then patties made from 4-mm mince. Grinding to a smaller size reduces muscle fibre and collagen size, which helps increase tenderness. A smaller grind size can improve tenderness without affecting flavour or juiciness (Berry *et al.*, 1999). Mixing the patties for three minutes increased cook yield and markedly decreased tenderness ($P<0.05$) but further mixing did not significantly change cook yield or peak force. Increased mixing extracts more salt-soluble proteins. These would coagulate during cooking and help bind the moisture and fat. Peak force and cook yield are usually inversely related. However, the opposite effect was observed in this trial.

Table 1. Effect of process temperature, grind size and mixing time on cook yield and peak force of beef patties.

	Cook yield, %	Peak force (N)
Process temperature, °C		
-2	68.4	132
4	68.2	132
10	66.1	123
LSD (5%)	1.00	6.4
Particle size, mm		
4	67.1	121
8	68.1	137
LSD (5%)	0.80	5.2
Mixing time, min		
1	66.3	115
3	68.0	134
5	68.4	138
LSD (5%)	1.00	6.4
Size x Temperature		
4 mm x -2°C	67.6	129
4 mm x 4 °C	67.1	122
4 mm x 10 °C	66.5	113
8 mm x -2 °C	69.3	135
8 mm x 4 °C	69.4	141
8 mm x 10 °C	65.7	134
LSD (5%)	1.38	9.0

Conclusions

Grind size, process temperature and process time affect the cook yield and texture of cooked beef patties. In general, higher cook yield and more tender patties were obtained by using smaller meat particles, processing at lower temperatures and mixing for moderate times.

Pertinent literature

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