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THE EFFECT OF INCLUDING OF MARIGOLD *(CALENDULA OFFICINALIS* L.*)* ON THE NET UTILIZATION OF THE ENERGY AND PROTEIN IN THE ECO-TECHNICAL CHAIN 'FODDER – LAYER'S EGGS'

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Abstract

The including of marigold *(Calendula officinalis* L.*)* in the compound feed for the layers of the net utilization of the energy and protein has been studied. Two new indexes of net utilization have been introduced: Clarc of energy distribution (CED) – the relation between consumed metabolizable energy and accumulated gross energy in the egg mélange and Clarc of protein transformation (CPT) - the relation between consumed crude protein and accumulated crude protein in the egg mélange.

The results show that 0.5% of the additive in the hens' diet influences on the net utilization: CED (fodder – egg mélange) was 0.1891 for the experimental group against 0.1820 for the control group. CPT was 0.2562 against 0.2358 respectively. The differences (especially for CPT) may arouse the interest of the scientific community in collecting more data in this field.

Keywords: Clarc of energy distribution, Clarc of protein transformation, marigold flowers' addition, layer's egg mélange

INTRODUCTION

The prohibitions on the use of nutritional antibiotics have directed the scientists' efforts to search for alternative natural stimulants of poultry productivity (Georgieva et al. 2008; Abadjieva et al., 2011; Kabakchiev et al. 2014; Gerzilov et al., 2015).

In our previous research we have established the effect of various natural products on the net utilization of nutrients from feed to directly consumed poultry products (Penkov and Grigorova, 2020), calculated by applying the newly introduced indexes "Clarc of energy distribution (CED)" and "Clarc of protein transformation (CPT)" - Penkov and Genchev (2018).

The flowers of the medicinal plant marigold (*Calendula officinalis L.)* contain many active substances such as flavonol and terpene glycosides (Ukjiya et al., 2006); sapponins (Vahed et al.,2016) and carotenoids – carotene and lycopene (Pintea et al., 2003), which have an antioxidant effect and are essential for the immune system (Breithaupt, 2007). Marigold flowers or its extracts have been used in poultry nutrition (in 0.5-1% dried herb per unit fodder) for enhancing the growth performance of broilers (Rajput et al., 2012), broilers' meat quality and antioxidant capacity (Wang et al., 2017) as well as for improving the egg yolk pigmentation (Karadas et al., 2006). Data on the effect of the herb on the egg productivity are scarce, and data on its effect on the transformation of nutrients in the feed-egg melange chain are lacking.

The aim of the present study is to investigate the influence of 0.5% marigold flowers' inclusion in the hens' diet on the net utilization of energy and protein in the eco – technical chain "fodder – egg mélange".

MATERIALS AND METHODS

The experiment was conducted at the Poultry Experimental Center of the Institute of Animal Science-Kostinbrod with 35 weeks old layers from Lohman Klassik Brown breed.

Two groups were organized (one control and one experimental) in separate boxes, 30 hens each. The hens were housed on a deep litter pen on a 16 h lighting schedule. The compound feed of the control group had the following composition: maize; soybean meal; sunflower meal; sunflower oil; limestone; monocalcium phosphate; salt; L-lysine; mineral premix and vitamin premix (Grigorova & Penkov, 2021). In the fodder of the experimental group 0.5% dry herb marigold was added (directly with a very good mixing). The diets of both groups had the same nutritional value:11.05 MJ metabolizable energy; 16.7% crude protein; 0.67% lysine; 0.65% methionine+cystine; 4.3% crude fats; 3.5% crude fiber; 3.70% Ca; 0.47% available P. All groups received 115g feed/day/hen. The duration of the experiment was 68 days. The birds were kept in a compliance with the Ordinance № 16 on the protection and welfare in the breeding and use of farm animals (BGSNP, 2006).

The laying capacity (in %), the health status of the birds, the feed provided and the feed rests were monitored daily. At the beginning and at the end of the experimental period, the following measurements were made on 30 eggs per group: masses of egg, egg yolk, egg white and shell with the sub-shell (with an electronic scale with an accuracy of ± 0.01g). Chemical analysis of the egg white and yolk was made on 6 eggs per group, with a mass close to the average.

The chemical composition of the feed and eggs was determined by the Weende method (AOAC, 2007). The feed metabolizable energy was calculated according to Todorov et al. (2016). The gross energy in the egg melange was calculated according to the formula of Schiemann et al. (1971). The Clarcs of energy distribution (CED) / protein transformation (CPT) were calculated by the original formula (Penkov and Genchev, 2018):

CED = Consumed ME from 1 layer/produced GE through the egg white/yolk/mélange

CPT = Consumed CP from 1 layer/produced CP through the egg white/yolk/mélange

All results were processed statistically using Descriptive statistics – Excel.

RESULTS AND DISCUSSION

Table 1 presents the data on the feed consumption, metabolizable energy and crude protein required for Clarc's calculations.

Table 1. Feed, metabolizable energy (ME) and crude protein (CP) consumption - mean from 1 layer for the whole experimental period (entrance of the system)

Indexes	Control group SEM±SD	Experimental group (with 0.5% marigold) SEM±SD
Consumed fodder – kg	7.82±0.22	7.79±0.20
Consumed ME – MJ	86.25±2.46	85.98±2.63
Consumed CP – kg	1.3063±0.11	1.2798±0.007

The average daily feed consumption was 115 g, so as no significant differences were observed in both the total amounts of feed and the metabolizable energy and crude protein consumed by the birds (P>0.05).

The total consumed feed was insignificantly lower than those established in previous our studies (Penkov and Grigorova, 2020), due to the smaller amount of the daily offered feed – 120 vs. 115 g.

The chemical composition and the gross energy content of the egg whites and yolks are shown in Table 2.

The melange's chemical composition of the control and experimental groups did not show significant differences, both in terms of the white and the yolk. On this basis, the gross

energy contents were also identical - for the white - 2.99 in the control against 2.89 MJ / kg native egg mass in the experimental group.

Our results do not differ significantly from those cited by the hybrid manufacturer (Lohmann Tierzucht, 2019), and confirm the opinion of Karadas et al., (2006) that marigold has a greater effect on the yolk pigmentation and the carotene content in eggs than on their common chemical composition.

Table 2. Chemical composition of the 1 kg egg's mélange (native substance)

Groups / Indexes	Control		Experimental	
	Egg white SEM±SD	Egg yolk SEM±SD	Egg white SEM±SD	Egg yolk SEM±SD
Dry matter, %	13.004±0.06	46.68±0.35	12.38±0.25	46.24±0.23
Crude protein, %	11.21±0.07	16.06±0.06	11.46±0.05	16.55±0.14
Crude fats, %	0.54±0.04	29.89±0.19	0.50±0.02	28.98±0.11
Ash, %	0.87±0.15	0.11±0.004	0.57±0.02	0.15±0.03
Gross energy, MJ	2.99±0.01	14.83±0.03	2.89±0.01	14.70±0.04

Table 3 shows the average amounts of the crude protein and the gross energy produced from the egg mélange per laying hen for the whole experimental period (system output) and the Clarcs were calculated on this basis.

The higher amounts of the egg white and yolk produced by the experimental birds are due to the larger egg mass rather than the larger egg numbers. However, the differences are insignificant (P> 0.05) and do not give us the grounds for definite general conclusions. In contrast to our study (Rajput et al., 2012) reported statistical significant differences of the growth performance in broiler chickens, when the herb was used.

Comparing the Clarcs of the energy distribution, it was found that the group receiving marigold had a 0.91% better net utilization of energy in the "fodder-egg mélange" chain compared to the control group. The difference in the protein is even more significant - the experimental birds have assimilated it more than 2% more efficiently.

Data on the influence of calendula on both indicators cannot be found for objective reasons. Therefore, we believe that our first study in this direction will arouse interest both at home and abroad.

CONCLUSION

In the conditions of the conducted experiment, the following net utilizations of energy and protein have been established:

-Clarc of energy distribution:

- Control group: 0.060 (fodder – egg white); 0.1220 (fodder – egg yolk; 0.1820 (fodder – egg mélange)

Experimental group (with 0.5% marigold) - respectively 0.062; 0.1271 and 0.1891.

-Clarc of protein transformation:

- Control group: 0.1485 (fodder – egg white); 0.0873 (fodder – egg yolk; 0.2358 (fodder – egg mélange)

-Experimental group (with 0.5% marigold) - respectively 0.1594; 0.0968 and 0.2562.

The authors recommend continuing the research in order to enrich the database.

Table 3. Produced gross energy (GE) and crude protein through the egg mélange from 1 layer for the whole experimental period (68 days) and Clarcs of energy distribution (CED) and protein transformation (CPT):

Indexes	Control group SEM±SD	Experimental group SEM±SD
Produced GE with the egg white from 1 layer for the whole period – MJ	5.19±0.23	5.36±0.40
Produced GE with the egg white yolk 1 layer for the whole period – MJ	10.52±0.38	10.925±0.32
Produced CP with the egg white from 1 layer for the whole period – kg	0.194±0.006	0.204±0.005
Produced CP with the egg white yolk 1 layer for the whole period – kg	0.114±0.003	0.124±0.004
Clarc of energy distribution (MEfodder-GEegg white)	0.060 (6.60%)	0.062 (6.62%)
Clarc of energy distribution (MEfodder-GEegg yolk)	0.1220 (12.20%)	0.1271 (12.71%)
Clarc of energy distribution (MEfodder-GEegg mélange)	**0.1820 (18.00%)**	**01891 (18.91%)**
Clarc of protein transformaion (CPfodder-CPegg white)	0.1485 (14.85%)	0.1594 (15.94%)
Clarc of protein transformaion (CPfodder-CPegg yolk)	0.0873 (8.73%)	0.0968 (9.68%)
Clarc of protein transformaion (CPfodder-CPegg mélange)	**0.2358 (23.58%)**	**0.2562 (25.62%)**

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