CHEMICAL COMPOSITION OF ORGANIC FREE-RANGE ROOSTER MEAT AS AFFECTED BY THE DIETARY SUPPLEMENTATION WITH AGRO-INDUSTRIAL BY-PRODUCTS AND FLAX SEED

Rubén Agregán[1*], Noemí Echegaray[1], Lucio García[1], Luis Vázquez[1], José M. Lorenzo[1,2]

[1] Centro Tecnolóxico da Carne de Galicia, San Cibrao das Viñas, 32900 Ourense, Spain

[2] Área de Tecnoloxía dos Alimentos, Facultade de Ciencias, Universidade de Vigo, 32004 Ourense, Spain

*Corresponding author email: rubenagregan@ceteca.net

I. INTRODUCTION

Poultry production systems based on free-range breeding of birds are being implemented as an alternative to large-scale conventional breeding operations [1]. On the other hand, the short cycle of poultry allows the use of agro-industrial by-products as feed, which can be transformed into edible meat and eggs [2]. In addition, the inclusion of these supplements in the diet of birds may improve their health and meat quality by increasing the intramuscular content of healthy fats, such as omega-3 (ω-3) and omega-6 (ω-6) polyunsaturated fatty acids (PUFAs) [3]. Taking into account the above-mentioned points, we proposed to study the influence of different fattening diets on the chemical composition of organic free-range rooster meat using various agro-industrial by-products, such as beer bagasse (BB) and olive pomace (OP), and flax seed (FS), an underused raw material in animal feeding in Spain.

II. MATERIALS AND METHODS

II.I. Animals and feeding

All roosters used in this study were males. These were raised for 3 months and then underwent fattening diet for the next 4 months in semi-freedom pens until slaughter. In this last stage, the birds were classified according to their diet into the following batches: control (CO), BB, OP, and FS. The diet of the CO batch was based exclusively on corn, wheat, and peas. This mixture was added with 5% (w/w) of BB, OP, and FS in each of the other batches, as appropriate.

II.II Sampling

After the first 24 h of sacrifice, the breasts of 10 birds per batch, of a total of 40, were randomly sampled. Proximal analysis was carried out on each of the breasts by determining the moisture, protein, intramuscular fat, and ash content. In addition, the fatty acids were also identified and quantified following the procedure described by Dominguez et al. [4].

II.III Statistical analysis

The detection of significant differences among the different batches was carried out through a one-way analysis of variance (ANOVA) using the IBM SPSS Statistics 23.0 program (IBM Corporation, Somers, NY, USA). Least square means were separated using Duncan's *post hoc* test (significance level $P<0.05$).

III. RESULTS AND DISCUSSION

The results hardly showed differences in the proximate composition of the breasts (Table 1). The different fattening diets did not affect the percentage of fat and protein. However, the Duncan's multiple range test displayed significant differences ($P<0.05$) among batches for the moisture and ash. Specifically, higher moisture was observed in the CO batch and a lower ash content in the BB batch. Similar values were found in breasts of broilers fed PUFA-rich food by-products [5]. The variation in the rooster's diet resulted in different fatty acid profiles. The BB batch showed a higher PUFA content than the CO batch, and ω-3 fatty acids were significantly higher when BB, OP, and FS were used during the fattening phase of the birds (Table 2). These compounds are highly prized due to their reported potential health effects [6]. However, the increase in ω-3 PUFAs was not reflected in the ratio of ω-6:ω-3 fatty acids, which was above the value recommended for human nutrition (4:1).

Table 1 – Influence of different fattening diets using agro-industrial by-products and flax seed on the chemical composition of organic free-range rooster breasts (*n* = 10).

g/100 g of meat	Batch				SEM	Sig.
	CO	BB	OP	FS		
Moisture	73.28 ± 0.64^{a}	72.40 ± 0.85^{b}	72.4 ± 0.87^{b}	72.84 ± 0.91^{a,b}	0.14	ns
protein	24.66 ± 0.32	25.01 ± 0.92	24.81 ± 0.73	24.99 ± 0.59	0.12	ns
Fat	0.94 ± 0.56	1.07 ± 1.23	1.46 ± 1.32	1.13 ± .93	1.16	ns
Ash	1.18 ± 0.04^{a,b}	1.14 ± 0.06^{a}	1.18 ± 0.05^{b}	1.19 ± 0.03^{b}	0.01	ns

CO: control; BB: beer bagasse; OP: olive pomace; FS: flax seed; SEM: standard error of mean; Sig.: significance (*, P<0.05; **, P<0.01; ***, P<0.001; ns, not significant). $^{a\text{-}c}$Means in the same row not followed by a common superscript letter are significantly different (P<0.05; Duncan's test).

Table 2 – Influence of different fattening diets using agro-industrial by-products and flax seed on the fatty acid profile of organic free-range rooster breasts (*n* = 10).

mg/100 g of meat	Batch				SEM	Sig.
	CO	BB	OP	FS		
SFAs	402.19 ± 172.09	687.34 ± 446.51	538.32 ± 310.77	473.59 ± 223.10	49.49	ns
MUFAs	487.95 ± 234.16^{a}	997.13 ± 706.86^{b}	725.68 ± 477.05^{a,b}	634.97 ± 371.42^{a,b}	78.68	ns
PUFAs	205.42 ± 49.62^{a}	366.24 ± 175.46^{b}	289.83 ± 108.11^{a,b}	275.60 ± 83.49^{a,b}	19.57	*
ω-3 FAs	23.70 ± 3.66^{a}	42.09 ± 12.56^{b}	33.69 ± 4.37^{c}	34.69 ± 8.71^{b,c}	1.62	***
ω-6 FAs	178.72 ± 46.05^{a}	319.69 ± 163.22^{b}	252.68 ± 104.25^{a,b}	237.48 ± 74.51^{a,b}	18.03	*
ω-6:ω-3	7.5 ± 1.3	7.42 ± 2.14	7.43 ± 2.45	6.82 ± 1.17	0.28	ns

SFAs: saturated fatty acids; MUFAs: monounsaturated fatty acids; PUFAs: polyunsaturated fatty acids; ω-3 FAs: omega-3 fatty acids; ω-6 FAs: omega-6 fatty acids; CO: control; BB: beer bagasse; OP: olive pomace; FS: flax seed; SEM: standard error of mean; Sig.: significance (*, P<0.05; **, P<0.01; ***, P<0.001; ns, not significant). $^{a\text{-}c}$Means in the same row not followed by a common superscript letter are significantly different (P<0.05; Duncan's test).

IV. CONCLUSION

Feeding organic free-range roosters with BB, OP, and FS barely produced significant changes in the proximal composition of the breasts. However, remarkable differences were observed in the amount of ω-3 PUFAs, suggesting the storage of these compounds in the meat. This finding might open an interesting avenue for experimentation in poultry feeding.

ACKNOWLEDGEMENTS

This study was supported by the project 2021/074A from "Rural Development Program (PDR) of Galicia 2014-2020" and financed with FEADER funds. Noemí Echegaray and Rubén Agregán acknowledge to Axencia Galega de Innovación (GAIN) for granting with a postdoctoral scholarship (grant numbers IN606B-2022/006 and IN606B-2022/005, respectively).

REFERENCES

1. El Jeni, R.; Dittoe, D.K.; Olson, E.G.; Lourenco, J.; Seidel, D.; Ricke, S.C.; Callaway, T.R. (2021) An overview of health challenges in alternative poultry production systems. Poultry Science, 100: 101173.
2. Brunetti, L.; Leuci, R.; Colonna, M.A.; Carrieri, R.; Celentano, F.E.; Bozzo, G.; Loiodice, F.; Selvaggi, M., Tufarelli, V.; Piamontese, L. (2022) Food industry byproducts as starting material for innovative, green feed formulation: A sustainable alternative for poultry feeding. Molecules, 27: 4735.
3. Georganas, A.; Giamouri, E.; Pappas, A.C.; Zoidis, E.; Goliomytis, M.; Simitzis, P. (2023) Utilization of agro-industrial by-products for sustainable poultry production. Sustainability, 15: 3679.
4. Domínguez, R.; Crecente, S.; Borrajo, P.; Agregán, R.; Lorenzo, J.M. (2015) Effect of slaughter age on foal carcass traits and meat quality. Animal, 9:1713-1720.
5. Banaszkiewicz, T.; Białek, A.; Tokarz, A.; Kaszperuk, K. (2018) Effect of dietary grape and pomegranate seed oil on the post-slaughter value and physicochemical properties of muscles of broiler chickens. 17:199-209.
6. Agregán, R.; Popova, T.; López-Pedrouso, M.; Cantalapiedra, J.; Lorenzo, J.M.; Franco, D. (2022) Fatty acids. In Lorenzo, J.M.; Munekata, P.E.S.; Pateiro, M.; Barba, F.J.; Domínguez, R., Food Lipids (pp 257-286). London: Academic Press (Elsevier).