# THE EFFECT OF BLUE ALGAE *SPIRULINA PLATENSIS* ON PIG GROWTH PERFORMANCE AND CARCASS AND MEAT QUALITY

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**Abstract.** In order to study the effect of fresh blue algae *Spirulina platensis* biomass on pigs fattening rate and meat quality an experiment was carried out with 85-days-old crossbreds of Landrass and Yorkshire. Two groups – control and experimental – were formed, each containing 16 pigs. Both groups of the pigs were fed standard concentrate forage. 1 kg of forage dry matter contained 13.4 MJ AE and 16 % of crude protein. The pigs of the experimental group were given daily and individually 2 g of 75 % humidity fresh blue algae *Spirulina platensis* biomass with forage. The pigs were weighed at the beginning and the end of the experiment. Control fattening was considered to be finished when pig weight reached 95 kg. At the end of the experiment, control slaughtering was performed. It was determined that the average daily weight gain of the pigs given 2 g of 75 % humidity fresh biomass of blue algae *Spirulina platensis* was by 9.26 % higher, 100 kg of weight was reached by 7.37 days faster, and the amount of AE consumed for 1 kg of weight gain was by 1.28 MJ AE lower than in the control group. Carcass output of the experimental pigs was by 2.02 % higher and the amount of intramuscular fat– by 0.33 % lower than in the control group of pigs.
**Keywords:** blue algae *Spirulina platensis*, pigs, weight gain, carcass, meat quality.

# MELSVADUMBLIO *SPIRULINA PLATENSIS* ĮTAKA KIAULIŲ AUGIMUI, SKERDENŲ IR MĖSOS KOKYBEI

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**Santrauka.** Aiškinantis šviežio melsvadumblio *Spirulina platensis* biomasės įtaką kiaulių penėjimosi spartai, mėsinėms savybėms ir mėsos kokybei, atliktas bandymas su 85 dienų landrasų ir Jorkšyrų veislės kiaulių mišrūnais. Sudarytos dvi po 16 kiaulių grupės – kontrolinė ir tiriamoji. Abi kiaulių grupės šertos standartiniu kombinuotuoju pašaru, kurio 1 kg sausųjų medžiagų buvo 13,4 MJ AE ir 16 proc. žalių baltymų. Tiriamosios grupės kiaulės su pašaru individualiai kiekvieną dieną gavo po 2 g 75 proc. drėgmės šviežios melsvadumblio *Spirulina platensis* biomasės. Kiaulės svertos bandymo pradžioje ir pabaigoje. Kontrolinis penėjimas buvo baigtas, kai kiaulės pasiekė 95 kg svorį. Bandymo pabaigoje atliktas kontrolinis skerdimas. Nustatyta, kad kiaulių, gavusių per dieną po 2 g 75 proc. drėgmės šviežios melsvadumblio *Spirulina platensis* biomasės, vidutinis paros priesvoris buvo 9,26 proc. didesnis, 100 kg masę jos pasiekė 7,37 dienomis greičiau, o 1 kg priesvorio sunaudojo 1,28 MJ AE mažiau, nei kontrolinės grupės kiaulės. Tiriamų kiaulių skerdenos išeiga buvo 2,02 proc. didesnė, o mėsoje nustatyta 0,33 proc. riebalų mažiau, nei kontrolinės grupės kiaulių.
**Raktažodžiai:** melsvadumblis *Spirulina platensis*, kiaulės, priesvoris, skerdena, mėsos kokybė.

**Introduction.** Recently, in Lithuania as in many European countries the requirements for productive features and production quality have been rising. In order to compete successfully in the European market, the production must be of high quality and safe to human health. As a consequence of the rising demand for qualitative and safe animal production, farmers tend to use natural and healthy zootechnical food additives which positively affect animal healthiness, increase animal productivity and improve production quality (Ellersiek, 2006; Leikus, Norviliene, 2006). The effectiveness and competitiveness of poultry meat production mainly depend on the quality of produced meat. Qualitative and safe food products are necessary to ensure human health and wealth and animal husbandry production remains an inseparable part of the whole food chain (Jimeneza–Colomnero et al., 2001). During the recent decades, the preparation of raw meat and its technological parameters – color, water holding capacity, and consistence – as well as prognosis during the early stages of meat preparation have become of primary importance for many scientists developing pig husbandry. It has been stated (Quden et al., 1998; Tikk et al., 2008), that raw meat quality to high extent determines the safety and quality of the final product.

For implementation of these requirements, it is necessary to reach that pigs are fed valuable balanced rations, suitable breeding methods are applied, consequent, purposeful selection with regard to the direction of productivity and production quality improvement are used, and optimal maintaining conditions are created (Malkowski, Zavadska, 2000; Knap et al., 2001; Yu et al., 2004; Jukna, Simkus, 2007).

Appropriate feeding of pigs mainly depends on the supply with all required nutritional substances. It is of primary importance that nutritional substances gained with food are properly assimilated and used for the production. It can be ensured by creating optimal microflora ratio in the digestive system. In order to better employ genetic potential of pigs and to prevent pigs from some diseases of the digestive system, biologically active food additives were started to be used (Dumanovski, 2001; Komisarov et al., 2004).

Substances, intended for the improvement of the digestive system activity and creation of microbiological balance are divided into the following groups: probiotics, prebiotics, phytobiotics and sinbiotics. The result of their activity tends to be similar – maintenance of the required amount or even increase of the number of useful microorganisms in the digestive system of animals and birds (Ducatelle et al., 2002; Jukna et al., 2005).

Phytobiotics are ascribed to preparations of plant origin and their phytochemical constituents, positively effecting animal intestinal microflora. The activity of phytochemical substances in the food of plant origin is related to the suppression of degenerative processes in the organism. It depends on the antioxidative properties, stimulation of detoxicative enzymes activity, effect on cellular functions, incorporation of some excessive substances, and the effect on the intestinal microflora. Plant phytochemical substances are able to bind cholesterol, to decrease its resorbtion and remove it from the organism; they are also distinguished for secretomotorical and secretolytic properties, can enhance immune system, destroy pathogenic microflora, and decrease concentration of ammonia and sulphuretted hydrogen in animal organism **(**Hristov et al., 1999; Colina et al., 2002; Turner et al., 2002; Jukna et al., 2005; Jukna, Simkus, 2007; Huang et al., 2007).

Blue algae *Spirulina platensis* is attributed to the group of phytobiotics. *Spirulina platensis* is characterized by a unique composition. As is reported by Kravchenko et al., (2006), the mentioned algae is distinguished for high protein, the composition of which is quite close to the so called „ideal“ protein concentration. *Spirulina platensis* itself is a concentrated source of beta carotene and other carotenes, vitamins of B group, biotine, pholio and pantotene acids, and iron. In the composition of *Spirulina platensis* structural polysaccharides prevail, and there is no cellulose in the cell walls; this fact is responsible for good digestibility and assimilation of the preparation.

Many scientists state that it is expedient to use *Spirulina platensis* not only in human, but in animal nutrition as well to supplement nutritional substances and to improve metabolism (Goksan et al., 2007; Simkus et al., 2007). However, data about the effect of blue algae *Spirulina platensis* on pigs' growth rate and meat quality are insufficient.

**The aim of this research** was to define the effect of fresh blue algae *Spirulina platensis* biomass on pig growth performance and carcass and meat quality.

**Material and methods.** The experiment was carried out in the State Pig Breeding Station (Radviliskis r.) with two groups (control and experimental) of fattening pigs, each containing 16 pigs. 85-days-old crossbreds of Landrass and Yorkshire pigs were selected for the experiment by the principle of analogy. The animals were grown and kept under the same conditions. Both groups of the pigs were fed standard concentrate forage. 1 kg of forage dry matter contained 13.4 MJ AE and 16 % of crude protein. The pigs of the experimental group were given daily and individually 2 g of 75 % humidity fresh blue algae *Spirulina platensis* biomass with forage. The pigs according to the recommended norms were fed twice daily – at 8 a.m. and 4 p.m.; the water was given ad libitum. Weight changes were defined 4 hours after feeding, at the beginning and the end of the experiment. Control fattening was considered to be finished when the pigs weighed 95 kg. After the end of control fattening, the duration of control days (d.), the average daily weight gain (g) and age in days after reaching 100 kg weight, the amount of consumed concentrate forage (kg) and the amount of concentrate forage per kilogram of weight gain (kg) were defined for each pig

Before pigs slaughtering, fat thickness and muscularity (two measurements of fat thickness and thickness of the *M. longissimus dorsi*) was measured by an ultrasound equipment „Piglog-105“ (SFK Technology, 1991). Fat thickness at the waist area (FAT-1) was measured at the 3–4-th lumbar vertebra and 7 cm from middle back line towards the underbelly, and (FAT-2) – 10 cm from the last rib edge to the cranial side. The thickness of the *M. longissimus dorsi* (mm) also also was measured.

The animals were slaughtered according to standard procedures. The internal organs, intestinal tract, head, feet and tail were removed. Afterwards, the carcass was split longitudinally down the midline. Eviscerated carcasses were weighed to determine hot carcass weight.

Dressing percentage was measured as ratio of carcass weight 1 h after slaughter and live weight.

Carcass length was measured from the cranial edge of first neck segment to the anterior edge of the *symphysis pubis*.

Bacon length was measured from the cranial edge of first rib on the sternum to the anterior edge of the *symphysis pubis*.

The area of the *M. longissimus dorsi*, ham weight, and fat thickness at the 6–7th and at 10th rib, behind the last rib and at the last lumbar vertebra were defined during the control slaughtering. Meat samples (500 g) were taken from the *M. longissimus dorsi* in the area of the last ribs for the evaluation of meat quality. Meat quality was evaluated at the Laboratory of Animals Meat Properties and Meat Quality Evaluation, LVA. Quality investigations were carried out 36 hours after slaughtering, the meat was kept at + 4 ºC temperature, its pH was measured by a pH-meter „Inolab", containing a contact electrode, meat colour by „MINOLTA Chromameter" measuring lightness $L^*$, redness $a^*$, yellowness $b^*$, the amount of intramuscular fat by the Soxlete method, ash by burning meat organic matter at 700ºC temperature, and protein by the Kjeldal method. Meat drip loss was determined by a package method, keeping the meat in special bags for 24 hours at + 4 ºC temperature, meat water holding capacity was evaluated according to Grau and Hamm, cooking loss by boiling meat packed in vacuum in a circulating water bath at 75°C temperature for 30 min., and meat tenderness according to Warner – Bratzler.

Statistical analysis was performed with Descriptive Statistics and Independent-Samples T test procedures in SPSS 13.0 for Windows. The means and standard errors of traits for each group were calculated. The difference was considered to be statistically significant when $p<0.05$.

**Results and discussion.** The experiments (Table 1) revealed that an average daily weight gain of fattening pigs which daily and individually were given 2 g of 75 % humidity fresh biomass of blue algae *Spirulina platensis* with ration was by 71.4 g or 9.26 % higher ($p>0.05$) than in the control group. The pigs of the experimental group reached 100 kg weight by 7.37 days faster and consumed per 1 kg weight gain by 1.28 MJ AE or 4.0 % less than the pigs of the control group ($p>0.05$). The results obtained during the experiment about the effect of fresh biomass of blue algae *Spirulina platensis* on the growth rate of fattening pigs coincided with the data obtained by other scientists (Altunin et al., 2000; Zaharchenko et al., 2001; Petrjakov et al., 2005). They have reported that daily weight gain in the pigs given biomass of blue algae *Spirulina platensis* may increase up to 15–26 %.

Table 1. **The effect of blue algae *Spirulina platensis* on pig growth rate and feed consumption**

| Parameters | Group | |
|---|---|---|
| | Control (n=16) | Experimental (n=16) |
| Age at the beginning of the experiment, d | 85.88 ± 2.64 | 85.18 ± 2.99 |
| Weight at the beginning of the experiment, kg | 31.38 ± 0.74 | 30.64 ± 1.43 |
| Age during slaughtering, d. | 171.38 ± 4.27 | 163.36 ± 7.53 |
| Weight before slaughtering, kg | 97.25 ± 3.65 | 96,45 ± 2,81 |
| Fattening duration, d. | 85.5 ± 4.96 | 78.18 ± 8.51 |
| Total weight gain, kg | 65.87 ± 2.64 | 65.81 ± 2.99 |
| Age d., having reached 100 kg | 174.95 ± 9.38 | 167.58 ± 10.33 |
| Daily weight gain, g | 770.41 ± 26.16 | 841.77 ± 47.44 |
| Consumed per 1 kg weight gain, MJ AE | 31.69 ± 1.18 | 30.41 ± 1.12 |

The results obtained using apparatus „Piglog-105" (SFK Technology, 1991) (figure 1) evidently demonstrate that fat thickness at the point (FAT-1) in the experimental group of the pigs was by 1.03 mm or 6.9 %, and at the point (FAT-2) by 1.68 mm or 11.8 % lower ($p>0.05$) if compared with the control group. The muscularity of the experimental pigs was on the average by 1.01 % higher ($p>0.05$) than that of control pigs.

The results of control slaughtering are presented in Table 2. It becomes evident from these results that fresh biomass of blue *Spirulina platensis* positively affected meat quality in pigs. Dressing percentage in the experimental group of pigs was by 2.02 % ($p<0.05$) higher than in the control group of pigs. What is more, the tendency of the longer carcass, bigger *M. longissimus dorsi* area and ham weight ($p>0.05$) were observed. Carcass fat thickness at measurement points in the experimental group of pigs was lower than in the control group of pigs: at the 6–7th ribs by 1.26 mm or 7.4 % ($p>0.05$), at the 10th rib by 1.29 mm or 8.05 %. ($p>0.05$), behind the last rib by 1.87 mm or 11.4 % ($p>0.05$) and at the last lumbar vertebra by 1.33 mm or 10.6 % ($p>0.05$).

The investigations of meat physico-chemical properties revealed (table 3) that the effect of fresh biomass of blue algae *Spirulina platensis* on these parameters was inconsiderable. The meat of the experimental group of pigs had by 0.33 % lower amount of intramuscular fat than in the control group of pigs ($p<0.05$), meat boiling loss on the average decreased by 3.23 %, and water holding capacity increased by 1.19 % ($p>0.05$).

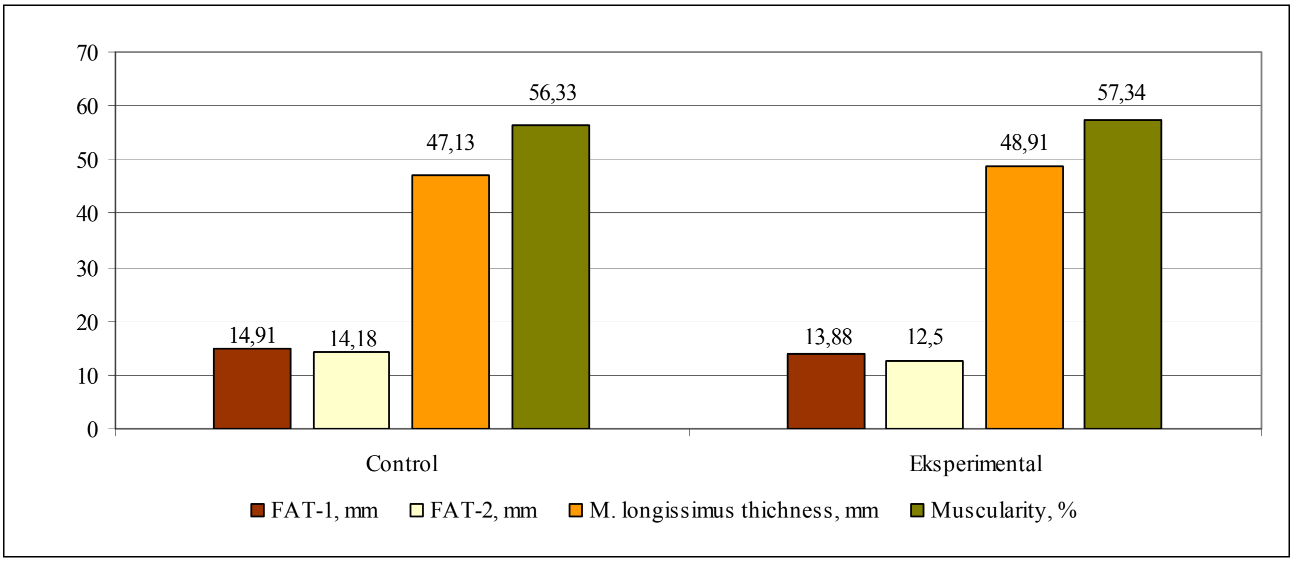


Fig 1. **Data of „Piglog-105“**

Table 2. **The results of control slaughtering**

| Parameters | Group | |
|---|---|---|
| | Control (n=16) | Experimental (n=16) |
| Carcass weight, kg | 73.61 ± 1.01 | 74.95 ± 0.83 |
| Dressing percentage, % | 75.69 ± 0.74 | 77.71 ± 0.65* |
| Carcass length, cm | 97.55 ± 0.60 | 97.98 ± 1.14 |
| Bacon length, cm | 77.13 ± 0.99 | 77.27 ± 1.27 |
| Area of the *M. longissimus dorsi*, $cm^2$ | 38.65 ± 2.66 | 39.54 ± 2.42 |
| Ham weight, kg | 11.78 ± 0.40 | 11.96 ± 0.26 |
| Fat thickness, mm: | | |
| At the 6–7th rib | 17.11 ± 1.54 | 15.85 ± 2.05 |
| At the 10th rib | 16.02 ± 1.53 | 14.73 ± 2.00 |
| Behind the last rib | 16.47 ± 1.87 | 14.60 ± 1.49 |
| At the last lumbar vertebra | 12.57 ± 2.53 | 11.24 ± 1.91 |

$^{*}p<0.05$

Table 3. **Meat physico-chemical properties**

| Parameters | Group | |
|---|---|---|
| | Control (n=16) | Experimental (n=16) |
| pH | 5.39 ± 0.04 | 5.49 ± 0.08 |
| Meat color: | | |
| $L^*$ | 53.75 ± 0.40 | 51.12 ± 0.91 |
| $a^*$ | 14.96 ± 0.16 | 14.86 ± 1.34 |
| $b^*$ | 5.98 ± 0.39 | 6.75 ± 0.42 |
| Drip loss of meat, % | 7.15 ± 1.34 | 8.68 ± 2.43 |
| Water holding capacity, % | 57.21 ± 0.27 | 58.40 ± 0.75 |
| Cooking loss, % | 28.25 ± 1.94 | 25.02 ± 3.27 |
| Tenderness, kg / $cm^2$ | 1.57 ± 0.14 | 1.43 ± 0.42 |
| Dry matter, % | 27.72 ± 0.98 | 28.18 ± 0.69 |
| Amount of intramuscular fat, % | 1.58 ± 0.11 | 1.25 ± 0.10* |
| Amount of ash, % | 1.25 ± 0.01 | 1.24 ± 0.01 |
| Amount of protein, % | 21.22 ± 0.87 | 22.37 ± 0.80 |

$^{*}p<0.05$

**Conclusions**

1. When daily ration of pigs was supplemented by 2 g of 75 % humidity of fresh blue algae *Spirulina platensis* biomass, dressing percentage in the experimental group of pigs was by 2.02 % ($p<0.05$) higher than in the control group of pigs.

2. The amount of intramuscular fat in meat under the effect of fresh biomass of blue algae *Spirulina platensis* decreased by 0.33 % ($p<0.05$).

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