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ABSTRACT Spent fowl muscle (raw or precooked) was flaked and formulated to include: 1) 100% raw meat; 2) 80% raw meat and 20% precooked meat; 3) 50% raw meat and 50% precooked meat; and 4) 20% raw meat and 80% precooked meat. The products were mixed, formed, pressed, and cut into restructured steaks. Steaks were evaluated for physical appearance, fat, and moisture content, cooking and textural properties, and sensory attributes. As the percentage of precooked spent fowl meat was increased in restructured steaks, the steaks appeared lighter in color, contained less moisture and more fat, and suffered greater cooking losses than restructured steaks made with a higher percentage of raw meat. In addition, as the percentage of precooked meat was increased, the restructured steaks became less tender, less cohesive, and received lower sensory scores.

(Key words: spent fowl, restructured steaks, flaked meat)

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INTRODUCTION

Precooking of whole spent fowl carcasses would aid in muscle removal from the bone. However, the convenience of using precooked meat may be offset by flavor defects, believed to be caused by lipid oxidation and other factors associated with the development of stale, rancid, or objectionable flavors (Cipra and Bowers, 1970; Hegarty and Herring, 1973; Lineweaver and Pippen, 1961).

Another disadvantage of using precooked meat in restructured spent fowl steaks is the inability of the meat to bind together during cooking (Seideman *et al.*, 1982). Schnell *et al.* (1970) postulated that binding involves water-holding capacity, cell disruption, release of intercellular material, and physical and chemical changes in the proteins on heating. Hamm (1966) studied the changes which occur in meat proteins during cooking and stated that the changes were dependent on the temperature reached and the denaturation of the sarcoplasmic and contractile proteins.

This investigation was designed to evaluate the physical and sensory attributes of restructured steaks formulated using varying levels of raw and precooked spent fowl muscle.

EXPERIMENTAL PROCEDURE

Processing. Spent fowl carcasses (approximately 1 kg in weight) were purchased from a commercial processor. Half of the carcasses were chilled and manually deboned. The other half were cooked in a 1% sodium tripolyphosphate solution for 60 min at 68 C in a steam jacketed kettle before being deboned. Deboning consisted of removing the breast, thigh, and drumstick muscles. The raw and cooked muscles were then frozen and separately flaked through an Urschel Comitrol, Model 3600 (Urschel Inc., Valparaiso, IN). A 2K030240 head was used to yield flakes approximately 6 mm long. Four formulations were prepared as follows: 1) 100% raw spent fowl muscle; 2) 80% raw, 20% cooked spent fowl muscle; 3) 50% raw, 50% cooked; and 4) 20% raw, 80% cooked muscle. Each formulation was mixed with .5% NaCl and .5% sodium tripolyphosphate for 5 min in a ribbon mixer. After mixing, the meat was formed into cylindrical logs, vacuum packaged, and frozen at −20 C for 24 hr. The frozen logs were tempered to −5 C, pressed at 400 psi, and refrozen. Steaks (2 cm

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thick) were cut from the logs, wrapped for freezer storage, and stored at −20 C for less than 1 month. The steaks were tempered under refrigeration (4 C) for 24 hr before analyses.

Evaluation. The steaks were evaluated for physical appearance, textural properties, moisture and fat content, cooking loss, and sensory attributes. Evaluation under retail shelf conditions consisted of placing three steaks from each formulation on styrofoam trays, overwrapping with PVC film, and evaluating them under 60 ft-c (5.52 lx) of fluorescent light. An experienced 7 member panel evaluated each steak for muscle color employing a 5-point scale (5 = too dark; 3 = excellent; 1 = too light), surface discoloration using a 7-point scale (7 = no surface discoloration; 4 = 25% to 50% surface discoloration; 1 = total surface discoloration), and overall appearance according to an 8-point scale (8 = extremely desirable; 1 = extremely undesirable).

Cooking loss was calculated from the difference in weight of the restructured steaks before and after cooking. Four raw steaks were cooked on Farberware Open Hearth broilers to an internal temperature of 71 C as monitored by copper-constantan thermocouple wires placed in the geometric center of each steak.

The cooked steaks were then cooled to room temperature, cut into cubes (2 cc), and sheared. A PEP Texture Tester (Model TT2) equipped with a heavy duty test cell TT2-0004 (PEP Inc., Houston, TX) was used for shearing. This machine is a modified Lee-Kramer shear press giving values for deformation (an index of elasticity as measured by the length of the baseline) and stress (an index of strength as measured by height to the bioyield point). Area under the stress/deformation curve was measured as an index of work required to shear the sample.

Moisture and fat analyses were performed in duplicate on three cooked and three raw steaks from each formulation. The steaks were powdered in liquid nitrogen and analyzed for fat and moisture content by ether extraction and oven-drying, respectively (Association of Official Analytical Chemists, 1970).

An eight-member panel experienced in sensory testing of chicken products individually evaluated warm sample cubes (1.5 cm^3) from each formulation. The sample order was randomized and there was no control. Panelists were not informed as to the composition or treatment of the steak samples. Each sample was evaluated for flavor desirability, texture desirability, and overall palatability using an 8-point hedonic scale (8 = like extremely; 1 = dislike extremely). Juiciness evaluations were based on an 8-point scale (8 = extremely juicy; 1 = extremely dry) as were tenderness scores (8 = extremely tender; 1 = extremely tough). Texture description was scored on a 7-point scale (7 = extremely tough and rubbery; 4 = excellent; 1 = extremely mushy or crumbly).

Statistical Analyses. Data were analyzed by analysis of variance (Steel and Torrie, 1960) for the main effects and interactions. When significant ($P>.05$) main effects were observed in the analysis of variance, mean separation was accomplished by the use of Duncan's multiple range test (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Physical Appearance. The physical appearance of the restructured steaks was significantly affected by level of precooked and raw meat (Table 1). Steaks made with 50% or more precooked meat were significantly lighter in color than steaks made to contain 20% or less precooked meat.

Surface discoloration was not significantly affected by formulation (Table 1). Overall appearance ratings (Table 1) showed no significant differences in restructured steaks containing up to 50% precooked meat; however, restructured steaks made with 80% precooked meat were rated significantly less desirable than steaks from the other formulations. These data suggest that the percentage of raw spent fowl must remain high if the product is to be sold retail where the steak surface is visible to consumers. The low mean values for overall appearance suggest that this may be a substantial problem in retail sales of restructured chicken steaks.

Textural Properties. The use of precooked meat had no significant effect on elasticity as indicated by deformation values (Table 1). Restructured steaks containing over 50% precooked meat portrayed significantly higher stress values, indicating an increase in toughness (a less tender product). These findings are in agreement with Seideman *et al.* (1982), who reported that spent fowl restructured steaks made from precooked meat were less tender than steaks made from raw meat. These increased stress values can be attributed to the relative dryness and toughening of the precooked, individual meat flakes and not to the

TABLE 1. *Mean values for physical appearance and textural properties of restructured spent fowl steaks as affected by varying levels of raw and precooked meat*

Treatment	Physical appearance			Textural properties		
	Muscle color[1]	Surface discoloration[2]	Overall appearance[3]	Deformation[4]	Stress[5]	Area[6]
100% Raw	3.6[a]	6.2[a]	5.7[a]	2.4[a]	3.0[a]	151.75[a]
20% Precooked/80% raw	3.1[a]	6.0[a]	5.5[a]	2.5[a]	2.9[a]	150.44[a]
50% Precooked/50% raw	2.0[c]	6.3[a]	5.4[a]	2.5[a]	3.5[b]	172.89[b]
80% Precooked/20% raw	1.7[c]	6.1[a]	4.4[b]	2.4[a]	3.7[b]	186.33[b]

[a,b,c]Means in the same column followed by a common superscript letter are not significantly different (P>.05).

[1] Means based on a 5-point scale (5 = too dark; 3 = excellent; 1 = too light).

[2] Means based on a 7-point scale (7 = no surface discoloration; 4 = 25 to 50% surface discoloration; 1 = total surface discoloration).

[3] Means based on an 8-point scale (8 = extremely desirable; 1 = extremely undesirable).

[4] Deformation = length of base of stress-deformation curve in centimeters, an index of elasticity.

[5] Stress = height of bioyield point in centimeters, an index of strength required to shear the sample.

[6] Area = area under the stress-deformation curve, an index of work.

binding together of the meat flakes (Vadehra and Baker, 1970). Area values (Table 1) represent an index of energy required to shear a sample of the product and were closely related to the stress values.

Cooking Losses. Moisture and fat content was significantly affected by the level of precooked meat (Table 2). As the proportion of precooked muscle was increased in the formulations, the steaks contained less moisture (%) and more fat (%). Moisture and fat losses showed the steaks lost significantly more moisture and less fat during cooking when formulated with precooked meat as compared to restructured steaks made from raw spent fowl muscle. Seideman *et al.* (1982) found restructured spent fowl steaks made from precooked muscle to have lower initial moisture content and to lose less moisture during cooking than restructured steaks made from raw meat. However, Seideman *et al.* (1982) found no significant differences in fat losses from cooking between raw and precooked steaks.

Cooking loss was not significantly affected by formulation, although it did increase as the percentage of precooked meat increased (Table 2). Most of these losses can be attributed to moisture lost during cooking. Cooked meat has a lower water-holding capacity due to denaturation of muscle proteins.

Sensory Attributes. The level of precooked and raw meat significantly affected all sensory attributes tested (Table 2). Ratings for juiciness decreased as the percentage of of precooked meat was increased. This is in agreement with Seideman *et al.* (1982) who found the use of precooked chicken to result in less juicy steaks with higher moisture and cooking losses. It would appear that juiciness ratings of spent fowl are primarily affected by moisture in the product and not by fat as observed in other muscle foods. The low values for juiciness indicate a potential problem in restructured chicken steaks. Cash and Carlin (1968) also found that precooked turkey meat was less juicy and had a lower moisture content than fresh meat.

Tenderness ratings tended to decrease as the percentage of precooked meat increased in the formulation (Table 3). These values correlate with the stress values (Table 1) and with the moisture content (%) of the cooked restructured steaks (Table 2). Wagnen and Skala (1968) and Wells and Dawson (1966) found that poultry meat decreased in tenderness with

TABLE 2. *Mean values for percentages of fat, moisture, and cooking loss of restructured spent fowl steaks as affected by varying levels of raw and precooked meat*

Treatment	Raw steaks		Cooked steaks		Loss during cooking		Cooking loss[3]
	Moisture	Fat	Moisture	Fat	Moisture[1]	Fat[2]	
	(%)						
100% Raw	72.00^{c}	4.58^{c}	66.91^{a}	5.52^{c}	17.65^{b}	−6.93^{a}	11.70^{a}
20% Precooked/80% raw	70.65^{b}	4.75^{c}	66.59^{a}	5.71^{c}	16.41^{b}	−6.59^{a}	11.09^{a}
50% Precooked/50% raw	68.90^{c}	5.25^{b}	64.20^{b}	6.12^{b}	18.82^{b}	−1.59^{b}	12.88^{a}
80% Precooked/20% raw	66.09^{d}	6.27^{a}	59.23^{c}	7.38^{a}	23.48^{a}	−.49^{b}	14.62^{a}

a,b,c,d Means in the same column followed by a common superscript letter are not significantly different (P>.05).

[1] Computed as [(g moisture in raw patty) − (g moisture in cooked patty)] ÷ (g moisture in raw patty) × 100.

[2] Computed as [(g fat in raw patty) − (g fat in cooked patty)] ÷ (g fat in raw patty) × 100.

[3] Cooking loss = % weight loss due to cooking.

TABLE 3. *Sensory attributes of restructured spent fowl chicken steaks as affected by varying levels of raw and precooked meat*

Treatment	Sensory attributes					
	Juiciness[1]	Tenderness[2]	Texture desirability[3]	Texture description[4]	Flavor desirability[3]	Overall palatability[3]
100% Raw	5.4^{a}	6.0^{a}	5.3^{a}	4.7^{a}	5.5^{a}	5.4^{a}
20% Precooked/80% raw	4.8^{ab}	5.7^{ab}	5.3^{a}	4.9^{a}	5.5^{a}	5.3^{a}
50% Precooked/50% raw	4.4^{b}	5.4^{bc}	5.3^{a}	4.6^{a}	5.4^{a}	5.1^{a}
80% Precooked/20% raw	2.6^{c}	5.1^{c}	4.0^{b}	2.8^{b}	4.4^{b}	3.9^{b}

^{a,b,c}Means in the same column followed by a common superscript letter are not significantly different (P>.05).

[1] Means based on an 8-point scale (8 = extremely juicy; 1 = extremely dry).

[2] Means based on an 8-point scale (8 = extremely tender; 1 = extremely tough).

[3] Means based on an 8-point hedonic scale (8 = extremely desirable; 1 = extremely undesirable).

[4] Means based on a 7-point scale (7 = extremely tough or rubbery; 4 = excellent; 1 = extremely mushy or crumbly).

increasing chronological age of birds. Since spent fowl meat is generally believed to be tough, a tenderness rating of 6.0 for restructured steaks containing 100% raw meat would indicate that the flaking process alleviates tenderness problems associated with spent fowl meat.

Sensory panel responses for texture desirability (Table 3) showed that restructured steaks containing 80% precooked meat were less desirable than restructured steaks containing 50% or less precooked meat. Texture description ratings (Table 3) indicated that the use of 80% precooked meat in the formulation will result in a mushy or crumbly texture as opposed to the more desirable texture of restructured steaks made with a lower percentage of precooked meat.

Flavor desirability ratings (Table 3) did not differ significantly except at the 80% precooked meat level. Other researchers (Cipra and Bowers, 1970; Hegarty and Herring, 1973; Lineweaver and Pippen, 1961) have shown that lipid oxidation and other factors associated with the development of a stale, rancid, or objectionable flavor can result from the precooking process. Carlin *et al.* (1959) and Cash and Carlin (1968) reported that fresh frozen poultry meat has a more desirable flavor than precooked poultry.

Restructured steaks made with 80% precooked meat received significantly lower overall palatability ratings than formulations containing less precooked meat (Table 3).

Restructured steaks made from raw meat were preferred to restructured steaks made from formulations containing varying percentages of precooked meat. From the practical standpoint, it is suggested that formulations containing 20 to 50% precooked spent fowl meat could be used in the manufacture of restructured steaks. Further research is needed to quantify the effects of various binding agents in the manufacture of restructured steaks containing varying percentages of precooked meat.

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