Effect of *Quercus cortex* extract on carcass and meat quality traits of broilers

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Abstract. In terms of consumers, broiler meat should have good nutritional characteristics. The scientific community has actively discussed the use of non-traditional ingredients for feeding poultry. Therefore, research in this direction may lead to an improvement of the quality of broiler meat. This study was designed to investigate the effect of *Bifidobacterium*, *Lactobacillus* and *Quercus cortex* extract (QCE) on the carcass traits and meat quality of broiler chicken. For this, 120 broilers were allocated to the groups: control group – base diet (BD); I – BD + QCE; II – BD + probiotic; III – BD + probiotic + QCE. The following methods were used: capillary electrophoresis and biochemical methods. There was 7.0 % increase in the pre-slaughter live weight of the broilers in group II by the end of the period, compared to the other groups, 8.4 % increase in the proportion of muscle tissue in the carcass, and an increase in the crude protein and dry matter (0.93 %) in the pectoral muscle, in comparison to the control group. There was an increase in the essential amino acids content in comparison to that of the control: in group III – lysine, leucine; in group II – methionine. The supplementation with QC and probiotic leads to an improvement of the amino acid composition of muscle tissue, depending on its localisation with minor changes to carcass traits.

1. Introduction

The nutritional value of meat, including that of poultry, is usually estimated based on parameters such as dry matter, protein content and composition, amino acid level and fat content [1, 2]. In terms of consumers, broiler meat should have good nutritional characteristics [3, 4]. Poultry meat mainly consists of proteins with a high essential amino acid content [5]. It should be noted that the muscles from different parts of the carcass have different chemical compositions; that of breast (pectoralis major) muscle is different from that of thigh (biceps femoris) muscle [6]. The use of vegetable additives in poultry feed can affect meat quality in different ways. [7–10] improve meat composition and the fatty acids profile. The use of probiotics to improve the quality of broiler meat has also been assessed, with contradictory results. For example, *Lactobacillus rhamnosus* reduces the fat and moisture content in muscle tissue [11–13]; in other experiments, it increased the weight of pectoral muscles [14]. The scientific community [15] has actively discussed the use of non-traditional ingredients for feeding poultry. Therefore, research in this direction may lead to an improvement of the quality of broiler meat. This study is a continuation of our early experiments, in which it was noted that the synergistic effect of *Quercus cortex* extract and a probiotic preparation (based on *Bifidobacterium adolescentis* and *Lactobacillus acidophilus*) in the feed of broiler chickens resulted in improvements in the immune responses and antioxidant activity of the organism [16]. A similar effect was found after the concurrent use of this extract and an enzyme preparation [17].
The purpose of this study was to determine the combined effect of *Quercus cortex* plant extract and a probiotic preparation (based on *Bifidobacterium adolescentis* and *Lactobacillus acidophilus*), as feed additives, on broiler meat quality assessed as the concentration of the essential amino acids, in the pectoral and femoral muscles.

2. Materials and methods

Every effort has been made to minimise the suffering of the animals and to reduce the number of samples used (Order of the Ministry of Health of the USSR No. 755 of 12.08.1977). The preparation of QCE included the following steps: placing of 50 g of shredded bark (medicinal form) into heat-proof ware with 500 ml of hot (70 °C) distilled water, heating in a water bath (30 min), followed by percolation and filtering. A probiotic preparation based on *Bifidobacterium adolescentis B-1-DEP-VGNKI* – 80 million CFU (colony forming units) and *Lactobacillus acidophilus LH1-DEP-VGNKI* – 1 million CFU. This research was performed using Smena-8 broiler chickens. Acclimatisation lasted 6 days and provision of the experimental diets began on day 7 and continued to day 42. For this, 120 7-day-old broiler chickens were attributed to 4 groups (n = 30), each with 3 replicates of 10 birds. The groups were as follows: reference group – BD; experimental group I – BD + QCE, at the level of 2.5 ml per kg of body; experimental group II – BD + probiotic preparation (1 g/kg feed); experimental group III – BD + probiotic + QCE. The formulation of the experimental diets was based on the recommendations of VNITIP. Feed intake was recorded every day. Q. cortex extract was supplied individually and daily (with drinking water through a sterile syringe). Poultry were decapitated after nembutal and ether anesthesia on day 42. Before slaughter, feed deprivation occurred (no for drinking water) for 12 hours. Birds were weighed before and after slaughter; the individual tissues and organs of the experimental birds were also weighed. During slaughter, the average muscle tissues were sampled from each bird, which were used to determine the chemical composition of the body tissues. Homogenised samples were dried at a temperature of 60–70 °C and stored in test tubes with a ground-in lid. The studied biochemical parameters included: determination of the chemical composition of tissue, including the mass fraction of fat; ash; protein, by the Kjeldahl method, with preliminary mineralisation of samples. To assess the full biological value of meat in the middle sample, the essential and non-essential amino acids content was determined by capillary electrophoresis (Capillary-105 M, Lumex).

Numerical data were processed by the one-way analysis of variance (ANOVA) and the results were presented as mean values for groups and standard errors of the mean (StatSoft Inc. 2009). All results are presented as means and the variability in data was expressed as pooled SEM. The significance of difference among the groups was assessed using Tukey’s test. Statistical significance was considered when P<0.05.

3. Results and discussion

The inclusion of a probiotic preparation (group II) in the ration contributed to a 0.7–7.0 % increase in the pre-slaughter weight of chickens by the end of the period, compared to the other groups. An increase in the final weight of broiler chickens after feeding with a *Bacillus subtilis fmbJ* probiotic supplement (3 × 10^{10} OE kg) was also observed in our earlier studies [18, 19], which is consistent with our current results. In addition, there was an 8.4 % increase in the proportion of muscle tissue in the carcasses from group II, in comparison to the control group. Similar studies with the inclusion of synbiotics in the diet, including probiotic substances (*Bacillus subtilis, Bacillus licheniformis and Clostridium butyricum;* 0 or 1.5 g kg^-1, 42 d.), also resulted in an increase in the pectoral muscle mass [14]. Cramer et al. [20] showed that the use of a probiotic based on *Bacillus subtilis* (1.0 × 10^8 cfu/g, 46 d.) in broiler chicken can improve the muscle mass of the carcass without any adverse effect on the meat quality.

The combined supplementation of QCE and of the probiotic preparation (based on *Bifidobacterium adolescentis* and *Lactobacillus acidophilus*) in group III did not significantly alter carcass traits (P=0.013).
The separate inclusion of a probiotic in the diet led to an increase in the pectoral muscle of raw fat by 0.51 %, crude protein by 0.93 % and dry matter by 0.93 %, in comparison to the control group. A similar trend was observed in group III after the combined feeding with a probiotic and QCE.

Chemical analysis of the femoral muscles showed similar changes as that observed in the pectoral muscles: there was an increase of crude fat, crude protein and dry matter in the birds from groups II and III.

Our results are consistent with the data from earlier experiments in poultry. Thus, phenolic compounds of a plant origin, including tannins from Q. cortex extract added into broiler chicken diets increase the fat content in the meat from the breast and thigh [8, 21]. In other studies, the meat from broiler chickens fed the probiotics Lactobacillus acidophilus and Bifidobacterium bifidum showed a higher content of protein and ash, compared to the control [22, 23], findings that were also confirmed in our experiment. A feed additive consisted of the combination of Indian ginseng Withania somnifera and synbiotic substances increases the ash content in pectoral muscles [24]; a similar trend was also observed in our experiment.

In the pectoral muscles of the broiler chickens from the experimental groups, there was an increase in the essential amino acids content in comparison to the control (Table 1); more specifically, in group III, there was an increase in lysine (by 23.5 %, P=0.021) and leucine-isoleucine (by 19.8 %, P=0.018), whereas in group II, there was an increase in methionine (by 59.0 %, P=0.031).

Table 1. Effect of QCE and probiotics on amino acid composition of pectoral muscles, ‘g 100 g’ dry muscle

| Amino acid* | Control | Group I | Group II | Group III | SEM | P-value |
|-------------|---------|---------|---------|-----------|-----|---------|
| Essential amino acids | | | | | | |
| Lys | 9.37 | 11.10 | 11.10 | 11.57 | 0.15 | 0.021 |
| Phe | 3.78 | 3.83 | 4.11 | 4.30 | 0.20 | 0.108 |
| Leu-Ile | 11.68 | 13.48 | 13.5 | 14.0 | 0.15 | 0.018 |
| Met | 2.81 | 3.48 | 4.47 | 2.51 | 0.20 | 0.031 |
| Val | 3.86 | 4.52 | 4.63 | 4.44 | 0.15 | 0.103 |
| Thr | 4.17 | 4.96 | 4.93 | 4.91 | 0.20 | 0.101 |
| (a) – Lys – lysin; Phe – phenylalanine; Leu-Ile – leucine-isoleucine; Met – methionine; Val – valine; Thr – threonine; Arg – arginine; Tyr – tyrosine; His – histidine; Pro – proline; Ser – serine; Ala – alanine; Gly – glycine; | | | | | | |
| Non-essential amino acids | | | | | | |
| Arg | 5.60 | 7.16 | 5.77 | 7.66 | 0.15 | 0.063 |
| Tyr | 4.50 | 5.26 | 6.12 | 5.93 | 0.15 | 0.101 |
| His | 2.67 | 2.89 | 3.20 | 3.05 | 0.131 | |
| Pro | 2.78 | 3.23 | 3.22 | 3.53 | 0.17 | 0.102 |
| Ser | 3.56 | 4.48 | 4.03 | 4.26 | 0.20 | 0.103 |
| Ala | 6.9 | 8.11 | 8.45 | 8.40 | 0.20 | 0.081 |
| Gly | 4.10 | 4.82 | 4.98 | 5.20 | 0.20 | 0.112 |

In addition, the inclusion of QCE in the diet of broiler chickens (groups I and III) significantly increased the content of arginine by 27.8 and 36.7 % (P=0.063), and alanine by 17.5 and 21.7 % (P=0.081), respectively.

These results are consistent with those of other authors that demonstrated the positive effects of probiotics (Bacillus subtilis PB6, CloSTAT) and plant substances (thyme essential oil (Thymus vulgaris L.) when used together in broiler nutrition [25]. As in our case, other authors have shown that there is a significant difference in the content of the essential amino acids in the pectoral muscle (for arginine, phenylalanine, isoleucine, leucine, lysine and methionine), and their total content in
experimental groups, compared to the controls. This overall increase indicates that probiotic substances contribute to an improved absorption and use of protein in animals [26, 27]. Recently, tannins have been shown to react with a wide range of different organic N-compounds, including arginine (of all amino acids) [28]. We assume that Q. cortex extract, containing polyphenolic substances in its composition, contributed to the formation of complexes and their significant accumulation in muscle tissue.

The amino acid composition of femoral muscles (Table 2) was characterised by an increase in the content of essential amino acids in groups II and III only; significant differences were observed for methionine (43.9 %; P=0.053) and valine (47.5 %; P=0.083) in comparison to the control.

Table 2. Effect of QCE and probiotics on amino-acid composition of femoral muscles, ‘g 100 g’ dry muscle

| Amino acid* | Control | I | II | III | SEM | P-value |
|-------------|---------|---|----|-----|-----|---------|
| Essential amino acids | | | | | | |
| Lys | 8.81 | 7.15 | 9.03 | 9.35 | 0.20 | 0.102 |
| Phe | 3.16 | 2.80 | 3.34 | 3.41 | 0.10 | 0.103 |
| Leu-Ile | 10.85 | 9.23 | 11.37 | 11.55 | 0.20 | 0.110 |
| Met | 2.05 | 1.94 | 2.95\(^a\) | 2.22 | 0.17 | 0.053 |
| Val | 3.26 | 2.75 | 3.39 | 4.81\(^b\) | 0.18 | 0.083 |
| Thr | 3.96 | 3.37 | 4.18 | 4.40 | 0.22 | 0.109 |
| Non-essential amino acids | | | | | | |
| Arg | 5.78 | 5.79 | 5.97 | 6.43 | 0.17 | 0.107 |
| Tyr | 3.02 | 2.47 | 3.13 | 3.16 | 0.12 | 0.103 |
| His | 2.10 | 1.68 | 2.44 | 2.32 | 0.15 | 0.102 |
| Pro | 2.79 | 2.56 | 2.97 | 3.20 | 0.20 | 0.103 |
| Ser | 3.55 | 2.95 | 3.75 | 3.95 | 0.18 | 0.105 |
| Ala | 5.91 | 5.01 | 6.27 | 6.36 | 0.20 | 0.121 |
| Gly | 4.19 | 3.85 | 4.43 | 4.59 | 0.17 | 0.111 |

\(^{(*)}\) – Lys – lysine; Phe – phenylalanine; Leu-Ile – leucine-isoleucine; Met – methionine; Val – valine; Thr – threonine; Arg – arginine; Tyr – tyrosine; His – histidine; Pro – proline; Ser – serine; Ala – alanine; Gly – glycine; a, b – means with different letters within a row are significantly different at P\(\leq\)0.05; SEM – standard error of the mean.

A previous study by [24] also noted an increase in essential amino acids, including methionine and valine. At the same time, the inclusion of the extract in the diet of broilers contributed to a reduction of most essential and non-essential amino acids apart from arginine [24].

4. Conclusion
The combined supplementation with QCE and probiotic leads to an improvement of the amino acid composition of muscle tissue, depending on its localisation, with minor changes to carcass traits.

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