Effect of the use of autolyzed brewer's yeast in compound feeds for weaned pigs

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Abstract

A scientific and economic experiment was conducted at the Agricultural Institute – Shumen with 2 groups of 21 pigs in each, or a total of 42 weaned pigs of the Danube white breed. The pigs were reared in raised pens with 7 animals in each pen, 3 pens in a group. The experiment started at 9.497–9.500 kg live weight and ended when the animals reached 30.081–32.760 kg. The aim of the study was to determine the influence of the use of autolyzed brewer's yeast in weaned pigs on productivity and some hematological parameters. The animals of group I were control, and those of group II were experimental. In the compound feed of the pigs of the experimental group, 3% of the soybean meal was replaced with added autolyzed brewer's yeast.

Substitution of 3% of soybean meal with autolyzed brewer's yeast in compound feed for weaned pigs (9.5 kg to 30.081–32.760 kg) of the Danube White breed increased feed consumption by 11.48% ($p < 0.05$) and the average daily gain increase by 16.50% ($p < 0.01$). The inclusion of brewer's yeast has a beneficial effect on the health of the piglets, expressed through some hematological indicators (significantly lower values of granulocytes, leukocytes and triglycerides).

Key words: autolyzed brewer's yeast, weaned pigs, gain, blood

Introduction

Piglets are subjected to various stresses at weaning due to a number of factors, including weaning, post-weaning diarrhea and reduced nutrient utilization due to an underdeveloped digestive system, which can cause serious damage to gut health (Hu et al., 2014). The application of nutritional supplements that increase the immunity of pigs in the early period after weaning are of great interest in pig farming.

Che et al. (2012) used high-quality feed ingredients to alleviate weaning stress, improve growth and immune response of animals. Animal proteins such as spray-dried plasma proteins (SDPP) have a well-balanced amino acid profile and are highly digestible for piglets. The prohibition of animal proteins imposed onto specialists and nutrition science the search for new protein supplements applied after weaning in order to prevent digestive diseases, stress and better immune status. Yeast has a high protein content (> 47% DM) with a high biological (3.6% lysine) and digestible value (> 85%), and its application in rations reduces feed costs for the formation of kg growth. Brewer's yeast is rich in B vitamins, especially biotin and folic acid (except vitamin B_1, B_2, B_6, B_{12}, PP, B_5) and vitamin D, with a content of 2000–5000 IU/g dry matter. The phosphorus content in yeast is up to 0.8–1.3%. Yeast promotes animal productivity and health.

Brewer's yeast supplementation helps improve growth, immune response and antioxidant capacity of piglets (Salobir et al., 2005; Superchi

et al., 2012; Sauer et al., 2012 b). Brewer's yeast, as eukaryotic unicellular organisms, have strong fermentation ability with lower toxic potential and high nutritional value (Zhang et al., 2019; Viera et al., 2012; Pancrazio et al., 2016).

In a conducted study by Hu et al. (2014) was found that compared to the control, piglets fed with YP (brewer's yeast) had a significantly higher total average daily gain (+ 14%, $P < 0.05$) and lower feed conversion ratio (-8%, $P < 0.01$). Overall, the results of this study showed that the ration with the inclusion of YP improved growth and partially improved antioxidant capacity as well as intestinal innate immunity of weaned piglets.

Li et al. (2006) reported that live yeast (Saccharomyces cerevisiae) increased growth and feed intake in an experiment with weaned pigs. Zhao et al. (2012) found an increase in growth in pigs fed with yeast extract. The authors indicate that the increased feed intake is due to the improvement in the taste of the food after the addition of yeast.

The aim of the study was to determine the effect of the use of autolyzed brewer's yeast in weaned pigs on productivity and some hematological parameters.

Material and methods

A scientific and economic experiment was conducted at the Agricultural Institute – Shumen with 2 groups of 21 pigs in each, or a total of 42 weaned pigs of the Danube white breed. The pigs were reared in raised pens with 7 animals in each pen, 3 pens per group. The animals were equalized by live weight, sex and origin. The experiment started at 9.497–9.500 kg live weight and ended when the animals reached 30.081–32.760 kg. The component composition and content of nutrients in kg feed, presented in Table 1 also represent the scheme of the experiment. The animals in group I were control, and those in group II were experimental. In the compound feed of the experimental group, 3% of the soybean meal was replaced with added autolyzed brewer's yeast. The mixtures for the two groups were equal in content of the main nutrients – protein, lysine, calcium and phosphorus. The content of protein, amino acids, vitamins and minerals in the applied brewer's yeast are presented in Table 2 (provided by the manufacturer BULDRYHIM, Bulgaria). For the preparation of the mixtures for the compound feed in the experiment, brewer's yeast was chemically analyzed (in the laboratory of the Agricultural Institute - Shumen) for moisture content, dry and organic matter, ash, protein, fiber, calcium and phosphorus.

The pigs were fed *ad libitum*. They received water *ad libitum*. The duration of the experiment was 50 days.

At the end of the experiment, blood samples were taken (15 samples per group, from 7 males and 8 females) from each pig from the orbital venous sinus (anterior vena cava) using a closed system method. All samples were collected in plastic blood collection tubes (Vacusera, Izmir, Turkey) and immediately inverted 10 times. Samples for serum biochemistry were collected

Table 1. Component composition and nutrient contents in kg of compound feed

Components, % \ Groups	I	II
Maize	10.93	11.07
Wheat	40.00	40.00
Barley	14.00	14.00
Soy meal	33.00	30.00
Synthetic lysine	0.05	-
Brewer's yeast	-	3.00
Chalk	1.12	1.08
Monocalcium phosphate	0.35	0.30
Premix	0.25	0.25
Salt	0.30	0.30
Total	100.00	100.00
1 kg of compound feed contains:		
Protein, %	20.90	20.80
Lysine, %	1.09	1.10
Threonine, %	0.75	0.76
Tryptophan, %	0.28	0.29
Ca, %	0.70	0.70
P, %	0.49	0.49

Table 2. Protein, amino acid, vitamin and mineral content of autolyzed brewer's yeast*

CHEMICAL COMPOSITION OF AUTOLYZED YEAST:			
Indicators	Autolyzed Yeast	Indicators	Autolyzed Yeast
Proteins, %	42 ÷ 46	Vitamin B6, mg/kg	35 ÷ 60
Vitamin B_1, mg/kg	30 ÷ 70	Choline, mg/kg	3000 ÷ 3600
Vitamin B_2, mg/kg	50 ÷ 110	Vitamin, B12, mg/kg	6 ÷ 7
Vitamin B_3, mg/kg	40 ÷ 75	Vitamin, K, mg/kg	1,0 ÷ 1,8
Vitamin PP, mg/kg	500 ÷ 750	Biotin, mg/kg	1,0 ÷ 1,2
Indicators (amino acids)	Autolyzed Yeast	Indicators (amino acids)	Autolyzed Yeast
Aspartic acid, mg/g	5.1 ÷ 4.5	Alanine, mg/g	4.4 ÷ 3.8
Threonine, mg/g	2.09 ÷ 1.8	Valine, mg/g	4.5 ÷ 3.9
Serine, mg/g	2.2 ÷ 1.9	Isoleucine, mg/g	4.8 ÷ 4.1
Glutamic acid, mg/g	6.5 ÷ 5.9	Leucine, mg/g	7.4 ÷ 6.3
Methionine, mg/g	1.6 ÷ 1.4	Tyrosine, mg/g	3.6 ÷ 3.1
Lysine, mg/g	3.8 ÷ 3 .2	Tryptophan, mg/g	1.1 ÷ 1.0
Proline, mg/g	2.4 ÷ 2.0	Phenylalanine, mg/g	4.3 ÷ 3.8
Glycine, mg/g	1.45 ÷ 1.1	Arginine, mg/g	3.6 ÷ 3.1
CONCENTRATION OF MINERAL ELEMENTS IN AUTOLYZED YEAST:			
Mineral elements	Autolyzed Yeast	Mineral elements	Autolyzed Yeast
Ca, %	0.2÷0.3	Zinc, mg/g	27.0
P, %	1.5÷1.7	Copper, mg/g	1.1
Cobalt, mg/kg	0.36	Manganese, mg/g	1.0
Sodium, %	0.73	Iron, mg/kg	500
Magnesium, %	0.14	Lead, mg/g	< 0.1

**Note: Based on data from the manufacturer, BULDRYHIM, Bulgaria*

in serum tubes and allowed to clot at room temperature for 2–3 h before centrifugation (2000 × g for 15 min). Serum was collected and stored at -20 °C for subsequent biochemical analysis. Whole blood samples were collected in EDTA tubes and stored at room temperature for hematological analysis within 6 h of sampling. Analytical blood count procedures were performed with a SYSMEX XS 500i 5-type differential count automatic hematology analyzer (Sysmex Europe GmbH, Norderstedt, Germany) and a Selectra Pro XL automatic biochemical analyzer (ELITech Group, Puteaux, France) in accordance with the instructions of the manufacturer. These include determination of leukocytes (WBC) by conductometric and visual optical method, erythrocytes (RBC) by conductometric method, hemoglobin (HGB) by cyan-methemoglobin method, hematocrit (HCT) by indirect based on method of conductometric analyses, average number of red blood cells (MCV) by conductometric method, mean content of hemoglobin in erythrocytes (MCH), mean concentration of hemoglobin in erythrocytes (MCHC).

Results and discussion

The obtained results for the productive parameters are presented in the Table. 3. The pigs from group II, which received brewer's yeast, consumed feed in higher levels. The received feed, on average per capita daily, was higher by 11.48% ($p < 0.05$) compared to the control group. Differences between groups are proven by pens, as the animals were housed in groups. The intake of

nutrients was higher in the animals of the experimental group than in the control group and was a consequence of the increased feed consumption. Our results for feed intake and nutrients are consistent with what was found by other authors (Sun et al., 2015: Dvorak and Jacques, 1998; Li et al., 2006). The reason for the increase in feed intake may be due to improving the taste in food after adding yeast. In addition, some researchers believe that yeast cells that have been treated with multiple enzymes have a better taste, since the enzymes have a strong influence on the degree of hydrolysis and the characteristics of the protein composition (Chae et al., 2001).

The addition of autolyzed yeast to the ration of weaned pigs had a beneficial effect on final live weight and average daily gain. Pigs from group II had a significantly higher daily gain by 16.50% ($p < 0.01$) compared to those from the control group (480 g/head/day vs. 412 g). Differences were also reported in the final live weight – in the animals of the second group it was higher by 8.91% (32.760 kg), compared to the first group (30.081 kg). Our results are in unison with those of Zhang et al. (2019). According to Kemp and Kiser (1970) cited by Zhang et al. (2019) glycan is a major component of yeast cells that has a significant impact on growth of animals. The probable reason is that yeast cells produce and release various proteolytic, glycolytic, or lipolytic enzymes to digest organic matter or absorb amino acids and monosaccharides, which has the effect of inhibiting bacteria, thereby increasing growth efficiency.

Regarding feed utilization, expressed in feed conversion ratio per kg of gain, significant differences between the two groups were not established.

The studied values of the complete blood picture and biochemical indexes can be a parameter for the health control of pigs, as they reflect the health status of the animals. The reference values of blood indicators in pigs vary considerably, mainly due to differences in age, breed, rearing and feeding technology and the laboratory methods of analysis used.

The results of the hematological tests show significant differences in the values of leukocytes, granulocytes and lymphocytes – forming elements of the body's cellular immune response (Table 4). The values of granulocytes in the animals receiving brewer's yeast were lower by 20.55% ($p < 0.01$) compared to those of the control group. The higher number of granulocytes in the pigs of group I could be associated with a probable avitaminosis B, taking into account the slightly lower hemoglobin (119 g/L with 6.05%) in these animals, compared to the experimental one (126.2 g/L). The increased values of granulocytes in the body are also associated with infectious and parasitic diseases – viral and bacterial infections, sepsis. No such diseases were reported during our experiment. Our study is in agreement with the research of Xiong et al. (2015), who

Table 3. Productive traits

Traits \ Groups	I Control	II Experimental
Feed intake, average per capita daily, kg		
$\bar{x}$	0.880	0.981*
%	100.00	111.48
$S^{\bar{x}}$	0.004	0.026
C	0.86	4.61
Protein intake, %	18.40	20.40
Lysine intake,%	0.96	1.08
Live weight, kg		
- At the beginning of the experiment	9.500	9.497
- At the end of the experiment	30.081	32.760
Average daily gain, g		
$\bar{x}$	0.412	0.480**
%	100.00	116.50
$S^{\bar{x}}$	0.017	0.017
C	19.04	14.99
Feed conversion ratio per kg gain, kg	2.138	2.113
Protein conversion ratio, %	44.69	43.95
Lysine conversion ratio, %	2.33	2.34
Duration of the experiment, days	50	50

Table 4. Hematological indicators

Indicators	Friendship (1984) Indicators	Group I Control		Group II + Brewer's yeast	
		$\bar{x}$	$S_{\bar{x}}$	$\bar{x}$	$S_{\bar{x}}$
Leukocytes (WBC)	8.7-37.9$_x$10^9/L	34.713	2.695	25.433**	1.981
Lymphocytes (LYM)	-	0.299	0.021	0.413***	0.023
Monocytes (MID)	0.001-5$_x$10^9/L	0.044	0.007	0.041	0.007
Granulocytes (GRAN)	-	0.657	0.018	0.545**	0.025
Lymphocytes (LYM)	-	9.740	0.358	10.087	0.588
Monocytes (MID)	-	1.007	0.196	1.133	0.257
Granulocytes (GRAN)	-	23.307	2.321	14.213**	1.604
Erythrocytes (RBC)	5.3-8.0$_x$10^{12}/L	7.081	0.113	6.859	0.111
Hemoglobin (HGB)	90-140 g/l	127.933	3.185	126.200	2.289
Hematocrit (HCT)	0.26-0.41 L/L	0.440	0.010	0.433	0.006
MCV	42-62 fL	62.067	0.963	63.267	0.886
MCH	14-21 pg	18.000	0.365	18.533	0.401
MCHC	320-360 g/L	290.800	2.075	291.867	2.232
RDW	-	0.158	0.004	0.151	0.005
Platelets (PLT)	-	354.800	31.043	404.867	23.393
MPV	-	10.107	0.165	10.280	0.182
PCT	-	0.284	0.013	0.292	0.017
PDW	-	14.567	0.379	13.540	0.394
Triglycerides	-	0.898	0.057	0.710*	0.068
Cholesterol	1.06-3.32 mmol/L	1.972	0.084	2.105	0.130
Urea	-	5.587	0.310	5.453	0.220
LDL cholesterol	-	0.869	0.063	0.970	0.073
HDL cholesterol	-	0.698	0.038	0.815	0.060

$^{***} - p \leq 0.001$, $^{**} - p \leq 0.01$, $^{*} - p \leq 0.05$

found a reduced number of neutrophil granulocytes in pigs fed diets enriched with β-glucans. Higher hemoglobin in the blood of pigs fed yeast, also found Gentry et al. (1991). The authors suggest that this is likely due to higher B vitamin content and that Hb (hemoglobin) status affects energy metabolism, with higher energy retention being associated with higher growth. According to Kogan and Kocher (2007) yeast cell wall components, such as β-glucans and mannanoligosaccharides, increase the production of immune cell populations, incl. neutrophils and monocytes.

Leukocyte values in pigs fed with brewer's yeast were lower by 36.48% ($p < 0.01$), while lymphocyte levels increased by 38.13% ($p < 0.001$), compared to those in the control group. The increased percentage of lymphocytes in the blood is characteristic of subcutaneous and chronic infections. T- and B- lymphocytes participate in immunogenesis and destroy harmful toxic substances that have come from the outside and have the importance of a filter in the lymph nodes. Dubreuil et al. (1993) reported that coping with stress can increase intraperitoneal temperature, but also increase the concentration of immune cells. According to Sanchez et al. (2019), weaned pigs fed with a compound feed with yeast supplementation had a reduced concentration of leukocyte populations, and that is associated with a stress response and not associated

with infections. In this experiment, it can be assumed that there is some nutritional stress when taking a yeast supplement. It is known that during stress, both carbohydrate and non-carbohydrate energy sources are mobilized, which allow the body to restore homeostasis. Considering this aspect, the increased level of lymphocytes can be considered as a useful adaptive reaction.

Based on the potential immune-enhancing effects of yeast products, it has been suggested that yeast supplementation results in improved growth, changes in leukocyte populations, and reduction of bacteria in the gastrointestinal tract (Sanchez et al., 2019).

Czarnecki-Maulden (2008) states that brewer's yeast directly binds pathogenic bacteria, thereby preventing the bacteria from binding to the gut, altering the pathogenic microbiota.

The values of triglycerides in the animals that received brewer's yeast were lower by 20.94% (0.710 mmol/l, $p < 0.05$), compared to those of the control group (0.898 mmol/l). Yeast has the property to normalize the function of the intestinal integrity. And the digestion and resorption of lipoids takes place under the influence of enzymes contained in the intestinal and pancreatic juice. This results in low blood lipid values, and probably accounts for the lower triglyceride values in the experimental animals.

Regarding the other indicators of the complete blood count and those of cholesterol and urea, the differences between the groups are insignificant and unreliable.

Conclusions

Substitution of 3% of soybean meal with autolyzed brewer's yeast in compound feed for weaned pigs (9.5 kg to 30.081–32.760 kg) of the Danube White breed increased feed consumption by 11.48% ($p < 0.05$) and the average daily gain increase by 16.50% ($p < 0.01$).

The inclusion of brewer's yeast has a beneficial effect on the piglet's health, expressed through some hematological indicators (significantly lower values of granulocytes, leukocytes and triglycerides).

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