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EFFECT OF THE ADDITION OF *SPIRULINA PLATENSIS* ON THE CARCASS TRAITS, CHEMICAL COMPOSITION AND PHYSICAL CHARACTERISTICS OF *M. LONGISSIMUS DORSI* IN FATTENING PIGS

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Abstract

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In Agricultural institute – Shumen a scientific-economic experiment with 33 fattening pigs from Danube white breed divided into three groups was carried out. The experiment was divided into two sub periods, has started in 34 kg live weight to 60 kg (I sub period) and has ended in 102.5–106.3 kg live weight. I group was control; the pigs from II group was supplemented with *Sperulina plantensis* during second sub period of fattening, and III group – during whole fattening period. A slaughter analysis was made of all the animals after 24 hours of cooling the carcass as the dimensions were established by Bulgarian State standard (BDS) 4349-78 (1978). The aim was to establish the effect of the addition of *Spirulina platensis* on the carcass traits, chemical composition and the physical characteristics of M. long. dorsi in fattening pigs. It was established that by adding of *Spirulina platensis* (2 g/pig/d) the percent of the meat with bones in the separate parts of the carcass increases and the values of the total fat quantity in the carcass are considerably lowered – with 20.31% in pigs from the II group and with 17.85% in those from the III group. The fat percent in animals' meat is insignificantly lower from the experimental group as a result of the lower lipogenesis caused by the addition of Spirulina platensis. *Spirulina platensis* didn't influence significantly on the traits water, fats, water retention, pH2 and loss of weight in heat treatment.

Key words: fattening pigs, *Spirulina platensis*, carcass, chemical composition

Introduction

The interest for the so-called functional foods (DG for Research FP7-Food, 2010) over the last years grew bigger. Functional foods contribute for the satisfaction of the basic food needs as well as for the positive effect on the human's health status. In this connection, ways are looking for improving the quality of food from animal origin. Such an opportunity is the addition of different biologically active supplements.

The biologically active addition *Spirulina platensis* (Solnceva, 2004; Aly et al., 2011; Alvarenga et al., 2011; Grinstead et al., 2000) is widely spread in people's feeding as well as in animals for a long time. The presence of microalgae (*Arthrospira, Spirulina platensis, Chlorella*) in ration helps the natural normalization of the metabolism in the system without using chemically synthesized medicine (Zaripov, 1982).

Spirulina contains to 70% of protein in the dry matter, the addition is rich of all unique amino acids. Spirulina also con-

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tains to 20% carbohydrates, 8% lipids, it is a valuable source of carotinoids, vitamins, microelements, plant hormones and other biologically active substances (Viktorovich, 2007).

Simkus et al. (2008, 2013) indicate improvement of carcass qualities – slaughter output and quality of meat in fattening pigs using the addition microalgae Spirulina platensis in rations.

The aim was to establish the effect of the addition of *Spirulina platensis* on the carcass traits, chemical composition and the physical characteristics of *M. longissimus dorsi* in fattening pigs.

Materials and Methods

In Agricultural institute – Shumen a scientific-economic experiment with 33 fattening pigs from Danube white breed divided into three groups was carried out. The experiment was divided into two sub periods, has started in 34 kg live weight and has ended in 102.5–106.3 kg live weight. During the first sub period (from 30.kg – 60.kg live weight) pigs from control (I) group were fed with compound feed containing 17.15% crude protein, 0.84% lysine, 12.83 MJ metabolizable energy, 1.01% calcium and 0.69% phosphorus, and during the second sub period (60 kg–110 kg live weight) animals were fed with compound feed containing 15.17% crude protein, 0.72% lysine, 12.76 MJ metabolizable energy, 0.52% calcium and 0.46% phosphorus. Animals from experimental (II and III) groups were fed with the same compound feed used for the first group. For the second group in the given compound feed was added 2 g Spirulina platensis per pig daily only during the second sub period and for the third one – during the whole experimental period.

After the end of the experiment slaughter analysis was made of all the animals after 24 hours of cooling the carcass as the dimensions were established according to Bulgarian State standard (BDS) 4349-78 (1978).

The chemical composition of meat was established by methods described by Sandev (1979).

Physical properties of meat were established by the following methods: pH in meat was established according to Pojariskaia et al. (1964). The colour of meat was determined in three samples on both sides respectively of the two centimeters cut made perpendicularly along the muscular fibers (24 h post mortem). The colour measurements were made using the spectrocolourmeter "Specol" in wave-length 525 nm according to Pinkas (1981). The thickness of muscular fibers and the loss of weight in backed meat were established by methods of Otto (1959, 1963, 1964). Water retention was estimated according to Grau and Hamm (1952).

Results

The results characterizing some of the carcass traits are shown in table 1. Pigs from the control group differed with larger area of *M. longissimus dorsi* compared with those from the experimental groups. The differences are statistically insignificant.

In pigs from the experimental groups (II and III) values of the fat in back and in points (x_1, x_2 and x_3) are significantly lower compared with those from the Ist (control) group (Table 1). Fat thickness in back is thinner with 18.10% (II group) and with 14.51% (19.833 mm, III group) in comparison with the control one (Figure 1). The fat thickness in points x_1, x_2 and x_3 is also with lower values in experimental animals – with 14.25% (II group) and with 4.11% (III group) in x_1, with 14,49% (II group) and with 3,51% (III group) in x_2 and with 9.94% (II group) and with 3.73% (III group) in x_3 (Figure 2).

Table 1

Slaughter qualities

Groups / Traits	I group			II group			III group		
	$\bar{x}$	C	E	$\bar{x}$	C	E	$\bar{x}$	C	E
Live weight, кg	111.600	1.359	0.608	108.500	1.270	0.519	111.000	1.507	0.615
Carcass weight, kg	80.080	3.912	1.749	76.500	1.486	0.607	79.933	1.498	0.612
Half part, кg	40.040	3.912	1.749	38.250	1.486	0.607	39.967	1.498	0.612
Slaughter output, %	71.759	3.789	1.694	70.507	0.942	0.384	72.019	1.530	0.625
Thickness of fat in shoulder, %	37.000	15.989	7.151	30.583	16.099	6.572	30.167	23.572	9.623
Thickness of fat in back, %	23.200	19.846	8.876	19.000	9.415	3.844	19.833	12.521	5.112
Stook x_1	29.200	19.881	8.891	25.333	13.132	5.361	28.000	17.053	6.962
Stook x_2	22.800	17.653	7.895	19.500	12.027	4.910	22.000	24.393	9.959
Stook x_3	32.200	12.108	5.415	29.000	11.744	4.795	31.000	11.896	4.857
Area MLD, cm^2	41.960	5.704	2.551	37.980	14.586	6.523	41.500	9.758	3.984

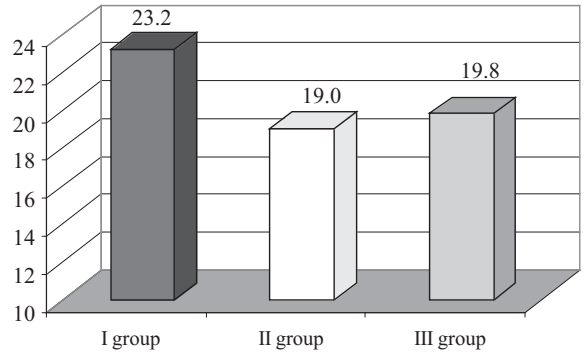

Fig. 1. Thickness of back fat, %

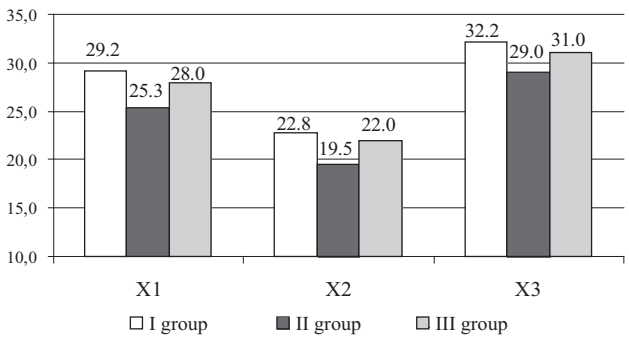

Fig. 2. Thickness of back fat in x_1, x_2 and x_3, mm

The obtained differences, even insignificant, in all traits which characterize the fat indicate that *Spirulina platensis* affects the lipid metabolism in system.

The results from the control slaughter in the experiment of Ufimcev (2009) presented an increase of the meat yield with 6.4% when microalgae are used in dose 125 ml/kg dry matter intake. These results also indicated that the area of *M. longissimus dorsi* increases with 10.52% in comparison with the control group.

Table 2
Carcass composition

Groups / Traits	I group			II group			III group		
	$\bar{x}$	C	E	$\bar{x}$	C	E	$\bar{x}$	C	E
Neck, kg	5.540	8.032	3.592	5.117	9.284	3.790	5.333	9.236	3.771
Meat, kg	5.020	9.280	4.150	4.633	10.092	4.120	4.867	8.489	3.466
Meat with bones, %	90.561	3.297	1.474	90.515	2.063	0.842	91.364	3.820	1.559
Fat, кg	0.520	28.524	12.756	0.483	20.342	8.305	0.467	44.263	18.070
Fat in carcass, %	9.439	31.633	14.147	9.484	19.686	8.037	8.635	40.411	16.498
ham, kg	5.140	6.540	2.925	5.283	7.796	3.183	5.667	4.274	1.745
Meat, kg	3.960	9.209	4.119	4.100	6.545	2.672	4.517	9.437	3.853
Meat with bones, %	76.947	3.174	1.419	77.762	5.553	2.267	79.625	6.562	2.679
Fat, кg	1.180	7.090	3.171	1.183	24.150	9.859	1.150	25.052	10.227
Fat in carcass, %	23.053	10.594	4.738	22.238	19.417	7.927	20.375	25.645	10.470
Chest, kg	6.520	8.498	3.800	5.967	5.264	2.149	6.267	6.592	2.691
Meat, kg	4.660	10.578	4.731	4.417	5.623	2.295	4.550	10.191	4.160
Meat with bones, %	71.389	3.048	1.363	74.052	3.715	1.517	72.543	6.308	2.575
Fat, kg	1.860	7.213	3.226	1.550	12.741	5.201	1.717	16.234	6.628
Fat in carcass, %	28.611	7.604	3.401	25.948	10.601	4.328	27.457	16.665	6.804
Stomach, kg	10.140	12.210	5.461	9.183	12.575	5.134	9.117	8.423	3.439
Meat, кg	6.260	11.102	4.965	6.317	12.721	5.193	6.150	17.292	7.060
Meat with bones, %	62.024	8.680	3.882	69.207	12.591	5.140	67.371	15.273	6.235
Fat, кg	3.880	22.791	10.193	2.867	36.763	15.009	2.967	31.162	12.722
Fat in carcass, %	37.976	14.177	6.340	30.793	28.297	11.552	32.628	31.537	12.875
Real ham, kg	8.260	7.394	3.307	8.233	4.588	1.873	8.533	6.490	2.649
Meat,кg	6.380	11.698	5.231	6.667	7.389	3.017	6.933	9.768	3.988
Meat with bones, %	77.047	4.839	2.164	80.921	4.313	1.761	81.144	4.260	1.739
Fat, кg	1.880	9.515	4.255	1.567	17.442	7.121	1.600	15.811	6.455
Fat in carcass, %	22.953	16.244	7.264	19.079	18.294	7.468	18.856	18.332	7.484
Shin, kg	1.460	3.752	1.678	1.417	5.314	2.169	1.433	9.532	3.891

Spirulina platensis intensifies the biological and food value of carcass products by increasing the protein and mineral elements (iron, copper, manganese) concentration in meat. The addition of Spirulina increased the content of vitamin A with 16% and vitamins of group B with 39.7% (Милогородский, 2006).

Investigations of Iansons and Zmelianov (2010) pointed to the fact that the addition of plant supplements in compound feed of fattening pigs has lowered the quality of intramuscular fat with 0.3% and the cholesterol with 9.2% in comparison with the control group.

The use of plant supplements (herbs) and organic acids improve the quality of meat, insure higher quality of protein in the muscular tissue, i.e higher nourishing value (Jansons et al., 2011).

Jansons and Jemeljanovs (2010) established that the applied phytogenic supplements improve the quality of the final product as the slaughter weight increases with 4.4% and the content of muscular tissue in the carcass increases with 2.7%.

In an experiment with fattening pigs was established that there were not any significant differences for the physicochemical traits of meat and fat. Ration of 0.04% probiotic additions in the experimental group didn't influence the composition of the intramuscular fat and back fat in comparison with the control group. The same tendency was observed in pigs with 0.06%, probiotic additions from the ration except for the increased palmitoleic acid of back fat (Sudikas et al., 2010).

Regarding the carcass composition there are not any significant differences in the traits between the separate groups (Table 2).

The values of neck weight, neck steak and fat in neck are higher in pigs from the control (I) group with about 3–8% in comparison with the experimental (II and III) groups. The percent of meat with bones in chest is the highest in animals from the second group ($p \leq 0.05$), as they stored up the least fat in this part of the carcass. The percent of meat with bones in real ham is the highest in animals from the third group. These pigs were fed with 2 g/day *Spirulina platensis* during the whole experimental period in comparison with the animals from first and second group. The quantity of fat in real ham is less in animals from second and third group. Pigs from second group had stored up significantly less fat ($p \leq 0.05$) compared with those from the control (I) one. Regarding animals from third group, differences are not significant and may be considered as a tendency. There are also significant differences between animals from first and third group regarding the weight of fore shank ($p \leq 0.05$) and percent fore shank from the half part ($p \leq 0.01$). In pigs from third group the quantity of meat in fore shank is significantly much more with 14.07% compared with those from the control one ($p \leq 0.05$) and not significantly bigger with 10.17% in comparison with animals from second group. Significant differences between values for stomach and shin in separate groups are not observed except for the higher percent of meat and less quantity of stored fat in stomach in experimental groups compared with the control one. Differences are not significant (Table 2).

The addition of *Spirulina platensis* in the compound feed for fattening pigs has increased insignificantly the total quantity of meat with bones with 5.03% in pigs from the II group and with 5.32% in those from the III group. The same addi-

Table 3

Chemical composition and quality of meat from m. longissimus dorsi

Groups / Traits	I group			II group			III group		
	$\bar{x}$	C	E	$\bar{x}$	C	E	$\bar{x}$	C	E
Water, %	69.62	1.33	0.54	69.87	1.73	0.71	69.92	1.57	0.70
Protein, %	24.56	4.40	1.80	24.49	2.50	1.02	24.63	2.50	1.12
Fat, %	4.60	10.71	4.37	4.42	16.64	6.79	4.22	21.40	9.57
Minerals, %	1.23	6.45	2.63	1.23	4.86	1.99	1.23	2.99	1.34
PH1	5.885	2.87	1.17	5.883	2.44	1.00	5.810	2.33	1.04
PH2	5.800	2.43	0.99	5.783	2.24	0.92	5.758	2.04	0.91
Thickness of muscular fibers, μm	49.105	4.12	1.68	44.773	5.37	2.19	43.328	18.40	8.23
Water retention, %	29.00	8.84	3.61	29.22	4.66	1.90	30.57	7.08	3.16
Colour, nm	23.737	7.50	3.06	25.705	4.15	1.69	25.378	5.79	2.59
Weight loss at boiling, %	49.50	5.38	2.20	51.000	2.15	0.88	49.600	5.26	2.35
Weight loss at roasting, %	53.17	2.50	1.02	53.333	2.82	1.15	53.000	2.67	1.19

tion has lowered significantly the values of the total fat quantity in the carcass – with 20.31% in pigs from the II group and with 17.85% in those from the III group. Those differences are probably due to the influence of microalgae *Spirulina platensis* on the lipid and protein metabolism in pigs. Therefore, *Spirulina platensis* is one of the few nutritive factors which influence on the values of the carcass traits.

In Table 3 are shown the chemical composition and quality traits of meat which are of a high importance for market value. Pigs' meat from the three groups differs by some quality traits. The examined addition from *Spirulina platensis* didn't influence on values of protein (%) and minerals (%) but lowered the level of intramuscular fat – for II group with 3.92% and for III one with 8.07% in comparison with the control (I) group. Even not significant results confirm that tendency of adding *Spirulina platensis* causes a decrease of quantity of fat in carcass. Lower levels of fat in meat from experimental animals can be explained by a decrease of lipogenesis, as a result from the addition of *Spirulina platensis*. Regarding the values of traits pH_1, pH_2, water retention and weight loss at boiling and roasting there are not significant differences. Dimensions of muscular fibres vary within large borders. According to Pinkas and Marinova (1984) the quality of meat is influenced by the diameter of muscular fibres. Pigs from experimental groups (II and III) have got thinner muscular fibers – in II group with 8.82%, in III group with 11.76% in comparison with the control one. These differences are not significant and may be considered as a tendency. According to Petrov (1990) the tenderness of meat results from thinner fibers.

Investigations of Angelov et al. (1993a) show that traits as water, fats, water retention, pH_2 and loss of mass in heat treatment are defined by animal's origin; the minerals and diameter of muscular fibers are defined by the level of protein in ration. The colour of meat is one of the main traits which characterize the quality of meat. The colour is a function of many biochemical and physicochemical processes which run in the muscles for a life time and post mortem (Pinkas and Marinova, 1984). Data analysis from the present investigation for the trait colour indicates that this trait is remarkable for a little higher values in experimental animals- with 8.29% in II group and with 6.91% in III group in comparison with the control one (I).

Conclusions

The addition of microalgae *Spirulina platensis* in dose 2 g/ pig daily increased the percent of meat with bones in the separate parts of carcass and significantly lowered the values of the total quality of fat in carcass – with 20.31% in pigs from II group and with 17,85% in those from the III one.

Insignificantly lower levels of fat in animals' meat fed with *Spirulina platensis* were established.

Spirulina platensis didn't cause a significant influence on traits water, fat, water retention, pH_2 and weight loss in heat treatment.

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