EXTRUSION-COOKED FABA BEAN-RAPESEED CONCENTRATE IN BROILER CHICKS DIETS

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For the evaluation of faba bean-rapeseed concentrate as a dietary protein and energy supplement, 96 (1 day old) broiler chickens were used. The following experimental diets were compared: C = soybean meal-based control diet, RO = soybean meal-based diet supplemented with rapeseed oil, T = soybean meal-based diet supplemented with beef tallow and FB-RS = faba bean-rapeseed based extruded concentrate. The starter and finisher types of the four experimental diets were used. The weight gain, feed conversion factor, and protein utilization in broiler chickens fed the FB-RS diet were higher than in those fed the control soybean meal-based diets. The carcass quality and yield were not different among dietary treatments, although the meats from chicks fed the FB-RS diet were slightly more yellowish. The results show that the FB-RS extruded concentrate can be used as a protein and energy source in broiler chicken diets, replacing soybeans. The extrusion technology improves the applicability of rapeseed-legume mixtures.

broiler chickens; faba beans; rapeseed; soybean extraction meal; beef tallow; extrusion cooking

INTRODUCTION

High costs of feeds based on imported components is major concern of poultry producers in Central Europe and many other countries. Therefore, considerable effort has been directed to obtain protein for poultry diets from sources which are less expensive, and moreover, can be grown locally, which improves the import-export balance. In countries not able to afford costly imported feedstuffs, the search for lower-cost alternatives is frequently an economical necessity.

Since several years, the feed industry has been interested in the nutritional potential of faba beans and rapeseed, both easily produced in Central Europe, as a source of protein in poultry diets. Both faba beans and rapeseed, because of their high protein content, are attractive feedstuffs for chickens, however, the nutritional value of these feeds, especially when applied as a sole source

of protein, has been questioned by several feed specialists. The main concern addressed includes the presence of toxic substances, nutrient antagonists, and low nutritional value.

Impaired growth and low feed intake in chickens fed diets, containing high levels of faba beans, were attributed to the presence of toxic constituents and low content of sulphur amino acids (Marquardt, Campbell, 1974; Griffith, 1979; Boutler, 1982). The low nutrition value could be improved by feeding mixtures of faba beans with rapeseed, which is relatively rich in sulphur amino acids (Schwenke, 1990). Further improvement may be achieved by extrusion cooking of the mixture, as various antinutritional agents may be destroyed, at least partially, in this way (Réblová et al., 1995a, b).

The addition of rapeseed extraction meal decreased the final weight (Würzner et al., 1989), which was attributed to low fat content, however, the application of full fat seeds had similar effect. Raw or autoclaved full-fat rapeseed at the 20% level in the broiler diets results in significant decrease in fat energy retention, and in increase in the size of the thyroid gland (Olomu et al., 1975). The content of 17.5% or more of full-fat canola seeds in diets of broilers (Summers et al., 1982) lowered both the body-weight gain and feed intake, although the feed efficiency was similar to that of broilers fed the control diet. The diet supplemented with raw full-fat canola seeds produced significantly lower weight gains than other diets (Nwokolo, Sim, 1989). However, autoclaved rapeseed can be added at 10% levels with no reduction in growth rate (Shires et al., 1981). If seeds are finely ground or the diets steam pelleted in order to rupture the seed coat, good results with up to 20% whole canola seed could be expected (Shen et al., 1983). The feed conversion factor is impaired even in case of low glucosinolate rapeseed (Elwinger, 1986). The adverse effect of rapeseed could be partially eliminated by thermical treatment (Petersen et al., 1988). Therefore, we considered the extrusion cooking of the seed mixture as advantageous.

Despite the experimental evidence attesting the nutritional potential of faba beans and rapeseed, there exists considerable reservation regarding the suitability of both ingredients as a feedstuff. Consequently, their routine application is not widely spread. The study reported here was undertaken to evaluate the suitability of FB-RS concentrate as an energy and protein source for broiler chick diets.

MATERIAL AND METHODS

During the feeding experiment, 96 (1 day old) sexed broiler chickens were used. Birds were housed in environmentally controlled rooms. Four replicate

cages of six birds (3 males and 3 females) were randomly assigned to each of 4 dietary treatments formulated as starter and finisher diets, respectively (Tabs. I and II). The experimental diets were as follows: C = soybean meal-based control diet; RO = soybean meal-supplemented with 8.9% (starter) and 7.0% (finisher) refined rapeseed oil, respectively; T = soybean meal supplemented with 8.9% (starter) and 7.0% (finisher) beef tallow, respectively; FB-RS = extrusion cooked dehulled-faba bean full-fat rapeseed based concentrate. The FB-RS extrudate (1 : 1 w/w) was described in our previous paper (Réblová et al., 1995a). The diets within starter or finisher were isonitrogenous, and the diets supplemented with fats were isoenergetic.

Feed and water were available *ad libitum*. Birds were fed the starter diets from 0 to 3 weeks, and the finisher diets from 4 through 7 weeks. The feed intake and body weights were monitored at weekly intervals. The measurements were performed on the same day of the week in each case.

The digestibility study (using the conventional balance method) of dry matter (DM), crude protein (CP), crude fat (CF), nitrogen-free extract (NFE), and organic matter (OM) was undertaken at the end of the 3rd and 7th weeks of the experiment.

At the end of experiment, 4 birds (2 males and 2 females), having body weights approximating the mean of each group, were used to evaluate the carcass quality, the yield, and the fat content.

Analyses of diets and faeces were performed after the conventional standard methods. The protein content in faeces was determined using the uranyl acetate method (Hartfiel, 1961).

The statistical analysis was carried out using GLM ANOVA software. Means were compared using contrasts (Steel, Torrie, 1980). The statistical significance was evaluated on the probability level of 0.05.

RESULTS

The nutrient retention values are shown in Tab. III. Higher digestibilities ($P < 0.05$) of CF in birds fed the RB-RS and RO supplement diets is noteworthy. The addition of fat (the diets FB-RS, RO, and T) resulted in better overall performance of chicken (Tab. IV). The birds fed on the T diet tended to have higher body weights in comparison to those fed the three remaining diets. The utilization of the feed was better during the first three weeks (Tab. IV). The diets RO and T resulted in the feed conversion factor lower ($P < 0.05$) than in the birds fed the C diet. However, among the birds fed the FB-RS diet, the feed conversion factor was lower ($P < 0.05$) than in any other experimental group. The utilization of protein unit of growth differed ($P < 0.05$) among dietary treatments being in the order: FB-RS T < RO < C.

I. The composition and analyzed nutrient content (%) of starter diets (0–3 weeks)

Component	C	FB-RS	T	RO
Wheat	63.9	39.5	51.5	51.5
Soybean extracted meal	26.1	6.5	29.6	29.6
Powdered milk	3.0	3.0	3.0	3.0
Fish meal	3.0	3.0	3.0	3.0
Beef tallow	–	–	8.9	–
Rapeseed oil	–	–	–	8.9
Calcium diphosphate	1.4	1.4	1.4	1.4
Limestone	1.3	1.3	1.3	1.3
Sodium chloride	0.3	0.3	0.3	0.3
FB-RS concentrate*	–	44.0	–	–
Vitamin-mineral premix**	1.0	1.0	1.0	1.0
Analyzed nutrient content:				
Dry matter (DM)	91.5	92.1	92.7	92.8
Crude protein (CP)	21.9	22.2	22.4	22.1
Crude fat (CF)	2.3	11.4	11.3	11.1
N-free extract (NFE)	57.2	49.9	49.0	49.5
Fibre	3.6	2.5	3.4	3.4
Ash	6.5	6.1	6.6	6.7
Calcium (Ca)	1.2	1.2	1.2	1.3
Total phosphorus (TP)	0.8	0.8	0.7	0.7
Magnesium (Mg)	0.12	0.10	0.08	0.09
Metabolizable energy*** MJ/kg	11.73	13.74	13.61	13.58

C = soybean meal-based control diet; RO = soybean meal, supplemented with 8.9% refined rapeseed oil; T = soybean meal, supplemented with 8.9% beef tallow; FB-RS = extrusion cooked dehulled-faba bean full-fat rapeseed based concentrate

*The concentrate was a mixture of dehulled faba beans and rapeseeds (1 : 1) and contained (5): 92.7% DM, 26.6% CP, 20.9% CF, 3.1 % fibre, 3.6% ash, and 38.5% NFE

**Vitamin-mineral premix provided per kg diet: 8 000 IU vitamin A, 1 200 IU vitamin D3, 10 IU vitamin E, 2 mg vitamin K, 4 mg riboflavine, 0.4 mg pyridoxine, 0.015 mg cobalamin, 12 mg nicotinic acid, 8 mg Ca pantothenate, 20 mg folic acid, 150 mg choline chloride, 50 mg Mn, 0.3 mg I, 30 mg Zn, 10 mg Se, 40 mg Co

***Calculated as described by Janssen (1986)

II. The composition and analyzed nutrient content (%) of the finisher diets

Component	C	FB-RS	T	RO
Wheat	73.9	54.4	64.4	64.4
Soybean extracted meal	19.1	2.6	21.6	21.6
Powdered milk	–	–	–	–
Fish meal	3.0	3.0	3.0	3.0
Beef tallow	–	–	7.0	–
Rapeseed oil	–	–	–	8.9
Calcium diphosphate	1.4	1.4	1.4	1.4
Limestone	1.3	1.3	1.3	1.3
Sodium chloride	0.3	0.3	0.3	0.3
FB-RS concentrate*	–	36.0	–	–
Vitamin-mineral premix**	1.0	1.0	1.0	1.0
Analyzed nutrient content:				
Dry matter (DM)	90.3	91.4	90.6	90.8
Crude protein (CP)	18.6	18.7	19.3	18.9
Crude fat (CF)	2.7	9.4	9.6	9.0
N-free extract (NFE)	57.2	49.9	49.0	49.5
Fibre	3.6	2.5	3.4	3.4
Ash	6.5	6.1	6.6	6.7
Calcium (Ca)	1.2	1.2	1.2	1.3
Total phosphorus (TP)	0.8	0.8	0.7	0.7
Magnesium (Mg)	0.12	0.10	0.08	0.09
Metabolizable energy*** MJ/kg	11.88	13.44	13.16	13.27

C = soybean meal-based control diet; RO = soybean meal, supplemented with 7.0% refined rapeseed oil; T = soybean meal, supplemented with 7.0% beef tallow; FB-RS = extrusion cooked dehulled-faba bean full-fat rapeseed based concentrate

**Vitamin-mineral premix provided per kg diet: 7 000 IU vitamin A, 10 000 IU vitamin D3, 0.01 mg vitamin E, 1.5 mg vitamin K, 4 mg riboflavin, 0.3 mg pyridoxine, 0.01 mg cobalamin, 10 mg nicotinic acid, 3 mg Ca pantothenate, 0.2 mg folic acid, 200 mg choline chloride, 50 mg Mn, 0.2 mg I, 30 mg Zn, 0.2 mg Se, 0.3 mg Co

***Calculated as described by Janssen (1986)

The carcass quality, yield and fat content were not affected by dietary treatments. However, the carcasses from the birds fed diets supplemented with the FB-RS concentrate had slight pigment tinge, when compared with the carcasses of the birds fed the remaining three diets.

III. Nutrient retention by chicks fed the four experimental starter and finisher diets

Diet	Dry matter	Crude protein	Crude fat	N-free extract	Organic matter
Starter diets:					
C	70.1 ab	87.0 ab	77.3 a	71.7 bc	73.4 ab
FB-RS	74.2 c	87.2 ab	92.7 c	73.3 c	77.2 c
T	69.2 a	87.0 b	76.5 a	69.5 a	72.5 a
RO	71.1 b	85.4 a	91.1 b	70.2 ab	74.5 b
(SE)	0.34	0.55	0.62	0.52	0.33
Finisher diets:					
C	76.5 a	83.5 a	80.3 a	82.2 b	80.3 a
FB-RS	76.7 a	82.7 a	90.2 b	81.2 ab	80.3 a
T	75.9 a	83.7 a	79.3 a	81.9 ab	79.8 a
RO	76.0 a	82.3 a	90.8 b	80.5 a	79.6 a
(SE)	0.43	0.32	0.74	0.47	0.43

C = soybean meal-based control diet; RO = soybean meal, supplemented with 8.9% (starter) or 7.0% (finisher) refined rapeseed oil; T = soybean meal, supplemented with 8.9% (starter) or 7.0% (finisher) beef tallow; FB-RS = extrusion cooked dehulled-faba bean full-fat rapeseed based concentrate

a, b, c – means followed by different letter are significantly different ($P < 0.05$); SE = standard error of the mean

DISCUSSION

In the present study, the addition of FB-RS concentrate to broiler chicken diets resulted in performance parameters, which were similar or better than those obtained from soybean meal-based diets. The results from the present study are thus somewhat in conflict with several reports, where negative effect on the feed performance was associated with the presence of high faba bean concentrations (Marquardt, Campbell, 1974; Marquardt et al., 1974; Griffith, 1979; Boulter, 1982) or rapeseed (Leslie, Summers, 1972; Olomu et al., 1975; Summers et al., 1982; Koucký, 1991; El-Nockrashy et al., 1975; Roth-Maier, Kirchgessner, 1987). Glucosinolates produced hypertrophy of the thyroid and increased the alimentary tract length (Kinals et al., 1990). Better results could be obtained in recent years as very low-glucosinolate cultivars have not only lower content of antinutritional agents, but also better amino acid composition (Voškeruša, 1988).

IV. Performance of broiler chicks fed the four experimental diets of starter and finisher types

Parameter	C	FB-RS	T	RO	(SE)
Body weight 3 wk (kg)	0.556 ab	0.546 b	0.600 a	0.564 a	0.030
Body weight 7 wk (kg)	1.749 b	1.815 b	1.980 a	1.850 ab	0.121
Feed utilization per kg body weight gain (kg):					
3 wk	1.629 a	1.391 c	1.493 b	1.495 b	0.016
7 wk	2.356 a	2.063 c	2.138 bc	2.180 b	0.029
Overall	2.132 a	1.870 c	1.952 b	1.981 b	0.021
Protein utilization per kg body weight gain (kg):					
3 wk	0.356 a	0.309 c	0.334 b	0.340 b	0.0035
7 wk	0.438 a	0.386 c	0.413 b	0.406 b	0.056
Overall	0.414 a	0.363 c	0.390 b	0.387 b	0.0041

Abbreviations have the same meaning as in Tab. III

Antienzymic activity has been reported in faba beans (Griffith, 1979), however, in the present study, slightly higher digestibilities of DM, CF, NFE and OM were reported in birds fed the FB-RS diet (Tab. III), and also, the presence of faba beans in the diet did not affect the retention in the most efficient ($P < 0.05$) utilization of protein per unit of growth (Tab. IV).

The sound performance of chicks fed the FB-RS diet can likely be attributed to the alleviation of the antinutrient activities from both the faba beans and rapeseed as a result of dehulling, and the improved biological value of the FB-RS diet's proteins by supplementation with methionine. It is noteworthy that the energy from rapeseed was as efficient as rapeseed oil, since the digestibility of CF in the FB-RS diet was comparable with that of the RO supplemented diet. Hence, the present study has shown that both the protein component and the energy component from the FB-RS concentrate were utilized very efficiently by chickens. The 1 : 1 ratio (W/W) used in the formulation of our concentrate allowed complete substitution of soybean protein, and provided an appropriate energy supplement in the diet.

The improved performance of the faba-bean-rapeseed mixture may be attributed to relatively high contents of sulphur amino acids (cysteine and methionine) in rapeseed protein, compared with legumes (Janicki et al., 1973; Rutkowski, 1971; Niewiadomski, 1983). Another advantage is the extrusion treatment of the feed mixture as some toxic and antinutritional components are decomposed, at least partially, during the extrusion (Réblová et al., 1995a, b).

Considering that the flavour (and off-flavours – scent), texture and colour of poultry meat can be affected by dietary factors (reviewed by Poste, 1990), replacement of components of a soybean diet with a lower-cost alternative diet requires the assessment of carcass characteristics and meat quality. In the present study, the carcass evaluation showed that the respective diets did not affect the quality and yield.

It is interesting, that despite relatively high fat supplements in the T, RO, and FB-RS diets, the fat content of chickens did not differ between the three experimental diets and the control diet C. However, it has to be emphasized that the carcasses from birds fed diets supplemented with the FB-RS concentrate had slightly different tinge of pigment from that of the birds from the remaining dietary groups. This phenomenon can be, apparently, attributed to higher contents of carotenoid and chlorophyll pigments in rapeseed (Čmolík et al., 1995).

The present study indicates that the FB-RS concentrate can be used in broiler chicken diets as the replacement of soybeans. The protein value of the concentrate, if supplemented with methionine, appears to be comparable with soybeans. In addition, the nutritional value of energy from rapeseed included in such a concentrate is comparable to that obtained from refined rapeseed oil.

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Extrudované koncentráty bobu a řepky v dietě brojlerů.

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Koncentráty extrudovaných směsí bobu obecného a řepky byly zkoumány jako zdroj bílkovin a energie ve výživě brojlerových kuřat. Do pokusu bylo zařazeno 96 jednodenních kuřat a byly srovnávány 4 experimentální diety: C = kontrolní dieta založená na sójových bobech, RO = sójová dieta s doplňkem řepkového oleje, T = sójová dieta s přídavkem hovězího loje, FB-RS = dieta založená na extrudovaných koncentrátech bobů a řepky. Do 21. dne věku dostávala kuřata starterové krmné směsi, později směsi výkrmové. Přírůstek hmotnosti, konverzní faktor a retence dusíkatých látek byly vyšší u kuřat krmených dietou FB-RS ($P < 0,05$) než u kuřat s dietami založenými na sójovém extrahovaném šrotu. Kvalita masa a výtěžnost se nelišily mezi jednotlivými dietami, i když maso kuřat krmených dietou FB-RS bylo mírně žlutší. Z výsledků vyplývá, že extrudovaný koncentrát bobu a řepky (1 : 1) je vhodným zdrojem bílkovin a energie pro brojlerová kuřata.

brojlerová kuřata; bob obecný; řepková semena; sójový extrahovaný šrot; hovězí lůj; extruze

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