Influence of finishing diet (concentrate *vs*. cereal) on chemical composition and physicochemical characteristics of broiler chicken

R. Domínguez[1], J. Méndez[2], L. Purriños[1], D. Franco[1], P. Cachaldora[2], and J.M. Lorenzo[1*]

[1] Centro Tecnológico de la Carne de Galicia, Rúa Galicia Nº 4, Parque Tecnológico de Galicia, San Cibrao das Viñas, 32900 Ourense, Spain

[2] COREN, Sociedad Cooperativa Galega, 32003 Ourense, Spain

*jmlorenzo@ceteca.net

Abstract – The effect of finishing feeding (fodder, wheat grain and wheat flour) on meat quality (pH, colour, texture and proximate composition) of breast of Broiler reared in intensive production system were examined. For this study, 254 chickens slaughtered at 45 days were used. The inclusion of wheat grain and wheat flour decreased pH values. In addition, breast from animals fed with wheat grain showed the lowest values of luminosity, while animals fed with wheat flour had higher yellowness values than breast from animals fed with fodder. Regarding proximate composition, diet affected the moisture (about 75%), protein (about 23%), ash (about 1.3%) and cholesterol content (50-55 mg/100 g). Chickens fed with wheat flour had lower values of moisture and higher content of protein, ash and cholesterol than animals from the other two treatments. Water holding capacity was no affected by the diet, while breast from animals fed with wheat flour presented the lowest values of shear force. In view of the results obtained, we could conclude that feeding the animals with wheat could allow us to reduce production costs, mainly due to high processing costs of compound feed.

Key Words – Chicken breast, feeding, meat quality, Wheat

I. INTRODUCTION

Nowadays, consumers are concerned about meat quality and demand meat products linked to natural feeding. However, it is important to note that meat quality are mainly influenced by diet [1], age and live weight [2] or genotype [3,4]. Indeed factors related to meat organoleptic characteristics (colour, cooking losses and tenderness) are affected. These parameters are considered important as quality indicators and they have an impact on consumer acceptability [5].

On the other hand, there is no information about chemical composition and physicochemical properties of meat from Broilers only fed with cereals. Therefore, the aim of this study was to evaluate the effects of finishing feeding on meat quality in breast meat from Broilers slaughtered at 45 days.

II. MATERIALS AND METHODS

II.1 Animal management and sample collection

A total of 254 1-day-old chickens of Broiler were used in the experiments. They were housed separately in intensive conditions (13 animals/m^2). The animals were divided into three groups. The control group (CO; n=43) were reared in 3 different farms and fed *ad libitum* with commercial diet. The second group of animals (WG; n=60) were reared in 4 different farms and fed *ad libitum* with commercial diet until 20 days and then a diet based only on wheat grains 25 days prior to slaughter. The third group (WF; n=148) were brought up in 11 different farms and fed *ad libitum* commercial diet until 20 days and then a diet based only on wheat flour 25 days prior to slaughter. All animals were slaughtered at 45 days.

The carcasses were chilled in a refrigerated room at 4°C for 24 h. The day after, the left breast (*pectoralis major* muscle) was obtained to carry out the analysis.

II.2 Proximate composition analysis

Moisture, protein and ash were quantified according to the ISO recommended standards [6-8], while total fat was extracted according to the AOCS Official Procedure Am 5-04 [9]. For determination of total cholesterol, saponification, extraction and identification were performed following the procedure described by Domínguez *et al*. [10].

II.3 Physicochemical analysis

The pH of the samples was measured using a digital portable pH-meter (Hanna Instruments, Eibar, Spain) equipped with a penetration probe. Colour parameters were measured using a portable colorimeter (Konica Minolta CM-600d, Osaka, Japan) with pulsed xenon arc lamp filtered to illuminant D65 lighting conditions, 0° viewing angle geometry and 8 mm aperture size, to estimate sausages colour in the CIELAB space: lightness, (L*); redness, (a*); yellowness, (b*). The colour was measured in three different points of each sample. Before each series of measurements, the instrument was adjusted using a white ceramic tile. Breast cuts were cooked and water-holding capacity (WHC) and Warner-Braztler test were conducted following Franco *et al.* [11].

II.4 Statistical analysis

The effect of diet on meat quality was examined using a mixed-model ANOVA, where the proximate composition and physicochemical properties were set as dependent variables, the diets as fixed effect, and replicates and farms as random effect. The pairwise differences between least-square means were evaluated by Duncan's method. Differences were considered significant if $P<0.05$. The values were given in terms of mean values and standard error of the mean (SEM). All analyses were conducted using the IBM SPSS Statistics 21.0 program (IBM Corporation, Somers, NY, USA) software package.

III. RESULTS AND DISCUSSION

The mean values of the physicochemical parameters and chemical composition are shown in Table 1. The pH values were affected ($P<0.001$) by the diet. Animals fed with wheat (grain and flour) presented lower pH values (around 6) than animals fed with a commercial diet (6.11). In contrast, Franco *et al*. [11,13,14] did not find differences on pH values between animals fed with fodder and corn. The pH values were similar to those found by other authors [12-14] and slightly higher than those results described by Amorim *et al*. [15] (about 5.8), Díaz *et al*. [16] (about 5.6) and Franco *et al.* [17] (5.68-5.92).

Table 1 Chemical composition and physicochemical properties of chicken breast fed with different diets

	Batch			**SEM**	**Sig**
	CO	***WG***	***WF***		
pH	6.11[b]	6.01[a]	6.02[a]	0.009	***
Colour parameters					
L*	55.07[b]	53.32[a]	55.97[b]	0.201	***
b*	7.75[a]	7.36[a]	9.08[b]	0.102	***
Composition (g/100 g)					
Moisture	75.62[b]	75.59[b]	75.27[a]	0.054	*
Fat	0.56	0.51	0.56	0.035	ns
Protein	23.12[ab]	22.86[a]	23.31[b]	0.066	*
Ash	1.28[a]	1.24[a]	1.34[b]	0.008	***
Cholesterol[1]	50.80[a]	50.60[a]	54.86[b]	0.518	***
WHC (%)	13.18	14.51	14.10	0.187	ns
Shear Force[2]	1.26[b]	1.22[b]	0.93[a]	0.023	***

[1]Expressed as mg/100 g of meat; [2] Warner-Braztler test: Results expressed as kg/cm^2; SEM: Error Standard of the Mean; Sig: Significance *** ($P<0.001$), ** ($P<0.01$), * ($P<0.05$), ns (not significant); CO: commercial diet; WG: animals fed with wheat grain; WF: animals fed with wheat flour.

Colour results showed that finishing diet is a factor that affects poultry meat colour. In fact, the use of one or another cereal may influence the colour of meat [18]. However, in this case there are not a clear trend. Animals from WG group presented the lowest values of luminosity (L*) (53.32 *vs.* 55.5), whereas animal from WF group showed the highest values of yellowness (b*) (9.08 *vs.* 7.5). The values obtain for L* were similar to those obtain by Franco *et al*. [11,13] (between 50 and 53) and higher than those obtain by Franco *et al*. [14,17] and Díaz *et al.* [16] (between 46 and 49). The values of b* agree with the results obtained by Franco *et al*. [13,17], while Franco *et al*. [11] presented lower b* values (between 1.65 and 3.80) and Díaz *et al*. [16] (28-32) showed higher values of b* than those obtained in the present research. Moreover, in agreement with our results, Franco *et al*. [11,13] observed that animals fed with cereal had higher b* values than animals fed with fodder.

Regarding chemical composition, moisture and protein content achieved significant differences ($P<0.05$) among batches. Animals fed with wheat flour showed lower moisture content than the other two groups. Despite significant differences, moisture values were very similar between

treatments (about 75%). Concerning protein content, animals from WG showed the lowest values (22.86%), whereas chicken from WF the highest (23.31%). In contrast, intramuscular fat content was no affected by finishing diet (around 0.5%). Fatness level plays an important role in meat quality due to IMF content is positively related with chicken meat quality [19]. To this regard, Díaz *et al*. [16] did not find any difference in proximate composition among animals fed with 3 different diets. In addition, Franco *et al*. [13,14] also did not notice differences in fat amount between animals fed with fodder and corn. However, Franco *et al*. [11] observed that chicken fed with corn had higher amounts of intramuscular fat than animals fed with fodder. Concerning ashes content, animals fed with WF presented higher (P<0.001) values (1.34%) than animals from the other two groups (1.28% and 1.24% for CO and WG batches, respectively). In contrast with us, other authors did not observe differences in ash content between animals fed with different diets. In the same line, animals fed with WF also showed higher amounts of cholesterol (54.86 mg/100 g) than animals from control (50.80 mg/100 g) and WG (50.60 mg/100 g) groups. A high level of adiposity in meat is not always linked to high cholesterol concentration, as cholesterol is present in large quantities in its free form in cell membranes [20]. Mean values of cholesterol found in breast are lesser that those reported by Sirri *et al*. [21] in Hubbard x Golden Comet crossbred and also in broiler meat [22]. Moreover, the knowledge about cholesterol content in foods is important, especially in poultry meat because consumption is currently increasing, due to healthy recommendations and price.

The cooking loss were not affected by the diet. The values were similar with those described in the bibliography for autochthonous breeds (about 11-13%) [11,12,14] and higher than other study carried out with Mos breed (8.6% *vs.* 9.6%) [13]. In contrast, Díaz *et al*. [16] showed higher cooking loss (about 18%) than the results obtained in this research. On the other hand, the lowest (P<0.001) shear force values were achieved in animals from WF group (0.93 kg/cm^2). However, animals from CO and WG treatments presented the same shear force values (about 1.25 kg/cm^2). Despite of the fact that an increase of IMF resulted in a significant decreasing of shear force values in chicken as reported by Zhao *et al*. [23] or even in other species such as bovine [24] and pigs [25]. However, in the present study we did not find this association between IMF and shear force values. The results obtained for shear force were lower than the values obtained by Franco *et al*. [13] (1.61 *vs.*1.71 kg/cm^2) and Díaz *et al.* [26] (1.51 *vs.* 3.23 kg/cm^2). In the same line, Jaturasitha *et al.* [3] found significant differences and higher shear force values (4.75 kg/cm^2) in four chicken breeds from Northern Thailand.

IV. CONCLUSION

The main differences from meat quality point of view were that the administration of wheat flour increased the yellowness and decreased the pH and shear force values. Therefore, the meat quality increased slightly with wheat flour diet. In view of the results obtained, we could conclude that despite the differences observed between batches, these variations were small, hence feeding with wheat allows us to reduce production costs related to processing and preparation of commercial feed.

ACKNOWLEDGEMENTS

Authors are grateful to Ministerio de Agricultura, Alimentación y Medio Ambiente (MAGRAMA) (Project: 20140020001781) for the financial support. Special thanks to COREN (Ourense, Spain) for the chicken samples supplied for this research.

REFERENCES

1. Puchała, M., Krawczyk, J., Sokołowicz, Z. & Utnik-Banaś. (2015). Effect of breed and production system on physicochemical characteristics of meat from multi-purpose hens. Annals of Animal Science 15: 247-261.
2. Touraille, C., Kopp, J., Valin, C., & Ricard, F. H. (1981). Chicken meat quality. 1. Influence of age and growth rate on physicochemcial and sensory characteristics of the meat. Arch Gefluegelkd. 45: 69–76.
3. Jaturasitha, S., Srikanchai, T., Kreuzer, M., & Wicke, M. (2008). Differences in carcass and meat characteristics between chicken indigenous to Northern Thailand (Black-Boned and Thai Native) and imported extensive breeds (Bresse and Rhode Island Red). Poultry Science 87: 160-169.
4. Wattanachant, S., Benjakul, S. & Ledward, D. A. (2004). Composition, color, and texture of Thai

Indigenous and broiler chicken muscles. Poultry Science 83: 123-128.
5. Andersen, H. A., Oksbjerg, N., Yung, J. F. & Herkildsen, M. (2005). Feeding and meat quality – A future approach. Meat Science 70: 543-554.
6. ISO (1997). Determination of moisture content, ISO 1442:1997 standard. In: International standards meat and meat products. International Organization for Standardization, Genève, Switzerland.
7. ISO (1978). Determination of nitrogen content, ISO 937:1978 standard. In: International standards meat and meat products. International Organization for Standardization, Genève, Switzerland.
8. ISO (1998). Determination of ash content, ISO 936:1998 standard. In: International standards meat and meat products. International Organization for Standardization, Genève, Switzerland.
9. AOCS (2005). AOCS Official Procedure Am 5-04. Rapid determination of oil/fat utilizing high temperature solvent extraction. American Oil Chemists Society, Urbana, IL.
10. Domínguez, R., Crecente, S., Borrajo, P., Agregán, R., & Lorenzo, J. M. (2015). Effect of slaughter age on foal carcass traits and meat quality. Animal 9(10): 1713-1720.
11. Franco, D., Rois, D., Vázquez, J. A. & Lorenzo, J. M. (2013). Carcass morphology and meat quality from roosters slaughtered at eight months affected by genotype and finishing feeding. Spanish Journal of Agricultural Research 11: 382-393.
12. Miguel, J. A., Ciria, J., Asenjo, B. & Calvo, J. L. (2008). Effect of caponisation on growth and on carcass and meat characteristics in Castellana Negra native Spanish chickens. Animal 2: 305-311.
13. Franco, D., Rois, D., Vázquez, J. A., Purriños, L., González, R. & Lorenzo, J. M. (2012). Breed effect between Mos rooster (Galician indigenous breed) and Sasso T-44 line and finishing feed effect of commercial fodder or corn. Poultry Science 91: 487-498.
14. Franco, D., Rois, D., Vázquez, J. A., & Lorenzo, J. M. (2012). Comparison of growth performance, carcass components, and meat quality between Mos rooster (Galician indigenous breed) and Sasso T-44 line slaughtered at 10 months. Poultry Science 91(5): 1227-1239.
15. Amorim, A., Rodrigues, S., Pereira, E., Valentim, R., & Teixeira, A. (2016). Effect of caponisation on physicochemical and sensory characteristics of chickens. Animal In press: DOI: http://dx.doi.org/10.1017/S1751731115002876.
16. Díaz, O., Rodríguez, L., Torres, A. & Cobos, A. (2013). Composition and physico-chemical properties of meat from capons fed cereals. Journal of Integrative Agriculture 12: 1953-1960.
17. Franco, D., Pateiro, M., Rois, D., Vázquez, J. A., & Lorenzo, J. M. (2016). Effects of caponization on growth performance, carcass and meat quality of Mos breed capons reared in free-range production system. Annals of Animal Science In Press: DOI: 10.1515/aoas-2016-0009.
18. Lyon, B. G., Smith, D. P., Lyon, C. E. & Savage, E. M. (2004). Effects of diet and feed withdrawal on the sensory descriptive and instrumental profiles of broiler breast fillets. Poultry Science 83: 275-281.
19. Welter, J.F. (1976). The effects of surgical caponization on production efficiency and carcass yield of roosters. Poultry Science 55: 1372-1375.
20. Karp, G. (2005). Cell and Molecular Biology: Concepts and Experiments. John Wiley and Sons, New Jersey, USA.
21. Sirri, F., Bianchi, M., Petracci, M., Meluzzi, A. (2009). Influence of partial and complete caponization on chicken meat quality. Poultry Science 88: 1466-1473.
22. Konjufca, V. H., Pesti, G. M., & Bakalli, R. L. (1997). Modulation of cholesterol levels in broiler meat by dietary garlic and copper. Poultry Science 76: 1264-1271.
23. Zhao, G. P., Chen, J. L., Zheng, M. Q., Wen, J., & Zhang Y. (2007). Correlated responses to selection for increased intramuscular fat in a Chinese quality chicken line. Poultry Science 86: 2309-2314.
24. Vestergaard, M., Madsen, N. T., Bligaard, H. B., Bredahl, L., Rasmussen, P. T., Andersen, H. R. (2007). Consequences of two or four months of finishing feeding of culled dry dairy cows on carcass characteristics and technological and sensory meat quality. Meat Science 76: 635-643.
25. Van Laack, R. L., Stevens, S. G., Stalder, K. J. (2001). The influence of ultimate pH and intramuscular fat content on pork tenderness and tenderization. Journal of Animal Science 79: 392-397.
26. Díaz, O., Rodríguez, L., Torres, A. & Cobos, A. (2010). Chemical composition and physico-chemical properties of meat from capons as affected by breed and age. Spanish Journal of Agricultural Research 8: 91-99.