EFFECT OF MEDIUM CHAIN FATTY ACIDS AND EMULSIFIER ON QUALITY PARAMETERS OF LAYING HEN'S EGGS

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Abstract. The objective of the experiment was to evaluate medium-chain fatty acids (MCFAs) and emulsifier influence on quality parameters of laying hens eggs. The feeding experiment was performed for 56 days with 30-week old *Lohmann Brown* lines combination 27 laying hens. Hens were divided into 3 groups; laying hens were fed with granular compound feed, 125 g/per day each. One of experimental groups compound feed was supplemented with MCFAs (dosage – 1 kg/t feeds) and anther group feed was supplemented with MCFAs (dosage – 1 kg/t feeds) +emulsifier Lipidol (dosage 0.5 kg/t). During the first test period additive of MCFAs significant reduced egg weight 2.93 % ($P<0.05$) and additive of MCFAs+emulsifier in layer's feeds increased egg's yolk weight 0.6% ($P < 0.001$). After all experiment period it was found that feeds supplemented with medium-length fatty acids additives improved parameters of egg yolk color and feeds supplemented with MCFAs +emulsifier Lipidol significant reduced egg weight 1.12 % ($P<0.05$) and pH of egg albumen 0.24% ($P<0.05$).

Keywords: egg quality, medium-chain fatty acids, emulsifier

Introduction. The poultry sector is continuously searching for new feed additives, in order to improve the feed efficiency and to appropriate nutrition provision to hen for optimal egg production.

Medium chain fatty acids have specific nutritional, metabolic and antibacterial effects (Devi et al., 2014; Skrivanova et al., 2010; Batovska et al., 2009). Lee, et al. (2015) reported that dietary supplementation of a microencapsulated organic acid blend with MCFAs can have positive effects on egg production, egg strength, Haugh units, calcium concentration, and fecal *Lactobacillus* and *E. Coli* contents in laying hens. In a study with laying hens fed diet supplemented of caprylic acid positive effects on egg weight and feed efficiency decreased the serum and yolk cholesterol concentration and reduced the proliferation of *Escherichia coli* (Wang, 2010).

The use of emulsifiers in bird's diets can increase lipids absorption, growth performance and feeding efficiency and modified the blood lipids (Aguilar et al., 2013). These products were considered to play an important role in strengthening the immune system by improving the physical conditions of gut ecosystem and enhancing functions of the defense system of chickens (Guo et al., 2003). Emulsifiers can be interspersed into feeds as they can improve egg weight, egg yolk color, nutrient digestibility and have beneficial effects on egg production, besides that, they can also influence egg's flavor and odor alterations (Mandalawi et al., 2015, Surech et al., 2014).

Many researches had been done in order to investigate MCFAs (Begum et al., 2015; Khosravinia H., 2015; Dierick et al., 2002; Zeitz J. O. et al., 2015) and emulsifiers effects on broilers health and productivity (Cho el. al, 2012; Zhao et al., 2013; Roy, 2010; Noy, 1998;) but there haven't been done many researches in pursuance to investigate laying hens productivity and eggs quality parameters. So, the objective of the experiment was to evaluate how medium-chain fatty acids and emulsifier feed additives influence quality parameters of laying hens eggs.

Methods and materials

The feeding experiment was performed in Institute of Animal Rearing Technologies, Lithuanian University of Health Sciences, Veterinary Academy. The research was carried out complying with the Law of the Republic of Lithuania on Animal Care, Housing and Use" (No. XI–2271) as well as complying with the amended Order of State Food and Veterinary Service "On Approval For Requirements For Housing, Care and Use of Animals for Experimental and Other Scientific Research" (No. B1-872 of 24-09-2015). The trial was performed in accordance with EU Directive 2010/63/EEC and the EC recommendation 2007/526 EC for Animal use and storage for experiments and other purposes.

The feeding experiment was performed for 56 days with 30-week old *Lohmann Brown* lines combination 27 laying hens. Hens were divided into 3 groups, each with 9 hens. During the experiment, layers were housed in individual cages (40 x 50 cm) with stationary drinkers and feeders, under equal feeding and housing conditions.

Table 1. **Compound feed nutritional value, %**

Parameter	I	II	III
Dry matter	90.34	90.04	90.15
Crude fat,	5.34	5.58	5.52
Crude fiber	4.77	5.12	4.98
Crude ash	8.03	8.21	8.13
Crude protein	18.53	18.09	18.04
Ca/Calcium	3.44	3.45	3.44
P/Phosphorus	0.63	0.63	0.63
Na/Sodium	0.15	0.15	0.15

Hens were fed with granular compound, 125 g/per day each. Layers were fed with standard compound feed (Table 1) (I group), supplemented with medium-chain fatty acids (dosage – 1 kg/t feeds, II group), besides that feeds were supplemented with emulsifier (Medium-chain fatty acids dosage – 1 kg/t feeds +Lipidol, dosage 0,5 kg/t, III group); The design of the trial presented in table 2. LIPIDOL® is feed additive base on functional lysophospholipids (LPLs) extracted from soybean lecithin. Medium-chain fatty acids composition was: 0.1–0.5 % Capronic acid; 3–4 %Caprylic acid; 3–4.5 % Capric acid; 41–44 %Lauric acid; 17–20 % Myristic acid; 9–14 %Palmitic acid; max 0.5 %Palmitoleinic acid; 2–5 % Stearic acid; max 0.5%Linolenic acid2–5 %Linolic acid; 6–14 %Oleic acid;

Table 2. **The design of the trial**

Index	Group		
	I	II	III
Basal diet	+	-	-
Basal diet + 1 kg/t medium chain fatty acids	-	+	
Basal diet + 1 kg/t medium chain fatty acids + 0.5 kg/t emulsifier LIPIDOL®	-	-	+

All eggs were counted and weighed daily, and average egg weight per group was calculated. Egg quality parameters were evaluated in 14 days intervals: egg quality parameters (albumen height, Hough unit (HU), shell weight, eggshell thickness, yolk weight, yolk color) were measured.

Eggs were collected and counted daily throughout the experimental period. The egg production was calculated using the total egg number divided by the number of hens per cage. Egg weight was measured by an electronic scale. Albumen high, Haugh unit, intensity of egg yolk color were established by multifunctional automatic egg characteristics analyzer "Robotmation (Japan) Egg Multi-Tester EMT-5200", hardness of eggshell – by "Robotmation co., LTD Egg Shell Force Gauge MODEL–II" device, and thickness of eggshell – by electronic micrometer „MITUTOYO Digimatic Micrometer".

Data analysis. SPSS software, version 15.0 (SPSS, Chicago, IL, USA) was used for statistical analysis. The differences between the control and experimental groups were considered to be statistically significant for $P < 0.05$.

Results and Discussion

During the first two weeks of experiment, production of second experimental group was 8.03 % ($P > 0.05$) higher and egg production of third group was 0.89 % ($P > 0.05$) lower in compare with control group (table 3). During the all experimental period laying hens fed with diet supplemented MCFAs showed lower egg production rate. In addition previous study showed that dietary supplementation of MCFAs improved egg production in the laying hen (Lee et al. 2015; Wang et al., 2009).

Table 3. **Average egg production of laying hens, %**

Age of the laying hens (weeks)	I	II	III
30-32	90.18	98.21	89.29
32-34	90.18	96.43	75.89
34-36	87.50	89.29	72.32
36-38	92.31	82.69	77.88
Average of all period	90.04±1.97	91.66±7.11	78.85±7.33

The first test period data (Table 4) indicated that the average egg weight of second group was 2.9 % ($P<0.05$) lower than control group. Emulsifier's additive in layer's feeds (III group) had marginally influence on egg's yolk weight, it was significant 0.6% ($P < 0.001$) higher compared to the control group. Atia et al. (2009) reported that inclusion of 30 g lecitin/kg diet increased egg weight and egg mass production from 47 to 70 weak of age and An et al. (1997) observed that the inclusion of 50 g of phospholipids improved egg mass in hens from 60 to 67 weak.

Table 4. **Criteria of eggshell and egg quality of laying hens (30-32 weeks)**

Group		I	II	III
Egg weight, g		65.11±5.75	63.20*±2.83	64.00±4.39
Yolk weight, g		17.14±1.46	16.71±1.68	17.25***±0.93
Eggshell strength, kg		3.60±0.83	3.74±0.64	8.78±15.07
Protein height, mm		7.90±1.32	8.09±1.62	6.44±1.40
Haugh unit, score		87.21±7.52	89.55±10.45	77.87±10.17
Color intensity, score		4.25±0.46	4.38±0.52	4.00±0.58
Yolk color	L*	63.49±2.23	62.95±1.17	64.12±1.78
	a*	-5.84±1.97	-4.24±4.20	-5.55±1.00
	b*	46.18±4.83	45.08±2.59	44.87*±3.57
Eggshell weight with shell membrane, g		8.21±1.68	8.12±0.83	7.73±1.04
Eggshell weight without shell membrane, g		5.83±1.08	5.78±0.54	5.43±0.93
pH	Yolk	6.28±0.10	6.46±0.22	6.52±0.23
	Albumen	8.43±0.32	8.39±0.17	8.34±0.28
* – P<0.05; ** – P<0.01; *** – P<0.001				

Table 5. **Criteria of eggshell and egg quality of laying hens (32-34 weeks)**

Group		I	II	III
Egg weight, g		64.10±4.38	62.55±3.77	63.50±1.88
Yolk weight, g		16.37±1.16	16.07±0.44	18.67±4.30
Eggshell strength, kg		3.38±0.96	3.77±1.13	3.32±0.60
Protein height, mm		8.41±2.34	8.78±1.37	7.72±1.74
Haugh unit, score		88.43±17.56	92.71±6.68	86.42±10.83
Color intensity, score		4.25±0.71	4.25±0.71	4.33±0.52
Yolk color	L*	64.18±0.46	65.50*±0.93	63.17±2.68
	a*	-4.98±1.58	-5.88±1.28	-6.45±1.32
	b*	44.23±2.92	44.99±3.35	44.58±4.50
Eggshell weight with shell membrane, g		8.55±1.62	8.46±1.08	7.86±0.72
Eggshell weight without shell membrane, g		5.66±0.57	5.65±0.67	5.45±0.56
pH	Yolk	6.23±0.13	6.32±0.25	6.00±0.17
	Albumen	7.87±0.42	8.02±0.23	7.85±0.12
* – P<0.05				

Table 6. **Criteria of eggshell and egg quality of laying hens (34-36 weeks)**

Group		I	II	III
Egg weight, g		66.27±4.87	60.19±3.25	61.14±4.56
Yolk weight, g		16.48±1.26	15.38±1.04	17.27±1.56
Eggshell strength, kg		3.27±1.23	3.15±1.09	2.99±1.15
Protein height, mm		7.59±1.97	7.08±2.03	6.47±1.83
Haugh unit, score		84.24±12.28	81.73±17.39	78.07±14.01
Color intensity, score		3.86±0.38	3.44±0.73	3.57±0.53
Yolk color	L*	64.92±2.44	65.71±2.10	66.64±1.15
	a*	-5.54±1.22	-6.13±0.90	-7.44±0.83
	a*	47.37±4.95	45.64±4.09	45.30±2.96
Eggshell weight with shell membrane, g		8.83±1.12	7.65±0.89	7.56±1.11
Eggshell weight without shell membrane, g		5.74±0.64	5.06±0.84	5.25±1.25
pH	Yolk	5.27±2.05	6.08±0.10	6.14±0.09
	Albumen	8.09±0.13	8.12±0.28	8.19±0.30
* – P<0.05				

After 4 weeks of this study (table 5) MCFA+ emulsifier supplementation to the diet of laying hens increased yolk weight 14.0 % (P > 0.05) but the eggshell strength decreased 1.9 %(P > 0.05) and Haugh unit score decreased 2.3 % (P > 0.05) compared to the control.

Data of 34-36 weeks experimental period and the effects of added supplements on egg quality parameter are shown in Table 6.

At the end of the experiment (Table 7) it was found that third experimental group egg weight was 6.4 % (P>0.05) higher compared with the control group. These results matches with Surech et al. (2014) data which found that egg weight was significantly higher in groups fed diet supplemented emulsifier.

Table 7. **Criteria of eggshell and egg quality of laying hens (34-36 weeks)**

Group		I	II	III
Egg weight, g		62.63±4.14	59.04±4.23	66.61±3.35
Yolk weight, g		15.66±1.06	15.12±1.39	16.90±1.43
Eggshell strength, kg		3.71±0.96	3.80±0.56	3.67±0.44
Protein height, mm		8.68±0.86	8.96±0.93	7.71±1.47
Haugh unit, score		92.54±4.31	94.7±14.52	86.58±10.45
Color intensity, score		3.50±0.53	3.25±0.71	3.50±0.76
Yolk color	L^*	76.46±2.08	75.87±1.28	75.02±1.78
	a^*	-6.85±0.93	-7.00±1.01	-5.,9±5.47
	b^*	52.50±4.97	50.70±4.21	49.58±3.17
Eggshell weight with shell membrane, g		8.23±0.62	8.14±0.55	8.52±0.86
Eggshell weight without shell membrane, g		5.59±0.56	5.35±0.55	5.47±1.22
pH	Yolk	6.32±0.07	6.27±0.07	6.33*±0.14
	Albumen	8.52±0.25	8.65±0.12	8.44±0.30
* – P<0.05				

Egg quality parameters through the all test period noted on the Table 8. Eggshell strength were higher in experimental groups, these results matches with Swiątkiewicz et al., (2010) study, which found that the addition of MCFA had a positive influence on eggshell characteristics, i.e. eggshell percent, density and breaking strength.

Table 8. **Criteria of eggshell and egg quality of laying hens (all experiment)**

Group		I	II	III
Egg weight, g		64.53±1.55	61.24±1.96	63.81*±2.24
Yolk weight, g		16.41±0.61	15.82±0.72	17.52±0.78
Eggshell strength, kg		3.49±0.20	3.62±0.31	4.69±2.74
Protein height, mm		8.14±0.49	8.23±0.85	7.09±0.73
Haugh unit, score		88.10±3.44	89.68±5.71	82.23±4.92
Color intensity, score		3.96±0.36	3.83±0.57	3.85±0.39
Yolk color	L^*	67.26±6.16	67.51±5.71	67.24±5.39
	a^*	-5.80±0.78	-5.81±1.15	-6.16**±1.01
	b^*	47.57±3.53	46.60*±2.75	46.08±2.35
Eggshell weight with shell membrane, g		8.46±0.29	8.09±0.34	7.92*±0.42
Eggshell weight without shell membrane, g		5.70±0.10	5.46±0.32	5.40±0.10
pH	Yolk	6.03±0.51	6.28±0.16	6.25±0.23
	Albumen	8.23±0.30	8.30±0.29	8.21*±0.26
* – P<0.05; ** – P<0.01;				

Our results indicate that inclusion of medium chain fatty acids in birds diet reduced egg and yolk weight, but difference with control group wasn‘t significant (P<0.05), Danicke and Halle (2002) concluded that weight of yolk and albumen were not significantly influenced by sources or inclusion level of lipids.

Silversides and Scott (2001) have shown that albumen pH is determined almost entirely by storage time because albumen pH not affected by the age or strain of hen, but it can be affected by nutrition. In our experiment albumen pH was significant lower by third group 0.24% (P<0.05) compare to control group.

Conclusions

In conclusion, the results of this study indicate that feeds supplemented with medium-length fatty acids additives improved parameters of egg yolk color and feeds supplemented of MCFAs +emulsifier Lipidol significant reduced egg weight and pH of egg albumen.

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