MANUFACTURE OF COLD EXTRUDED RESTRUCTURED PORK CHOPS WITH DENUDED HAM MUSCLE.

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SUMMARY

Techniques for cold extrusion processing of restructured pork chops were investigated. Six treatment combinations of extruded chops (EC) were manufactured with three extrusion speeds (200, 300 and 400 rpm) and two mixing times (20 and 40 min). Control chops (CC) were prepared from intact pork loin muscle. Chops were cooked to 72°C on a flat top grill prior to evaluation. Consumer panelists indicated EC were more desirable for texture, flavor and overall acceptability ($P<0.01$). Instron compression data revealed CC were harder, more cohesive, chewier and less springy than EC ($P<0.01$). Control chops required less total work ($P<.05$) to shear and more peak force to shear ($P<.01$) than EC. HunterLab colorimeter analysis showed raw EC were darker, more red and more yellow ($P<.01$) than CC. Cooked EC were darker, less red and less yellow ($P<.01$). Extrusion speed and mixing time had no effect ($P<.05$) on any of the variables measured. Cold extrusion technology can be used to manufacture restructured pork chops that have more desirable texture and palatability than intact loin chops.

Introduction

Considerable research has been conducted in the area of restructured meats since the late 1960's in an attempt to simulate the textural and sensory properties of intact steaks. The basic premise in most restructuring attempts is the extraction of myofibrillar proteins through physical cell disruption in the presence of salt. A matrix can thus be developed between meat particles consisting of extracted myofibrillar proteins, salt and water. Products are then normally formed into logs and sometimes pressed into steak or chop shapes. In the uncooked state, binding is achieved through freezing, and upon cooking the matrix is stabilized by gelation of the proteins.

There are two schools of thought when reviewing texture of restructured products. Some researchers believe the goal of restructuring is to simulate intact muscle texture (Huffman and Cordray, 1979; Booren et al., 1981) and others believe restructured products are of "intermediate value", with texture somewhere between ground meat and intact muscle products (Breidenstein, 1982; Smith, 1982). Texture can be modified and improved by comminution method. Flaking, chunking, slicing and grinding have all been implemented in restructuring of meat products as methods of comminution. These methods have been reported to influence binding and textural analysis.

Improvements in mechanically deboned chicken meat texture through warm extrusion have been reported. (Maurer, 1979). A relatively new method of textural improvement involving cold extrusion has been introduced (Yuan, 1992). He used cold extrusion technology as a texture modifying step to produce restructured pork chops.

The objective of this study was to evaluate various extrusion speeds and mixing times on textural, color and organoleptic properties of cold extruded restructured pork chops.

Materials and Methods

Fresh denuded pork hams from a commercial source were course ground through a 2.54 cm plate and mixed for 20 or 40 min, depending on treatment specifications. Salt (0.25%) and sodium tripolyphosphate (0.5%) were added during the initial mixing period (within 1 min of start time).

A Wenger TX 52 (Wenger Manufacturing, Sabetha, KS) twin screw extruder was used with a screw configuration, consisting of 3/4" pitch screws, 1/2" pitch screws, cone screws, circular locks and shear locks.

The twin screws moved in a co-rotating motion as they conveyed the mixed meat formulation through the extruder horn. The die configuration consisted of a circular opening, 10 mm in diameter, through which product would continuously flow. The extruder horn was equipped with a cold water jacket with a constant temperature of 2°C. The product was extruded at 200, 300 or 400 rpm. Extruded ropes were placed on stainless steel trays lined with polyethylene. Product was frozen for at least 6 h at -10°C and then tempered for 12 h at -2°C. The tempered, extruded ropes were pressed into large diameter logs resembling a boneless loin roast. The logs were cleaved into 2.54 cm thick chops.

Boneless 414 (NAMP, 1990) loin chops were used as controls. Control chops (2.54 cm) were removed from the center loin and all visible fat was removed. All chops (extruded and control) were vacuum packaged in and stored at -17°C for 14 days.

Chops were tempered at 0°C for 12 h and cooked on a flat top grill pre-heated to 176°C. Chops were turned at 7.5 min and removed at an internal temperature of 72°C. Chops were blotted after cooking to remove grease. Four chops from each treatment were evaluated for cook loss. Two raw and two cooked chops were randomly selected for fat, protein, moisture and ash analysis (AOAC, 1990). Four chops were analyzed for raw and cooked color using a Hunter tristimulus colorimeter (HunterLab, Model Labscan 6000, Hunter Associates Laboratory, Reston, VA). Raw chops were analyzed in the tempered state and cooked chops were cooled 15 min prior to color evaluation. Values were recorded for three "L", "a" and "b" readings per chop.

Four chops were allowed to cool for 25 min and evaluated on an Instron Universal Testing Machine (Model 1123, Instron Corporation, Canton, MA) for compression and Kramer shear analysis. Chops were compressed to 25% of the original chop height in a two cycle compression test. Values from the resulting compression curves were used to calculate hardness [peak force of compression cycle 1], cohesiveness [area under curve 2/ area under curve 1], springiness [width of compression cycle 2] (Bourne, 1978) and chewiness [hardness x cohesiveness x springiness] (Bourne, 1968). Instron settings for the compression test included load cell=2500 g; full scale load = 500 kg; cross head speed = 50 mm/min; chart speed=2:1.

Samples (4 x 4 cm) were cut and weighed for use in the Kramer shear cell. Peak force and area under the curve measurements for each of the four samples were reported as maximum force to shear per gram and total force to shear per gram, respectively. Instron settings for the Kramer shear were as follows: load cell=2500 kg; full load scale=50 kg (extruded chops) and 100 kg (intact boneless chops); Cross head speed=50 mm/minute; chart speed=2:1.

Cooked chop samples (1 cm x 1 cm) were held warm in double boilers a maximum of 15 min and served warm to a consumer sensory panel. Panelists (n=50) were seated in individual cubicals under red lighting. Samples

were evaluated for texture, flavor, juiciness and overall acceptability on an eight point hedonic scale where 1=extremely undesirable and 8=extremely desirable.

Data were analyzed with the general linear models procedure of SAS (SAS Institute, 1985). Means were separated by Fisher's protected Least Significant Difference test.

Results and Discussion

No significant differences existed due to extrusion speed, mixing time or the combined effect of extrusion speed and mixing time for any of the variables tested. Raw control chops were ($P<.01$) lower than extruded chops in moisture and ash (Table 1). Differences in ash were due to addition of salt and phosphate to extruded chops. A similar relationship for cooked chops was found ($P<.01$). No differences ($P<.01$) were detected for protein or fat in the raw state. Cooked control chops were ($P<.01$) higher in fat and protein.

Raw and cooked control chops were lighter ($P<.01$) than extruded chops (Table 1). Raw extruded chops had ($P<.01$) higher "a" values (redder) than control chops. These color differences would be expected to occur since extruded chops were formulated with a darker lean than the longissimus muscle of the control chops. After cooking, this relationship changed. Cooked control chops were ($P<.01$) redder than extruded chops. A similar relationship for "b" values in extruded chops was found. Raw extruded chops were more yellow ($P<.01$) than control chops. Cooked control chops were ($P<.01$) more yellow than extruded chops. This may be due to the dispersion of fat particles in the extruded chops versus natural marbling in the control chops.

Control chops were harder, chewier, springier and more cohesive ($P<.01$) than extruded chops (Table 2). This is supported by Huffman et al. (1984) and Demos et al. (1994). These researchers reported intact beef loin steaks were more cohesive than restructured beef steaks. Extruded chops had lower (P<.05) values for Kramer peak force per gram and higher values for area under the curve per gram (P<.01) than the control chops (Table 2). Extraction and binding of myofibrillar proteins in extruded chops versus the intact muscle control may be a contributing factor. Modification of the meat protein matrix through extrusion processing could explain the

increased energy to shear the sample (increased area under the curve). Increases in bind strength may be explained by the potential realigning of muscle fibers forming a rigid, almost intact-like structure.

Extruded chops were more desirable (P<.01) in taste panel texture, flavor and overall acceptability than control chops (Table 2)). There was no difference (P>.05) for sensory juiciness between the control chops and the extruded chops. Johnson et al. (1990) reported no differences were detected for juiciness or overall acceptability between intact muscle and comminuted restructured steaks. These researchers reported intact muscle steaks received more desirable flavor scores than restructured steaks. Demos et al. (1994) found restructured beef steaks manufactured without salt or phosphate were less juicy and desirable than intact beef steaks. Extrusion processing has produced a desirable product in texture, flavor and overall acceptability when compared to boneless loin chops.

There was no difference (P>.05) among treatments for cook yield (data not shown). This indicates that extruded chops, with addition of salt and phosphate, were comparable in cooking yield to that of the intact muscle control. Demos et al. (1994) found no differences in cook yield between restructured beef steaks made without salt and phosphate and intact beef steaks. These results conflict with Johnson et al. (1990) who reported cooking losses were greater for intact muscle steaks than for restructured steaks.

Conclusions

Results of this study indicate that cold extruded restructured pork chops made from denuded ham muscles had palatability equal to or better than intact boneless loin chops. Intact muscle control chops were harder, chewier and more cohesive than extruded pork chops. Textural differences were also detected by the consumer taste panel which rated the extruded chops more desirable. Panelists also preferred the flavor and overall acceptability in the extruded chops to that of the intact muscle control chops. Extruded chops were comparable to control chops for cooking loss. This study indicates that extrusion technology can produce meat products with similar attributes to that of intact muscle.

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