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Effect of dietary mulberry leaves on performance parameters and nutrient digestibility of laying hens

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ABSTRACT

The purpose of this study was to investigate the effect of the dietary mulberry leaves on nutrient digestibility and layer performances. The experiment was conducted for 30 days on 105 Lohman Brown layers assigned to 3 groups (C, E1 and E2) with 35 layers/group. The experimental diets included 3% (E1) and 6% (E2) mulberry leaves. The layers had free access to the food. The feed intake, egg production, feed conversion ratio, egg mass production and egg weight were recorded; no significant difference was noticed between the 3 groups. Digestibility studies were performed on weeks 2 and 3 (5 days/week). Organic matter digestibility was significantly higher in the control group compared to the experimental groups: E1 and E2. Nitrogen free extractives significantly differed in groups too. The physical parameters of the eggs (egg weight, egg white weight, egg shell thickness, Haugh unit, egg yolk weight and egg shell weight) did not differ significantly between the groups. Yolk colour intensity was significantly higher in the experimental groups E1 and E2 compared to the control group. Use of mulberry leaves in laying hens nutrition by including into ratio up to 6% had no negative effects on breeding performances and egg quality.

Key words: Layers, Mulberry leaves, Nutrient digestibility, Performance

Doi *et al.* (2001) reported that the mulberry tree roots have been used as blood pressure depressor in China and Japan since ancient times. Pieroni *et al.* (2004) studied use of mulberry leaves *(Morus alba)* against coughing. Oku *et al*. (2006) studied the inhibitory effects of extracts of mulberry *Morus alba* leaves on disaccharidase activity in the small intestine of rats. Al-Mustafa and Al-Thunibat (2008) determined the antioxidant activity of *Morus nigra* and *Morus mica*. The mulberry leaves have also been used in animal feeding, taking into consideration that mulberry leaves are rich in nutrients with absence of or negligible anti-nutritional factors (Omar *et al.* 1999, Sanchez 2000, Saddul *et al.* 2004). Kandylis *et al.* (2009) evaluated the nutritive value of the mulberry leaves. Effects of the supplementary mulberry leaves on layer performance and egg quality were studied (Zhao Chun-Xiao *et al.* 2007, Zhang Naifeng *et al.* 2009, Riyadh Abbas Al-Kirshi *et al.* 2010).The increased prices of the feeds triggered concerns to find cheaper alternative sources. This work was done to study the effect of the dietary mulberry leaves on layer performance and nutrient digestibility, since the mulberry leaves are a by-product from silk-worm production in Romania.

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MATERIALS AND METHODS

The trial was conducted on 105 Lohman Brown layers aged 40 weeks for 30 days. There was no significant difference between groups concerning the average initial body weight (Table 3). The layers were assigned to 3 groups: control (C), experimental 1 (E1) and experimental 2 (E2), with 35 birds / group, 7 cages /group, respectively, 5 birds/ cage. The layers were housed in three-tier digestibility cages (60 cm width × 60 cm length × 40 cm height) which allowed the daily recording of the ingesta, excreta and egg production. The layers had free access to the feed and water. The lighting program was 16 h daily and the environmental temperature was maintained at 29°C, throughout the experiment. The layers received a diet based on corn, wheat, rice filings, rapeseed meal and soybean meal (Table 1). In the diets for the experimental groups, part of the corn and soybean meal was replaced by ground mulberry leaves (3% for E1 and 6% for E2).

The composition of each diet was calculated as per Burlacu *et al.* (1999) according to the feeding requirements recommended for the intensive rearing of this category of

Table 1. Diet formulation and chemical analysis results

	C	E1	E2
Ingredients			
Corn (%)	26.2	23.7	21.7
Rice filings (%)	20	20	20
Wheat (%)	20	20	20
Rapeseed meal (%)	10	10	10
Soybean meal (%)	10	9.5	8.5
Oil (%)	2.5	2.5	2.5
Ground mulberry leaves (%)	0.0	3.0	6.0
Monocalcium phosphate (%)	0.7	0.7	0.7
Calcium carbonate (%)	9.2	9.2	9.2
Salt (%)	0.3	0.3	0.3
Methionine (%)	0.05	0.05	0.05
Choline (%)	0.05	0.05	0.05
Vit-min premix* (%)	1	1	1
Total	100	100	100
Chemical analysis results			
DMr (%)	89.79	89.72	89.77
Metabolizable energy (MJ/kg)	11.76	11.74	11.71
Crude protein (%)	16.37	16.04	16.34
Ether extractives (%)	6.86	6.77	6.60
Crude fibre (%)	5.89	6.67	6.33
Ash (%)	13.90	14.11	14.65
Lysine (%)	0.73	0.73	0.72
Methionine (%)	0.32	0.35	0.36
Calcium (%)	3.24	3.48	3.47
Phosphorus (%)	0.67	0.69	0.64

*Content/kg diet: vitamin A, 13500 IU; vitamin D_3, 3000 IU; vitamin E, 27mg, vitamin K_3, 2mg; vitamin B_1, 2mg; vitamin B_2 4.8mg; pantothenic acid, 14.85mg; nicotinic acid 27mg; vitamin B_6, 3mg; vitamin B_7, 0.04mg; vitamin B_9, 1mg; vitamin B_{12}, 0.018mg; vitamin C, 25mg; Mn, 71.9mg; Fe, 60mg; Cu, 6mg; Zn, 60mg; Co, 0.5 mg; I, 1.14 mg; Se, 0.18 mg.

poultry. In the same time, control, experimental 1 and experimental 2 diets were analyzed, to establish the main nutrients (Table 1).The dried and ground mulberry leaves were procured commercially. Their nutritive value (Table 2) is in agreement with the literature (Sanchez 2000, Saddul *et al.* 2004, Riyadh Al-Kirshi 2010).

For digestibility study, on weeks 2 and 3 of the experiment (5 days/week) the excreta was recorded and collected on a daily basis. There have been combined 10 average samples of excreta per group (C, E1, E2) and these were analyzed to assess the organic matter, protein, fat and crude fibre content. The digestibility coefficients were calculated taking into consideration the ingesta and excreta quantities and nutrient content.

The dry matter (DM) was determined with the gravimetric method; crude protein (CP) by using the Kjeldahl method; ether extractives (EE) by extraction in organic solvents; crude fibre (CF) by alkali and acid hydrolysis; ash with the gravimetric method, calcinations at 550°C; calcium by titrimetric method and phosphorus by spectrophotometry. Average daily feed intake, egg production, average egg weight, and feed conversion into eggs were recored throughout the experiment.

Egg samples were collected on 2 occasions (weeks 2 and 3), for 5 consecutive days, from each group. A total of 36 average egg samples were formed, 12 samples/group, with 3 eggs/sample: the egg white, egg yolk and egg shell were sampled separately and weighed. A pH-meter was used to measure egg white pH, egg yolk pH and an egg analyzer was used to measure the Haugh unit and the egg yolk colour intensity. The data were subjected to Origin 5.0 software for variance analysis, using t-Test (2 populations) and at a significance level of 0.05.

RESULTS AND DISCUSSION

The use of 3% mulberry leaves in group E1 and of 6% mulberry leaves in group E2 did not influence adversely layer performance compared to the C group. Thus, average daily feed intake (g/layer/day), egg production (%), average egg weight (g), egg-mass production (g/layer/day) and feed conversion ratio (g feed/g egg-mass production) did not differ significantly ($P \leq 0.05$) between the experimental groups and the control group (Table 3).

Our results are in agreement with the data reported by Naifeng *et al.* (2009), who reported that layer performance did not differ much between the control group (0% mulberry leaves) and the 5% mulberry leaves treatment, but feed intake, egg production and laying percentage decreased for 7% mulberry leaves treatment. Similar results were reported by Lokaewmanee *et al.* (2009), who reported no adverse effects for the feed intake, weight gain and egg production compared to control group.While Riyadh Abbas Al-Kirshi *et al.* (2010) found that inclusion rates higher than 10% depressed significantly ($P<0.05$) feed intake, egg production, egg weight and egg mass.

Zhao Chun-Xiao *et al.* (2007) observed that feeding birds 7.5% mulberry leaves meal depressed the ingesta but did not affect the physiological state of layers; it also depressed number of eggs, but there were no damaged, soft or deformed eggs. The higher rate of inclusion (15%) showed the adverse

Table 2. Gross chemical composition of the mulberry leaves

Item	Crude protein, % DM	Ether extractives, % DM	Crude fibre, % DM	Ash, % DM	Calcium, % DM	Phosphorus, % DM	Gross energy, kcal/gDM
Mulberry leaves	20.34	1.44	11.63	13.37	2.94	0.23	3,65

Table 3. Layer performance (average values) ($\overline{X} \pm S_{\overline{X}}$)

Parameter	C	E1	E2
Average daily feed intake-(g/day/layer)	125.666±9.213	124.038±12.218	125.702±15.916
Egg production (%)	78.88±12.48	78.77±10.35	77.86±7.01
Average initial body weight (kg/bird)	1.848±0.16	1.831±0.11	1.852±0.13
Average final body weight (kg/bird)	1.919±0.15	1.921±0.12	1.942±0.14
Average egg weight (g)	66.375±1.069	66.568±1.642	66.553±1.310
Egg-mass production (g/layer/day)	52.35±8.18	52.43±6.42	51.82±4.86
Feed conversion ratio (g feed/g egg-mass production)	2.40±0.47	2.37±0.42	2.42±0.38
Egg weight (g)	64.158 ± 3.732	63.956 ± 4.288	64.506 ± 3.928
Egg white weight (g)	38.650 ± 3.950	38.961 ± 3.666	38.412 ± 3.025
Yolk weight (g)	18.224 ± 1.770	18.110 ± 1.4201	18.666 ± 1.589
Egg shell weight (g)	7.228 ± 0.634	7.277 ± 0.624	7.440 ± 0.862
Egg shell thickness (mm)	0.329 ± 0.026	0.337 ± 0.023	0.336 ± 0.025
Egg white pH	8.496 ± 0.193	8.661 ± 0.289	8.841 ± 0.256
Yolk pH	6.239 ± 0.142	6.282 ± 0.106	6.187 ± 0.115
Yolk colour intensity	4.917 ± 0.840	5.800 [a.c] ± 1.051	6.500 [a.b] ± 1.044
Haugh unit	61.266 ± 10.386	61.393 ± 10.409	61.346 ± 8.960

[a,b,c]significant difference (P≤0.05), compared to C, E1 and E2, respectively.

effects on layer performance.The results in physical parameters of harvested eggs (Table 3), showed no significant differences between groups, except yolk colour intensity.Yolk colour intensity was significantly higher (P≤0.05) in E2, than in groups E1 and C, being in agreement with the literature. Mulberry leaves contain β-carotene, which can be converted with varying efficiency by animals to vitamin A and the xanthophylls, which can be a good source of the pigmentation of egg yolk (Lokaewmanee *et al.* 2009, Riyad Abbas Al-Kirshi *et al.* 2010). The addition of mulberry leaves to the diets produced higher yolk colour intensity.

Shell thickness was not affected (P>0.05), but a slight improvement in shell weight was observed due to sufficient Ca intake in the groups fed 3% and 6% mulberry leaves. Thus, Naifeng *et al.* (2009), in a study on layers, reported that yolk colour intensity was higher in 5% mulberry leaves powder treatment than in the control group.

Similar results were reported by Wu Ping *et al.* (2007), who studied the effect of the supplemental 0, 3, 5 and 7% mulberry leaves powder on layer performance. Egg yolk colour intensity and the Haugh units increased in treated groups compared to the control group.

The higher supplements of mulberry leaves, 15 and 20% (Riyadh Abbas Al-Kirshi *et al.* 2010) decreased egg shell weight and egg yolk weight (P<0.01), but egg shell thickness and egg white weight were not affected (P>0.05). The Haugh unit and egg yolk colour intensity increased (P<0.001) with the dietary level of mulberry leaves.

Egg white pH, egg yolk pH and the Haugh unit were not significantly different in the experimental groups compared to the control group, as also reported by Lokaewmanee *et al.* (2009).

Slight decreases (Table 4) were noticed in the experimental groups for protein and fat digestibility, but the differences were not significant.

Table 4. Digestibility coefficients of the main nutrients (%)

Nutrient	C	E1	E2
Organic matter	75.96±5.734	70.813[a]±9.689	73.045[a]±6.058
Protein	80.323±2.361	79.041±3.583	79.863±2.938
Fat	81.732±7.373	79.897±9.326	79.785±4.370
Fibre	40.723±13.295	42.379±13.468	41.314±12.878
Nitrogen-free extracts	74.696±6.129	67.986[a]±10.796	70.728[a]±6.683

[a]Significant differences (P≤0.05), compared to C.

Organic matter digestibility was higher (P≤0.05) in the control group by 7.27% compared to group E1 and by 3.99% compared to group E2. This is due to the digestibility of the nitrogen-free extracts, which was higher in the control group compared to the experimental groups by 9.87% compared to group E1 and by 5.61% compared to group E2.

As a result of this study, the use of up to 6% supplemental mulberry leaves in layer diets does not affect adversely layer performance and egg quality. Furthermore, the use of dietary mulberry leaves produced yolks with brighter colour, which are more attractive for the consumers.

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