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Effect of genetic background, pen size and outdoor access on meat quality in two slow growing broiler hybrids

(#317)

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Introduction

The aim of the present study was to evaluate the effect of two different rearing systems, indoor (small pens) (S) versus big pens with outdoor access (B), on meat quality and fatty acid (FA) composition of two slow growing broiler hybrids. An additional aim was to evaluate if phospholipid FA composition is altered with exercise load as found earlier in human [1].

Consumer demand and subsequently production of organic broilers has increased during the recent years [2]. Fast-growing, high yielding genotypes have been of interest and focus for the conventional production but may not be as suitable for organic production systems [3]. Broiler chickens for organic production should be of a slow-growing hybrid. Both hybrid and activity could affect muscle composition and quality parameters, e.g. tenderness, lipid composition [3, 4]. From a human nutritional point of view, meat rich in n-3 FA is preferable and therefore hybrids being better in accumulating these FA are advantageous.

Methods

Four hundred day-old chicken of two hybrids (Rowan Ranger (RR) and Hubbard CYJA57 (H)) were reared in either small pens (S, 1 x 1.5 m) or in a big pen (B, 8 x 113.5 m) with access to a 1.400 m^2 fenced outdoor yard. Indoor space was 0.3 m^2/chicken in both systems. All chickens had access to perches. Chickens received organic commercial feed and lucerne as roughage. At 73 days chickens were slaughtered and pH and slaughter weight (SW) were recorded. Breast and leg were sampled and frozen in -20°C for analyses. Evaluated meat quality parameters were muscle weight, pH, colour, water holding capacity (WHC), and tenderness of the breast muscle (*M. prectoralis major*) (as Warner Bratzler shear force (WB)). In addition total fat content, lipid class composition as well as phospholipid (PL) FA composition of one leg muscle (*M. flexor hallucis longus*) were analysed [5, 6]. GLM procedure of SAS (SAS 9.4, SAS Inst. Inc., Cary, NC, USA). Tukey's test was used for pair wise comparisons and differences were considered significant if $p < 0.05$.

Results

General meat quality parameters are shown in table 1. RRS chicken had significantly higher SW compared to HS and significantly higher breast weight compared to H from both rearing systems, but not to RRB. RRB chicken showed highest values of WB for both maximum force and work done with significant difference compared to both H groups but not to RRS. Significant higher levels of cholesterol were found in HS compared to RRS and PL were significantly higher in HB compared to RRS (table 2). Chickens with outdoor access had highest percentage of polyunsaturated FA and lowest in saturated FA with RRB differing significantly from RRS (table 3).

Conclusion

The obtained data indicate only minor differences of quality indices between the rearing systems. The found differences seem to be mainly depending on the hybrids. WB value were quite low in both hybrids and production systems, indicating a tender meat. However, with regard to the higher values in RRB, H might be the better choice for outdoor rearing. HB had highest proportion of n-3 also indicating that from a human nutritional perspective the combination H and B might be the preferably one. PL composition has been slightly altered in the groups with outdoor access but FA differed only in RR hybrids between S and B. We suggest that the voluntary exercise was not sufficient to affect FA profiles in H chickens.

Literature

1. Andersson, A., et al., *Effects of physical exercise on phospholipid fatty acid composition in skeletal muscle.* Am J. of Physiology-Endocrinology and Metabolism, 1998. **274**(3), E432-E438.
2. Moyle, J.R., et al., *Growth performance of fast-growing broilers reared under different types of production systems with outdoor access: Implications for organic and alternative production systems.* J. of Applied Poultry Research, 2014. **23**(2), 212-220.
3. Sirri, F., et al., *Effect of fast-, medium- and slow-growing strains on meat quality of chickens reared under the organic farming method.* Animal, 2011. **5**(2), 312-319.
4. Castellini, C., C. Mugnai, and A. Dal Bosco, *Effect of organic production system on broiler carcass and meat quality.* Meat Science, 2002. **60**(3), 219-225.
5. Hematyar, N., et al., *Nutritional quality, oxidation, and sensory parameters in fillets of common carp (Cyprinus carpio L.) influenced by frozen storage (-20 degrees C).* J. of Food Processing and Preservation, 2018. **42**(5), 13.
6. Hullberg, A., L. Johansson, and K. Lundstrom, *Sensory perception of cured-smoked pork loin from carriers and noncarriers of the RN(-)allele and its relationship with technological meat quality.* J. of Muscle Foods, 2005. **16**(1), 54-7

Notes

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Table 2. Lipid class composition in leg muscle (*M. flexor hallucis longus*) of two slow growing broiler breeds raised in either small pens or big pens with outdoor access (means ± stdev).

	Hubbard big pen (HB)	Hubbard small pen (HS)	Rowan Ranger big pen (RRB)	Rowan Ranger small pen (RRS)
phospholipids	15.7 ± 1.76 ^{a}	15.0 ± 1.48 ^{ab}	14.7 ± 1.26 ^{ab}	13.1 ± 0.67 ^{b}
MAG + DAG	1.61 ± 0.16	1.84 ± 0.06	1.76 ± 0.33	1.74 ± 0.17
Cholesterol	10.0 ± 0.99 ^{ab}	10.1 ± 0.94 ^{a}	9.72 ± 0.62 ^{ab}	8.48 ± 0.84 ^{b}
free fatty acids	7.55 ± 1.25	8.71 ± 1.44	7.98 ± 1.49	7.45 ± 2.07
TAG	65.2 ± 3.74	64.3 ± 2.53	65.9 ± 2.63	69.3 ± 3.15

Abbreviations: MAG + DAG: combined mono- and diacylglycerols, TAG: triacylglycerols. Different superscript letters in a row indicate significant difference ($p > 0.05$)

Table 2.

Table 1. Slaughter weight, breast weight and general meat quality parameters in breast muscle (*M. prectoralis major*) of two slow growing broiler hybrids raised in either small pens or big pens with outdoor access (means ± stdev).

	Hubbard big pen (HB)	Hubbard small pen (HS)	Rowan Ranger big pen (RRB)	Rowan Ranger small pen (RRS)
Slaughter weight (g)	2454^{ab} ± 113	2396^{a} ± 211	2440^{ab} ± 272	2658^{b} ± 163
pH after slaughter	5.89 ± 0.12	5.89 ± 0.19	5.97 ± 0.19	6.05 ± 0.17
Weight_breast (g)	242^{a} ± 20.7	240^{a} ± 36.1	272^{ab} ± 51.1	307^{b} ± 38.6
Breast weight percentage	9.90^{a} ± 0.74	9.80^{a} ± 0.83	11.2^{b} ± 1.39	11.1^{ab} ± 0.96
texPeak (N)	16.7^{a} ± 3.48	17.3^{a} ± 5.39	29.3b ± 12.75	23.0^{ab} ± 8.03
texTotal area (Nmm)	90.8^{a} ± 17.52	93.3^{a} ± 33.81	151.6^{b} ± 55.04	128.5^{ab} ± 37.48
Drip loss %	1.91 ± 0.44	1.49 ± 1.75	1.52 ± 0.87	1.97 ± 0.65
Thawing loss %	9.93 ± 2.38	10.2 ± 2.79	10.4 ± 1.77	9.43 ± 2.38
Cocking loss %	14.5 ± 2.43	13.2 ± 1.36	14.0 ± 1.99	14.0 ± 1.43
Colour L*	44.2 ± 0.87	44.2 ± 1.11	43.8 ± 0.83	44.3 ± 1.21
Colour a*	-4.19 ± 0.47	-3.56 ± 0.59	-3.99 ± 0.54	-4.20 ± 0.47
Colour b*	20.5 ± 0.51	20.4 ± 0.88	20.0 ± 0.34	20.1 ± 0.71

Breast percentage is calculated as the percentage of breast per total slaughter weight. Colour L*= lightness, Colour a* =redness and colour b* = yellowness. Different superscript letters in a row indicate significant difference ($p > 0.05$)

Table 1.

Table 3. Selected fatty acids in phospholipids of leg muscle (*M. flexor hallucis longus*) of two slow growing broiler breeds raised in either small pens or big pens with outdoor access (means ± stdev).

	Hubbard big pen (HB)	Hubbard small pen (HS)	Rowan Ranger big pen (RRB)	Rowan Ranger small pen (RRS)
Fat %	2.41 ± 0.48	2.39 ± 0.29	2.53 ± 0.21	2.89 ± 0.53
C16:0	19.3 ± 0.71^{ab}	20.1±0.86^{ab}	18.4±2.15^{a}	21.0±0.90^{b}
C18:1n-9	12.0 ± 0.51^{a}	13.0±0.49^{ab}	12.2±1.05^{a}	13.8±0.61^{b}
C20:4n-6	15.4 ± 0.31^{a}	13.6±0.77^{bc}	14.9±1.27^{ab}	13.3±0.73^{c}
C20:5n-3	0.54 ± 0.09^{a}	0.55±0.08^{a}	0.45±0.36^{ab}	0.12±0.23^{b}
C24:0	1.73 ± 0.13^{ab}	1.92±0.10^{a}	1.63±0.23^{b}	1.68±0.16^{ab}
DPA	2.72 ± 0.22	2.66±0.20	2.72±0.34	2.68±0.20
DHA	5.69 ± 0.40	5.31±0.39	5.74±0.80	5.22±0.25
SFA	38.7 ± 0.85^{ab}	39.5±0.62^{ab}	38.3±1.12^{a}	40.0±1.16^{b}
MUFA	16.0 ± 0.61^{a}	17.2±0.34^{ab}	16.5±1.11^{a}	18.2±0.68^{b}
PUFA	42.2 ± 1.16^{a}	40.2±0.92^{ab}	42.1±1.99^{a}	38.5±1.54^{b}
n-3	8.96 ± 0.39	8.52±0.56	8.91±0.84	8.02±0.45
n-6	33.2 ± 1.25^{a}	31.7±1.02^{ab}	33.2±2.13^{a}	30.5±1.25^{b}
n-6/n-3	3.72 ± 0.25	3.74±0.30	3.77±0.49	3.81±0.18

Abbreviations: AA: Arachidonic acid (20:4n-6); DPA: Docosapentaenoic acid (22:5n-3); DHA: Docosahexaenoic acid (22:6n-3); SFA: Sum of saturated fatty acids, MUFA: Sum of monounsaturated fatty acids, PUFA: polyunsaturated fatty acids; n-3: sum of n-3 fatty acids; n-6: sum of n-6 fatty acids.

Table 3.

Notes