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Effect of Supplement Feed on the Composition of the Black Ostrich's Eggs

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Abstract

At the *Aikanat Kustary* ostrich farm located in the South-East of Kazakhstan, out of 9 females of the black ostrich aged 25 months (2.1 years) and 9 males aged 36-38 months (3–3.2 years), three groups of 6 specimen (3 pairs of female and male), which were kept in separate races, were formed by the analogous principle. The birds of the first group were the control and were fed according to a diet. The ostriches of the second group additionally received a supplement feed at the rate of 10 g/kg of feed, and the birds of the third group – at the rate of 15 g/kg of feed.

During the experiment the authors studied the morphometric parameters of the egg, such as large diameter, small diameter, shape index, shell thickness, protein, yolk and shell weight that were within the standard but higher in the experimental groups.

When studying the chemical composition of the ostrich's eggs, the authors researched such parameters of the egg as moisture, ash, fat, protein, energy value that were also within the standard but increased in the experimental groups.

The introduction of the supplement feed in the diet also contributed to change of the quality of the macro- and microelement composition of ostriches' eggs and vitamins. As compared to the control eggs, an increase in the content of mineral elements (Ca, P, Fe, Mg, Mn, K and Zn), vitamins (A, E, B_1, B_2 and PP) was noted in the ostrich egg of the experimental groups significantly depending on the volume of the supplement feed ($P \leq 0.001$-$P \leq 0.05$).

It has been determined that the use of the supplement feed balanced according to the protein, mineral, and vitamin composition has positive impact not only on the ostriches' egg production but also on the fertilization of eggs, hatching and preservation of ostrich chicks.

Key words: ostrich, ostrich egg, supplement feed, nutritional and biological value of ostrich eggs.

INTRODUCTION.

The effectiveness of breeding ostriches on farms considerably depends on the level of their fertility. The increase in the fertility is actual not only for the chickens domesticated 4-7 thousand BC but also for the ostriches domesticated in 1864 [1].

When bred on farms under favorable feeding and keeping conditions, ostriches lay at least 40 eggs per the reproductive season [1].

As it is known [1, 2], the process of egg formation (from ovulation to demolition) with ostriches lasts two days (48 hours) on average while it takes only 1 day (on average 24 hours) for other birds species (chickens, turkeys, ducks, geese, etc.). For 20 weeks, or 140 days of the reproductive season, the ostrich female can theoretically demolish about 70 eggs because it is physiologically able to lay only one egg in two days. At the same time it is necessary to consider the obtaining of 30 eggs from 70 theoretically possible ones over a 20-week reproductive season of ostrich females (the average egg production rate per season is about 43%) as a relatively good result.

The ostriches that are relatively newly domesticated and are still half-wild birds, have been used to produce delicatessen meat and eggs in industrial scales since about 1990 in the South African Republic, Israel, the USA and some other countries, and since 2001 – in Kazakhstan [3].

The economic efficiency and intensity of ostrich farming depends on a scientifically based system of keeping and feeding taking into account the characteristics of ostriches. For normal life and reproduction, the bird needs a full and varied diet where the physicochemical composition and the ratio of feed ingredients must meet the body's needs for energy generation, growth of new cells and tissues [4]. Deficiency of nutrients that is quite common in case of commercial ostrich farming is caused by improper formula of feed, fodder mixes and storage conditions. These disadvantages cause a decrease in the rate of growth, deformation of the limbs bones, and diseases leading to the young birds' death [5].

In the world practice of ostrich breeding, various supplement feeds based on industrial feed production are used to increase the productivity and improve the quality of meat, eggs and other products [6]. Taking into account the physiological features of digestion and needs of the ostrich, it is considered relevant to use supplement feeds based on regional natural minerals [7].

Successful reproduction depends on many factors. The most important of them is a high-quality diet with high protein and vitamin-mineral content.

The present research is aimed at investigating the impact of the supplement feed on the quality of black ostrich's eggs under the conditions of the South-Eastern Kazakhstan.

MATERIALS AND METHODS

Experiment setting and feeding diets. At the *Aikanat Kustary* ostrich farm located in the South-East of Kazakhstan, out of 9 females of the black ostrich aged 25 months (2.1 years) and 9 males aged 36-38 months (3–3.2 years), three groups of 6 specimen (3 pairs of female and male), which were kept in separate races, were formed by the analogous principle. As a result of more than a century of selection work on the farm, females begin to carry eggs at the age of 2-2.5 years old, and the males become mature at the age of 3 (M.M. Shanawany, 1999).

Under intensive farming one male and up to four females are placed in the breeding pen (a separate section in the pen). Fertilization is higher when the ratio of females and males is 1:1 (D. C. Deeming October 1996). Therefore, the 1:1 ratio was taken, three families in each group.

The daily diet of one ostrich on the farm included concentrated feed at the rate of 10 g/kg of the live weight, Lucerne hay – 20 g/kg, the basic food (green parts of plants) – 13-20 g/kg of the live weight, and ostriches also obtained minerals from shell rock.

The birds of the first group were the control and took the accepted feeding diet. The ostriches of the second group additionally ate a supplement feed at the rate of 10 g/kg of the feed, and those of the third group – at the rate of 15 g/kg of the feed. The composition of the proposed supplement feed (weight in

%) included shell rock – 38.25, bentonite - 38.25, bischofite – 4.5, elemental sulfur – 4.0, sodium selenite – 0.000004, potassium iodide – 0.001, iron sulfate – 0,01, zinc sulfate 0.001, dry brewer's yeast – 2.5, dry acidophilic milk – 1.5, fish meal – 2.5, meat and bone meal – 4.0, nettle flour – 0.1, flour from licorice roots– 0.1, and flour from plantain leaves – 0.1. The experiment lasted for 140 days. At the same time the feed intake was recorded on a daily basis.

Watering was carried out ad lib from semi-automatic drinkers through a centralized water supply system. Eggs quality control was determined by the average sample in the laboratory. According to GOST 31654-2012, GOST R 52121-2003, GOST R 53404-2009, from 1 or 10% of eggs from different packing units were taken from every batch depending on its volume. At the same time the purity of the shell, smell, the contents of eggs, density and color of the protein were determined.

The cleanliness of the eggshells of the selected eggs was checked visually in brightly scattered light or fluorescent light in terms of the combined sample of the product. The smell of the eggs' content was determined organoleptically, the density and color of the protein were determined visually by pouring out onto a smooth surface according to GOST 31655-2012 "Eggs for food (turkey, chesary, quail, ostrich)" and GOST 31720-2012 "Food products of processing agricultural poultry eggs". The mass of eggs was determined by weighing on scales for static weighing according to GOST 53228-2008 "Laboratory scales. General technical requirements, middle-class accuracy, with a maximum weighing limit of up to 1 kg".

Every egg was marked with the means allowed by the authorized bodies in the established order for contact with food. Marking of eggs must be clear, easily readable, according to GOST 15846-2002 "Labeling of eggs intended for shipment to regions of the Far North and equated areas". The condition of the air chamber and its height, the state and position of the yolk, the integrity of the shell were determined by the transmission of eggs on the ovoscope by turning them according to GOST 31654-2012 "Chicken eggs for food, technical conditions".

Ostrich eggs were stored at the temperature from 0^0 C to 8^0C and relative air humidity from 65% to 70%, for not more than 30 days (GOST R 54486-2011). Organoleptic analyses of black ostrich's eggs were carried out according to GOST 31720-2012 "Food products of processing agricultural poultry eggs. Methods of sampling and organoleptic analysis". The shape of the eggs was estimated mainly by the index by dividing the small diameter of the egg by the large one and expressed in percentage (Hoyt, 1979 and Faris A.Al-Obaidi, 2015).

The chemical composition of eggs was determined according to GOST 31469-2012: the mass fraction of fat – by using a filtering funnel or Soxhlet extractor, the mass fraction of protein substances – according to Kjeldahl, humidity – by drying the samples in a conventional oven at 98°C during 24 hours. The ash content was determined by sampling using a muffle oven at 600°C during 6 hours. The energy value was determined on the following basis: 1 g of proteins = 4.0 kcal; 1 g of fat = 9.0 kcal.

Minerals were determined in accordance with P 4.1.1672-03 – control methods. Chemical factors (2004) of potassium, calcium, magnesium, iron, manganese and zinc were determined by the atomic absorption method, the molybdenum-vanadium method of phosphorus determination.

The following methods were used to determine vitamins: Method for determining vitamin B_1 (thiamine) in food products (MVI.MN 2052-2004) and Method for determining vitamin B_2 (riboflavin) in food products (MVI.MN 2147-2004), Determining fat-soluble vitamins A, E by the method of high-performance liquid chromatography, Method for determining vitamin PP (niacin) in food products (MVI.MN 3008-05).

RESULTS AND DISCUSSION

During the experiment, in order to take into account the origin of eggs, after laying the egg by the female ostrich it was weighed and a mark was made on the shell with a graphite pencil; it contained the following data: the date of laying, the weight of the egg, the name of the female with the serial egg number for the current year. It is necessary to note that the ostrich egg is not oval, and it is also very difficult to visually distinguish the round and the blunt end.

The egg consists of a shell, a sub-shell, a white and a yolk. Ostriches have a greater percentage of eggshell as compared to other poultry species. The shell has a lot of small holes – pores; they are especially numerous at the blunt end of the egg where there is an air chamber. The vitelline membrane is elastic, tough, the shape of the yolk is convex. The white is a viscous, transparent, very mobile mass. It consists of the smallest cells containing liquid albumin. The state of the air chamber of ostrich eggs is fixed, the height is 18.5-20.1 mm. The biological value and technological properties of eggs are determined by their morphometric and physicochemical parameters.

Initially, the impact of the supplement feed on the morphometric parameters of the ostrich eggs was studied (Table 1).

The experiment studied such morphometric parameters as large diameter, small diameter, shape index, shell thickness, white, yolk, and shell weight that were normal but increased in experimental groups. It is necessary to note that according to the morphological index of ostrich eggs the obtained results comply with the references that are generally of limited nature (Ipek and Sahan et al., 2006; EI-Safty and Mahrose, 2009; Koutinhouin et al., 2014).

It was determined that the greatest increase in the weight of eggs in the experimental groups was noted with the birds of the third group (by 121 g ($P \le 0.05$) as compared to the control group.) In the second experimental group the eggs mass was higher than in the control group by 104 g.

An increase in the index of the eggs' shape was noted. In the second and third groups as compared to the control group, it was higher by 0.22 and 0.59 ($P \le 0.05$-$P \le 0.01$), respectively. The results of the studies showed that the supplement feed under research had a certain effect on the ostrich indicators (Table 1).

When studying the density of eggs, as compared to the control group, its increase was noted by 0.003 g/cm^3 in the second group, and by 0.008 g/cm^3 in the third one.

The study of the egg contents' mass showed an increase in the mass of the white, yolk and shell by 65.6 g, 27.45 g, 12.28 g, respectively, in the second group and by 75.99 g, 31.8 g, and 14.5 g, respectively, in the third group as compared to the control group.

When taking into account the percentage ratio of the white, yolk and shell mass, the white and yolk mass increased by 0.2% and 0.4% in the second group and by 0.2% and 0.45% in the third group as compared to the control group, and the ratio of shell mass decreased by 0.5% in the second group and by 0.55% in the third group as compared to the control group.

When giving the supplement feed, the thickness of the blunt end, the equatorial part, and the blunt end of the shell increased by 0.2 μm, 0.3 μm and 0.8 μm, respectively, in the second group and by 0.6 μm, 0.8 μm, 1.1 μm, respectively, in the third group as compared to the control group.

When giving the supplement feed, the height and diameter of the air chamber increased by 0.22 mm and 0.5 mm in the second group and by 0.33 mm and 1.2 mm in the third group as compared to the control group.

Next, the impact of the supplement feed on the chemical composition of the ostrich egg was studied (Table 2).

During the experiment, such chemical indicators of the black ostrich's eggs as moisture, ash, fat, white, energy value were studied. They were within the standard but increased in the experimental groups.

It was determined that in the control group there was higher moisture content in the white and yolk than in the experimental ones. In the first experimental group the moisture in the white was less by 2.42 g, and in the second experimental group the moisture decreased by 3.21%. The moisture in the yolk in the first experimental group was lower by 2.16 g, and in the second experimental group the moisture reduced by 2.92%.

In the experimental groups there was an increase in eggs' ash, which in the second and third groups was higher by 0.02 and 0.04% ($P \leq 0.05$-$P \leq 0.01$), respectively, as compared with the control group.

When studying the fat content in the egg yolk, it increased as compared with the control group by 1.3% in the second group and by 2.44% in the third group.

The research of the white content in the egg showed its increase by 0.97% in the second group and by 2.29% in the third group as compared to the control group. In addition, the energy value of the egg increased from 151 ± 3.6 kcal to 162 ± 2.4 kcal in the second group and to 167 ± 5.5 in the third experimental group.

Thus, the results of the conducted studies have shown that the proposed supplement feed has a certain positive effect on the composition of the ostrich's egg: it increases ash, fat, protein and caloric content, which points at the increase in the nutritional value of eggs.

It is known that the biological value of food is largely determined by vitamins. Therefore, the vitamin composition of eggs and the impact of the supplement feed on it were studied (Table 3).

The results of the experiment showed that the supplement feed had a positive effect on the vitamin composition of ostrich's eggs.

The content of vitamin A was studied in the egg yolk, while as compared with the control group, the content of vitamin A in the egg yolk in the second group was higher by 0.09%, and by 0.22% ($P \leq 0.005$) in the third group. The same was observed for vitamin E where as compared with the control group the indicators of the second experimental group were higher by 0.08% in the white and by 0.017% in the yolk, and by 0.1% in the white and by 0.25% in the yolk in the third group.

Table 1. Morphometric Indicators of Ostrich Eggs

No.	Indicators	Groups of ostriches		
		I (control)	Experimental	
			II	III
1	Eggs' weight, g	1,236±20.4*	1,340±21.8	1,357±33.5
2	Large diameter, cm	14.4±1.21	14.7±1.09*	14.9±1.32
3	Small diameter, cm	11.85±1.02*	12.13±1.57	12.35±1.14
4	Form index	82.29±1.88	82.51±1.62	82.88±1.39
	Density, g/cm^3	1.127±0.01	1.130±0.05***	1.135±0.027**
5	Weight, g			
6	White weight	747.78±0.47	813.38±0.34	823.77±0.51***
7	Yolk weight	262.032±1.1	289.44±1.6	293.826±1.03
8	Eggshell weight	224.9±1.051***	237.18±0.97	239.404±1.044
5	Correlation of weight (white, yolk, eggshell), g%			
	White	60.5±0.47	60.7±0.34	60.7±0.51***
	Yolk	21.2±1.1	21.6±1.6	21.65±1.03
	Eggshell	18.2±1.051***	17.7±0.97	17.65±1.044
8	Eggshell thickness, um: sharp endequatorial partflush end	18.6±0.02 18.1±0.09** 17.5±0.05*	18.8±0.02** 18.4±0.147 18.3±0.02**	19.2±0.04* 18.9±0.01** 18.6±0.11
9	Size of air cell, mm: height,diameter	7.2±1.8 53.7±2.4	7.42±2.05 54.2±3.6	7.53±1.03 54.9±2.8
Note: *- P≤0.05, **- P≤0.01, ***P≤0.001				

Table 2. Chemical Composition of Ostrich's Egg

No.	Indicators	Groups of ostriches					
		I(control)		experimental			
		White	Yolk	II		III	
				White	Yolk	White	Yolk
1	Humidity, %	89.92±0.4*	51.3±1.2**	87.5±0,5	49.14±0.1*	86.71±0.18	48.38±0.22**
2	Ash, %	1.9±0.8	2.3±1.02*	2.1±0.9	2.5±1.4	2.3±0.9	2.7±1.7
3	Fat, %	-	26.52±2.4	-	27.82±3.5	-	28.96±1.4*
4	Proteins, %	11.4±0.6**	17.6±0.2	12.3±0.4**	18,57±0.01**	12.76±1,2	19.89±0.5
5	Caloric value per 100 g of egg, kcal	151±3.6		162±2.4		167±5.5 *	
Note: *- P≤0.05, **- P≤0.01, ***P≤0.001							

Table 3. Vitamins In Poultry Eggs, Mg/100

Vitamins	Groups of ostriches					
	I(control)		experimental			
	white	yolk	II		III	
			white	yolk	white	yolk
A	-	0.16±0.01*	-	0.25±0.07	-	0.38±0.02*
E	0.21±0.1	0.43±0.04	0.29±0.05*	0.56±0.04*	0.31±0.08	0.68±0.03
B_1	0.002±0.9	0.028±0.02**	0.004± 0.1	0.036±0.3	0.009±0.3	0.052±0.07
B_2	0.11±0.05*	0.07±0.04	0.15± 0.03***	0.11±0.22	0.19±0.05*	0.2±0.1**
PP	0.09±0.1	0.13±0.2*	0.12±0.1**	0.18±0.14	0.26±0.01*	0.32±0.24
Note: *- P≤0.05, **- P≤0.01, ***P≤0.001						

Table 4. Composition Of Mineral Substances In Ostrich's Eggs

No.	Mineral substances	Amount, mg/100 g					
		1(control)		experimental			
				II		III	
		white	yolk	white	yolk	white	yolk
1	Iron (Fe)	1.8±0.22	5.3±0.6	1.93±0.09	6.1±0.51	2.1±0.5	7.5±1.5***
2	Potassium (K)	134±1.84	103±1.1	138±1.21	106±1.4*	141±2.2	109±1.9
3	Magnesium (Mg)	8.2±0.02*	12.4±0.28	9.1±0.8*	13.6±0.84	10.4±0.5*	16.2±0.38
4	Calcium (Ca)	22±0.39	138±1.2**	23.7±0.5	144±1.9	27.4±0.28	148±0.02**
5	Phosphorus (P)	16±0.33*	327±4.1	17.5±0.6*	333±7.5	18.2±0.1*	336±0.04
6	Manganese (Mn)	-	-	< 1±0.00	-	< 1±0.00	< 1±0.00
	Zinc (Zn)	-	1±0.00	< 1±0.00	< 1±0.00	< 1±0.00	< 1±0.00
	Note: *- P≤0.05, **- P≤0.01, ***P≤0.001						

During the experiment positive changes were observed in terms of increasing the quantitative indices of water-soluble vitamins in the ostrich's egg, while they were significantly correlated with the volume of the supplement feed. For example, the content of vitamin B_1 in the egg in the second test group was higher by 0.002% in the white and by 0.008% in the yolk, and in the third group it was higher by 0.007% in the white and by 0.024% in the yolk, respectively, as compared with the control one. The content of vitamin B_2 was higher by 0.004% in both the white and the yolk in the second group, and by 0.008% in the white and 0.013% in the yolk in the third group. The content of vitamin PP was higher by 0.003% in the white and 0.05% in the yolk in the second group, and by 0.017% in the white and 0.019% in the yolk in the third group.

The proposed supplement feed contains a certain set of microelements and minerals. That is why its impact on some egg mineral substances was also studied (Table 4).

In particular, depending on the amount of supplement feed in bird eggs from the experimental groups, the relative increase in the content of Fe, Mg, K was observed as compared with the control group, while the concentration of elements increased in accordance with the volume of the prescribed supplement feed (Table 4).

In the experimental groups there was an increase in iron (Fe) that in the second and third groups as compared with the control group was higher by 0.8% and 2.2% (P≤0.01) in the yolk, and by 0.13 % and 0.3% in the egg white, respectively.

When studying the content of potassium (K), as compared with the control group, it increased in the yolk in the second group by 3%, and by 6% in the third group, and by 4% and 7% in the white, respectively.

The content of calcium (Ca) in the yolk of ostrich's egg in the second and third experimental groups increased by 6% and 10%, respectively, and by 1.7% and 5.4% in the white.

The phosphorus content (P) in the egg was higher by 1.5% in the white and 6% in the yolk in the second experimental group, and by 2.2% in the white and 9% in the yolk in the third experimental group as compared with the control one (P≤0.05).

As for mineral substances, the amount of manganese (Mn) and zinc (Zn) was defined. At the same time in the control group manganese was not found, in the second group the trace content was determined in the white, and in the third group the trace content was determined both in the white and yolk. Zinc in the control group was not found in the white, and in the yolk there was the trace content, in the experimental groups the trace content was determined both in the white and yolk.

The obtained data prove higher nutritional value, the content of macro- and microelements, vitamins in the eggs obtained from ostriches that ate the recommended supplement feed.

CONCLUSION

As a result of the experimental studies, it has been determined that the use of the complex feed supplement increased the weight of protein, egg yolk and shell, respectively, by 65.6 g, 27.45 g, 12.28 g in the second group, and by 75.99 g, 31.8 g, 14.5 g in the third group as compared to the control group.

When taking into account the percentage ratio of protein, yolk and shell weight, the protein and yolk weight increased by 0.2% and 0.4%, respectively, in the second group and by 0.2% and 0.45% in the third group as compared to the control group, and the ratio of shell weight decreased by 0.5% in the second group and by 0.55% in the third group as compared to the control group.

The results of the conducted research have shown that the offered supplement feed has positive effect on the composition of the ostrich's egg. Its use causes an increase in ash, fat, protein and energy value, i.e. it says about the nutritional value of eggs.

The experiment also displayed positive changes in terms of increasing quantitative indicators of water-soluble vitamins in the ostrich's egg, while they were significantly correlated with the volume of the supplement feed.

In the eggs of birds from the experimental groups, depending on the amount of the supplement feed, a relative increase in the Fe, Mg, K contents was observed in comparison with the control group, while the concentration of the elements increased in accordance with the volume of the used supplement feed.

Thus, the use of the supplement feed balanced in protein, mineral, and vitamin composition is positive for the nutritional value of eggs.

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