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Biochemical and mineral blood indices in fattening pigs fed mixtures containing yellow lupine *(Lupinus luteus)*

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Thirty crossbred pigs [♀ (Landrace x Yorkshire) x ♂ Duroc] were fattened in a three-stage fattening period. Soybean extraction meal (Group K) or soybean extraction meal with seeds of yellow lupine in the amount of 7.5% (Group D1) or 15% (Group D2) were used as a source of protein in their diet. The animals were slaughtered after reaching a body weight of about 117.5 kg. Blood samples were collected from all pigs at this time. Activity of ALP, AST and ALT and the level of TP, GLU, CHOL, HDL, TG, CREA, UREA, Ca, P, Mg, and Fe were determined in order to assess the impact of the dietary factor on the homeostasis and health of the animals. The values of all biochemical and mineral blood indicators were lower in the experimental groups (D1 and D2) than in the control. Most of these differences were statistically significant (P≤0.05 and P≤0.01). The values of the characteristics were within the reference limits for the species. The dietary factor had no negative effect on homeostasis in the animals.

KEY WORDS: fatteners / yellow lupine / blood indices

When using domestic legumes in compound feeds for monogastric animals it seems advisable to monitor the health condition of the animals. This is because these feed materials contain various anti-nutrient substances which may have a negative impact on animals, manifested as disturbances of homeostasis and a reduction in production results [2, 3, 5, 15].

A significant element of monitoring of internal parameters is determination of the effect of the raw materials used in feed on the level of biochemical and mineral indicators in the blood of the animals. The use of legume seeds in compound feed for poultry and pigs [1, 6, 17] has shown that a nutritional advantage of certain legumes is their hypocholesterolaemic effect [6, 7, 9, 11, 12]. This is most likely the effect of reduced absorption of cholesterol from the gastrointestinal tract due to greater reabsorption of bile acids, which reduces the solubility of cholesterol [6]. The results of research on blood lipid levels in

poultry, pigs and hamsters are unfortunately neither unidirectional nor unambiguous [3, 17]. It seemed that research on model animals would offer a broader look at the problem of using legumes in the diet, but these results also proved to be varied [7, 8, 11, 13, 15].

Genetic gains in breeding and improved quality of plant material, as well as the implementation of new technology for processing legume seeds, have changed the nutritional value and usefulness of various species and cultivars, so that it has become possible to increase their share in compound feeds [16]. Breeding work on animals has resulted in changes in their breeding value, as well as better production effects. In view of these changes and the various opinions on the suitability of legumes in feeding monogastric animals presented in one of our previous studies [14], a study was undertaken to determine the effect of partial replacement of soybean extraction meal with yellow lupine meal in compound feeds for pigs on their biochemical and mineral blood indices.

Material and methods

Experimental fattening was conducted on 30 crossbred gilts and young boars [♀ (Landrace x Yorkshire) x ♂ Duroc] with body weight ranging from 27.2 kg to 117.5 kg. The animals were divided into three groups, a control (K) and two experimental groups (D1 and D2), with 10 pigs in each group (1:1 sex ratio), and placed in separate pens. Housing conditions were the same for all groups [10]. During the three-stage fattening period the pigs received *ad libitum* total mixed rations with continual access to water, as described in a study by Sońta et al. [14]. In the control group the only source of protein was soybean extraction meal, while the experimental groups D1 and D2 additionally received yellow lupine in the amount of 7.5% and 15%, respectively, partially replacing the soybean meal. After completion of the fattening period the growth rate and feed conversion rate were determined for each stage of fattening, and carcass parameters were determined after slaughter [14].

Blood was collected from the vena cava cranialis of all pigs at the time of slaughter. The blood was centrifuged (10 min, 3500 rpm) and the serum obtained was frozen (–20ºC) until analysis. The analyses were conducted with a Cormay Accent 200 biochemical analyser. We used Cormay multicalibrator level 1, HP and HN sera, and reagents. The following were determined: activity of alkaline phosphatase (ALP), aspartico-aminotransferase (ASPAT), and alanine-aminotransferase (ALAT), and content of albumin (ALB), total protein (TP), glucose (GLU), total cholesterol (CHOL), HDL cholesterol (HDL), triglycerides (TG), creatinine (CREA), urea (UREA), and the elements calcium (Ca), phosphorus (P), magnesium (Mg) and iron (Fe).

Statistical analysis of the results was performed using the IBM SPSS Statistics 21 package. Differences between groups were tested by the Kruskal-Wallis test.

Results and discussion

Juśkiewicz et al. [4] report that the alkaloids contained in lupine seeds reduce feed intake and stimulate metabolism in the gastrointestinal tract of rats and piglets. In high concentrations they can have a negative effect on production results and on animal health [2, 5].

In the present study, the use of yellow lupine in the feed produced very good fattening and carcass results in the animals. No statistical differences were noted between the control and experimental groups (Tab. 1).

Table 1
Mean values for selected blood indices

Specification	Groups			*P*-value
	control (K)	experimental 1 (D1)	experimental 2 (D2)	
Mean body weight at start of fattening (kg)	27.2	27.7	26.7	0.946
Mean body weight of fatteners at slaughter (kg)	117.6	118.2	116.6	0.964
Daily weight gain during fattening (g)	1056	1075	1081	0.850
Fed consumption per 1 kg of weight gain (kg/kg)	2.72	2.72	2.69	0.068
Meatiness (%)	58.8	59.4	59.2	0.858

It was therefore hypothesized that biochemical and mineral blood indices would be similar in the experimental and control groups. However, the values for all indices tested proved to be higher in the control (K) than in experimental groups D1 and D2 (Tab. 2). Some of them were within the range of reference values (including ALP, CREA and UREA), and in some cases deviations were noted only in certain groups (e.g. ASPAT, ALAT, ALB, TP and Ca) [18]. In the case of certain indices the differences between group K and groups D1 and D2 were statistically significant or highly significant (Tab. 2). In the blood of the pigs in groups D1 and D2 the level of ALP was lower than in group K by 13.8% and 14.9%, respectively. ASPAT activity was lower in groups D1 and D2 by 36.8% and 37.8%, and ALAT activity was 16.5% and 31.1% lower. The ALB level was lower by 11.4% and 7.7%, TP by 12.6% and 20.3%, GLU by 23.2% and 21.5%, CHOL by 23.9% and 39.4%, and TG by 26.7% and 21.9%. The level of HDL was high in group K, but 26.7% and 40.9% lower in groups D1 and D2. The highest CREA concentration was noted in group K, and it was 10.2% and 17.0% lower in groups D1 and D2, respectively. The UREA level was lower in groups D1 and D2 than in group K, by 13.0% and 15.4%, respectively. As compared to the control the Ca level was lower in groups D1 and D2 by 12.2% and 14.3%, P by 17.6% and 25.6%, and Fe by 16.2% and 6.7%, while Mg was 21.7% lower in group D1 than in the control (Tab. 2).

Table 2
Biochemical and mineral blood indices

Specification	Units	Groups			*P*-value
		control (K)	experimental 1 (D1)	experimental 2 (D1)	
Alkaline phosphatase (ALP)	U/l	127.4	109.8	108.4	0.210
Aspartico-aminotransferase (ASPAT)	U/l	79.90	50.50	49.67	0.205
Alanine-aminotransferase (ALAT)	U/l	61.10^{A}	51.00^{Ba}	42.11^{Bb}	0.001
Albumin (ALB)	g/l	32.6	28.9	30.1	0.075
Total protein (TP)	g/l	59.5^{A}	52.0	47.4^{B}	0.011
Glucose (GLU)	mmol/l	11.46^{a}	8.80^{b}	9.00^{b}	0.007
Cholesterol (CHOL)	mmol/l	2.26^{A}	1.72^{B}	1.37^{B}	0.001
HDL-cholesterol (HDL)	mmol/l	0.908^{A}	0.666^{B}	0.537^{B}	0.001
Triglycerides (TG)	mmol/l	0.626^{a}	0.459^{b}	0.489^{ab}	0.008
Creatinine (CREA)	µmol/l	124.4^{a}	111.7^{ab}	103.2^{b}	0.020
Urea (UREA)	mmol/l	6.54^{a}	5.69^{b}	5.53^{b}	0.029
Calcium (Ca)	mmol/l	2.45^{a}	2.15^{b}	2.10^{b}	0.029
Phosphorus (P)	mmol/l	3.01^{aA}	2.48^{b}	2.24^{B}	0.001
Magnesium (Mg)	mmol/l	0.97^{a}	0.76^{b}	b.d.	0.014
Iron	µmol/l	22.91	19.20	21.37	0.411

b.d. – no data
a, b – means in rows with different lower-case letters differ significantly at P≤0.05
A, B – means in rows with different capital letters differ significantly at P≤0.01

After using lupine seeds in feed rations for pigs, Zralý et al. [19] noted increased levels of TP, ALB, GLU, TG, CHOL, HDL and ASPAT activity, and a decrease in ALAT and ALP activity and in concentrations of Ca and P. In another study by the same authors [20], following the use of white lupine seeds an increase was noted in the plasma level of TP, ALB, TG, CHOL, HDL, Ca and P and in ALP activity. A decrease was observed in GLU and in ALAT and ASPAT activity as well; the results differed somewhat from those obtained in the previous experiment [19]. The results of studies on pigs, rats and poultry [3, 6, 15, 17], as well as the results of the present study, indicate a different trend in lipid indicators in the experimental and control groups as compared to the results of the experiments by Zralý et al. [19, 20]. In the present study, in which yellow lupine was used in the diet of fattening pigs, significantly lower ($P \leq 0.05$) content of CHOL and HDL was noted in the animals in groups D1 and D2, as compared to group K, and lower ($P \leq 0.05$) content of TG in group D1 as compared to K. Following the use of lupine in compound feeds for pigs [6] and broiler chickens [17], a decrease in cholesterol, its LDL fraction and triglycerides was observed, which can be considered beneficial in terms of health. The results of a study by Fontanari et al. [3] also indicate a hypocholesterolaemic effect of legume seeds. Using white lupine (seeds or isolate) in hamster feed, the authors noted a decrease in the level of total cholesterol and an increase in HDL cholesterol. Moreover, the diet containing the isolate caused a reduction in the level of triglycerides, while the diet with seeds caused an increase in this biochemical indicator with respect to the control [3]. In a dietary experiment on rats using three varieties of narrow-leafed lupine, Stanek et al. [15] noted an increase in the level of glucose and triglycerides and a decrease in ALAT activity in the experimental groups as compared to the control. The authors reported no differences in cholesterol content between groups. The greatest reduction in alanine-aminotransferase activity (ALAT) was noted in the groups receiving the lupine varieties containing the most alkaloids, while activity levels of aspartico-aminotransferase (ASPAT) were similar [15]. Comparison of the results of the study with reference data [18] indicates a slight reduction in the level of ALB, TP and TG in the experimental groups D1 and D2 and of Mg in group D1, while levels slightly above the references values were noted for GLU (groups K, D1 and D2), CHOL (group K), ALAT activity (groups K and D1) and ASPAT activity (group K). The reduction in the values of some blood indices in the experimental pigs in relation to the control had no negative effect on the health of the animals, as no negative changes were observed in production parameters in these groups [14, 18]. The small decrease in TP would suggest a slightly impaired protein absorption, but no decline in growth rate was observed in the pigs in the experimental groups as compared to the control. The available literature does not reveal such a clear trend of changes in biochemical and mineral blood indicators in pigs receiving legume seeds in their feed [16, 19, 20].

The values for all biochemical and mineral blood indicators tested were lower in the experimental groups D1 and D2 than in the control. For most of the parameters statistically significant differences were confirmed. The production results and the biochemical and mineral blood indicators indicate that the dietary factor had no negative effect on homeostasis in the animals.

REFERENCES

1. BIELECKA G., KOROL W., PUZIO I., 2006 – Wpływ nasion łubinu żółtego i rzepaku „00" na odchów oraz wybrane wskaźniki krwi kurcząt brojlerów. ***Medycyna Weterynaryjna*** 62 (4), 420-422.
2. DE CORTES-SANCHEZ M., ALTARES P., PEDROSA M.M., BURBANO C., CUADRADO C., GOYOAGA C., MUZQUIZ M., JIMÉNEZ-MARTINEZ C., DÁVILA-ORTIZ G., 2005 – Alkaloid variation during germination in different lupin species. ***Food Chemistry*** 90 (3), 347-355.
3. FONTANARI G.G., BATISTUTI J.P., JOSÉ DA CRUZ R., SALDIVA P.H.N., ARÊAS J.A.G., 2012 – Cholesterol-lowering effect of whole lupin *(Lupinus albus)* seed and its protein isolate. ***Food Chemistry*** 132 (3), 1521-1526.
4. JUŚKIEWICZ J., GODYCKA-KŁOS I., MATUSEVICIUS P., ZDUŃCZYK Z., JUŚKIEWICZ M., 2006 – Influence of pea and lupin oligosaccharides on caecal short-chain fatty acids production and nitrogen excretion patterns in rate. ***Polish Journal of Food and Nutrition Sciences*** 15 (Suppl. 1), 77-82.
5. MAKNICKIENE Z., ASAKAVICIUTE R., BAKSIENE E., RAZUKAS A., 2013 – Alkaloid content variations in *Lupinus luteus* L. and *Lupinus angustifolius*. ***Archives of Biological Sciences. Belgrade*** 65 (1), 107-112.
6. MARTINS J.M., RIOTTOT M., DE ABREU M.C., VIEGAS-CRESPO A.M., LANÇA M.J., ALMEIDA J.A., FREIRE J.B., BENTO O.P., 2005 – Cholesterol-lowering effects of dietary blue lupin *(Lupinus angustifolius L.)* in intact and ileorectal anastomosed pigs. ***Journal of Lipid Research*** 46, 1539-1547.
7. MOUSA R.M.A., 2015 – Influence of Functional Sweet White Lupin Biscuits on Lipid Profile and Food Efficiency of Induced Hyperlipidemia Rats. ***Journal of Food Research*** 4 (3), 14-25.
8. OLKOWSKI B., 2001 – Ocena porównawcza wartości odżywczej białka nasion roślin strączkowych w badaniach na szczurach. ***Zeszyty Naukowe. Seria: Rolnictwo. Akademia Podlaska*** 59, 59-67.
9. RAHMAN M.H., 2005 – Hypocholesterolemic activity of lupin proteins – A serendipitous discovery. In: Optimized processes for preparing healthy and added value food ingredients from lupin kernels, the European protein-rich grain legume. Proceedings of the Final Conference of the European Project, Milan, 9-10 November 2005, pp. 199-202.
10. ROZPORZĄDZENIE MINISTRA ROLNICTWA I ROZWOJU WSI z dnia 15 lutego 2010 r. w sprawie wymagań i sposobu postępowania przy utrzymaniu gatunków zwierząt gospodarskich, dla których normy ochrony zostały określone w przepisach Unii Europejskiej. Dz.U. nr 56, poz. 344.
11. SIRTORI C.R., LOVATI M.R., MANZONI C., CASTIGLIONI S., DURANTI M., MAGNI C., MORANDI S., D'AGOSTINA A., ARNOLDI A., 2004 – Proteins of white lupin seed, a naturally isoflavone-poor legume, reduce cholesterolemia in rats and increase LDL receptor activity in HepG2 cells. ***Journal of Nutrition*** 134 (1), 18-23.
12. SIRTORI C.R, TRIOLO M., BOSISIO R., BONDIOLI A., CALABRESI L., DE VERGORI V., GOMARASCHI M., MOMBELLI G., PAZZUCCONI F., ZACHERL C., ARNOLDI A., 2012 – Hypocholesterolaemic effects of lupin protein and pea protein/fibre combinations in moderately hypercholesterolaemic individuals. ***British Journal of Nutrition*** 107 (8), 1176-1183.

13. SOBOTKA W., STANEK M., BOGUSZ J., MATUSEVICIUS P., 2013 – The effect of oligosaccharides and alkaloids contained in yellow and blue lupine seeds on feed intake, body weight and fermentation processes in the cecum of rats. ***Veterinarija ir Zootechnika*** 63 (85), 63-70.
14. SOŃTA M., REKIEL A., WIĘCEK J., 2016 – Efektywność tuczu świń mieszankami z udziałem łubinu żółtego. ***Roczniki Naukowe Polskiego Towarzystwa Zootechnicznego*** 12 (2), 9-18.
15. STANEK M., ROTKIEWICZ T., SOBOTKA W., BOGUSZ J., OTROCKA-DOMAGAŁA I., ROTKIEWICZ A., 2015 – The effect of alkaloids present in blue lupine (*Lupinus angustifolius*) seeds on the growth rate, selected biochemical blood indicators and histopathological changes in the liver of rats. ***Acta Veterinaria Brno*** 84, 55-62.
16. ŚWIĘCICKI W., SZUKAŁA J., MIKULSKI W., JERZAK M., 2007 – Możliwość zastąpienia białka śruty sojowej krajowymi surowcami. ***Zeszyty Problemowe Postępów Nauk Rolniczych*** 522, 515-521.
17. VIVEROS A., CENTENO C., ARIJA I,., BRENES A., 2007 – Cholesterol-Lowering Effects of Dietary Lupin (*Lupinus albus* var Multolupa) in Chicken Diets. ***Poultry Science*** 86, 2631-2638.
18. WINNICKA A., 2015 – Wartości referencyjne podstawowych badań laboratoryjnych w weterynarii. Wyd. SGGW, Warszawa.
19. ZRALÝ Z., PISARIKOVA B., TRČKOVÁ M., HERZIG I., JŮZL M., SIMEONOVOVÁ J., 2006 – Effect of lupine and amaranth on growth efficiency, health and carcass characteristics and meat quality of market pigs. ***Acta Veterinaria Brno*** 75, 363-372.
20. ZRALÝ Y., PISARIKOVA B., TRČKOVÁ M., HERZIG I., JŮZL M., SIMEONOVOVÁ J., 2007 – The effect of white lupine on the performance, health, carcass characteristics and meat quality of market pigs. ***Veterinarni Medicine*** 52, 29-41.