Some aspects of nutritive and sensory quality of meat of restrictively fattened chickens

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Summary
Female chickens (Ross 208), divided in four groups of 18 birds each, were fed one of the following respective diets: whole-wheat type fed restrictively (WR), maize-meal type fed restrictively (MR), maize-meal type fed semi-ad libitum (MS) and a control commercial feed mixture (C). Birds of the three experimental groups were slaughtered when they reached live weight 2200 g (87, 90 and 74 days of age for WR, MR and MS group, respectively), C-chickens were slaughtered at the age of 46 days. Sensory traits of chicken meat (colour, fibrousness, odour, tenderness, juiciness and flavour) were evaluated by a panel of eight assessors within three consecutive sessions. Meat tenderness decreased in the following sequence of the diets: C > MS > both restrictively fed diets. Both breast meat and thigh meat of MS-chickens was better scored (P<0.01) from the sensorial viewpoint in comparison with the C-birds. It was concluded, that on the one hand, it is possible to produce meat with a higher organoleptic quality using chickens of a common meat hybrid combination on the assumption that the reaching of the desirable slaughter weight is delayed to the higher age (12 weeks) due to the quantitative and qualitative (lower protein content) feed restriction. However, on the other hand, slowly growing chickens of all experimental groups deposited in meat more (P<0.01) cholesterol (in average by 20 \%) and in average seven times more (P<0.01) arachidonic acid in comparison with the control group. Meat of chickens fattened deliberately slow by the cereal diets and slaughtered at twelve weeks of age was therefore less favourable from the viewpoint of a healthy human nutrition than meat of conventionally fed broilers slaughtered at six weeks of age.

Introduction
Most producers aim to fatten chickens to a desirable slaughter weight as quickly as possible. However, the meat of rapidly fattened chickens is considered tasteless and not firm enough. Therefore some producers fatten chickens deliberately slow to a higher age to achieve higher sensory quality of the product (Culioli \textit{et al.}, 1990). On the other hand, papers concerning the nutritive value, especially the composition of the lipid fraction of such a product, are scarce (Komprda \textit{et al.}, 2000). Both dietary cholesterol and fatty acid pattern in the dietary lipid fraction are in a close relationship to serious chronic diseases in humans. As far as fatty acids are concerned, the decrease of polyunsaturated fatty acids (PUFA) n-6/n-3 ratio in the diet, and especially the decrease of arachidonic acid (AA) intake are recommended (Taber \textit{et al.}, 1998). The objective of the present study was to compare meat of chickens fattened deliberately slow to a higher age by the diets based nearly exclusively on cereals, with typically intensively fed chickens, slaughtered upon reaching a comparable live weight, regarding cholesterol content and content of physiologically most important fatty acids on the one hand, and sensorial quality on the other hand.

Material and methods
Female chickens (Ross 208), divided in four groups of 18 birds each, were fed one of the following respective diets: whole-wheat type fed restrictively (WR), maize-meal type fed restrictively (MR), maize-meal type fed semi-ad libitum (MS) and a control commercial feed mixture (C). Birds were slaughtered when they reached live weight 2200 g, that is 87, 90 and 74 days of age for WR, MR and MS group, respectively; C-chickens were slaughtered at the age of 46 days. After slaughter and...
cooling, breast muscles (BM) and thigh muscles (TM) were separated from twelve carcasses within each group of chickens, frozen and stored at −20 °C until analyses. Consequently, total lipids in the tissues were extracted by hexane/2-propanol mixture, and cholesterol and fatty acids were determined by liquid chromatography and gas chromatography, respectively (according to Komprda et al., 2000).

Six carcasses from each group of chickens were frozen, stored at −20 °C and consequently used in sensory analysis. Sensory traits of chicken BM and TM (colour, fibrousness, odour, tenderness, juiciness and flavour) were evaluated by a panel of eight assessors within three consecutive sessions. A 100 mm unstructured line scale was used for all descriptors with the anchor points located 20 mm from both ends of a given line scale. Before session, carcasses were defrosted overnight, divided into the portions (TM, BM) and cooked one hour at 200 °C.

One-way classification and four-way classification with interaction, including Duncan multiple-range test, was used within the analysis of variance regarding nutritive and sensory traits, respectively.

Results and discussion
The treatment (diet composition, including the method of fattening) influenced (P<0.01) colour, fibrousness and tenderness of BM and all sensorial traits of TM, except odour. A significant (P<0.01) effect of the assessor on quantification of most traits of sensory quality was found. The assessors coincided only in the trait of tenderness in BM (P>0.05). No interaction diet-assessor was found in any sensorial trait either in BM or in TM. However, significant interactions (P<0.01) diet-session were found in colour and tenderness in BM, and odour, tenderness and flavour in thigh meat.

Chickens of all three experimental groups had darker (P<0.01) BM and TM in comparison with the C-group. Tenderness of BM tended to decrease in the sequence control chickens > chickens fed semi-ad libitum > restrictively fed chickens. Only BM of chickens fed the wheat-type diet and slaughtered at the age of 14 weeks was significantly tougher (P<0.01) in comparison with BM of chickens of all other groups. However, as far as TM is concerned, an unambiguous and significant (P<0.01) decrease of tenderness with increasing slaughter age of chickens was observed.

We found differences (P<0.01) between the diets regarding juiciness of TM but not of BM. This fact can be explained by substantially higher fat content of TM (21.5, 38.3, 44.8 and 55.4 % in C, WR, MR and MS group) in comparison with BM (7.7, 12.7, 16.0 and 14.7 % in C, WR, MR and MS group, respectively), and by significant differences (P<0.01) between total lipid content in TM of chickens fed the different diets.

Regarding flavour, only BM and TM of MS chickens (but not of other experimental groups) was better scored in comparison with C-broilers (Figure 1).

Chickens fed the maize-type diet semi ad-libitum had higher (P<0.01) cholesterol content both in BM and in TM than wheat-type diet fed chickens (Figure 2). Moreover, chickens of all experimental groups deposited more (P<0.01) cholesterol in both tissues in comparison with traditionally fed control birds. The reason was probably not a higher total lipid content in meat of experimental chickens (according to Hoelscher et al., 1988, cholesterol content in the muscle tissue did not change with an increase of intramuscular fat content), but rather much higher growth intensity of C-chickens (Komprda et al., 1999, found significant decrease of cholesterol content in the lipid fraction of BM and TM with increasing growth intensity of chickens), and/or fatty acid composition of the diets. It is generally accepted (Jones et al., 1990), that higher saturated fatty acid (SFA) content increases, and higher monounsaturated fatty acid (MUFA) and PUFA content decreases total plasmatic cholesterol. Experimental diets had on average 65 % higher SFA content and nearly 60 % lower MUFA content in comparison with the control diet in the present experiment.

As far as PUFA n-6 are concerned, physiologically most important metabolite of the parent substance, linoleic acid (LA), is arachidonic acid (AA). AA-derived eicosanoids are proinflammatory and proaggregatory; higher AA intake is therefore unfavourable (Taber et al., 1998). Fat from poultry meat could be a significant contribution to the dietary intake of AA (Li et al., 1998), which was confirmed in the present experiment (Figure 3). Substantially higher (P<0.01) AA content in the tissues of all groups of experimental chickens as compared to the control group was probably a consequence of unfavourable linoleic acid/α-linolenic acid ratio in the particular diets (9.2, 17.5, 25.9 and 25.9 in the C, WR, MR and MS diet, respectively).

Contrary to AA-derived eicosanoids, eicosanoids derived from n-3 PUFA, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA; metabolites of α-linolenic acid, LNA), cause vasodilation and are antiaggregative. Increasing the intake of n-3 PUFA is a safe and effective means in reducing morbidity and mortality after myocardial infarction (vonShacky, 2001). Antiinflammatory properties of n-3 PUFA in the arterial wall may contribute to their protective effects on cardiovascular diseases (Yaqoob, 2004). Because LNA and its very-long-chain (VLC) metabolites (EPA + DHA) are not
biologically equivalent, suggested Ollis et al. (1999) the use of the so-called VLC n-3 PUFA equivalents (VLCE): VLCE = 0.15LNA + EPA + DHA (in mg/100 g of the tissue). VLCE values found in the present experiment are shown in Figure 4. VLCE content in both BM and TM of chickens of all three experimental groups were higher in comparison with the control group, due to the higher fat content in the particular tissues of WR, MR and MS chickens.

From the viewpoint of a healthy human nutrition, to keep the proper balance between intake of n-6 and n-3 PUFA is a matter of the utmost importance. Okuyama et al. (1997) recommended the PUFA n-6/PUFAn-3 ratio to be 2 or below. As it is apparent from the Figure 5, neither meat of experimental chickens, nor meat of the control ones was an ideal food from this viewpoint in the present experiment. However, BM of MS chickens, and TM of both MR and MS chickens was still worse in this trait (P<0.01) in comparison with the control group.

Conclusions

The present study proved that chickens fattened by maize-based cereal mixture and slaughtered at the age of ten weeks were more flavourable in comparison with broilers fed a commercial finisher and slaughtered at the age of six weeks. However, within the time interval followed in this experiment, we were not able to confirm the hypothesis that the higher slaughter age of chickens yields a more flavourful product. This was in part caused by the fact, that the primary effect on sensory quality was that of the diet (including the method of fattening) and not that of the slaughter age.

On the other hand, based on the nutritive traits important from the viewpoint of the current trends in the evaluation of the relationship between composition of animal products and serious chronic diseases in humans (total lipid, cholesterol, arachidonic acid, very-long-chain PUFA), meat of intentionally slow fattened chickens were considered less favourable product (with the exception of VLC PUFA) than meat of commercially fed broilers. We estimated an average intake of the above constituents in 200 g of chicken meat (100 g of BM + 100 g of TM). The intake in meat of slow growing chickens fed the cereal diets (mean of all three experimental groups, WR, MR, MS), expressed in the absolute values and as a per cent of the intake via 200 g of meat of conventionally, intensively fattened chickens (in parentheses) was as follows: total lipid 29.2 g (170 %), cholesterol 127 mg (120 %), arachidonic acid 2105 mg (700 %), VLC PUFA equivalent 429 mg (255 %).

References


C - control commercial feed mixture; WR - whole-wheat type diet fed restrictively; MR - maize-meal type diet fed restrictively, MS - maize-meal type diet fed semi-ad libitum
BM – breast meat; TM – thigh meat
a, b – means with different superscripts within a given tissue differ significantly (P<0.01)
Figure 3
Arachidonic acid

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C, WR, MR, MS; BM, TM – see Figure 1
a, b, c – means with different superscripts within a given tissue differ significantly (P<0.01)

Figure 4
Very-long-chain polyunsaturated fatty acid equivalent*

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* VLCE = 0.15 α-linolenic acid + eicosapentaenoic acid + docosahexaenoic acid content
(all values in mg/100 g of a tissue)
C, WR, MR, MS; BM, TM – see Figure 1
a, b, c – means with different superscripts within a given tissue differ significantly (P<0.01)
Figure 5
Polyunsaturated fatty acid n-6/n-3 ratio

C, WR, MR, MS; BM, TM – see Figure 1
a, b – means with different superscripts within a given tissue differ significantly (P<0.01)