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# Soybean meal and sunflower meal as a substitute for fish meal in broiler diet

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**ABSTRACT**

The aim of this study was to evaluate the possibilities of soybean meal and sunflower meal as plant protein alternatives to fish meal in broiler feed mixtures. The experiment was conducted on 180 one-day-old broiler chickens (Ross 308) divided into one control (C) and two experimental groups (E-1 and E-2). Chickens in the control group (C) were fed feed mixtures which contained fish meal, as opposed to experimental mixtures containing only soybean meal in starter mixture for both experimental groups, and sunflower meal (E-1) or soybean meal (E-2) as the only source of protein in finisher mixtures. Throughout the 42-day period of fattening, chicks were housed in cages in controlled environmental conditions and fed *ad libitum*. Effects on production results were evaluated by live weight, live weight gain, feed efficiency, mortality rate and carcass quality. Recorded values showed that the control group of chickens achieved higher live weight gain and lower feed efficiency compared to the experimental groups. The difference was statistically significant only in correlation with E-1 group ($P<0.01$). Carcass yield performance produced better results in both experimental groups, but with no statistical significance ($P>0.01$).

**Key words:** broilers, fish meal, soybean meal, sunflower meal

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## Introduction

Fish meal is a well known source of true protein with high biological value in the nutrition of monogastric animals. Except for highly essential amino acid content, this feedstuff also has a good balance of unsaturated fatty acids, high content of certain minerals (available phosphorus) and vitamins (A, D, B-complex).

However, there is a number of unfavourable characteristics which present limiting factors in fish meal usage. Firstly, there is a permanent danger of transmission of alimentary disease causative agents, such as *Salmonella* spp. It is also well known fact that fish meal, as a protein-rich feedstuff, is very sensitive to storage conditions. In the event of inadequate storage conditions degradation processes of protein can appear, followed by emergence of biogenic amines such as histamine. High levels of histamine in feed can cause gizzard erosion in chickens.

Moreover, public opinion is extremely sensitive to issues concerning human food safety. For the last fifteen years consumers' fears which arose as a result of the incidence of bovine spongiform encephalopathy has to be taken into account as a limiting factor in the use of feedstuffs of animal origin. Due to this fact, feed manufacturing has to increase the usage of well known alternative sources of protein. Numerous trials have been conducted on a number of currently used plant protein sources such as sunflower meal (ŠERMAN et al., 1996; ŠERMAN et al., 1997), soybean meal (AZIZ et al., 2001), rapeseed meal (KARAČIĆ et al., 2003), corn gluten meal (BABIDIS et al., 2002) or yeast as a single-cell protein source (DAGHIR and ABDOUL-BAKI, 1977). Additionally, certain new commercial feed additives have been produced and evaluated as fish meal substitutes (MIKULEC et al., 2003).

The aim of this study was to evaluate the effects of high levels of soybean and sunflower meal as a fish meal substitute in broiler chickens rations on health and production results.

## Materials and methods

*Animals and diets.* The investigation was carried out on 180 Ross 308 line broiler chickens. On the first day of the experiment one-day-old

chickens were weighed and divided into three groups (one control (C) and two experimental groups (E-1 and E-2)). Throughout the 42-day fattening period all birds were kept in cages and in the same microclimatic conditions. Health status of animals was checked daily.

Feed and water were provided *ad libitum*. In the first three weeks of age chickens were fed starter diet, and throughout the final three weeks with finisher feed mixture (Table 1).

Table 1. Composition of starter and finisher mixtures used in the trial

| Compounds (%) | Starter C | Starter E-1/E-2 | Finisher C | Finisher E-1 | Finisher E-2 |
|---|---|---|---|---|---|
| Maize | 56.5 | 52.0 | 59.3 | 39.4 | 56.2 |
| Soybean meal | 30.0 | 40.0 | 28.7 | - | 34.5 |
| Sunflower meal | - | - | - | 48.0 | - |
| Methionine | - | - | - | 0.1 | 0.2 |
| Lysine | - | - | - | 0.5 | 0.1 |
| Fish meal | 6.0 | - | 4.0 | - | - |
| Oil | 2.5 | 3.0 | 3.0 | 7.0 | 4.0 |
| Premix | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |

The control group (C) of chicks was fed mixtures based on standard feedstuffs, which means that the main source of protein was soybean meal supplemented with fish meal as an essential amino acid source. Both experimental groups of chickens (E-1/E-2) were fed the same starter mixture which did not contain fish meal, the only protein source being soybean meal. However, finisher mixtures for experimental groups had different protein sources. Finisher mixture for E-1 group contained a high level of sunflower meal as a protein source supplemented with lysine. Furthermore, finisher mixture used in feeding of chickens in E-2 group contained only soybean meal as a protein source, with supplementation of methionine and lysine. The feature common to all mixtures fed to the experimental groups was that they were prepared without fish meal. Nutritive values and chemical composition of used feed mixtures are shown in Table 2.

*Measuring of production results.* The effects of soybean and sunflower meal as a sole protein source and without the addition of fish meal were evaluated by the final live weight (LW), total live weight gain (LWG), feed efficiency (FE) and carcass yield.

Table 2. Nutritive values and chemical composition of feed mixtures used in the trial

| | Starter C | Starter E-1/E-2 | Finisher C | Finisher E-1 | Finisher E-2 |
|---|---|---|---|---|---|
| Crude protein ($g.kg^{-1}$) | 216.3 | 221.3 | 200.1 | 199.7 | 201.0 |
| Arginine ($g.kg^{-1}$) | 15.0 | 15.2 | 13.9 | 13.2 | 13.6 |
| Methionine ($g.kg^{-1}$) | 7.1 | 5.0 | 6.7 | 5.4 | 5.7 |
| Cystine ($g.kg^{-1}$) | 2.9 | 3.3 | 2.7 | 3.0 | 3.0 |
| Met. + cys. ($g.kg^{-1}$) | 10.0 | 8.3 | 9.4 | 8.4 | 8.7 |
| Lysine ($g.kg^{-1}$) | 14.3 | 12.0 | 13.0 | 9.8 | 11.8 |
| Triptophan ($g.kg^{-1}$) | 2.9 | 5.6 | 2.7 | 2.1 | 2.3 |
| Threonine ($g.kg^{-1}$) | 8.5 | 8.5 | 7.9 | 6.5 | 7.7 |
| Crude fat ($g.kg^{-1}$) | 55.7 | 55.8 | 59.7 | 87.3 | 66.6 |
| Crude fibre ($g.kg^{-1}$) | 34.0 | 43.5 | 33.5 | 94.7 | 40.4 |
| Ash ($g.kg^{-1}$) | 72.1 | 62.0 | 68.7 | 59.2 | 61.3 |
| Calcium ($g.kg^{-1}$) | 12.2 | 9.3 | 11.4 | 9.8 | 10.1 |
| P-total ($g.kg^{-1}$) | 7.3 | 5.5 | 6.7 | 6.5 | 5.8 |
| P-available ($g.kg^{-1}$) | 4.8 | 2.6 | 4.2 | 2.2 | 3.1 |
| Sodium ($g.kg^{-1}$) | 1.9 | 1.6 | 1.8 | 1.7 | 1.4 |
| ME (kJ/kg) | 12 453 | 12 198 | 12 671 | 12 646 | 12 675 |

Live weight gain was determined by individual weighing of birds every seven days throughout the trial period. Feed consumption for all groups was checked daily in order to determine weekly and total feed efficiency.

On the last day of the trial (day 42) 10 chicks (5 males and 5 females) selected from each group were slaughtered in order to determine carcass yield performance, with regard to share of carcass weight and certain the body portions in live weight. Carcasses were processed by the "grill" standard (carcass without head, neck, internal organs and distal parts of legs) (ŽIVKOVIĆ, 1986). All birds were fasted for 12 hours prior to slaughter

Health of chicks was assessed clinically and also by gross pathology examination of dead animals. All groups were vaccinated against Newcastle disease at the 21st day of age.

*Statistical analysis.* Statistical differences in average live weight, live weight gains, feed efficiency and carcass performance between experimental groups were analyzed by One-Way Analysis of Variance (STEEL and TORRIE, 1980). The criterion for significance was a probability of 0.01.

## Results

Production results monitored and analyzed in this trial are shown in the tables. The data which refer to basic production results of live animals as LW, LWG, FE and mortality rate are shown in Table 3. This table represents average values related to the starter and finisher periods of fattening, as well as total values.

Table 3. Production results

| n | Group | Average live weight (g) | Average live weight gain (g) | Feed conversion rate (kg/kg) |
|---|---|---|---|---|
| 60 | C | 40.2 | - | - |
| 60 | E-1 | 39.7 | - | - |
| 60 | E-2 | 38.8 | - | - |
| 59 | C | 575.1 | 534.9 | 1.85 |
| 60 | E-1 | 522.8* | 483.1* | 1.60 |
| 58 | E-2 | 534.4* | 495.6* | 1.67 |
| 57 | C | 2065.8 | 1490.7 | 1.91 |
| 60 | E-1 | 1807.3 | 1284.5* | 2.21 |
| 58 | E-2 | 1984.2 | 1449.8 | 2.02 |
| 57 | C | 2065.8 | 2025.6 | 1.89 |
| 60 | E-1 | 1807.3* | 1767.6* | 2.04 |
| 58 | E-2 | 1984.2 | 1945.4 | 1.93 |

In addition to production results, carcass yield and the share of body portion in live weight was observed as additional indicator for evaluating the effects of fish meal substitution. Results of carcass yield performance are shown in Table 4.

Table 4. Carcass yield performance (n = 10)

| | | Share in live weight (%) | | |
|---|---|---|---|---|
| | | Breast | Thigh and drumstick | Wings |
| C | 75.0 | 24.0 | 20.6 | 8.2 |
| E-1 | 74.6 | 24.7 | 20.9 | 9.3 |
| E-2 | 76.0 | 24.8 | 20.9 | 8.5 |

## Discussion

During the starter period of the trial (up to day 21) experimental groups (E-1/E-2) of chickens were fed the same starter feed mixture without fish

meal. As a result of this the average values of body weight and the weight gain between E-1 and E-2 groups were similar (LW 522.8 g and 534.4 g; LWG 483.1 g and 495.6 g, respectively) and with no statistical significance ($P>0.01$). The control group (C) of chickens achieved better production results in the same period (LW 575.1 g; LWG 534.9 g) with differences which were statistically significant ($P<0.01$). However, values of FE were similar in both experimental groups. The possibilities of fish meal substitute with plant protein (groundnut, soybean or sesame cake) in starter mixture for broilers were also investigated by REDDY and ESHWARIAH (1989). Their results showed that fish meal can be successfully replaced with soybean meal and sesame cake up to a level of 75% without supplementary lysine and methionine.

In the finisher period of the trial (from day 22 to day 42) production results showed a higher degree of difference between groups. Highest average LWG (1490.7 g) together with the lowest value of FE (1.91 kg/kg) for this period was recorded in the control group of chickens. The lowest production results were achieved by chickens in E-1 group. This means that they achieved the lowest value of LWG (1284.5 g) with the highest FE (2.21 kg/kg). These lower values were anticipated due to the fact that chickens in this group were fed finisher mixture containing a high proportion (48%) of sunflower meal. The results achieved by chickens in E-2 group (LWG 1449.8 g; FE 2.02 kg/kg) were similar to the results obtained in the control group. Statistical analysis of different values of LWG between groups showed significance ($P<0.01$) only between control and E-1 groups.

Total values of production results for this trial showed that the control group achieved the best results in LW (2065.8 g), LWG (2025.6 g) and FE (1.89 kg/kg). These results were significantly ($P<0.01$) better in relation to results obtained in E-1 group (LW 1807.3 g; LWG 1767.6 g and FE 2.04 kg/kg). In relation to the other groups, production results of the E-2 group in total (LW 1984.2 g; LWG 1945.4 g and FE 1.93 kg/kg) were placed between the results of C and E-1 group. The difference between values of the E-2 group and the other groups were not statistically significant ($P>0.01$).

Similar results related to soybean meal as a substitute for fish meal in broiler rations were obtained as reported by AZIZ et al. (2001). They concluded that protein from fish meal can be replaced completely by soybean meal with methionine supplementation (0.10%). Achieved live weight gain, feed consumption and feed efficiency did not differ significantly among the groups.

In the study performed with a high content of sunflower meal in broiler ration VALDIVIÉ et al. (1976) obtained significantly lower body mass in groups of broilers receiving sunflower meal. Similarly, according to OLOGHOBO (1991) feed mixtures containing 50, 75 and 100% sunflower meal as a replacement had a negative effect on broiler performance.

Although differences between results of carcass yield performance did not show a statistical significance between groups ($P>0.01$), the results are interesting. As is shown in Table 4. both experimental groups gained higher percentages of body portion share in live weight. These data correspond to the findings of MIKULEC et al. (2003) where the addition of protein feed additive declared as a fish meal substitute gained higher value of carcass and higher shares of breast, thigh and drumstick in live weight in comparison with broiler rations that included the fish meal. It should be mentioned that in both trials the values of carcass yield performance correspond to the values declared for Ross 308 broilers (ANONYM., 2002).

Also, as described by BABIDIS et al. (2002) and AZIZ et al. (2001), the addition of plant protein feedstuffs as a fish meal substitute did not significantly affect carcass yield performance.

Mortality rate in the present trial for C, E-1 and E-2 groups was 5%, 0% and 3 %, respectively. The pathoanatomical findings of the birds did not indicate any connection between diet and cause of death. According to the findings, causes of death were traumatic liver rupture and stunted growth.

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**MIKULEC, Ž., N. MAS, T. MAŠEK, A. STRMOTIĆ: Sojina i suncokretova sačma kao zamjene za riblje brašno u hrani za tovne piliće. Vet. arhiv 74, 271-279, 2004.**

**SAŽETAK**

Utvrđene su mogućnosti primjene sojine i suncokretove sačme kao biljne bjelančevinaste alternative ribljem brašnu u tovu pilića. Pokus je proveden na ukupno 180 jednodnevnih pilića (Ross 308) raspodijeljenih u kontrolnu (C) i dvije pokusne skupine (E-1 i E-2). Pilići kontrolne skupine bili su hranjeni krmnim smjesama koje su sadržavale riblje brašno, dok su početne smjese za obje pokusne skupine sadržavale samo sojinu sačmu kao glavni izvor bjelančevina. U završnim smjesama u pilića pokusnih skupina kao jedini izvori bjelančevina korištena je samo suncokretova (E-1) ili samo sojina sačma (E-2). Tijekom 42 dana tova pilići su držani u kavezima u kontroliranim zoohigijenskim prilikama, a hranjeni su *ad libitum*. Učinci na proizvodne rezultate ustanovljeni su na vrijednostima tjelesne mase, prirasta tjelesne mase, konverziji hrane, klaoničkoj iskoristivosti i mortalitetu. Zabilježene vrijednosti proizvodnih rezultata pokazale su da je kontrolna skupina pilića postigla najveći prirast tjelesne mase i najnižu konverziju hrane u usporedbi sa pokusnim skupinama. Razlike su bile statistički značajne samo u odnosu na E-1 skupinu ($P<0,01$). Klaonička iskoristivost se pokazala većom u obje pokusne skupine u odnosu na kontrolnu, ali bez statističke značajnosti ($P>0,01$).

**Ključne riječi:** tovni pilići, riblje brašno, sojina sačma, suncokretova sačma