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INFLUENCE OF COMPLETE FEED MIXTURE CONTAINING NAKED OAT OF THE TATRAN VARIETY ON PARAMETERS OF UTILITY AND QUALITY OF EGGS OF LAYING HENS

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ABSTRACT

The aim of this experiment was to define the nutritional response of laying hens (Hy-Line Brown hybrid) receiving feed mixture consisting partly of Tatran naked oat on the utility parameters and egg quality in comparison with control group, which was fed a complete feed mixture based on the maize-wheat-soybean extract meal. Totally 72 hens were divided into two groups of 36 animals per each group. In the experimental group, hens were fed with a feed mixture based on 60 % of naked oat of the Tatran variety, maize and soybean extract meal. In the control group, the laying hens were fed with feed mixture based on maize, wheat, soya extract meal and the sunflower oil. Hens of experimental group had statistically significantly higher average of egg production (276.07 ± 0.05 pieces, 16.96 ± 0.004 kg) per 1 hen against control group (267.97 ± 0.062 pieces, 16.11 ± 0.005 kg) ($P<0.001$). The average weight of eggs was significantly higher ($P<0.001$) in the experimental group (61.42 ± 3.160 g) compared to the control group (60.13 ± 3.412 g). The number of non-standard eggs per hen was significantly lower (13.79 ± 0.041) in the experimental group in comparison with the control group (15.89 ± 0.045) ($P<0.05$). Likewise, significantly higher average number of double-yolk eggs (2.09 ± 0.018) per hen was recorded in the experimental group. Only the colour of egg yolk was significantly higher ($P<0.01$) in the control group in comparison with the experimental group. For a whole season we recorded significantly higher daily consumption of feed calculated per 1 egg (125.95 ± 17.828 g) and per 1 kg of the egg mass (2.094 ± 0.311 kg) in the control group ($P<0.001$) in comparison with the experimental group (121.38 ± 14.664 g) per 1 egg and (1.976 ± 0.257 kg) per 1 kg of the egg mass. The results suggest that the naked oat-based feed mixture for laying hens might improve intensity of the egg production, increase the weight of eggs, reduce the number of non-standard eggs and consequently reduce cost of the egg production.

Key words: laying hens; naked oat; diet; egg quality

INTRODUCTION

Naked oat is phenotypically characterized by non-lignified husk, which becomes detached during harvesting and this leads to increased metabolisable energy in feed mixture for poultry. Their potential in poultry nutrition has been increased by selection for high oil content. High-oil naked oat lines yielded 12 % more metabolizable energy than wheat. Naked oats, excluding the experimental high-oil lines, yielded 8.5 % more energy than simultaneously assayed wheat samples. The addition of β-glucanase produced an increase of about 4 % in the apparent metabolisable energy of oats for broiler chickens (MacLeod *et al*., 2008).

Naked oats has higher proportion of essential amino-acids than wheat or barley. This offers the possibility of replacing some imported soya and animal proteins by valuable energy of oats. Further advantages of naked oats include a high concentration of polyunsaturated oils (40 % of oil is monounsaturated,

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40 % polyunsaturated) and significant antioxidant activity. The latter two characteristics confer benefits on egg and meat quality. The health benefits of polyunsaturated oils could make eggs and meat from oat-fed hens more attractive to consumers. The effects on meat quality have been shown to include enhanced sensory evaluation and properties such as low drip loss and longer shelf life (Lopez-Bote *et al.*, 1998a, b).

Research shows that naked oat supplemented with feed-grade lysine and methionine or with canola meal, to the exclusion of soybean meal, dietary levels with content of 70 or 88 % naked oat supported egg laying equally to the corn-soy control. By the 88 % level of naked oat, egg size was significantly increased. This is of benefit to younger laying flocks, giving better egg grades and higher monetary returns (Burrows *et al*., 1993).

Naked oats provide a successful alternative to corn as the staple grain of poultry layer and breeder diets, and can replace a large part of soybean meal traditionally used in such diets. When supplemented with lysine plus methionine or with canola meal, no soybean meal is required in the naked oat diet. While egg yield was satisfactory, egg weight was increased from levels of 300 $g.kg^{-1}$ and feed utilization was decreased at levels of 600 to 874 $g.kg^{-1}$ (Cave *et al.*, 1989).

Naked oats may be used by 40 % inclusion in broiler diets with no adverse effect on growth, feed efficiency, dressing percentage or bone strength (Maurice *et al*., 1985).

MATERIAL AND METHODS

The aim of this experiment was to verify the effect of inclusion of naked oat of the Tatran variety into complete feed mixture for high-production laying hens, on egg performance and quality of eggs, in comparison with control group, which was fed with a complete feed mixture based on maize, wheat, soya extract meal and the sunflower oil.

The Tatran variety is medium to early maturing of naked oat variety. This variety has good resistance to powdery mildew, stem rust, crown rust, leaf stripe. Resistance to lodging is consistent with the Avenuda variety. The average of weight of thousand grains is 29.14 g, volume weight is 64.0 $kg.hl^{-1}$ and low percentage of husk corns (3.1 %). The Tatran variety overcame the control Avenuda variety in pure grain yield by 5 % for 2 years (MPSR, 2010).

Totally, 72 laying hens were divided into the experimental group (36 pieces of hens fed with feed mixture based on 60 % of naked oat of the Tatran variety, maize and soybean extract meal) and the control group (36 pieces of hens fed with feed mixture based on maize-wheat-soybean extract meal and the sunflower oil). The mineral feed and premix of the supplement mass were used in the same production batch. This experiment was performed on laying hens with brown egg shell production of hybrid Hy-Line Brown starting since 140 days of age. Hen's condition was verified by

Table 1: Composition and nutritional value of feed mixtures

Components (%)	Mixture		Nutritional value ($g.kg^{-1}$)	Mixture	
	CFM-E	CFM-C		CFM-E	CFM-C
Ground naked oat „Tatran"	60.00	-	Dry matter	893.0	887.0
Ground maize	15.20	38.00	Nitrogenous compounds	163.0	162.0
Ground wheat	-	30.00	Fat	62.7	45.0
Soybean extract meal	15.40	21.10	Fiber	18.4	22.3
Sunflower oil	-	1.50	Ash	107.0	105.0
Calcium carbonate	7.80	7.80	NFE	541.9	552.7
Monocalcium phosphate	0.70	0.70	Carbohydrates	33.6	36.0
Sodium chloride	0.30	0.30	Starch	427.0	424.0
Vitamin-mineral premix	0.50	0.50	Ca	33.6	30.6
Methionine 99 %	0.10	0.10	P	5.70	5.26
Totally	100.00	100.00	Na	1.38	1.45

NFE- nitrogen-free extract
CFM-E - complete feed mixture in the experimental group
CFM-C - complete feed mixture in the control group

individual weighing before starting the experiment.

The production test was divided in two phases. The first phase of the egg production lasted since 20th to 46th weeks of age and the second phase since 47th to the first day of 62nd weeks of hen´s age. Pullets were randomly divided into pairs and placed to the cages for laying hens. Microclimatic condition and light regime were regulated on the principles of valid technological condition for hybrid production. The experiment was finished by the second day after 62nd weeks of hen´s age.

The live weight of hens was detected by individual weighing three times during the experiment: first time in 20 weeks of hen´s age, second time in 46 weeks of age and third time in 62 weeks of hen´s age.

Complete feed mixtures were fed *ad libitum*. Fresh clean water was always at disposal from automatic poultry drinker.

To ensure the correct microclimate housing conditions, temperature and humidity were monitored three times a day (Table 2).

An essential part of the investigation of the actual development of the animals were individual weighing of all laying hens included to the experiment with the exactness of 5 gramm (at the beginning of the experiment, at the end of the first phase of production, in hens of 47th week of age, at the end of the experiment). The egg production was monitored once per day and collectively.

The level of utility was monitored with precise control of feed consumption of (by group). The average consumption of feed and nutritions was calculated per 1 egg and per 1 kg of eggs. The number of non-standard eggs was recorded daily in both groups. The number of eggs with cracked shell, broke shell, double-yolk, shell-free egg or other non-standards were recorded individually. The weight of eggs was recorded daily in both groups.

From each group 10 pieces of eggs were evaluated, which were randomly selected in monitoring of quality indicators of eggs. For each of four weeks the following parameters were evaluated: egg-yolk index, egg-white index, compactness of shell (the weight and surface of the egg). Egg quality was determined using the Haugh units (Haugh, 1937), colour of raw egg yolk – by a scale of Hoffmann La Roche (Weis *et al.*, 2002). Sensory quality of eggs, such as taste and smell of boiled eggs were evaluated twice during the experiment (each time on 5 pieces of random selected eggs from each group on 25th and 45th weeks of age of laying hens).

The cost of consumed feed was evaluated every day per 1 hen, per 1 egg, per 1 kg of eggs. Results of experiment were statistically evaluated by Student‘s t-test.

Table 2: Climatic and technological indicators from 20th to 62nd weeks of hen´s age

Temperature in hall (˚C)			
Age of laying hens	Min	Max	$\bar{x}$
20th – 46th week	10	18	14,55
47th – 62nd week	14	26	20,15
20th – 62nd week	10	26	16,57
Relative humidity in hall (%)			
Age of laying hens	Min	Max	$\bar{x}$
20th – 46th week	29	82	53,53
47th – 62nd week	35	86	62,82
20th – 62nd week	29	86	56,88

RESULTS AND DISCUSSION

At the first weighing we recorded higher average live weight of hens in the control group. At the second and last weighing we recorded the higher average live weight of hens in the experimental group. However, these differences were not statistically significant.

Hartini *et al.* (2003) confirmed highly statistically significant weight of the gizzard ($P<0.01$) in laying hens, which were fed with oats and statistically highly significant total weight of juvenile hens fed oats. Positive effect on the weight of laying hens was significantly confirmed ($P<0.05$) in the previous study of Brenesl *et al.* (1993).

The whole season of egg production lasted from the 22nd to the first day of the 62nd weeks of hen´s age. During the whole season all evaluated indicators of egg production were better parameters of

Table 3: Egg production

Group	$\bar{x}$	s	T test (significance)
The average egg production per 1 hen (piece)			
1.	276.07	0.050	***
2.	267.97	0.062	5.689E-09
The average egg production per 1 hen (kg)			
1.	16.96	0.004	***
2.	16.11	0.005	5.503E-14
The average weight of eggs (g)			
1.	61.42	3.160	***
2.	60.13	3.412	2.045E-06
The average number of non-standard eggs per 1 hen			
1.	13.79	0.041	*
2.	15.89	0.45	0.0481
The average number of double-yolk eggs per 1 hen			
1.	2.09	0.018	**
2.	0.94	0.011	0.0018

1. Experimental group (complete feed mixture based on 60 % of naked oat, maize and soybean); 2. Control group (complete feed mixture based on the maize, wheat, soybean, and sunflowers oil); N eggs = 295; N hens in the experimental group = 36; N hens in the control group = 36; *P<0.05; **P<0.01; ***P<0.001

the utility in the experimental group in comparison to the control group. Animals of experimental group had statistically significantly higher average egg production (276.07 ± 0.050 pieces, 16.96 ± 0.004 kg) per 1 hen compared to the control group (267.97 ± 0.062 pieces, 16.11 ± 0.005 kg) (P<0.001). The average weight of eggs was significantly higher (P<0.001) in the experimental group (61.42 ± 3.160 g) in comparison with the control group (60.13 ± 3.412 g). The significantly lower (P<0.05) number of non-standard eggs per hen (13.79 ± 0.041) was recorded in the experimental group in comparison with the control group (15.89 ± 0.045). We recorded significantly higher average number of double-yolk eggs (2.09 ± 0.018) per 1 hen only in the experimental group in comparison with control group (15.89 ± 0.045) (Table 3).

Our results suggest that naked oat is a valuable feedstuff with positive influence on the egg production, which is related to nutrition profile of naked oat. In the experimental group of hens we detected higher intensity of egg production P<0.001 in comparison with the control group. Recorded results are in agreement with the previous finding of MacLeod (2010), who confirmed a trend to raise the average of laying hens fed with oats.

Table 4: Feed consumption

Group	$\bar{x}$	s	T test (significance)
The average feed consumption per 1 egg			
1.	121.38	14.664	***
2.	125.95	17.828	3.872E-04
The average feed consumption per 1 kg of egg mass			
1.	1.976	0.257	***
2.	2.094	0.311	2.159E-07

1. Experimental group (complete feed mixture based on 60 % of naked oat, maize and soybean); 2. Control group (complete feed mixture based on the maize, wheat, soybean, and sunflowers oil); N eggs = 295; *P<0.05; **P<0.01; ***P<0.001

Increasing in the egg production of laying hens fed with oats was confirmed in the study of Bennett and Classen (2003). Shafey *et al.* (1999) detected significantly higher weight of yolk and higher share of unsaturated fatty acids (oleic, linoleic and linolenic) in the yolk mass in hens, which were fed with naked oat. Hsun and Maurice (1992) stated that the naked oats can be used to replace all or part of the maize meal and part of the soyabean meal without any reduction in performance.

For the whole season we detected daily significantly higher consumption of feed per 1 egg and per 1 kg of the egg mass in the control group ($P<0.001$) in comparison to the experimental group (Table 4). These results related to the high available energy content of a naked oat.

According to Scheideler *et al.* (1998) oats increased the weight of eggs and potential nutrient digestibility in laying hens. It is also worth noting that oats, a high-fibre cereal, is being used in north-western Europe for feeding poultry, especially during the moulting, and obviously with positive results (Pottgüter and Tierzucht, 2008). Sokol *et al*. (2004) confirmed that the feed consumption does not decrease when naked oat is added into feed mixtures.

In laying hens, Krimpen (2008) observed that the nutrient dilution and addition of (coarse) insoluble non-starch polysaccharides increases feeding related behavior, as expressed by prolonged eating time and decreased eating rate. Supplementation with 15 % of diluted diets to rearing hen resulted in less damage of feather during the laying period.

Qualitative properties of eggs involve the evaluation of Haugh units, yolk colour, egg white index, yolk index and egg soundness. The results of evaluation are shown in table 5. The colour of egg yolk was different between groups in relative terms 15.25 % for the control group. These differences were also statistically very highly significant ($P <0.001$) for control group. Other qualitative characteristics of eggs were not statistically significant.

For the whole season of the experiment we found an average egg yolk index in the control group at 37.16 and 36.95 in the experimental group. The Haugh units were different between groups in relative units 0.18 % for the experimental group.

The naked oat does not contain carotenoids, which influence the final concentration of pigments in the yolk, for that reason the intensity of yolk colour was significantly lower. Oat has lack of carotene pigment and yolk colour intensity decreases with increasing content of oat (Burrows *et al*. 1993). According to Hammershøj and Steenfeldt (2005), yolk colour became significantly lighter and more yellow with lupin content, but darker

Table 5: Qualitative evaluation of eggs (average of the two ratings)

Group	n	$\bar{x}$	s	T test (significance)
Color of the egg yolk				
1.	100	4.50	0.249	**
2.	100	5.31	0.401	0.000037
The Haugh units				
1.	60	105.57	4.803	-
2.	60	105.38	6.066	0.851089
Egg yolk index				
1.	100	36.95	1.756	-
2.	100	37.16	1.547	0.774654
Egg white index				
1.	100	168.30	11.764	-
2.	100	167.91	11.722	0.941817
Egg soundness				
1.	100	1.00	0.083	-
2.	100	0.98	0.098	0.784885

1. Experimental group (complete feed mixture based on 60 % of naked oat, maize and soybean); 2. Control group (complete feed mixture based on the maize, wheat, soybean, and sunflowers oil); 1.*P<0.05; **P<0.01; ***P<0.001

and less greenish with foraging material. The decisive factor for obtaining the desired colour is the content of egg yolk carotenoids in feed mixture for laying hens. Factors responsible for the colour of yolk are: feed mixture, physiological factors, health status of laying hens, feed production, and properties of carotenoid premix (Baker and Günther, 2004).

CONCLUSION

Through interventions in hen's nutrition it is possible to influence the health of laying hens, utility and also enrich the final product for important substances for human nutritional needs. In the experiment of hybrid Hy-Line Brown laying hens we tested the variety of naked oat called Tatran. The live weight of laying hens was not affected by the experimental intervention. The average parameters of the egg production were higher in the experimental group, which was fed with a feed mixture based on 60 % of naked oat of the Tatran variety, maize and soybean extract meal. The number of non-standard eggs and share of the egg production was lower in the experimental group. Using qualitative evaluation of eggs, we found statistically very significant differences in yolk color in comparison to control group. In others qualitative evaluations there differences between the groups were slight and statistically insignificant. At the sensory evaluation of boiled eggs we did not find significant differences. The taste and smell of eggs were found as a typical for eggs. For a whole experimental season, significantly lower ($P<0.001$) cost of consumed feed mixture in the experimental group per 1 egg and per 1 kg of the egg mass was recorded in comparison with the control group. Significantly higher average egg production per 1 laying hen was recorded in the animals of the experimental group in comparison with the control group. Significantly higher number of egg masses, as well as the average weight of eggs was obtained in the experimental group.

On the basis of the obtained results we can recommend for practice to use the experimental complete feed mixture based on 60 % of naked oat of the Tatran variety, maize and soybean extract meal, which significantly improved the egg production and the weight of eggs, whilest the feed consumption was reduced compared to the control complete feed mixture used in this experiment.

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