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STUDIES ON THE INFLUENCE OF THE USE OF WHITE LUPINE SEEDS IN THE DIET OF BROILERS ON MEAT QUALITY

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Abstract

Acest The objectives of this study were to determine the effect of the introduction of alkaloid-free white lupine grains in the feed of broiler chickens on slaughter rates, meat nutrient content and fatty acid profile of meat fat. A total of 200 broiler chickens belonging to the one-day-old commercial hybrid Ross 308 were divided into four groups (n = 50), which were randomly assigned to one of four treatments, consisting of four levels (0, 8, 16 and 20%) of introduction of white lupine grains into food: LC (control batch, 0% lupine); LE8 (8% lupine in food), LE16 (16% lupine in food) and LE24 (24% lupine in food). Replacement of soybean meal in chickpea feed with lupine grains did not affect the main slaughterhouse indices, carcass quality and weight of the breast and lower thighs in the carcass structure, if lupine grains do not exceed 16% in the combined feed structure (% by weight) . This nutritional solution, which aims to use alternative sources of protein in poultry feed, has led to an improvement in the quality of chicken fat (breast, thigh and intra-abdominal fat) due to a decrease in the proportion of saturated fatty acids and an increase in unsaturated fat. polyunsaturated considered a benefit for the health of the consumer. Thus, the highest proportion of polyunsaturated fatty acids (especially α-linolenic acid) was recorded in the meat of chickens that received in the feed 16% white lupine grains. The introduction of lupine grains in the feed of chicks in proportion of more than 16% had negative effects both on the productive performances and on the slaughterhouse indices and the pointing of the meat of superior quality in the carcass structure. The partial replacement of soybean meal with lupine in the feeding of broilers did not lead to significant changes in the chemical composition of the meat in the chest and thigh. The most important difference in chemical composition was recorded in terms of crude fat content, which increased in proportion to the increase in the proportion of white lupine in the structure of the food.

Key words: lupine seeds, broiler, diets, meat quality

INTRODUCTION

The nutrition and feeding of birds in our country is currently dependent on imports of soybean meal, which have a high protein content (42-46%) with a profile of essential amino acids that corresponds to the nutritional requirements of birds. In addition, banning the cultivation of genetically modified plants and limiting the use of genetically modified soy products and by-products requires the evaluation of new sources of protein with good biological value, which may be available locally and at the same time be economical. Thus, a promising alternative is alkaloid-free white lupine beans.

The introduction of lupine in proportions of up to 25% in the feed of broilers does not affect the growth performance and capitalization of the feed, nor the production and quality of meat obtained, compared to diets based on soybean meal (Egorov et al., 2001; ., 2010; Suchy et al., 2010; Mierliţă et al., 2014a; 2014b; 2014c). However Hejdysz et al. (2018) reported that lupine flour can be introduced into the feed of chicken broiler chickens in a maximum proportion of 30%, without affecting the bioproductieve performance, economic and meat quality, but soybean meal can not be completely eliminated from the chicken diet.

The results obtained by Mierlitţă et al. (2013a; 2013b) show that if broiler feed is well balanced in energy, protein and limiting amino acids, soybean meal can be replaced with white lupine grains in broiler feed, up to 30% in the feed phase. starter (1-21 days) and 60% in the growth phase (22-35 days) and finishing (36-42 days), without affecting the weight gain, the degree of capitalization of the food, the quality of the carcass and the meat. A negative influence ($p < 0.05$) was found when soybean meal was replaced with lupine in a proportion of 40% in the starter phase and 80% in the growth and finishing phase, respectively.

The use of lupine in the diet of chickens has led to an increase in the concentration of C18: 1 cis-9 (oleic acid - OA) and C18: 3 n-3 (α-linolenic acid - ALA) in chicken fat (Mieczkowska and Smulikowska, 2005; Strakova et al., 2010), which leads to a better nutritional quality of meat, which can be considered ″functional food″.

The introduction of white lupine in chicken broiler feed does not affect the meat's protein and fat content (Suchy et al., 2010), but it does improve the nutritional quality of fats due to the decrease in the share of saturated fatty acids with high atherogenic potential (C14:0, C16:0, C18:0) and increase the share of n-3 polyunsaturated fatty acids (especially ALA), positively influencing the ratio of omega-6/omega-3 fatty acids (Mierliţă, 2015; Șanta et al., 2022) .

The objectives of this study were to determine the effect of the introduction of alkaloid-free white lupine grains (Amiga variety) in the feed of broiler chickens on slaughter rates, meat nutrient content and fatty acid profile of meat fat.

MATERIAL AND METHOD

The experiment of productive effect took place over a period of 42 days, in production conditions at SC Rosbro Avicom SRL. A total of 200 broiler chickens belonging to the one-day-old commercial hybrid Ross 308 were divided into four groups (n = 50), which were randomly assigned to one of four treatments, consisting of four levels (0, 8, 16 and 20%) of introduction of white lupine grains into food: LC (control batch, 0% lupine);

LE8 (8% lupine in food), LE16 (16% lupine in food) and LE24 (24% lupine in food).

At the end of the experimental period (42 days), 10 chicks from each group (5 roosters + 5 chicks) were slaughtered, their average weight representing approximately the average weight of the chicks from that group. In order to assess the quality of meat production, the following were determined: slaughter yield, the share of regions with high economic value in the carcass structure, the raw chemical composition of the meat and the fatty acid profile of intramuscular and storage fat.

The chicks were weighed individually using an electronic scale, with a deviation of 5 g, after a diet of 4 hours (without water diet), after which they were slaughtered, in farm conditions. After plucking, they were harvested during the evisceration: the pipette (cleaned), the liver (without the gallbladder) and the heart (without blood clots) were wrapped in plastic wrap and then placed in the carcasses where they came from. The carcases and edible internal organs were weighed after a 24-hour refrigeration period. Based on them, the carcass yield and the commercial yield, respectively, were calculated as an expression of the percentage ratio between the weight of the refrigerated carcass together with the edible internal organs (heart, liver, pipette) and the live weight of the chicks.

The quality of the carcasses was assessed on the basis of the share of regions with high economic value in the carcass structure. Thus, the cutting of the resulting carcasses, after refrigeration, was done according to the established techniques, in the following component parts: chest (with bone and skin), thighs (thigh + leg). Intra-abdominal fat was also determined as an important parameter for assessing the quality of the carcasses. They were weighed and expressed as a percentage by weight of the refrigerated carcase.

The raw chemical composition of the meat was determined from samples (including adherent skin) collected from the chest and thigh region. Only the right half of the hull was used on the chest, and the right half on the bone was used on the thigh, the other half being stored at -20^{0}C to determine the fatty acid profile of intramuscular fat. Each determination was made in two repetitions. The chemical composition of the meat (breast and thigh) has been determined using established methods.

Given the weight, but especially the place and role of fat in maintaining the health of the consumer, the profile of fatty acids in intramuscular fat in the chest and thigh but also in intra-abdominal fat was established. The gas chromatographic method was used with three working steps: fat extraction, obtaining fatty acid methyl esters (FAME) followed by separation of methyl esters of fatty acids on the chromatographic column and identification of fatty acids using standards, based on retention times, using laboratory technique described by Mierliță (2015).

All recorded data were statistically processed in order to establish differences between treatments (batches). To test the homogeneity of the averages, the univariate and factorial ANOVA technique was used as the mathematical calculation model, and the "t" (Tukey) test was used to test the significance of the differences between the averages. The difference between the means of two samples was considered significant for $p < 0.05$.

RESULTS AND DISCUSSION

1. Yield at slaughter

The introduction of lupine grains into the feed of broiler chickens up to 16% (in the case of experimental groups LE8 and LE16), in general, did not affect the yield at slaughter. The introduction of lupine in the feed of broiler chickens in proportion of 24% (the case of experimental group LE24), compared to the control group (LC), but also with the groups in which lupine was introduced into food in smaller proportions (LE8 and LE16) led at a significant decrease in carcass efficiency (Table 1).

Table 1

Effect of lupine input in broilers feed related to slaughter yield

Specification	Groups			
	LC	**LE_8**	**LE_{16}**	**LE_{24}**
Average body weight (g/head)	2837.6 ± 36.4	2773.9 ± 29.8	2740.8 ± 35.2	2573.8 ± 32.1
Carcass weight after refrigeration (g)	2068.9 ± 27.5	2017.4 ± 32.7	1989.8 ± 46.2	1837.7 ± 30.1
Edible internal organs weight*	145.58 ± 5.15	144.24 ± 5.21	141.79 ± 5.19	140.27 ± 5.45
Carcass yield (%)	72.91 ± 0.88^a	72.43 ± 0.56^a	72.60 ± 0.91^a	71.40 ± 0.72^b
Commercial yield (%)	78.05 ± 0.74^a	77.93 ± 0.81^a	77.77 ± 0.68^a	76.85 ± 0.85^b

*heart + liver + pipette (cleaned and without adherent fat).

$^{a-b}$values in the same row that have different letters differ significantly ($p < 0.05$).

The presence of white lupine in the feed of broilers did not lead to a significant change in the weight of the internal edible organs.

The decrease in slaughter yield in chickens that received large amounts of lupine in food was also observed by King et al. (2000) and Van Nevel et al. (2000), being caused by a better development of the intestine, but also by the higher degree of its filling, determined by a higher content of crude cellulose in the food.

2. Carcasses quality

The introduction of lupine grains in the feed of broiler chicks up to 16% (in the case of experimental lots LE8 and LE16), in general, did not affect the share of regions with high economic value in the carcass structure, but the introduction of lupine in broiler chick feed in proportion of 24% (the case of the experimental group LE24), compared to the control group (LC), but also with the groups in which lupine was introduced in food in smaller proportions (LE8 and LE16) led to a significant decrease in the weight of the breast in the carcass structure ($p < 0.05$) (Table 2).

Table 2

Effect of lupine input in broilers feed related to carcass quality

Specification	**Groups**			
	LC	**LE_8**	**LE_{16}**	**LE_{24}**
Whole leg (thigh + drumstick): - g	623.15	612.08	601.52	546.90
- %	30.12	30.34	30.23	29.76
Breast (with bone and skin): - g	653.98	642.94	621.81	544.88
- %	31.61^{a}	31.87^{a}	31.25^{ab}	29.65^{b}
Intraabdominal fat*: - g	25.45	26.43	26.86	29.59
- %	1.23^{b}	1.31^{b}	1.35^{b}	1.61^{a}

*% of the weight of the refrigerated housing; a-bvalues in the same row that have different letters differ significantly ($p < 0.05$).

The results obtained by us are confirmed by previous research done by Suchý et al. (2006), who found that the introduction of white lupine grains in the diet of broiler chickens in a low proportion (8.7-15.5%) did not have a negative effect on the weight of the breast and leg in the carcass structure. Contrary to these results, Orda et al., (2006) concluded that the introduction of yellow lupine grains from modern genotypes without alkaloids in the feed of broiler chickens in proportion of 10% in the starter period (1-21 days) and 20% in the growth period (22-42 days) causes a significant decrease in the weight of the chest in the carcass structure ($p < 0.01$).

3. The chemical composition of the meat

The partial replacement of soybean meal with lupine in the feeding of broilers did not lead to significant changes in the chemical composition of the meat in the chest and thigh. The most important difference in chemical composition was recorded in terms of crude fat content, which increased in proportion to the increase in the proportion of white lupine in the structure of the food (Table 3).

The results obtained in this study are somewhat in line with the conclusions reported by Egorov et al. (2001) and Rothmaier and Paulicks (2003), who found that the best results were obtained when lupine was included in the feed of broiler chickens in a maximum proportion of 20%; The increase in the proportion of lupine in broiler feed to 25% has negatively affected both the bioproductive performance and the quality of the carcass and the chemical composition of the meat, by increasing the intramuscular fat deposits and in the form of intra-abdominal and subcutaneous deposits.

Table 3

Crude chemical composition of breast and thigh region meat (% of DM)*

Specification		LC	LE_8	LE_{16}	LE_{24}
Breast	Dry matter	28.31	28.81	28.34	28.55
	Crude protein	85.76	85.32	85.70	85.02
	Crude fat	8.31^b	8.77^b	8.21^b	9.84^a
	Crude ash	4.42	4.57	4.31	4.25
Thigh	Dry matter	27.18	27.58	27.14	27.33
	Crude protein	61.73	62.18	61.15	60.78
	Crude fat	25.18^b	26.14^b	26.39^b	30.42^a
	Crude ash	4.31	4.07	4.81	4.72

*n = 3; a-b values in the same row that have different letters differ significantly ($p < 0.05$).

4. Fatty acid profile of intramuscular and storage fats

For economic reasons, the fatty acid profile of intramuscular and storage fats was determined only in the case of chickens from the groups that achieved the best bioproductive and economic performance, respectively in chickens from the control group and those from the experimental group LE16 (with 16% lupine in food).

The share of polyunsaturated fatty acids (PUFA) in the structure of the analyzed fats (intramuscular fat in the chest and thigh and intra-abdominal fat) increased in the case of chickens in which lupine was introduced as an alternative source of protein, due to the fact that lupine grains in polyunsaturated fats (10.7% fat, of which 30.3% PUFA; Mierliță et al. (2018) (fig. 1).

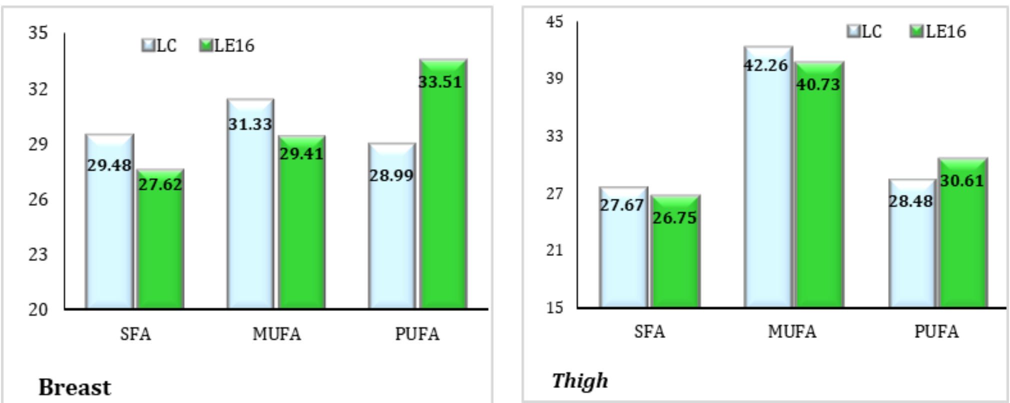

Fig. 1. Fatty acid profile of breast and thigh intramuscular fats (% of FAME)

Comparing the three analyzed regions, namely breast, thigh and intra-abdominal fat, the best fat quality given by a higher content of polyunsaturated fatty acids and lower saturated fatty acids was recorded in the breast meat in the case of chickens from experimental group LE16 in which some of the soybean meal was replaced with white lupine grains. Among the polyunsaturated fatty acids (PUFA) the best represented is linoleic acid (C18: 2, n-6), while the share of linolenic acid (C18: 3, n-3), considered deficient in the rational human diet (Blackberry, 2019) increased in the experimental group that received lupine grains as food, by 31.2% in the case of breast; by 13.8% in the case of the thigh and by 48.5% in the case of intra-abdominal fat (fig. 2).

In conclusion, the partial replacement of soybean meal with white lupine grains has led to an improvement in the fatty acid profile of carcass fats (breast, thigh and intra-abdominal fat) by increasing the share of polyunsaturated fatty acids to the detriment of saturated ones. Thus, the best quality of carcass fat, analyzed in terms of its influence on human health and defined by an increased proportion of PUFA and decreased by SFA, was recorded in the case of chickens from the experimental group LE16, in whose food lupine was introduced into proportion of 16%.

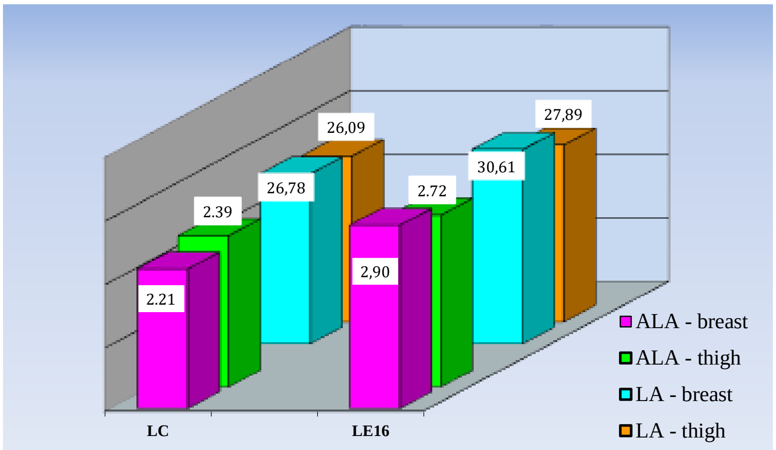

Fig. 2. PUFA structure of intramuscular fats (breast and thigh) (% of FAME)
(LA - linoleic acid; ALA - linolenic acid)

CONCLUSIONS

Replacement of soybean meal in chickpea feed with lupine grains did not affect the main slaughterhouse indices, carcass quality and weight of the breast and lower thighs in the carcass structure, if lupine grains do not exceed 16% in the combined feed structure (% by weight). This nutritional solution, which aims to use alternative sources of protein in poultry feed, has led to an improvement in the quality of chicken fat (breast, thigh and intra-abdominal fat) due to a decrease in the proportion of saturated fatty acids and an increase in unsaturated fat. polyunsaturated considered a benefit for the health of the consumer. Thus, the highest proportion of polyunsaturated fatty acids (especially α-linolenic acid) was recorded in the meat of chickens that received in the feed 16% white lupine grains. The introduction of lupine grains in the feed of chicks in proportion of more than 16% had negative effects both on the productive performances and on the slaughterhouse indices and the pointing of the meat of superior quality in the carcass structure. The partial replacement of soybean meal with lupine in the feeding of broilers did not lead to significant changes in the chemical composition of the meat in the chest and thigh. The most significant difference in chemical composition was recorded in terms of crude fat content, which increased in proportion to the increase in the proportion of white lupine in the structure of the food.

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