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The effect of replacement of soybean meal with rape meal free of erucic acid and glucosides on growth performance and fatty acids profile of meat in turkeys

Daniel Mierliță

Department of Animal Science, University of Oradea, Oradea, Romania. Corresponding author: D. Mierliță, dadi.mierlita@yahoo.com

Abstract. Research we have conducted were conceived designed to check to what extent soybean meals in broiler turkey can be partially replaced with rapeseed meal free of free of erucic acid and glucosides (canola rapeseed type "00"), while monitoring the effect of this important alternative protein source on the production performance, carcass quality and fatty acid profile of intramuscular fat. The experiment was conducted as a completely randomized experimental design consisting of four treatments, which involved a control diet consisting of corn - soybean meal (LC) and three experimental diets (E_1, E_2 and E_3, respectively) in which proteins from soybean meal were replaced by rape meal free of erucic acid and glucosides. Rapeseed meal obtained after oil extraction by cold pressing from rapeseed, i.e. Helga variety grown in the climatic conditions of the western Romania region was included in the structure of combined fodder at a rate of 10% (in the case of group E_1), 15 % (if the case of group E_2), and 20% (in the case of E_3, respectively). Placing rapeseed meal variety "00" at a rate of up to 15% (% by weight) in the structure of combined fodder has no negative effect on weight gain, degree of food recovery, slaughterhouse indices and carcass quality. Increasing the share of rapeseed meals in food to 20% (in the case of E_3) has significantly reduced ($p<0.01$) the final weight of broilers and feed intake too, and increased specific consumption of fodder for one kilo weight gain. The presence of rapeseed meal in the diet of turkey broiler at a rate of 15% in comparison with the control group caused a decrease in the share of saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA) in the structure of fat in the breast muscles and an increase in the share of polyunsaturated fatty acids (PUFA), especially of those belonging to n-3 series (the α-linolenic acid, C18:3 n-3 being the best represented), which equates to an improvement in the nutritional quality of turkey meat as analyzed in terms of impact on human consumer health.
Key Words: Canola rapeseed "00", polyunsaturated fatty acids, C18: 3 n-3.

Introduction. In the context of banning animal origin flours in the poultry diets and the high price of soy products and by-products, the rape free of free of erucic acid and glucosides may represent a promising alternative for ensuring from domestic production the vegetable protein in poultry diet in our country.

Common rapeseeds can not be used in large amounts in poultry feed, due to their high content in erucic acid and glucosides which could lead to hypothyroidism, thyroid function disorders, cardiac disorders, inactivation of some liver enzymes, feet bone ossification disorders (Karunajewa et al 1990).

Successes in improving rape, after the discovery of Stefansson et al (1961) of the free erucic acid mutant, led to the creation after of some fall and spring varieties free of erucic acid and glucosides (00) commonly called canola "00" (Marcu et al 2002). The farming and especially use of canola rapeseed type "00" in the poultry diet in our country is not promoted as in other countries, though, it could be a reliable alternative to soy meals from import, both of in terms of bio-productive terms and from economic point of view. The interest to use rape meal in the diet of turkey broiler is justified primarily by its high protein content (35.3% CP).

Compared to soybean meal, rape meal from canola variety "00" provided similar results in experiments carried out on young swine (Baidoo et al 1987) on fattening pigs (Noll et

al 2002; Farahat et al 2013), on chicken broilers and laying hens (Marcu 2005), on turkeys (Salmon 1982; Rost 2005), thus resulting in the possibility of substituting soybean meal with rape meal at a rate of 25-50-75% in the fodder structure in swine and adult poultry. Placing in the structure of fodder recipes of canola rapeseed "00" at a rate of 5% for starter to 15% for growing and finishing phase had as effect of increasing the body weight by 4.75% and reducing specific consumption by 3.1% compared to the control group (Ciurescu et al 2003). Marcu (2005) determined that rape meal administered at a rate of up to 20% in the fodder structure does not affect growth performance in the case of broiler chickens.

Research conducted by Ciurescu et al (2003) highlighted the possibility of using rape meal at a rate of 5-10% and rapeseed at a rate of 10-15% in the structure of combined fodder recipes for chicken broilers, depending on the their growth phase without affecting growth performance, slaughter yield and carcass quality. Research made by Waibel et al (1992) showed that canola type rapeseed meal can be used in diets for growing and finishing of turkeys broiler at a rate of 20%, without influencing the final weight of broilers and feed recovery, respectively.

Using canola-type rapeseed meal in chicken and turkeys broiler diet is limited by its low caloric value compared to other protein sources (Mierliță 2014). Thus, in order to ensure high specific energy level in broilers it is necessary to use large amounts of fodder specific fat which implies additional costs for the farmers.

Research conducted were designed to verify to what extent soybean meal in turkey broiler chickens can be partially replaced with rapeseed meals free of erucic acid and glucosides (canola rapeseed type "00"), watching the effect of this important alternative protein source on production performance, carcass quality and fatty acid profile of intramuscular fat.

Material and Method. The experiment was conducted as a completely randomized experimental design consisting of four treatments, which involve a control diet consisting of corn – soy meals (LC) and three experimental diets (E_1, E_2 and E_3, respectively) to which the proteins from the soy meals were replaced with rapeseed meal free of erucic acid and glucosides. This alternative source of protein in the diet of turkey broilers was included in the structure of combined fodder at a rate of 10% (in the case of group E_1), 15% (in the case of group E_2) and 20% (in the case of E_3), respectively (Table 1). Soybean meal proteins were substituted by rape meals as follows: up to 37% (stage 0-3 weeks), 40% (stage 3-9 weeks), 46% (stage 9-12 weeks), 58% (stage 12-15 weeks) and 74% (after 15 weeks to slaughter).

Table 1

Experimental desing

Group	*Treatment*	*Targets*
LC	Soybean meal	✓ Effect of rape meal on the main indices of production and consumption (weight gain, feed use);
E_1	Rape meal – 10%	✓ Effect of rape meal on the main slaughter indices and carcass quality (yield at slaughter, the share of main parts cut out of the carcass);
E_2	Rape meal – 15%	✓ Effect of rape meal on the structure of intramuscular fat into fatty acids.
E_3	Rape meal – 20%	

In our experiment we used rapeseed meals, resulted after oil extraction from variety Helga rapeseed by cold pressing, improved in Germany and farmed in the specific climatic conditions of western Romania. All diets were formulated to contain similar levels of metabolizable energy, raw protein and limiting amino acids (lysine and methionine + cystine), thus providing specific nutritional requirements of the hybrid.

A total of 36 broiler turkeys (Grade Maker hybrid, imported from Austria), male, aged one day were divided randomly into four lots. The dynamics of body weight was based on individual weighing of (one day) broilers from each lot when populating and during growth period, *i.e.* at age 3, 6, 12 and 18 weeks, respectively, when the experiments for productive purposes would haven been concluded. Fodder was given *ad libitum*; the amount of feed consumed was determined by means of weighting for each of the broilers group and for each growth period (0-3, 3-6, 6-12, and 12-18 weeks respectively).

At 18 weeks and in order to assess the quantitative and qualitative indicators of meat production, seven broilers from each lot were sacrificed, eliminating minus lot variants. At the time of such slaughter for control purposes we determined the carcass weight, internal organ mass, slaughter yield, the weight of the main parts chopped out from the carcass, the weight of trans-abdominal fat carcass structure specific fat.

Given the weight but especially the place and role of fats in preserving the human consumer health, we determined the fatty acid profile of intramuscular fat in the breast (n = 4/group), as a comparison between the control group and the lot that achieved the best bio-performance amongst the three experimental groups. The lipids of the tissue samples were extracted by means of a chloroform/methanol mixture (2:1, vol./vol.). Fatty acid methyl esters (FAME) were obtained using the procedure described by Watkins et al (1997). FAME were analyzed using a HP 5890 Series II gas chromatograph equipped with a DB23 column (30 m, 0.53 mm i.d., 0.5 μm film thickness). The identification of fatty acids as methyl esters was done by comparison of their retention times with standards and with FAME obtained from fish oil.

Testing the significance of the differences between groups was made by applying ANOVA testing (Pallant 2007). Differences were declared as being significant at $p<0.05$.

Results and Discussion. From the analysis of data on the evolution of body mass of turkeys broilers as shown in Table 2, one may assess that substituting soy meal protein with rapeseed meal does not have a significant impact on the amount and dynamics of turkeys broiler body weight, provided that the share of rapeseed meals in combined fodder structure does not exceed 15% (in the cases of groups E_1 and E_2). Increasing the share of rapeseed meals in fodder structure above 15% (% by weight of the feed) has a negative impact on weight gain, reducing significantly ($p<0.05$) the average body weight of the turkey broilers at slaughter age (in the case of group E_3).

Table 2

The effect of partial substitution of soybean grits with rape meal on turkey broiler weight gain

Age	*Group*			
	LC	*E_1*	*E_2*	*E_3*
	X ± sx	*X ± sx*	*X ± sx*	*X ± sx*
a) Evolution of body weight				
1 day (g)	50.7 ± 0.02	50.4 ± 0.02	51.2 ± 0.01	50.8 ± 0.03
3 week (g)	691.8 ± 0.31	676.4 ± 0.37	645.6 ± 0.51	604.4 ± 0.57*
6 week (kg)	2.70 ± 0.11	2.62 ± 0.05	2.57 ± 0.07	2.54 ± 0.11*
12 week (kg)	9.27 ± 0.20	9.15 ± 0.19	8.97 ± 0.16	8.80 ± 0.17**
18 week (kg)	19.87 ± 0.28	19.17 ± 0.54	18.75 ± 0.39	18.21 ± 0.45**
b) Average daily gain (g/day)				
0-3 week	30.52	29.81	28.28	26.33
3-6 week	95.79	92.62	91.91	92.38
6-12 week	156.43	155.40	152.31	149.05
12-18 week	252.29	238.62	232.81	223.95
Average	157.29	151.78	148.41	144.12

LC – Control; E_1 – 10% rape meal; E_2 – 15% rape meal; E_3 – 20% rape meal.
* $p<0.05$; ** $p<0.01$.

Similar aspects are found from the data collected on the average body weight daily gain. Throughout the growth period, compared to the control group which had an average gain of 157.29 g/day, experimental groups achieved slightly lower weight increases, with values ranging between 151.78 g/day in group E_1 and 144.12 g/day in group E_3. Placing rapeseed meals in large proportions in turkey broilers diet (20% - in the case of group E_3) had a negative influence on both feed intake and on the degree of food recovery (Table 3, Figure 1). Thus, the daily feed intake in relation to the whole experimental period, decreased by up to 3.7% in lots where rapeseed meals was inserted in food compared to LC group. Moreover the average consumption of fodder for achieving a kilo in weight based on the entire growth period (0-18 weeks) was almost equal to that registered in the control group in the cases of the experimental groups E_1 and E_2 where the rapeseed meals represented more than 15% of mixed food structure and increased by 4.58% when rapeseed meals accounted for 20% of the structure of combined fodder (in the case of group E_3).

Table 3

The effect of partial substitution of soybean grits with rape meal on feed consumption

Group	g feed/day/bird				Average
	0-3 week	3-6 week	6-12 week	12-18 week	(0-18 week)
LC	46.1	162.3	364.0	788.7	419.0
E_1	45.7	159.5	368.0	768.8	413.1
E_2	45.3	159.8	364.9	763.4	410.3
E_3	43.1	162.4	361.7	739.9	401.5

LC – Control; E_1 – 10% rape meal; E_2 – 15% rape meal; E_3 – 20% rape meal.

Placing rapeseed meals type "00" in the structure of combined fodder for phased diet of turkey broilers, at a rate of up to 15% (% by weight of the feed) is recommended without negative effects on weight gain, the consumption and degree of food recovery. Increasing the share of rapeseed in food to 20% (in the case of group E_3) has significantly reduced ($p<0.01$) the final weight of broilers and feed intake, and increased consumption of combined fodder for one kilo gain in weight.

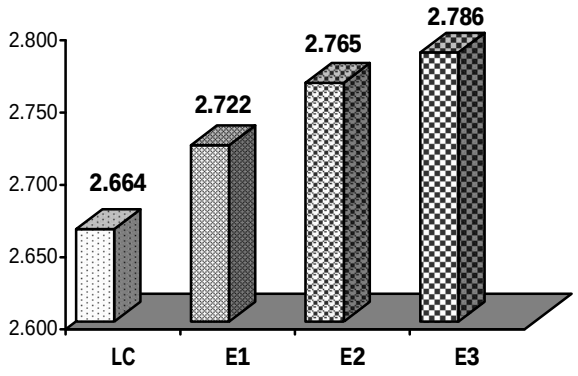

Figure 1. The effects of rape meal on the feed conversion ratio.

Most studies published in the international literature mention that placing rapeseed meals in broilers diet in the amount of up to 150 g/kg does not affect growth performance and feed recovery if the diet is balanced in terms of amino acids content (Teixeira & Dos 1995; Olver & Jonker 1997; Roth-Maier & Paulicks 2003; Farahat et al 2013), considering that the amount of lysine and sulphur amino acids in rapeseed meals is only 70-80% of that found in soybean meals (Waldroup et al 1998; Rost 2005). Placing rapeseed meals in the diet of chicken broilers in shares >25% reduces their production performance (Noll et al 2002; Roth-Maier & Paulicks 2003; Steenfeldt et al 2003; Rost 2005; Meng et al

2006), the negative influence is caused by the large amount of NSPs (nonstarch polysaccharides), amino acid imbalance in protein and low energy value.

The outcomes of control slaughter carried out at the end of the growing period are shown in Table 4. The data for analyzed indicator show generally only statistically generated differences in broilers from the group E_3, in which food it was introduced the highest share of rapeseed meals. The highest values of the slaughter indices analyzed are recorded in control group (LC). These results lead to the conclusion that rapeseed meal can be placed in the structure of compound fodder for turkey broilers phased diet purposes at rate of up to 15% while the higher shares have a negative influence on carcass characteristics. Thus, considering the LC group, carcass yield was lower by 1.11 percentage points (72.47% vs. 71.36%) in broilers of E_3, the differences being generated statistically ($p<0.05$).

Table 4

The impact of partial substitution of soybean grits with rape meal on main indices of slaughter and carcass quality of turkeys broiler (n = 7)

Parameter	Group			
	LC	E_1	E_2	E_3
	$X \pm sx$	$X \pm sx$	$X \pm sx$	$X \pm sx$
a) Evolution of the main indicators of slaughterhouse				
The weight (kg)	19.38 ± 0.34	19.07 ± 0.61	18.81 ± 0.54	18.17 ± 0.74*
Carcass weight (kg)	14.05 ± 0.21	13.81 ± 0.43	13.53 ± 0.76	12.96 ± 0.61*
The yield of the casing (%)	72.47 ± 0.57	72.44 ± 0.67	71.97 ± 0.81	71.36 ± 0.69*
Edible offal (heart, gizzard, liver) (%)[1]	1.91 ± 0.11	1.88 ± 0.09	1.91 ± 0.14	1.84 ± 0.11*
Commercial yield (%)	74.38 ± 0.62	74.32 ± 0.59	73.88 ± 0.47	73.20 ± 0.71
b) Share the trans main housing (% of carcass weight)				
Chest (%)	37.08 ± 2.05	35.68 ± 0.9*	35.60 ± 1.17*	33.74 ± 0.78**
Chicken drumsticks (%)	17.59 ± 0.67	17.11 ± 0.4*	17.77 ± 0.82*	16.14 ± 1.07*
Thighs (%)	12.70 ± 0.39	12.30 ± 0.48	12.21 ± 0.91	11.94 ± 0.83
Wings (%)	10.93 ± 0.27	10.76 ± 0.60	10.64 ± 0.37	10.51 ± 0.49
Fat deposit[2]	2.24 ± 0.11	2.59 ± 0.14	2.72 ± 0.22	3.18 ± 0.23*

LC – Control; E_1 – 10% rape meal; E_2 – 15% rape meal; E_3 – 20% rape meal.
* $p<0.05$; ** $p<0.01$; [1] % of live weight; [2] – intraabdominal fat and fat adherence gizzard.

Placing rapeseed meals in turkey broilers diet had a negative impact on carcass quality, resulted in reducing the share of parts with high economic value in the carcass structure. Thus, compared with the control group, in the turkeys from experimental groups there was a linear decrease directly proportional to the share of rapeseed meals in broilers diet of the breast and drumsticks shell in the carcass structure with values of up to 3.34 ($p<0.01$) and 1.45 respectively ($p<0.05$) percentage points. Breast meat, in most countries, is the most valuable part of the carcass obtained after slaughtering turkey broilers, providing approx. 60-70% of income from carcass selling. Therefore, both increasing the weight of the breast in the carcass structure and improving its quality, mainly by increasing the proportion of polyunsaturated fatty acids from fat structure represent research priorities in this area (Kocher et al 2000; Steenfeldt et al 2003; Farahat et al 2013; Mierliță & Popovici 2013). In this context it is surprising that despite the economic importance of breast meat, most research tends to focus on maximizing fodder conversion rate. The proportion of fat deposited in the carcass (intra-abdominal fat and gizzard fat) was significantly higher in turkeys receiving the highest proportion of rapeseed meals (20% rapeseed meals), and correlated negatively with growth rate which shows a slight imbalance of food nutrients. This suggests that lower bioavailability and biological value of the proteins in experimental compound fodder did not allow a proper protein synthesis in body according to the genetic potential, which would have been reflected in a high share of the breast in the carcass structure. Thus a surplus of energy emerged and that energy was stored in the body as fat (Rost 2005; Mierliță 2014).

The findings of our study are consistent with the findings reported by Egorov et al (2001) and Marcu (2005), which showed that the best results were obtained when rapeseed males were within 15% of the diet structure for chicken broilers. Similar studies reaching to the same conclusions were carried out by Roth-Maier & Paulicks (2003) and Suchý at al (2010). Suchý et al (2010) reported that by replacing soybean nitrogen at a rate of up to two thirds does not affect the breast and thigh muscles content in terms of protein and fat, but the content of crude ash increases only in the breast.

For economic purposes, the quality of sanogenous fat in breast and the fatty acid profile were determined only for comparison purposes between the control group and the experimental group where the best production performance was achieved (*i.e.* group E_2 - 15% rapeseed meal in food structure). The analysis was focus only on intramuscular fat in the breast. Placing rapeseed meals in turkey broilers resulted in a decrease in the proportion of saturated fatty acids (SFA) ($p<0.05$) and monounsaturated fatty acids (MUFA) in the structure of breast muscles fat and an increase in the share of polyunsaturated fatty acids (PUFA) ($p<0.05$) (Table 5).

Table 5

Effect of rape meal on the structure of intramuscular fat into fatty acids

Parameters	*Group*	
	LC	*E_2 (15% rape meal)*
Crude fat (%)	2.85	3.29
Lauric, C12:0	0.620	0.969*
Miristic, C14:0	0.721	0.732
Pentadecanoic, C15:0	0.199	0.178
Palmitic, C16:0	36.534	34.562*
Stearic, C18:0	9.094	9.032
Total SFA	47.168	45.473*
Palmitoleic, C16:1	8.037	7.573
Oleic C18:1 n-9	19.019	18.224
Trans-vaccenic C18:1 t-11	0.375	0.337
Eicosenoic, C20:1 n-9	0.446	0.523
Total MUFA	27.877	26.627
Linoleic, C18:2 n-6	6.322	7.886*
Arachidonic, C20:4 n-6	8.588	9.037
Total PUFA n-6	14.910	16.923*
Linolenic, C18:3 n-3	2.789	3.072*
Eicosadienoic, C20:5	1.071	1.205
Eicosatrienoic, C22:5	1.953	2.336*
Docosapentaenoic, C22:6	1.726	1.818
Total PUFA n-3	7.539	8.431*
Total PUFA (n-3 + n-6)	22.449	25.354*
Unidentified fatty acids	2.506	2.516
PUFA n-6/n-3	1.978	2.007

SFA = Saturated fatty acids; MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids; LC –Control; E_2 – 15% rape meal. * $p<0.05$;

Among the SFA, the sharpest decrease was found for palmitic acid, and in the case MUFA, the largest decrease was found for palmitoleic acid and oleic acid, which are the most important fatty acids in this group.

In PUFA, the most important and analyzed acid in terms of impact on consumer health is the α-linolenic acid (C18:3 n-3). Placing rapeseed meals in turkey broilers diet caused an increase in the share of both fatty acids n-6 series and n-3 series in the breast intramuscular fat structure, which equates to an improvement in their nutritional quality.

Rapeseed meals are characterized by a high content of protein, yet they have a high fat content of high quality and, and a high content of polyunsaturated fatty acids,

especially linoleic and α-linolenic acids (Mierliță 2014). The high content of fatty acids from n-3 series and the favourable n-3/n-6 fatty acids ratio allow the use of rapeseed meals in the diet of animals for strengthening eco-sanogenous quality of food of animal origin.

Increasing the share of n-3 polyunsaturated fatty acids in breast meat, following the introduction of rapeseed meals in turkey broilers is particularly beneficial for the human consumer health, and the nutritional qualities of turkey meat are improved. Supplementing the turkey broilers diet with rapeseed meals resulted in a decreased weight of saturated fatty acids with high atherogenic potential (C14:0, C16:0, C18:0) in the breast intramuscular fat and an increased weight of n-3 polyunsaturated fatty acids (α-linolenic acid in particular), thus enhancing the nutritional quality of turkey meat, analyzed in terms of impact on human health. Marcu (2005) showed that the placing rapeseed cake in the chicken broilers diet resulted in an increased concentration of oleic and α-linolenic acids in chicken fat.

Conclusions. Substituting soy protein in the meals of turkey broilers by placing rapeseed meals free of free of erucic acid and glucosides in the structure of compound fodder at a rate of up to 15% (% by weight) has no negative effect on both the weight gain and food recovery degree, but it lowers the quality of carcass by reducing the breast share in carcass overall structure. A significant decrease ($p<0.05$) of production performance was shown in the case of the broilers from the lot E_3 where rapeseed meals were placed in the structure of combined fodder at a rate of 20%. This presence of rapeseed meals in turkey broilers diet caused a decrease in the proportion of saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA) in the structure of breast muscles fat and an increase in the share of polyunsaturated fatty acids (PUFA) and in particular those of Omega 3 series, which equates to an improvement in the nutritional quality of turkey meat analyzed in terms of impact on human consumer health.

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References

Baidoo S. K., Aherne F. X., Mitaru B. N., Blair R., 1987 Canola meal as a protein supplement for growing-finishing pig. Anim Feed Sci Technol 18:37-44.

Ciurescu G. C., Grosu D. V., Moldovan I., Vasile A., 2003 Efectele substituirii srotului de soia cu full fat soia, srot sau seminte de rapita canola asupra performantelor productive ale puilor de carne. Proccedings of the IBNA Symposium, pp. 139-147.

Egorov I. A., Chesnokova N. Y., Takunov I. P., 2001 Feed value of lupin for broiler chickens and laying hens. Kormoproizvodstvo 1:28-30.

Farahat M., Hassanein S., Abdel-Razik W., Noll S., 2013 Effect of dietary corn dried distillers grains with solubles, canola meal, and chloride on electrolyte balance, growth performance, and litter moisture of growing turkeys. Poult Sci 92:1254–1265.

Karunajewa H., Ijagbuji E. G., Reece R. L., 1990 Effect of dietary levels of rapeseed meal and polyethyleneglycol on the performance of male broiler. Br Poult Sci 31:545-555.

Kocher A., Choct M., Hughes R. J., Broz J., 2000 Effect of food enzymes on utilisation of lupin carbohydrates by broilers. Br Poult Sci 41:75-82.

Marcu N., 2005 Raport cercetare: Studiul eficientei cultivarii si utilizarii in furajare a unor soiuri de rapita libere de glucozizi si acid erucic. USAMV Cluj-Napoca, Romania, 40 pp.

Marcu N., Rotar I., Vidican R., Gherman M., 2002 The establish of productive performance to a new rape variety Helga. Bulletin USAMV - CN, Romania 57:229.

Meng X., Slominski B. A., Campbell L. D., Guenter W., Jones O., 2006 The use of enzyme technology for improved energy utilization from full-fat oilseeds. Part I: Canola Seed. Poult Sci 85:1025–1030.
Mierliță D., 2014 The effect of replacement of soybean meal with lupine seed on digestion and bioconvesion of food in turkeys. Analele Universitatii din Oradea, Fascicula: Ecotoxicologie, Zootehnie si Tehnologii de industrie alimentara, XIIIB:307-314.
Mierliță D., Popovici D., 2013 Effect of partial substitution of soybean meal with lupine seeds on growth and economic efficiency of broilers. Lucrari Stiintifice - Seria Zootehnie 59:60-65.
Noll S. L., Stangeland V., Speers G., Parsons C., Brannon J., 2002 Utilization of canola meal and distiller grains with solubles in market turkey diets. Poult Sci 81(Suppl.1):92.
Olver M. D., Jonker A., 1997 Effect of sweet, bitter and soaked micronised bitter lupins on broiler performance. Br Poult Sci 38(2):203-208.
Pallant J., 2007 SPSS Survival manual. Mc Graw Hill, Open University Press Aplicatii, http://www.allenandunwin.com/spss3/default.htm
Rost K. F., 2005 Canola meal in turkey diets. MSc Thesis. University of Minnesota, St. Paul, USA.
Roth-Maier D. A., Paulicks B. R., 2003 Feeding and nutritional value of sweet blue and yellow lupin seed (*Lupinus angustifolius* L., *Lupinus luteus* L.) for broiler chicks. Arch Geflügelk 67:175-178.
Salmon R. E., 1982 Canola meal and fish meal in turkey starter diets. Poult Sci 61:2126-2128.
Steenfeldt S., Gonzalez E., Knudsen K. E. B., 2003 Effects of inclusion with blue lupins (*Lupinus angustifolius*) in broiler diets and enzyme supplementation on production performance, digestibility and dietary AME content. Anim Feed Sci Technol 110(1-4):185-200.
Stefansson B., Hougen F., Downey R., 1961 Note on the isolation of rape plants with seed oil free from erucic acid. Can J Plant Sci 41:218-219.
Suchý P., Straková E., Herzig I., Steinhauser L., Vopálenský J., Kroupa L., 2010 Effect of replacing soybean meal with lupin seed-based meal in chicken diet on performance, carcass value and meat quality. Acta Vet Brno 79:195-202.
Teixeira A. S., Dos R., 1995 Replacement of soyabeans by lupins (*Lupinus luteus*) in the feeding of broiler fowls. Rev Portug Ciênc Veter 90:20-28.
Waldroup P. W., England J. A., Kidd M. T., Kerr B. J., 1998 Dietary arginine and lysine in large white toms. Increasing arginine: lysine ratios does not improve performance when lysine levels are adequate. Poult Sci 77:1364-1370.
Waibel P. E., Noll S. L., Hoffbeck S., Vickers Z. M., Salmon R. E., 1992 Canola meal in diets for market turkeys. Poult Sci 71:1059–1066.
Watkins B. A., Shen C-L., McMurtry J. P., Xu H., Bain S. D., Allen K. G. D., Seifert M. F., 1997 Dietary lipids modulate bone prostaglandin E_2 production, insulin-like growth factor-I concentration and formation rate in chicks. J Nutr 127:1084-1091.

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Author:
Daniel Mierliță, University of Oradea, Department of Animal Science, Romania, Oradea, 410087, Universității Street 1, e-mail: dadi.mierlita@yahoo.com

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