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PAPER

Effect of slaughtering age in different commercial chicken genotypes reared according to the organic system: 1. Welfare, carcass and meat traits

Alessandro Dal Bosco,[1] Cecilia Mugnai,[2] Monica Guarino Amato,[3] Luca Piottoli,[1] Alice Cartoni,[1] Cesare Castellini[1]

[1]Dipartimento di Scienze Agrarie, Alimentari ed Ambientali, Università di Perugia, Italy

[2]Dipartimento di Scienze degli Alimenti, Università di Teramo, Mosciano Sant'Angelo, Italy

[3]Consiglio per la Ricerca e la Sperimentazione in Agricoltura, Ministero delle Politiche Agricole Alimentari e Forestali, Roma, Italy

Abstract

The carcass and meat quality of three different commercial chicken genotypes reared according to the organic system and slaughtered at two different ages (70 and 81 days) were compared. The used genotypes were Naked Neck (CN1), Kabir (KR4) and Ross 308 (R). All animals were raised in the facilities of a big Italian company, in production units of 3000 birds. Before slaughtering, plumage conditions, foot pad dermatitis as well as qualitative traits of carcasses, such as skin damage and the presence of breast blisters, were registered (n=50). Naked Neck birds showed the best plumage conditions at both ages; the other genotypes had similar body conditions showing a dramatically worsening at the end of rearing cycle (81 days), mainly at breast level. The carcass conformation showed differences mainly for the CN1 genotype, which was more slender with higher proportions of head, neck and legs; thus, ready-to-cook-carcass yield was lower. The meat of CN1 chickens showed lower levels of lipids, pH and brightness values, but higher index of redness. Ross 308 genotype showed a bad welfare status even at 70 days, confirming that the rearing of this strain should not be permitted in organic systems. In conclusion, this study indicates that genotype deeply affects performance, welfare and qualitative characteristics of meat. Regarding the slaughtering age, although the inconsistency of European Commission rules which authorise the reduction of slaughtering age in less mature strains, at 70 days chickens show higher feed efficiency and thinness of carcass and meat.

Corresponding author: Prof. Cesare Castellini, Dipartimento di Scienze Agrarie, Alimentari ed Ambientali, Università di Perugia, Borgo XX Giugno 74, 06100 Perugia, Italy.
Tel. +39.075.5857110 - Fax: +39.075.5857122.
E-mail: cesare.castellini@unipg.it

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Introduction

It is widely known that the use of fast-growing genotype in organic broiler poultry production creates severe problems on animal welfare (*e.g.* leg and metabolic problems; Berg, 2002; Dal Bosco *et al.*, 2010). To prevent the use of strain selected for intensive systems, the Regulation (EC) n. 889/2008 (European Commission, 2008) provides that broilers shall either be reared until they reach a minimum age (81 days) or come from slow-growing strains. Such a Regulation, though, causes a controversy. Indeed, by definition, slow-growing strains mature after fast-growing strains and therefore there is no physiological reason to permit their slaughtering before other strains. The Regulation also asks each member state to lay down criteria for the definition of slow-growing genotypes considered as more suitable for organic production and to compile a list of such strains. Some European member states (Austria, Belgium, Bulgaria, Denmark, France, Germany, Ireland, Holland, Poland, United Kingdom and Czech Republic) have already given a definition of slow-growth for broilers based on daily weight gain (WG), whereas others have identified parental egg-type lines produced by genetic industry.

The Italian and French producers complain that many other European countries, by means of the derogation of slow-growing genotypes, can slaughter the animals before the 81-day-period. It is evident that slaughtering animals earlier represents a commercial advantage since in the last part of the rearing cycle the feed index becomes very unfavourable. Therefore, it is necessary to clearly define slow-growing strains for the attainment of slaughtering animals earlier. Indeed, it should be underlined that adaptation to organic farming is affected by many factors, that daily gain alone could be a prerequisite, and that many other traits (welfare, foraging behaviour, immune response) should be considered as well. By modifying the age at slaughtering other qualitative traits are affected: *e.g.* yield of edible parts and fat deposition change dramatically (Crawley *et al.*, 1980; Brake *et al.*, 1993; Leenstra, 1986; Albuquerque *et al*., 2003).

The aim of this study was to compare welfare, carcass and meat traits of three different commercial chicken strains reared under organic system and slaughtered at two different ages.

Materials and methods

Animals, housing and feeding

The trial was conducted in the facilities of an European supplier of organic broilers in Central Italy. The genotypes used were Naked Neck (strain CN1), Kabir (strain KR4) and Ross 308 (R); all the birds were furnished by a commercial hatchery (Avicola Berlanda, Carmignano di Brenta, Italy). Kabir and CN1 were of both sexes, while R were only females due to the too high BW reachable by males.

The trial was carried out from April to June 2012 in the facilities of the company in production units of 3000 birds (with 3 internal replications) and vaccinated against Marek and Newcastle diseases and coccidiosis (Paracox®-8). At 21 days of age, all the birds were put in 3 covered shelters (0.10 m^2/bird) with straw litter and access to a grass paddock (4 m^2/bird); feeders and drinkers were available both outdoors and indoors.

Chickens were fed *ad libitum* the same starter (1 to 21 days) and finisher (22 days to slaughter) diets, containing 100% certified organic ingredients (Table 1). Chemical analyses of diet were done according to AOAC methods (1995). Productive performance was recorded all over the trial. In particular, at the end of study, individual body weights (BWs; 10% of the animals in each group/replication/age) were recorded, and daily WG and feed efficiency (FE) were calculated accordingly. Bird mortality was recorded daily. Half of the birds were sacrificed at 70 days, while the remaining part at 81 days of age.

Welfare

Before slaughtering, the foot pad dermatitis (FPD) of a sample of 50 birds per group (17, 17 and 16 birds replication) was assessed by assigning them to 1 of 3 different classes: 0=no mark (no lesion), 1=mild lesions (superficial lesions, erosions, papillae, and discoloration of the footpad) or 2=severe lesions (deep lesions, ulcers and scabs) (Berg, 2002). The FPD score was calculated by applying the formula reported in the Proposal for a Council Directive of the European Commission (European Commission, 2005). The plumage condition was also assessed according to Tauson *et al.* (2005). Other welfare-related traits of carcasses, such as skin damage and the presence of breast blisters were also recorded.

Carcass dissection, sampling and determinations

After killing, carcasses were plucked, eviscerated (non-edible viscera: intestines, proventriculus, gall bladder, spleen, oesophagus and full crop) and stored for 24 h at +4°C. Head, neck, legs, edible viscera (heart, liver, gizzard) and fat (perivisceral, perineal and abdominal) were removed in order to obtain the ready-to-cook carcass (Romboli *et al*., 1996).

Breast conformation was measured as follows: the maximal breast width and length were measured with a calliper, whereas the thickness was evaluated by inserting a metal needle in the fourth anterior of the sternum. From the refrigerated carcasses (24 h at 4°C), 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 to bone ratio. On 20 samples of *Pectoralis major* muscle per genotype/age, moisture, ash and total nitrogen were assessed by using the AOAC methods (950.46B, 920.153, and 928.08, respectively; 1995). Total protein was calculated by Kjeldahl nitrogen using a 6.25 conversion factor. Ultimate pH (pH*u*) was measured with a Knick digital pHmeter (Broadly James Corp., Santa Ana, CA, USA) after homogenisation of 1 g of raw muscle for 30 s in 10 mL of 5 M iodoacetate (Korkeala *et al.*, 1986). The water-holding capacity was estimated by placing 1 g of whole muscle on tissue paper inside a tube and centrifuging for 4 min at 1500 g. The water remaining after centrifugation was quantified by drying the samples at 70°C overnight. Water-holding capacity was calculated as follows: (weight after centrifugation - weight after drying)/initial weight 100 (Castellini *et al.*, 1998). The cooking loss (CL) was measured on samples of about 20 g placed in open aluminium pans and cooked in an electric oven (pre-heated to 200°C) for 15 min to an internal temperature of 80°C. The CL was estimated as the percentage of the weight of the cooked samples, (cooled for 30 min to about 15°C and dried on the surface with a paper towel), with respect to the weight of the raw samples (Cyril *et al.*, 1996). Shear force was evaluated on cores (1.25 cm Ø; 2 cm length) obtained from the mid-portions of the roasted samples by cutting them perpendicularly to the direction of the fibre, using an Instron (model 1011; Instron, Norwood, MA, USA), equipped with a Warner-Blatzler meat shear apparatus. The colour parameters [brightness (L*), redness (a*) and yellowness (b*)] were measured using a tristimulus analyser (Minolta Chroma meter CR-200; Minolta, Tokyo, Japan), with the Cielab colour system (Commission Internationale de l'Eclairage, 1976).

Statistical analyses

A linear model (StataCorp, 2005; ANOVA procedure) was used to evaluate the interactive effect of genetic strain and slaughtering age. Significance of differences ($P\leq0.05$) were assessed with a Bonferroni multiple *t*-test. Differences in mortality rates, plumage conditions, percentage of FPD and breast blisters were evaluated by the χ^2 (FREQ procedure).

Results and discussion

As expected, performance was influenced by both genotype and slaughtering age (Table 2). In particular, CN1 and KR4 chickens showed similar body and carcass weights, while the R strain showed higher values. At all ages, birds largely exceeded the 2.5 kg of live weight showing a daily WG of about 37 g/d for CN1 and KR4 and 48 g/d for R.

At 70 and 81 days of age, R broilers reached 3398 and 3843 g BW, respectively, with a high culling and mortality rates, confirming our pre-

Table 1. Formulation, chemical composition and energetic value of the diets.

	Starter diet	Finisher diet
Ingredients, %		
Corn	52.0	46.0
Full fat soybean	30.5	12.5
Wheat	-	20.0
Soybean meal	9.0	14.0
Alfalfa meal	2.8	2.8
Gluten feed	3.0	2.0
Vitamin-mineral premix°	1.0	1.0
Dicalcium phosphate	1.0	1.0
Sodium bicarbonate	0.5	0.5
NaCl	0.2	0.2
Chemical composition		
DM, %	90.89	90.80
CP, % DM	22.30	18.05
EE, % DM	7.95	4.98
CF, % DM	4.67	4.01
Ash, % DM	5.76	5.59
NDF, % DM	10.74	10.11
ADF, % DM	5.58	5.06
Cellulose, % DM	4.22	3.56
ADL, % DM	1.03	1.11
Hemicellulose, % DM	5.16	5.05
ME,# MJ kg^{-1}	12.54	12.98

DM, dry matter; CP, crude protein; EE, ether extract; CF, crude fibre; NDF, neutral detergent fibre; ADF, acid detergent fibre; ADL, acid detergent liquid; ME, metabolisable energy. °Amounts per kg: vitamin A, 11,000 U; vitamin D_3, 2000 U; vitamin B_1, 2.5 mg; vitamin B_2, 4 mg; vitamin B_6, 1.25 mg; vitamin B_{12}, 0.01 mg; α-tocopheryl acetate, 30 mg; biotin, 0.06 mg; vitamin K, 2.5 mg; niacin, 15 mg; folic acid, 0.30 mg; panthotenic acid, 10 mg; choline chloride, 600 mg; Mn, 60 mg; Fe, 50 mg; Zn, 15 mg; I, 0.5 mg; Co, 0.5 mg. #Estimated following Carrè and Rozo (1990).

vious findings (Castellini *et al.,* 2002). Almost all these birds (92.7%, data not shown) had leg problems attributable to acute inflammation at joints level, which prevented their natural movement. The reasons for such high lameness were probably due to the excessive weight of the birds and the resulting low activity. Reiter and Bessei (1996) reported that exercise reduces leg weakness. Weeks *et al.* (1994) observed that about 80% of the fast-growing birds had gait abnormality at the 7th week of age. With increasing age and weight, the leg joints of these animals are excessively constrained and limping, ascites and other related problems increase.

Meat-type broilers have been intensively selected for growth rate and feed conversion. These strains grow very rapidly and behave very differently from birds of the less intensely selected strains. Their productive efficiency is largely a consequence of having to maintain their BW over a much shorter lifespan than required for slow-growing strains. That is, as age at slaughtering decreases, FE of poultry decreases due to the reduction in body maintenance requirements. It is evident that fast-growing birds do not well perform under extensive environmental conditions, whereas intensive rearing provides them with what is needed for covering all of their physiological needs (Reiter and Bessei, 1996).

Besides leg weakness, some authors (Rauw *et al.*, 1998; Yunis *et al.*, 2000; Thiele, 2001) reported that selection for rapid growth reduces the immune-competence and increases the susceptibility to environmental stress (Qureshi *et al.*, 1994). Medium-growing genotypes (KR4 and CN1) confirmed the greater welfare status and higher adaptability to the poorer conditions of the organic system than the fast-growing hybrids (Castellini *et al.*, 2002).

Plumage conditions, frequencies of foot pad lesions and breast blisters are shown in Table 3. The CN1 birds showed the best plumage conditions at both ages; the other genotypes had poorer conditions showing a dramatically worsening at the end of rearing cycle, mainly at breast level. Foot pad dermatitis lesions vary from darkish spots, associated with mild lesions that disappear after the scales are peeled through processing, to severe ulcers that cause inflammation remaining as red/brown skin spots after processing (Martrenchar *et al.,* 2002). About 80% of CN1 birds did not show any FPD lesions at 70 days of age, whereas KR4 and particularly R chickens showed severe lesions (class 2) in 19.8 and 50.6% of birds, respectively. In all strains, the FPD incidence increases with older age. Even the occurrence of breast blisters in KR4 and R birds was noticeably higher than in CN1. Kabir and R carcasses, showed 20 and 30% of breast blister at 70 and 81 days of age, respectively, with significant loss of commercial value. To a large extent, this situation may depend on the different behaviour of chickens. In a previous study (Castellini *et al*., 2002) medium-growing birds always displayed a more kinetic behaviour, spent a lot of time out of the shelter and ate grass; on the contrary, R birds spent majority of the rearing period almost crouching due to their very high body and breast weight. Considering that the most prevalent form of FPD is related to litter wetness and crustiness (Martland, 1985) which are caused by a combination of moisture and chemical irritants, the time spent outdoors

Table 2. Productive performance of chickens at different ages.

	70 days			81 days			SEM
	CN1	KR4	R	CN1	KR4	R	
Live weight, g	2790.9^{b}	2509.4^{a}	3386.5^{c}	3171.6^{c}	2811.1^{b}	3803.0^{d}	303.2
Feed intake, g/d	105.7^{a}	101.4^{a}	138.1^{b}	108.8^{a}	107.1^{a}	139.6^{b}	35.1
Daily gain, g/d	39.1^{b}	35.1^{a}	47.6^{c}	38.8^{b}	34.7^{a}	46.9^{c}	1.22
Feed:gain, g/d	2.65^{a}	2.83^{b}	2.86^{b}	2.67^{a}	2.90^{b}	2.91^{b}	0.20
Mortality, %	3.00^{a}	3.00^{a}	5.50^{b}	3.50^{ab}	4.00^{ab}	8.30^{c}	2.5*

CN1, Naked Neck; KR4, Kabir; R, Ross 308. *χ^2 value. $^{a-d}$Different letters in the same row denote significant differences (P<0.05).

Table 3. Mean values of plumage conditions, percentage of foot pad dermatitis and breast blister.

	70 days			81 days			χ^2
	CN1	KR4	R	CN1	KR4	R	
Plumage conditions							
Neck	-	4.0	4.0	-	4.0	4.0	2.2
Breast	4.0^{c}	3.0^{c}	2.5^{b}	3.5^{c}	2.0^{b}	0.0^{a}	0.4
Wings	4.0^{b}	4.0^{b}	3.0^{b}	3.5^{ab}	3.5^{ab}	2.5^{a}	0.2
Cloaca/vent	4.0^{b}	4.0^{b}	3.5^{b}	4.0^{b}	3.0^{b}	0.0^{a}	0.3
Back	4.0^{b}	3.5^{ab}	3.0^{b}	4.0^{b}	3.0^{a}	3.0^{a}	0.1
Tail	4.0^{b}	3.5^{ab}	3.0^{a}	3.0^{a}	3.0^{a}	3.5^{a}	0.1
Total score	20.0^{c}	22.0^{b}	19.0^{a}	18.0^{c}	18.5^{b}	13.0^{a}	5.6
FPD,° %							
Class 0	79.0^{c}	37.1^{b}	9.0^{a}	62.4^{c}	32.8^{b}	6.5^{a}	25.5
Class 1	15.6^{a}	43.1^{c}	40.4^{c}	24.3^{a}	45.9^{c}	36.1^{b}	18.3
Class 2	5.4^{a}	19.8^{b}	50.6^{c}	13.3^{a}	21.3^{b}	54.4^{c}	19.1
Breast blister	0.00^{a}	20.0^{a}	20.0^{a}	20.0^{a}	30.0^{b}	30.0^{b}	0.62

CN1, Naked Neck; KR4, Kabir; R, Ross 308; FPD, foot pad dermatitis. °Score classes: 0=no mark (no lesion), 1=mild lesions (superficial lesions, erosions, papillae, and discoloration of the footpad), 2=severe lesions (deep lesions, ulcers, and scabs). $^{a-c}$Different letters in the same row denote significant differences (P<0.05).

reduces these problems. The carcass appearance could also be considered as an indirect index of welfare conditions of the birds (Campo *et al.*, 2001).

The analysis of the carcass traits (Table 4) showed significant differences mainly between fast- and medium-growing strains. Within medium-growing, CN1 was more slender with higher proportions of head, neck and legs; accordingly, the yield of ready-to-cook-carcass and abdominal fat was lower.

In KR4 and R birds, abdominal fat increased with age (Brake *et al.*, 1993; Rabello, 1998), whereas in CN1 it remained stable, probably due to the above mentioned higher kinetic activity. Naked Neck strain presented typical traits of birds with high kinetic activity like a longer tibia and a higher development of drumsticks (Castellini *et al.*, 2002).

The amount of fat carcass is currently a concern, since consumers consider undesirable the excess of fat in broiler carcasses. In addition, extra work is needed to remove abdominal fat from the carcasses in the processing plant, which increase the cost of carcass processing.

The R birds showed the typical structure of meat-chicken: higher breast width, thicknesses and breast yield associated with a lower tibia length and percentage of drumstick and with a muscle/bone ratio significantly higher.

Breast yield increased with the age in all the strains. The higher breast yield in older birds was reported by many Authors (Brake *et al.*, 1993; Young *et al.*, 2001). Gordon and Charles (2002) assessed that the differences of breast yield are maxim ised after the growth inflection point at about 8 weeks. Because all of the birds in this study were older, breast yield was much higher at 81 days of age. This trend is positive in term of carcass composition but very bad for the animal welfare; indeed, since the breast grows more than the whole body (mainly in R) consequently, the birds became more and more unbalanced as the age increase.

The edible viscera, head and neck decreased in older birds and mainly in fast-growing strain.

Interesting results are related to the heart weight: Ross birds, with respect to medium-growing strains, showed a lower heart weight (0.28 to 0.31% carcass weight at 70 and 81 days, respectively). Earlier studies affirm that muscular-skeletal development in fast-growing *vs* slow-growing birds exceeds the cardiovascular development (Martinez-Lemus *et al.*, 1998); under this point of view, CN1 birds showed the highest heart percentage (0.41 to 0.44% carcass weight at 70 and 81 days, respectively).

Meat:bone ratio is higher in fast-growing strain and increased with the age. Perreault and Lesson (1992) observed a meat to bone ratios of 1.31 at 35 days and 1.57 at 60 days of age.

The chemical characteristics of the breast muscle are presented in Table 5. Moisture and lipids contents were both affected by genotype and slaughtering age. R birds presented the lower moisture and the higher lipid content, whereas, the CN1 chickens showed higher moisture and lower lipid level, indicating a less physiologically mature state; KR4 showed intermediate values. Concerning the age effect, in general, increasing the age the level of moisture in meat decreased and that of lipid increased.

As previously affirmed, the kinetic behaviour and the different maturity stage could explain why the CN1 birds at the same age exhibited lower lipid content and higher moisture (Grey *et al.*, 1983; Baeza *et al.*, 1999).

Concerning the physical characteristics

Table 4. Carcass traits of chickens at different ages.

	70 days			81 days			SEM
	CN1	KR4	R	CN1	KR4	R	
Head and neck, % LW	7.02^{d}	6.83^{d}	4.74^{b}	6.51^{d}	5.90^{c}	3.55^{a}	0.36
Legs, % LW	3.83^{cd}	3.57^{c}	2.31^{a}	4.03^{d}	2.86^{b}	2.27^{a}	0.28
Ready-to-cook-carcass, % LW	70.8^{a}	74.4^{b}	74.2^{b}	70.1^{a}	74.0^{b}	80.4^{c}	1.72
Heart, g	11.0^{b} (0.42)	10.5^{b} (0.40)	9.70^{a} (0.28)	13.4^{d} (0.44)	10.6^{b} (0.36)	12.6^{c} (0.32)	1.33
Liver, g	39.7^{b}	40.5^{b}	48.4^{c}	43.5^{b}	34.8^{a}	61.5^{d}	6.64
Abdominal fat, %	2.65^{a}	2.72^{a}	3.15^{b}	2.87^{ab}	3.91^{c}	4.10^{c}	0.70
Breast width, cm	17.4^{a}	17.7^{a}	19.7^{b}	18.2^{a}	18.9^{ab}	19.9^{b}	1.32
Breast layer thickness, cm	2.79^{a}	2.63^{a}	3.71^{b}	2.96^{a}	2.95^{a}	4.26^{c}	0.34
Length of tibia, cm	16.2^{c}	12.9^{a}	12.4^{a}	17.5^{c}	13.9^{b}	12.8^{a}	1.13
Breast meat yield, %	18.5^{a}	18.6^{a}	24.1^{c}	19.0^{a}	21.5^{b}	29.3^{d}	1.34
Drumstick, %	18.7^{d}	16.2^{c}	12.0^{a}	15.8 ^{c}	13.3^{b}	12.5^{a}	0.67
Meat:bone	2.62^{a}	2.51^{a}	3.54^{c}	2.74^{ab}	2.96^{b}	4.02^{d}	0.32

CN1, Naked Neck; KR4, Kabir; R, Ross 308. Values in brackets are expressed as percentage. $^{a\text{-}d}$Different letters in the same row denote significant differences (P<0.05).

Table 5. Chemical composition of breast meat at different ages.

	70 days			81 days			SEM
	CN1	KR4	R	CN1	KR4	R	
Moisture, %	77.1^{b}	76.6^{b}	75.8^{a}	76.7^{b}	76.1^{ab}	75.6^{a}	1.02
Protein, %	20.4	21.0	21.2	20.6	20.9	21.4	1.23
Lipids, %	0.93^{a}	1.05^{a}	1.42^{c}	1.23^{b}	1.44^{c}	1.70^{d}	0.16
Ash, %	1.52	1.37	1.60	1.44	1.52	1.26	0.60

CN1, Naked Neck; KR4, Kabir; R, Ross 308. $^{a\text{-}d}$Different letters in the same row denote significant differences (P<0.05).

Table 6. Physical traits of breast meat at different ages.

	70 days			81 days			SEM
	CN1	KR4	R	CN1	KR4	R	
pH*u*	6.02[a]	6.33[b]	6.30[b]	6.12[a]	6.32[b]	6.28[b]	0.13
CL, %	24.6	25.7	25.8	25.1	28.7	27.2	3.84
Shear force, kg/cm^2	1.26[a]	1.28[a]	1.40[a]	1.70[b]	1.90[b]	1.85[b]	0.43
Colour							
L*	51.1[a]	57.6[b]	56.3[b]	56.2[b]	59.2[b]	60.3[b]	4.33
a*	5.91[c]	4.53[a]	5.05[b]	5.96[c]	3.83[a]	5.18[b]	1.44
b*	1.25	1.14	0.83	1.35	1.53	1.81	1.91

CN1, Naked Neck; KR4, Kabir; R, Ross 308; CL, cooking loss; L*, brightness; a*, redness; b*, yellowness. [a-c]Different letters in the same row denote significant differences (P<0.05).

(Table 6), CN1 chickens showed lower pH values, probably attributable to their more energetic metabolism which probably enhances the storage of glycogen in muscle (Hocquette *et al*., 1998; Fernandez *et al*., 2001).

Tenderness was only affected by age: meat from older animals was tougher. Tenderness is probably one of the most critical factors associated with the consumers' ultimate satisfaction with meat product, even if it should be pointed that in poultry sector this parameter is not particularly critical. The two major contributors to meat tenderness are the maturity of the connective tissues and contractile state of the myofibrillar proteins. The maturity of the connective tissue involves the chemical cross bonding of the collagen in the muscle (Fletcher, 2002). Accordingly, collagen cross-linking increases with age and meat from older animals is less tender. With regard to the colour, significant differences, for L* and for a* were due to genetic strain. The muscles of the CN1 chickens showed lower L* values and higher index of red. The L* values of the breast meat of KR4 and R genotypes were similar. According to Berri *et al.* (2001), the breast meat of birds highly selected for growing-rate (R) differed in colour, with significantly more lightness and less redness. Our findings are also consistent with previous results on several commercial species (Le Bihan-Duval *et al.*, 1999; Santé *et al.*, 1991; Baéza *et al.*, 1997) showing a decrease in colour intensity and an increase in lightness in fast-growing genotypes compared to less selected strains. This difference in colour could be at least partly due to a decrease in heme pigment content. Indeed iron, which is representative of the total pigment content, has been shown to be highly related to the colour (redness and lightness) of broiler breast meat (Boulianne and King, 1995). A strong negative correlation between ultimate pH and L* of broiler breasts has already been reported (Barbut, 1997, Le Bihan-Duval *et al*., 1999). This trend was also found in the present study, as the selected genotypes that exhibited the lightest breast meat were characterised by the higher pH. Surprisingly, KR4 birds, even if characterised by a medium-growth rate, showed a meat more similar to R than to CN1. It is known that the pH*u* influence the structure of myofibrils and consequently the water retention capacity and the colour of the meat. According to Warris (2000) the connections between the muscle fibres are broken due to the low pH so decreasing the capacity to retain water. These relationships, although not statistically significant, are confirmed in this study where the meat of chickens KR4 and R, in combination with higher values of pH showed higher percentages of CL.

Conclusions

This trial shows that fast-growing birds, even at 70 days, have a bad welfare status confirming that the rearing of animals highly selected for productive performance should not be permitted in organic systems.

On the contrary, CN1 genotype, although it did not show the highest productive yields (body characteristics, higher proportions of head, neck and legs), showed a good adaptation to organic environment (hearth size, carcass damages and conformation). Then, the adaptability to the organic system is not only attributable to the growth rate, but also to the different grazing attitude, kinetic activity and body structure intrinsic to the genotype.

The conformation of the body may also imply a sale in the form of whole chicken. In the organic market, whole chicken gives a good impression of carcass quality as a whole, combining the advantages of a smaller manipulation of the meat with an image more similar to the traditional chicken.

Regarding the slaughtering age, experimental results demonstrate that, despite the inconsistency of European Community rules, which authorise the reduction of slaughtering age in less mature strains, at 70 days the chickens showed best FE, thinness of carcass and meat, and lower presence of carcass damages, despite having less breast yield.

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