Performance and meat quality of pure Ancona and Cornish × Ancona chickens organically reared

Leistung und Fleischqualität von Hühnern der Rasse Ancona und der Kreuzung Cornish × Ancona in der Biomast

A. Dal Bosco, Cecilia Mugnai and C. Castellini


Introduction

The consumer attention to healthy foods and to the welfare conditions of animals, has favoured organic farming system that is supposed as an environmentally friendly production method, sustaining animals in good health and with high welfare standards (Sundrum, 2001). Some slow-growing poultry products have a long history in Europe as for example the French Label Rouge program, which requires outdoor access and a growing period of at least 81 d. This typical product captures 30% of the French poultry market despite selling products for twice the price of conventional poultry products (Westgren, 1999; Fanatico and Born, 2001).

In Europe, over 4 million laying hens and 1.8 million broilers are kept according to the organic principles. Although the regulations are the same for every country, there is a large diversity in farm sizes and farming systems (Bestman and Maurer, 2006). Italy has the largest organic farmland in Europe, with 1.23 million hectares and 60,509 farms. Nevertheless, there is a shortage of organic animal products and significant amounts are imported from other European countries. Rigorous rule (Reg. EC 834/07) avoids the use of chemical products for assuring the absence of residues and the safety of food; however, the effects of organic protocol on the qualitative characteristics of meat are lacking and the few studies show conflicting results.

Some authors (Castellini et al., 2002a; Lewis et al., 1997) showed that one aspect of free-range animals could be the lower oxidative stability of the meat due to the higher motor activity that improves the oxidative metabolism and the free radical production of chicken. Different adaptation of genetic strains to larger space availability and to outdoor environment greatly affect such assessment by modulating the intake of grass (Castellini et al., 2002a), muscle metabolism (Branciari et al., 2009) with implications on the lipid profile and oxidative stability of meat (Castellini et al., 2005). In order to assure a good welfare status, the EC Regulations and the final recommendation of Network for Animal Health and Welfare in Organic Agriculture (Hovi et al., 2003), suggest to utilize slow-growing birds (daily weight gain < 35 g; Guémené et al., 2009) for their higher adaptability to poorer environment. On the contrary, fast-growing strains selected to produce under highly controlled conditions, seem to be quite unsuitable for extensive systems because the environment is less controlled and the too heavy weight at older ages.

In this contest, the use of purebred strains could also be a valuable alternative, particularly if they are in danger of extinction (Sundrum, 2001). Breeds with a slow growth rate have been selected by several breeders, e.g. Isa-Hubbard, Sasso, Kabir (Guémené et al., 2009) but it should be also considered that the maintenance of biodiversity is one of the main goals of organic farming (IFOAM, 2000). According to this the Italian Agricultural Ministry funded some projects oriented towards the valorisation of local poultry purebred for organic production. Unfortunately, such birds showed very poor productive performance and it is unprofitable to widespread such strains in commercial field. Possible solutions could be the creation of crossed lines in order to increase live weight and feed efficiency.

Thus, the aim of this study was to evaluate the performance, carcass and meat quality of pure versus crossbred Ancona chicks organically reared.

Materials and methods

Animals and diets

For this trial one hundred male chicks one-day-old Ancona and one hundred one-day cross male chicks (Cornish × Ancona), were used. All the animals were reared according to EU Regulation 834/07 and to Italian directives (Gazzetta Ufficiale, 1992) on animal welfare for experimental and other scientific purposes.

All birds were kept from hatching to 20 days of age in an environmentally controlled poultry house with temperature and relative humidity ranging from 32 to 20°C and from 65 to 70% respectively. At 21 days of age they were transferred to a straw bedded poultry house (0.10 m²/bird), equipped with feeders and drinkers and with free access to grass paddock (4 m²/bird; 2 replications per sex and genotype). The pasture lands were not treated with pesticides and herbicides during the three years previous to the organic production. The pasture area also had mature trees, bushes and hedges. The chicks were vaccinated against Marek and New Castle disease.

Chicks were fed a starter (1-21 d) and finisher (22 d to slaughter, 120 days) diets, that were formulated assuming a slightly higher protein and energy requirement than Leghorn type chickens (NRC, 1994) (Table 1). As required by EC Regulation diets contained more than 90% of organic ingredients and were certified by a National agency. Feed and water were provided ad libitum.
Total protein was calculated from Kjeldahl nitrogen using methods N. 950.46B, 920.153, and 928.08, respectively.

Moisture, ash, and total nitrogen using AOAC analyzed in duplicate to determine proximate composition the successive analysis. Samples were immediately

At 14 wks, a sample of 20 birds per group, each weighing ± 10% of the population mean, were slaughtered in the Department processing plant, 12 hours after feed

Individual body weights were recorded every week and daily weight gain (DWG) and feed efficiency (FE) were calculated accordingly. Bird mortality and weight (of dead birds) were recorded daily.

**Sample collection and analytical determinations**

At 14 wks, a sample of 20 birds per group, each weighing between ± 10% of the population mean, were slaughtered in the Department processing plant, 12 hours after feed withdrawal. Chickens were not transported and were electrically stunned (110 V; 350 Hz) before killing. The birds were successively plucked and from the refrigerated carcasses (24 hours at + 4°C), head, neck, legs, edible viscera and fat were removed in order to obtain the

**Breast conformation was measured as follows: the maximal breast width and length were measured with a callipers, whereas the thickness was evaluated by inserting a metal needle in the fourth anterior of the sternum. Successively, the breast muscles and the thigh and drumstick (bone and meat) were excised to calculate the breast meat yield, the thigh and drumstick weight and the meat/bone ratio.**

**From the breast the Pectoralis major muscle was excised for the successive analysis. Samples were immediately analyzed in duplicate to determine proximate composition and energy. Moisture, ash, and total nitrogen using AOAC methods N. 950.46B, 920.153, and 928.08, respectively. Total protein was calculated from Kjeldahl nitrogen using a 6.25 conversion factor. Total lipids were extracted in duplicate from 5 g of each homogenised sample and calculated gravimetrically (FOLCH et al., 1957).

**Ultimate pH (pHu) was measured at 24 h with a Knick digital pHmeter (Broadly Corp., Santa Ana, CA, USA) after homogenization of 1 g of raw muscles for 30 sec in 10 ml of SM iodoacetate (KORKEALA et al., 1984).**

**The Water Holding Capacity (WHC) was estimated (NAKAMURA and KATOH, 1985) by centrifuging 1 g of muscle placed on tissue paper inside a tube for 4 min at 1,500 × g. The water remaining after centrifugation was quantified by drying the samples at 70°C overnight. WHC was calculated as follows: (weight after centrifugation – weight after drying)/initial weight × 100.**

**Samples of about 20 g of weight were placed in open aluminium pans and roasted in an electric oven (pre-heated to 200°C) for 15 min to an internal temperature of 80°C. Cooking Loss (CL) was estimated as the percentage of the weight lost during roasting, after cooling samples for 30 min to about 15°C and drying them on the surface with a paper towel.**

**Shear Force (SF) was evaluated on cores (1.25 cm × 2 cm) obtained from the mid-portions of the roasted samples by cutting them perpendicularly to the fibre direction, using an Instron, model 1011, equipped with a Warner-Blatzler Meat Shear Apparatus.**

**The colour parameters were measured using a tristimulus analyser (Minolta Chroma Meter CR-200, Azuchi-Machi Higashi-Ku, Osaka 541, Japan), with the CIELAB Colour System (1976). The L*a*b* colour system consists of a luminance or lightness component (L*), and 2 chromatic components: the a* component for green (–a) to red (+a) and the b* component from blue (–b) to (+b) yellow colours. The colorimeter was calibrated using a standard white plate. Values of the white standard were L* = 97.10, a* = 0.13, and b* = 1.88.**

**Fatty acids were quantified as methyl esters with a Mega 2 Carlo Erba Gas Chromatograph, model HRGC (Milano, Italy), using a D-B wax capillary column (0.25 mm Ø, 30 m long). The mean value of each fatty acid was used to calculate the sum of saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA).**

**The extent of lipid oxidation was evaluated as TBARS (Thio Barbituric Acid Reactive Substances) according to the modified method of Ki et al. (1977). Oxidation products were quantified as malondialdehyde equivalents (MDA mg/kg muscle).**

**Statistical analyses**

A linear model (STATA®CORP, 2005) was used to analyse data to assess the effect of genotype. Significance of the differences was assessed by the multiple t-test and X-square was used for the mortality rate.

**Results**

All performance traits of Cornish × Ancona birds were better (P < 0.05) than for Ancona birds, except for mortality rate (Table 2). Crossbreds showed higher slaughter weight respect to pure Ancona chickens with a contrary trend in feed intake that obviously affected feed efficiency. Daily weight gain followed the same trend of body weight.

The carcass traits reported in Table 3 showed that the weight of the ready-to-cook carcass was significantly lower (P < 0.01) in Ancona chickens than in the Cornish × Ancona, higher dressing percentage (P < 0.05), as well as
the percentage of empty gastrointestinal tract and of abdominal fat (P < 0.01). Moreover, crossbreds showed higher: breast meat yield and breast width (P < 0.05), breast bone length (P < 0.01) and meat to bone ratio (P < 0.05).

Birds of Ancona group were (P < 0.01) leaner in respect to the Cornish × Ancona ones. The proportion of breast meat yield, breast width, thigh and the meat to bone ratio were greater in Cornish × Ancona chickens.

The chemical composition of Pectoralis maior muscle (Table 4) was affected by the crossbreds only for lipid content. Considering physical traits of the same muscle (Table 5), pHu was affected by crossbred (P < 0.05), whereas WHC, shear force and cooking loss did not show significant differences. Concerning colour, Ancona pure chickens showed higher values of a* and b* traits.

The fatty acid profile (Table 6) of the Pectoralis maior muscle did not show significant variations, only the percentage of PUFA was slightly higher, particularly the levels of eicosapentaenoic (EPA), docosapenaenoic (DHA) and total n-3 fatty acids in Ancona group. TBARS values were higher (P < 0.05) in Cornish × Ancona birds.

Discussion

Productive performance of Cornish × Ancona and mainly of Ancona birds are much lower than of meat-type birds (FARRAN et al., 2000). However, data of present study agree with those obtained in previous researches (CASTELLINI et al., 1992; CASTELLINI et al., 1994) which showed, at 94 days and under conventional rearing system, a live weight of 1,262 g (Ancona) whereas crossbreds with Hubbard reached 2,308 g. In the present investigation, the body weight of Cornish × Ancona birds at 120 days was higher than 2 kg, which is the minimum marketable weight for organic products (SAUVEUR, 1997), whereas pure Ancona showed a too low body weight.

Meat-type chickens have been selected for growth rate and feed conversion. As such these strains grow very rapidly and behave very differently from some of the less intensely selected strains. Their efficiency is largely a consequence of having to maintain their body weight over a much shorter lifespan than is required for less intensely selected slow-growing strains (DUCLOS et al., 2007).

Carcass traits were influenced by final live weight: crossbred chickens showed a lower dress percentage and higher gastrointestinal tract. Carcasses of pure breed chickens were leaner with lower percentage of thigh and meat to bone ratio confirming the results of CASTELLINI et al. (2005).

Table 2. Productive performance

<table>
<thead>
<tr>
<th></th>
<th>Ancona</th>
<th>Cornish × Ancona</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final live weight g</td>
<td>1.874a</td>
<td>2.369b</td>
<td>52</td>
</tr>
<tr>
<td>Feed intake g/d</td>
<td>54.4b</td>
<td>50.9a</td>
<td>3.1</td>
</tr>
<tr>
<td>Daily weight gain g/d</td>
<td>22.9a</td>
<td>29.1b</td>
<td>1.5</td>
</tr>
<tr>
<td>Feed efficiency %</td>
<td>3.9b</td>
<td>3.2a</td>
<td>0.2</td>
</tr>
<tr>
<td>Mortality %</td>
<td>10.0</td>
<td>10.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>

N = 100 per strain.
Means within rows bearing different superscript (a..b) differ significantly at P < 0.05.

Table 3. Carcass characteristics

<table>
<thead>
<tr>
<th></th>
<th>Ancona</th>
<th>Cornish × Ancona</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready-to-cook-carcass (RC)</td>
<td>1.299A</td>
<td>1.622B</td>
<td>178</td>
</tr>
<tr>
<td>Dress percentage %</td>
<td>69.3a</td>
<td>68.5b</td>
<td>0.59</td>
</tr>
<tr>
<td>Empty gastrointestinal tract</td>
<td>5.90A</td>
<td>6.25B</td>
<td>0.24</td>
</tr>
<tr>
<td>Abdominal fat %</td>
<td>1.30A</td>
<td>2.14B</td>
<td>0.40</td>
</tr>
<tr>
<td>Breast meat yield %</td>
<td>8.88a</td>
<td>9.21b</td>
<td>0.31</td>
</tr>
<tr>
<td>Breast width cm</td>
<td>11.0a</td>
<td>14.5b</td>
<td>1.60</td>
</tr>
<tr>
<td>Breast layer thickness</td>
<td>2.20</td>
<td>2.50</td>
<td>0.55</td>
</tr>
<tr>
<td>Breast bone length</td>
<td>15.9</td>
<td>15.8</td>
<td>2.50</td>
</tr>
<tr>
<td>Thigh %</td>
<td>17.2A</td>
<td>18.2B</td>
<td>0.55</td>
</tr>
<tr>
<td>Drumstick %</td>
<td>15.7</td>
<td>16.9</td>
<td>1.92</td>
</tr>
<tr>
<td>Meat to bone ratio</td>
<td>2.64a</td>
<td>2.98b</td>
<td>0.27</td>
</tr>
</tbody>
</table>

N = 20 per group.
Means within rows bearing different superscript (a..b) differ significantly at P < 0.05; whereas means within rows bearing different superscript (A..B) differ significantly at P < 0.01.

Table 4. Chemical characteristics of Pectoralis maior muscle

<table>
<thead>
<tr>
<th></th>
<th>Ancona</th>
<th>Cornish × Ancona</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture %</td>
<td>26.0</td>
<td>26.2</td>
<td>2.41</td>
</tr>
<tr>
<td>Protein %</td>
<td>21.7</td>
<td>21.6</td>
<td>1.45</td>
</tr>
<tr>
<td>Fat %</td>
<td>3.05a</td>
<td>3.29b</td>
<td>0.16</td>
</tr>
<tr>
<td>Ash %</td>
<td>0.88</td>
<td>0.85</td>
<td>0.56</td>
</tr>
<tr>
<td>Gross energy MJ kg d.m.–1</td>
<td>6.00</td>
<td>6.05</td>
<td>0.10</td>
</tr>
</tbody>
</table>

N = 20 per group.
Means within rows bearing different superscript (a..b) differ significantly at P < 0.05.

Table 5. Physical characteristics of Pectoralis maior

<table>
<thead>
<tr>
<th></th>
<th>Ancona</th>
<th>Cornish × Ancona</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>pHu</td>
<td>5.69a</td>
<td>5.80b</td>
<td>0.09</td>
</tr>
<tr>
<td>WHC</td>
<td>53.0</td>
<td>53.2</td>
<td>2.58</td>
</tr>
<tr>
<td>Cooking loss %</td>
<td>34.0</td>
<td>34.0</td>
<td>1.25</td>
</tr>
<tr>
<td>Shear Force kg/cm²</td>
<td>4.02</td>
<td>4.15</td>
<td>0.67</td>
</tr>
<tr>
<td>Colour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L*</td>
<td>55.6</td>
<td>55.4</td>
<td>2.41</td>
</tr>
<tr>
<td>a*</td>
<td>5.76b</td>
<td>5.42a</td>
<td>0.14</td>
</tr>
<tr>
<td>b*</td>
<td>4.54b</td>
<td>4.26a</td>
<td>0.10</td>
</tr>
</tbody>
</table>

N = 20 per group.
Means within rows bearing different superscript (a..b) differ significantly at P < 0.05.

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Ancona hens with Cornish male improves growth rate of in different strains having various growing rate (BERRI et al., 2003; FANATICO et al., 2007). Regarding the genetic strains of broilers (RAMMOUZ et al., 2004; NISSEN (2007) than reported in slow-growing birds – half values available substrate susceptible to lipid peroxidation. Due to the lower muscle fat level and thus of the lower fast ones.

Yield reduced the rate of pH decline (BERRI et al., 2005, CASTELLINI et al., 2008), possibly due to a decrease in the glycolytic potential (BAEZA et al., 2002). Also, FANATICO et al. (2007) observed that birds with slower-growing rate, fast ones (WATTANACHANT et al., 2004; BERRI et al., 2005; found lower pH in slow-growing genotypes compared with crossed ones, according to others authors that have also values observed in this study were normal, the pure breed gen concentration at the time of slaughter. Although pHu and colour were studied. In the present trials, there was no geno-type effect on L* value according to FANATICO et al. (2007).

The higher lipid stability of pure Ancona birds could be due to the lower muscle fat level and thus of the lower available substrate susceptible to lipid peroxidation.

From these results, it can be concluded that crossing Ancona hens with Cornish male improves growth rate of Ancona breed and thus results in better performance, with little modifications in meat characteristics. This crossbreed seems a suitable compromise between the adaptability and rusticity which are key factors in pasture-based farming system and the economical sustainability.

Summary

The aim of the work was to evaluate the performance, carcass and meat quality of pure Ancona and Cornish × Ancona crossbred chicks organically reared. For this trial one hundred one-day-old Ancona male chicks and one hundred one-day old crossed male chicks (Cornish × Ancona) were used. The productive performance of Cornish × Ancona was better than of pure Ancona birds (final live weight 2,369 vs. 1,874 g; feed efficiency 3.2 vs. 3.9; ready-to-cook-car cass 1,622 vs. 1,299 g). The chemical composition of breast was affected by strain only for lipid content (3.29 vs. 3.05%). Also pHu and colour were affected by crossing (5.80 vs. 5.69; 5.42 vs. 5.76 and 4.26 vs. 4.54, respectively for a* and b* values). The fatty acid profile of breast did not show significant variations. TBARS (ThioBarbituric Acid Reactive Substances) values were higher in Cornish × Ancona birds (1,75 vs. 1.50 mg MDA/kg). From these results it is concluded that Cornish × Ancona chickens with respect to purebred ones showed higher performance and almost similar meat characteristics and could be a suitable compromise between the diffusion of a local breed and their economical sustainabil-ity.

Key words

Organic fattening, Ancona, carcass quality, meat quality

Zusammenfassung

Leistung und Fleischqualität von Hühnern der Rasse Ancona und der Kreuzung Cornish × Ancona in der Biomast

Das Ziel der Untersuchung war die Bestimmung der Leistung, der Schlachtkörper- und der Fleischqualität von männlichen Hühnern der Rasse Ancona sowie der Kreuzung Cornish × Ancona in der Biomast. Hierzu wurden jeweils 100 männliche Hühner der Rasse Ancona und der Kreuzung Cornish × Ancona verwendet. Die Produktionsleistung der Kreuzungstiere war besser als die der reinen Ancona (Mastendgewicht 2369 zu 1874 g, Futterverwer tung 3,2 zu 3,9, Schlachtkörpergewicht 1622 zu 1299 g). Für die chemische Zusammensetzung des Brustfleischs konnte nur für den Fettgehalt ein signifikanter Einfluss der Genetik festgestellt werden (C × A 3,29%, Ancona 3,05%). Ferner unterschieden sich die Kreuzungstiere von den reinen Ancona im pHu und der Farbe (pHu 5,80 zu 5,92; a* 5,42 zu 5,76; b* 4,26 zu 4,54). Für das Fettsäuremuster des Brustfleischs konnten keine Unterschiede festgestellt werden. Die TBARS-Werte (ThioBarbituric Acid Reacti ve Substances) waren für die Kreuzungstiere signifikant höher (1,75 zu 1,50 mg MDA/kg). Aus den Ergebnissen kann geschlossen werden, dass die Kreuzungshühner Cornish × Ancona im Vergleich zu den reinrassigen Tieren eine höhere Produktionsleistung bei ähnlichem Fleischqualitätsniveau erreichen und daher einen sinnvollen Kompromiss zwischen der Verbreitung einer Lokalrasse und ihrer wirtschaftlichen Nachhaltigkeit darstellen.

Table 6. Fatty acid profile and oxidative stability of Pectoralis major muscle

<table>
<thead>
<tr>
<th></th>
<th>Ancona</th>
<th>Cornish × Ancona</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΣSFA % total fatty acid</td>
<td>35.5</td>
<td>34.7</td>
<td>3.01</td>
</tr>
<tr>
<td>ΣMUFA</td>
<td>31.2</td>
<td>33.1</td>
<td>2.64</td>
</tr>
<tr>
<td>ΣPUFA</td>
<td>33.4</td>
<td>32.2</td>
<td>3.24</td>
</tr>
<tr>
<td>C20:5(n-3) EPA</td>
<td>0.51</td>
<td>0.32</td>
<td>0.87</td>
</tr>
<tr>
<td>C22:6(n-3) DHA</td>
<td>0.90</td>
<td>0.81</td>
<td>0.15</td>
</tr>
<tr>
<td>Σ(n-3)</td>
<td>4.19</td>
<td>4.02</td>
<td>1.20</td>
</tr>
<tr>
<td>TBARS mg MDA/kg</td>
<td>1.50a</td>
<td>1.75b</td>
<td>0.24</td>
</tr>
</tbody>
</table>

N = 20 per group.
Means within rows bearing different superscript (a..b) differ significantly at P < 0.05.
Stichworte
Biomast, Ancona, Schlachtkörperqualität, Fleischqualität

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References


Fanatico, A.C., P.B. Pillai, J.L. Emmert, C.M. Owens, 2007: Meat quality of slow- and fast-growing chicken genotypes fed low-nutrient or standard diets and raised indoors or with outdoor access. Poult. Sci. 86, 2245-2255.


NISSEN, P.M., J.F. YOUNG, 2004: Creatine monohydrate and glucose supplementation to slow- and fast-growing chickens changes the postmortem pH in Pectoralis major. Poult. Sci. 85, 1038-1044.


STATECORP, 2005: Stata Statistical Software: Release 9.0. College Station, Texas, USA.


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