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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Effects of Genotype and Sex on Lipid Oxidation and Fatty Acid Profile of Chicken Breast Meat

Benabdelmoumene Djilali[1], Benakriche Benmehel[1], Beghdadi Farouk[2] and Halbouche Miloud[1]
[1]Department of Agriculture Sciences, Faculty of Nature Sciences,
Abdelhamid IbnBadis University, Mostaganem, Algeria
[2]Department of English, Faculty of Foreign Languages, Mustapha Stambouli University, Mascara, Algeria

Abstract: Total lipids, composition of fatty acids and an estimation of degree of oxidation were determined for both sexes in the muscles of Naked Neck (NaNa) local chickens and in another common chicken breed, the Isa Brown (ISA). The lowest content of total lipids and the highest content of unsaturated fatty acids were found in the muscle of the Naked Neck. Twenty-five fatty acids were quantified in the TL from the Naked Neck and higher concentrations of polyunsaturated fatty acids (PUFAs), essential fatty acids (EFAs) and linolenic acids (AA) were found in the total lipids from the Naked Neck than in the muscle from the other chicken breed. Oleic and linoleic acid were found to be the dominant PUFAs in the total lipids from all breeds, with the highest MUFA content in the breast meat from the Naked Neck. The concentration of long chain n-3 fatty acids is considerably higher in Naked Neck meat than in the Isa Brown. The total lipids from the Naked Neck were found to have anti-fatigue and anti-hypoxic activities and to inhibit isoproterenol-induced oxygen consumption. These results indicate that the Naked Neck chicken has superior quality and bioactivity compared to the Isa Brown breed.

Key words: Naked neck, isa brown, fatty acids

INTRODUCTION

The poultry industry is going through a gradual but definite change in product differentiation in response to consumer and industry demands. To implement these changes, genetic improvements have focused primarily on selection for growth rate, feed conversion efficiency and degree of muscling, resulting in gross changes in commercial poultry. During the last 50 years, the amount of time required to reach market weight and the quantity of feed needed to produce a pound of meat have been reduced by 50% (Anthony, 1998). Of the phenotypic changes in poultry, 90% have come from genetic progress (Havenstein *et al*., 1994 a, b).

Chicken genotype strongly influences the meat's functional properties and nutritional characteristics (Sirri *et al*., 2011). Several factors have been shown to affect carcass yield, carcass composition and the quality of meat. These factors include strain, nutrition, age, live weight and sex (Moran and Orr, 1969; Bouwkamp *et al*., 1973; Young *et al*., 2000). Several authors concluded that broiler strain, age at slaughter and post-chilling aging are the main factors that affect meat quality parameters (colour, tenderness, cooking loss, water-holding capacity and pH) (Lyon and Lyon, 1992; Mehaffey *et al*., 2006; Musa *et al*., 2006).

Indigenous chicken breeds are abundant in Algeria and the world as a whole. They are widely distributed in the rural areas where they are kept by a majority of rural households. These chickens are economically, nutritionally and culturally important to rural households (Food and Agriculture Organization, 2010). The meat from these chickens is very much liked by many people because of its good taste (Fanatico *et al*., 2005; Moula *et al*., 2009; Kingori *et al*., 2010). Consequently, a real demand for meat from indigenous chicken breeds is currently requested in spite of their relatively high prices (Kingori *et al*., 2010).

Naked neck, a phenotypic expression controlled by a single dominant autosomal gene (Na), is characterized by reduced feathers in the neck region of the chicken. The naked neck (Na) gene is incompletely dominant; the heterozygotes can be identified by a tuft of feathers on the ventral side of the neck (Scott and Crawford, 1977), whereas homozygotes have no plumage on the neck, with reduced feather tract or no feather tracts (Somes, 1988). Davenport (1914) identified the naked neck gene in the 20th century; Hertwig (1933) assigned the symbol 'Na' to the gene. The Na gene received greater attention in the recent past in broiler production because of its association with heat tolerance (Merat, 1986; Cahaner *et al*., 1993; Singh *et al*., 2001; Lin *et al*., 2006), which is considered to be the most important inhibiting factor for poultry production in hot tropical climates (Horst, 1987). In broiler chickens the 'Na' gene results in a relatively higher growth rate and meat yield than normal birds at normal temperature and the effect is more pronounced

Corresponding Author: Benabdelmoumene Djilali, Department of Agriculture Sciences, Faculty of Nature Sciences, Abdelhamid IbnBadis University, Mostaganem, Algeria

at high temperatures (Cahaner *et al*., 1993). The fatty acid composition and cholesterol levels in the meat have received increasing attention due to their implications for human health and product quality. The ratios of PUFA/SFA and n-6/n-3 PUFA are widely used to evaluate the nutritional value of fat. Over the last decades, research has focused on the effects of individual fatty acids upon lipid metabolism and prevention of coronary heart diseases. Recently, research has been focused on conjugated linoleic acid (CLA), due to its anticarcinogenic activity and the CLA/SFA+cholesterol ratio (Carlos *et al*., 2008).

Lipid oxidation is a major cause of meat quality deterioration, resulting in rancidity and the formation of undesirable odours and flavours, which lower the functional, sensory and nutritive values of meat products and, therefore, consumer acceptability (Bou *et al*., 2004).

The objective of this study was, therefore, to determine the effect of sex and strain on the fatty acid composition and lipid oxidation of chicken breast meat.

MATERIALS AND METHODS

Birds: This trial was conducted at the experimental section of Mostaganem University (Algeria) from October to December 2013. Two hundred birds were compared and categorized with regard to their genotype: Naked Neck (NN) and Hubbard Isa Brown (a hybrid variety from a cross between Rhode Island and Leghorn breeds).

The NN genotypes originated from a local chicken farm at 1 day of age; the Hubbard Isa Browns were recovered from the poultry egg incubator group Mostaganem at 1 day of age.

The chickens were kept separate after hatching until 20 days of age in an environmentally controlled poultry house with temperatures ranging from 22 to 34°C and with RH ranging from 70 to 78%. Incandescent light (30 lx) placed at bird level was used for heating and illumination. The chicks were vaccinated against Marek and Newcastle diseases.

At 21 d of age, each genotype was represented in 2 batches containing 100 chicks each. Sexing was conducted on the 32th day of rearing; the phenotypic characteristics are different between the sexes.

At 60 days of age, a sample of 20 birds per strain, each weighing between ±15% of the population mean, were slaughtered in the experimental section of the university 8 hours after feed withdrawal. After killing, the carcasses were placed in hot water (56.5°C for 1 min) and then plucked, eviscerated (non-edible viscera: intestines, proventriculus, gall bladder, spleen, oesophagus and full crop) and stored for 24 h at 4°C.

Diets: The chickens were fed *ad libitum* the same starter (1-21 d) and grower-finisher (22 d to slaughter) diets (Table 1), access to feed and water was freely available and all the diets were formulated to contain adequate nutrient levels as defined by the ONAB (2012).

The chemical composition of the diets used in our work was determined for each type of food (start and finish) (n = 25); the results of the dietary regiment composition are shown in Table 1.

Fatty acids: The lipids were extracted according to Folch *et al*. (1957), using 25 mg of ground flaxseed (Folch 25 mg) with an initial addition of 3 ml chloroform/methanol (2:1 v/v). The samples were vortexed and an aqueous buffer (0.2 M sodium phosphate) was added to isolate the organic phase containing the total lipids. The organic phase was collected and a second extraction was completed after adding additional (2 ml) chloroform. The two organic phase collections were combined.

Aliquots of the lipid extract were esterified with BF3-methanol (Joseph and Ackman, 1992). The fatty acid composition of each aliquot was determined by gas chromatography in a 60 m fused capillary column with an internal diameter of 0.20 mm (CP Sil 88). The analysis was performed on a Hewlett-Packard 6890® gas chromatograph equipped with a flame ionization detector. Helium was used as the carrier gas and nitrogen as the make-up gas. The injection port temperature was 200°C and the detector temperature was 250°C. The oven temperature was ramped to 150°C for 3 min and increased to 160°C at 1.5°C/min; it was then held at 160°C for 3 min, increased to 190°C at 1.5ºC/min and held at 190°C for 1 min. Finally, the temperature was increased to 220°C at 1°C/min. A Hewlett-Packard computing integrator calculated the retention times and peak area percentages. The fatty acids were identified by comparing sample retention times with standard retention times (36 saturated, monounsaturated and polyunsaturated fatty acid standards, Sigma and Polyscience®, U.S.A.). Quantification was carried out by normalization and transformation of the area percentage to mg per 100 g of the edible portion, using the lipid conversion factor recommended by Holland (1998).

Lipid oxidation: The extent of lipid oxidation was evaluated as TBARS by the modified method of Ke *et al*. (1977). Ten grams of minced muscle were homogenized for 2 min with 95.7 ml of distilled water and 2.5 ml of 4N HCl. The mixture was distilled until 50 ml was obtained. Then, 5 ml of the distillate and 5 ml of TBA reagent (15% trichloroacetic acid, 0.375% thiobarbituric acid) were heated in a boiling water bath for 35 min. After cooling under running tap water for 10 min, the absorbance was measured at 538 nm against a blank. The TBARS values were obtained by multiplying the optical density by 7.843.

The oxidation products were quantified as malondialdehyde equivalents (mg MDA kg-1 muscle).

Statistical analyses: The data collected in this completely randomized design were subjected to an

analysis of variance (SAS Institute, 2008) and the treatment means were separated using Duncan's multiple range test. Single degree of freedom contrasts were used to test the overall effects of genotype and sex. The level at which differences were considered significant was $p<0.05$.

RESULTS AND DISCUSSION

The fatty acid composition of the diets (starter and finisher) are shown in Table 2.

The fatty acid profiles of the starting and finishing diets reveal the presence of a high concentration of unsaturated fatty acid. The starter diet contains 51.05% monounsaturated fatty acid against 25.66% from the finishing diet. The finishing diet contains a high content of polyunsaturated fatty acid based on the starting diet, 57.5 vs., 32.71, respectively. The n6/n3 ratio is slightly higher in the final finishing diet.

According to other authors (Ponte *et al*., 2008), linoleic acid (LA, C18:2n-6) is the major fatty acid in feed.

Chemical composition of chicken meat: The moisture, ash, protein, fat and cholesterol content of the chicken meat are described in Table 3.

Moisture was higher in the Hubbard Isa chicken meat than in the Naked Neck and the male Isa Brown presented higher moisture content than the female of the same genotype.

The protein content of the Naked Neck meat is slightly less than that of the Hubbard Isa (22.82 g vs., 23.16 g, respectively). However, the results of the statistical analysis ($p<0.05$) indicate a higher level of protein in the meat from the Naked Neck males compared to the other samples analyzed. Our results are consistent with those of Pavlovski *et al*. (2013).

More total lipids are present in the ISA Hubbard meat samples (both sexes) compared to the Naked Neck meat; the Isa male chicken contains an estimated amount of lipid of 1.67 g/100 g compared to 1.36 for the Naked Neck males.

The results of Hanzel and Somes (1983) noted a lower content of total carcass lipids in the NaNa genotype, which is consistent with the difference found for the intermuscular fat in the males in this work and in the two sexes.

Fatty acid composition: The averages of the fatty acid profiles of the breasts of the investigated chicken breeds are presented in Table 4, showing that the various fatty acids were different in proportion among the genotypes and sexes.

In this experiment, there were significant differences in the fatty acid composition of the breast meat between the chicken breeds. As far as breast saturated fatty acids (SFA) are concerned, the Naked Neck group showed the highest ($p\leq0.05$) percentage and the Isa Brown showed the lowest.

Table 1: Ingredients composition of diets

Percentage	Starter	Finisher
Item		
Maïze	60.5	68.7
Soyben meal	29.2	26.8
Fine wheat bran	6	0.85
Dicalcium phosphate	1.7	1.65
calcium carbonate	0.6	0.6
Vitamin-mineral premix	1	1
Methionine	1	0.4
Chemical composition		
DM	94.11	92.8
Protein	21.2	19
Lipids	1.91	1.12
Cellulose	3.8	3.2
Ash	5.36	5.25

Table 2: Fatty acid composition of the diets (expressed as g/kg)

Fatty acids	Starter	Finisher
C14:0	0.1	0.24
C14:1	0.4	0
C16:0	12.53	12.43
C16:1(n7)	0.34	0.31
C18:0	3.14	2.73
C18:1(n9)	25.15	50.06
C18:2(n6)	21.01	26.11
C20:0	0.47	0.45
C18:3(n3)	3.29	3.12
C20:1(n9)	0.61	0.64
SFA	16.24	16.85
MUFA	51.05	25.66
PUFA	32.71	57.5
N-6	21.11	26.11
N-3	3.29	3.12
n6/n3	6.41	8.36

(n = 15)
SFA: Saturated fatty acid.
MUFA: Mono unsaturated fatty acid.
PUFA: poly unsaturated fatty acid

Table 3: Effect of genotype and sex on chemical composition of chicken meat

	--------- Naked neck ---------		---------- Hubbard Isa ----------	
	Male	Female	Male	Female
Moisture (%)	72.28±3.21^{c}	74.25±2.75^{b}	75.98±2.84^{a}	74.51±3.05^{b}
Ash (%)	2.07±0.23^{a}	2.04±0.14^{a}	1.82±0.53^{c}	1.95±0.19^{b}
Protein (%)	23.37±2.11^{a}	22.28±1.57^{c}	23.15±3.08^{b}	23.18±2.56^{b}
Fat (%)	1.36±0.34^{c}	1.17±0.54^{d}	1.67±0.58^{a}	1.56±0.86^{b}
Cholesterol (mg/100 g)	73.12±3.59^{d}	74.62±5.12^{c}	76.95±7.53^{a}	75.28±7.14^{b}

(n = 20)
^{a,b,c}Means corresponding to a certain factor with different superscripts differ significantly ($p<0.05$)

The proportion of C14:0 does not reveal any significant difference ($p<0.05$) between the meat of the male Naked Neck and the male Isa Brown, with an average of 0.79%. However, a large significant difference ($p<0.05$) is distinguished between the females of both strains (0.09 vs., 1.06%).

Through these results, it can be reported that there is a significant difference ($p<0.05$) in palmitic acids between the Naked Neck males (19.49%) and the Isa Brown males (21.19%) and between the Naked Neck females (18.25%) and the Isa Brown females (23.71%).

The proportion of palmitoleic acid was slightly higher in the meat of both sexes of the Naked Neck chickens than in the Isa Browns. For the sex factor, individuals of the same strain pose no significant difference ($p<0.05$) and the average for Naked Neck is 0.53% and for Isa Brown is 0.45%.

The proportion of C18:0 is higher in the Naked Neck breast than in the Isa Brown. However, the male of both genotypes showed important differences in the proportion of stearic acid compared to the females.

There is no difference in the same sex between the two breeds. An average of 0.043% is seen for the males and an almost zero average for the females. A significant difference ($p<0.05$) is visible between the sexes in the same breed, wherein the amount of C22:0 in the male Naked Neck (0.08%) is higher than that of the female Naked Neck.

At first glance, there is no significant difference ($p<0.05$) between the Isa Brown and the Naked Neck in saturated fatty acid composition. However, a difference is clearly noticed between the Naked Neck females (28.69%) and the Isa Brown females (32.84%), with an interval of 4.15%.

The content of monounsaturated fatty acids is slightly higher in the Isa Brown male's breast than in the other samples.

As mentioned, there is no significant difference ($p<0.05$) between the male Naked Neck and the Isa Brown females in C18:1n7. The averages are 2.17 and 1.97%, respectively.

The total PUFA concentrations, which in chickens are related either to endogenous synthesis or to the gut absorption from the diet, showed the highest levels in the local genotypes; these PUFA concentrations were mainly represented by linoleic and by linolenic acid. Low PUFA levels were observed in the commercial meat for the EPA and DHA levels.

The proportion of linoleic acid does not reveal any significant difference ($p<0.05$) between the males of the two strains (0.08% against 0.06%). The linoleic acid level is lower in the breast of the females of both strains compared to the males.

The n3 level is higher in the breast of the Naked Neck than in the commercial strain; the males of both strains had a more important level of n3 than the females.

For the n-6, the largest proportion is located in the Naked Neck, with an average of 22.63%, followed by an amount of 19.99% for the male Isa Browns and finally a lesser amount of 15.91% in the Isa Brown females.

Regarding the n6/n3 ration, according to the data acquired a distinctly significant difference ($p<0.05$) was seen between the Naked Neck and Isa Brown males, with a gap of 3.02 reported. A difference between the female Naked Neck and female Isa Brown, with a gap of 2.96, is reported.

However, there is no significant difference ($p<0.05$) between the male and female Naked Neck, but a difference is found between the male and the female Isa Brown, with a difference of 0.52.

The most important report is that of the female Isa Brown (12.93), then the male Isa Brown (12.41) and finally the Naked Neck duo (9.68). It is important to emphasize that the n6/n3 ratio is greater in the females than in the males, with an increase in the Isa Brown female.

Concerning LA/ALA, these results show significant differences ($p<0.05$) between the strains and in intra-strain samples. The relative gap between the Naked Neck males and the Isa Brown males is 0.85, while that in the females is 4.15.

The descending ranking of the reports is as follows: the ratio of the female Naked Neck (18.44), the ratio of the male Isa Brown (16.47), the ratio of the male Naked Neck (15.62) and the ratio of the female Isa Brown (14.29).

As already affirmed, the differences in the fatty acid profiles of breast meat may be attributed to genetic and epigenetic effects or to causal interactions between genes and their products, which brings the phenotype into play, which could affect lipid metabolism and fatty acid deposition.

It is well-known that Naked Neck chicken meat is characterized by higher proportions of MUFA and PUFA compared to meat from other genotypes. Palmitic acid (C16:0) was the most common SFA in the chicken breast, followed by stearic (C18:0; Table 4); this is generally observed in chicken meat (Zanetti *et al*., 2010). The total fat content of the meat in the current study is in good agreement with those reported by Givens *et al.* (2011).

In this experiment, there were significant differences in the fatty acid composition of the breast between the chicken breeds. As far as breast saturated fatty acids (SFA) are concerned, the Naked Neck group showed the highest percentage ($p\leq0.05$) and the Isa brown showed the lowest, which is consistent with results reported by Wattanachant *et al.* (2004) for a Thai indigenous breed. There were no differences in the MUFA level between the indigenous and broiler breeds in the experiment of Wattanachant *et al.* (2004). In this experiment, the total monounsaturated fatty acids showed variations among the sexes. The breast MUFA were slightly higher in the males of both genotypes than in the females. The MUFA content of all the chickens in this study were lower than those reported by Castellini *et al.* (2002) for organically reared Ross male chickens, 56 days old. This could be due to the differences in the lipids in the diets of the birds.

PUFA consumption reduces the risk of cardio-vascular disease (Temple, 1996) and inhibits the growth of mammary and prostate gland tumours (Pandalai *et al*., 1996). Significant variations were observed for the

Table 4: Fatty acid composition (% total fatty acids) of breast meat (*Pectoralis minor*) according to genotype and sex

	--------- Naked neck ---------		---------- Isa Brown ----------	
	Male	Female	Male	Female
C10:0	0.019±0.01^{b}	0.01±0.002^{c}	0.028±0.02^{b}	0.06±0.02^{a}
C12:0	0.07±0.01^{b}	0.07±0.01^{b}	0.09±0.07^{b}	0.169±0.03^{a}
C14:0	0.75±0.10^{b}	0.09±0.01^{c}	0.84±0.40^{b}	1.06±0.13^{a}
C14:1	0.024±0.01^{b}	0.02±0.01^{b}	0.013±0.01^{c}	0.05±0.01^{a}
C15:0	0.15±0.015^{a}	0.12±0.01^{a}	0.10±0.05^{b}	0.06±0.01^{c}
C16:0	19.49±1.16^{b}	18.25±1.01^{b}	21.19±1.19^{a}	23.71±1.07^{a}
C16:1 n-9	0.52±0.08^{a}	0.54±0.11^{a}	0.46±0.05^{b}	0.44±0.08^{b}
C16:1 n-7	2.19±0.34^{c}	2.12±0.38^{c}	3.57±1.04^{a}	3.07±0.56^{b}
C18:0	10.31±1.11^{a}	9.90±0.93^{a}	7.40±1.21^{b}	6.81±0.89^{b}
C18:1 n-9c	36±1.78^{b}	37.09±1.10^{a}	36.85±1.50^{b}	33.12±0.60^{c}
C18:1 n-7	2.12±0.12^{a}	2.07±0.49^{b}	2.22±0.47^{a}	1.87±0.19^{b}
C18:2 n-6t	0.08±0.03^{b}	0.08±0.02^{b}	0.06±0.03^{b}	0.12±0.02^{a}
C18:2 n-6c	18.56±0.96^{a}	17.31±0.79^{a}	16.16±2.35^{b}	13.20±0.62^{c}
C18:3 n-6	0.08±0.03^{b}	0.09±0.01^{b}	0.18±0.04^{a}	0.23±0.03^{a}
C18:3 n-3	1.19±0.11^{a}	1.00±0.11^{b}	0.99±0.17^{b}	0.94±0.12^{b}
C18:4 n-3	0.23±0.07^{a}	0.23±0.03^{a}	0.27±0.23^{a}	0.24±0.03^{a}
C20:0	0.12±0.14^{c}	0.25±0.02^{b}	0.27±0.07^{b}	0.68±0.10^{a}
C20:1 n-9	0.58±0.14^{a}	0.60±0.1^{a}	0.49±0.19^{b}	0.44±0.06^{b}
C20:2	2.24±0.70^{b}	2.62±0.16^{a}	0.72±0.37^{c}	0.46±0.07^{d}
C20:3 n-6	1.55±0.55^{a}	1.05±0.1^{d}	1.37±0.37^{b}	1.24±0.05^{c}
C20:4 n-6	2.31±0.58^{a}	1.36±0.09^{c}	1.87±0.63^{b}	0.97±0.3^{d}
C20:3 n-3	0.006±0.01^{a}	0±0^{b}	0±0^{b}	0±0^{b}
C20:4 n-3	0±0^{b}	0±0^{b}	0.008±0.001^{a}	0±0^{b}
C20:5 n-3	0.30±0.26^{b}	0.43±0.07^{a}	0.11±0.02^{c}	0.05±0.01^{d}
C22:0	0.08±0.01^{a}	0±0^{b}	0.007±0.01^{a}	0±0^{b}
C22:1 n-9	0.01±0.02^{a}	0±0^{b}	0.002±0.001^{a}	0±0^{b}
C22:4 n-6	0.24±0.03^{b}	0.24±0.02^{b}	0.35±0.13^{a}	0.15±0.03^{c}
C22:5 n-3	0.22±0.05^{b}	0.23±0.02^{a}	0.17±0.08^{c}	0±0^{d}
C22:6 n-3	0.46±0.14^{a}	0.36±0.08^{b}	0.069±0.09^{c}	0±0^{d}
SFA	33.24±2.19^{a}	28.69±1.32^{b}	31.95±1.60^{a}	32.84±1.57^{a}
MUFA	41.46±2.21^{a}	42.44±1.15^{a}	42.59±1.80^{a}	38.99±0.90^{b}
PUFA	25.22±2.06^{a}	25.18±0.84^{a}	21.61±2.52^{b}	21.628±0.84^{b}
n-6	22.82±1.41^{a}	22.44±0.51^{a}	19.99±2.46^{b}	15.91±0.80^{c}
n-3	2.43±0.36^{a}	2.25±0.44^{b}	1.61±0.51^{c}	1.23±0.13^{d}
n6/n3	9.39±1.3^{c}	9.97±2.08^{c}	12.41±3.894^{b}	12.93±1.56^{a}
LA/ALA	15.62±1.61^{c}	18.44±2.27^{a}	16.47±2.66^{b}	14.29±2.42^{d}

(n = 20)

^{a,b,c,d}Means corresponding to a certain factor with different superscripts differ significantly ($p<0.05$).

SFA: Saturated fatty acid.

MUFA: Mono unsaturated fatty acid.

PUFA: Poly unsaturated fatty acid

Table 5: Oxidative status of *Pectoralis minor* of chicken

	-------- Naked neck -------		---- Hubard Isa Brown -----	
	Male	Female	Male	Female
TBARS mg of MDA/kg of meat	0.15±0.02^{c}	0.17±0.01^{b}	0.17±0.01^{b}	0.19±0.01^{a}

(n = 20)

^{a,b,c}Means corresponding to a certain factor with different superscripts differ significantly ($p<0.05$)

polyunsaturated fatty acids (PUFA) in the breast. The results of this experiment are inconsistent with the statement of Pavlovski *et al.* (2013).

The Naked Neck males had significantly higher ($p \leq 0.05$) contents of PUFA, total n-6 and total n-3 than the other genotypes and sex.

The effects of the genotypes and sex on FA composition have been described in previous studies, but the results have been inconsistent. Chen *et al.* (2003) found that the essential FA and the linoleic acid contents in cocks were 2.5 and 5.31% higher, respectively, than that in hens, while the sinapic acid in cocks was 5.4% lower than that in hens. Based on the results of Chen *et al.* (2003), we found that sex affects FA composition. In contrast, another study reported that a chicken's sex had no significant effect on FA composition and content (Zhu *et al.*, 2012). In the present study, the male chickens were found to have higher arachidic acid, sinapic acid, linoleic acid and eicosapentaenoic acid contents than the females, whereas some FA contents were not affected by sex. This agrees with the results of Pu *et al.* (2009). According to Robert *et al.* (2008), the content of saturated fatty acids is strongly related to the nature of the dietary fats ingested by the chicken and to the levels of the carbohydrate fraction.

Rosebrough *et al.* (2007) report that the assumption of hepatic lipogenesis is a function of the content of the carbohydrates and fats contained in the diet.

Concerning linoleic acid, we note that the content of this fatty acid is slightly higher in the males than in the female chickens of the same plan. Our results are confirmed by Bilgili *et al.* (2006) and Musa *et al.* (2006) who explain this difference by the amount of linoleic acid deposited in the muscle of the males and females.

Lipid oxidation: The results of lipid oxidation are described in Table 4.

The Lipid Oxidation (Table 4) shows the effects of the genotypes and chicken sex on the TBARS of breast meat. In general, a low lipid oxidation level was observed in all samples, which was confirmed by the oxidation product parameters; these data are in agreement with those reported in literature (Barroeta, 2007; Betti *et al.*, 2009). In fact, low TBARS (0.06-0.19 and 0.10-0.13 mg of MDA/kg of breast samples) were found, regardless of the commercial category. Both oxidation parameters are far below the TBARS level (1 mg of MDA/kg of sample) associated with lamb meat rancidity (Ripoll *et al.*, 2011). However, the Isa Brown breast meat showed a significant TBARS content in the breast meat. Several studies report that the dietary polyunsaturation level significantly affects the TBARS values (Cortinas *et al.*, 2005). Different studies (Castellini *et al.*, 2002, 2008) have reported higher TBARS in female breast meat, which could be due to the higher intake of metallic ions (total and heme Fe) that catalyze peroxidation; this is also the case to the greater degree of instauration of intramuscular lipids.

Conclusion: The Naked Neck chickens are shown to have significantly different fatty acid composition compared to the Isa Hubbard chickens. The breast meat from the Naked Neck chickens had more PUFA and less SFA content compared to the meat from the commercial broilers. The total n-6 fatty acids content was higher in the breast meat of the Naked Neck chickens compared

to the Isa Brown and the total n-3 fatty acids were slightly more important in the breast meat of the male Naked Neck breed compared to other chickens. The results indicate that the genotypes used showed different abilities to incorporate fatty acids and a possible interaction between strain and sexes may exist in the absorption and utilization of dietary components.

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