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# Effects of ginger or ginger and thyme extract in laying hens feeding on productive results and eggs quality

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**Abstract:** *Effects of ginger or ginger and thyme extract in laying hens feeding on productive results and eggs quality.* This experiment was aimed at determining the potential of extracts from ginger and from ginger and thyme for enhancing the production performance of laying hens and eggs quality. A total of 216 laying hens were divided into 3 feeding groups: standard diet, diet with a 0.0032% addition of a ginger extract, and diet with the addition of ginger (0.0016%) and thyme (0.0016%). Fresh eggs were analyzed for: egg weight, yolk weight and yolk weight ratio to egg weight, yolk color, albumen quality, strength and thickness of the eggshell. Boiled eggs were analyzed for: yolk color, consistency, aroma, and taste. The results demonstrated that hen diet supplementation had a beneficial effect on egg weight, but did not affect egg production rate nor feed conversion ratio. Fresh and hard-boiled eggs of the hens administered diet with a ginger extract addition were characterized by a darker color of the yolk. Both the ginger extract and the ginger + + thyme extract contributed to albumen quality improvement. Considering results obtained in this study, it seems advisable to investigate the feasibility of extending storage time of eggs of the hens fed a diet with various doses of a ginger and thyme extract.

*Key words*: laying hen, ginger and thyme extract, production results, egg quality

## INTRODUCTION

A growing demand for table eggs has led to strong intensification of the sector of laying hens. Unfortunately, a high number of hens in one flock and high stock density per surface area unit of a hen house facilitate the occurrence and spreading of diseases. The elimination of antibiotics, whose use ban has been introduced in many European countries since the 1 January 2006 (Castanon 2007), from a diet for laying hens has resulted in deterioration of hens' health and lowering their productivity. It has been proved many times that the use of some plants in poultry feeding has a positive effect on their health status as well as may become an alternative to antibiotics, and may boost production results. Olobatoke and Mulugeta (2011) demonstrated that hen diet supplementation with garlic powder improved their production results and albumen quality. They showed, however, that the 5% addition of garlic powder resulted in a strong scent of garlic developed in eggs, which severely reduces the

applicability of this plant in table eggs production. It has been proved earlier that the use of some oil plants, like rapeseed and flaxseed, in diet for laying hens had a negative impact on the odor of eggs (Caston et al. 1994, Lichovniková et al. 2008). In turn, the addition of the extract from garlic and onion with standardized quercetin content to the feed mixture for laying hens was reported to improve the typical aroma and taste of eggs, without causing changes in yolk color nor albumen consistency (Damaziak et al. 2017). The effect of quercetin extracted from onion on the laying performance and egg quality was investigated by Liu et al. (2013, 2014), who demonstrated that its addition in the dose of 0.4% was improving production results of hens and egg quality, in particular by improving albumen quality and reducing cholesterol level in yolk.

Due to the presence of biologically--active components, e.g. [6]-gingerol and [6]-sholaol, an extract from ginger (*Zingiber officinale*) possesses anti-inflammatory and antioxidant properties as well as displays anticarcinogenic activity (Akimoto et al. 2015). In turn, the major constituents of thyme (*Thymus vulgaris*) include: essential oils (borneol, carvacrol, cymene, linalool, thymol), tannin, flavonoids (apigenin, luteolin), saponins, and triterpene acids. Even a small amount of this herb has a sedative effect, whereas its higher does have stimulating effects (Porte and Godoy 2008, Grigore et al. 2010). Among the biologically-active substances of the discussed plants, Hashemi and Davoodi (2011) demonstrated as many as 6 antioxidative, 6 antiviral and 17 bactericidal substances in the composition of ginger as well as 4 antioxidative, 3 antiviral and 5 bactericidal substances in the composition of thyme.

Both ginger and thyme have been investigated as feed additives to diets for laying hens, however the published data are often inconsistent, or refer to some selected production parameters as well as different forms and doses of the preparations used. The application of a thyme oil additive in laying hen feeding was confirmed to improve the feed conversion ratio and increase egg production rate and egg weight (Bölükbaşi et al. 2008). These authors demonstrated also that thyme oil was reducing the count of *Escherichia coli* bacteria in feces. Saki et al. (2014), who supplemented hen diets with a phytogenic additive being a mixture of garlic, pot marigold, fennel, and thyme, showed an increase in egg weight and a decrease in trimethylamine level in yolk, which resulted in egg odor improvement. In turn, thyme added to a diet in the form of powder together with powdered garlic (1 : 1) was shown not to affect laying yield nor egg quality (Mohebbifar and Torki 2010). In contrast, Akbarian et al. (2011) showed that the addition of ginger root powder to laying hen diet in doses of 0.25–0.75% was improving egg production, but had no influence on the feed conversion ratio and egg weight.

To the best of authors' knowledge, apart from sparse studies addressing the effect of broiler chicken diet supplementation with a ginger and thyme extract (Rahimi et al. 2011, Fakhim et al. 2013), no research has been conducted so far to analyze the effect of this form of these herbs on production traits of other technological groups of poultry, including laying hens, nor on the quality of table eggs. In

addition, very little is known about the effect of these plants on the sensory traits of eggs. An advantage of the extract over other forms these herbs are applied in feed mixtures is a high concentration of biologically-active components. Noteworthy is that feed additives for laying hens may evoke various effects on sensory characteristics of eggs, including particularly products that contain natural flavonoids or essential oils. Supplements should not be perceptible by consumers because odor and flavor in table eggs are important both aesthetically and physiologically as they stimulate the secretion of digestive juices.

It may be expected that hen diet supplementation with ginger and thyme in the form of extracts will have a more positive effect on production results than the earlier applied forms of these plants. In addition, this supplementation should not deteriorate the quality and sensory traits of eggs. Considering the above, the objective of this study was to analyze the effect of diet supplementation with extracts from ginger and thyme on production results of laying hens and their egg quality.

## MATERIAL AND METHODS

Two hundred sixteen ISA Brown laying hens at the age of 16 weeks were obtained from a commercial facility. Hens were kept in three-level battery of furnished cage, that meet the standards of the European Union. Each treatment had 72 laying hens arranged in 6 replicates of 12 laying hens. A 16L:8D lighting program and the average room temperature of 18° ±2°C were maintained during the experiment. Water was available *ad libitum* from two nipple drinkers in each cage. Experimental diets were limited to 114 g/hen/day and administered to 240 cm long feeders (20 cm/hen) twice a day (in 57 g portions) after switching on the light and at the 8th h of the day.

For easier adaptation, feed provided by the producer was administered for 7 days since hens introduction to cages. Its composition was consistent with that declared by the ISA Management Guide – Cage Production System (Hendrix-Genetics 2014). Since the 17th week of life, the hens were fed experimental feed mixtures in the previously divided groups, i.e.: control diet (C) (no diet supplementation), diet supplemented with 0.0032% ginger extract (G), diet supplemented with 0.0016% ginger and 0.0016% thyme extract (GT). Components and nutrients of the diets can be found in Table 1. Extracts were provided by the producer (Bellako Limited Company, Warsaw, Poland) in the powdered form, with maltodextrin used as the carrier (starch substance in the form of loose white powder). The content of pure extracts in the supplement was 0.8%. The supplements were premixed with 2 kg of basal diet and next mixed into an appropriate quantity of basal diet to obtain the level of 0.04%. The extracts were standardized for cineol content; its content in the crude extract reached 0.2–0.23%.

Control of laying performance, egg weight and feed intake was started from the 19th week of life, assuming this moment as the 1st week of production. The mortality rate for laying hens throughout the experimental period was 0% in each group. A weekly production

TABLE 1. Composition of diets and nutrient content (air-dry basis)

| Item | Content | | |
|---|---|---|---|
| | C | G | GT |
| Ingredient (%) | | | |
| Wheat | 33.35 | 33.31 | 33.31 |
| Maize | 30.00 | 30.00 | 30.00 |
| Soybean meal | 15.20 | 15.20 | 15.20 |
| Sunflower meal | 10.00 | 10.00 | 10.00 |
| Rapeseed meal | 2.00 | 2.00 | 2.00 |
| Sunflower oil | 1.00 | 1.00 | 1.00 |
| $CaCO_3$ | 6.23 | 6.23 | 6.23 |
| Dicalcium phosphate | 1.28 | 1.28 | 1.28 |
| Ginger suplement[1] | – | 0.04 | – |
| Ginger and thyme suplement[2] | – | – | 0.04 |
| Premix[3] | 0.30 | 0.30 | 0.30 |
| NaCl | 0.24 | 0.24 | 0.24 |
| $NaHCO_3$ | 0.18 | 0.18 | 0.18 |
| Lysine + Methionine | 0.22 | 0.22 | 0.22 |
| Nutrient | | | |
| Metabolizable energy (kcal/kg) | 2 731.10 | 2 731.10 | 2 731.10 |
| Total protein (%) | 17.76 | 17.76 | 17.76 |
| Crude fiber (%) | 3.94 | 3.94 | 3.94 |
| Crude ash (%) | 10.65 | 10.65 | 10.65 |
| Total calcium (%) | 2.75 | 2.75 | 2.75 |
| Available potassium (%) | 0.45 | 0.45 | 0.45 |
| Lysine + Methionine (%) | 1.27 | 1.27 | 1.27 |

C – control group (standard diet); G – experimental group (diet supplementation with ginger extract); GT – experimental group (diet supplementation with ginger and thyme extract).

[1, 2]The carrier of extract was maltodextrin (content of pure extract in the supplement 0.8%); i.e. extract level in feed was 0.00325 ginger in G group and 0.0016% ginger + 0.0016% thyme in GT group.

[3]Provided per kg of diet: vit. A 11,500 IU; vit. $D_3$ 3,000 IU; vit. E 12 IU; vit. K 3 mg; vit. $B_1$ 2 mg; vit. $B_2$ 6 mg; vit. $B_6$ 3 mg; vit. $B_{12}$ 0.012 mg; biotin 0.04 mg; folic acid 0.6 mg; niacin 20 mg; pantothenic acid 10 mg; chromium picolinate 0.5 mg; Cu 10 mg; I 0.30 mg; Fe 65 mg; Mn 120 mg; Se 0.30 mg; Zn 60 mg.

of eggs was calculated from the number of eggs laid in each of the 7 days of a week in the period from the 1st to the 16th week of production. Because there was no one dead hen during the experiment the hen day and hen housed numbers were the same in each group. Egg weight (±0.1 g) was controlled once a week. Feed conversion ratio (*FCR*) was computed as kg of feed per 1 kg of egg weight.

Egg quality assessment was conducted in the: 6th, 8th, 10th, 12th, 14th and 16th week of the laying period. Thirty eggs from each experimental group (five

randomly selected from replicate) were collected the same day and placed in a cold store (4°C). Analyses were carried out the next day. The eggs were removed from cold storage immediately before quality assessments to ensure comparable egg temperatures. Egg temperature was monitored throughout quality assessments and ranged between 6° and 8°C. Shell breaking strength (N) was assessed using the test machine ZWICK (ZWICK type 1120, Germany), with a cylindrical probe 75 mm in diameter. A test speed of 2 mm/s and a trigger force of 0.001 kg were used. Further analyses were carried out using the Egg Analyzer device (ORKA Food Technology, USA). This electronic instrument determines egg weight, yolk weight, and yolk color. Yolk color range corresponds to the DSM scale from 1 through 15 units. Haugh units are automatically calculated from the measurements made (expressed on a scale of 0 to 130). The achieved data were used to calculate the content (%) of egg yolk in egg weight. Eggshell thickness (μm) was defined using a digimatic micrometer (Mitutoyo Corporation, Japan).

Sensory properties were analyzed using eggs collected in two terms of hens laying period: in the 7th week analyses were conducted for 27 eggs from each experimental group, and in the 15th week for 48 eggs from each experimental group. The different number of eggs in the analytical terms resulted from the difference in the number of panelists able to conduct the assessment. Eggs collected each day were stored at 4°C for 7 days. They were cooked in an automatic egg cooker (Egg Boiler FA-5115, TZS First, Austria) and then cooled to a room temperature, shelled and divided into four equal parts. The sensoric test was performed by employing untrained panelists but usual consumers of eggs. All panelists received three coded pieces of egg, each representing a different experimental group. A randomized design allowed the sampling of eggs in any order, however panelists rinsed their mouths with pure water after each bite. Samples of eggs to be assessed were free of any seasonings and salt. During assessment, the panelists were asked to express their opinion in five-point scales, i.e. regarding yolk color and egg consistency: 1 – very undesirable, 2 – undesirable, 3 – acceptable, 4 – desirable, 5 – highly desirable; and; regarding aroma: 1 – intense undesirable, 2 – perceptible slightly undesirable, 3 – imperceptible, 4 – typical perceptible, 5 – desirable and regarding taste: 1 – bad, 2 – poor, 3 – satisfactory, 4 – good, and 5 – very good.

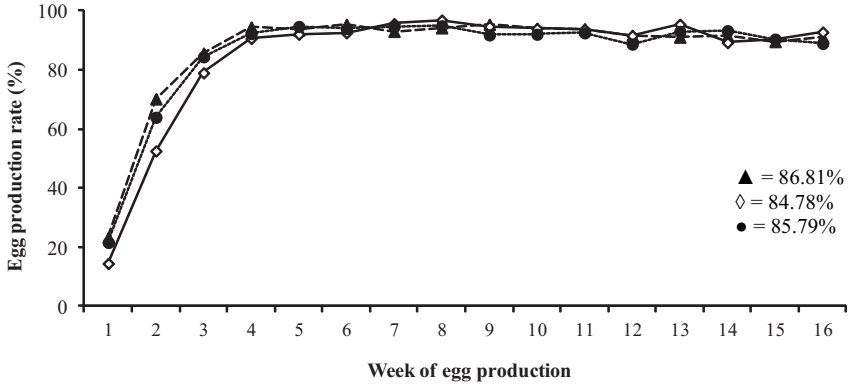
Data concerning egg production rate, egg white and *FCR* in the entire experimental period were compared with the one-way analysis of variance and Duncan test or Kruskal–Wallis test (in the case of the lack of normality of distribution – based on Shapiro–Wilk test or in the case of variance inequality between experimental groups – based on Levene test). Results of morphological and sensory analysis of eggs were analyzed with the two-way analysis of variance (diet supplementation and week of laying production) with interaction. Because the interactions between the analyzed factors (diet supplementation and week of laying production) were not significant and, thus, did not affect any of the studied parameters (except yolk weight; $P = 0.025$), they were not shown in the tables. In addition, the

multivariate differences of the analyzed experimental groups of hens regarding egg quality traits were evaluated with cluster analysis. The square of Euclidean distance was adopted as a measure of distance for standardized data, and the grouping of objects was conducted with the Ward method. Results were depicted in the form of dendrograms. Multivariate differences of the groups were additionally assessed with multivariate analysis of variance (MANOVA) and Wilk test. All statistical analyses were carried out in Statistica 12 software, at significance levels of 0.05 and 0.001.

## RESULTS AND DISCUSSION

The average weekly egg production rate over the 16-week period of egg production is shown in Figure 1. Hen diet supplementation with extracts from ginger or from ginger and thyme had no effect on the average egg production rate over the entire experimental period ($P = 0.223$). The addition of both plant extracts significantly improved the mean egg weight computed for the entire production period ($P = 0.003$). No differences were confirmed in mean egg weight between experimental groups of hens (Fig. 2). The most favorable *FCR* was determined in the case of hens administered a diet with the extract containing additionally thyme (GT), however comparative analysis of all three groups of hens did not confirm significant differences ($P = 0.708$) in the values of this parameter determined for the entire experimental period (Fig. 3).

The quality analysis of fresh eggs demonstrated a positive effect of the applied plant extracts on yolk color ($P = = 0.001$) and albumen quality expressed in Haugh units ($P < 0.001$). Yolks of eggs of the hens from experimental groups were darker, and eggs were characterized by a better albumen quality especially at the later stage of the egg-laying period (Table 2). The age of hens had a significant effect on all analyzed traits




▲observed egg production rate for group C
– – fitted curve for egg production rate for group C
◊ observed egg production rate for group G
— fitted curve for egg production rate for group G
● observed egg production rate for group GT
··· fitted curve for egg production rate for group GT

FIGURE 1. Fitted curves for weekly egg production rate using Yang model

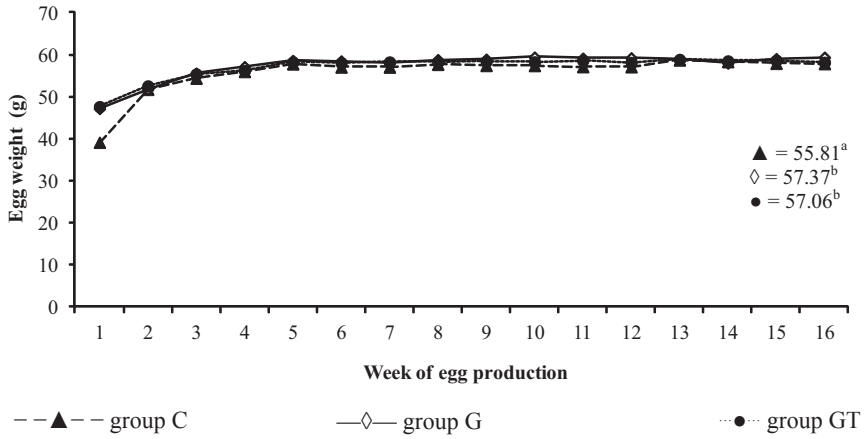



FIGURE 2. Egg weight curves of hens production period. [a-b]Egg weight differed significantly between treatment group at $P \leq 0.05$, and ** at $P \leq 0.01$

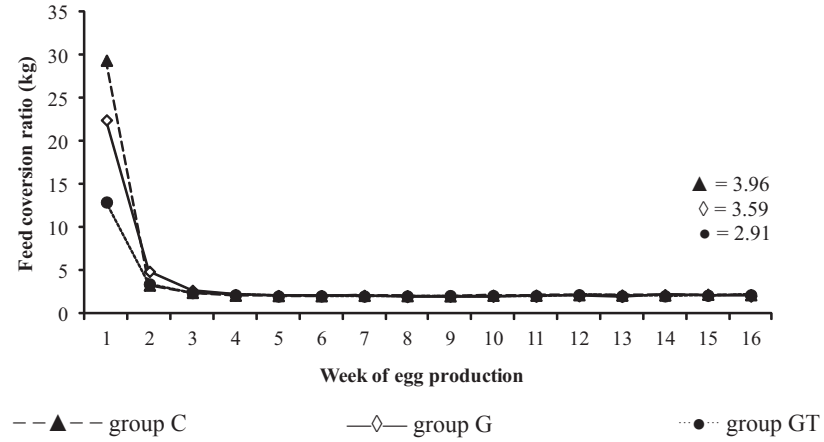



FIGURE 3. Feed conversion ratio (kg/kg egg weight) curves of hens production period. ** Differ significantly between treatment groups at $P \leq 0.01$

($P < 0.001$) except for Haugh units and shell thickness ($P = 0.601$).

Both the addition of ginger extract and ginger + thyme extract had not effect upon results of the sensory evaluation of eggs, except for yolk color which in consumers' opinion was the most favorable in eggs of hens from group GT ($P = = 0.017$; Table 3). Scores made by the panelists demonstrated that the consistency of eggs originating from older hens (age 15 weeks old) was more favorable ($P = 0.001$) compared to eggs from birds at the early stage of the laying period (age 7 weeks old). The remaining traits of hard-boiled eggs received similar scores in both terms of analysis ($P > 0.05$).

TABLE 2. Fresh egg quality characteristics

| Item | Week of laying production | Number of analyzed eggs | Egg morphology characteristics | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | EW | YW | YR | YCF | HU | Shell strength (N) | Shell thickness (mm) |
| C | 6th–16th | 180 | 55.6 | 12.9 | 23.2 | 4.34$^{a}$ | 83.5$^{ab}$ | 40.4 | 0.367 |
| G | | 180 | 56.3 | 13.1 | 23.3 | 4.69$^{ab}$ | 86.0$^{a}$ | 41.0 | 0.369 |
| GT | | 180 | 56.6 | 13.0 | 23.0 | 4.46$^{b}$ | 86.7$^{b}$ | 41.6 | 0.365 |
| *SEM* | | | 0.90 | 0.22 | 0.40 | 0.16 | 1.54 | 1.61 | 0.008 |
| *P*-value | | | | | | | | | |
| Diet supplementation | | | 0.124 | 0.279 | 0.354 | 0.001 | < 0.001 | 0.430 | 0.671 |
| Week of laying production | | | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.118 | < 0.001 | 0.601 |

C – control group (standard diet); G – experimental group (diet supplementation with ginger extract); GT – experimental group (diet supplementation with ginger and thyme extract). EW – eggs weight (g); YW – yolk weight (g); YR – yolk weight ratio to egg weight (%); YCF – yolk color fan; HU – Haugh units of albumen.

Values differ significantly between treatment groups at $P \leq 0.05$. Means within a column for the same test time (week) with a common superscript differ significantly (Duncan test) between treatment groups (diet supplementation), $^{a\text{-}b}P \leq 0.05$.

TABLE 3. Hard-boiled egg sensory evaluation and consumer acceptance in a 1–5-point scale

| Item | Week of laying production | Number of analyzed eggs | Egg sensory characteristics | | | |
|---|---|---|---|---|---|---|
| | | | yolk color[1] | consistency[1] | aroma[2] | taste[3] |
| C | 7th and 15th | 75 | 3.27$^{a}$ | 3.61 | 3.66 | 3.96 |
| G | | 75 | 3.29$^{b}$ | 3.69 | 3.73 | 3.79 |
| GT | | 75 | 3.60$^{ab}$ | 3.79 | 3.75 | 3.84 |
| *SEM* | | | | | | |
| Week 7 | | | 0.177 | 0.190 | 0.124 | 0.148 |
| Week 15 | | | 0.111 | 0.119 | 0.117 | 0.132 |
| *P*-value | | | | | | |
| Diet supplementation | | | 0.017 | 0.600 | 0.682 | 0.399 |
| Week of laying production | | | 0.468 | 0.001 | 0.675 | 0.768 |

C – control group (standard diet); G – experimental group (diet supplementation with ginger extract); GT – experimental group (diet supplementation with ginger and thyme extract).

[1]Numerical rating scale for yolk color and egg consistency: 1 – very undesirable; 2 – undesirable; 3 – acceptable; 4 – desirable; 5 – high desirable.

[2]Numerical rating scale for egg aroma: 1 – intense undesirable; 2 – felt slightly undesirable; 3 – imperceptible; 4 – typical perceptible; 5 –intense undesirable.

[3]Numerical rating scale for egg taste: 1 – bad; 2 – poor; 3 – satisfactory; 4 – good; 5 – very good.

Differ significantly between treatment group for $P \leq 0.05$. Means within a column for the same test time (week) with a common superscript differ significantly (Duncan test) between treatment groups (diet supplementation), $^{a\text{-}b}P \leq 0.05$.

Results based on MANOVA and pairwise multivariate comparisons for fresh egg quality and hard-boiled egg sensory evaluation and consumer acceptance were presented in Table 4 and in dendrograms (Figs. 4 and 5). The multivariate comparison of all 7 morphological traits of fresh eggs demonstrates that hen diet supplementation with the ginger extract and with the ginger + thyme extract affected ($P < 0.001$) the overall quality of eggs. Figure 4 shows explicitly a large distance especially between eggs of hens from groups C and G and these of hens from group GT. In contrast, a simultaneous comparison of four sensory attributes of hard-boiled eggs made in both evaluated terms of the laying period of hens shows no effect ($P = 0.100$) of the applied plant extracts on the analyzed traits of hard-boiled eggs (Table 4). Nevertheless, results of the cluster analysis conducted based on standardized variables demonstrate that eggs of the hens fed a diet with 0.0032% addition of a ginger extract are in other homogenous group than the eggs of hens from groups C and GT (Fig. 5).

The lack of a significant effect of hen diet supplementation with a ginger extract and a ginger + thyme extract concerning the egg production rate and *FCR* obtained in this study is consistent with the findings published earlier by other

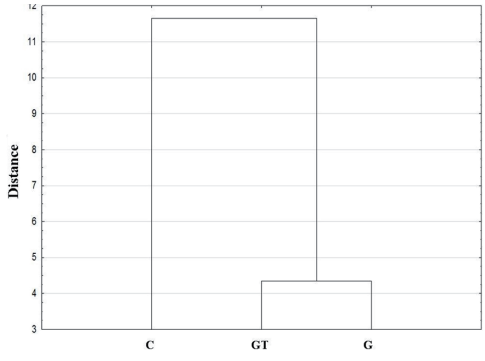



FIGURE 4. Dendrogram presenting multivariate similarity of the fresh egg quality depending on diet supplementation, based on cluster analysis (Ward method of agglomeration). Explanations in the text

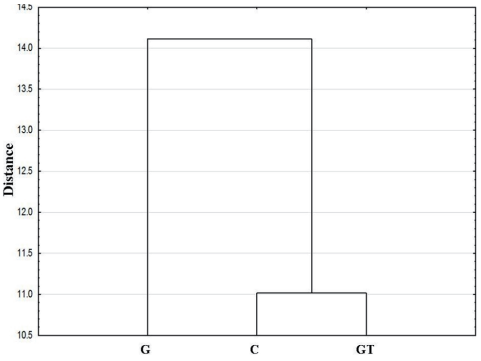



FIGURE 5. Dendrogram presenting multivariate similarity of the hard-boiled egg sensory evaluation and consumer acceptance depending on diet supplementation, based on cluster analysis (Ward method of agglomeration). Explanations in the text

TABLE 4. Results based on MANOVA and pairwise multivariate comparisons for fresh egg quality and hard-boiled egg sensory evaluation and consumer acceptance

| Item | Fresh egg quality | | Hard-boiled egg sensory evaluation and consumer acceptance | |
|---|---|---|---|---|
| | *F* | *P*-value | *F* | *P*-value |
| Diet supplementation | 3.35 | < 0.001 | 1.68 | 0.100 |
| Week of laying production | 15.14 | < 0.001 | 3.10 | 0.016 |

*F* – statistics based on Wilk lambda and *P*-value based on multivariate analysis of variance were results of Wilk test differ significantly $P \leq 0.05$

authors who applied various forms of the discussed herbs. Bölükbaşi et al. (2008) did not demonstrate any effect of thyme oil, whereas Zhao et al. (2011) – of a ginger powder on the improvement of laying performance of hens. It has been demonstrated many times that the addition of an extract from ginger to feed mixtures for laying hens, both in the form of powder (Akbarian et al. 2011, Zhao et al. 2011) and oil (Nasiroleslami and Torki 2010), has no effect on changes in the *FCR* value. On the contrary, Ghasemi et al. (2010) demonstrated a decreased *FCR* value in laying hens after the application of the thyme + garlic extract, however it has been confirmed several times that garlic itself has not impact on *FCR* (Chowdhury et al. 2002, Damaziak et al. 2017). Earlier, Al-Kassie (2009) reported *FCR* decrease in broiler chickens administered an extract from pure thyme (200 ppm), which – in authors' opinion – was caused by the presence of a biologically-active substance – thymol. Also, thymol has been reported to stimulate digestion, including the secretion of amylase from saliva, bile, small intestinal mucosa and development of intestinal villi (Platel and Srinivasan 2004), which has a direct effect on *FCR* value decrease.

The results demonstrated that the laying hens fed the diet containing the extract of ginger and ginger + thyme had higher egg weight than the control birds. The mechanisms by which the ginger and thyme extracts increased egg weight are not clear. Positive anti-inflammatory, antioxidant, bactericidal and digestion-stimulating effects of both herbal supplements were reported (Platel and Srinivasan 2004, Hashemi and Davoodi 2011, Akimoto et al. 2015). All of these have a favorable influence on poultry productivity, which may have partially contributed to the increased egg weight of the laying hens in this study.

The darker color of raw and hard-boiled egg yolks in the case of hens administered feed mixtures with the addition of plant extracts was, probably, due to natural pigments of ginger imparting a deep yellow color to this plant such as: curcumin, demethoxycurcumin, and 6-dehydrogingerdione (Lijima and Joh 2014, Ajileye et al. 2015). Unfortunately, the available literature provides no information about the effect of thyme on yolk color. However, Zomrawi et al. (2014) did not confirm a significant effect of hen diet supplementation with a ginger powder on yolk color, likewise Ademola et al. (2012) did not demonstrate such an effect upon the addition of powder from ginger and garlic to feed mixtures. It may be speculated that ginger pigments significantly affect yolk color only when this plant is incorporated into a hen diet in the form of an extract. These results demonstrate also that ginger pigments which are accumulated in the yolk, are not degraded during the cooking of eggs.

In this study, fundamental was the positive effect of extracts on egg albumen quality. This trait is, most of all, affected by the period and conditions of eggs storage and by hen age (Samli et al. 2005). The effect of the plant extracts was observed mainly in the last two terms of analyses, i.e. in the 14th and 16th week of production, when albumen quality usually begins to deteriorate. The antioxidative effect of ginger probably minimizes albumen quality deterioration through lesser lipid and protein oxidation.

Earlier, Yalcin et al. (2006) demonstrated a similar effect after supplementing diets for laying hens with a feed additive of garlic, which is also regarded as a plant with antioxidative properties. The most beneficial effect of supplementation with an extract from ginger and thyme on albumen Haugh units could, in turn, be due to the additional effect of carvacrol being one of the main essential oils of thyme. Denli et al. (2004) observed significant improvement in quail albumen quality upon bird diet supplementation with black seed characterized by a significant content of carvacrol. It has been demonstrated several times that the bioactive material of medicinal plants has a strong power to protect magnum and uterus cells and also to increase the level of albumin in laying hens (Denli et al. 2004, Nadia et al. 2008).

Except for the changes in the color of egg yolks, the remaining traits of hard-boiled eggs assessed by the panelists were not affected by the plant extracts. These results are satisfactory because it has been proved many times that the additives of some plants to feed mixtures for laying hens, e.g. rapeseed (Lichovniková et al. 2008) or linseed (Stearns et al. 1994), may negatively influence the sensory traits of eggs. Motozono et al. (1999) demonstrated also that the 2% addition of garlic to diet for hens caused a perceptible unpleasant aroma. The available literature lacks information about the effect of ginger addition to feed mixtures for hens on the sensory quality of eggs. Some sparse studies concerning the effect of ginger as a feed additive on quality attributes of meat did not confirm such a correlation either (Naveena 2004, Janz et al. 2007). In turn, Tserveni-Gousi (2001) demonstrated that 2% addition of thyme to feed mixtures for laying hens may prevent the negative effects on the sensory assessment of eggs at the simultaneous supplementation of bird diet with 10% of linseed.

It is concluded that diet supplementation with an extract from ginger (0.0032%) and an extract from ginger (0.0016%) with thyme (0.0016%), in both cases, has a positive effect on egg weight, without reducing the egg production rate of hens. Though insignificantly, but a lower value of *FCR* determined in the hens receiving the extract with thyme suggests that the use of the mixture of these herbs may contribute to a reduction of costs of table eggs production. Egg yolks dyed with a natural intensive yellow color and preserving appropriate taste and aroma values as well as consistency are desirable by direct consumers and by processing plants of table eggs. Undoubtedly, a measurable benefit of applying both analyzed dietary supplements is the improvement of albumen quality in eggs from older hens. In the future, it would be advisable to investigate whether the improvement of albumen quality upon the influence of the analyzed plant extracts could affect the extension of storage time of eggs. It would also be recommended to analyze other doses of the applied preparations.

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**Streszczenie:** *Wpływ ekstraktu z imbiru i imbiru z tymiankiem w żywieniu kur nieśnych na wyniki produkcyjne i jakość jaj*. Badania zostały przeprowadzone w celu zbadania potencjału ekstraktu z imbiru i imbiru z tymiankiem w zwiększaniu wyników produkcyjnych kur nieśnych oraz morfologicznej i sensorycznej jakości jaj. W sumie 216 kur niosek ISA Brown utrzymywanych w klatach, w systemie intensywnym przydzielono do 3 grup żywieniowych: dieta standardowa bez suplementacji (C), z dodatkiem 0,0032% ekstraktu z imbiru i imbiru (0,0016%) z tymiankiem (0,0016%). Analiza surowych jaj obejmowała: masę jaja, masę i udział żółtka w masie jaja, barwę żółtka, jakość białka oraz wytrzymałość i grubość skorupy. Analiza gotowanych jaj obejmowała: kolor żółtka, konsystencję, zapach i smak jaj gotowanych. Uzyskane wyniki wykazały, że suplementacja diety kur miała korzystny wpływ na

masę jaja, ale nie wpłynęła na wielkość produkcji i wykorzystanie paszy. Surowe i gotowane jaja kur żywionych dietą z dodatkiem ekstraktu z imbiru cechowała ciemniejsza barwa żółtka, która dla jaj gotowanych uzyskała najwyższe noty panelistów. Zarówno ekstrakt z imbiru, jak i imbiru z tymiankiem wpłynęły na poprawę jakości białka jaja. Zasadne są dalsze badania dotyczące możliwości wydłużania okresu przechowywania jaj pochodzących od kur żywionych paszą o różnym poziomie ekstraktów imbiru i tymianku.

*Słowa kluczowe*: kury nioski, ekstrakt z imbiru i tymianku, wyniki produkcyjne, jakość jaj

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