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The effect of *Chlorella* suspension on productivity of chickens

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The full feeding is one of the most important conditions that form the level of productivity in poultry industry. The value of feeding rations is known to depend not only on the presence of all essential substances in them, but also on the degree of its biological availability. Due to a wide range of vitamins, including fat-soluble, as well as macro- and micro elements in a biologically accessible form in *Chlorella* composition, *Chlorella* suspension can be become the useful component in feeding of poultry farming. Therefore, the aim of our study was to investigate the influence of the *Chlorella* water suspension on growth, daily weight increment and amount of eggs of chicken. The *Chlorella* suspension was produced by “Samvel Farm Enterprise” in Bilyaivka district of Odessa region, Ukraine. The investigation was carried out on layer chickens of “Brown” breed at the age of 360 days, which were divided into 3 experimental groups: one of them was control group and two were research groups with 300 heads of layer chickens in each. Despite of *Chlorella* suspension chickens were fed by ordinary animal feeding stuff. Most of the feed composition for all chicken groups consisted of wheat, barley and limestone. The nutritional value of this complete feed involved the presence of the crude protein, crude fiber and necessary amino acids including lysine, methionine. The second chicken group, throughout the experiment during 160 days was fed with a suspension of *Chlorella* in a concentration of 50 million, and in the 3d experimental group – 60 million cells in 1 milliliter of fluid. The results of research showed that the use of *Chlorella* suspension positively influences the raise of growth of chickens in the 2nd and 3rd experimental groups, which is characterized by the higher absolute, relative and average daily increments. The maximum result was achieved in 2nd experimental group, where the optimal cell concentration in the *Chlorella* suspension was 50 million cells in 1 milliliter of fluid and daily rate of increment was 30 grams per 1 head. Also after feeding with *Chlorella* suspension egg-laying increased by 12.4% compared to egg-laying of chickens in control group. Consequently, the inclusion of *Chlorella* suspension in chicken feeding allows obtaining poultry products with the maximum consumer qualities.

Key words: feeding, layer chickens, suspension, *Chlorella*, productivity.

Вплив суспензії хлорели на продуктивність курей

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Повноцінне годування відноситься до числа найважливіших умов, що формують рівень продуктивності в тваринництві. Відомо, що значення кормових раціонів залежить не тільки від наявності в них усіх необхідних речовин, але і від ступеня їх біологічної доступності. Завдяки широкому спектру вітамінів, включаючи жиророзчинні, а також макро- та мікроелементи в біологічно доступній формі у складі хлорели, суспензія хлорели може стати важливим компонентом у годівлі птиці. Тому метою нашого дослідження було вивчення впливу водної суспензії Хлорели на ріст, добовий приріст ваги та кількість яєць курей. Суспензія Хлорели була виготовлена компанією “Самвел Фермерське підприємство” у Більяївському районі Одеської області, Україна. Дослідження проводили на курах породи “Браун” у віці 360 днів, які були розділені на 3 експериментальні групи: одна з них була контрольною

групою, дві – дослідні групи по 300 голів курей. Окрім суспензії Хлорели, курей годували звичайним кормом для тварин. Пшениця, ячмінь і вівсяк складали найбільшу частину корму для всіх груп курей. Поживна цінність цього корму полягала у наявності сирого протеїну, сирій клітковини і необхідних амінокислот, включаючи лізин, метіонін. Другу групу курей протягом всього експерименту протягом 160 днів, годували суспензією хлорели в концентрації 50 мільйонів, а 3-ю дослідну – в 60 мільйонів клітин в 1 мл рідини. Результати досліджень показали, що застосування суспензії Хлорели позитивно впливає на підвищення росту курей у 2-й і 3-й дослідних групах, що характеризується вищим абсолютним, відносним і середньодобовим приростом. Максимальний результат був досягнутий у 2-й дослідній групі, де оптимальна концентрація клітин в суспензії Хлорели становила 50 мільйонів клітин в 1 мл рідини і добова швидкість приросту становила 30 грамів на 1 голову. Також після годівлі суспензією Хлорели яйцекладка збільшилася на 12,4% в порівнянні з яйцекладкою курей контрольної групи. Отже, включення суспензії хлорели в годівлю курей дозволяє отримувати продукти птахівництва з максимальними споживчими якостями.

Ключові слова: годівля, кури-несучки, суспензія, Хлорела, продуктивність.

Introduction

The use of biologically active additives (BAA) in feed production is fundamentally important. In turn, the effectiveness of using BAA itself depends on their composition and concentration of biologically active substances in them, their form, digestibility, origin, production technologies, etc (Yun & Park, 2001; Skřivan et al., 2009). One of the ways to increase the productivity and safety of poultry is using of *Chlorella* in feeding, which allows to improve the quality and biological safety of marketable products by reducing the amount of synthetic additives (Doucha et al., 2009; Liang et al., 2009; An et al., 2016). Notable among the biologically active additives is the *Chlorella* microalgae (*Chlorella Vulgaris*), composing of a significant amount of protein, a wide range of vitamins, including fat-soluble, as well as macro- and micro elements in a biologically accessible form (de-Bashan et al., 2002; Heindl et al., 2010; Kang, et al., 2017). In the course of its lifetime, microalgae synthesize substances that possess both bacteriostatic and probiotic effects. In recent years, as part of the practical use of *Chlorella*, production experiments have been carried out in various livestock farming sectors with positive results compared with other feed additives (Watanabe et al., 1955; Widjaja et al., 2009). These results indicate that there is no alternative to *Chlorella* as a feed additive in animal husbandry (Watanabe et al., 1955; Sevcikova et al., 2006; Kang et al., 2013).

The benefit of this product is possibility to be cultivated throughout the year. The level of technology, the quality of raw materials and other factors determine the biological value of the final product. But the main reason is the impossibility of using live natural plants in a dry matter (Huang et al., 2010). It is its inclusion as a source of high biological value remains a large reserve for poultry farming today. The usage of suspensions helps not only significantly increase the productivity of the poultry and improve the quality of products, but also increase the profitability of the industry in general.

Technological peculiarities of the use of *Chlorella* biomass is possible to be introduced into the diet, both in the form of a paste, and into feed, and in the form of a suspension. *Chlorella* concentrate is a new fodder product of natural origin, which includes the higher complex of biologically active substances (Halle & Janczyk, 2009). Unlike paste, the suspension has biologically active products of *Chlorella*'s secondary metabolism, but it has a low

dry matter content and a low expiration date (Ogbonna et al., 1997).

The unique biological composition, large energy capacity, antioxidant properties and the ability to stimulate the activity of the immune system put this valuable microscopic organism of plant origin in the category of true natural healing remedies, synthesized *Chlorella* substances. This makes it easy to obtain products of a functional purpose, for example, enriching of essential microelements, poultry meat and eggs by changing the composition of the nutrient medium (Surai, 2002; Janczyk et al., 2007; Skřivan et al., 2008; Zhu et al., 2013; Kotrbáček et al., 2015). This fact alone in combination with high ecological purity of products has great importance for human health (Janczyk et al., 2005; Doucha et al., 2006). Also the production of *Chlorella* suspension has no waste, because it is used as animal feed (Kotrbáček et al., 2013). Despite the clear benefits of using *Chlorella* as a feed additive, currently there are few publications devoted to the influence of *Chlorella*'s suspension on poultry productivity and its product quality.

The aim of the work was to study the influence of the *Chlorella* water suspension as a part of complete feeding for chickens on changing of their live weight at different stages of feeding, productivity.

Materials and methods

The breed chickens “Brown” were used in this research. The study of the use of *Chlorella* suspension was carried out at the poultry plant “Samvel Farm Enterprise” in Bilyaivka District of Odessa region. The feed updates occurred daily.

Materials. The objects of research were Brown breed chickens at the age of 365 days and 3 experimental groups were formed: 1 – control group and 2 and 3 were experimental groups, 300 head in each group according to the principle of analogues with a concentration of 50 and 60 million cells per 1 milliliter respectively (Table 1).

For the preparation of the feed additive, the planktonic strain *Chlorella vulgaris* IGF No. C-111 was used, which is distinguished by a high degree of use of light energy (efficiency of photosynthetically active radiation of 3.6%) and the chemical composition of the cell according to the content of proteins, essential amino acids, vitamins, and biologically active substances. Algae were reproduced into the aquarium for a month.

Table 1
Scheme of research

Groups of the poultry	Number of chicken in each group, heads	Variant of feed	Duration of the research, days
1 – control group	300	Complete feed (CF)	160
2 – research group	300	CF + <i>Chlorella</i> suspension with a concentration of 50 million cells per 1 milliliter	160
3 – research group	300	CF + <i>Chlorella</i> suspension with a concentration of 60 million cells per 1 milliliter	160

The composition and nutritional value of complete feed used in feeding for the experimental groups are presented in Tables 2 and 3 respectively. The *Chlorella* suspension was added in the drinking water of the 2nd and 3rd research groups, at a concentration of 50 and 60 million cells per 1 milliliter of culture fluid. Cells concentration in suspension of *Chlorella* was diluted with tap water.

Table 2
Composition of complete feed for experimental groups of chicken, %

Constituents	%	Constituents	%
Corn	-	Baking soda	-
Wheat	52.69	Limestone	9.00
Barley	14.20	Soya bean oil	-
Sunflower oil cake	7.00	Vitamin-mineral premix	0.50
Soybean cake	5.23	Mono-calcium phosphate	0.90
Fishmeal	4.46	Lysine	0.50
Wheat bran	5.02	Kreoline	0.10
Table salt	0.25	Methionine	0.15
Total		100	

Table 3
Nutritional value of complete feed for experimental groups of chicken, %

Constituents	%
Available energy	1.10
Crude protein	12.50
Crude fiber	2.50
Lysine	0.05
Methionine	0.80
Tryptophan	0.40
Calcium	3.50
Phosphorus	0.70
Sodium	0.20

Methods. The main indicators of assessing the effectiveness of *Chlorella* suspension using were the dynamics

Table 4
Dynamics of the chickens live weight of research groups

Poultry age, days	Group		
	1 – control group, grams	2 – research group, grams	3 – research group, grams
365	1805a	1800a	1800a
445	1887b	1998b	1896b
525	1980c	1993bc	1990c
<i>p-significance</i>	***	**	**

of changes in poultry live weight and feed costs by 1 kg of growth. Live weights, absolute increment, average daily weight increment were determined by weight equipment after 445 and 525 day in all groups of chickens. The chicken weighing was conducted 2 times per day, especially in the morning and in the evening.

Statistical analysis. Reliability of the data received was determined by t-criterion using Microsoft Excel 2007 (Microsoft Co., USA). In order to present data ANOVA as well as Fisher's LSD post-hoc test were performed using XL STAT (Addinsoft, Paris, France).

Results and discussion

The poultry in all the groups were fed by the basic diet, energy and nutritional value conformed to generally accepted norms. In two research groups, the increment of weight in chickens from the beginning of the research and until the end of the research was higher in relation to the control group; the largest increment was especially determined in the 2nd experimental group. As for the ratio of the amount of feed per one kilogram of weight increment, the rates of in all groups were almost equal, but lower than the control group by 6.2%. The results are shown in Table 4.

The use of *Chlorella* suspension as a part of basic feeding significantly increased the average daily weight of chickens. According to ANOVA results, the chickens live weight of research groups are differed depending to poultry age and concentrations of *Chlorella* suspension utilizing for feeding (Table 4). The obvious fact is that average daily weight has increased every day but in the second group on day 525 there was no noticeable difference after 80 days of feeding.

The pattern of poultry growth was estimated on the basis of absolute and daily average increments (Table 5). Based on the results, the relative increment in the first group of chickens did not change during 525 days.

Table 5
Indices of increment of live weight of the poultry in experimental groups

Group	Age, days	Parameters		
		Absolute increment, grams	Average daily weight increment, grams	Relative increment, %
1 – control group	365	-	-	-
	445	82.0a	1.0a	100
	525	80.0a	1.0a	100
2 – research group	365	-	-	-
	445	98.0b	1.2b	119.5
	525	95a	1.1ab	118.7
3 – research group	365	-	-	-
	445	96.0b	1.2b	117.0
	525	94.0ab	1.1ab	117.5
<i>p-significance</i>				
1 – control group		ns	ns	-
2 – research group		**	*	-
3 – research group		**	*	-

Each value is based on n = 300. Means separated at P < 0.05 by Fisher's Least Significant Difference. Means within columns followed by different letters are significantly different, ns – no significant

Absolute increment and average daily weight increment of first chicken research group were not changed according to age (Table 5). The same indicators of the second and third research groups were decreasing with duration of days.

The main products of poultry farming are eggs and meat. Poultry lay eggs which vary in size. The egg mass determines the overall presence of yolk and protein in them and it is one of the main indicators for classification according to the standard.

The poultry of the control group gave 20181 eggs, accounting for 69% egg-laying. The productivity of the poultry of the research group amounted to 79.4% (23820 eggs were obtained), which is 12.4% higher than in the control group. The weight of the poultry's egg in the control group was 63%, while in the experimental group it was 69.2%, which is by 5.5 grams or by 8.6% higher. According to these parameters, the egg mass in the control group was 128 kg, in the experimental group the egg mass was 165 kg, which is by 37 kg higher with an average egg weight of 69.2 g.

The possibility of providing of chicken with a natural plant of such biological value opens up to the poultry industry without exaggeration the widest prospects and up to two times the profitability of the products produced. Also it allows obtaining poultry products at the maximum consumer qualities, both in terms of taste and environmental indicators that will lead to increase the popularity and consumption of poultry products in general by the population, and will allow increasing large-scale production volumes.

Conclusions

Summing up the analysis of study, we conclude the following statements:

1. Using *Chlorella* suspension it is possible to increase the main indicators of chicken productivity during the year.

2. The use of *Chlorella* suspension in the feeding for layer chickens in the dose of 30 ml/head with a

concentration of 50 million cells per 1 milliliter of solution positively affects chicken growing quicker, as indicated by the higher absolute, relative and average daily increments in experimental groups compared to control group.

3. Feeding with *Chlorella* suspension also improves the quality of obtained products from chickens, especially the mass of eggs and their number.

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