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Abstract 1. An experiment involving 60 male chickens reared in an organic production system
 was carried out in order to investigate carcase characteristics and qualitative meat traits of three
 slow-growing Italian local breeds of chicken (Ermellinata, Padovana and Pépoi).

2. Chicks were randomly selected at hatch, raised together under the same conditions,
slaughtered at 190 d of age, dissected for carcase traits, and meat (breast and thigh) stored for
subsequent analysis of quality parameters.

39 3. Ermellinata chickens were significantly different from Padovana and Pépoi chickens for live,
40 carcase and thigh weights. Breeds were also different for breast muscle protein content
41 (Ermellinata > Pépoi and Padovana), shear force (Padovana < Ermellinata and Pépoi) and
42 cooking loss (Pépoi > Padovana and Ermellinata) values.

43 4. The CIE system values of lightness (L*), redness (a*), and yellowness (b*) evidenced a
44 distinctive darker meat and lighter skin colour of Padovana breast meat.

45 5. Polyunsaturated fatty acids composition of breast meat was similar among the analysed
46 breeds. Ermellinata had significantly higher saturated but significantly lower monounsaturated
47 fatty acid contents than the other two breeds.

INTRODUCTION

Consumer interest is growing in specialty poultry products, particularly in Europe. Examples exist in France, with 'Label Rouge' (Westgren, 1999) and Poulet de Bresse, and in Italy with Padovana chicken (De Marchi et al., 2005). Production systems require extensive rearing conditions with outdoor access. Despite a higher retail price than conventional poultry products, these types of chicken have aroused lively interest in national markets (Westgren, 1999; Fanatico and Born, 2001). In Italy, among those slow-growing genotypes there are several local chicken breeds that showed interesting meat quality traits (e.g. colour and flavour) (De Marchi et al., 2006a). Fast-growing meat strains of chicken are characterised by a very low degree of adaptation and resistance to natural environment (Reiter and Bessei, 1996); in contrast, the slow-growing strains can fully benefit from organic system (pasture availability, older age). Several studies have investigated differences in the sensory quality of meat from fast- and slow-growing birds, but there was a wide variation in breed (purebred, broiler or layer), slaughter age and production system (standard, extensive or organic) (Touraille et al., 1981; Brown et al., 2008; Jaturasitha et al., 2008; Sandercock et al., 2009). This has produced contrasting results regarding consumer preference and acceptance, but reports have generally been more favorable for slower-growing birds than conventional products.

British Poultry Science

In the Veneto region of Italy, the increasing interest in the conservation of bovine, ovine and poultry local breeds (De Marchi et al., 2006a,b; Dalvit et al., 2008, 2009; Zanetti et al., 2010) is due to historical, social and economical reasons. A few breeds of chicken, Padovana (PA), Ermellinata (EA), and Pépoi (PI), which are typically reared in extensive systems, provide interesting alternatives to commercial broilers. The recent development of organic animal production and consumer requests for food safety and sustainable systems of production might encourage the use of local chicken breeds for several niche markets. Previous research has been focused on the carcase characteristics and quality meat traits of the Padovana breed of chicken (De Marchi et al., 2005) because it has been in great demand.

The interest in local genotypes has increased noticeably in the last decade, mostly because biodiversity conservation and management has become an important issue for the international scientific community (Fao, 2007). Productive performance analysis and phenotypic traits, together with genetic diversity, reproductive and adaptative performances, and historical interest, are therefore highly relevant to the inclusion of local breeds in conservation programmes (Ruane, 1999).

81 The objective of this research was to describe carcase characteristics and qualitative 82 meat traits of three local Italian chicken breeds at maturity, as well as at a light, medium or 83 heavy body weight.

MATERIALS AND METHODS

85 Animals, diets and experimental procedures

A trial was conducted at the Duca degli Abruzzi Agricultural High School in Padova. Three slow-growing genotypes were compared, Pépoi (PI), Padovana (PA) and Ermellinata (EA), and categorised according to the weight they reached at 190 d (market weight): PI had a live weight of 1400 -1600 g, PA a live weight of 2000 - 2200 g and EA a live weight of 2800 -3000 g (De Marchi et al., 2006a). Twenty 30-d male birds were obtained from each breed and housed together in an indoor pen (5 $birds/m^2$) which had access to a grass paddock (4 m²/bird). All birds were provided with a grower diet (210 g CP/kg, 50 g/kg lipids, 40 g/kg fibre, 70 g/kg ash, and 13.39 MJ ME/kg) from 2 d before the trial commenced until slaughter at 190 d. Ingredients for the grower diet were maize flour, toasted soybean meal, maize gluten meal, maize gluten, soybean oil, dicalcium phosphate, calcium carbonate, sodium chloride and DL-methionine. Feed and water were supplied ad libitum. The diets were crumbled vegetable diet without animal products, antibiotics or coccidiostats. A total of 60 birds (20 males for each breed) were slaughtered at 190 d of age. Feed was withdrawn 18 h prior to slaughter, and the birds weighed, electronically stunned, plucked and eviscerated.

The carcases were cooled in a tunnel, refrigerated at 4° C for 24 h and weighed. The breast and thigh meat from all chickens were then harvested and processed for meat quality parameters determination. Other breast meat samples were also collected and stored at -20°C for further analyses.

Analytical determinations

Breast (Pectoralis superficialis) and thigh (Peroneus longus) muscle pH were measured 24 h post-mortem using a Delta Ohm HI-8314 pH-meter (Delta Ohm, Padova Italy). Colour, tenderness and cooking loss were also determined 24 h post-mortem. Colour parameters were measured using a Minolta CM-508c (illuminate: D65, observer: 10°) on thigh and breast skin and on breast meat. Breast meat colour was taken immediately after skin removal. Readings were performed at the same anatomical positions for all breast and thigh samples. For each sample, three measurements were performed and the final value for each chicken was the average of those readings. Skin colour of breast and thigh and meat colour of breast were expressed in the CIELab colour space by reporting L*, a* and b* values (CIE, 1978).

Cooking loss percentage (CL%), expressed as the ratio of the weight before and after cooking, was measured on the left part of the breast muscle without the skin using 2-cm thick samples sealed in a polyethylene bag and heated in a water bath to an internal temperature of 70°C for 40 min (ASPA, 1996). Shear force (SF) on breast muscle was measured on 5 cylindrical cores, 1.13 cm in diameter and taken parallel to muscle fibres, using a TA-HDi Texture Analyser (Stable Macro System, London, Great Britain) with a Warner-Bratzler shear attachment (10 N load cell, crosshead speed of 2 mm/s) and interpreted using texture expert software (ASPA, 1996).

All chemical analyses were performed on the right breast, without skin, and were in accordance with AOAC (1990) standards. Moisture was determined after drying at 102°C for 16 h, ash was determined after mineralisation at 525°C for 6 h and total lipids analysed by extraction with petroleum ether (Soxhlet method). Protein content was estimated by difference. For the determination of total fatty acids composition, lipids were extracted according to the method of Folch et al. (1957). A 5-g homogenised meat sample was blended twice with extraction solvent chloroform/methanol (1:2, v/v), 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 in a rotary evaporator, lipid extracts were prepared for trans-esterification in n-Heptane according by Christie (1982) and transferred to test tubes for subsequent gas chromatographic analysis,

British Poultry Science

which was conducted on a Thermo Quest (model 8000 Series Top, Milan, Italy) instrument
equipped with a Omegawax 250 capillary column (length 30 m, internal diameter 0.25 mm,
Supelco, Bellafonte, PA, USA).

137 Statistical analysis

138 Data were subjected to ANOVA by the GLM procedure considering breed as a fixed effect 139 using SAS[®] software (1997, SAS Institute, Cary, NC). For breed effect, a multiple 140 comparison of means was performed using the Bonferroni's test (P < 0.05).

6 141

RESULTS

The least square means of carcase composition, pH values, breast chemical composition, shear force and cooking loss values are shown in Table 1. Final live weights of the three breeds at 190 d of age (just before slaughter) were significantly different. Ermellinata had heavier live, carcase and thigh weights than PA and PI, while PI had lighter breast weight than PA and EA. Breast weight and total dressing did not differ statistically for PA and EA, while the incidence of breast on carcase weight was similar for PA and PI. Dressing percentage was greater for PA and EA than PI, while PA and PI had greater breast percentage than EA. Table 1 near here

Dry matter, protein and lipid contents of the breast muscle differed only slightly among breeds (Table 1). Maximum shear force values for PA birds, as measured on cooked breast muscle, were significantly different from the other breeds (Table 1). The pH values measured in the breast muscle were significantly higher for PA than the other two breeds, while, the thigh pH of PI birds had the highest values. The PA breed showed the highest tenderness followed by EA and PI, while cooking loss values were higher for PI breed relative Tables 2 & 3 near here

Breast and thigh colour values are shown in Table 2. PA breed showed a significantly higher L* value of breast skin than PI or EA, while the PI showed significantly lower a* and b* values than PA or EA. The L* value of thigh skin for PI was significantly higher than either PA or EA, a* indices were not significantly different for the three breeds, while the b* index was significantly higher for EA than either PI or PA. The breast meat colour for PA had a significantly lower L* value than for EA or PI, while EA b* values were significantly lower than PA or PI.

Raw breast meat (without the skin) fatty acid compositions are shown in Table 3.
Raw breast meat (without the skin) fatty acid compositions are shown in Table 3.
Ermellinata breed had a significantly higher content of saturated (SFA) but lower amount of monounsaturated (MUFA) fatty acids than either PA or PI. There were no significant differences between breeds for n-3 and n-6 polyunsaturated fatty acids. Ermellinata differed

168 from the other breeds because of a higher $C_{16:0}$ content and a lower production of $C_{18:1cis n-9}$ and

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O C_{18:2cis n-6} fatty acids (Table 4). There were no significant differences in DPA nor CLA fatty

acids among breeds but PI breast meat had a significantly higher content of DHA than PA.
 DISCUSSION

Table 4 near here

The EA, PA and PI chickens exhibited medium, light and very light carcase weights respectively. The dressing and breast percentages of PA were slightly lower than those reported for the same breed by De Marchi et al. (2005). Dressing percentages for PA, EA and PI breeds were also slightly lower than those reported for local Thai chicken genotypes (Jasurasitha et al., 2008) and markedly lower than that reported for commercial broilers (Havenstein et al., 2003; Cortinas et al., 2004). These results indicate that the Italian local chicken breeds have relatively low carcase weights, and inferior dressing and breast percentages to other meat-type genotypes.

Contrastingly, the pH values were higher than expected; possible reasons are slaughter stress and a higher content of oxidative muscle fibre in other common slow-growing genotypes (Dransfield and Sosnicki, 1999). Regarding the first hypothesis, it is likely that the old unselected breeds have a more aggressive and alert behaviour than the modern broilers (Jaturasitha et al., 2004; Debut et al., 2005); this higher sensibility to the stressful conditions before slaughter can lead to poor glycogen content in muscle at the time of death. However, no other information is available concerning muscle fibre analysis for these breeds. Nevertheless, the breast pH values of the PA breed were lower than those reported previously by De Marchi et al. (2005) for the PA breed.

Dry matter, protein and lipid contents of the breast muscles differed slightly among breeds. The chemical composition of the PA breed breast was consistent with values reported by De Marchi et al. (2005). The dry matter and protein contents of these three local Italian breeds were similar to those reported for other organic chickens (Castellini et al., 1994; Castellini et al., 2002). In contrast, protein, lipids and ash contents were higher for the Italian local breeds than for Thai indigenous chickens or normal commercial broilers (Wattanachant et al., 2004). As expected, local chicken muscle contains a high proportion of protein and low fat and ash contents, which agrees with previously reported findings from Wattanachant et al. (2005). The PA and EA breeds showed a greater cooking loss compared with the values reported by De Marchi et al. (2005) and Rizzi et al. (2007).

Low L* values are associated to a higher ultimate pH value because of the weak light
 scattering in high-pH chicken meat (Swatland, 2008). The darker breast muscle of the PA
 breed can thus reflect differences in the muscle fibre composition and in the glycogen content

of the muscle. For this reason, the analysis of breast meat L* values were also conducted
using the fixed effect of breed and the effect of pH as co-variate. In the preliminary analysis,
the interaction between breed and pH was not significant. Furthermore, the PA had the lowest
L* value of breast meat.

The fatty acid composition of the breast meat in this study was similar to that reported by De Marchi et al. (2005) and Castellini et al. (2006) for Ross 205 and Kabir chickens reared in an organic rearing system. The observed differences in SFA and MUFA among the three breeds in this study can be attributed only to their genetic make-up, because diets and rearing system were identical for all breeds throughout the experimental period. Even the highest saturated fatty acid contents of the EA breed were still lower than those reported for organic (38%) and Thai local chickens (62%) (Wattanachant et al., 2004). Among SFA, palmitic (C16:0) and stearic (C18:0) acids were the most abundant, as generally observed in chicken breast meat.

In conclusion, the study demonstrated significant differences in meat quality traits among the three breeds studied, for example in carcase yield, colour, tenderness and fatty acid composition. From a consumer point of view, each breed offers unique features. Besides a greater traditional interest and a high historical and cultural value, the tenderness of the PA meat and its distinctively darker colour differentiated it from the other breeds. In contrast, none of the meat quality traits of EA and PI showed the meat of these breeds to be significantly distinctive from other meat-type genotypes. Additionally, adaptability features, traits of scientific and economic interests, cultural/historical value, strong links to local traditions and its ability to generate incomes from tourism justify the efforts for their conservation and characterisation (Ruane, 1999). The commercialisation and capitalisation of local markets represent an opportunity for future added value and development of these local genetic resources. Alternative strategies, such as the use of crosses of these breeds with more productive commercial breeds, are currently under evaluation to enhance their use for niche and regional markets.

REFERENCES

AOAC (1990) Official Methods of Analysis (15th ed.). Association of Official Analytical
 Chemists. Washington, DC.

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- ³ 234 BROWN, S.N., NUTE, G.R., BAKER, A., HUGHES, S.I. & WARRISS, P.D. (2008) Aspects
- of meat and eating quality of broiler chickens reared under standard, maize-fed, free-range or
 organic systems. *British Poultry Science*, 49:118–124.
- 8 237 CASTELLINI, C., DAL BOSCO, A., MUGNAI, C. & PEDRAZZOLI, M. (2006) Comparison
- $\begin{array}{c} 10\\ 11 \end{array}$ 238 of two chicken genotypes organically reared: oxidative stability and other qualitative traits of
- 12 239 the meat. *Italian Journal Animal Science*, 5: 355-368.

- CASTELLINI, C., MUGNAI, C. & DAL BOSCO, A. (2002) Effect of organic production
 system on broiler carcass and meat quality. *Meat Science*, 60: 219-225.
- 17 18 242 CASTELLINI, C., PANNELLA, F. & LATTAIOLI, P. (1994) Impiego della razza Ancona per
- ¹⁹ 243 l'impiego di un pollastro di qualità. *Rivista di Avicoltura*, **5:** 1-45.
- 24 CHRISTIE, W.W. (1982) A simple procedure for rapid transmethylation of glycerolipids and
 22 23 245 cholesterol ester. *Journal of Lipid Research*, 23: 1072-1075.
- 24 25 246 CIE (1978) International Commission on Illumination, recommendations on uniform color
- 26 247 spaces, color, difference equations, psychometric color terms. CIE publication No. 15 (Suppl.
- 28 248 2), (E-1.31) 1971/(TC-1.3). Bureau Central de la CIE, Paris, France.
- CORTINAS, L., VILLAVERDE, C., GALOBART, J., BAUCELLS, M.D., CODONY, R. &
 BARROETA, A.C. (2004) Fatty acid content in chicken thigh and breast as affected by
 dietary polyunsaturation level. *Poultry Science*, 83: 1155-1164.
- ³⁵ 252 DALVIT, C., DE MARCHI, DAL ZOTTO, R., ZANETTI. E., MEUWISSENM. M. &
 ³⁶ 253 CASSANDRO, M. (2008) Genetic characterization of the Burlina cattle breed using
 ³⁸ 254 microsatellites markers. *Journal of Animal Breeding and Genetics*, **125**: 137-144.
- ⁴⁰
 ⁴¹
 ⁴²
 ⁴³
 ⁴⁵
 ⁴⁶ DALVIT, C., DE MARCHI, ZANETTI. E. & CASSANDRO, M. (2009) Genetic variation
 ⁴⁷ and population structure of Italian native sheep breeds undergoing in situ conservation.
 ⁴⁴ 257 *Journal of Animal Science*, 87: 3837–3844.
- 45 46 258 DE MARCHI, M., CASSANDRO, M., LUNARDI, E., BALDAN, G. & SIEGEL, P.B. (2005)
- ⁴⁷/₄₈ 259 Carcass characteristics and qualitative meat traits of the Padovana breed of chicken.
 ⁴⁹/₅₀ 260 *International Journal of Poultry Science*, 4: 233-238.
- ⁵¹ 261 DE MARCHI, M., CASSANDRO, M., TARGHETTA, C., BARUCHELLO, M. & NOTTER, 52
- 53 262 D.R. (2006*a*) Conservation of poultry genetic resource in the Veneto region of Italy. *Animal*
- 54 Genetic Resources Information (FAO/UNEP), **37:** 63-74.
- ⁵⁶₅₇ 264 DE MARCHI, M., DALVIT, C., TARGHETTA, C., & Cassandro, M. (2006*b*). Assessing
- ⁵⁸ 265 genetic diversity in the indigenous Veneto chicken breeds using AFLP markers. *Journal of*
- 60 266 Animal Genetics, **37:** 101–105.

DEBUT, M., BERRI, C., ARNOULD, C., GUEMENÉ, D., SANTÉ-LHOUTELLIER, V., SELLIER, N., BAÉZA, E., JEHL, N., JÉGO, Y., BEAUMONT, C. & LE BIHAN-DUVAL, E. (2005) Behavioural and physiological responses of three chicken breeds to pre-slaughter shackling and acute heat stress. British Poultry Science, 46: 527–35. DRANSFIELD, E. & SOSNICKI, A.A. (1999) Relationship Between Muscle Growth and Poultry Meat Quality. Poultry Science, 78: 743–746. FANATICO, A.C. & BORN, H. M. (2001) Label Rouge: Pastureraised poultry in France. ATTRA publication. National Center Appropriate Technology, Fayetteville, AR. FAO (2007). The state of the world's animal genetic resources for food and agriculture. Commission on genetic resources for food and agriculture. Food and Agriculture Organization of the United Nations. Rome. FOLCH, J., LEES, M. & SLOANE-STANLEY, H. (1957) A simple method for the isolation and purification of total lipids from animal tissue. Journal of Biological Chemistry, 226: 497-509. HAVENSTEIN, G.B., FERKET, P.R. & QURESHI, M.A. (2003) Carcass composition and yield of 1957 versus 2001 broilers when fed representative 1957 and 2001 broiler diets. Poultry Science, 82: 1509-1518. JATURASITHA, S., KHIAOSAARD, R., PONGPAEW, A., LEAWTHARAKUL, A., SAITONG, S., APICHATSARANGKUL, T. & LEAUNGWUNTA, V. (2004) Carcass and indirect meat quality of native and Kai Baan Thai chickens with different sex and slaughter weight. In: Proceedings 42nd Annual Conference Kasetsart University, Bangkok, Thailand, pp. 116-126. JATURASITHA, S., SRIKANCHAI, T., KREUZER, M. & WICKE, M. (2008) Differences in Carcass and Meat Characteristics Between Chicken Indigenous to Northern Thailand (Black-Boned and Thai Native) and Imported Extensive Breeds (Bresse and Rhode Island Red). Poultry Science, 87: 160-169. REITER, K. & BESSEI, W. (1996) Effect of the distance between feeder and drinker on behaviour and leg disorders of broilers. In Proceedings of 30th Intrational Congress of Applied Ethology, Guelph, Canada, p. 131 RIZZI, C, MARANGON, A & CHIERICATO, G.M. (2007) Effect of Genotype on Slaughtering Performance and Meat Physical and Sensory Characteristics of Organic Laying Hens. Poultry Science, 86: 128–135

- ³ 299 RUANE, J. (1999) Selecting breeds for conservation, in: OLDENBROEK, J.K. (Ed)
 - 300 *Genebanks and the conservation of farm animal genetic resources*, pp. 59-73 (The 301 Netherlands, DLO Institute for Animal Science and Health).
- SANDERCOCK, D. A., NUTE, G. R. & HOCKING, P. M. (2009) Quantifying the effects of
 genetic selection and genetic variation for body size, carcass composition, and meat quality in
 the domestic fowl (Gallus domesticus). *Poultry Science*, **88**: 923-931.
- 13
 14 305 SAS Institute, (1997) SAS/STAT® User's Guide: Statistics, Version 6.12, SAS Institute Inc.,
 15
 16 306 Cary, NC.
- 307 SWATLAND, H.J. (2008) How pH causes paleness or darkness in chicken breast meat. *Meat*308 Science, 80: 396-400.
- 21 309 TOURAILLE, C., KOPP, J., VALIN, C. & RICARD, F.H. (1981) Chicken meat quality. 1.
- 2223 310 Influence of age and growth rate on physicochemical and sensory characteristics of the meat.
- ²⁴ 311 Archiv für Geflügelkunde, **45:** 69–76.

1 2

5

6

7

323

- ²⁶ 312 WATTANACHANT S., BENJAKUL, S. & LEDWARD, D.A., (2005) Microstructure and
- 313 Thermal Characteristics of Thai Indigenous and Broiler Chicken Muscles. *Poultry Science*, 84:
 30 314 328–336.
- 31
 315 WATTANACHANT, S., BENJAKUL, S. & LEDWARD, D.A. (2004) Composition, Color,
 316 and Texture of Thai Indigenous and Broiler Chicken Muscles. *Poultry Science*, 83: 123-128.
- 35 317 WESTGREN, R.E. (1999) Delivering food safety, food quality, and sustainable production
 37 318 practices: The Label Rouge Poultry System in France. *American Journal of Agricultural* 38 319 *Economics*, 81: 1107-1111.
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| 3 | 324 | Table 1. Least square means of o | carcase compo | osition, pH value | es, breast cl | hemical | |
| 4 5 6 | 325 | composition, shear force and cooking | loss values of | Ermellinata, Pa | dovana ana | l Pépoi s | low- |
| 7 | 326 | growing | chicken at 19 | 00 d of age | | | |
| 8 9 10 | | - | Padovana | Breed Frmellinata | Pènoi | - r ² | Res MS |
| 11 | | Live weight (LW) g | 2144 ^b | 2718 ^a | 1434 ^c | 0.89 | 187 |
| 12 | _ | Carcase weight (CW) g | 1346^{b} | 1726^{a} | 879 ^c | 0.89 | 125 |
| 13 | _ | Breast weight (BW) g | 225^{a} | 243^{a} | 140^{b} | 0.00 | 29 |
| 14 | _ | Thigh weight (TW) g | 478^{b} | 667^{a} | 322° | 0.72 | 50 |
| 15 16 | Г | Dressing (CW/IW) % | 63 ^a | 64^{a} | 61 ^b | 0.07 | 1 59 |
| 17 | F | Breast (BW/CW) % | 17 ^a | 14 ^b | 16 ^a | 0.27 | 1.55 |
| 18 | י ר | Thigh (TW/CW) % | 35 ^c | 38 ^a | 36 ^b | 0.27 | 1.60 |
| 19 | E I | Breast meat nH | 6.18 ^a | 5 97 ^b | 5 00 ^b | 0.39 | 0.18 |
| 20 | т Т | Thigh meat pH | 6.10 ^b | 6.15 ^b | 5.99 6 30 ^a | 0.21 | 0.10 |
| 21 | I | Praget muscle chamical composition | 0.19 | 0.15 | 0.30 | 0.10 | 0.15 |
| 22 | L | Dry matter (%) | 24.85 ^b | 26 18 ^a | 25 15 ^{ab} | 0.26 | 0.05 |
| 23 24 | - | Dry matter $(\%)$ | 24.03 22.22 ^b | 20.10 24.65^{a} | 23.43 22.90 ^b | 0.20 | 0.95 |
| 25 | - | Total lipida $(\%)$ | 23.23 | 24.03 | 0.40^{ab} | 0.11 | 0.79 |
| 26 | - | $\frac{1}{2} \int dx dx = \frac{1}{2} \int $ | 0.01 | 0.29 | 0.40 | 0.57 | 0.20 |
| 27 | - c | ASII (%) | 1.00 | 1.12 16.76 ^b | 1.10 15.94 ^b | 0.20 | 0.05 |
| 28 | 3 | Solving loss (0/) | 12.31 18.20 ^b | 10.70 10.21 ^b | 13.64 | 0.19 | 5.62 2.91 |
| 29 | $20\frac{1}{7}$ | $\frac{a,b,c}{a,b,c}$ Within a new means not sharing | 18.20 | 19.51 | 22.34 | 0.29 | 2.01 |
| 31 | 321 | within a row, means not sharing | a common suj | perscript are sign | inficantly di | inerent a | al P |
| 32 | 320 | | <0.03. | | | | |
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| | | chicken at190 | d of age. | | |
|-------------|--------------------|--------------------|--------------------|----------------|---------|
| Item | | Breed | | r ² | Pec MS |
| Item | Padovana | Ermellinata | Pepoì | 1- | Kes MIS |
| Skin colour | | | | | |
| Breast | | | | | |
| - L* | 62.41^{a} | 56.96 ^b | 59.20^{b} | 0.32 | 3.27 |
| - a* | -2.15^{a} | -2.42^{a} | -3.07 ^b | 0.25 | 0.69 |
| - b* | 1.91 ^a | 1.06 ^a | -1.47 ^b | 0.21 | 2.84 |
| Thigh | | | | | |
| - L* | 62.08 ^b | 62.35 ^b | 63.81 ^a | 0.15 | 1.89 |
| - a* | -2.19 | -1.99 | -2.47 | 0.08 | 0.69 |
| - b* | -1.97 ^c | 3.94 ^a | 0.01^{b} | 0.62 | 1.94 |
| Meat colour | | | | | |
| Breast | | | | | |
| - L* | 46.00^{a} | 48.41 ^b | 49.84 ^b | 0.35 | 2.38 |
| - a* | -1.42 | -1.72 | -1.39 | 0.11 | 0.42 |
| - b* | -0.45^{a} | -1.64 ^b | 0.04^{a} | 0.14 | 1.75 |

Table 2. Breast and thigh colour values of Ermellinata, Padovana and Pépoi slow-growing

^{a,b} Within a row, means not sharing a common superscript are significantly different at *P* <0.05.

rt sharing a c..

| | | Breed | | r ² | Res MC |
|--------------------------------|--------------------|--------------------|--------------------|----------------|---------------|
| | Padovana | Ermellinata | Pépoi | 1 | 1/03 1/13 |
| Breast muscle | % of tot | al analysed fatt | y acid | | |
| Total SFA | 33.88 ^b | 35.59 ^a | 32.82 ^b | 0.46 | 1.29 |
| Total MUFA | 23.45 ^a | 20.21 ^b | 24.92^{a} | 0.39 | 2.55 |
| Total PUFA | 40.24 | 41.38 | 40.09 | 0.05 | 2.71 |
| Total n-6 FA | 36.63 | 37.74 | 36.23 | 0.08 | 2.27 |
| Total n-3 FA | 3.60 | 3.64 | 3.85 | 0.02 | 0.73 |
| n-6/n-3 | 10.51 | 10.93 | 9.66 | 0.06 | 2.19 |
| ^{a,b} Within a row, m | eans not shari | ng a common s | uperscript | are signif | icantly diffe |
| <i>P</i> <0.05. | | | | | |
| SFA: saturated fatt | ty acid; MUFA | A: monounsatur | ated fatty a | acid; PUF | A: polyuns: |
| fatty acid; FA: fatt | y acid. | | | | |
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| Fatty agid | Breed | | | r) | Dec MC |
|-----------------|--------------------|--------------------|----------------------------|------|--------|
| | Padovana | Ermellinata | Pépoi | 1~ | |
| Breast muscle | % of tota | al analysed fatt | y acid | | |
| C6:0 | 0.02 | 0.02 | 0.01 | 0.18 | 0.02 |
| C8:0 | 0.06^{b} | 0.10^{a} | 0.11 ^a | 0.40 | 0.03 |
| C10:0 | 0.06 | 0.08 | 0.07 | 0.08 | 0.02 |
| C12:0 | 0.03 | 0.02 | 0.02 | 0.08 | 0.02 |
| C14:0 | 0.44^{a} | 0.29^{b} | 0.28^{b} | 0.28 | 0.12 |
| C15:0 | 0.09 | 0.08 | 0.07 | 0.08 | 0.02 |
| C16:0 | 20.65 ^a | 21.40^{a} | 19.50 ^b | 0.34 | 1.13 |
| C17:0 | 0.28^{a} | 0.25^{ab} | 0.24^{b} | 0.16 | 0.04 |
| C18:0 | 11.51^{b} | 12.64 ^a | 11.86 ^b | 0.27 | 0.81 |
| C20:0 | 0.08^{ab} | 0.06^{b} | 0.09^{a} | 0.15 | 0.04 |
| C21:0 | 0.01 | 0.01 | 0.01 | 0.10 | 0.01 |
| C22:0 | 0.01^{b} | 0.01 ^b | 0.02^{a} | 0.21 | 0.02 |
| C10:1 n-1 | 0.05 | 0.04 | 0.04 | 0.05 | 0.02 |
| C14:1 n-1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| C16:1 n-9 | 0.20 | 0.16 | 0.18 | 0.09 | 0.05 |
| C16:1 n-7 | 0.39 | 0.34 | 0.46 | 0.08 | 0.17 |
| C17:1 n-9 | 0.03 | 0.07 | 0.11 | 0.09 | 0.10 |
| C17:1 n-7 | 0.01 ^b | 0.01^{ab} | 0.02^{a} | 0.38 | 0.01 |
| C18:1 n-7 trans | 0.04 | 0.03 | 0.02 | 0.13 | 0.02 |
| C18:1 n-9 trans | 0.01^{b} | 0.02^{ab} | 0.02^{a} | 0.17 | 0.01 |
| C18:1 n-9 cis | 20.69^{a} | 17.79 ^b | 2 1.53 ^a | 0.33 | 2.38 |
| C18:1 n-7 cis | 1.73 ^b | 1.46 ^c | 2.18^{a} | 0.68 | 0.21 |
| C20:1 n-9 | 0.19 ^a | 0.13 ^b | 0.22^{a} | 0.34 | 0.05 |
| C18:2 n-6 trans | 0.01 | 0.01 | 0.01 | 0.04 | 0.01 |
| C18:2 n-6 cis | 25.25^{a} | 21.79 ^b | 21.84 ^b | 0.18 | 3.52 |
| C18:3 n-6 | 0.08^{a} | 0.04^{b} | 0.05^{b} | 0.32 | 0.03 |
| C18:3 n-3 | 0.93 ^a | 0.56^{b} | 0.61 ^b | 0.26 | 0.28 |
| CLA | 0.01 | 0.01 | 0.01 | 0.06 | 0.01 |
| C20:2 n-6 | 0.45^{a} | 0.39^{b} | 0.43^{ab} | 0.15 | 0.05 |
| C20:3 n-6 cis | 0.41^{b} | 0.73^{a} | 0.54^{b} | 0.43 | 0.16 |
| C20:4 n-6 | 9.06 ^b | 13.11 ^a | 11.78^{ab} | 0.19 | 3.64 |
| C22:1 n-9 cis | 0.01 | 0.01 | 0.01 | 0.03 | 0.01 |
| C20:5 n-3 cis | 0.06 | 0.05 | 0.08 | 0.03 | 0.06 |
| C22:2 n-6 | 0.17 | 0.29 | 0.22 | 0.10 | 0.16 |
| C22:4 n-6 | 0.01 | 0.03 | 0.01 | 0.14 | 0.04 |
| C22:5 n-6 | 1.19 | 1.33 | 1.36 | 0.04 | 0.34 |
| C24:1 n-9 cis | 0.30 | 0.29 | 0.34 | 0.02 | 0.13 |
| C22:5 n-3 DPA | 1.19 | 1.37 | 1.26 | 0.04 | 0.41 |
| C22:6 n-3 DHA | 1.42^{b} | 1.66 ^{ab} | 1.90 ^a | 0.13 | 0.53 |

Table 4. Least square means of raw breast (without skin) detailed fatty acid

 composition of Ermellinata, Padovana and Pépoi slow-growing chicken at 190 d of age

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