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Carcass Characteristics and Qualitative Meat Traits of the Padovana Breed of Chicken

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Abstract: The aim of this study was to describe meat quality and carcass characteristics of the Padovana breed of chicken. The Padovana chicken is a historical fancy breed found in the Veneto region of Italy and produces meat that is typical to some local markets. The experiment reported here involved 60 chickens reared in an organic production system where housing was an indoor pen with access to a grass paddock. Experimental chicks were randomly selected from May 17 and 24, 2001 hatches and slaughtered at 150 and 180 days of age, respectively. Meat from 30 chickens (16 males and 14 females) from each slaughter age was stored for subsequent analysis of breast and thigh meat quality. Males were consistently heavier then females for live; without blood and feathers; eviscerated with head; neck, and legs; carcass; breast; and right thigh weight. There were no differences between males and females for chemical composition of the breast except for percentages of dry matter and ash (female > male). Generally, overall weights were greater at 180 then 150 days of age, whereas there was no difference between ages for breast chemical composition except for % protein (180 > 150). The breast and thigh had a low value of brightness and a distinctive blue meat color. The fatty acid profile of the breast consisted of a high percentage of polyunsaturated fatty acids. There were no differences between sexes for fatty acids, except for C16:0, C18:3w3 (female > male) and C18:1w7t, C20:4w6 (male > female).

Key words: Padovana breed of chicken, carcass characteristics, qualitative meat traits

Introduction

Recently, there has been increased interest in safeguarding animal biodiversity in Italy (Gandini *et al*., 1998; Cassandro *et al*., 2004) and particularly in the Veneto region in the north-east part of Italy, where there has been economic support for development of local organic production systems. The CO. VA. project (Veneto Agricoltura, 2004) was the first marker-assisted conservation scheme for animals in the Veneto region. All local poultry breeds from this region were included in the traditional Italian product list of the Ministry of Agricultural and Forestry Policy (Ministero delle Politiche Agricole e Forestali, 2004). One of the breeds being evaluated as a traditional product for local markets in the Padova country is the Padovana chicken.

The Padovana chicken is a fancy breed that had been used primarily for ornamental purposes since Romans times and was cited by Aldrovandi (1600) on his ornithology treatise for the presence of a cerebral hernia below a big forelock. The Padovana breed may be described further as a slowly growing chicken that, when raised in an extensive production system, reaches sexual maturity at approximately 180 days of age.

Widespread societal concerns with animal welfare (Sundrum, 2001) and environmental issues caused by intensive farming are primary factors contributing to an emerging interest in the diversification of poultry industry towards more extensive and sustainable systems of production. Although an alternative production system has allowed genetic conservation of the Padovana breed, it will be necessary to establish consistent demand for it as food by consumers to insure its future non-assisted survival. The recent development of organic animal production and consumer requests for food safety and environmentally rural relations (Ismea, 2001) might encourage use of local chicken breeds in a gastronomical niche market. Compared with the standard broiler, the local breeds of chickens are characterized by slower growth rates and lower carcass fat (Culioli *et al*., 1990). The aim of the present study was to describe carcass characteristics and qualitative meat traits of the Padovana breed of chicken.

Materials and Methods

Animals and diets: Day-old chicks were obtained from the Padovana nucleus flock of the Agricultural High School "Duca degli Abruzzi" in Padova. The experiment consisted of 60 Padovana chickens, hatched May 17 and 24, 2001 and slaughtered at two different ages (150 and 180 d). At hatch, chicks were individually weighed and

placed in two indoors pens with access to grass paddocks. Feed and water were supplied *ad libitum*. Chicks were fed a crumbled vegetable diet that consisted of 23.0% crude protein, 4.0% lipids, 5.0% fiber, 8.5% ash, and 3,300 kcalME/kg to 21 days of age. Thereafter they were fed a crumbled vegetable diet that consisted of 18.5% crude protein, 4.0% lipids, 4.0% fiber, 6.0% ash, and 2,800 kcalME/kg. No antibiotics were included in the diet.

Experimental procedures: Sixteen males and fourteen females were slaughtered at 150 and 180 days of age. Feed was withdrawn 18 h prior to slaughter and weights were obtained just prior to slaughter; after removal of blood and feathers; eviscerated with head, neck and legs attached; and for the final carcass. After processing, the chickens were cooled in a cold tunnel and refrigerated at 4°C for 24 h after which the breast (left and right) with and without skin and right thighs with and without skin were removed and color determinations were made (see Color Measurements). They were then stored at -20°C for further analyses.

Chemical analysis: Chemical analyses were performed on left breast without skin in accordance with AOAC (1990) standards. Moisture was determined by drying at 102°C for 16 h. Ash was determined at 525°C. Total lipids were analyzed by extraction with petroleum ether (Soxtec method). Protein was calculated by difference.
For determination of fatty acids, lipids were extracted according to the method of Folch *et al*. (1957). Briefly, a 5 g homogenized meat sample was blended with extraction solvent chloroform/methanol (1:2, v/v) twice, filtered, placed in separator funnels, and mixed with saline solution (0.88% KCl). After separation in two phases, the methanol aqueous fraction was discarded, and the lipid chloroform fraction washed with distilled water/methanol (1:1, v/v). Following a further filtration and evaporation by means of a rotary evaporator, lipid extracts were transferred to test tubes for subsequent gas chromatographic analysis performed on a Thermo Quest Italia model 8000 Series Top instrument equipped with a Omegawax 250 capillary column (length 30 m, internal diameter 0.25 mm).

Color measurements: Color was determined with a colorimeter (Spectrophotometer CM-508; illuminate: D65, Observer: 10°) according to the method of CIELAB (1976). Readings were made on the right thigh and breast with and without skin. Brightness (L*), red (a*), and yellow (b*) indexes which are chromaticity coordinates were determined. The CIELAB color space model (CIE, 1978) was chosen to numerically describe the color parameters. Lightness (L) is the amount of incident light that a surface reflects; - a* values represent green and + a* values represent red color; - b* values represent blue and + b* values represent yellow color.

Tenderness: Two cores with cross-sectional areas of 1.25 cm^2 (Aspa, 1996) were taken from the right breast without skin. Maximum shear force with pre-speed and speed tests of 2 mm/s were measured using a Henoco Tahdi texture analyzer with a blade to fork distance of 2 mm and a Warner-Bratzler Blade.

Cooking losses: Cooking loss was measured on the left breast without skin. Samples were weighed, then cooked in bain marie at 70°C for 40 min., cooled, dried, and weighed again. Cooking loss was calculated from the difference of weight before and after cooking.

Statistical Models: A preliminary analysis was made to determine if there were pen effects within each age. No pen effects were found for any trait considered and a two-way ANOVA was performed with the GLM procedure of SAS (1999) package using a linear model with sex (S), age (A), and the age by sex interaction (AxS) as fixed effects.

Results and Discussion

Carcass characteristics: Males had heavier live, without blood and feathers, eviscerated, carcass, breast, and right thigh weights than females (Table 1). Percentage breast and thigh pH were greater for females than males while there was no difference between sexes for dressing percentage and breast pH. There were consistent differences between ages (150 vs 180) for all carcass characteristics except for breast and right thigh weights, breast percentage, and breast pH. These results showed that the Padovana breed is a fancy chicken with a moderate net carcass weight, dressing percentage, and breast percentage consistent with values reported for other organic chickens (Castellini *et al*., 2002). Dressing percentage for the Padovana breed was slightly lower than that reported for commercial broilers (Cortinas *et al*., 2004; Havenstein *et al*., 2003). Breast and thigh pH were similar to those reported for the Thai indigenous chicken and commercial broilers (Wattanachant *et al*., 2004), while pH was consistent with values reported in the literature (Holownia *et al*., 2004).

Chemical and physical characteristics of breast and thigh: Percentage dry matter and ash were higher for females then males, with no sexual dimorphism for percentage protein and lipids, cooking loss, and degree of tenderness (Table 2). An age effect (180>150) was present only for percentage protein demonstrating that tissue protein deposition persisted after 150 days. Percentage dry matter and protein were similar to those reported for organic chickens (Castellini *et al*., 2002; Castellini *et al*., 1994), whereas percentage protein,

Table 1: Least square means of carcass values by age and sex of the Padovana breed

Trait	Sex			Age (days)			Residual Standard Deviation
	Male	Pb	Female	150	Pb	180	
Weight (g):							
- Live (LW)	1882	***	1328	1536	**	1674	338
- Without blood and feathers	1678	***	1177	1360	**	1496	312
- Eviscerated	1576	***	1094	1271	**	1399	299
- Carcass weight (CW)	1345	***	939	1084	**	1200	254
- Breast (B)	248	***	199	213	NS	234	43.0
- Right thigh	211	***	140	171	NS	179	47.0
Dressing (CW/LW), %	72	NS	71	71	**	72	1.00
Breast (B/CW), %	18	***	21	20	NS	20	2.00
Breast pH	5.83	NS	5.79	5.81	NS	5.81	0.08
Thigh pH	6.03	**	6.14	6.17	***	6.00	0.15

b: NS = not significant, ** = P<0.01, ***=P<0.001

Table 2: Least square means of chemical breast composition by age and sex of the Padovana breed

Trait	Sex			Age (Days)			Residual Standard Deviation
	Male	Pb	Female	150	Pb	180	
Dry matter, %[a]	25.37	*	25.99	25.46	NS	25.90	0.78
Protein, %[a]	22.8	NS	13.10	22.67	**	23.22	0.59
Lipids, %[a]	1.39	NS	1.65	1.59	NS	1.45	0.67
Ash, %a	1.19	**	1.24	1.20	NS	1.22	0.05
Cooking loss, %	13.20	NS	13.65	13.65	NS	13.43	2.71
Tenderness, g/cm^2	1,706	NS	1,498	1,551	NS	1,652	263

a Percentage per 100 g of edible portion. b: NS = not significant, *=P<0.05, **=P<0.01

lipids, and ash were higher for the Padovana breed then the Thai indigenous chicken and commercial broilers (Wattanachant *et al*., 2004). Cooking loss of 13-14% was low when compared to the 33% reported for organic chickens (Castellini *et al*., 2002), 23% for the Thai indigenous chicken, and 20% for broilers (Wattanachant *et al*., 2004 and Liu *et al*., 2004). Sex and age effects were not significant for percentage lipids, cooking loss, and degree of tenderness.

There were no differences between sexes or ages for color of breast with skin except for b* where values were higher at 180 than 150 days of age (Table 3). For breast without skin, L* and a* values for males and females were similar at both ages. For b* there was a sex effect (F > M), but the age effect noted for breast with skin disappeared. The influence on a* reflected a greenish color which reduced yellow pigmentation. The yellowness (b*) of thigh with and without skin increased with age while there was no age effect for L* or a*. The only major sex effect for a* index was for thigh without skin (M>F). The Padovana breed appears to have darker breast and thigh muscles than commercial broilers (Polidori *et al*., 1999) and other organic chickens (Castellini *et al*., 2002). The Padovana breed had a lower a* and b* values of breast and thigh then the Thai indigenous chicken and commercial broilers (Wattanachant *et al*., 2004).

Fatty acid composition of breast: Oleic acid (C18:1w9) was the main fatty acid in breast fat, followed by palmitic acid (C16:0) and linoleic acid (C18:2w6) (Table 4). This pattern was consistent with that reported by Pereira *et al.* (1976) and Sheu and Chen (2002). Oleic and palmitic acids were the major fatty acids in breast fat followed by linoleic acid. Females had greater C16:0 and C18:3w3 (linolenic acid) fatty acids than males, whereas C18:1w7t and C20:4w6 fatty acids were greater for males than females. There were no differences between sexes for the other fatty acids. An age effect (150 >180) was present for C16:0, C18:1w7t, C24:1, C20:2w6, C20:3w6, C20:4w6, and (180>150) C14:0, C15:0, C14:1, C16:1, C20:1, C18:2w6, and C20:5w3. The fatty acid composition of chicken fat varies with breed, sex, and diet (Marion and Woodroof, 1963; Miller *et al*., 1962; Edwards and Denman, 1975). Saturated fatty acids (SFA) of the Padovana chicken were lower than those reported for the Thai indigenous chicken and commercial broilers (Wattanachant *et al*., 2004). The monounsaturated fatty acids (MUFA) of Padovana breed were consistent with values for the Thai indigenous chicken (Wattanachant *et al*., 2004) and commercial broilers (Du and Ahn, 2002). The polyunsaturated fatty acids (PUFA) of Padovana breed were greater those for the Thai indigenous chicken or commercial broilers (Wattanachant *et al.*, 2004) and consistent with those for

Table 3: Least square means of breast and thigh muscular tissue (raw) coloration by age and sex of the Padovana breed

Trait	Index	Sex			Age (days)			Residual Standard Deviation
		Male	Pb	Female	150	Pb	180	
Breast with skin	Lightness (L*)	58.62	NS	58.80	58.31	NS	59.11	3.04
	Redness (a*)	-2.51	NS	-2.59	-2.53	NS	-2.57	0.36
	Yellowness (b*)	1.14	NS	1.91	0.50	*	2.55	2.21
Breast without skin	Lightness (L*)	46.11	NS	44.79	45.75	NS	45.16	2.25
	Redness (a*)	-2.38	NS	-2.56	-2.56	NS	-2.38	0.43
	Yellowness (b*)	-0.24	***	2.72	1.50	NS	0.98	2.07
Thigh with skin	Lightness (L*)	59.71	**	57.32	58.36	NS	58.67	2.68
	Redness (a*)	-1.94	NS	-2.04	-2.07	NS	-1.89	0.42
	Yellowness (b*)	-2.15	NS	-2.05	-2.76	***	-1.44	1.27
Thigh without skin	Lightness (L*)	45.87	NS	44.41	45.97	NS	44.31	2.83
	Redness (a*)	-0.26	***	-2.12	-1.44	NS	-0.89	1.98
	Yellowness (b*)	0.64	NS	1.54	0.29	**	1.89	1.40

b: NS = not significant, *=P<0.05, **=P<0.01, ***=P<0.001

Table 4: Least square means of raw breast (without skin) fatty acid composition (expressed as g/Kg) by sex and age of the Padovana breed

Trait	Sex			Age (days)			Residual Standard Deviation
	Male	Pb	Female	150	Pb	180	
Total SFA	35.19	NS	35.50	35.77	NS	34.92	1.39
C10:0	0.03	NS	0.04	0.04	NS	0.03	0.03
C12:0	0.04	NS	0.05	0.04	NS	0.05	0.03
C14:0	0.63	NS	0.75	0.61	*	0.78	0.20
C15:0	0.05	NS	0.07	0.04	**	0.08	0.03
C16:0	23.54	*	24.26	24.33	*	23.48	1.04
C17:0	0.15	NS	0.16	0.16	NS	0.16	0.04
C18:0	10.06	NS	10.06	10.47	NS	10.22	0.96
C20:0	0.09	NS	0.09	0.08	NS	0.10	0.06
Total MUFA	31.23	NS	32.89	31.80	NS	32.33	4.61
C14:1	0.03	NS	0.04	0.02	*	0.04	0.03
C16:1t	1.40	NS	1.69	1.51	NS	1.59	0.68
C16:1	0.27	NS	0.33	0.23	**	0.37	0.13
C18:1w9	26.00	NS	27.66	26.48	NS	27.19	4.08
C18:1w7t	2.64	*	2.44	2.70	***	2.37	0.28
C20:1	0.19	NS	0.21	0.15	***	0.25	0.08
C24:1	0.24	NS	0.20	0.30	***	0.14	0.11
Total PUFA	32.21	NS	30.62	31.81	NS	31.03	0.15
C18:2w6	16.52	NS	17.87	16.08	**	18.32	2.29
C18 :3w3	0.30	**	0.45	0.33	NS	0.43	0.15
C20:2w6	0.37	NS	0.32	0.38	*	0.32	0.08
C20:3w6	0.53	NS	0.44	0.56	**	0.41	0.15
C20:4w6	11.32	*	8.87	11.36	*	8.83	3.40
C20:5w3	0.03	NS	0.02	0.01	***	0.05	0.02
C22:4w6	0.09	NS	0.01	0.01	NS	0.08	0.17
C22:6w3	1.32	NS	1.23	1.36	NS	1.18	0.49
PUFA:SFA	0.91	NS	0.86	0.89	NS	0.89	0.10

b: NS = not significant, *=P<0.05, **=P<0.01, ***=P<0.001. SFA = saturated fatty acids; MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids

another broiler stock (Sirri *et al*., 2004). The PUFA:SFA ratio for the Padovana chicken were greater then those reported for broilers fed diets supplemented with 15 g of PUFA/kg of feed (Cortinas *et al*., 2004).

The high linoleic acid (C18:2w6) observed in breast meat was probably due to presence of soy bean oil in the diet (Bavelaar and Beynen, 2003). This result is consistent with the strong relationship between dietary and adipose tissue linoleic acid reported in cats (Van Niel and Beynen, 1997), rabbits (Lin *et al*., 1993), and pigs (Bosi *et al.*, 2000).

Conclusions: The Padovana breed of chicken may be described as having lean carcasses with moderate meat yield. This fancy chicken breed appears to have promise in terms of carcass characteristics for low-input systems where poultry production is aimed at household food security and to preserve local traditions and the rural culture. The breast and thigh meat had low values for brightness and a particular bluish meat color. Further research is necessary to evaluate growth characteristics under semi-intensive conditions and to determine sensory characteristics and consumer acceptability of the Padovana breed of chicken.

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