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EFFECT OF THE ADDITION OF *SPIRULINA PLATENSIS* ON THE PRODUCTIVITY AND SOME BLOOD PARAMETERS ON GROWING PIGS

R. NEDEVA[1], G. JORDANOVA[1], E. KISTANOVA[2], K. SHUMKOV[2], B. GEORGIEV[2], D. ABADGIEVA[2], D. KACHEVA[2], A. SHIMKUS[3] and A. SHIMKINE[3]
[1] *Agricultural Institute, BG – 9700 Shumen, Bulgaria*
[2] *BAS, Institute of Biology and Immunology of Reproduction, BG – 1113 Sofia, Bulgaria*
[3] *Lithuanian University of Health Sciences, Kaunas, Lithuania*

Abstract

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A scientific - economic experiment with a total number of 48 Danube White pigs, divided into 3 groups of 16 pigs each, spread into 8 pig pens in two repetitions was carried out at the Agricultural institute – Shumen. The experiment was started with 12.15-12.471 kg live weight and finished with 30.9-33.9 kg. The experiment period was 47 days.

The aim of the present study was to investigate the effect of the addition of Spirulina platensis on the productivity, some blood parameters and health status on growing pigs.

The addition of microalgae *Spirulina platensis* (2 and 3 g/capita daily) in the compound feed of growing pigs (from 12.15-12.471kg to 30.9-33.9 kg live weight) from Danube White breed, significantly ($p \leq 0.05$) increases the growth intensity with 12.50 % and 14.25 % and reduces the compound feed conversion and nutrients.

The addition of *Spirulina* platensis effects insignificantly on the hemopoiesis stimulation – the number of erythrocytes and hemoglobin are higher with 15 % and 13 % respectively in animals fed with 3 g/capita daily microalgae.

There is a tendency of small number of sick animals (2.40 % and 2.13 %) fed with *Spirulina platensis* compared with those in the control group (5.40 %).

Key words : Spirulina platensis, fattening pigs, productivity, blood parameters

Introduction

It is a fact that the process of pig weaning causes physiological and psychological stress which is the reason of health problems in the gastrointestinal tract chiefly, reducing the daily gain and adequate utilization of feed. There are different scientific researches of alternative additions because of the limited usage of antibiotics in animal breeding. Because of this statement, nutrients with healthy and healing properties became more widely used. There is a tendency of looking for ecological safety nutrients which effect on the high biological value of feed (Ufimcev, 2009; Gamko et al., 2011; Hamad et al., 2011; Heidarpour et al., 2011; Shimkus et al., 2008a, b).

There is a wide currency of blue-green algae in the human and animal nutrition in the last few years, including species of microalgae Spirulina platensis as biologically active food supplements (Solntceva, 2004; Aly et al., 2011; Alvarenga et al., 2011; Belay et al., 1993; Cheoug Sun Hee et al., 2010; Grinstead et al., 2000).

Spirulina, as a constitution, was created by nature 3.6 million years ago (Shimkus et al., 2005). Spirulina is a unique system with its biochemical composition and its balanced content of vitamins, minerals and amino acids. Spirulina comprises high quantities of phycocyanin - 27% part of the composition (Shimkus et al., 2008b). It is a natural product which could even block the cancer cells' development. Spirulina is a source of carotenoids, chlorophyll, pigments

E-mail: r.nedeva@abv.bg

and essential polyunsaturated fatty acids as gamma linoleic acid (Peiretti and Meineri, 2011).

The aim of the present study was to investigate the effect of the addition of *Spirulina platensis* on the productivity, some blood parameters and health status on growing pigs.

Material and Methods

A scientific - economic experiment with a total number of 48 Danube White pigs, divided into 3 groups of 16 pigs each, spread into 8 pig pens in two repetitions was carried out at the Agricultural institute – Shumen. The experiment was started with 12.15-12.471 kg live weight and finished with 30.9-33.9 kg. The experiment period was 47 days.

Pigs from I (control) group were fed with starter compound feed, containing 19.1% crude protein, 1.01% lysine, 13.30 MJ digestible energy, 12.69 MJ metabolizable energy, 1.01% calcium and 0.65% phosphorus. Animals from II and III (experimental) groups were fed with the same starter compound feed with an addition of 2g and 3g/capita daily Spirulina platensis (SP), respectively. The content of the addition was of 100% dry biomass of microalgae Spirulina platensis (Platensis Ltd product, Lithuania). The content of vitamins and minerals in the used SP is given in Table 1. This product has been examined for the first time with boars in our country (Kistanova et al., 2009; Kistanova et al., 2010) and it hasn't been examined for the rest of the categories.

Some traits were controlled during the experiment as: feed intake – daily, in groups in pig pens; average daily gain – in the beginning and in the end of the experiment, individually; feed conversion/ kg gain – for the whole period; health status – daily.

Finishing the experiment, some blood was taken from 10 pigs/ group for a complete blood count analysis and for some biochemical traits: liver enzymes' cholesterol; total protein and albumin; minerals.

The pig breeding was made in groups, devided into 8 pigs in pig pen, fed and watered *ad libitum*.

The data have been treated by the methods of the variation statistics.

Results and Discussion

The obtained results from feed intake and average daily gain are given in Table 2. The data analysis showed that the feed intake in pigs from the experimental (II and III) groups fed with Spirulina platensis addition was higher with 6.98% and with 7.56% in comparison with those from the control I group.

The addition of Spirulina platensis in dose 2g or 3 g/per capita daily caused a significant increase of growth intesity with 12.50 % ($p \leq 0.05$) in animals from II group and with 14.25% ($p \leq 0.05$) in those from III group. Feed utilization expressed in feed conversion per kg gain was better in pigs from the experimental groups. The feed conversion and nutrients in pigs from II group, fed with 2 g per capita daily, was lower with about 5% compared with those from the III group (fed with 3 g per capita daily) where the feed conversion was lower with about 6%. The obtained results from our study were not entirely the same as those of Grinstead et al. (2000), which have established minimal improvement of the growth of piglets fed with Spirulina platensis. Authors have added Spirulina by treating the animals with antibiotics Carbodox 55 µg/kg and 2000-3000 mg Zn as growth stimulators. The difference was that there was not an addition of any antibiotics or growth stimulators in our experiment.

Solntceva (2004) established some increase of the gain with 18.2% in weaning pigs and some decrease of the feed

Table 1
Characteristic of Spirulina platensis, in 10g (vitamins and minerals)

Traits	Units	Values
Vitamin A	IU	23000
Beta carotene	µg	14
Vitamin D	IU	1200
Vitamin E	µg	1
Vitamin K	µg	200
Biotin	µg	0.5
Inositol	µg	6.4
Vitamin B_1 (thiamine)	µg	0.35
Vitamin B_2 (riboflavin)	µg	0.4
Vitamin B_3 (niacin)	µg	1.40
Vitamin B_6 (pirydoxine)	µg	80.00
Vitamin B_{12} (cobalamin)	µg	20
Pantothenic acid	µg	10
Minerals:		
Calcite	µg	70
Iron	µg	15
Phosphorus	µg	80
Magnesium	µg	40
Zinc	µg	0.3
Selenium	µg	10
Copper	µg	120
Manganese	µg	0.5
Chrome	µg	25
Sodium	µg	90
Potassium	µg	140
Germanium	µg	60

Table 2
Productive traits

Groups	I	II	III
Traits	control	+ 2g SP per capita/ daily	+ 3g SP per capita/ daily
Feed intake, capita/daily:			
Compound feed, kg	1.178	1.260	1.267
%	100.00	106.98	107.56
Protein, g	224.8	240.4	241.7
Lysine, g	11.90	12.73	12.80
Live weight, kg			
- in the beginning of the experiment			
x	12.150	12.471	12.380
C	10.53	9.05	9.82
E	2.82	2.42	2.54
- in the end of the experiment			
x	30.929ab	33.600a	33.867b
C	7.45	10.90	12.77
E	1.99	2.91	3.30
Average daily gain, g			
x	400ab	450a	457b
C	9.63	17.51	18.77
E	2.57	4.68	4.85
Feed conversion per 1kg gain:			
Compound feed, kg	2.952	2.800	2.772
%	100.00	94.85	93.90
Protein, g	563.2	534.2	528.9
Lysine, g	29,8	28,3	28,0

SP - Spirulina platensis
a, b - $p \leq 0.05$ Significant differences between groups are marked with equal letters.

conversion ratio and utilization of metabolizable energy with 15.2% and 15.6% respectively by adding Spirustim (preparation based on Spirulina platensis) in the ration.

The analysis of the biochemical blood parameters indicated that *Spirulina platensis* didn't affect liver function in piglets (Table 3). There were not any significant differences in the levels of liver enzymes – gamma-glutamine aminotrasferase (GGT), alanine aminotrasferase (ALT) between the control and experimental groups. The absolute values of these enzymes in both experimental groups were within the acceptable physiological norms. The level of the alkaline phosphatase was significantly ($p \leq 0.05$) higher in the experimental groups with 43.38% in II and with 52.35% in those from III group.

There was a tendency of reducing the level of urea with 13.7% and with 25,5% respectively in animals fed with 2 g and 3 g Spirulina (Table 3) in comparison with the control group. The above mentioned data indicated about the anabole effect of the addition. These data confirmed the results about the weight development of animals from the experimental groups where there was some indication of higher growth intensity. The alkaline phosphatase with its higher values corresponded well with the level of urea and with fact that the metabolism in the experimental groups was higher which was also confirmed by the data about the average daily gain.

There was no change of the cholesterol level in the blood by adding 2 g and 3 g per capita Spirulina. Some literary data (Heidarpour et al., 2011) indicated that the cholesterol level became significantly lower in blood in young calves being fed with higher content of Spirulina in the ration – 25g/capita and with – 2 g and 6 g/capita, there were not determined any differences in the cholesterol level between the experimental and control groups, as well as in our experiment.

There was a tendency in III group of increasing the values of total protein and globulin. Because of the big individual traits' variation significant differences between the groups were not established. The proportion between globulin and albumin in blood was an important trait for the normal protein metabolism. The stability of this trait in all three groups indicated that the addition of Spirulina platensis didn't effect in any way on the protein metabolism.

Heidarpour et al. (2011) didn't find out any tendency for changing these traits in growing calves compared with the control group depending on the different content of Spirulina in the ration.

The addition of Spirulina in the ration improved the proportion of Ca/P in blood better (0.89 in III group in comparison with 0.75 in control group) and didn't reach the reference value which was more than 1. The insufficiency of the dose or the short period of the feeding up might be the reason for the above mentioned statement.

There was a positive but insignificant effect of the Spirulina on the hemopoiesis (Table 4). Animals in III group differ from those in the control one by 15% higher number of red blood cells and 13% higher content of hemoglobin. Hematocrit was also with higher value (41% compared to 35% in the control group). Similar results were obtained by adding the same product in experiments with cows (Shimkus et al., 2008a), fattening pigs (Shimkus et al., 2008b) and lambs after weaning (Shimkiene et al., 2010). It was, probably, due to the high content of folic acid and vitamin B12 in the addition and their better absorbtion. Regarding the white blood cells (WRC) there were no significant differences between the groups and the values in all three groups were in the limits of the physiological norms and in accordance with the values established by Ivanova (2007) in piglets.

Table 5 presents the diseases rate of pigs and indicates that the frequency of the digestive diseases is twice lower in pigs fed with *Spirulina platensis*, while the whole experimental period there were only two days of intestinal diseases in animals. Shimkus et al. (2008a) have established positive influence of Spirulina on the intestinal microflora in the experiment with fattening pigs. The addition of *Spirulina platensis* in the researches of Shimkus et al. (2008a) has indicated significant increase of the number of lactic acid bacteria in all parts of the large intestine. The percent of the other diseases rates was very small while in III experimental group there were not any diseases rates. Our results pointed to the lower total diseases rate in pigs fed with the addition Spirulina platensis in the ration. The percent of diseases rate in experimental (II and III) groups was 2.40 % and 2.13% respectively and in those from the control one was 5.34%. The given results were achieved because of the high biological activity of the Spirulina components – vitamins, minerals. Many researches confirmed that the use of Spirulina positively effects on the immune system and increases the stability of the system toward deseases (Khan et al., 2005).

Conclusions

The addition of microalgae *Spirulina platensis* (2 and 3 g/capita daily) in the compound feed of growing pigs (from 12.15-12.471kg to 30.9-33.9 kg live weight) from Danube White breed, significantly ($p \leq 0.05$) increases the growth intensity with 12.5 % and 14.25% and reduces the compound feed conversion ratio and nutrients with 5-6%.

The addition of *Spirulina* platensis effects insignificantly on the hemopoiesis stimulation – the number of erythrocytes and hemoglobin are higher with 15% and 13% respectively in animals fed with 3 g/capita daily microalgae.

Table 3
Biochemical parameters in plasma of growing pigs

Groups	I group		II group		III group	
Traits and reference values	n=10		n=10		n=10	
		E		E		E
UREA, 2.9-8.8mmol/L	5.10	0.8	4.40	0.4	3.80	0.3
GGT, 31-52 U/L	39.3	2.50	38.9	4.70	49.2	5.70
ALP, 41-176 U/L	363.5ab	44.1	521.2a	43.3	553.8b	34.70
ALT, 22-56 U/L	53.4	4.10	44.7	3.50	56.7	5.30
Cholesterol, 2.1-3.48 mmol/L	5.10	0.20	5.20	0.10	5.0	0.20
Total Protein (TP), 58-83 g/L	77.2	2.50	77.3	1.80	80.6	2.00
Albumin(Alb), 23-40 g/L	54.4	1.30	54.7	3.80	56.6	3.10
Total Gl, TP-ALB	22.80	-	22.60	-	24.00	-
Ratio Gl/Alb	0.42	-	0.41	-	0.42	-
P, 1.8-3.0 mmol/L	4.10	0.3	3.90	0.1	3.80	0.1
Ca, 2.3-2.9 mmol/L	3.10	0.2	3.10	0.1	3.40	0.1
Ratio Ca/P	0.75	-	0.79	-	0.89	-

Note : Reference values are indicated in brackets below the corresponding traits.
a, b - $p \leq 0.01$

Table 4
Changes in cell composition of blood

Groups	Reference values *	I group		II group		III group	
Traits		n=9		n=10		n=10	
			E		E		E
WBC	11,0-22,0	21.6	1.4	20.6	1.3	22.7	1.2
RBC	6,0-8,0	5.9	0.2	6.0	0.5	6.8	0.5
Hgb	100-170	103.8	2.9	107.3	10.3	116.9	7.2
Hct	32,0-50,0	35.1	0.08	37.1	2.8	41.0	3.5

* Reference values are according Parvanova (2004)

Table 5
Diseases of pigs

Diseases	Groups		
	I	II	III
	control	+ 2g SP per capita/daily	+ 3g SP per capita/daily
Digestive troubles:			
number	38	16	16
%	5.20	2.13	2.13
Affection of the lungs:			
number	1	-	-
%	0.14	-	-
Other diseases:			
number	-	2	-
%	-	0.27	-
Dead:			
number	1	-	-
%	0.14	-	-
Diseases (totally)			
number	39	18	16
Rate, %	5.34	2.40	2.13

There is a tendency of a lower level of diseases animals (2.40% and 2.13%) fed with *Spirulina platensis* compared with those in the control group (5.40%).

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