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Effect of partial substitution of soybean meal with autolyzed brewer's yeast on the productivity and health status of weaned pigs

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Abstract

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The aim of the study was to determine the influence of the addition of autolyzed brewer's yeast on the productivity and the health status of weaned pigs.

A scientific and economic experiment was conducted at the Agricultural Institute – Shumen with 2 groups of 21 pigs in each group, or a total of 42 weaned pigs of the Danube white breed. The pigs were reared in raised pens of 7 pigs in a pen, 3 pens in a group. The animals were equalized by live weight, sex and origin. The experiment started at 9.385–9.464 kg of live weight and ended when it reached 28.95–30.786 kg. In the compound feed of the pigs in the experimental group, the 3% of the soybean meal was replaced with added autolyzed brewer's yeast.

The inclusion of autolyzed brewer's yeast (replacing 3% of soybean meal in the compound feed) in weaned pigs (9.385–9.464 kg to 28.95–30.786 kg lw) of the Danube White breed indicated a tendency for higher daily gain by 8.82% and lower feed conversion ratio per kg gain by 6.93%.

Addition of autolyzed brewer's yeast leads to optimization of lipid metabolism and changes some hematological parameters within physiological reference values.

Keywords: brewer's yeast; weaned pigs; blood indexes

Introduction

The use of antibiotics in pig farming as growth stimulants leads to an increase in antimicrobial resistance in humans. This also necessitated their ban in the EU countries, the USA and China. Even now, the problems of poor gut health and low growth performance of weaned pigs have not been fully resolved with antibiotic-free rations (Wang, 2022).

Live yeast and their cell wall directly bind pathogenic bacteria, thereby preventing their actions and potentially influencing host–microbiome interactions (Perez-Sotelo et al., 2005). In addition, cell wall components, such as mannan oligosaccharides, can bind directly to the intestinal wall and thus prevent bacterial binding to host epithelial cells (Kogan & Kocher, 2007; Spring et al., 2000; Ganner & Schatzmayr, 2012) and can directly affect bacterial growth within the gut, altering the pathogenicity of the microbiome (Czarnecki-Maulden, 2008). Both actions suggest a reduction in inflammation in the gut, which may alter other immune parameters.

Yeast cell wall components such as β-glucans and mannan oligosaccharides have been shown to alter immune function (Kogan & Kocher, 2007; Nochta et al., 2009) by activating recognition receptors, although the induced immune response may be influenced by the general health status of the animal (Teng & Kim, 2018). Approximately 70% of immune tissues are associated with the gastrointestinal tract (Jha et al., 2019). Reduction of inflammation in the gut may

lead to changes in other immune parameters and reduce the migration of pathogens from the gastrointestinal tract, thereby lowering overall systemic inflammation (Berg, 1999).

Based on the potential immune-enhancing effects of yeast products, it has been suggested that yeast supplementation will improve growth while altering the populations of various circulating leukocyte populations and reducing bacterial concentrations in the gastrointestinal tract (Sanchez et al., 2019).

Vetvicka et al. (2014) demonstrated that beta-glucans, a component of the yeast cell wall, play a role in pig growth. They stimulate the barrier functions of the mucosa by modulating the intestinal microbiota and maintaining the immune system in the intestine.

The aim of the study was to determine the influence of the addition of autolyzed brewer's yeast on the productivity and the health status of weaned pigs.

Material and Methods

A scientific and economic experiment was conducted at the Agricultural Institute – Shumen with 2 groups of 21 pigs in each group, or a total of 42 weaned pigs of the Danube white breed. The pigs were reared in raised pens of 7 pigs in each pen, 3 pens in a group. The animals were equalized by live weight, sex and origin. The experiment started at 9.385–9.464 kg of live weight and ended when the animals reached 28.95–30.786 kg. The component composition and the content of nutrients in kg of feed, presented in the Table 1, also represents a scheme of the experiment. The animals in group I were control, and those in group II were experimental. In the compound feed of the pigs in 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 (Table 1). The ratio of energy and nutrients in the compound feed (Table 2) is practically the same for animals in both groups. The content of protein, amino acids, vitamins and minerals in the applied brewer's yeast are presented in Table 3 (provided by the BULRAIDHIM, Bulgaria).

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 (14 per group, 5 males and 9 females) were taken 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 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

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
Soybean meal	33.00	30.00
Synthetic lysine	0.05	-
Brewer's yeast	-	3.00
Limestone	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 compound feed contains:		
Digestible energy, MJ	13.55	13.54
Metabolizable energy, MJ	13.00	13.00
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. Nutrient's ratio in compound feeds

Indicators \ Groups	I control	II + autolyzed brewer's yeast
Protein, g/MJ CE	15.42	15.36
Protein, g/MJ OE	16.08	16.00
Lysine, g/MJ **O**E	0.84	0.85
Lysine, g/100 g protein	5.21	5.29
Tryptophan, g/MJ OE	0.21	0.22
Tryptophan, g/100 g protein	1.34	1.39
Threonine, g/MJ OE	0.58	0.58
Threonine, g/100 g protein	3.59	3.65

Table 3. Protein, amino acid, vitamin and mineral content of autolyzed brewer's yeast*

Chemical composition of autolyzed yeast:			
Indicators	Autolyzed Yeast	Indicators (amino acids)	Autolyzed Yeast
Moisture, %	<5	Aspartic acid, mg/g	5.1÷4.5
Proteins, %	42÷46	Threonine, mg/g	2.09÷1.8
α –amino nitrogen,%	0.95÷1.05	Serine, mg/g	2.2÷1.9
Ash, %	<7	Glutamic acid, mg/g	6.5÷5.9
Vitamin B1, mg/kg	30÷70	Methionine, mg/g	1.6÷1.4
Vitamin B2, mg/kg	50÷110	Lysine, mg/g	3.8÷3.2
Vitamin B3, mg/kg	40÷75	Proline, mg/g	2.4÷2.0
Vitamin PP, mg/kg	500÷750	Glycine, mg/g	1.45÷1.1
Vitamin B6, mg/kg	35÷60	Alanine, mg/g	4.4÷3.8
Choline, mg/kg	3000÷3600	Valine, mg/g	4.5÷3.9
Vitamin, B12, mg/kg	6÷7	Isoleucine, mg/g	4.8÷4.1
Ergosterol, %	0.8÷1.1	Leucine, mg/g	7.4÷6.3
Total carbohydrates, %	34÷36	Tyrosine, mg/g	3.6÷3.1
Vitamin K, mg/kg	1.0÷1.8	Tryptophan, mg/g	1.1÷1.0
Biotin, mg/kg	1.0÷1.2	Phenylalanine, mg/g	4.3÷3.8
		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

(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).

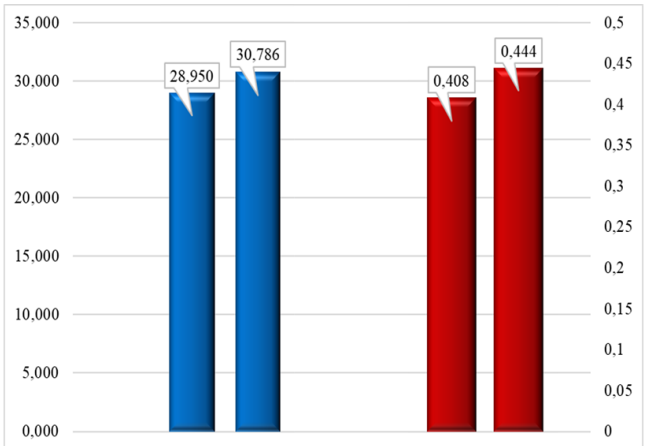
Results and Discussion

Feed consumption was practically the same in both groups, which is an indicator that the tested factor had no effect on the amount of received feed. Pigs from both groups received practically the same amount of compound feed (0.984±0.016 kg/day for I and 0.997±0.02 kg/day for II group). In our previous study (Yordanova et al., 2023), the inclusion of brewer's yeast had a significant impact on consumption. Chae et al. (2001) indicated that yeast cells that were treated with multiple enzymes had a better taste, since the enzymes had a strong influence on the degree of hydrolysis and the characteristics of the protein composition. Probably due to the insufficient number of animals in the present experiment, consumption was not affected.

The addition of autolyzed yeast to the diet of weaned pigs had a beneficial effect on final live weight and average daily gain (Figure 1). Pigs from group II had a higher daily gain by 8.82%, compared to those from the control group (444 g/animal/day vs. 408 g). Differences were also recorded in the final live weight – in the animals of group II it was higher by 6.34% (30.786 kg), compared to the I (28.95 kg). Our results are in agreement with those of Zhang et al. (2019). According to Zhang et al. (2019), glucan is a major component of yeast cells that has a significant impact on animal growth. 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.

Feed utilization expressed as feed conversion per kg gain was better in animals receiving brewer's yeast with the feed. There was a tendency for lower feed conversion in the pigs of group II by 6.93%, compared to those of group I (2.245 kg/day in group II vs. 2.412 kg/day – I group, Table 4).

The feed conversion ratio and nutrients per kg gain were lower by 5.37–7.36% in the animals receiving brewer's



	Live weight at the end, kg		Average daily gain, kg	
	I	II	I	II
Sx̄	0,473	1,306	0,009	0,025
C	7,30	15,87	10,13	21,44

Fig. 1. Live weight (kg) and average daily gain, kg

yeast, compared to those in the control group. These results are identical to those obtained in our previous study (Yordanova et al., 2023), where feed utilization was also better in pigs receiving brewer's yeast. The lower feed and nutrients per kg gain arena consequence of higher growth intensity although not significant in the present experiment.

Hematological examination is among the methods that can contribute to the detection of some changes in the health and physiological status of animals. Hematological parameters are good indicators of the physiological status of farm animals, and large differences have been found in farm animals caused by some factors. Therefore, it is necessary to investigate these factors and how they affect blood parameters (Etim et al., 2013).

Characterizing the results of the WBC (leucocytes) values in the blood, we observe a tendency towards a gradual increase of this indicator in the control group. Leukocytes take part in the mechanism of immunity by forming antibodies and atrephons, which promote the growth of tissues and the recovery of the body (Table 5). The increased values of this indicator in the control group indicates the slower and more difficult coping of the organism during the weaning period. Yeast cell wall components such as β-glucans and mannan oligosaccharides have been shown to increase the production of immune cell populations, including neutrophils and monocytes (Kogan & Kocher, 2007). Although there was no statistical increase in the concentrations of neutrophils and monocytes in the experimental group, the concentration of lymphocytes was decreased in the experimental group compared to the control pigs. These results are similar to the research conducted by Burdick Sanchez et al. (2019).

Hemoglobin values indicated a slight increase in the control group and a slight decrease in the experimental group animals, within the reference values, which could be interpreted as an optimization of the organism, which is directly related to the elevated MCHC values; MCV; MCH in the control and lowered ones in the experimental (287.500 g/l; 59.929 fl; 17.357 pg at the control and 228.429 g/l; 59.357 fl; 17.214 pg at the trial). The increased values of PLT (thrombocytes) in the experimental group cannot be analyzed as a sign of thrombocytosis, because it is within the normal range, but can be interpreted as a pronounced enhancement of the liver function in terms of the formation of blood clotting factors. Recovery in yeast supplementation after a state of vitamin B12 and/or vitamin B9 deficiency can result in enhanced thrombopoiesis (platelet formation) and high platelet levels over a period of time. MPV (mean platelet volume) reflects the average size of platelets present in the examined blood sample, while PDW (platelet distribution width) reflects the uniformity of platelet size.

Larger platelets are usually young and more likely to be released from the bone marrow, while smaller platelets are older and have been circulating in the blood for several days. Higher PDW values indicate that platelet sizes vary widely, suggesting increased thrombocytopoiesis. Platelets play a critical role in blood clotting and are first responders at sites of vascular injury or pathogen invasion, platelets play multiple roles in modulating both innate and adaptive immunity, thereby enhancing the body's defense against infection (Yeaman, 2014). Waititu et al. (2016) found that pigs receiving

Table 4. Feed intake, feed conversion ratio and nutrient intake in 1 kg compound feed

Groups / Indexes	Group I	Group II	%
	$\bar{x}$	$\bar{x}$	
Feed intake per capita/daily, kg	0.984	0.997	101.32
Protein intake daily, kg	205.7	207.4	100.83
Lysine intake daily, kg	10.7	11.0	102.80
Feed conversion ratio per kg gain, kg	2.412	2.245	93.07
Protein conversion, kg	504.1	467.0	92.64
Lysine conversion, kg	26.2	24.7	94.27

Table 5. Hematological indicators

Indicators	Units	I group control		II group + autolyzed brewer's yeast		Units on Friendship (1984)
		$\bar{x}$	S$\bar{x}$	$\bar{x}$	S$\bar{x}$	
WBC	G/L	21.343	0.941	20.786	0.709	8.7–37.9 x 10^9/L
LYM		0.634	0.014	0.637	0.025	–
MID		0.056	0.005	0.058	0.014	0.001–5 x 10^9/L
GRAN		0.312	0.016	0.305	0.028	–
LYM	G/L	13.493	0.637	13.214	0.620	–
MID	G/L	1.143	0.107	1.200	0.272	–
GRAN	G/L	6.707	0.489	6.371	0.640	–
RBC	T/L	6.879	0.127	6.741	0.129	5.3–8.0 x 10^{12}/L
HGB	g/L	118.143	1.927	115.143	1.997	90–140 g/l
HCT	L/L	0.412	0.006	0.400	0.008	0.26–0.41 L/L
MCV	fl	59.929	0.606	59.357	0.520	42–62 fL
MCH	pg	17.357	0.199	17.214	0.187	14–21 pg
MCHC	g/L	287.500	1.010	228.429	1.623	320–360 g/L
RDW	CV	0.161	0.004	0.159	0.004	–
PLT	G/L	420.000	13.183	483.071	39.771	–
MPV	fl	9.829	0.158	9.843	0.142	–
PCT	L/L	0.254	0.013	0.260	0.012	–
Triglycerides	mmol/l	0.669	0.280	0.563	0.076	–
Cholesterol	mmol/l	2.606	0.175	2.420	0.137	1.06–3.32 mmol/l
Urea	mmol/l	4.007	0.177	4.150	0.233	–
LDL	mmol/l	1.429	0.127	1.302	0.084	–
HDL	mmol/l	0.876	0.042	0.864	0.071	–

WBC – Leukocytes, LYM – Lymphocytes, MID – Monocytes, GRAN – Granulocytes, LYM – Lymphocytes, MID – Monocytes, GRAN – Granulocytes, RBC – Erythrocytes, HGB – Hemoglobin, HCT – Hematocrit, MCV – mean volume of erythrocytes, MCH – mean content of hemoglobin in erythrocytes, MCHC – mean concentration of hemoglobin in erythrocytes, RDW – red cell distribution width, PLT – Platelets, MPV – mean platelet volume, PCT – procalcitonin, LDL – low-density cholesterol, HDL – high-density lipoprotein cholesterol

yeast extract maintained higher white blood cell and platelet counts compared to the control group and suggested that yeast extract supplementation either had a role in preventing blood cell death or resulted in prolonged moderate formation of the formed elements of the blood during the intake of the supplement.

The results of the study by Zhang et al. (2019) indicate that yeast replacing imported feed protein sources used in pig farming has less impact on biodiversity loss, climate change and eutrophication. Meanwhile, yeast hydrolyzate can increase serum urea nitrogen in growing pigs, which trend we observed in the present experiment – 4.007 mmol/l for the control group and 4.150 mmol/l for the experimental group. The biochemical analysis of the blood shows certain fluctuations in the values of Cholesterol, HDL, Trigl, LDL chol, LDL cal., which testifies to changes in lipid metabolism. Zhang et al. (2019) reported that yeast extract reduced blood cholesterol content in pigs and this statement was consistent with the linear reduction in cholesterol content in broilers and matched the results obtained in the present study. Addition of yeast to pig feed significantly increased *Lactobacillus cecum* populations and increased lactate concentration in lactic acid bacteria (Daly et al., 2014), leading to optimization of lipid metabolism. Yeast also has the ability to normalize the function of the intestinal integrity, and the digestion and resorption of lipoids occurs under the influence of enzymes contained in the intestinal and pancreatic juices. This leads to lower values of blood lipid indicators in the experimental group.

Conclusions

The inclusion of autolyzed brewer's yeast (replacing 3% of soybean meal in the compound feed) in weaned pigs (9.385–9.464 kg to 28.95–30.786 kg lw) of the Danube White breed indicated a tendency for higher daily gain by 8.82% and lower feed conversion ratio per kg gain by 6.93%.

Addition of autolyzed brewer's yeast leads to optimization of lipid metabolism and changes some hematological parameters within physiological reference values.

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