MODIFIED BEEF CONNECTIVE TISSUE AS AN INGREDIENT IN LOW-FAT GROUND BEEF PATTIES.

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SUMMARY

Beef connective tissue is an abundant by-product of large mechanical desinewing operations. Modification of this connective tissue by freezing and flaking yields a material that had been shown to improve texture and palatability of a variety of meat products. Connective tissue from one or two passes through a desinewing machine was modified (MCT) and added at three levels (8, 16 and 24%) to low-fat ground beef (10-12% fat) patties. These formulations were compared to 10% and 15% control patties. Sensory tenderness improved ($P<.01$) with increasing levels of MCT. Flavor scores decreased ($P<.05$) at 24% added MCT. HunterLab Colorimeter lightness increased in raw patties and decreased in cooked patties ($P<.01$) with the addition of MCT. Raw patties containing MCT expressed more ($P<.01$) moisture than 10% fat control patties. Cooked patties with MCT had less ($P<.01$) expressible moisture than either control formulation. Increasing levels of MCT reduced peak shear force values to near that of the 15% fat control. The MCT, from either pass, increased ($P<.01$) objective hardness, chewiness and springiness over control patties. Increasing levels of frozen, flaked beef connective tissue improved sensory tenderness and shear force values of low fat ground beef patties.

Introduction

Incorporation of connective tissue or high collagen meats into processed meat products has been investigated as a way to decrease ingredient costs and modify texture (Rao and Henrickson, 1983; Eilert et al., 1993). An increasing amount of connective tissue is being produced as beef packers install desinewing machines to upgrade lean trimmings. Use of this connective tissue in meat products would be advantageous to beef packers if product acceptability can be maintained or improved. Most processors utilize a two-pass desinewing process to maximize lean meat yields. Processors might be inclined to use a one-pass process to leave enough lean tissue on the connective tissue so that the material can be labeled as "beef".

To decrease the detection of connective tissue in processed meats, Lockhorn (1987) developed a modification procedure for beef connective tissue from a desinewing machine that reduces particle size to 1.5 mm. This particle reduction was proven advantageous for an emulsified product by Eilert et al. (1993) but has not been investigated in a ground beef patty. Chavez et al. (1985) investigated the use of bovine hide collagen in ground beef patties and found improvements in sensory juiciness and decreases in shear force with increases in added collagen. These advantages combined with the particle reduction accomplished by Lockhorn (1987) merit study in a low-fat ground beef system where texture and palatability are compromised due to fat reduction (Troutt et al., 1992). The objectives of this study were to characterize the effects of adding different levels of modified beef connective tissue (MCT) to low fat ground beef patties and compare the use of first pass MCT to second pass MCT in these patties.

Materials and Methods

Frozen beef trimmings (obtained from USDA Choice and Select carcasses) were tempered and coarse ground through a 2.54 cm plate. Samples were taken for fat determination. Beef connective tissue obtained from a commercial packer was frozen (-26°C) before use. Frozen connective tissue was tempered, ground with a double plate grinder (kidney-shaped and 1.27 cm plates) and refrozen (-26°C). Ground, frozen connective tissue was flaked 15 hr later using a 1.5 mm head on a Comitrol (Model 3600, Urschel Laboratories, Inc., Valparaiso, IN) and held at -26°C until production. Three replicates of eight treatments were manufactured: 10% fat, no MCT; 15% fat, no MCT; 10% fat with 8 or 16 or 24% first pass MCT; 10% fat with 8 or 16 or 24% second pass MCT. Coarse ground beef trimmings and frozen MCT were mixed for 5 min, reground through a 0.32 mm plate and formed into patties (113 g/ patty). Patties were double bagged in polyethylene and stored at -17°C for further analysis.

Patties were cooked from the frozen state (A.M.S.A., 1983) on a 164.5°C electric grill. Patties were turned at 1, 2.5 and 4 min and removed at 5 min. This cooking schedule left no pink color internally. After being removed from the cooking surface, patties were gently blotted with paper towels. Two raw and two cooked patties were randomly selected and powdered in liquid nitrogen for proximate analysis (A.O.A.C., 1990). Samples of raw patties were collected for pH determination, and samples of cooked patties collected for collagen analysis (Eilert and Mandigo, 1993; Bergman and Loxley, 1963). Raw and cooked expressible moisture determinations were performed on duplicate 3 g samples of two homogenized patties using the centrifugation method described by Bouton et al. (1971).

Four raw patties per formulation were placed on foam meat trays, overwrapped and stored 18 hr in a dark cooler. Three readings on each patty were taken on a HunterLab Colorimeter (HunterLab Model Labscan 6000, Hunter Associates Laboratory, Reston, VA) to determine "L," "a" and "b" values. Similar color analysis was conducted on four cooked patties. Samples (2 cm x 2 cm) were cut from cooked patties and served to a consumer sensory panel. Panelists were asked to evaluate samples for tenderness, juiciness, flavor and overall acceptability using an eight point scale where 1=extremely undesirable and 8=extremely desirable. Kramer Shear and compression tests were conducted using an Instron Universal Testing Machine (Model 1123, Instron Corporation, Canton, MA). Hardness, cohesiveness (Bourne, 1968), chewiness and springiness (Bourne, 1978) were obtained from the two cycle compression test.

This experiment was conducted as a randomized complete block design, with replicate as blocking criterion. Means were separated using Fisher's least significant difference test (Steel and Torrie, 1980). Contrast statements were used to detect differences in first and second pass MCT and linear trends due to MCT level.

Results and Discussion

Raw patty fat ranged from 8.6% for the low-fat control formulation to 14.7% for the higher fat control formulation (Table 1). The steadily increasing amount of fat as percent added MCT increased is due to the fact that the MCT contained 21.3% and 24.2% fat for first and second pass, respectively. The higher fat formulation had less (P<.01) protein and moisture on a percentage basis when compared to other formulations. Soluble, insoluble and total collagen content (Table 1) of cooked patties increased (P<.01) in a linear fashion with increasing MCT. Patties made with second pass MCT contained more (P<.01) collagen than patties made with first pass MCT due to higher collagen levels in the second pass MCT. Patties made with MCT had higher (P<.01) pH values (Table 1) than higher fat control patties. This is a result of the addition of first or second pass connective tissue, pH 6.22 and 6.45, respectively, which is higher than that of normal post-rigor beef. The amount of expressible moisture of raw patties (Table 1) increased (P<.01) with increasing amounts of added MCT over the low-fat control, but was still less than that of higher fat control patties. It is likely that MCT physically disrupted myofibrillar protein water binding resulting in a higher percent expressible moisture. With higher levels of MCT, cooked patties expressed less moisture (P<.01; Table 1). The gelatinization of collagen binds and holds water better than myofibrillar proteins. The addition of second pass MCT, which contains more collagen, resulted in patties that expressed less (P<.05) moisture than patties made with first pass MCT.

Raw patties with added MCT were lighter (higher "L" values, Table 1) than low-fat control patties and more red (higher a values) than either control formulation. Patties made with second pass MCT were significantly lighter (P<.01) than first pass MCT patties since the second pass MCT contains proportionately less myofibrillar and sarcoplasmic protein. The 15% fat control patty had the lightest cooked color (P<.01). HunterLab "a" and "b" values of cooked patties were not affected by treatment (P>.05).

Sensory tenderness increased (P<.01) while flavor of patties decreased (P<.05) due higher levels of MCT. Chavez et al. (1985) also noted an increase in crumbliness and a decrease in flavor scores due to hide collagen addition. The desirability of patty flavor decreases as myofibrillar proteins are diluted with added MCT. Interestingly, 15% fat control patties scored lower than other formulations for flavor desirability. This contradicts the findings of past research which found no differences in beef flavor intensity due to fat level (Cross et al., 1980; Kregal et al., 1986). Sensory juiciness and overall acceptability were not affected (P>.05) by formulation. Other researchers found decreases in patty acceptability due to collagen addition

(Chavez et al., 1985). The means for these variables indicate that patties made with 8%, first pass MCT scored lower in sensory tenderness, juiciness and overall acceptability than other MCT formulations.

Adding MCT at the 24% level decreased ($P<.01$) Kramer area under the curve values (Table 2) indicating that the patties required less total energy to shear than low-fat patties made without MCT. Higher fat control patties required less total energy to shear than patties made with 24% MCT. Second pass MCT addition (24%) decreased ($P<.01$) peak force to shear (Table 2) to near the level of higher fat control patties. Addition of MCT tended to decrease peak force to shear when compared to low-fat control patties. These data are supported by Chavez et al. (1985) who found that hide collagen additions of 10 and 20% to 25% fat beef patties decreased peak force to shear. Opposite effects on shear values were noted in finely comminuted products (Rao and Henrickson, 1983; Eilert et al., 1993). The addition of MCT increased ($P<.01$) patty hardness, chewiness and springiness (Table 2) which is in agreement with Eilert et al. (1993) for 16 and 24% fat frankfurters. Patties made with second pass MCT were chewier and springier than patties made with first pass MCT. Cohesiveness was not affected by treatment ($P>.05$).

Conclusions

Second pass MCT, which is higher in collagen, has advantages over first pass MCT in water retention and decreased peak force to shear. However, it results in patties that are lighter in color and may have more complicated label ramifications. Sensory tenderness, Kramer shear and expressible moisture improvements make connective tissue an attractive ingredient for use in LFGB if the diluting effect of connective tissue on sensory flavor can be compensated for by using salt or another flavor enhancer. Patties made with MCT, especially at high (16 or 24%) levels, were found to be overall as acceptable as low-fat patties made with no MCT and more acceptable than 15% fat patties in terms of sensory tenderness and overall acceptability.

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