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EFFECT SOYBEAN HEAT TREATMENT ON BROILER SLAUGHTER TRAITS

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Abstract

The aim of this study was to determine the influence of the effect soybean dependence of heat treatment on the broiler carcass conformation, hybrid Ross – 308, which were reared separately by sex. The first group was fed with a standard diets for chickens, in which the entire amount of soybean in the mixture was extruded, and the second group was fed with the same diets but the soybean was raw (not extruded). The measured the weight of broilers at slaughter and the yield was processed carcasses (conventional processing, ready to roast, ready to grill), the proportion of: pancreas (target tissue), body parts (wings, drumsticks, legs, thigh, chest and back), abdominal fat and edible offal. The testing results showed that heat treatment had a significant and better effect on body weight, the carcass yield, "conventional processing", "ready to grill" and "ready to roast". Also visible is the effect of extrusion on the internal organs of chickens. The group that had consumed raw soybeans was observed pancreatic hypertrophy, an enlarged liver, heart and spleen. The group that had consumed heat treated soybeans was significantly greater amount of abdominal fat.

Key words: *heat treatment, soybean, broiler chickens, broiler carcasses, carcass parts*

Introduction

Soybean is the most used nutrient in the diet of broiler chickens to meet the needs of protein and essential amino acids. Full use of high quality vegetable protein in soybeans is only possible with the previous heat treatment, which significantly increases production costs. Therefore, in order to reduce the cost of many tests conducted on the possibility of the use of raw soybeans in the diet of poultry, from which it came to the realization that the main carriers of inhibitory activity of raw soybeans protease inhibitors, primarily: Kunitz trypsin inhibitor (Kunitz, 1945) and Bowman-Birk trypsin inhibitor (Bowman, 1944; Birk, 1961; Tseng Yen et al., 1977). Other factors taken into account the hem agglutinin or lectins (Douglas et al., 1999), and antivitamin, goitrogene and indigestible olygo-saharide (Parsons et al., 2000). However the inclusion of raw grain in the food does not only have a negative effect on the growth of chickens, but also leads to an increase in relative weight of digestive organs, particularly the pancreas (Gertler et al., 1966; Arija et al., 2006, Brenes et al., 2008), which the target organ, and the size and activity changes depending on the level of trypsin inhibitors. Efforts to increase the use of legumes led to the development of a wide range of method processing, including extrusion. This technology has numerous advantages, including the possibility of wide application, high productivity, energy efficiency and high quality of the resulting product (Brenes at al., 2008).

The aim of this study was to compare the effects of raw soybeans and extruded soybean on broiler slaughter traits.

Material and method

One-day old broiler chicks' male hybrids Ross-308 were measured and arranged in 16 boxes, with each box were 60 chickens. The average initial weight of chicks was equal and it was 42.5 + / - 7 g. The experiment included two groups with four replicates. The holding system has been the floor type, with a straw mat, and food and water were available ad libitum, with a light regime of 24 hours. Temperature and air circulation are controlled and regulated in accordance with the technology for hybrid Ross 308^{th}. Dead chickens are removed from pen daily and mortality was below 3%.

One-day old chicks hybrid Ross-308 are separated by gender method based on the length of cover and primary wing feathers.

Food and water were provided ad libitum, during the fattening period. At the end of the experiment, which lasted 42 days, were sacrificed by 32 individuals from each group. Before sacrificing chickens are starved twelve hours and weighed individually.

Table 1. Diet composition used in the experiment

Feedstuffs	Starter	Grower		Finisher	
Mixture type		Raw soybean	Heat treated soybean	Raw soybean	Heat treated soybean
Maize	51.77	53.65	53.35	56.56	55.36
Soybean meal	24.46	8.22	8.52	5.32	6.54
Raw soybean	-	30.00	-	30.00	-
Heat treated soybean	15.34	-	30.00	-	30.00
Yeast dry	4.00	4.00	4.00	4.00	4.00
Limestone	1.60	1.40	1.40	1.40	1.40
MCP	1.48	1.37	1.37	1.35	1.35
Salt	.35	.35	.36	.37	0.35
Premix	1.00	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.0	100.00

The chickens' diet was based on corn and soybeans. Starter mixture contained 23% CP and 12.65 MJ of metabolic energy and was used from 1st to 10th days. Starter mixture, where intake all chickens in the experiment and in it was included maize 51.77%, 24.46% full fat soybean meal, 15.34% soybean meal, 4% yeast, chalk, monocalcium phosphate, salt and premix. So this starter mixture contained 23% of crude protein and 12.60 MJ of metabolic energy. Experimental diet started from the tenth day, because raw soybean can't be successfully used in young chickens without heat treatment (Palacios et al., 2004). Experimental mixtures were grower and finisher, and differed in two groups. The mixtures used in the experiment were iso-energy and iso-protein. Chemical analysis of mixtures was made in Animal feed laboratory, Faculty of Agriculture in Novi Sad. Grower diet containing 22% of crude protein was used from 11th to 24th days, a paver with 21% of crude protein from 25th to 42th days. Mixtures consisting of maize, soybean meal, dried yeast, chalk, monocalcium phosphate, salt and premix. The experimental mixture included 30% soybean and to the treatments: 1) raw soybeans with 2) extruded. The levels of trypsin inhibitors in soybean are presented in Table 2.

Table 2. Levels of trypsin inhibitors in soybean

Group	*Raw soybean*	*Heat treated soybean*
TI (mg/g/min)	30.21	12.30

According to the Regulations on the quality of poultry meat („Službeni list SFRJ“, 1/81 and 51/88) yield was dressed carcasses (conventional tillage, ready to roast, grill ready), then cut the carcasses and the measurement of its parts: the head, neck, legs, wings, drumsticks, thighs, chest and back. Abdominal fat and edible offal were carefully separated and measured manually. Share of abdominal fat and edible offal is expressed as the ratio of their mass relative to weight prior to slaughter. The data were analyzed by statistical variation methods in the statistical package STATS 10th

Results and Discussion

Table 3 shows the final mass of chickens in the experiment, where it can be seen a significant difference $p < 0.001$ in the final mass. Chickens who have consumed the mixture that contained untreated soybeans have lower final mass that averaged 1253.8 g, worse slaughtering yield (79.80) versus group who have consumed the mixture with heat treated soybeans where the average final weight was 2486.3 g, and slaughtering yield 82.53%. Experiments conducted on rats (Friedman et al., 1991), chickens (Anderson - Hafermann et al., 1992; Douglas et al., 1999; Palacios et al., 2004), laying hens (Zhang et al., 1991) and pigs (Palacios et al., 2004) have shown that the inclusion of thermally treated soy in the diet has a significant effect on the lower body weight in relation to consumption of heat treated soybeans.

Table 3 The values of the final mass slaughter and conventional carcass processing depending on the treatment of soybeans in the mixture

	Heat treated soybean		Raw soybean	
	Mean	St . Dev.	Mean	St. Dev.
Body mass, g	2486.3[a]	176.90	1253.8[b]	187.29
Conventional processing, g	2049.4[a]	15.80	1000.1[b]	154.08
Conventional processing, %	82.53[a]	2.50	79.80[b]	3.67
Ready to roast, g	1835.2[a]	113.90	878.3[b]	146.64
Ready to roast, %	73.87[a]	1.70	69.93[b]	2.76
Ready to grill, g	1681.3[a]	93.60	764.69[b]	163.58
Ready to grill, %	67.71[a]	1.80	61.16[b]	9.04

a-b different letters in each row indicate statistically significant differences at the level of $p<0.01$

When it comes carcasses "ready to roast" and "ready to grill" it can also be concluded that there is significant disparities $p < 0.001$ between groups depending on whether the soybean was heat treated (73.87% ready to roast, and 67.71% ready to grill) or not (69.16% ready to roast, and 61.16% ready to grill).

Table 4. Shares of edible parts of carcass depending on the soy treatment in the mixture.

	Heat treated soybean		Raw soybean	
	Mean	St. Dev.	Avg.	Mean
Chest,%	31.71[a]	2.51	22.93[b]	1.99
Thighs, %	11.47[a]	0.73	12.76[b]	1.02
Drumstick, %	12.50[ns]	2.32	13.69[ns]	1.22
Wings, %	9.35[ns]	2.01	10.41[ns]	0.69
Back,%	19.28[ns]	1.93	19.26[ns]	1.34

a-b - different letters in each row indicate statistically significant differences at the level of $p<0.01$
ns - statistically non significant differences

Table 4, shows the portions of edible parts of chickens carcass depending on heat treatment of soybeans in a mixture for chicken. Percentage of breast and thigh of chickens that consumed the mixture with heat processed soybeans was 31.71% respectively 11.47% which is statistically highly significant ($p <0.01$) as compared to 22.93% respectively 12.76%, what was noted in the group whose mixture contained heat untreated soybean. Considering the drumsticks, there is evidence of a higher percentage in the group that consumed the heat untreated soybeans (13.69%). The same trend was also noted for the wings where the group who consumed raw soybeans, where the share of wings was 10.41%, as opposed to the group that consumed the heat-treated soybean where the share was 9.35% lower. Considering the back, there are almost no differences; the average share of the back of the chickens that consumed the mixture with heat treated soybeans was 19.28% and 19.26% for chicken with the mixture of heat untreated soybean. There is no significant difference between the groups in terms of drumsticks, wings and back.

A high percentage of the share breasts in the group that consumed the heat treated soybeans can be explained by a sufficient quantity of proteins that chickens adopted during the growth, what is not the case for the group where the heat treated soybeans were used. Where is due to the presence of anti-nutritive factors in the first place of the proteases, proteins adoption was difficult or impossible.

Considering the drumsticks, which, according to Table 4, have a larger share in the group on raw soybeans than in the group that has been on heat treated soybeans, the explanation lies in the fact that in terms of relative weight ratio (compared to conventional treatment), noting that the mass after conventional treatment of chickens was half less in the group that consumed a meal without heat treatment.

Table 5 shows the percentage share of the internal organs in relation to the final weight of chickens, where it can seen a significant difference in the percentage of pancreas between the groups of chickens who has used heat treated soybean (0.24%) respectively the group that has used a mixture of soybeans, without heat treatment (0.51%). If the relative weight of the pancreas of the chickens who have consumed raw soybeans reflect on the relative weight of the pancreas of chickens who have consumed heat treated soybeans, it comes to the value of more than 212% increase of the pancreas.

Table 5 Shares of edible parts of carcass depending on the soybeans treatment in the mixture.

	Heat treated soybean		Raw soybean	
	Mean	St. Dev.	Mean	St. Dev.
Pancreas,%	0.24 [a]	0.01	0.51 [b]	0.17
Liver,%	0.21 [a]	0.22	0.75 [b]	0.51
Spleen, %	0.12 [A]	0.03	0.15 [B]	0.04
Heart, %	0.51 [a]	0.05	0.61 [b]	0.08
Gizzard, %	1.38 [a]	0.17	0.95 [b]	0.44
Abdominal fat, %	1.04 [a]	0.33	0.76 [b]	0.28
Gizzard fat, %	0.36[ns]	0.14	0.43[ns]	0.12

a-b - different letters in each row indicate statistically significant differences at the level of $p<0.01$
A-B - different letters in each row indicate statistically significant differences at the level of $p<0.05$
ns – statistically non significant differences

The increase can be attributed to the pancreatic effects of trypsin inhibitors and lectins. Inactivation of free trypsin in the intestine stimulates the release of cholecystokinin from neuroendocrine cells in the intestine, thus leading to hyper-secretion of pancreatic digestive enzymes and subsequent enlarge of the pancreas (Lacourse at al., 1999). Cholecystokinin regulates the growth of pancreatic enzyme secretion and contraction of gall bladder (Rehfeld, 1998).

Changes in secretions affect the digestive structure and function, particularly disorders in the digestion and absorption, changes in the passages of content, increase microbial activity in the small intestine and the entire increase in the digestive tract and related organs (Hoerr, 1998). Hypertrophy of the pancreas was detected in chickens and rats in the food that added pure extract of soybean trypsin inhibritor (Gertler et al., 1966), chickens fed raw velvet beans (*Phaseolus vulgaris L.var. Pinto*) (Arija et al., 2006), raw chickpea (Cicero arietinum L.) (Brenes et al., 2008) and smooth beans (Mucuna pruriens) (Carew et al., 2003.; Tuleun and Igba, 2008). The effect of these raw legumes on the mass of the pancreas is probably the result of a well-known presence in the grain anti-trypsin factors that interfere with normal function pancreas enzymes, thus forcing the pancreas to enhanced work (Carew et al., 2003).

It is also evident and statistically significant $p <0.001$ the enlargement of the liver, heart and gizzards of the chickens who have been fed with raw soybeans. Carew et al. (2003) have also observed a significantly higher relative heart weight of chickens and found that this increase may represent an additional burden that can lead to stress and disease. Observed increase in relative liver weight could be attributed to mobilization of body reserves in order to bear all expenses the need for rapid growth of certain organs which can lead to increase of the liver and cause hypertrophy and poor nutritional status of chickens who have been fed with raw soybeans (Arija et al., 2006; Carew et al., 2003).

In Table 3 it can be seen that there is significant increased $p <0.005$ in relative spleen weight of chickens whose meal contained raw soybeans. In the study of (Arija et al., 2006; Brenes et al., 2008) extrusion caused the increase in relative spleen weight.

Considering the abdominal fat, it was significantly lower $p <0.001$ the relative weight of chickens who have been fed with raw soybean. While in relative weight fat of the gizzards there is no significant differences in relative masses. This is explained with the lack of nutritional status chickens due to the presence of anti-nutritive factors (Arija et al., 2006).

Conclusion

Based on all the above facts, it can be concluded that the omission of heat treatment soybeans in the mixtures for chickens due to the presence of thermolabile anti-nutritional factors have a negative impact on the final weight and slaughter yield as well as in the conventional process of "ready to roast" or "ready to grill".

Reduction of the breast share, in the group where heat untreated soybeans have been used, is the consequence of the absence of the heat treatment.

Considering the internal organs and deposited fat, it can be concluded and it can be confirmed by many previous studies that heat untreated soybeans causes the hypertrophy of pancreatic due to presence of the trypsin inhibitor as well as some other anti-nutritive factors. It is evident the increase in the weight of liver, heart and gizzard as a result of nutritional status and stress of the chickens who have been fed with raw soybeans.

Significant reduction in abdominal fat in the group that have been fed with raw soybeans is also a direct result of poor nutritional status of the lack of heat treatment of soybeans.

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