

LAYING PERFORMANCE, EGG QUALITY AND HATCHING RESULTS IN GEESE FED WITH DRY APPLE POMACES

Lesia Fialovych, Iaroslav Kyryliv

Department of Small Animals Production Technology, Lviv National University of Veterinary Medicine and Biotechnologies, vul. Pekarska 50, 79010 Lviv, Ukraine

Abstract. The article provides the results of the studies on the efficiency of using dry apple pomaces with and without chelate copper and zinc addition in diet of breeding geese. The experiment demonstrated the effective level of these additives and their influence on the morphological qualities of eggs and on the level of productivity was examined. It is found that the usage of non-traditional feed additives improves the process of egg laying, and increases hatchability and vitality of goslings. Thus, it is obvious that inexpensive, practically dry apple pomaces can significantly increase the income of a poultry farm. Besides, it was shown that the highest level of hatchability and survival was present at a content of 7% of dry apple pomaces, enriched with chelate copper and zinc forage supplementation. This implies that such feed additives meet the high physiological needs – not only in nutrients, but also in biologically active matter, which satisfy the needs of the organism and provide appropriate level of realization of the genetic potential of breeding geese performance, especially promote more intensive usage of substrates for synthesis of the main components of the eggs.

Key words: geese, feed additives, reproductive performance, egg quality, lipids in yolk

INTRODUCTION

At present, due to economic and organizational difficulties, there is a lack of complete forages which contain important biologically active substances [Svezhentsov 2001]. These substances include microelements, which normalize intestine

✉lesya_fialovych@ukr.net

digestion, improve digestibility of the diet and positively influence the processes of blood creation and immunity. They intensify the metabolism in the body and have a direct impact on the productivity and health status of the farm animals [Georgievsky et al. 1979].

Thus, there is no doubt that improvement of productivity calls for additional supply of microelements, including zinc [Daineko 2012]. This is caused by the fact that this microelement greatly influences reproductive capacities of poultry [Bratyshko et al. 2013].

Microelements, especially zinc and copper, are the main factors of securing the normal life of an organism. They are part of many biologically active compounds – enzymes, hormones, vitamins, take part in the metabolism of substances and energy in the body. Thus, they directly influence poultry productive capacity, reproductive performance and natural immunity [Khvostyk 2014].

However, the issue of supplementing poultry feeds that would guarantee and effective forms and norms of additives of microelements is not resolved yet. Inorganic compounds of microelements in premixes and mixed fodder accelerate the destruction of fat-soluble vitamins, create non digestible complexes and, as a result, the elements are used ineffectively [Horobets 2005]. At present, it is known that the alternative for inorganic salts of microelements are their chelate compounds that positively influence productivity, quality of the product, and also have high biological availability for the bird [Lokhova 2005].

Some authors demonstrate that bioavailability of microelements from chlorides, oxides, carbonates and sulfates in the poultry organism is quite high [Kalnytskyi 1985, Kishchak 1995]. However, new information about the mechanisms of absorption and metabolism of microelements in the poultry organism, as the achievements in the sphere of biotechnology of natural minerals production, allow to assume that in the future the usage of their inorganic forms will be minimum. Organic elements – is the natural solution of the problem of mineral nutrition of agricultural poultry [Zheinova 2014].

Therefore, today more and more attention is being paid to the finding new forms and non-traditional additives that have high biological activity and are more available and effective for the avian body [Daineko 2012]. One of such novel additives is apple pomace. However, crude pomaces can be quickly deteriorated and this is the reason why they should be quickly fed or dried [Barta et al. 1984]. According to literature, dry apple pomaces have a large number of biologically active substances, especially carotenoids, phospholipids, and a range of minerals, especially cobalt and iodine [Tkachuk 2012].

Thus, the aim of our research was the theoretical and practical justification of expediency of the usage in the mixed fodders for geese non-traditional feed

additives and examine their influence on the productivity and quality of eggs. To achieve these aims, this feeding trial was carried out.

MATERIAL AND METHODS

The experiment was carried out in the SF “Myklashivske” of the Institute of Agriculture of Carpathian Region of UAAS. We selected the pedigree type of Obroshyn geese and formed groups of 100 heads in each. While forming the parent flock of geese, we maintained the ratio 1:4.

The research was carried out on three-year-old breeding geese, similar in the live weight. The selection and formation of parent stock was done according to groups, which during the period of copulation and oviposition (from February to May) were held separately.

Geese maintenance was not restricted with the free access to forage and water. The temperature was held on the level +14°C with relative humidity 75%. The length of daylight for geese was held in the frames of 14 hours.

All birds were fed balanced mixed feed containing main nutritional and biologically active substances. However, the experimental groups of geese were – during the period of laying – fed with mixed with forage at a dose 7% in relation to the general mass (instead of grain components of the ration: wheat, oats, barley) dry apple pomaces without and with an addition of chelate copper, 15 mg · kg⁻¹ forage per 24 hours, and zinc, 30 mg · kg⁻¹ forage per 24 hours.

Table 1. Scheme of the research

Tabela 1. Układ doświadczenia

Group Grupa	Amount of poultry, heads Liczebność grupy	Conditions of feeding System żywienia
Control Kontrolna	100	MR (main ration – dawka podstawowa)
I experimental I doświadczalna	100	MR* (7% of dry apple pomaces – 7% suszonych jabłkowych wytlóków)
II experimental II doświadczalna	100	MR (7% of dry apple pomaces, enriched with chelate copper and zinc – 7% suszonych jabłkowych wytlóków z chelatem miedzi i cynku)

*optimal dose 7% was set in previous research – optymalna dawka 7% została ustalona we wcześniejszych doświadczeniach.

The forage consisted of the following components: energy (wheat, oats, barley, corn, wheat bran), protein (oil pomace, yeast, soybean expeller, fish meal, meat and bone meal, bone meal), mineral supplements (salt, chalk, limestone, tricalcium phosphate without fluorine) and vitamin supplements (vitamin and mineral premix).

Dry apple pomaces were used due to their nutritional value as a feed additive, which to some extent contains a significant portion of the compounds that make up the starting material.

This non traditional additive is added to the main mass of the mixed forage, qualitatively mixed and distributed on its mass, therefore to secure the equal distribution of micro doses of biologically active components in all forage. The production is being made on the enterprise *Iablunevyi dar* ("Apple gift") as dry apple mass, obtained according to the modern technologies and additionally in the conditions of department laboratory, enriched with chelate compounds of microelements.

Highly efficient chelate preparations of microelements have been synthesized in the laboratory conditions of the Bilotserkivskiy National Agricultural University. The technology of production presupposed that weighted mass of salts microelements, in particular copper sulphate (copper sulfate water 5) according to GOST 4165-78 and zinc (zinc sulphate 7-water) according to GOST 4174-77 were dissolved in distilled water. While constant mixing, 24% solution of potassium hydroxide was added. At the same time centrifugation was carried out, i.e. deposition of suspended particles in a liquid. As a result, after draining supernatant liquid, L – lizyn hydrochloride was added to precipitate.

Microelements in the form of chelates have chemically protected form thereby increasing the bioavailability of metals that promotes the retention of dietary element in organs and tissues.

Feeding trial with the mixed forage lasted for three months, during which daily counting of the process of laying eggs was carried out (oviposition duration – 95 days).

A number of 5 eggs every 10 days were selected during the whole period of the research and were placed in an incubator with a total party, marking the group number. The total number of placed eggs for incubation in each group was 400.

Before setting eggs for incubation, their morphometric indicators according to general methods was determined [Kyryliv and Ratych 2000, Vlizlo et al. 2012].

Egg weight, eggshell, albumen and yolk was measured on scales of type VLKT-500, shape index – index meter IM-1 of P.P. Tsarenka construction, elastic deformation of the eggshell – device PUD-2, eggshell thickness – micrometer, albumen and yolk diameter – by caliper. Concentration of hydrogen ions of protein and yolk (pH) was measured by potentiometer.

The researched indicators of the general lipids content, the ration of individual lipid classes and the amount of carotenoids in egg yolks was determined by current methods [Folch et al. 1957, Stefanyk 1985, Vlizlo et al. 2004], and subjected to biometric processing.

RESULTS AND DISCUSSION

To study the influence of optimal dose of dry apple pomaces and biologically active micro mixed fodders on the quality indicators of eggs was carried out their morphological evaluation (Table 2). High quality of eggs incubation is provided on condition the conformity of morphological qualities of eggs to the needs of embryo, since it is known that physical parameters of eggs plays crucial role in the embryonic development and successful hatching of birds.

Table 2. Qualitative indicators of geese eggs ($\bar{x} \pm SD$, $n = 45$)Tabela 2. Wskaźniki jakościowe jaj gęsi ($\bar{x} \pm SD$, $n = 45$)

Indicator – Wskaźnik	Group – Grupa		
	Control Kontrolna	I experimental I doświadczalna	II experimental II doświadczalna
Egg weight, g – Masa jaja, g	141.64 \pm 4.41	139.82 \pm 4.30	141.00 \pm 2.30
Egg length, mm – Długość jaja, mm	63.00 \pm 0.84	60.00 \pm 1.58	68.80 \pm 0.10***
Egg width, mm – Szerokość jaja, mm	37.80 \pm 0.73	38.00 \pm 0.55	36.60 \pm 0.05
Egg shape index, % – Indeks kształtu, %	60.20 \pm 0.80	63.60 \pm 1.03*	53.24 \pm 1.00***
Yolk weight, g – Masa żółtka, g	52.82 \pm 2.15	49.07 \pm 1.62	46.90 \pm 1.03*
%	37.3	35.1	33.3
Albumen weight, g – Masa białka, g	69.28 \pm 4.18	70.32 \pm 2.93	76.79 \pm 1.62
%	48.9	50.3	54.5
Eggshell weight, g – Masa skorupki, g	19.54 \pm 0.80	20.43 \pm 0.77	17.31 \pm 0.15*
%	13.8	14.6	12.2
Eggshell strength, kg \cdot cm ⁻² Wytrzymałość skorupki, kg \cdot cm ⁻²	3.52 \pm 0.18	3.56 \pm 0.13	3.86 \pm 0.05
pH of albumen – pH białka	9.39 \pm 0.04	9.40 \pm 0.02	8.03 \pm 0.16***
pH of yolk – pH żółtka	7.03 \pm 0.36	7.18 \pm 0.21	6.15 \pm 0.09*
Eggshell thickness in sharp end, mm Grubość skorupki na ostrym końcu, mm	0.53 \pm 0.001	0.52 \pm 0.002**	0.59 \pm 0.010***
Eggshell in blunt end, mm Grubość skorupki na tępych końcu, mm	0.52 \pm 0.001	0.52 \pm 0.001	0.61 \pm 0.008***

* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$.

While evaluating the influence of these additives, it should be noted that there are not some essential changes among the changes of the indicators of eggs. However in the first experimental group the weight of an eggs decrease slightly for 1.82 g or 1.3%. Owing to this, the weight of yolk decreases for 3.75 g, but the weight of albumen and shell increases for 1.04 and 0.89 g correspondently. Concerning the percentage correlation, percentage of yolk is decreased for 2.2%, protein and shell increases for 1.4% and 0.8%, in comparison with the control group.

Average mass of the egg of the second experimental group was practically the same as with the control group. However, it should be noted that the mass of yolk decreases, but the mass of albumen and eggshell increase in comparison with the control group. A supplementation of 50% of the amount of minerals in organic sources increases egg weight, according to Maciel et al. [2010].

The level of pH of albumen in control and the first experimental groups was almost the same, however this indicator decreases in the second experimental group (Fig. 2). However, this indicator increases for 2.1% in yolk in the first experimental group, in comparison with the control group.

While eggs selection for incubation, great attention is paid to qualitative indicators of the eggshell. The biological function of the eggshell is to ensure the development of the embryo [Sezer 2007].

Adding these feed additives in the forage of breed geese leads to the improvements of the shell quality. The strength of the egg shell is raised in the first researched group for $0.04 \text{ kg} \cdot \text{cm}^{-2}$ or 1.1%, however in the second experimental group it was higher than in the control group for 9.7% and the result is that decreases the number of broken eggs.

Inclusion of Zn, Cu, and Mn trace minerals chelated to the hydroxy analogue of methionine had a significant impact on eggshell thickness and strength in the later part of the laying cycle [Manangi et al. 2015].

The thickness of eggshell was on the same level in both, control and the first experimental groups. However it can be seen the slight decrease of this indicator in the sharp end of an egg of the first experimental group. Generally, the second experimental group prevail the control group according to these indicators.

Carvalho [2012] found that the total change of inorganic mineral affected the quality of the shell, increasing eggshell thickness and the amount of pores per square centimeter. While feeding non traditional feed additives, in particular new forms of microelements, the content of general lipids increases for 2.1% in the first experimental group and for 4.4% in the second (Table 3).

If we analyze the lipids classes in the first experimental group, decrease can be seen according to the level of phospholipids and NNFA respectively for 10.4% and 18.5%. Slightly rise the level of mono and diacylglycerols. The content of free cholesterol, triacylglycerol and cholesterol esters increases respectively for 13.7%, 6.4% and 38.6% in comparison with the control group.

While analyzing provided in the Table 3 lipid classes, it should be noted that in the second experimental group increase is traced according to the level of mono and diacylglycerols for 18.5% and decreasing the level of phospholipids and triacylglycerol respectively for 20.7% and 3.2%. Slightly rises the level of NNFA. The content of free cholesterol and cholesterol esters increases, that probably is

connected with their accumulation in a geese egg yolk, as a basic structural materials, that plays positive role in the process of embryo development.

It was determined according with the research data that the decreasing of cholesterol content in the blood serum of ostriches during the reproductive period, probably, is connected with its accumulation in the egg yolk as a main structural material, necessary for embryo development [Noble et al. 1996].

The level of carotenoids increases in the first experimental group, which were fed with apple pomaces for $0.95 \text{ mg} \cdot \text{g}^{-1}$ or 6.91%, however in the second group for 16.30% (Table 4).

Table 3. Content of general lipids and their distribution according to classes in the yolk of geese eggs, % ($\bar{x} \pm m$, $n = 5$)

Tabela 3. Zawartość ogółem tłuszczu i ich podział według klas w żółtku jaja gęsi, % ($\bar{x} \pm m$, $n = 5$)

Indicator Wyszczególnienie	Group – Grupa		
	Control Kontrolna	I experimental I doświadczalna	II experimental II doświadczalna
General lipids – Tłuszcz ogółem	28.70 \pm 0.66	29.30 \pm 0.34	29.97 \pm 0.36
in that – w tym:			
– phospholipids – fosfolipidy	31.97 \pm 0.36	28.65 \pm 0.39***	25.36 \pm 0.76***
– mono and diacylglycerols – mono i diacylglicerole	19.68 \pm 0.35	20.10 \pm 0.26	23.32 \pm 0.31***
– free cholesterol – choresterol	5.31 \pm 0.09	6.04 \pm 0.15***	6.32 \pm 0.42*
– NNFA (nonetherified fatty acids) – NNFA (nienasycone kwasy tłuszczowe)	6.22 \pm 0.13	5.07 \pm 0.13***	6.85 \pm 0.30
– triacylglycerol – triacyloglicerol	33.87 \pm 0.26	36.04 \pm 0.33***	32.79 \pm 0.99
– cholesterol esters – estry cholesterolu	2.95 \pm 0.13	4.09 \pm 0.10***	4.68 \pm 0.27***

* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$.

Table 4. Content of carotenoids in yolks of geese eggs, $\text{mg} \cdot \text{g}^{-1}$ ($\bar{x} \pm \text{SD}$, $n = 5$)

Tabela 4. Zawartość karotenoidów w żółtku jaj gęsich, $\text{mg} \cdot \text{g}^{-1}$ ($\bar{x} \pm \text{SD}$, $n = 5$)

Indicator Wyszczególnienie	Group – Grupa		
	Control Kontrolna	I experimental I doświadczalna	II experimental II doświadczalna
Carotenoids – Karotenoidy	13.74 \pm 0.28	14.69 \pm 0.27*	15.68 \pm 0.22*

* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$.

Such intergroup difference, is connected with the content of these biologically active matters in the products of apple processing that has much bigger number of carotenoids ($10.89 \text{ mg} \cdot \text{kg}^{-1}$), in comparison with the other vegetative forages particularly grain concentrates ($0.22\text{--}0.96 \text{ mg} \cdot \text{kg}^{-1}$) that were included to the ration. As a result, the geese yolk color of experimental groups was brighter, indicating the consumption by poultry of apple pomaces, rich for carotene and xanthophyll pigments. Higher number of carotenoids deposits in geese eggs yolks is caused by their higher content in dry apple pomace than in mixed forage.

The results of the researched eggs productivity of geese that are presented in the Table 5, testify the rise of eggs laying. Adding to the ration of breeding geese dry apple pomaces, enriched with chelate compounds of copper and zinc promotes the rise of egg laying of geese from 37 to 45.8 and 44 eggs per goose respectively in the 1st and 2nd experimental groups.

Table 5. Indicators of geese productivity during the period of research

Tabela 5. Wskaźniki produktywności gęsi podczas doświadczenia

Indicator	Group – Grupa		
	Control Kontrolna	I experimental I doświadczalna	II experimental II doświadczalna
Egg production, pcs. Nieśność, szt.	37.0	45.8	44.0
Number of eggs for incubation Liczba jaj do inkubacji	1300	1200	1300
Goslings hatching, % Wylężonych gąsiąt, %	73.0	84.7	88.9
Gosling survival, % Przeżywalność gąsiąt, %	85.0	93.5	94.6

Pomace can be used safely as energy source in broiler ration replacing maize by 10% without any side effects on the broiler production [Zafar et al. 2005]. It was determined that the usage in the breed geese feeding dry apple pomaces, enriched with chelate copper and zinc caused the increase of the number of incubation eggs for 18.9% in the second experimental group.

The percentage of the goslings born from eggs, obtained from geese of the second group was 88.9%, and from eggs, obtained from geese of the control group – 73%, thus the number of born goslings of the experimental group was higher for 15.9%. It is explained by the fact, that dry apple pomaces positively influenced on the increasing of the level of carotenoids in geese eggs yolks for 16.4% and also by the fact that the usage in the content of forages chelate microelements of copper and zinc promote the better digestibility of these substances in the organism of poultry.

The given data shows that dry apple pomaces, enriched with chelate improve the viability of goslings, since the preservation of geese was higher in the second experimental group. The survival of goslings during the whole period of growing was 85% in the control and 94.6% in the experimental group, thus the difference was on the level of 9.6%.

Results showed that apple pomace can be used up to 10% level in broiler diets especially in terms of body weight [Ayhan et al. 2009].

It is proved as well, that the usage of dry apple pomaces in the first experimental group secure the rise of the process of laying eggs of geese for 23.8%, promote the rise of the carotenoids level in eggs yolks that in its turn rise the hatching and survival of goslings respectively for 11.7% and 8.5%.

This is due to the fact that this nontraditional forage materials of vegetable origin, contains in its structure much more cobalt and iodine in comparison with the concentrated forage, that effectively can enrich the ration of birds, especially can have positive impact on geese egg productivity and incubation egg quality.

CONCLUSIONS

Our researches have shown that during the feeding of the ration, based on the dry apple pomaces, enriched with chelate of copper and zinc, happens significant changes, in particular increases the hatching and vitality process of goslings. This is caused due to the fact that microelements in the form of chelate have chemically protected form, as result the biological accessibility of material increases that promote keeping of the microelements in the organs and tissues, as the result the productivity of poultry rises.

Apple pomaces is the main element in increasing the intensity of goslings growth and the level of eating forage by the poultry. Researches have proven that feeding with this non traditional forage give the yolk of a goose egg saturated color. This means that dry apple pomaces is the source of the color substances (pigments caused by the presence of beta-carotenoids) and can provide poultry with the nutritive and biologically active substances, as close as possible to their needs.

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WSKAŹNIKI NIEŚNOŚCI I WYLĘGU ORAZ JAKOŚCI JAJ U GĘSI ŻYWIANYCH Z WYKORZYSTANIEM DODATKU SUCHYCH JABŁKOWYCH WYTŁOKÓW

Streszczenie. W artykule przedstawiono wyniki badań efektywności stosowania suchych jabłkowych wytlóków bez dodatku i z dodatkiem chelatu miedzi i cynku w żywieniu gęsi. Eksperymentalnie określono efektywny poziom tych dawek i zbadano ich wpływ na cechy morfologiczne, jakości jaj i poziom produkcyjności u gęsi. Ustalono, że stosowanie w mieszance paszowej dodatku suchych jabłkowych wytlóków zwiększa nieśność u gęsi, sprzyja podwyższeniu wylęgowości z jaj zapłodnionych i zdolności do przeżycia u gąsiąt. Użycie tanich, pełnowartościowych suchych jabłkowych wytlóków może istotnie zwiększyć dochodowość drobiarstwa. Oprócz tego, stwierdzono również, że najwyższy poziom wylęgu z jaj zapłodnionych i zdolności do przeżycia zaznaczał się w grupie żywionej z dodatkiem 7% suchych jabłkowych wytlóków wzbogaconych chelatami miedzi i cynku w mieszance paszowej. Świadczy to, że dodatki te zabezpieczają nie tylko fizjologiczne zapotrzebowanie podstawowych składników odżywczych, ale i w biologicznie aktywnych substancjach, co determinuje odpowiedni poziom produktywności gęsi, a w szczególności sprzyja intensywnemu użyciu substratów dla syntezy głównych elementów jaj.

Słowa kluczowe: gęsi, wylókki jabłkowe, reproduktywność, jakość jaj, lipidy żółtka

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