The use of amaranth grain in diets for broiler chickens and its effect on performance and selected biochemical indicators

J. Roučková[1], M. Trčková[2], I. Herzig[2]

[1]University of Veterinary and Pharmaceutical Sciences, Brno, Czech Republic
[2]Veterinary Research Institute, Brno, Czech Republic

ABSTRACT: The objective of our experiment was to test the possibility of using amaranth grain, either heat-treated (AO) or without treatment (AN), in vegetable diets for broilers as a substitution for meat-and-bone meals. The effect of amaranth on performance and selected biochemical parameters was investigated. The groups of chickens fed with amaranth obtained comparable results in all characteristics with the control group whose diet included a component of animal origin. We did not observe any statistical differences in live weights of monitored groups of chickens on day 41 (Kab 2 149.9 ± 274.3; ANab 2 192.2 ± 255.2; AOab 2 186.2 ± 260.8 g). Feed conversion ranged from 1.9 kg in the control group of hens to 2.2 kg in the experimental group of cocks AOa. Carcass yield was significantly higher ($P < 0.05$) in the control group compared to the group AN. Biochemical characteristics, i.e. the concentrations of proteins, total lipids, cholesterol and glucose in blood sera of broiler chickens were monitored. The inclusion of amaranth in the rations of experimental groups had no effect on protein concentrations compared to the control group. The hypocholesteraemic and hypolipidaemic effects of amaranth grain, as mentioned in the literature, were not confirmed in our experiment. Glucose levels were significantly lower in the experimental groups of chickens ($P < 0.05$; $P < 0.01$). We can conclude that amaranth can be successfully used as a substitution for meat-and-bone meals in diets of broiler chickens, and that the tested amount of 7% in a ration had a positive effect on performance.

Keywords: plant protein; weight; feed conversion; carcass yield; blood biochemistry

In the Czech Republic, meat-and-bone meals are banned ingredients in the manufacture of feeds for farm animals. Therefore alternative sources providing proteins, limiting amino acids and energy in the ration have to be found. Out of vegetable protein feeds, rape, soybean, peanut and legumes are especially considered, and to a lesser extent other oil plants and products of the oil industry, i.e. oil cakes or extracted meals. Certain limitations of use exist in all the above-mentioned feeds, e.g. in connection with the content of antinutritional substances (erucic acid and glucosinolates), moulds and their toxic products, etc. (Herzig, 2001).

Among plants that meet the requirements for feeds that replace meat-and-bone meals, amaranth and its products appear to be suitable, being classified as pseudocereals. The genus *Amaranthus (*L*)* belongs to the family Amaranthaceae and includes more than 60 species. Under our conditions, three grain species *Amaranthus cruentus*, *Amaranthus hypochondriacus* and *Amaranthus caudatus* are of importance. The genotypes suitable for cultivation in the Czech Republic, environmental requirements and technological conditions under which the plants can be grown are already well known. Experience obtained in the cultivation of amaranth to date has shown that field yields range from 0.6 to 2.4 t/ha (Jarošová *et al*., 1997).

Amaranth has a high nutritional value. The dry matter of amaranth grain contains 12.6 to 18.0% of proteins, 5 to 8% of fat, 60 to 65% of saccharides, and 3 to 5% of crude fibre (Cole, 1979; Bressani *et al*., 1993; Yanez *et al*., 1994). The advantage of amaranth grains compared to conventional cereals is a relatively high content of proteins and more balanced amino acid composition. Amaranth grain is

rich in lysine and sulphur amino acids. A suitable content of lysine and tryptophan together with low content of leucine makes it a high-quality supplement for e.g. maize, which is rich in leucine but poor in lysine and tryptophan (Correa *et al*., 1986; Imeri *et al*., 1987a; Bressani *et al*., 1989). Amaranth oil is rich in unsaturated fatty acids, especially linoleic acid and oleic acid (Lorenz and Hwang, 1985; Yanez *et al*., 1994); the content of squalene (5 to 6%) is also important. Squalene is a natural substance of isoprenoid type, and it is the precursor of steroid synthesis and some antioxidants as is the co-enzyme Q10 (ubiquinone). It is a part of cell membranes and has an effect on their resistance to heat and chemical damage. Vitamins are concentrated predominantly in grain germs. The contents of riboflavin, niacin, pantothenic acid and especially vitamin E make the amaranth grain particularly valuable. Amaranth grain is also rich in mineral substances. The content of calcium in the grain is higher than in milk, and the contents of iron, phosphorus and potassium are important too.

Amaranth is used especially as a supplement to human nutrition and due to its composition it is used in the prevention of diseases. It was confirmed that squalene together with the fibre and tocotrienols in amaranth grains can reduce cholesterol content in blood serum (Qureshi *et al*., 1996; Grajeta, 1999). Amaranth grains, dry vegetable parts of amaranth (containing 12 to 21% of proteins) and liquid extract, the so called amaranth milk (which contains 20 to 25% of proteins), can be used as feeds.

The suitability of amaranth grain in animal nutrition was tested in experiments on hens (Tillman and Waldroup, 1987), rats (Andrasofszky *et al*., 1998; Grajeta, 1999), lambs (Pond and Lehmann, 1989), rabbits (Alfaro *et al*., 1987) and ruminants (Škultéty *et al*., 1991; Jalč *et al*., 1999). With a proportion of 40% of amaranth and more in the ration, lower performance parameters than expected were recorded together with some pathological changes (Alfaro *et al*., 1987). This can be due to the presence of antinutritional substances. Data are known from literature about the contents of trypsin inhibitor, phenols, tannins, saponins, and phytohaemagglutinins (Correa *et al*., 1986; Imeri *et al*., 1987b). Antinutritional substances were partially or totally degraded by heat treatment i.e. autoclaving, popping and extruding (Andrasofszky *et al*., 1998).

The objective of our study was to test the possibility of using amaranth, with or without heat treatment, in diets for broiler chickens as a substitution for meat-and-bone meals.

MATERIAL AND METHODS

240 day-old broiler chickens ROSS 308 were included in the experiment. The chickens were divided into six groups, forty animals each, and were separated according to their sex (according to outward sexual signs), and housed on deep litter. The density of chickens in pens was 11.2 animals per 1 m^2. Hygienic conditions met the requirements for the fattening of broiler chickens ROSS 308. A 24-hour lighting regime was applied. The experiment was conducted in an accredited experimental stable of the University of Veterinary and Pharmaceutical Sciences in Brno.

During the whole fattening period, feed mixture was applied as follows:

Control group Ka (male chicks) and Kb (female chicks) were fed the BR mixture with a supplement of animal origin (fish and meat-and-bone meals)

Experimental group ANa (male chicks) and ANb (female chicks) were fed the BR mixture with untreated amaranth (AN), without any supplement of animal origin

Experimental group AOa (male chicks) and AOb (female chicks) were fed the BR mixture with heat-treated amaranth (AO), without any supplement of animal origin

Feed mixtures were supplied to all groups of broiler chickens *ad libitum* from feeders recording the amount of consumed feed. Drinking water was also provided *ad libitum*.

Nutritional values of amaranth grains and the feed mixtures used in the experiment were determined prior to the start of the experiment. The values for dry matter were determined as well as N according to Kjehldal, fat according to Soxhlet, further fibre, and ash. Gross energy was determined calorimetrically, and the content of nitrogen-free extract (NFE) was calculated based on Regulation No. 222/1996. The composition of nutrients was the same in all feed mixtures and was in accordance with nutritional requirements for growing chickens (Zelenka *et al*., 1999).

During the fattening period on days 12, 21, 30 and 40 the live weight of chickens was recorded and the gains were calculated for certain periods as well as the total gains. Feed consumption and conversion were also determined. Fattening was terminated on day 41, and after slaughtering the percentage yield was determined as the ratio of carcass and edible giblets to live weight of a broiler chick.

On days 21 and 41 blood was collected from the chickens by puncture from *vena basilica* and subsequently biochemical and haematological analyses were carried out. Blood samples were stabilized by heparin. Out of biochemical characteristics total protein, total lipids, cholesterol and glucose were determined. Biochemical examinations were completed using the commercial kits BIO-LA-TEST, and the values were determined by photometry (Spekol-253).

Statistical evaluation was carried out using the programme Stat-plus (Matoušková *et al*., 1992). Arithmetic mean, standard deviation and the coefficient of variation were calculated, and statistical significance of mean differences was determined using the paired *t*-test.

RESULTS AND DISCUSSION

EU measures adopted to ensure food safety and the effort to enhance the trust of consumers in food safety require adequate and rapid measures in livestock production (Anonym, 2000). These measures should bring back the trust of consumers in food safety and at the same time minimize the impact of the absence of animal proteins in feed mixtures on performance and health state, especially in monogastric animals during fattening.

The composition of feed mixtures and the used components are shown in Table 1. The nutritional values of amaranth grain before and after heat treatment and nutritional values of feed mixtures are shown in Table 2. Feed mixtures for broilers in the

Table 1. Composition of feed mixtures BR1 used in the experiment (%)

Ingredients	Composition	
	BR1-K	BR1-AN, BR1-AO
Wheat	70.80	59.00
Soya extracted meal	15.60	25.00
Soya oil	1.18	2.20
Amaranth	–	7.00
Fish meal 62%	2.50	–
Meat-and-bone meal	5.00	–
Vitex Q	2.50	2.50
Lysine – HCl 100%	0.45	0.37
D.L-Methionine 100%	0.26	0.26
L-Threonine 100%	0.14	0.10
Monocalcium phosphate	0.16	0.95
Monosodium phosphate	0.25	0.26
Feeding salt	0.11	0.24
Ground limestone	0.55	1.62
Premix 0.5% BR1 Mikrop	0.5	0.5

The Premix BR1 Mikrop contains in 1 kg: 1 600 mg of copper sulphate pentahydrate, 16 000 mg of iron sulphate monohydrate, 16 000 mg of zinc oxide, 20 000 mg of manganese oxide, 70 mg of cobalt sulphur heptahydrate, 400 mg of calcium iodate monohydrate, 30 mg of sodium selenite, 3 000 000 i.u. of vitamin A, 1 000 000 i.u. of vitamin D3, 10 000 mg of vitamin E, 800 mg of vitamin K3, 600 mg of vitamin B1, 1 600 mg of vitamin B2, 1 000 mg of vitamin B6, 3.2 mg of vitamin B12, 40 mg of biotin, 12 000 mg of niacin amide, 400 mg of folic acid, 3 600 mg of calcium pantothenate, 50 000 mg of betaine

BR1-K = feed mixture for broilers containing animal component

BR1-AN = feed mixture for broilers containing untreated amaranth

BR1-AO = feed mixture for broilers containing heat-treated amaranth

experimental groups contained 7% of heat-treated or untreated amaranth grain. Heat treatment resulted in an increase in fibre content and decrease in nitrogen-free extracts, which is in accordance with the data reported by Hoover and Vasanthan (1994) and Varo *et al*. (1983). Heat-treated amaranth grains contained more proteins, fat, ash and gross energy. Heat treatment induces the inactivation of antinutritional factors but on the other hand, it might cause amino acid degradation, formation of intramolecular bonds and Maillard reactions, which impairs digestibility of nutrients (Hurrell *et al*., 1976; Nestares *et al*., 1993).

The live weight of chickens was monitored on days 12, 21, 30 and 41 of the experiment. The values are shown in Table 3 and Figure 1. The live weight of chick at the onset of the experiment was 35 g. The average weight (254.1 ± 34.9 g) of chickens in the experimental group AO was significantly lower ($P < 0.01$) on day 12 compared with the control group K (273.9 ± 25.9 g). Further, the growth of chicks was balanced, and at the end of the experiment on day 41 the average weight of the control group K was 2 149.9 ± 274.3 g, that of the group AN 2 192.2 ± 255.2 g, and 2 186.2 ± 260.8 g in the group AO. The differences in average weights were not significant and growth curves differed only minimally in individual groups. The balance of individual groups was also confirmed by the coefficient of variation that did not exceed 12.8% at the end of the experiment. Higher weight gains at feeding heat-treated grains of cereals were reported by Viveros *et al*. (2001) in chick pea, and by Ward and Marquardt (1988) in cereals. The higher weight of chickens on a diet without animal proteins compared to those fed with animal proteins was also found by Suchý *et al*. (2002).

The weights of broiler chickens based on sex are shown in Table 3 and Figure 2. Male chickens reached higher average weights than female chicks during all investigation periods. Significant differences of means were found on days 21, 30 and 41 ($P < 0.01$). At the end of the experiment, the highest average weight was found in the group AOa

Table 2. The contents of basic nutrients, ash and gross energy (g)

Amaranth	AN		AO	
	original	absolute	original	absolute
Dry matter	896.4.0	1 000.0	929.8	1 000.0
Proteins	151.9	169.5	166.9	179.5
Fat	76.5	85.3	78.6	84.5
Fibre	31.2	34.8	51.8	55.7
Ash	30.9	34.5	34.4	37.0
Nitrogen-free extract (NFE)	605.9	675.9	598.1	643.3
Gross energy MJ/kg	18.8		20.0	

BR1	BR1-K		BR1-AN		BR1-AO	
	original	absolute	original	absolute	original	absolute
Dry matter	879.8	1 000.0	882.4	1 000.0	887.4	1 000.0
Proteins	228.6	259.8	221.4	250.9	232.9	262.4
Fat	43.0	48.9	46.0	52.1	41.6	46.9
Fibre	16.2	18.4	16.4	18.6	18.6	21.0
Ash	51,0	58.0	57.4	65.0	57.0	64.2
NFE	541.0	614.9	541.2	613.4	537.3	605.5
Gross energy MJ/kg	18.3		18.1		18.2	

AO = heat-treated amaranth; AN = untreated amaranth

BR1-K = feed mixture for broilers containing animal component

BR1-AN = feed mixture for broilers containing untreated amaranth

BR1-AO = feed mixture for broilers containing heat-treated amaranth

Table 3. Average weights in the groups of broilers (g)

Group	Age of chickens			
	day 12	day 21	day 30	day 41
Ka	276.3 ± 23.4	752.8 ± 75.6	1 482.1 ± 151.3	2 222.4 ± 317.2
n	36	36	36	36
V %	8.3	10.0	10.2	14.3
Kb	271.8 ± 27.7	693.5 ± 69.4^{x++}	1 325.6 ± 129.8^{x++}	2 084.7 ± 208.4^{x+}
n	40	40	40	40
V %	10.2	10.0	9.79	10.0
Kab	273.9 ± 25.9	721.5 ± 78.2	1 399.7 ± 160.7	2 149.9 ± 274.3
V %	9.4	10.8	11.5	12.8
ANa	276.9 ± 25.6	718.1 ± 74.4	1 444.3 ± 140.8	2 211.8 ± 239.3
n	36	36	36	36
V %	9.2	10.4	9.7	10.8
ANb	278.6 ± 28.7	708.2 ± 82.3	1 363.8 ± 173.9^{y+}	2 171.4 ± 269.4
n	34	34	34	34
V %	10.3	11.6	12.8	12.4
ANab	277.7 ± 27.2	713.3 ± 78.5	1 405.1 ± 162.8	2 192.2 ± 255.2
V %	9.8	11.0	11.6	11.6
AOa	247.1 ± 42.7	733.8 ± 91.0	1 427.8 ± 144.1	2 291.3 ± 219.6
n	30	30	30	30
V %	17.3	12.4	10.9	9.6
AOb	259.7 ± 25.5	701.5 ± 72.6	1 300.3 ± 139.8^{z++}	2 100.9 ± 237.0^{z++}
n	37	37	37	37
V %	9.8	10.3	10.8	11.3
AOab	254.1 ± 34.9^{y++y++}	715.9 ± 83.9	1 357.4 ± 169.5	2 186.2 ± 260.8
V %	13.8	11.7	12.5	11.9

a = male chicks; b = female chicks; K = control; AO = heat-treated amaranth; AN = untreated amaranth
Statistical significance:
x = the difference between group1 and 2 is statistically significant; y = the difference between group 1 and 3 is statistically significant; z = the difference between group 2 and 3 is statistically significant; + = significance level $P < 0.05$; ++ = significance level $P < 0.01$

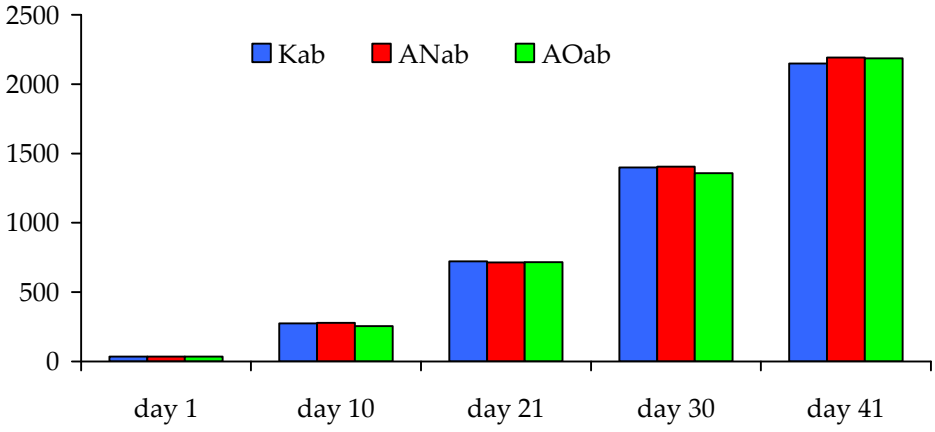

Figure 1. Average weights in the groups of broilers (g)

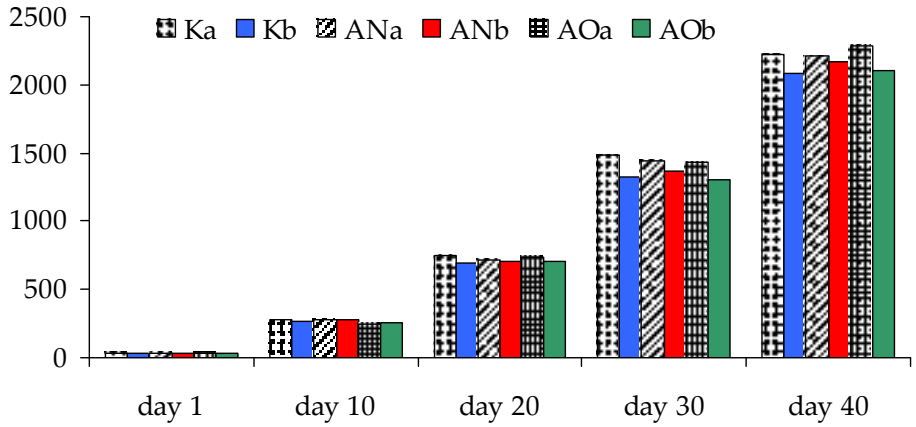

Figure 2. The weights of broiler chickens based on sex (g)

(2 291.3 ± 219.6 g), followed by the control group Ka (2 222.4 ± 317.2 g) and the group ANa (2 211.8 ± 239.3 g). The growth of female chicks was balanced; insignificantly higher weights were recorded in the group ANb (2 171.4 ± 269.4 g), followed by the group AOb (2 100.9 ± 237.0 g). The lowest weights were found in the control group Kb (2 084.7 ± 208.4 g).

The average feed consumption per animal and fattening period ranged from 3.9 kg in the control group of female chicks Kb to 4.9 kg in the experimental group of male chicks AOa. Feed intake was higher in the group fed with heat-treated amaranth compared with the group fed with a mixture containing untreated amaranth. This result is in accordance with the results of authors who investigated the effect of heat treatment on chick pea (Viveros *et al*., 2001) and cereals (Sosulski *et al*., 1988). Feed consumptions are summarized in Table 4.

The highest feed conversion (FCR) was observed in female chickens of the control group Kb (1.9 kg), the lowest was found in male chickens of the experimental group AOa (2.2 kg), which is shown in Figure 3. Lower FCR can be connected with heat treatment of amaranth grain when protein is partially degraded and changes causing digestibility deterioration can occur (Hurrell *et al*., 1976; Nestares *et al*., 1993; Hendrix *et al*., 1999) as well as increased content of fibre (Varo *et al*., 1983). Comparison of FCR between the sexes showed higher values in the female chickens of the groups K and AO than in male chicks. In the group AN fed with untreated amaranth grain, FCR was better in male chicks. Suchý *et al*. (2002) also indicated best FCR in male chicks.

Carcass yields were 77.8%, 76.4% and 77.3% in the control group, AN and AO groups, respectively (Table 5). Carcass yield of the control group K was significantly higher compared to the group AN ($P < 0.05$). The control group of female chickens obtained higher values compared to the group of female chickens fed with untreated amaranth ($P < 0.05$). Simeonová and Ingr (2000) reported the values of 75.3% in male chicks and 74.9% in female chicks on day 42 of fattening, and Suchý *et al*. (2002) indicated the values of 69.12% and 67.51% when exclusively vegetable diets were applied. The diet containing meat-and-bone meals resulted in carcass yields of 69.38% and 71.31%. Malá *et al*. (2002) mentioned the values of carcass yield 71.28% in male chicks and 67.86% in female chicks. In our experiment all groups gave higher carcass yields compared to data from literature. The assessment of sex effects on carcass yields showed significantly higher yields in the control group of female chicks compared to male chicks ($P < 0.05$), which is in contrast to the data of the cited authors. Carcass yields are predominantly affected by age and sex (Pipek and Pour, 1998).

Health state and death rates were also recorded in broiler chickens during the experiment. Two chickens were culled due to an innate defect or died in the control group of male chicks; no death was recorded in the control group of female chicks.

Table 4. Feed consumption (kg) and feed conversion (FCR) (kg) by day 41 of age

Group	Ka	Kb	ANa	ANb	AOa	AOb
Feed consumption	4.6	3.9	4.3	4.6	4.9	4.1
FCR	2.0	1.9	2.0	2.1	2.2	2.0

a = male chicks; b = female chicks; K = control; AO = heat-treated amaranth; AN = untreated amaranth

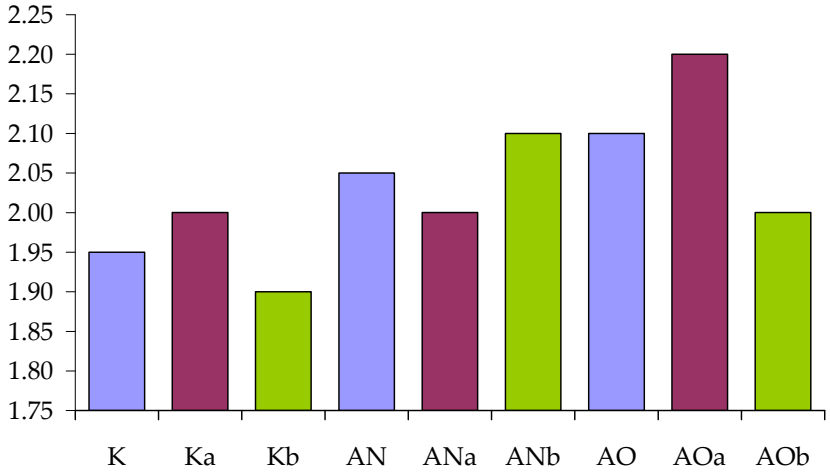

Figure 3. Feed conversion (kg)

In the experimental group ANa two young cocks were culled as well as five young hens in the group ANb. Five young cocks were culled in the group AOa during the experimental period. In the group AOb two young hens died. The health state of the chickens was good during the whole experimental period.

Average values of blood plasma total proteins (TP) were about 30 g/l on day 21 of the experiment in all groups, and increased to about 38 g/l (Table 6). The increase in total proteins with age was confirmed by several authors (Sturkie, 1976; Franchini *et al*., 1988). Ross *et al*. (1978) found the average values of TP 27.4 g/l and 38.1 g/l in sera of 28-day-old and 42-day-old chicks, respectively. The differences in TP values in dependence on the season were published by Meluzzi *et al*. (1992). The values of TP in the plasma of 21-day-old chicks ranged from 30.1 to 50.5 g/l in summer and from 20.3 to 43.3 g/l in winter. The obtained values of 45-day-old chickens were higher, from 33.1 to 53.9 g/l in summer, and from 29.7 to 52.5 g/l in winter. The wide range of values might be due to the age, sex and blood sampling stress. The values found by Straková *et al*. (1993) during fattening of broiler chicks ranged between 37.9 and 38.1 g/l.

Table 5. Carcass yields in the groups of broilers on day 41 (%) (n = 20)

Group	Carcass yields (%)
Kab	77.8 ± 2.2
Ka	77.5 ± 2.7
Kb	78.1 ± 1.7
ANab	76.4 ± 1.4^{x+}
ANa	76.5 ± 1.6
ANb	76.4 ± 1.3^{x+}
AOab	77.3 ± 1.3
AOa	77.2 ± 1.0
AOb	77.3 ± 1.6

a = male chicks; b = female chicks; K = control; AO = heat-treated amaranth; AN = untreated amaranth
Statistical significance:
x = the difference between group1 and 2 is statistically significant
+ = significance level $P < 0.05$

A significant difference ($P < 0.05$) in the TP values in blood plasma was found only on day 21 between the experimental group with untreated amaranth (AN) and the group AO where heat-treated amaranth was used. The values were higher in the AO group. At the end of the experiment on day 41 total protein values were not significantly influenced by amaranth addition to the feed mixtures. Similar values of total proteins in blood sera at substitution of animal meal by Proenergol were determined by Suchý *et al*. (2002).

The average values of total lipids (TL) in blood plasma of broilers in different groups were not significantly different on day 21 (Table 6). On day 41 of the experiment, total lipid concentrations were higher in the experimental groups compared to the control; the values of the group AO with heat-treated amaranth were significantly ($P < 0.05$) higher compared to the control. The published hypolipidaemic effect of amaranth was not confirmed in our experiment. Grajeta (1999) stated that the hypolipidaemic effect of amaranth was influenced by the type of fat used in the diet; e.g. sunflower oil can enhance the effect. The presence of α-linolenic acid and n-3 fatty

Table 6. The content of total protein (TP), total lipids (TL), cholesterol (CHOL) and glucose (GLU) in blood plasma in the groups of broilers (g/l) (n = 20)

Group	Kab			ANab			AOab		
	$\bar{x}$	sd	V %	$\bar{x}$	sd	V %	$\bar{x}$	sd	V %
Day 21									
TP	29.9	2.4	8.3	29.0	2.5	8.5	31.2 $^{z+}$	3.8	12.1
TL	4.1	0.4	10.7	4.2	0.6	14.6	4.0	0.8	19.6
CHOL	3.1	0.4	12.2	3.3	0.4	12.0	3.2	0.6	18.2
GLU	9.5	1.9	19.8	8.9	0.8	9.2	7.8 $^{y++z++}$	0.7	8.7
Day 41									
TP	38.2	5.4	14.2	38.0	3.9	10.3	39.8	5.3	11.3
TL	4.0	0.8	20.9	4.5	0.6	13.6	4.5 $^{y+}$	0.7	15.7
CHOL	2.2	0.6	25.1	2.7 $^{x++}$	0.4	14.3	3.1 $^{y++z++}$	0.4	11.3
GLU	8.5	0.9	10.7	7.4	1.4	18.8	7.1 $^{y++}$	1.1	15.0

a = male chicks; b = female chicks; K = control; AO = heat-treated amaranth; AN = untreated amaranth
Statistical significance:
x = the difference between group1 and 2 is statistically significant
y = the difference between group 1 and 3 is statistically significant
z = the difference between group 2 and 3 is statistically significant
+ = significance level $P < 0.05$
++ = significance level $P < 0.01$

acids in the diet has a greater impact on the drop of lipid contents in blood than the presence of saturated or n-6 fatty acids (An *et al*., 1997).

Cholesterol (CHOL) concentrations in blood sera of chicks (Table 6) were lower in all groups on day 42 compared to day 21. These results are consistent with the findings of other authors. Sova (1981) recorded the highest CHOL levels (12.95 to 17.35 mmol/l) in chicks during the first 5 days after hatching. A decrease was observed from day 7 (3.88 to 5.36 mmol/l), and on day 42 an average value of 4.43 mmol/l was measured. Ross *et al*. (1978) indicated CHOL level in broilers from 1.86 to 3.37 mmol/l. In contrast, Meluzzi *et al*. (1992) found the same average CHOL levels in both 21 and 45-day-old chickens (3.36 mmol/l).

The lowest CHOL levels were found on days 21 and 41 of the experiment in the control group (3.1 and 2.2 mmol/l), i.e. in the group fed with a complete feed mixture containing meals of animal origin. The inclusion of certain components in the diet e.g. fish oil, sunflower, palm, soybean and flax oils, barley, oat bran, amaranth results in the drop of blood CHOL level (Chaturvedi *et al*., 1993; Qureshi *et al*., 1996; An *et al*., 1997; Grajeta, 1999; Castillo *et al*., 2000). This effect on CHOL level is ascribed to the presence of polyunsaturated fatty acids (Skrivan *et al*., 2000; Newman *et al*., 2002), and in the case of amaranth it is due to the presence of tocotrienols and squalene or β-glucans (Qureshi *et al*., 1996; Kalač and Moudrý, 2000). We have to note that the effect of amaranth on the decrease of CHOL level was not confirmed in our experiment. Laovoravit *et al*. (1986) obtained similar results.

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Received: 04–01–23
Accepted after corrections: 04–10–28

ABSTRAKT

Použití zrna amarantu v dietách pro brojlerová kuřata a jejich vliv na ukazatele užitkovosti a vybrané biochemické parametry

Cílem pokusu bylo ověřit možnost použití zrna amarantu tepelně ošetřeného (AO) a bez tepelného opracování (AN) ve vegetabilních dietách pro brojlerová kuřata jako náhrady živočišných mouček, sledovat vliv na ukazatele užitkovosti a vybrané biochemické parametry. Skupiny brojlerových kuřat krmené směsí s amarantem jak tepelně ošetřeným, tak bez tepelného ošetření, dosahovaly srovnatelných výsledků s kontrolní skupinou krmenou směsi s živočišnou komponentou ve všech produkčních ukazatelích. Hmotnost skupin brojlerových kuřat před porážkou se mezi sebou statisticky nelišila (Kab 2149,9 ± 274,3; ANab 2192,2 ± 255,2; AOab 2186,2 ± 260,8 g). Konverze krmiva se pohybovala v rozmezí 1,9 kg u kontrolní skupiny slepiček po 2,2 kg u experimentální skupiny kohoutků AOa. Jateční výtěžnosti byla u kontrolní skupiny statisticky vyšší oproti skupině AN ($P < 0,05$). Z biochemických ukazatelů byla sledována koncentrace bílkoviny, celkových lipidů, cholesterolu a glukózy v krevním séru brojlerů. Zařazení amarantu do krmné dávky pokusných skupin neovlivnilo hodnoty bílkoviny oproti kontrolní skupině. Literaturou uváděný hypocholesterolemický a hypolipidemický efekt se v našem pokusu nepotvrdil. Hladina glukózy byla u pokusných skupin brojlerů signifikantně nižší než u pokusných skupin ($P < 0,05$; $P < 0,01$). Je možné konstatovat, že amarant je plodinou, kterou lze úspěšně využít jako náhrada živočišných mouček ve vegetabilních dietách pro brojlerová kuřata, a že ověřené množství 7 % v krmné dávce příznivě ovlivňuje ukazatele užitkovosti.

Klíčová slova: rostlinný protein; hmotnost; konverze krmiva; jatečná výtěžnost; krevní sérum

Corresponding Author

MVDr. Jana Roučková, Táborská 181, 615 00 Brno, Česká republika
Tel. +420 732 502 578, e-mail: janarouckova@atlas.cz