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ORIGINAL ARTICLE

The effect of Genotype and Cooking on Nutritional Composition of fatty acids of the naked neck chicken meat quality

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ABSTRACT
The effect of genetic and grilling on fatty acid profile of chicken meat was investigated. The lipid content and fatty acid composition were identified in breast meat. Cooking losses, total lipids, increased directly with the cooking time and temperature used, naked neck meat present high level in monounsatured fatty acids (MUFA) than the commercial meat, cooked chicken meat had lower proportion in monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA) and saturated fatty acids (SFA) than the fresh meat. Naked neck presents more oleic acid than the commercial chicken meat (2.43% vs 1.61%). The naked neck cooked meat presents more favourable fatty acids profile than the commercial chicken meat.
Keywords*: genetic, fatty acids, chicken meat, cooking.*

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INTRODUCTION

The demand and consumption of chicken meat, particularly breast meat, has been increasing considerably during the last few decades, probably because of the nutritional advantages of chicken meat over red meat, easy preparation and fewer religious restrictions [6]. Compared with broilers, which are widely accepted because of their fast growth and high yields of meat [20], native chicken is in demand for the unique organoleptic characteristics of its meat, such as rich flavors and unique chewy texture, which are preferred in oriental cuisine [45].

Cooking makes meat digestible, nutritious, palatable, and safe [44]. [43]categorised meat-cooking methods into dry, moist and novel heating (i.e. microwave and infrared). When evaluating various cooking techniques, [2] indicated that heat transfer methods, the meat surface temperature, and temperature profile for the meat are the three major determinative factors. Cooking duration and temperature combinations as well as the heat transfer coefficient of the heating medium substantially influence the amount of heat transferred to the meat [43]. In moist-heat cooking methods, such as braising and water-cooking (WC), hot water or condensing steam, which has high surface heat transfer coefficients, transfer heat to the meat surface efficiently [16]. By contrast, in dry-heat cooking, such as oven-cooking (OC) or roasting, dry heat is transferred from a flame, oven, or other heat sources to the meat surface, and consequently, a temperature gradient is created inside the meat product, which leads to an increase in internal temperature, moisture loss, protein denaturation, meat fiber shrinkage, as well as unique flavors and an appearance probably resulting from the browning reaction [43].

The influence of different cooking methods pan frying, and microwave ovens on chevon patties with and without added fat, whey protein concentrates and flavour was studied by [36]. Significant differences were observed for product yield, cooking losses, gain in height, reduction in diameter, moisture, protein, fat and sensory attributes between different cooking methods. With added flavours microwave oven cooking and without added flavours, pan-frying method was found to be the most suitable. Deep fat frying of the coated meat products helps in achieving an acceptable texture, flavour and appearance.

The temperature and time of frying is important, as the overheated product, gives a dry sensory perception. Fat absorption was also high for deep fat frying when compared to oven frying and skillets frying.

Chicken genotype strongly influences the meat's functional properties and nutritional characteristics[40]. 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 [29]; [4]; [46]. 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) ([26]; [27]; [30]).

Naked neck, a phenotypic expression controlled by a single dominant autosomal gene (Na), is characterised 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 [38], whereas homozygotes have no plumage on the neck, with reduced feather tract or no feather tracts[41]. [10]identified the naked neck gene in the 20th century; [17]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 [28]; [5]; [39]; [25], which is considered to be the most important inhibiting factor for poultry production in hot tropical climates [19].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 at high temperatures [5].

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

MATERIAL 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 categorised 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 genotype 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.

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 [31].

Fatty acids: The lipids were extracted according to [12], 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 BF3methanol[21]. 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 [18].

Lipid oxidation: The extent of lipid oxidation was evaluated as TBARS by the modified method of[23]. Ten grams of minced muscle were homogenised 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).

Determination of cooking loss

Cooking loss was determined from the difference in meat weight before and after cooking [24].

Statistical analyses: The data collected in this completely randomized design was subjected to an analysis of variance [37]and the treatment means were separated using Duncan's multiple range test. Single degree of freedom contrasts was used to test the overall effects of cooking and genotype. The level at which differences were considered significant was $p<0.05$.

RESULTS AND DISCUSSION

Chemical composition of chicken meat

The moisture, ash, mineral and protein content of the chicken cooked meat are described in Table 2.

In the raw state (Table 3) meats of the genotype, naked neck and Isa Hubbard, have dry matter contents of 27.71% and 22.37 respectively. After cooking, there is an increase in the dry matter content with a difference of 63.63% in the Naked neck and 69.40% in Isa Hubbard. This consequence is related to the loss of water during cooking, these results are similar to those of [15].

The mineral content increases significantly with cooking, the difference in the mineral composition of cooked meat cooked is significantly higher compared to the raw meat of the same genotype (7.33% Vs 2.71%). Similarly, cooked Isa Hubbard meats have higher proportions of mineral matter than raw meats (6.81% vs. 2.28%). Latif *et al.* (2016) explain that in white meat the loss of mineral salts is practically zero for grilled and roasted meat, this is explained according to the same authors by the percentage of minerals of cooked meats are referred to the material dried.

The protein content of naked neck meat decreases significantly after cooking (22.37g for cooked meat versus 16.31g for raw meat), the differential ratio is estimated at 27%. Similarly, the protein composition of Isa Hubbard meats is significantly affected by cooking, the difference ratio between raw and cooked Isa meats are estimated at 16%. Latif *et al.* (2016) explain the loss of proteins during cooking by the fact that the bonds involved in the spatial structure of the protein break up and unfold. Which leads to protein denaturation. Amino acids that were previously buried in the heart of the protein are exposed to the surrounding environment, facilitating their reaction with other constituents present in the environment [22]. According to the same author, the heat causes their coagulation on the surface of the meat and which evolves in the heart of it, one notes then a formation of the crust and a change of colour.

We noticed that cooking resulted in an increase in lipid content, from 3.59% to 5.92% for the Naked neck line, and from 4.22 to 6.88% for Isa Hubbard. However, it is important that cooked meats contain a high fat content relative to the dry matter. These results are consistent with those of Normand (2006). Several factors affect lipid quality, including boning time, animal age, genetics, and cooking methods [33].

Cooking loss

The effect of cooking on weight is illustrated on table 3.

Naked neck meats lose 13.25% of their weight after cooking, while Isa Hubbard meats lose 14.96%, the ratio of dissimilarities between the two is estimated at 11%.

The loss of mass after cooking is mainly due to the loss of water and lipids during cooking, it also depends on the mass transfer during heat treatment [14] affected by the different cooking methods.

[13]has noted that cooking losses tend to be linear over time and following the muscle typology of meats.

Fatty acid composition

The averages of the fatty acid profiles of the breasts of the investigated chickens are presented in table 4, showing that the various fatty acid was different in proportion among the cooking and genotype

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 cooking effect and genotype.

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 ($p< 0.05$) percentage and the Isa Brown showed the lowest.

Our results show that fatty acids are strongly influenced by cooking, saturated and unsaturated fatty acids drop significantly after cooking in both genotype.

According to our statistical results, we note a significant effect of cooking on the fatty acid profile, losses of AGS, AGM, PUFA are respectively in the naked neck strain 18.81% 31.46% 54.92% and 13.83% 31.37% 54.60% in the other genotype.

A significant decrease in C18: 1 n-9 Cis (main constituent of MUFA) was recorded in the Isa Hubbard strain 35.16% vs 24.13% in the other genotype.

The content of polyunsaturated fatty acid is significantly lower after cooking in both strains. In contrast, omega 6 fatty acid decreased from 22.04% to 9.81 in the Naked neck line after cooking, from the same omega 3 increased from 1.71% against 0.82% in the Naked neck strain. and 1.21% against 0.68% in Isa Hubbard, the contents are also significantly different in some of their long chain derivatives after cooking (EPA, C22: 4n-6 and DHA). We also noticed that the fatty acid profile of Isa Hubbard is deficient in C18: 4n-3 and DHA, but they are present in the naked neck (0.412 vs. 0.121) and (0.15 vs. 0.04) respectively. The Omega6 / Omega3 ratio is higher in the Isa Hubbard Strain for both before and after cooking, low ratios after cooking are 17.89 vs 14.24 and 13.05 vs. 11.91 in Isa Hubbard and naked neck respectively. Only the C18: 2 n-6 Trans fatty acid kept the same value after cooking in the Naked neck strain (0.03 Vs 0.03). In contrast to the latter C18: 2 n-6 cis, we recorded a decrease in both strains after firing with a difference of 56.10% and 53.29% in naked neck and Isa Brown respectively.

Our results on the behaviour of fatty acids during cooking are similar to those of [8], [7], the latter also noted losses in AG during cooking. [11]found that cooking affects the content of certain amino acids in poultry meat. These losses can be due to three essential mechanisms: oxidation, loss of fatty acid by diffusion, exchanges between the chicken and [32].

PUFA consumption reduces the risk of cardiovascular disease [42]and inhibits the growth of mammary and prostate gland tumours[34]. Significant variations were observed for the polyunsaturated fatty acids (PUFA) in the breast. The results of this experiment are inconsistent with the statement of [35].

The Lipid Oxidation (Table 4) shows the effects of the genotype 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 [1][3].

The lipid oxidation is similar in the two breeds, the statistical study did not reveal a significant difference between cooked meats and raw meats.

Cooking increases the oxidation of lipids, this is explained by the release of lipids by which increases their exposure to oxidation.

Pectoralis major of the naked breed are more susceptible to lipid oxidation than Isa brown meats. This suggests that the degree of unsaturation of the lipids in the meat of the chicken is greater compared to that of chickens marketed. several studies report that the dietary polyunsaturated level significantly affects the TBARS values [9].

Table 1: Ingredients composition 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		
Dry Matter	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: Effect of cooking and on chemical composition of chicken meat

	Naked neck		Isa Hubbard	
	Cooked	**Raw**	**Cooked**	**Raw**
Moisture (%)	76,2 ± 1,29 [a]	27,71 ± 2,54 [b]	73,18 ± 1,61 [a]	22,37 ± 1,21 [b]
Ash (%)	7,33±0,68 [a]	2,71 ± 0,64 [c]	6,81 ± 0,67 [b]	2,28 ± 0,37 [d]
Protein (g)	16,31 ± 0,67 [c]	22,37 ± 1,15 [a]	17,59 ± 0,65 [c]	21,15 ± 0,7 [b]
Lipids (g)	5,92 ± 0,79 [b]	3,59 ± 0,43 [d]	6,88 ± 0,59 [a]	4,22 ± 0,5 [c]

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

Table3: cooking loss of breast chicken's meat

	Naked neck	**Isa Hubbard**
Cooking loss (%)	13,25 ± 2,11 [b]	14,96 ± 2,13 [a]

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

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

	Naked neck		Isa Hubard	
	Raw	**Cooked**	**Raw**	**Cooked**
Saturated fatty acid	28,80 ± 0,79 [b]	23,38 ± 0,25 [d]	30,34 ± 1,21 [a]	26,14 ± 0,35 [c]
C14:0	0,75 ± 0,06 [a]	0,61 ± 0,05 [b]	0,41 ± 0,07 [c]	0,35 ± 0,05 [d]
C16:0	18,77 ± 0.63 [c]	15,13 ± 0.87 [d]	23,89 ± 0.1 [a]	20,66 ± 0.21 [b]
C18:0	9,19 ± 0,46 [a]	7,59 ± 0,07 [b]	5,99 ± 0,98 [c]	5,11 ± 0,36 [d]
Monoinsaturated fatty acid	44.31 ± 2.22 [a]	30.37 ± 0.55 [b]	42.88 ± 1.4 [a]	29.34 ± 0.23 [b]
C16: 1 n-9	0.57 ± 0.06 [a]	0.29 ± 0.04 [c]	0.38 ± 0.1 [b]	0.17 ± 0.02 [d]
C16: 1 n-7	2.72 ± 0.28 [c]	1.34 ± 0.06 [d]	5.11 ± 0.99 [a]	3.88 ± 0.1 [b]
C18:1 n-9 Cis	38.36 ± 2.3 [a]	27.26 ± 0.53 [c]	35.16 ± 0.78 [b]	24.13 ± 0.27 [d]
C18:1 n-7	2.11 ± 0.3 [a]	1.17 ± 0.16 [c]	1.81 ± 0.23 [b]	1.03 ± 0.15 [d]
C20: 1n-9	0.51 ± 0.15	0.29 ± 0.04	0.41 ± 0.08	0.13 ± 0.02
Polyunsaturated fatty acid	23.34 ± 0.78 [a]	10.52 ± 0.3 [c]	22.6 ± 0.85 [b]	10.26 ± 0.37 [d]
C18:2 n-6 trans	0,03 ± 0,013 [b]	0,03 ± 0,01 [c]	0,04 ± 0,012 [a]	0,01 ± 0,002 [d]
C18:2 n-6 cis	18,66 ± 0,57 [a]	8,19 ± 0,29 [c]	16,92 ± 0,81 [b]	7,90 ± 0,29 [c]
C18:3 n-6	0,08 ± 0,02 [b]	0,04 ± 0,01 [c]	0,18 ± 0,02 [a]	0,07 ± 0,01 [b]
C18: 3 n-3	1.11 ± 0.26 [a]	0.66 ± 0.052 [c]	1.06 ± 0.18 [b]	0.65 ± 0.07 [d]
C18: 4n-3	0,15 ± 0.01 [a]	0,04 ± 0.01 [b]	0,12 ± 0.01 [a]	0,05 ± 0,02 [b]
C20: 2	1,70 ± 0,06 [a]	1,41 ± 0,071 [b]	0,68 ± 0,083 [c]	0,59 ± 0,11 [d]
C20: 3n-6	1,18 ± 0,18 [b]	0,661 ± 0,16 [d]	2,11 ± 2,11 [a]	1,03 ± 0,03 [c]
C20:4 n-6	1,82 ± 0,06 [a]	0,83 ± 0,05 [c]	1,69 ± 0,09 [b]	0,49 ± 0,08 [d]
C22: 4n-6	0,26 ± 0,04 [b]	0,07 ± 0,014 [c]	0,442 ± 0,083 [a]	0,08 ± 0,01 [c]
C22:5n-3(EPA)	0,19 ± 0,03 [a]	0,04 ± 0,01 [b]	0,15 ± 0,02 [c]	0,02 ± 0,01 [c]
C22: 6 n-3(DHA)	0,41 ± 0,05 [a]	0,12 ± 0,02 [b]	0,31 ± 0,03 [a]	0,18 ± 0,02 [b]
Omega 6	22.04 ± 0.59 [a]	9.81 ± 0.29 [c]	21.38 ± 0.85 [b]	9.58 ± 0.33 [d]
Omega 3	1,71 ± 0,25 [a]	0,82 ± 0,04 [c]	1,21 ± 0,17 [b]	0,68 ± 0,07 [d]
Omega6/Omega 3	13,05 ± 1,59 [a]	11,91 ± 0,63 [b]	17,89 ± 2,32 [b]	14,24 ± 1,56 [c]

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

Table 5: Oxidative status of chicken meat

	Naked neck		Isa Hubard	
	Cooked	**Raw**	**Cooked**	**Raw**
TBARS mg of MDA/kg of meat	1,84±2,17 [a]	0,69± 0,28 [b]	1,52±0,44 [a]	0,5±0,1 [b]

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

CONCLUSION

few studies have investigated the effects of cooking on the quality of native chicken meat. In our study, we demonstrated that significant differences existed between the fatty acids profile of naked neck chicken and commercial broiler chicken meat, particularly for the oleic and linoleic acids.

In the current study, our results revealed that commercial chicken cooked meat present higher cooking losses, as well as a lower protein, lipids and ash content. Our study provides practical information on how cooking affects the quality parameters of native chicken breast meat.

This information would be crucial to poultry processors or users who want to optimize the quality of cooked native chicken breast meat.

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