

The effect of different vegetable oils on energy content of table eggs yolk

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The aim of this study was to analyse the gross energy (GE) value of egg yolk from hens feed with different vegetable oils addition and based on gained results calculate the linear regression between GE and dry matter% (DM) in yolk. Total 66 hens Lohmann Brown Lite were divided in to 11 groups according to concentration and type of used vegetable oil (pumpkin oil 3%, flax seed oil 3%, indian hemp seed oil 2.5% and 5%, grape seed oil 2.5% and 5%, olive oil 2.5 and 5%, apricot seed oil 2.5% and 5%). Hens were in 40th week of life and were housed per 6 in cage. From each group eight eggs were randomly selected. In total 88 egg yolks were separated and analysed for DM and GE content. The highest yolk GE was detected in group with 3% pumpkin oil addition (1,639 kJ 100 g⁻¹) followed by groups with 2.5 and 5% indian hemp seed oil addition 1,632 and 1,632 kJ 100 g⁻¹, respectively. Difference between these three groups compared to yolk GE content (1,584 kJ 100 g⁻¹) in control group was significant ($P < 0.05$). All other added oils increased the yolk GE ($P > 0.05$). GE concentration of yolk can be calculated as follows: $GE = -17.34 + (32.73 * DM)$, $R^2 = 0.819$.

Keywords: laying hens; egg yolk gross energy, regression

1 Introduction

Incubation within poultry hatching is not easy process, during which is necessary to create desirable microclimatic condition, microbiological status of laying eggs (Benková, 2008; Hrnčár & Bujko, 2012), but the appropriate composition of nutrients and energy content in the egg is also very important. The yolk and albumen in the egg supply the developing embryo with nutrients, water and minerals for normal growth. Yolk is an important nutritional component of the avian egg because it contributes 75% of the joules and provides all the lipids, and thus energy for the developing embryo (Noble et al., 1996). Results of Javad et al. (2011) show that egg weight, egg production, fertility and hatchability are significantly affected by diet formulation based on energy, which effects the reproductive performance of hens. Furthermore, according to Herkel

et al. (2016) the addition of oil in to feed of laying hens affects the egg nutrients as well as the quality of yolk. Besides the importance of yolk for embryonic health and hatchability, plays yolk essential role in human nutrition through increasing the energy value and therewith also nutritional value of whole egg. Therefore, the aim of this study was to determine the effect of six different vegetable oil sources in feedstuff of laying hens on energy content of table eggs yolk.

2 Material and methods

Egg yolks used for gross energy determination were gained from eggs of Lohmann brown lite hens (during 40th week of age), which were housed in three-floor cages (six hens in one cage; with a space allowance of 943.2 cm² per hen). There were six hens per cage. One cage represents one experimental group. Standard microclimatic condition

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and 16 hours light regime was used during experiment. Together 11 groups included this experiment. Group names were according to used vegetable oil supplement and its concentration in diet (Table 1).

In this study a commercial oils, as well as commercial feed mixture were used. Control (Con) group feed with commercial mixture for laying hens also included in experiment. All hens had diet and water *ad libitum*. The nutrient analysis of feed mixtures used in this experiment were realised according to standard methodology (AOAC, 2000) in Laboratory of Quality and Nutritional Value of Feeds at Department of Animal Nutrition (SUA in Nitra) and is shown in Table 2. Feeding of hens according to group was realised from 38th to end of 40th week of age. The 40th week of age was the experimental week. For yolk GE determination eight randomly selected eggs per group were used (together 88 samples).

Yolks were separated, weighed and freeze-dried. After homogenization the DM gravimetrically at $t\ 103 \pm 2\ ^\circ\text{C}$ was determined. For GE determination a Calorimeter Leco AC 500 (Leco Corporation, USA) was used (direct calorimetry – measuring of the heat released after combustion of a sample according to manufacturer instruction). Gained results were statistically processed in IBM SPSS v. 20. Descriptive statistic was calculated and differences of means between groups were tested with one way ANOVA (Tukey HSD test). In addition, linear regression between DM (%) and GE content ($\text{kJ}\ 100\ \text{g}^{-1}$) of yolk was calculated.

3 Results and discussion

Average DM content of analysed yolks arranged from lowest was as follows: Gra5 ($49.13 \pm 1.10\%$), Gra2.5 (49.22 ± 1.36), Con ($49.42 \pm 1.21\%$), Apr5 ($49.53 \pm 0.18\%$),

Table 1 Doses of vegetable oils used in experiment

Group name	Used oil	Feed mixture (%) + oil (%)	Vit. E dose in feed mixture
Con	no extra oil	100% + 0%	–
Pum3	pumpkin seed oil	97% + 3%	10 g 100 kg ⁻¹
Iho2.5	indian hemp seed oil	97.5% + 2.5%	10 g 100 kg ⁻¹
Iho5	indian hemp seed oil	95% + 5%	10 g 100 kg ⁻¹
Fla3	flax seed oil	97% + 3%	10 g 100 kg ⁻¹
Gra2.5	grape seed oil	97.5% + 2.5%	10 g 100 kg ⁻¹
Gra5	grape seed oil	95% + 5%	10 g 100 kg ⁻¹
Oli2.5	olive oil	97.5% + 2.5%	10 g 100 kg ⁻¹
Oli5	olive oil	95% + 5%	10 g 100 kg ⁻¹
Apr2.5	apricot seed oil	97.5% + 2.5%	10 g 100 kg ⁻¹
Apr5	apricot seed oil	95% + 5%	10 g 100 kg ⁻¹

Table 2 Nutritional characteristic of feed mixtures in each hens group

Group	DM	CP	Fat	CF	Ash	Starch	Sugar	MEn
Con	94.4	17.4	6.33	4.79	15.1	31.4	4.90	10.7
Pum3	94.3	17.1	6.63	4.79	15.7	32.3	4.32	10.9
Iho2.5	94.3	18.6	6.55	4.93	15.7	29.5	4.99	10.7
Iho5	94.1	17.8	6.48	4.95	14.3	30.5	4.90	10.7
Fla3	94.1	17.0	6.61	4.97	15.4	31.1	4.42	10.7
Gra2.5	94.4	17.7	6.43	5.03	15.8	30.9	4.70	10.7
Gra5	94.8	18.3	6.30	4.72	15.5	31.4	4.61	10.8
Oli2.5	94.0	16.9	6.76	4.99	15.1	31.5	4.70	10.8
Oli5	94.3	16.8	6.79	4.62	15.4	31.6	4.42	10.7
Apr2.5	94.7	17.9	6.43	4.68	14.5	30.6	4.90	10.7
Apr5	94.5	17.1	6.97	4.78	15.0	32.5	4.80	11.1

DM – dry matter (%); CP – crude protein (%); Fat (%); CF – crude fibre (%); Ash (%); Starch (%); Sugar (%); MEn – metabolisable energy for poultry ($\text{MJ}\ \text{kg}^{-1}$ of feed)

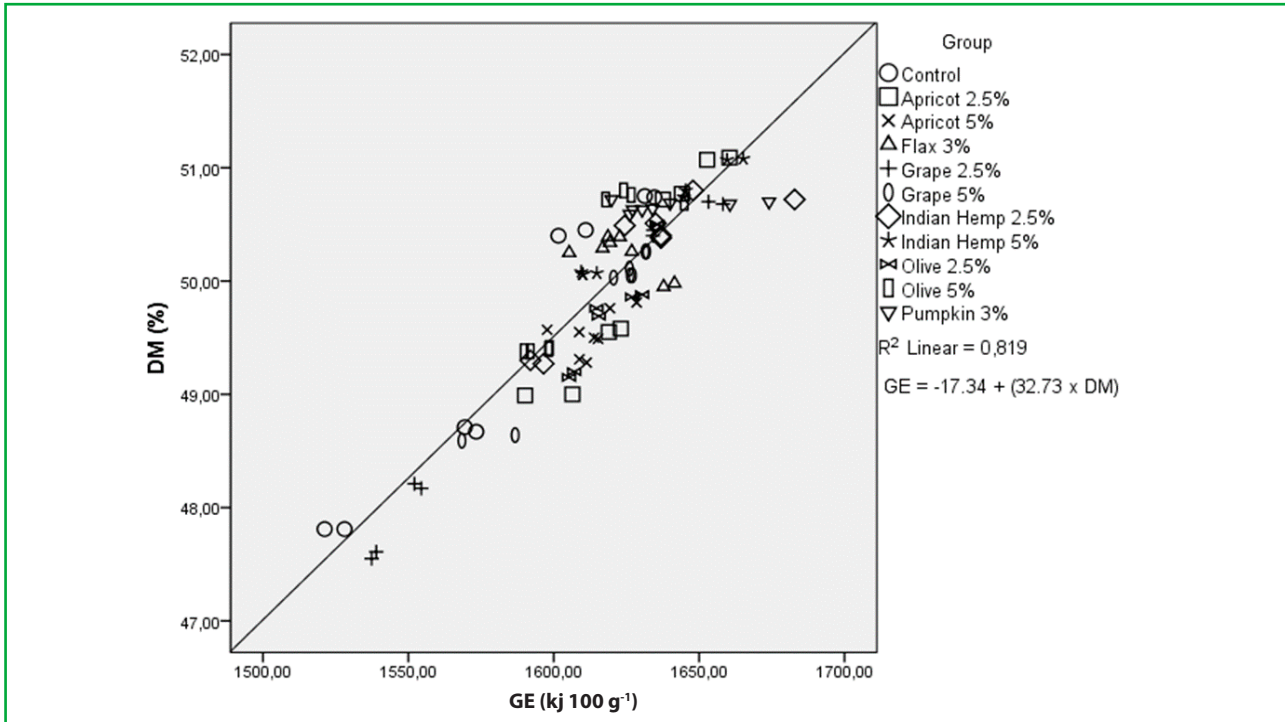


Figure 1 Linear regression for GE calculation from dry matter content

Oli2.5 (49.82 ±0.47), Oli5 (50.07 ±0.68%), Apr2.5 (50.10 ±0.85%), Fla3 (50.23 ±0.16%), Iho2.5 (50.23 ±0.56%), Iho5 (50.50 ±0.44%) and Pum3 (50.66 ±0.04%). Gálik et al. (2014) published yolk DM content in range from 49.7 to 50.7%, which is comparable with results of this study. Antova et al. (2017) determined yolk GE for 7 chicken genotypes in range from 1,438 to 1,608 kJ 100 g⁻¹ of yolk and the differences attributed to the genotype. Content of GE in yolks analysed in this study is shown in Table 3. The highest energy value of yolk was determined in groups,

where the feed mixture contained 3% of pumpkin oil, or 2.5, resp. 5% indian hemp seed oil. Compared to these three groups, the energy value of yolk in control group fed with commercial diet was significantly (P <0.05) lower (Table 3). It was detected that addition of each vegetable oil (each concentration) increased the energy value of yolk. This can affect hatchability in positive way, because yolk with higher energy value provides more energy to embryo. This was confirmed in review of Van der Wagt et al. (2020). Also, conclusions of Zhang (2016) indirectly

Table 3 Energy value of table eggs yolk in each hens group

Group	n	GE	S.D.	SEM	min	max
Con	8	1,584 ^a	43.49	15.38	1,521	1,635
Pum3	8	1,639 ^b	18.77	6.64	1,620	1,674
Iho2.5	8	1,632 ^b	28.82	10.19	1,592	1,683
Iho5	8	1,632 ^b	23.84	8.43	1,609	1,665
Fla3	8	1,624 ^{ab}	11.69	4.13	1,605	1,642
Gra2.5	8	1,595 ^{ab}	53.99	19.09	1,537	1,658
Gra5	8	1,615 ^{ab}	23.76	8.40	1,568	1,632
Oli2.5	8	1,621 ^{ab}	12.30	4.35	1,605	1,636
Oli5	8	1,612 ^{ab}	19.77	6.99	1,590	1,645
Apr2.5	8	1,629 ^{ab}	23.94	8.46	1,590	1,660
Apr5	8	1,613 ^{ab}	8.92	3.15	1,598	1,628
Average	88	1,618	30.56	3.26	1,521	1,683

GE – mean for gross energy concentration (kJ 100 g⁻¹ of yolk); S.D. – standard deviation; SEM – standard error of the mean; min – minimal value; max – maximal value; a, b – within column a means with different superscript are significantly (P <0.05) different

emphasized the importance of energy content of yolk on embryonic health and hatchability. Significant effect of diet composition on hatchability confirmed Javad et al. (2011) and also Pearson and Herron (1981). On the other hand, Antova et al. (2019) attributed different energy value of yolk to the chicken genotype, when they were reared under the same condition and fed with same feed. Whereas, Pištěková et al. (2006) found effect of rearing system of laying hens on egg quality. Also Roztočilová et al. (2018) highlighted the importance of feed quality on qualitative parameters of the eggs. Antova et al. (2019) determined GE of yolk by calorimetric method, which was similar as in this study. They gained yolk GE concentration in area from 1,438 to 1,608 kJ 100 g⁻¹ of yolk. Radu-Rusu et al. (2014) published lower yolk energy value 1,208 to 1,330 kJ 100 g⁻¹ of yolk, but they calculate the GE, whereas our results are established by direct calorimetry. Roe et al. (2013) published energy value for raw egg yolk 1,437 kJ 100 g⁻¹, which was lower compared to our results. Based on gained results of DM and GE content in raw yolk we calculate the linear regression for GE content. As published Vojtaššáková et al. (2000), the gross energy content is calculated according to average concentration of proteins, lipids, saccharides, food fibre, alcohols and variable "c", which for eggs has value 15.70. Calculation of GE according to DM percentage is more easily, than calculation according to determined nutrients as published Vojtaššáková et al. (2000).

4 Conclusions

The highest yolk gross energy content was determined in hens group fed with addition of 3% pumpkin oil, as well as indian hemp oil 2.5% or 5% addition. Yolk with higher energy content could provide more energy to embryo, which could have positive effect on hatchability of hatching eggs. This is a theme for future experiments in this area. The gross energy content of yolk can be estimated from dry matter content by using formula $GE = 17.34 + (32.73 * DM)$, $R^2 = 0.819$.

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