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# The effect of different doses of dried yeast *Yarrowia lipolytica* on production effects of turkey hens and hematological indicators of blood

Wpływ różnych dawek suszonych drożdży *Yarrowia lipolytica* na efekty produkcyjne indyczek oraz wskaźniki hematologiczne krwi

**Summary.** The objective of this study was to determine the effectiveness of different doses of dried yeast *Yarrowia lipolytica* in feed mixtures for turkey hens based on the evaluation of their production effects and changes of haematological indices of blood. The experiment was carried out on 240 turkey hens of Big 6 line, aged from 1 up to 16 weeks. The birds were assigned to three groups, 80 turkeys each. Turkey hens from group I did not receive any additive to their feed mixtures, while the birds from groups II and III received a compound feed with 3 and 6% share of dried yeast *Yarrowia lipolytica*. In the 15th week of turkey hens rearing, their blood was sampled and hematological parameters were established(the number of WBC and RBC, Ht value and Hb concentration). After the rearing, the birds were slaughtered, and their carcasses were subjected to slaughter analysis. The obtained results indicate that the application of the additive dried yeast *Yarrowia lipolytica* in a dose of 3% positively influenced the evaluation of slaughter carcasses of turkey hens and changes of hematological indices of blood.

**Key words:** turkey hens, yeast, *Yarrowia lipolytica*, performance, blood

## INTRODUCTION

For almost 70 years the yeasts are used in animal feed as a valuable component of compound feed, especially because of their nutritional value (protein, amino acid or fat composition and vitamins) [Musiał *et al*. 2003]. In recent years, increased the possibility of using alternative materials for the production of non-conventional yeast biomass. Among them are found row materials, by-products and waste products of fats industry, which are a good source of carbon and energy for these yeasts such as: *Candida utilis, Candida tropicalis, Trichosporon cutaneum* and *Yarrowia lipolytica* [Zheng *et al*. 2005]. Yeast of the species *Yarrowia lipolytica* known as synonymous *Saccharomycopsis*

*lipolytica*, *Candida lipolytica* and *Mycotorula lipolytica* [Yu *et al*. 2007; Turki *et al*. 2010] are grown on culture medium with the participation of raw materials and waste products of fats industry, contain about 50% of the protein and accumulate in cells a significant amount of fat, in which more than 90% of the fatty acids are unsaturated fatty acids, with a considerable share EFA (*Essential Fatty Acid)* – 28-44%. [Musiał *et al*. 2003; Petkov *et al*. 1999; Puniya *et al*. 1995; Riaublanc *et al*. 1992; Rymowicz *et al*. 1997]. Even though they can grow on various nutrient sources, it commonly exists in natural habitats as well as in food products [Gdula *et al*. 2003]. For a long time yeast are used as natural growth promoters for animals also in poultry [Al-Mansour *et al*. 2011]. So far there was no studies that have performed the application of yeast strain *Y. lipolytica* in the nutrition of turkey hens, so it was important to examine whether and what extent the addition of the yeast strain affects the results of rearing of these animals group, as well as indicators showing state of animal health. Also it seems appropriate to analyze what dose of *Yarrowia lipolytica* will bring the most expected results.

The aim of this study was to evaluate the efficacy of two doses of dried yeast *Yarrowia lipolytica* on production effects and changes hematological indices of blood of turkey hens.

## MATERIAL AND METHODS

The experiment was carried out on 240 turkey hens of Big 6 line, aged from 1 up to 16 weeks. The birds were randomly assigned to 3 experimental groups, 80 turkeys each, allocated for 5 replications, 16 birds each. The birds were kept in cages, under zoohygienic conditions recommended for turkeys fattening [Faruga and Jankowski 2000]. Turkey hens from all groups had free access to drinking water. Group I served as a control (K) and didn't received any experimental additives. The turkey hens from experimental groups (DY3, DY6) were administered dried yeast *Yarrowia lipolytica* in two various doses of 3% and 6% in feed mixtures. Birds from all groups received feed mixtures, in which the content of nutrients was consistent with NCR [1994] (Tab. 1). At the end of the experimental period ($16^{th}$ week of birds life), blood was sampled for analyses from the brachial vein of 10 birds from each group. Blood was sampled to heparinized test tubes 10 ml in volume under the supervision of a veterinarian. Hematological tests included the determination of white blood cells (WBC) and red blood cells (RBC) number with the manual chamber technique, after dilution in Natt-Herrick solution, hematocrit (Ht) level using the microhematocrit method, and hemoglobin (Hb) content – following the Drabkin's method [Pinkiewicz 1971; Feldman *et al.* 2000].

At the end of the rearing period (16 weeks of life), ten birds from three experimental groups were slaughtered following the LEC euthanasia protocol (all the birds from a group/ subgroup were weighed and then chosen for slaughter analysis on the grounds of the mean values of body weight measurement). The slaughter procedure was approved by the II Local Ethical Commission for Experiments with Animals in Lublin (approval no. 19/2012). During the experiment, the turkey hens' body weight (taken on last day of the each week their lives) and feed intake were recorded. On the basis of the productive performance, the value of the European Efficiency Index (EEI) was calculated following the formula given below:

$$\mathrm{EEI} = \frac{\text{mean body weight after rearing (kg)} \times \text{liverbility (\%)}}{\text{day of rearing} \times \text{feed conversion (kg} \cdot \text{kg}^{-1})}$$

Table 1. Nutrient content of the standard diets
Tabela 1. Wartość pokarmowa standardowych mieszanek

| Ingredient (Feeding period) | Starter (1–3 week) | | | Grower 1 (4–7 week) | | | Grower 2 (8–12 week) | | | Finisher 1 (13–16 week) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group/Grupa | K | DY3 | DY6 | K | DY3 | DY6 | K | DY3 | DY6 | K | DY3 | DY6 |
| Wheat (%)<br>Pszenica (%) | 42.3 | 42.3 | 42.3 | 50.0 | 50.0 | 50.0 | 48.8 | 48.8 | 48.8 | 59.0 | 59.0 | 59.0 |
| Triticale/sharps (%)<br>Pszenżyto/śruta (%) | - | - | - | - | - | - | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Soybean meal (%)<br>Śruta sojowa (%) | 44.2 | 41,2 | 38.2 | 35.3 | 32.3 | 29.3 | 26.3 | 23.3 | 20.3 | 13.8 | 10.8 | 7.8 |
| Rapeseed oil cake (%)<br>Makuch rzepakowy (%) | - | - | - | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 9.0 | 9.0 | 9.0 |
| Potato protein (%)<br>Białko ziemniaczane (%) | 5.0 | 5.0 | 5.0 | - | - | - | - | - | - | - | - | - |
| Soya oil (%)<br>Olej sojowy (%) | 3.0 | 3.0 | 3.0 | 5.0 | 5.0 | 5.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Fodder chalk (%)<br>Kreda pastewna (%) | 1.8 | 1.8 | 1.8 | 1.5 | 1.5 | 1.5 | 1.7 | 1.7 | 1.7 | 1.5 | 1.5 | 1.5 |
| Yeast (%)<br>Drożdże (%) | - | 3.0 | 6.0 | - | 3.0 | 6.0 | - | 3.0 | 6.0 | - | 3.0 | 6.0 |
| Cytromix Plus[1] (%) | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Farmix[2] (%) | 3.5 | 3.5 | 3.5 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 2.5 | 2.5 | 2.5 |
| | Nutrient composition – Składniki odżywcze | | | | | | | | | | | |
| Crude protein (CP) (%)<br>Białko surowe (%) | 23.1 | | | 20.1 | | | 21.1 | | | 19.39 | | |
| ME, kcal · kg$^{-1}$<br>EM, kcal · kg$^{-1}$ | 2800 | | | 3000 | | | 3100 | | | 3200 | | |
| Lysine (%)/Lizyna (%) | 1.11 | | | 1.81 | | | 1.45 | | | 1.25 | | |
| Methionine + Cysteine (%)<br>Metionina + cysteina (%) | 1.11 | | | 1.00 | | | 0.91 | | | 0.82 | | |
| Tryptophan (%)<br>Tryptofan (%) | 0.35 | | | 0.40 | | | 0.30 | | | 0.25 | | |
| Calcium (%)/Wapń (%) | 1.25 | | | 1.22 | | | 1.22 | | | 1.20 | | |
| Phosphorus (%)<br>Fosfor (%) | 0.60 | | | 0.58 | | | 0.50 | | | 0.50 | | |
| Sodium (%)/Sód (%) | 0.16 | | | 0.16 | | | 0.16 | | | 0.15 | | |

[1] Cytromix Plus – citric acid, fumaric acid, phosphoric acid (62%)

[2] Farmix – the mineral and vitamin premix provided the following per kilogram of diet – 3 000 000 IU of vitamin A; 900 000 IU of vitamin $D_3$; 10 000 mg of vitamin E; 500 mg of vitamin $K_3$; 700 mg of vitamin $B_1$; 2000 mg of riboflavin; 1200 mg of vitamin $B_6$; 6 mg of vitamin $B_{12}$; 400 mg of folic acid; 72 mg of biotin; 15 000 mg of niacin; 120 000 mg of choline; 4200 mg of calcium pantothenicum; 30 000 mg of Mn; 18 000 mg of Zn; 12 000 mg of Fe ; 3000 mg of Cu ; 200 mg of I; 60 mg of Se; 40 mg of Co; 15 g of Ca.

Numerical data achieved were subjected to a statistical analysis, by determining mean values and standard errors of the means using Statistica ver. 6.1 software, according to the model:

$$Yi = \mu + ai + ei$$

where: μ – overall mean
ai – influence of the oil additive, $i = 1$,
ei – random error.

The significance of differences between means was determined with the one-way analysis of variance test ANOVA, at significance levels of 0.05.

## RESULTS AND DISCUSSION

Yeasts can be used as a natural growth promoters for poultry and other livestock [Al-Mansour *et al.* 2011]. The use of yeast in feed mixtures for chickens [Ignacio 1995; Onifade *et al*. 1999; Al-Mansour *et al.* 2011] and piglets [Kasprowicz-Potocka 2009] may influence for better weight gain of animals. Unfortunately, there are few studies describing the impact of the yeast *Yarrowia lipolytica* on animal growth, biochemical and hematological indices.

Table 2. The productivity of turkey hens
Tabela 2. Efekty produkcyjne indyczek

| Item – Wskaźnik | Groups/Grupy | | | P value |
|---|---|---|---|---|
| | K | DY3 | DY6 | |
| Body weight/week of life/Masa ciała/tydzień życia, kg | | | | |
| 1 | 0.184 ±0.001 | 0.183 ±0.001 | 0.185 ±0.002 | NS |
| 7 | 2.35 ±0.18 | 2.32 ±0.19 | 2.27 ±0.22 | NS |
| 8 | 3.21 ±0.17 | 3.04 ±0.25 | 3.29 ±0.19 | NS |
| 9 | 3.99 ±0.27 | 3.51 ±0.24 | 3.69 ±0.32 | NS |
| 10 | 4.91 ±0.24 | 4.44 ±0.37 | 4.46 ±1.28 | NS |
| 11 | $5.54^{a}$ ±0.38 | $5.21^{ab}$ ±0.44 | $5.09^{b}$ ±0.48 | * |
| 12 | 5.99 ±0.42 | 5.95 ±0.30 | 5.53 ±0.31 | NS |
| 13 | 7.12 ±0.45 | 6.75 ±0.51 | 6.61 ±0.43 | NS |
| 14 | 7.81 ±0.47 | 7.23 ±0.50 | 7.21 ±0.32 | NS |
| 15 | 8.08 ±0.45 | 8.03 ±0.53 | 7.67 ±0.39 | NS |
| 16 | $8.46^{a}$ ±0.44 | $8.45^{a}$ ±0.58 | $8.16^{b}$ ±0.33 | * |
| Body weight gains/Przyrosty masy ciała, kg | | | | |
| 1–7 wk | 2.17 ±0.09 | 2.13 ±0.11 | 2.08 ±0.08 | NS |
| 7–12 wk | $3.64^{a}$ ±0.30 | $3.63^{a}$ ±0.26 | $3.26^{b}$ ±0.29 | * |
| 12–16 wk | 2.47 ±0.21 | 2.50 ±0.44 | 2.63 ±0.34 | NS |
| Feed intake, kg/bird/day<br>Spożycie paszy, kg/szt./dzień | 0.201 | 0.207 | 0.202 | NS |
| Feed conversion ratio,<br>Zużycie paszy, kg/kg 0–16 | 2.680 | 2.760 | 2.805 | NS |
| EWW pts | $281.85^{a}$ | $273.36^{ab}$ | $259.76^{b}$ | * |

a, b – values in the same rows with different letters differ significantly at $p \leq 0.05$ / wartości w wierszach oznaczone różnymi literami różnią się istotnie przy $p \leq 0.05$
* $p \leq 0.05$

At the initial fattening period, rearing effects of the turkey hens receiving dried yeasts *Yarrowia lipolytica* addition in their feed mixture were not significantly different from those obtained for the control birds (Tab. 2). Starting from the 11th week of rearing the body weight of turkey hens receiving yeast in dose 6% was significantly ($P \leq 0.05$) lower – 5.09 kg, than in the group with 3% addition of yeast *Yarrowia lipolytica* (5.21 kg). During the whole experiment turkey hens receiving additive of yeast in an amount of 3% (DY3) had higher body weights compared to birds from the group DY6 (6%). Analyzing the final body weight of turkey hens (16th week of life), it was found that the birds from the group DY3 achieved a similar body weight, as the birds from the control group. In case of body weight gains during the period between 7–12 week of birds life, there was statistically significant differences between both experimental groups, respectively 3.63 kg (DY3) and 3.26 kg (DY6). Furthermore, the analysis of the European Efficiency Index (EEI) shows that both experimental groups had significantly ($P \leq 0.05$) lower value of this index compared to the control group (K), respectively by 8.49 and 22.09 points.

Table 3. Results of slaughter analysis of turkey hens after 16-week rearing period (% body weight prior to slaughter)
Tabela 3. Wyniki analizy rzeźnej indyczek po 16 tygodniach odchowu (% masy ciała przed ubojem)

| Parameter<br>Cecha | Experimental group/Grupy doświadczalne | | | P value<br>Wartość p |
|---|---|---|---|---|
| | K | DY3 | DY6 | |
| Dressing percentage, %<br>Wydajność rzeźna, % | 82.60 | 80.64 | 79.44 | NS |
| Breast muscle, %<br>Mięsień piersiowy, % | 20.64 ±1.45 | 18.81<br>±0.65 | 18.62<br>±0.85 | NS |
| Femoral muscle, %<br>Mięsień udowy, % | 8.41 ±0.99 | 7.78 ±1.00 | 6.74 ±1.20 | NS |
| Shank muscle, %<br>Mięsień podudzia, % | $7.26^{a}$ ±0.34 | $7.05^{b}$ ±0.53 | $6.10^{b}$ ±0.46 | * |
| Liver/Wątroba, % | 1.34 ±0.07 | 1.05 ±0.06 | 1.00 ±0.10 | NS |
| Stomach/Żołądek, % | 1.30 ±0.11 | 0.88 ±0.03 | 0.92 ±0.14 | NS |
| Heart/Serce, % | 0.42 ±0.01 | 0.35<br>±0.025 | 0.32<br>±0.045 | NS |
| Abdominal fat, %<br>Tłuszcz sadełkowy, % | $0.485^{a}$<br>±0.08 | $0.42^{b}$ ±0.21 | $0.41^{b}$ ±0.24 | * |

a, b – values in the same rows with different letters differ significantly at $p \leq 0.05$ / wartości w wierszach oznaczone różnymi literami różnią się istotnie przy $p \leq 0,05$
* $p \leq 0.05$

Results of slaughter analysis presented in Table 3 show that additive of dried yeast *Yarrowia lipolytica* mostly had no significant effect on the analyzed slaughter traits of turkey hens. Only share of shrank muscles from both experimental groups – DY3 and DY6, were significantly ($P \leq 0.05$) lower compared to the control group respectively by 2.90 and 16%. Similar situation was with the share of abdominal fat in both experimental groups, which also was statistically lower than in the control group (by 13.4 and 15.5%). Similar results were obtained by Savage *et al.* [1985], finding that supplementation of yeast cultures reduces the fat content of the carcasses of turkey hens.

Table 4. Hematological parameters in blood of turkey hens
Tabela 4. Parametry hematologiczne krwi indyczek

| Item/Wskaźnik | Experimental groups/Grupy doświadczalne | | | P value Wartość |
|---|---|---|---|---|
| | K | DY3 | DY6 | |
| Red blood cells<br>Krwinki czerwone, $10^{12} \cdot l^{-1}$ | $3.05^{b}$ ±0.07 | $6.09^{a}$ ±0.09 | $3.88^{b}$ ±0.08 | * |
| White blood cells<br>Krwinki białe, $10^{9} \cdot l^{-1}$ | 31.39 ±0.32 | 30.29 ±2.47 | 30.87 ±0.25 | NS |
| Hemoglobin/Hemoglobina, $g \cdot l^{-1}$ | $7.75^{b}$ ±0.56 | $7.69^{b}$ ±0.66 | $8.02^{a}$ ±0.77 | * |
| Hematocrit/Hematokryt, % | 33.42 ±0.56 | 35.67 ±1.35 | 34.95 ±1.26 | NS |

a, b – values in the same rows with different letters differ significantly at $p \leq 0.05$ / a, b – wartości w wierszach oznaczone różnymi literami różnią się istotnie przy $p \leq 0,05$
* $p \leq 0.05$

Essential element in the evaluation of efficiency of additives in animal nutrition may be the course of metabolic processes, which is expressed in changes of biochemical and hematological indices of blood [Ganong 2005]. Results obtained for contents of hematological indices of turkey hens blood correspond with results of other authors [Koncicki *et al*. 1999; Özsoy and Yalçin 2011]. The results obtained in the experiment indicate a significant effect of the addition of yeast *Yarrowia lipolytica* to improve red blood cell indices namely the increased hemoglobin level in the group DY6 and the number of red blood cells RBC in the group DY3, compared to the other experimental groups (Tab. 4). This indicates beneficial effects of yeast *Yarrowia lipolytica* to improve the erythropoietic process. Yeast are a valuable source of nutrients such as iron and copper, which are components of blood cells [Andrews *et al*. 1999].

## CONCLUSIONS

1. The obtained results of evaluation of slaughter carcasses and hematological indices indicate a better usefulness in nutrition turkey hens dried yeast *Yarrowia lipolytica* at a dose of 3%.

2. The addition of yeast *Yarrowia lipolytica* to feed mixture have a positive effect on reducing the percentage content of abdominal fat in the carcasses of turkey hens.

## REFERENCES

Al-Mansour S., Al-Khalf A., Al-Homidan I., Fathi M.M., 2011. Feed efficiency and blood hematology of broiler chicks given a diet supplemented with yeast culture. Int. J. Poult. Sci. 10, 8, 603–607.

Andrews N., Fleming M.D., Phil. D., Gunshin H., 1999. Iron transport across biologic membranes. Nutr. Rev. 57, 4, 114–123.

Faruga A., Jankowski J., 2000. Indyki, hodowla i użytkowanie. PWRiL, Warszawa.

Feldman B.J., Zinki N., Jain P., 2000. Schalm's veterinary haematology. Lippincott and Wilkins, Philadelphia.

Ganong W., 2005. Review of Medical Physiology. Wyd. McGraw-Hill.

Gdula A., Chrzanowska J., Szołtysik M., Wojtatowicz M., Guerzoni M.E., 2003. Enzymatic abilities and comparision of lipolytic activity of two *Yarrowia lipolytica* strains. Acta Sci. Pol., Biotechnology 2(1–2), 83–89.

Ignacio E.D., 1995. Evaluation of the effect of yeast culture on the growth performance of broiler chick. Poult. Sci. 74, 196.

Kasprowicz-Potocka M., 2009. Mieszanki z dodatkiem drożdży. Portal Hodowcy 4, 1–4.

Koncicki A., Krasnodębska-Depta A., Guiro S., 1999. Wskaźniki hematologiczne i biochemiczne krwi w przebiegu histomonadozy indyków. Med. Wet. 55(10), 674–677.

Musiał I., Juszczyk P., Rymowicz W., Kinal S., 2005. Produkcja drożdży paszowych *Yarrowia lipolytica* wzbogaconych w selen i chrom. Biotechnologia 4, 55–64.

Musiał I., Rymowicz W., Kramkowski R., 2003. Charakterystyka drożdży paszowych *Yarrowia lipolytica* suszonych metodą rozpyłową. Biotechnologia 2, 41–49.

NRC, 1994. Nutrient Requirement of Poultry, 9th edn. National Academy Press, Washington, USA.

Onifade A.A., Odunsi A.A., Babatunde G.M., Olorede B.R., Muma E., 1999. Comparison of the supplemental effects of *Saccharomyces cerevisiae* and antibiotics in low-protein and high--fiber diets to broiler chicken. Arch. Anim. Nutr. 52, 29–39.

Özsoy B., Yalçin S., 2011. The effects of dietary supplementation of yeast culture on performance, blood parameters and immune system in broiler turkeys. Ankara Üniv. Vet. Fak. Derg. 58, 117–122.

Petkov K., Kinal S., Rymowicz W., Łukaszewski Z., Biel W., 1999. Charakterystyka składu chemicznego biomasy drożdży *Yarrowia lipolytica*. Pasze Przem. 2/3, 60–63.

Pinkiewicz E., 1971. Diagnostyka laboratoryjna chorób zwierząt. WSR, Lublin.

Puniya A.K., Singh S., Kumar C.G., Singh K., 1995. Single cell protein: A promising dietary substitute. Ind. J. Exp. Biol. 33, 545–551.

Riaublanc A., Boze H., Domuynck M., Maulin G., Ratomahenina R.M., Grailla J., Galzy P., 1992. Optimatisation of biomass production from palm oil culture using *Candida rugosa*. Fat. Sci. Technol. 2, 41–46.

Rymowicz W., Kinal S., Wojtatowicz M., Musiał I., Bodarski R., 1997. Charakterystyka biomasy drożdży *Yarrowia lipolytica* wyprodukowanej na substratach tłuszczowych. Biotechnologia 38, (3), 70–77.

Savage T.F., Nakaue H.S., Holmes Z.A., 1985. Effects of feeding a live yeast culture on market turkey performance and cooked meat characteristics. Nutr. Rep. Int. 3, 695–703.

Turki S., Ayed A., Chalghoumi N., Weekers F., Thonart P., Kallel H., 2010. An enhanced process for the production of a highly purified extracellular lipase in the non-conventional yeast *Yarrowia lipolytica*. Appl. Biochem. Biotechnol. 160, 1371–1385.

Yu M., Qin S., Tan T., 2007. Purification and characterization of the extracellular lipase Lip2 from *Yarrowia lipolytica*. Proc. Biochem. 42, 384–391.

Zheng S., Yang M., Yang Z., 2005. Biomass production of yeast isolate from salad oil manufacturing wastewater. Biores. Technol. 96, 1183–1187.

**Streszczenie.** Celem badań było określenie skuteczności różnych dawek suszonych drożdży *Yarrowia lipolytica* w mieszankach paszowych dla indyczek na podstawie efektów produkcyjnych i zmian wartości wskaźników hematologicznych krwi. Doświadczenie przeprowadzono na 240 indyczkach typu Big 6, utrzymywanych od 1. do 16. tygodnia życia. Ptaki podzielono na trzy grupy po 80 sztuk w każdej. Indyczki należące do grupy I nie otrzymywały żadnego dodatku do mieszanki paszowej, podczas gdy ptaki z grup II i III otrzymywały mieszankę paszową z 3% i 6% udziałem suszonych drożdży *Yarrowia lipolytica*. W trakcie doświadczenia kontrolowano przyrosty ptaków oraz spożycie i wykorzystanie paszy. W 15. tygodniu odchowu indyczek pobrano krew, w której oznaczono wskaźniki hematologiczne (liczba WBC i RBC, wartość Ht oraz stężenie Hb). Po zakończonym odchowie ptaki ubito, a tuszki poddano analizie rzeźnej. Uzyskane wyniki wskazują, że zastosowanie dodatku suszonych drożdży *Yarrowia lipolytica* w dawce 3% pozytywnie wpłynęło na efekty oceny rzeźnej indyczek oraz wskaźniki hematologiczne krwi.

**Słowa kluczowe:** indyczki, drożdże, *Yarrowia lipolytica*, efekty odchowu, krew