CHARACTERISTICS OF THE MEAT OF GEESE FORCE-FED FOR FOIE-GRAS PRODUCTION.

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SUMMARY: Proximate composition, pH, hemopigment and hydroxyproline contents, cooking loss (inversely related to water holding capacity), gel strength and emulsion stability of force-fed geese breast and leg meat were determined. Moisture and fat contents showed significant differences ($P<0,05$) between both cuts, whereas protein and ash contents didn't show. Leg pH was higher than breast pH. Breast hemopigment (6,80 mg/g) and leg hemopigment (4,80 mg/g) contents were into the beef range. Breast hydroxyproline content was lower than that of the leg.

Color differences between breast and leg were not striking. Goose meat color was deep red of low purity.

Water holding capacity for both cuts (cooking loss: average 44%) was practically the same, similar to that of beef and higher than that of pork. Gel strength of leg (1089 g/cm^2) was greater than that of breast (627,9 g/cm^2).

Meat from force-fed geese did not differ greatly from those of other meat-producing species.

INTRODUCTION: Geese are fast-growing, efficient meat producing animals (Snyder and Orr,1953). However, goose meat has not been as thoroughly studied as chicken and turkey meat, both them widely consumed fresh as well as in meat products. There are only a few reports on post mortem changes in goose muscles (Pour and Mikolasek,1980,1982) and goose meat composition and quality (Larmond et al, 1968; Karasinski et al, 1977; Mikolasek and Pour, 1979; Puchajda and Faruga, 1980; Puchajda, 1981; Hrouz, 1981; Friend et al, 1983).

In Cuba commercial production of geese has been initiated, its main purpose being the production of feathers and fat livers for export. Meat production for the internal market comes as a sizable bonus.

In order to use efficiently goose meat in industry it is necessary to know the quality and functional characteristics of the meat from the animals fattened for foie-gras production. Such is the purpose of this paper.

MATERIALS AND METHODS: 30 males geese of the Landes breed, which were force-fed for 21 days from their 70th day of age with a mixture of maize and feed, were slaughtered. Slaughter weight was 7,0 ± 0,5 kg.

The left side of the breast (Pectoralis major muscle) and all the muscles of the left leg were taken of every carcass. Each sample was skinned and all subcutaneous fat was trimmed off. The meat was finely ground and chilled at ca. 4 ^{0}C to be analyzed within the next 24 hours (48 hours post-mortem).

The following analysis were carried out: moisture (AOAC, 1980), free fat (ISO, 1976), total nitrogen(ISO,1978a), ash (ISO,1969), hydroxyproline (ISO,1978b),pH (ISO,1974) and cooking loss as a measure of water holding capacity (WHC) (Honikel et al, 1981).

From the right side of the breast of every carcass a 15-20 mm thick slice was cut, bloomed at 2-4 ^{0}C for 1 hour and its CIE tristimulus values X, Y, Z were measured over 3 circular areas of 10 mm diameter in a MOMCOLOR D tristimulus colorimeter (MOM, Budapest). These values transformed into the Hunterlab $\underline{L}$, $\underline{a}$, $\underline{b}$ and the saturation, $S = (a^2 + b^2)^{1/2}$, and hue, $H = \arctan(b/a)$, were calculated (Wyszecki and Stiles,1967).

From the right leg three muscles were excised: Peroneus longus, Gastrocnemius and Quadriceps femoris. They were cut by the middle across the fiber, bloomed and color parameters measured as described in one circular area of the cross section . After the color was measured, the meat of the right side of the breast and the right leg were finely ground and their total content of hemopigment was determined according to Hornsey (Kormendy and Kovacs, 1975).

Cores (diam 2,5 cm) from the left and right side of the cooked breast muscle of other 25 geese were tested using an Instron Universal Testing Machine fitted with a Warner Bratzler (WB) shear cell at a crosshead speed of 10 cm/min. The maximum shear force in kg was calculated from the graphic as a measure of the muscle tenderness.

Emulsion stability was determined according to Girard et al (1985). For this purpose, meat batters were prepared with pork fat adjusting the proportion of fat:protein:water at 2:1:6. The % recovery after cooking was measured.

Homogenates were prepared by blending with water and sodium chloride (2% of the total paste), in such proportions as to maintain a protein:water ratio of 5:1, similar to that reported by Montejano et al (1984). Portions of the homogenate were cooked in a water bath at 75 ^{0}C until an internal temperature of 70-72 ^{0}C was reached, after which they were chilled in water at 2 ^{0}C. Gel strength was measured by the maximum force (g/cm^2) required for a flat-ended punch, 11 cm in diameter, to penetrate the sample at a constant crosshead speed of 50 mm/min.

Mean values and standard deviations were calculated. Results of chemical analyses of breast and leg meat were compared by a Student's "t" test and color measurements were compared by analysis of variance, using Duncan's multiple range test where necessary.

RESULTS AND DISCUSSION: Significant differences ($P<0,05$) were found for moisture and free fat contents between breast and leg meat (Table 1). Breast meat values were similar to those reported by Hrouz (1981) for fatty-liver geese of the White Italian x Rhenish x Landes crossing. He found a moisture content of 71,7 % in the thigh and 71.9 % in the breast, whereas his results for fat were 7,4 % and 5,8 % for thigh and breast respectively. Results reported here for leg meat indicate a somewhat higher fat content, since our sampling included intermuscular fat (depot fat), occurring in leg but not in breast meat from force-fed geese.

Protein and ash contents of both cuts didn't show significant differences ($p<0,05$).

Hemopigment content of breast was significantly higher ($p<0,05$) than that of the leg (Table 1) The values obtained were located into the range reported for beef, 4-10 mg/100g (Whitaker and Tannenbaum,1977), and similar to others reported for geese by Pikul et al (1982,1986).

Leg pH value was significantly higher ($P<0,05$) than breast pH value (Table 1). This is a common characteristic of poultry. A variety of ultimate pH values have been reported for goose meat. Pour and Mikolasek (1982) reported 5,83 and 6,09 for breast and leg, respectively, whereas higher values, 6,1 and 6,7 were found by Pikul et al (1986). Goose meat (specially leg meat) shows a higher ultimate pH than beef and pork, normal values for which are in the range 5,4-5,8 and 5,6-6,0 respectively (Wirth et al, 1981).

Hydroxyproline content of leg meat was significantly higher ($P<0,05$),than that of breast meat (Table 1). There is a larger number of smaller muscle bundles in the leg and thus, the amount of hydroxyproline associated with connective tissue should correspondingly greater in leg meat. In Hrouz (1981) a difference in connective tissue content between breast and thigh meats of about 40 % can be appreciated, similar to that found by us.

Table 2 shows the results of color measurements. L values did not differ significantly ($P<0,05$) between any of the muscles. The maximum change of L was approximately 1,0 far below a normally noticeable difference. Karasinski et al (1977) reports Y values for breast of geese of two breeds and their crossings equivalent to L values of 32,2; 34,0; 34,4 and 38,2. With the exception of the first value, they are representative of a meat lighter than that evaluated in this work.

The a, b values of breast were significantly higher ($P<0,05$) than the respective values of leg muscles, specially a values, most likely due to the higher pigment content in the breast. However, if the a/b ratio is analyzed as an index of color difference in meat (Acton, 1984), it can be observed that the a/b ratio diminishes only slightly from 1,62 in the breast to 1,48 in the leg, with no change between leg muscles. a/b ratios for chicken and turkey (calculated from a, b values in Table 2) change from 0,71 in breast to 1,33 in thigh for chicken and from 0,53 to 2,21 for turkey, reflecting the remarkable difference between the "white" breast meat and the "dark" leg meat in these species, an effect quite absent in goose cuts.

Also Table 2 shows that H values did not differ significantly ($P<0,05$) among the muscles tested.

Breast meat exhibited a significantly ($P<0,05$) more saturated color than leg meat.

Hue and saturation values found correspond with the description of goose meat color as deep red of low purity (i.e. with a considerable amount of gray), particularly as compared to the corresponding values of beef (Table 2), the color of which can be described as vivid bright red.

The shear force value in breast was 5,2 ± 1,1 kg, indicating that breast meat was more tender than cattle L. dorsi (13,8kg: De Hombre et al, 1982), buffalo L dorsi (12,5 kg) (de Hombre et al, 1985) and pig L dorsi(9,7 kg: Casals et al, 1986). De Hombre et al (1982) have found that shear force values below 11 kg (WB shear and sample core of 2,5 cm) corresponded to beef evaluated as "very tender" by a sensory panel. Babji et al (1982) reported a shear force value of 4,3 kg (sample core of 2,5 cm) for turkey breast, which it is comparable to the value found for goose breast.

It can be seen in Table 3 that the difference in cooking losses between breast meat and leg meat is in fact practically negligible. The cooking loss of goose meat was similar to that of beef and lower than that of pork.

The high WHC of goose meat is probably related to its relatively high ultimate pH.

Gel strength in leg meat homogenates was higher than that of breast meat (Table 3). With regard to beef, both cuts produced homogenates with lower gel strength. Pork homogenates show a gel strength value intermediate to the values of breast and leg meat homogenates.

Emulsion stability values of meat batters manufactured with breast and leg meat were equal, this being related to the fact that both meat cuts showed a similar WHC. Emulsion stability of beef is higher than that of goose meat, but with regard to pork, goose meat stability was superior.

CONCLUSIONS: Meat from force-fed geese had a proximate composition comparable to lean beef and pork. Its color was quite similar that of beef. Color differences between breast and leg meat were not as striking as in the case of chicken and turkey meat. Goose breast meat was more tender than either beef or pork.

Its functional properties specially its WHC, were satisfactory and they suggest a suitable behavior in the manufacturing of meat products.
In general, meat from force-fed geese did not differ greatly from

those of other meat-producing species, and its utilization in meat products should be tried.

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Table 1 Mean values (standard deviation in parentheses) of proximate composition, total hemopigment and hydroxyproline contents and pH.

Sample	Moisture (%)	Fat (%)	Protein (Nx6,25) (%)	Ash (%)	Total hemo pigments content (mg/g)	Hydroxy proline content (µg/g)	pH
Breast	71.6 (1.3)	6.1 (1.2)	20.8 (0.9)	1.14 (0.06)	6.80 (1.54)	903.8 (118.6)	5.88 (0.16)
Leg	69.6 (1.2)	8.8 (1.5)	20.5 (0.8)	1.12 (0.08)	4.80 (1.14)	1421.2 (109.4)	6.18 (0.29)
t value	6.43*	7.94*	1.39 ns	1.04ns	5.91*	6.42*	6.47*

* P<0,05

Table 2 Mean values (standard deviation in parentheses) of L, a, b, H and S values of force-fed geese meat and the mean values for meats of other meat-producing species.

Sample		L	a	b	H	S
Goose breast		32.8a (3.8)	13.3a (2.2)	8.2a (1.4)	31.7a (3.0)	15.6a (2.5)
Goose leg	P. longus	32.3a (3.4)	10.2b (1.6)	6.9b (1.6)	34.0a (6.6)	12.4b (1.6)
	Gastrocnemius	32.9a (4.0)	9.5b (1.8)	6.4bc (1.2)	34.4a (5.7)	11.5b (1.7)
	Q. femoris	31.9a (3.5)	9.2b (2.6)	6.2c (1.2)	35.0a (8.5)	11.2b (2.3)
Standard error		0.669ns	0.367*	0.223*	1.134ns	0.646*
Chicken (1)	Breast	51.12	11.62	16.31	54.5	20.0
	Thigh	39.56	14.24	10.70	36.9	17.8
Turkey (2)	Breast	35.21	2.85	5.35	68.2	7.7
	Thigh	29.96	7.11	3.22	31.0	6.2
Beef L. dorsi (3)		34.9	21.1	10.2	25.8	23.4

* P <0,05
a,b,c Mean values within the same column without letter in common differ at P<0,05
H,S: Calculated with a,b values that appear in the Table
(1) Lyon et al, 1976
(2) Maki and Froning, 1987
(3) Ledward et al, 1986

Table 3 Mean values (standard deviation in parentheses) of some functional properties of force-fed geese meat, beef and pork.

Sample	Cooking losses (%)	Gel strenght (g/cm^2)	Emulsion stability (% cooked recovery)
Goose breast	43,5 (3,6)	627,9 (70,1)	89,0 (4,6)
Goose leg	44,8 (3,3)	1089,1 (67,0)	88,8 (5,4)
Beef (1)	44,8 (1,8)	2535,1 (136,5)	95,6 (0,2)
Pork (2)	50,2 (1,0)	962,9 (174,1)	83,7 (1,6)

(1) Venegas et al, 1988
(2) Venegas and Pérez, 1989