

# THE EFFECT OF RAW SOYBEANS IN MIXTURES FOR LAYING HENS ON PRODUCTION PERFORMANCE AND THE RELATIVE WEIGHT OF THE PANCREAS

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Original scientific paper

**Abstract:** The study was conducted on Isa Brown hybrid hens at the age of 49-57 weeks. The effect of using different levels of share of raw soybean of two varieties in mixtures for feeding hens on egg production, body weight, food consumption, the occurrence of defective eggs, mortality and the relative weight of the pancreas was studied. The possibility of replacing the heat-treated soybean grains, varieties Lana, with reduced trypsin inhibitor (TI) and Lydia with a standard level of TI, with raw soybean grains was examined. The research was conducted on the principle of two factorial experiment 2 x 4 (2 varieties x 4 levels of share of raw grain in the mixture) with a total of 8 diet treatments and 4 replicates per each treatment. In the first 5 weeks of the study, the differences in the number of eggs produced under the influence of tested factors were not significant. Under the influence of soybean varieties, the level of share of raw soybean and interaction of the studied factors showed significant differences ( $p < 0.01$ ) after 53 week of age. The use of soy with lower TI in the diet for laying hens resulted in a significantly greater capacity compared to standard variety. The share of raw soybean grains of 8 % in the mixtures significantly reduced the number of eggs laid. The differences in body weights, food consumption, occurrence of defective eggs and the relative weight of the pancreas were not significantly influenced by the studied factors or by their interaction effect.

**Key words:** soybean, trypsin inhibitor, layer hens, egg production, pancreas

## Introduction

The introduction of soybean grain into diet of laying hens to a large extent can meet the requirements in protein and essential amino acids. Soybeans should have the higher protein content, with the full level of all the necessary amino acids,

high oil content and lower content of anti-nutritional factors. Heat process reduces the presence of anti-nutritional factors, but increases costs of food preparation that significantly burdens the overall cost of production. Trypsin inhibitors (TI) are the most important soybean antinutritive factors (*Perez-Maldonado et al., 2003; Ruiz et al., 2004*).

The varieties with reduced content of specific anti-nutritive substances have been created as the result of breeding work. As a result of the domestic soybean breeding program aimed at reducing the TI activity in our conditions a variety Lana was created with lower TI level compared to standard varieties.

Comparing the nutritional value of soy with lower TI in the experiments conducted on chickens (*Han et al., 1991; Jokić et al., 2004; Petričević et al., 2013*), on layer hens (*Zhang et al., 1991*) and on pigs and chickens (*Palasios et al., 2004*), have determined better product results when compared with standard soybean. *Cook et al. (1988)*, in a study with pigs, have found that the negative effects of the use of raw soybeans decreased with the age of the animal. *Senkoylu et al. (2005)* and *Koci et al. (1997)* have not established significant differences in production performance between laying hens fed diets with different levels of participation of full-fat soybean.

The aim of this study was to investigate the effects of replacing a portion of heat-treated soybean of Lydia standard variety and variety with reduced TI content Lana, with raw grains in mixtures for laying hens on production performance and the relative weight of the pancreas.

## Materials and methods

The study was conducted at the experimental farm of the Institute of Animal Husbandry in Zemun, using light line hybrid hens Isa Brown. The mixtures for laying hens used two varieties of raw and heat-treated, Lana variety with reduced trypsin inhibitor and variety Lydia with standard level of TI (Table 1). The research was conducted on the principle of two factorial experiment 2 x 4 (2 varieties x 4 levels of participation of raw grain in the mixture) with a total of 8 diet treatments and 4 replicates per treatment (a total of 512 animals).

**Table 1. Level of trypsin inhibitor in soybean**

Treatment	Raw soybean		Heat-treated (extruded) soybean	
Variety	Lana	Lydia	Lana	Lydia
TI (mg/g)	17.71	36.74	4.38	14.03

The experiment was conducted on hens at the age of 49-57 weeks. In the preparation of the meal/diet, recommendations for the studied hybrid were used. Raw material composition of the mixture was the same with adjustment for

soybean variety and the relationship between heat-treated and raw grain to achieve the objective of the research. Participation of thermally processed grains of both varieties was 8 % in the mixture in the two control treatments (K). In groups (I), with 8 % of full-fat soybean in the mixture, 6 % was heat-treated and 2 % raw. In groups (II) 4 % heat treated and 4 % raw soybean was added to the mixture. In groups (III) only 8 % of the raw soybeans was included. Ingredients of mixtures and the chemical composition of the mixture used in the experiment, determined in the laboratory, are given in Table 2.

**Tabela 2. Ingredients and chemical composition of mixtures–diet for layer hens during the experiment (%)**

Feeds	Groups (Treatments)							
	Lana				Lydia			
	K	I	II	III	K	I	II	III
Heat-treated (extruded) soybean	8	6	4	0	8	6	4	0
Raw soybean	0	2	4	8	0	2	4	8
Corn	59	59	59	59	59	59	59	59
Soybean meal	15	15	15	15	15	15	15	15
Sunflower meal	6	6	6	6	6	6	6	6
Livestock lime, granules	8	8	8	8	8	8	8	8
Livestock lime, powder	2	2	2	2	2	2	2	2
Monocalcium phosphate	1	1	1	1	1	1	1	1
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Mikozel	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Σ (%)	100	100	100	100	100	100	100	100
Chemical composition								
ME, MJ/kg	11.84	11.78	11.76	11.70	11.84	11.78	11.76	11.70
Crude protein	15.30	15.60	15.80	15.40	15.90	15.40	15.30	15.10
Crude fat	5.12	5.11	5.16	5.14	4.99	4.99	4.93	4.91
Crude fibre	4.87	4.64	4.51	4.40	4.18	4.33	4.25	4.35
Ash	12.4	12.75	12.43	12.9	13.1	12.5	13.04	13.14
Calcium	3.53	3.97	3.72	3.66	3.69	4.01	3.65	3.87
Total phosphorus	0.65	0.58	0.60	0.63	0.62	0.57	0.59	0.60

During the experiment, the number of eggs produced was daily registered. Based on the data obtained the laying capacity was determined. The incidence of defective eggs was monitored and recorded (change in shape, size and defective egg shells) and the overall frequency of defective eggs calculated.

Body weight of laying hens was determined by measuring of all hens at the beginning and end of the experiment, using weighing scales with an accuracy of

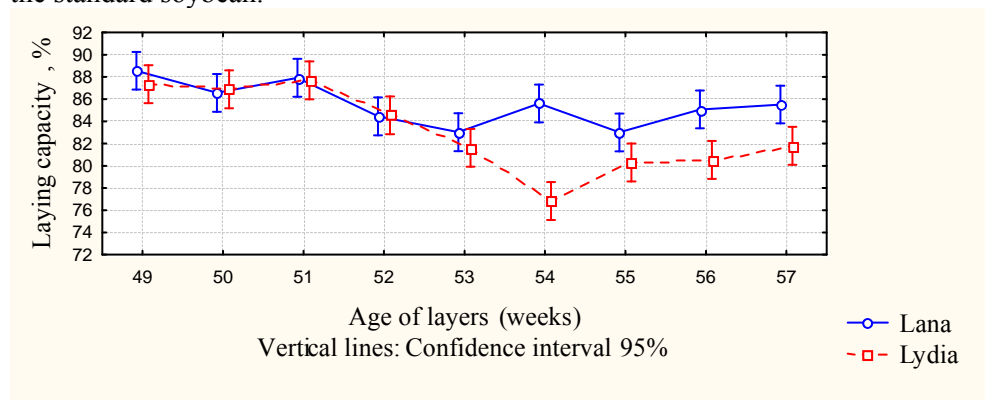
10<sup>-2</sup> kg. The unconsumed food was collected and measured weekly in order to determine food consumption and calculate the average daily food consumption. Followed by the health condition and mortality of animals were monitored. At the end of the study, 6 layers in each group were taken randomly (a total of 48 layers) that were sacrificed and the pancreas taken in order to determine the relative masses and morphological changes.

The software package STATISTICA, version 12 (Stat Soft Inc.) was used for statistical analyses. The level of statistical significance of differences between groups was determined by Tukey-test.

## Results and discussion

In order to assess the impact of the variety and level of participation of raw soybeans in mixtures for laying hens, average weekly capacity was calculated (Graphs 1 and 2). Based on the results obtained it can be seen that the layers of all groups had uniform capacity between 49 and 53 weeks of age. The variety and level of participation of raw soybeans had no effect on the capacity.

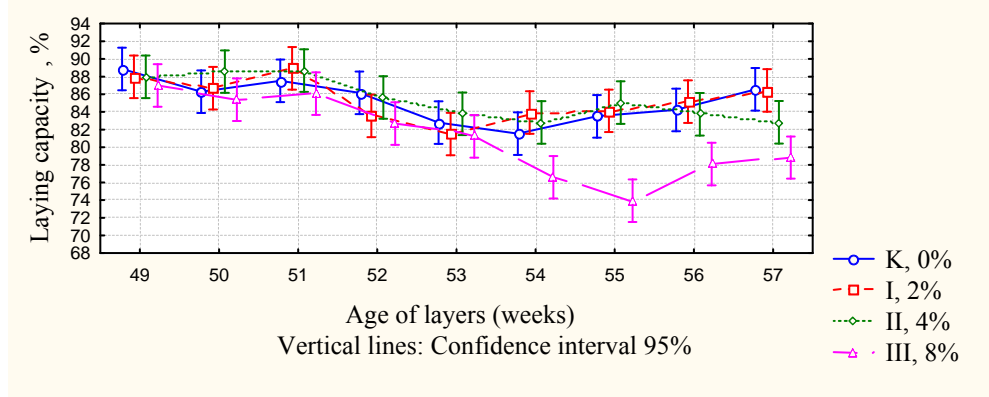
Statistically significantly lower ( $p < 0.01$ ) laying capacity was determined from 54 up to 57 weeks of age in hens fed diets which included the standard variety Lydia (Graph 1), with the lower capacity in that period by an average of 5 % compared to the soybean with lower TI level. Similar to our results (*Perez-Maldonado et al., 2003*) have reported that feeding laying hens diets that include soy with lower level of TI results in significantly higher laying capacity compared the standard soybean.



**Graph 1. Changes in laying capacity depending on the diet containing different soybean varieties**

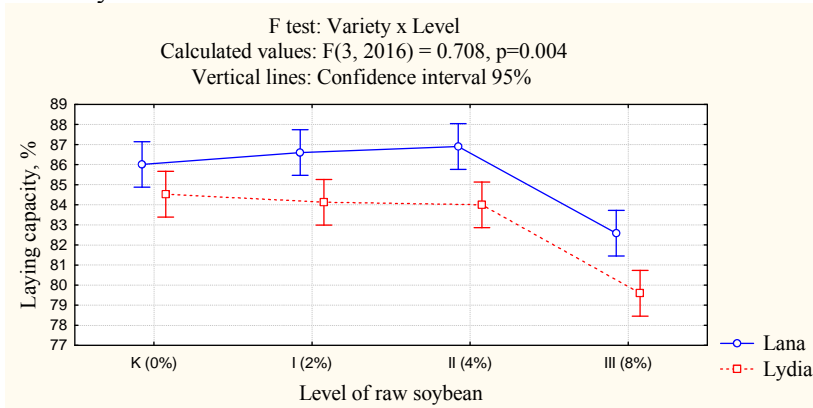
Increasing the level of share of raw soybeans in diets for laying hens also exhibited statistically significant effect ( $p < 0.01$ ) on the laying capacity from 54 to 57th week. Significantly lower capacity was recorded in hens fed diet with 8 % of the raw soybeans compared to other groups of hens (Graph 2). Differences in laying capacity that occurred between the groups fed with 0 %, 2 % and 4 % of the

raw soybeans in the diet were not significant. *Zhang et al. (1991)* have reported that the increase of the share of raw soybeans with standard or lower TI levels, in diets for laying hens, gradually reduces capacity.



**Graph 2. Changes in laying capacity depending on the diet containing different shares of raw soybean**

Interactions between studied factors had statistically significant effect ( $p < 0.01$ ) on the total capacity (Graph 3). At all levels of participation (0, 2, 4 and 8 %), raw soybean with lower TI level influenced greater number of eggs laid in relation to the standard variety. Best laying capacity was achieved in groups Lana K, Lana I and Lana II. Significantly lower ( $p < 0.01$ ) capacity was determined in groups of Lana III and Lydia I and II, whereas, significantly lower ( $p < 0.01$ ) capacity compared to all other groups was found in the group Lydia III. *Senkoylu et al. (2005)*, *Koci et al. (1997)* and *Han et al. (1988)* have not established significant difference in the laying capacity in hens fed diets with different shares of the full-fat extruded soybean.



**Graph 3. Average laying capacity by treatments for entire trial period**

Average initial body weights of laying hens in the experiment (Table 3) were consistent. In the analysis of the impact of studied factors on body weight at the end of the experiment no significant differences were found. Food consumption (Table 3) ranged from 114 g in hens of group Lana K to 116 g in groups Lydia I and Lydia II. Determined differences in average daily food consumption of laying hens under the influence of the studied factors were not significant. Similar to our results, *Zhang et al., (1991) and Perez-Maldonado et al., (2003)* have reported no influence of the different varieties of soybean in diets for hens on food consumption.

**Table 3. Production indicators in layer hens and share of pancreas**

Variety	Level of raw soybean (%)	Parameters	BW Trial beginning (g)	BW Trial end (g)	Food consumption (g)	Defective eggs (%)	Mortality (%)	Share of pancreas (%)
Lana	0%(K)	x	<b>1834</b>	<b>1871</b>	<b>114</b>	<b>0.21</b>	<b>1.56</b>	<b>0.23</b>
		Sd	169.1	185.5	8.7	0.02		0.03
	2%(I)	x	<b>1813</b>	<b>1841</b>	<b>115</b>	<b>0.11</b>	<b>0</b>	<b>0.24</b>
		Sd	147.2	149.8	7.7	0.01		0.03
	4%(II)	x	<b>1811</b>	<b>1828</b>	<b>115</b>	<b>0.17</b>	<b>1.56</b>	<b>0.23</b>
		Sd	126.9	163.1	5.8	0.02		0.01
	8%(III)	x	<b>1854</b>	<b>1876</b>	<b>115</b>	<b>0.09</b>	<b>1.56</b>	<b>0.29</b>
		Sd	171.2	182.4	6.5	0.01		0.04
Lydia	0%(K)	x	<b>1868</b>	<b>1888</b>	<b>115</b>	<b>0.32</b>	<b>0</b>	<b>0.24</b>
		Sd	162.5	176.3	9.8	0.03		0.03
	2%(I)	x	<b>1841</b>	<b>1870</b>	<b>116</b>	<b>0.14</b>	<b>1.56</b>	<b>0.26</b>
		Sd	148.3	165.7	6.9	0.01		0.04
	4%(II)	x	<b>1861</b>	<b>1885</b>	<b>116</b>	<b>0.35</b>	<b>1.56</b>	<b>0.29</b>
		Sd	146.4	179.0	7.0	0.03		0.03
	8%(III)	x	<b>1827</b>	<b>1846</b>	<b>115</b>	<b>0.17</b>	<b>1.56</b>	<b>0.32</b>
		Sd	156.2	209.8	6.6	0.02		0.02

As deficiencies of eggs (Table 3) mostly eggs with thin or no shell occurred, also eggs with rough and pimply shell. Statistical analysis of data revealed that the studied factors have a significant impact on the occurrence of defective eggs. The lowest incidence of defective eggs (0.09 %) was determined in the group of hens Lana III, while the hens in the group Lydia K most often laid defective eggs (0.32 %). The occurrence of death of hens was not observed among hens of group Lana I and Lydia K, in all other groups, one hen in each group has died (1.56 %).

The lowest relative weight of the pancreas (0.23 %) was in the group of hens Lana K (mixture without raw soybeans) and the highest relative weight of the pancreas (0.32 %) in group Lydia III (mixture with 8 % of the raw soybeans). *Zhang et al. (1991) and Perez-Maldonado et al. (2003)* have reported that hens fed

diets containing raw soybeans with a standard level of TI have higher shares of pancreas compared to hens fed diets containing raw soybeans with lower TI level.

## Conclusions

Based on the study of the individual influence of varieties and levels of participation raw soybeans, as well as the interactive influence of both factors in the diet for laying hens from 49 to 57 weeks of age, the following can be concluded:

- Analysis of the impact of variety on the total number of eggs laid, showed significantly lower ( $p < 0.01$ ) laying capacity in hens fed diets which included soybean variety Lydia.
- The level of participation of raw soybean in the mixture of 8 % showed statistically significant effect on the lower ( $p < 0.01$ ) laying capacity in relation to other groups of hens.
- Interaction of investigated factors confirmed a significant effect ( $p < 0.01$ ) on the laying capacity. The share of raw soybean of variety Lana, of 2 and 4 % in the diet did not cause significant differences in capacity compared to the group with 0 % raw soybeans of both varieties, while in other groups significantly lower capacity ( $p < 0.01$ ) was determined.
- In general it can be concluded that soybean with lower TI may be included in diet for older laying hens in the form of untreated grain to 4 %, while the use of untreated soybeans with a standard level of TI exerted a negative impact on the laying capacity of hens.
- In the statistical analysis of data, the influence of the studied factors on body weight of laying hens, feed intake and the occurrence of defective eggs was not established.
- The highest share of the pancreas was determined in the group Lydia III. The differences found in relation to the groups of hens fed a mixture with lower participation of raw soybean, were not statistically significant.

## Acknowledgments

The research was funded by the Ministry of Education, Science and Technological Development, Republic of Serbia, project TR-31033.

## **Efekat upotrebe sirove soje u smešama za ishranu kokoši nosilja na proizvodne rezultate i relativnu masu pankreasa**

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## Rezime

Cilj ovih istraživanja je bio da se ispituju mogućnosti zamene termički obrađenog sojinog zrna, sorte Lana sa smanjenim sadržajem tripsin inhibitora (TI) i sorte Lidija sa standardnim nivoom TI, sirovim zrnom. Ispitan je efekat korišćenja različitog nivoa učešća sirove soje obe sorte u smešama za ishranu kokoši nosilja hibrida Isa Brown na proizvodnju jaja, telesne mase, konzumaciju hrane, pojavu defektnih jaja, mortalitet i relativnu masu pankreasa.

Istraživanje je izvedeno po principu dvofaktorijskog ogleda 2 x 4 (2 sorte soje x 4 nivoa učešća sirovog zrna u smeši) sa ukupno 8 tretmana ishrane i 4 ponavljanja po tretmanu.

U prvih 5 nedelja ispitivanja razlike u broju ukupno smešenih jaja pod uticajem ispitivanih faktora nisu bile značajne. Pod uticajem sorte soje, nivoa učešća sirovog sojinog zrna i interakcije ispitivanih faktora utvrđene su značajne razlike ( $p < 0,01$ ) nakon 53. nedelje uzrasta. Korišćenje soje sa nižim nivoom TI u ishrani nosilja uticalo je na značajno bolju nosivost u odnosu na standardnu sortu soje. Sa učešćem sirovog sojinog zrna od 8 % u smešama značajno se smanjio broj ukupno snešenih jaja. Razlike u ostvarenim telesnim masama, konzumaciji hrane, pojavi defektnih jaja i relativnoj masi pankreasa koje su se javile nisu bile pod značajnim uticajem ispitivanih faktora kao ni pod uticajem njihovog interakcijskog dejstva.

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