Scientific Papers. Series D. Animal Science. Vol. LX, 2017
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

EFFECTS OF THE USE OF HIGH-PROTEIN RAPESEED FEED ON LAYING PRODUCTIVITY AND EGG QUALITY IN JAPANESE QUAILS

Svetlana GRIGOROVA[1], Sabka SURDJIISKA[1], Natasha GJORGOVSKA[2]

[1]Institute of Animal Science, Spirka Pochivka, 2232 Kostinbrod, Bulgaria
[2]Institute of Animal Science, Ss Cyril and Methodius University in Skopje, 92a Ilinden Blvd, 1000 Skopje, Macedonia

Corresponding author email: inst.stoc.gjorgovska@gmail.com

Abstract

The objective of this scientific paper is to establish the chemical composition and the nutritive value of a high-protein rapeseed feed produced in Bulgaria, and to study the possibilities for replacing soybean meal with this product in the diet of Japanese quails. Chemical composition of the tested product was determined, and the following results regarding its contents were obtained: crude protein – 42.50%, crude fibers – 8.50%, crude fats – 3.50%, lysine – 2.24%, methyonine – 0.85%, tryptophan – 0.51%, threonine – 1.81%, glucosinolates – 11.2 μmol/g. An experiment was performed with a total of 200 female Japanese quails from Pharaoh breed, 8 weeks old, randomly divided in four groups – a control and three experimental groups, 50 quails in each. The poultry from the control group received diet with soybean meal as the basic protein component, while in the experimental groups a part of the soybean meal was substituted with 5%, 10% and 15% of the tested product (for experimental groups I, II and III, respectively). All diets were equal by their nutritional value. During the experiment the feed consumption, laying capacity and health condition were monitored every day. Eggs morphological characteristics and their taste were controlled periodical. In experimental groups I and II, where 5% and 10%, respectively, of high-protein rapeseed product was included in the quail's diets, laying capacity and laying intensity were significantly higher than in the control group (P<0.05). The addition of 5%, 10% or 15% of the tested product didn't have negative influence on the egg weight, the eggshell strength, the yolk or the albumen colour, or the boiled eggs' taste and smell. The examined diets with inclusion of 5%, 10% and 15% of high-protein rapeseed product, according to the results obtained in this experiment, are recommendable for use in the practice.

Key words: *rapeseed product, quail, laying productivity, egg quality.*

INTRODUCTION

The protein problem on a world scale demands new sources of protein to be looked for. Many countries in Europe and Asia, as well as Canada, increased their production of protein, by extending the areas where various cultures are grown – beans, canola and other, in order to reduce the dependence of their animal husbandry on the import of expensive protein feed, like soybean meal (Naseem et al., 2006; Wickramasuriya et al., 2015). Around 90% of the byproducts obtained in the processing of rapeseed into oil, appertain to the rapeseed extraction meal (REM). The industrial extraction of oil generates rapeseed meal as a byproduct, which can be acquired by producers at a low price (Moraes et al., 2015). In some countries like Germany, Poland, the Czech Republic and others, REM is in the second place as a protein component in compound feeds, only behind the soybean meal. Rapeseed meal is a good source of protein with high contents of amino acids lysine, methyonine, cysteine, tryptophan and threonine (Min et al., 2009). By the contents of sulphur-containing amino acids and threonine, rapeseed meal excels soybean meal. In the inclusion of rapeseed extraction meal in compound feeds, especially those intended for poultry and pigs, its following properties must be taken into account:

– REM has lower content of crude protein (36%) compared to soybean meal (Wickramasuriya et al., 2015);
– The content of crude fibers in REM is two times higher (12%) than in soybean meal (Jia et al., 2012);
– REM contains antinutritive factors (glucosinolates, sinapine, pentosanes, erucic acid, cellulose, chemicellulose), which are the cause for reducing the nutrients' digestibility and the

metabolizable energy level (Bell, 1993; Dale, 1996; Khajali and Slominski, 2012).

In the past few decades, the scientific and research work of selectors, technologists and nutrition experts has been oriented towards improvement of the nutritive value of rapeseed and its products (Slominski et al. 2011). Via selection, a reduction of glucosinolate content has been achieved, from 80–120 µmol/g to 5–25 µmol/g (the so-called 00 sorts have been created, with low contents of erucic acid and glucosinolates). The goal of rapeseed's technological processing is to partially or completely remove the husk which contains a large amount of antinutritive factors, and this way to improve the nutritive value of rapeseed feeds.

The purpose of this study was to characterize the chemical composition and nutritional value of the high protein rapeseed feed produced in Bulgaria based on rapeseed meal; to establish the possibilities of replacing soybean meal with this product in compound feed for laying Japanese quails (*Coturnix coturnix japonica*);to investigate the influence of three different levels (5%, 10% and 15%) of the product on laying productivity and egg quality in order to determine its optimal dose for the practice.

MATERIALS AND METHODS

The subject of the current research is examination of the high-protein rapeseed feed *Rapro,* manufactured according to the technology worked out by the scientific-research and production team of the company Bonmix EOOD, from Lovech, Bulgaria, a product registered in Europe and Canada.

This technology employs deagglomerative processes for decomposition of meal's agglomerates. For this purpose machines are used that prevent the husk's cellulose layer to be torn into small pieces.

This way a mixture of cellulose, protein and cellulose-protein particles is obtained. Then, these particles are separated by achieving granulometric dimensions suitable for rough sorting and their classification according to the parameters absolute weight and mass density.

The following properties of the tested product *Rapro* were determined: total chemical composition (according to the conventional Weende analysis); the contents of Ca and P (according to AOAC, 2007); the contents of amino acids lysine, methyonine, cysteine, threonine, tryptophan (by amino analyzer *Perkin-Elmer*); the content of linoleic acid (by gas chromatograph); the content of glucosinolates (by spectrophotometer).

In Table 1 are shown the chemical compositions of *Rapro*, rapeseed meal and soybean meal.

Table 1 Chemical composition of *Rapro*, Rapeseed meal and soybean meal

Items	*Rapro*	Rapeseed meal	Soybean meal
Moisture,%	12	11	11
Metabolizableenergy, hens, kcal/kg	1810	1794	2200
Crude protein, %	42.5	36.0	44.0
Crude fiber,%	8.50	12.8	6.30
Crude fat,%	3.50	2.50	1.50
Lysine, %	2.24	2.12	2.75
Methionine,%	0.85	0.72	0.62
Methionine +Cysteine,%	1.88	1.58	1.25
Threonine,%	1.81	1.55	1.73
Tryptophan,%	0.51	0.44	0.60
Crude Ash,%	6.50	6.80	6.30
Calcium,%	0.63	0.66	0.20
Phosphorus, total, %	1.00	0.92	0.65
Phosphorus, available,%	0.17	0.27	0.24
Linoleic acid,%	1.60	0.80	0.70
Nitrogen free extracts,%	27.0	30.9	28.5

The present study was conducted in the period October–December 2014 in the quail farm of the company Gary–2 Ltd., Etropole, Bulgaria. An experiment was carried out with a total of 200 female Japanese quails (56 days old) from Pharaoh breed. The poultry were randomly divided into four groups – one control and three experimental groups, 50 quails in each group. The quails from all the groups were housed on the second floor of a five-floor cell battery, on a 16 hours lighting schedule, at 21–24°C air temperature and 70–85% relative humidity. Water was supplied via nipple drinkers. The trial lasted 76 days, 16 days - a preparatory period, and 60 days- an experimental period. In Table 2 are presented ingredient and chemical composition of the compound feed for each group. The diet for the control group didn't contain the product *Rapro*, its basic protein component being the soybean meal. In the compound feeds for the experimental groups a part of the soya meal was substituted with 5%, 10% and 15% of Rapro (for I, II and III experimental groups, respectively). The diets for all the groups were equal by their nutritional composition and adjusted to the specific needs of laying Japanese quails.

Table 2 Ingredient and chemical composition of compound feeds for laying Japanese quails from control and experimental groups

Groups / Components, %	CG	I EG	II EG	III EG
Maize	30.844	44.795	43.165	42.223
Wheat	27.831	12.282	13.000	13.000
Soybean meal, 44%	31.129	27.724	23.215	18.754
Rapro, 42%	-	5.000	10.000	15.000
Sunflower oil	1.000	1.000	1.489	1.956
L- lysine	0.086	0.110	0.138	0.165
DL-methionine	0.167	0.148	0.114	0.081
Limestone	7.570	7.483	7.432	7.380
Monocalcium phosphate	0.742	0.822	0.814	0.810
Vitamin premix 15C for layers	0.200	0.200	0.200	0.200
Choline chloride	0.050	0.050	0.050	0.050
Salt	0.260	0.265	0.262	0.260
Bonzyme W-P	0.100	0.100	0.100	0.100
Ronozyme P 5000	0.009	0.009	0.009	0.009
Oxigard	0.012	0.012	0.012	0.012
Total:	**100**	**100**	**100**	**100**
Chemical composition				
Metabolizable energy,kcal/kg	2800	2800	2800	2800
Crude protein, %	20.30	20.30	20.30	20.30
Lysine, %	1.150	1.150	1.150	1.150
Methionine + Cysteine, %	0.780	0.780	0.780	0.780
Tryptophan, %	0.239	0.229	0.228	0.226
Threonine, %	0.688	0.708	0.717	0.727
Calcium, %	3.220	3.220	3.220	3.220
Phosphorus, available, %	0.410	0.410	0.410	0.410

CG –control group
EG – experimental group

During the experiment, on daily basis, the following parameters were controlled: laying capacity (in egg number /group), laying intensity (in percent/group), and the mortality (in quail number).

Also, the feed intake and feed conversion were calculated for each group.

At the beginning, in the middle and at the end of the experiment, 20 eggs from each group were submitted to the following measurements: egg's weight and eggshell's weight (using an electronic scale OHAUS 2000 with the tolerance of 0.01 g); eggshell thickness (in millimeters) without the shell membrane (using a micrometer Amer 25 EE); shape index (calculated according to the formula: Small diameter / Large diameter × 100); yolk colour (according to the 15-grade Roche scale). Albumen colour was determined visually, as well as the presence of blood stains or others not typical inclusions in the yolk and in the albumen.

Twenty boiled eggs from each dietary group laid at the end of the experiment were evaluated organoleptically by a panel of 10 semi-trained judges on an eight point hedonic scale in terms of colour, flavor, taste, smell, odor, texture and overall acceptability. The taste and the smell of the boiled eggs were evaluated while the eggs were still warm.

The results are presented as mean values with their standard errors. Statistical analysis of *Rapro's* effects on the egg production and eggs' morphological characteristics was performed using Excel 200, Single factor, Anova program.

RESULTS AND DISCUSSIONS

In Table 1 are shown the results of the chemical analysis of the tested high-protein rapeseed product *Rapro*. The table also contains data on the chemical composition of both rapeseed and soybean meal, thus giving the opportunity for making comparative analysis of all the three nutrients. The metabolizable energy is the highest in the soybean meal (2200 kcal/kg), the lowest in the rapeseed meal (1794 kcal/kg), while *Rapro*'s metabolizable energy is 1,810 kcal/kg. The content of crude protein in *Rapro* is higher (42.50%) than in rapeseed meal (36%), being very close to the level of crude protein in soybean meal (44%). Rapeseed meal has higher content of crude fibers (12.80%) than the soybean meal (6.30%), while as a result of the employed technical processing, the content of crude fibers in *Rapro* is reduced to 8.50%. Rapeseed meal and *Rapro* have lower contents of the amino acid lysine (2.12% and 2.24%, respectively), at the same time having higher contents of the sulphur-containing amino acids (methyonine and cysteine) than the soybean meal which contains 2.75% lysine and 1.25% methyonine + cysteine. *Rapro* has two times higher content of linoleic acid (1.60%) than rapeseed (0.80%) and soybean meal (0.70%). The content of glucosinolates in *Rapro* is 11.20 μmol/g.

In Table 3 are presented the laying capacity (in egg number/week/group), for the period between 11 and 18 weeks' age of the quails; the laying intensity (in percent). The highest amount of eggs (287) was obtained in experimental group II where *Rapro*'s share in the feed was 10%, and the lowest amount (249) in experimental III group where *Rapro*'s share was 15%, the difference between the latter group and the control group being statistically insignificant (P>0.05).

Table 3 Weekly egg intensity and egg capacity of quail layers from control and experimental groups

Groups / Age,week	CG	I EG	II EG	III EG
Laying capacity, eggs'number/week				
11	266	272	281	256
12	259	260	288	257
13	256	281	293	259
14	270	274	302	252
15	261	279	291	252
16	255	279	285	235
17	263	277	282	238
18	235	286	277	246
Average	258 ± 10.59 a. b	276 ± 7.75 a	287 ± 7.95 b	249 ± 8.91
Laying intensity, %/week				
11	76.0	77.7	80.3	74.6
12	74.0	74.3	83.9	74.9
13	73.1	80.3	87.2	75.5
14	78.7	78.3	86.3	73.5
15	76.1	79.7	87.5	73.5
16	74.3	79.7	86.6	68.5
17	78.3	79.1	85.7	70.8
18	69.9	81.7	86.0	73.2
Average	75.1 ± 2.88 a. b	78.9 ± 2.21a	85.4 ± 2.35 b	73.1 ± 2.33

a, b – values in the same row with no common superscript differ significantly (P<0.05).

Similar results were obtained regarding laying intensity. The poultry receiving diet with 5% and 10% *Rapro* havesignificantly higher laying intensity (P<0.05) than the control group. The laying intensity of the group receiving 15% *Rapro* in the diet is the lowest (73.10%), but the difference between this value and that of the control group is statistically insignificant (P>0.05).

During the whole experimental period, the poultry from all the groups consumed the diets willingly. The results about feed intake, feed conversion and mortality of the quails from control and experimental groups are presented in Table 4. The daily feed intake per quail was 29.60 g, 30.50 g, 30.40 g and 29.20 g (for the control group, I, II and III experimental groups, respectively), which proves that all the diets used in this experiment had equally good taste. The feed conversion was the best in the group receiving 10% of *Rapro* in the diet (experimental group II), where 37.10 g of forage were spent for obtaining one egg. The next best result (38.60 g) was achieved in experimental group I, receiving 5% of *Rapro*. In the control group and the group with 15% content of *Rapro* in the diet (experimental group III) these values are much closer (40.26 and 41.10, respectively). In the whole period of the experiment the poultry were in good health, very lively, and with good looks and feathering. The number of dead poultry during the whole experiment was 2 for control group, 0 for I experimental group, 2 for II experimental group and 2 for III experimental group. The analysis of the results obtained justifies the dosage of 10% of *Rapro* in the diets to be designated as the optimal one. These results are similar with the results obtained by other researchers who made experiments with rapeseed meal in laying hens (Sommers et al., 1988) and in Japanese quails (Elangovan et al., 2001; Hameed et al., 2002).

Table 4. Feed intake and mortality of the quails from control and experimental groups

Groups / Items	CG	I EG	II EG	III EG
Total eggs number	2203	2368	2454	2131
Feed intake during the whole experimental period, kg	88,700	91,500	91,200	87,500
Feed intake/quail /day, g	29.60	30.50	30.40	29.20
Feed intake per one egg, g	40.26	38.6	37.1	41.1
Mortality, quails' number	2	0	2	2

Data about eggs' morphological characteristics are given in Table 5. Non significant difference was found between the groups regarding eggs' weight at the beginning, in the middle and at the end of the experiment. On the average, in all the groups, it is a higher in the end of the experiment, which is a normal occurrence related with the advance of quails' age. For the eggs' quality of big importance is the eggshell thickness. The percentage of *Rapro* used in the experimental diets had no influence on this parameter which was 0.192 mm at the beginning, 0.197 mm in the middle and 0.201 mm at the end of the experiment, in all the experimental groups). The ratio eggshell mass/egg mass, which is an indicator of the eggshell's strength, was 9.70% at the beginning, 10.25% in the middle, and 10.10% at the end of the experiment, taken on average for all the groups, and no problems regarding eggshell's strength were noticed.

Table 5 Morphological characteristics and organoleptic properties of the quails' eggs from control and experimental groups (X±SE)

Items \ Groups	CG	I EG	II EG	III EG
At the beginning of experiment				
Egg weight, g	11.19±0.27	11.30±0.17	11.51±0.38	11.16±0.19
Eggshell weight, g	1.12±0.03	1.07±0.02	1.11±0.03	1.10±0.03
Eggshell weight in % of the egg weight	10.00±0.78	9.47±0.69	9.64±0.72	9.68±0.76
Eggshell thickness, mm	0.193±0.003	0.197±0.001	0.195±0.003	0.187±0.003
Shape index, %	76.93±1.02	79.28±0.68	79.69±1.18	78.20±0.83
Yolk colour, Roche's scale	1.73±0.18	1.67±0.16	2.13±0.29	1.53±0.17
Taste and smell of boiled eggs	Normal Typical	Normal Typical	Normal Typical	Normal Typical
In the middle of experiment				
Egg weight, g	11.04±0.27	11.27±0.25	11.10±0.30	11.27±0.36
Eggshell weight, g	1.11±0.03	1.14±0.02	1.17±0.03	1.16±0.04
Eggshell weight in % of the egg weight	10.10±0.73	10.10±0.70	10.50±0.74	10.30±0.79
Eggshell thickness, mm	0.197±0.003	0.199±0.003	0.195±0.003	0.196±0.003
Shape index, %	77.61±0.73	78.99±0.88	78.77±0.97	76.79±0.90
Yolk colour, Roche 's scale	3.73±0.18	3.20±0.30	3.80±0.26	3.66±0.19
Taste and smell of boiled eggs	Normal Typical	Normal Typical	Normal Typical	Normal Typical
At the end of experiment				
Egg weight, g	11.60±0.27	11.77±0.26	11.89±0.28	11.31±0.23
Eggshell weight, g	1.20±0.04	1.17±0.03	1.17±0.03	1.17±0.05
Eggshell weight in % of the egg weight	10.30±0.74	9.94±0.72	9.84±0.76	10.30±0.79
Eggshell thickness, mm	0.206±0.003	0.199±0.003	0.200±0.004	0.200±0.004
Shape index, %	75.71±2.47	78.31±0.69	77.73±0.65	77.54±0.69
Yolk colour, Roche 's scale	2.87±0.32	3.40±0.50	3.72±0.32	3.47±0.32
Taste and smell of boiled eggs	Normal Typical	Normal Typical	Normal Typical	Normal Typical

Similar results were reported by Moraes et al. (2015) who investigated the influence of different amounts of rapeseed meal in the diet of laying Japanese quails on morphological characteristics of eggs. The amount of *Rapro* in the feed mixtures had no negative influence on yolk and albumen colour. The eggs from all the groups did not have any blood stains and other not typical inclusions. In the degustation of the boiled eggs no unspecific, unpleasant or side smell or taste were found, in any of the groups.

CONCLUSIONS

The high-protein product *Rapro*, tested in this study, contains 1,810 kcal/kg metabolizable energy, 42.50% CP, 8.50% crude fibers, 3.50% crude fats, 2.24% lysine, 1.88% methyonine + cysteine, 1.81% threonine, 0.51% tryptophan, 1.60% linoleic acid, 11.20 μmol/g glucosinolates. As a result of the technological processing employed, the content of crude fibers in Rapro was reduced whereas the contents of ME and CP were increased compared with those in the initial rapeseed meal, which way Rapro's digestibility and nutritive value were improved.

In the cases where Rapro's share in the diet given to laying Japanese quails was 5% or 10%, the laying intensity was significantly higher ($P<0.05$) in relation to the control group. In the group receiving 15% of *Rapro* in the diet, the laying intensity was close to that in the control group.

In all the experimental groups (i.e. regardless whether Rapro's share in the compound feeds was 5%, 10% or 15%), feed intake and feed conversion were very close to those in the control group.

The inclusion of Raproin the diets for Japanese quails in the dosage up to 15% has no negative influence on egg weight, eggshell strength, shape index, yolk colour, and boiled eggs' smell and taste. The tested product *Rapro* can partially replace soybean meal in the compound feeds for laying Japanese quails. The optimum dosage of *Rapro* is 10%, and the maximum is 15%. So, the examined diets for Japanese quails with the inclusion of 5%, 10% or 15% of *Rapro*, are recommendable for use in the practice.

ACKNOWLEDGEMENTS

The authors are grateful to Bonmix Ltd, Company, Lovech, Bulgaria for supplying the product *Rapro* and the compound feeds, used in the present research.

REFERENCES

Bell J.M., 1993. Factors affecting the nutritional value of canola meal: A review. Can. J. Anim. Sci., 73:679-697.

Dale N., 1996. Variation in feed ingredient quality: Oilseed meals. Animal Feed Science and Technology, 59(1-3):129-135.

Elangovan A.V., Verma S.V.S., Sastry V.R.B., Singh S.D., 2001. Effect of Feeding High Glucosinolate Rapeseed Meal to Laying Japanese Quail. Asian-Australian Journal of Animal Science, 14(9):1304-1307.

Hameed S., Ahmad N., Rabbani M., 2002. Effect of replacing Dietary levels of soybean meal with canola meal in Japanese quail. International Journal of Agriculture and Biology, 4(3):389-391.

Jia W., Mikulski D, Rogiewicz A, Zdunczyk Z, Jankowski J, Slominski B.., 2012. Low-fiber Canola (2) nutritivevalue of the meal. Journal of Agricultural and Food Chemistry, 60(50):12231–12237.

Khajali F., Slominski B.A., 2012. Factors that affect the nutritive value of canola meal for poultry. Poultry Science, 91(10):2564-2575.

Min Y.N., A. Hancock, F. Yan, C. Lu, C. Coto, A. Karimi, J.H. Park, F.Z. Liu, P.W. Waldroup, 2009. Use of combinations of canola meal and distilers dried grains with solubles in broiler. Journal of Applied Poultry Research, 18(4):725-733.

Moraes P.O., Gopinger E., Catalin A.A., De Castro M.L.S., Elias M.C., Xavier E.G., 2015. Effect of feeding canola meal to laying Japanese quails. Acta Scientiarum Animal Science, 37(3):295-299.

Nassem M.Z., Uhan S.N., Yousat M., 2006. Effect of feeding various levels of canola meal on the performance ofbroiler chicks. Journal of Animal and Plant Sciences, 16 (3-4):78-81.

Slominski, B.A., Jia W., Mikulski D., Rogiewicz A., Jankowski J., Rakow G., Jones R.O., Hickling D., 2011. Chemical composition and nutritive value of low-fiber yellow-seeded *B. napus* and *B. juncea* canola for poultry. In Proceeding of 16th International Rapeseed Congress, Prague, 443-445.

Summers J.D., Bedford M., Spratt D., 1988. Aminoacid supplementation of canola meal. Canadian Journal of Animal Science, 69:469-475

Wickramasuriya S.S., Yi Y.J., Yoo J., Kang N.K., Heo J.M., 2015. A review of canola meal as an alternative feed ingredient for ducks.Journal of Animal Science and Technology, 57:38.

WPSA, 1989. European table of energy values for poultry feedstuffs, 3rd edition.