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Source / Izvornik: **Poljoprivreda, 2024, 30, 60 - 66**

Journal article, Published version
Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

https://doi.org/10.18047/poljo.30.1.8

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:151:221573

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Senzorska svojstva jaja obogaćenih ribljim i lanenim uljem

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Poljoprivreda / Agriculture

ISSN: 1848-8080 (Online)
ISSN: 1330-7142 (Print)

https://doi.org/10.18047/poljo.30.1.8

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ISSN 1330–7142
UDK=637.482
https://doi.org/10.18047/poljo.30.1.8

THE SENSORY CHARACTERISTICS OF EGGS ENRICHED WITH THE FISH AND LINSEED OIL

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Original scientific paper
Izvorni znanstveni članak

SUMMARY

This research investigates the effect of fish and linseed oils supplemented to the laying hens' feed on the sensory characteristics of table eggs. The experiment was performed on 480 laying hens of TETRA SL hybrid, which were divided into three groups (K: 5 % of soybean oil, P1: 1.5 % of fish oil and 3.5 % of linseed oil, and P2: 2 % of fish oil and 3% of linseed oil). A sensory analysis of eggs was comprised of an assessment of egg color, smell, taste, and texture and was performed by a panel of tasters (n=52) who administered the triangle test and the hedonic test. The panel determined that there was a significant difference (P<0.05) in taste of eggs between the treatment pairs K: P1 and K: P2 but no significant difference between the treatment pair P1: P2. The most frequently detected difference between the treatment pairs referred to the taste, then to color and smell, and the difference in egg texture between the pairs was not represented that much. An increased amount of fish oil in the hens' diet increased a sensory perception of egg smell and decreased a sensory perception of taste. The egg taste liking differed significantly between the treatments (P<0.05). Referring to the sensory characteristics of likability of color and odor of eggs, there were no significant differences (P>0.05) determined between the treatments.

Key–words: eggs, sensory characteristics, fish oil, linseed oil

INTRODUCTION

In order to enrich the eggs with the n–3 polyunsaturated fatty acids, the laying hens' diets are supplemented with the oils of desired fatty acid profile. Fish and linseed oils are rich in α–linolenic, eicosapentaenoic, and docosahexaenoic fatty acids, but their use as the animal-feed dietary supplements of is limited, because they cause undesirable sensory characteristics, such as a fishy and rancid smell (Lawlor et al., 2010; Fraeye et al., 2012; Feng et al. 2020). Previous research has shown that some people found such a smell acceptable to certain extent. However, the intensity of fishy and rancid smell of eggs increases with a higher n–3 PUFA content, especially the DHA in egg yolks (Gonzalez–Esquerra and Lesson, 2000; Lawlor et al., 2010). Petrović et al. (2016) investigated the dietary supplementation of linseed oil to the laying hens' feed (1 % –4 %) and its effect on the sensory characteristics of eggs to conclude that the differences in the contents of n–3 PUFA in the eggs, influenced by the hens' dietary supplementation with the linseed oil, did not change the sensory characteristics of eggs. These results are in accordance with the research results obtained by Scheideler et al. (1997) and Mazalli (2004). The products with specific positive effects on human health should be acceptable to consumers (Friganović et al., 2011). Petrović et al. (2016) emphasized that such products should have satisfactory sensory characteristics, such as the color, taste, smell, texture, and overall likeability. The occurrence of unfavorable sensory characteristics of eggs related to the fish oil supplemented to the laying hens' feed was highlighted by Schreiner et al. (2004), and Carrillo–Dominiguez et al., 2010). Petrović et al. (2016) investigated the dietary supplementation of linseed oil to the laying hens' feed

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(1 % – 4 %) and its effect on the sensory characteristics of eggs to conclude that the differences in the contents of n–3 PUFA in the eggs, influenced by the hens' dietary supplementation with the linseed oil, did not change the sensory characteristics of eggs. These results are in accordance with the research results obtained by Scheideler et al. (1997) and Mazalli (2004). The products with the specific positive effects on human health should be acceptable to consumers (Friganović et al., 2011). Petrović et al. (2016) emphasized that such products should have the satisfactory sensory characteristics, such as the color, taste, smell, texture, and overall likeability. The occurrence of unfavorable sensory characteristics of eggs connected with fish oil supplemented to the laying hens' feed was highlighted by Schreiner et al. (2004), and Carrillo–Dominiguez et al. (2005). Caston et al. (1994) reported on the occurrence of a slight "off flavor" in the eggs laid by the hens that were fed by the linseed. Ferrier et al. (1994) determined that 15 to 20 % of linseed added to the laying hens' feed caused their eggs to have an unpleasant smell and taste of fish oil, which was also confirmed by Scheideler et al. (1997). Other researchers, such as Cloughley et al. (1997) and Marshall et al. (1994), did not detect the undesirable organoleptic properties of the n–3 PUFA eggs when comparing them to the conventional eggs. An undesirable egg smell can be prevented or reduced by adding the antioxidants to the laying hens' diet (Scheideler et al. 1997, Singh et al. 2010). As reported by Sedoski et al. (2012), the eggs laid by the hens whose diet was supplemented by algae, fish, linseed, and rapeseed oils were acceptable for consumption, as determined by the sensory professionals after testing all groups of eggs ($P>0.005$). While investigating the effect of algae, vegetable, and fish oils added to the hens' diet, Parpinello et al. (2006) found that the type of oil and its amount could cause the fishy smell in cooked eggs. Kartikasari et al. (2021) supplemented the laying hens' diet with 0.3 %, 3 % and 6 % of ALA to determine its influence on the increased deposition of ALA in the yolk lipids while evaluating the overall taste liking of table eggs. They employed the hedonic test and obtained the following sensory scores: 6.4, 5.6, and 5.4, and for conventional eggs the sensory score was 6.0 points. Although the third group of eggs obtained a better score, the tasters' panel considered all groups of eggs acceptable for consumption. Such assessment is in accordance with the research results obtained by Hayat et al. (2010).

The research objective was to assess the sensory characteristics of eggs (i.e., the color, smell, taste, and texture) laid by the hens whose diets were supplemented with the linseed oil and fish oil in different concentrations.

MATERIAL AND METHODS

Laying hens' feeding treatment

In this research, the experimental procedures applied to the laying hens and tested eggs were aligned with the protocols approved by the Animal Research Ethics Committee of the Faculty of Agrobiotechnical Sciences Osijek.

Table 1. Chemical composition of feeding mixtures used in the experiment (%)

Tablica 1. Kemijski sastav krmnih smjesa korištenih u pokusu (%)

Parameter / *Parametar*	K	P1	P2
Moisture / Vlaga	9.8	9.5	9.7
Crude protein / Sirove bjelančevine	17.23	17.31	17.07
Crude fat / Sirova mast	7.7	7.7	7.7
Crude fibre / Sirova vlaknina	4.9	4.7	4.8
Crude ash / Pepeo	11.88	11.67	11.18

Moisture – HRN ISO 6496:2001; Crude protein – ISO 1871:2009; Crude fat – HRN ISO 6492:2001, Crude fiber – RU–013–06; Mod. HRN EN ISO 6865:2001, Crude ash – HRN ISO 5984:2004/Corr. 1:2016

The research was performed on 480 laying hens of TETRA SL hybrid divided into three groups. The laying hens of the control group K consumed a diet with 5 % of soybean oil, the experimental group P1 was given a diet with a combination of 1.5 % of fish oil and 3.5 % of linseed oil, and the experimental group P2 had a diet supplemented with 2 % of fish oil and 3 % of linseed oil. Each group consisted of 160 hens divided into 16 repetitions. The laying hens' feeding mixtures were balanced at 17.00 % crude protein and 12.10 MJ/kg ME. The chemical composition of feeding mixtures is presented in Table 1. The feed and water were available to the laying hens ad libitum. The experimental period lasted for 30 days, of which the first two days were reserved for the hens' adaptation to the groups, while the remaining 28 days were experimental. On the last experiment day, the eggs laid by each group of hens were sampled for the sake of a sensory analysis.

Triangle test and hedonic test

A sensory analysis of eggs was performed by administering the triangle test and the hedonic test. The panel consisted of 28 tasters in the first session and 24 tasters in the second session. Out of the total number of panel members, 70 % were the trained sensory professionals with a previous long–term experience in sensory analysis, and the remaining 30 % of testers have previously participated in similar analyses but had no formal training therein. Such a panel composition aimed at providing a part of tasters acting as ordinary consumers

in order to obtain a more representative analysis. The sensory analysis rules and procedure were explained to all panel members prior to test administration. The egg samples were cooked by putting them in cold water, heating the water to the boiling point, and then boiling the eggs for 10 minutes. Subsequent to cooking, the eggs were placed in cold water for 5 minutes, the shells were removed, and the eggs were kept at 40–60 °C until consumption. Prior to tasting, the eggs were cut longitudinally into quarters, and one quarter represented a tasting sample served to the tasters. Within the triangle test, the three sets, consisting of the three egg samples marked with a three–digit code, were given to each taster. Within each set, two egg samples were the same, and one was different (Figure 1).

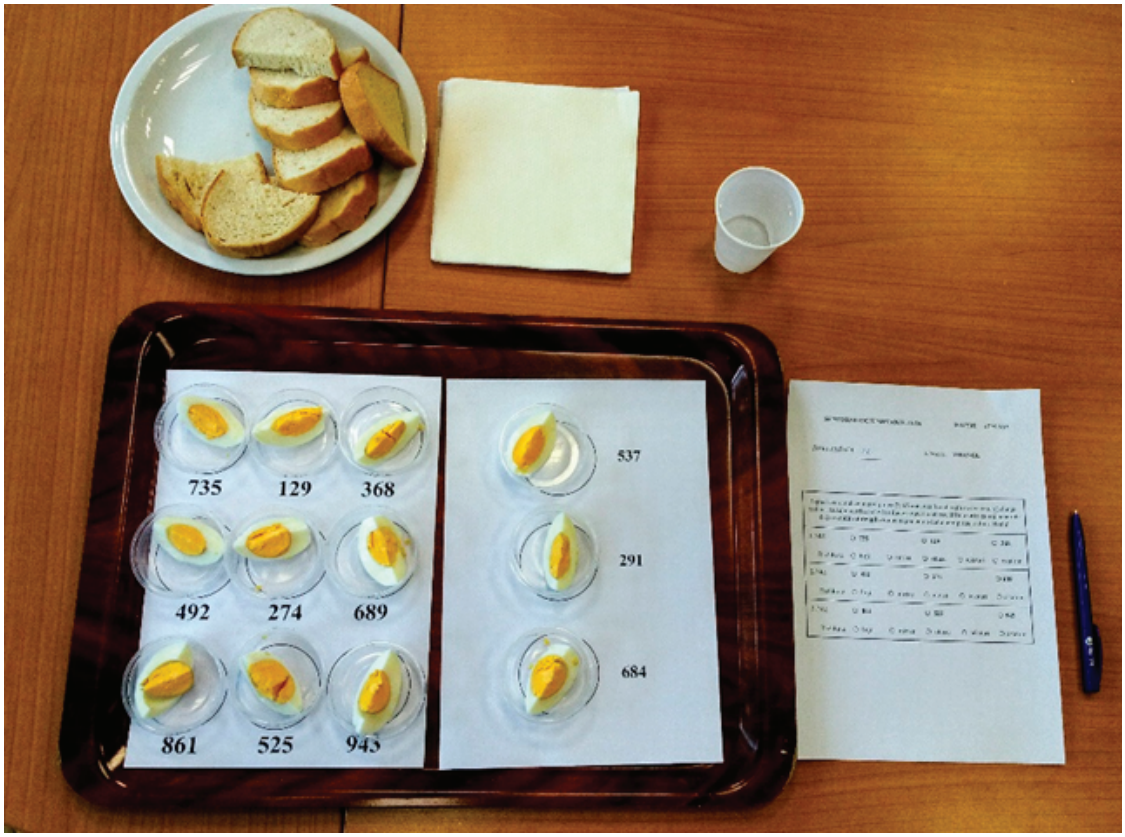

Figure 1. The egg samples prepared for sensory analysis (Kos, 2019)

Slika 1. Uzorci jaja pripremljeni za senzorsku analizu (Kos, 2019.)

The panel members were then instructed to choose which sample was different and to note the difference they tasted (referring to the egg color, smell, taste, texture, etc.). The order of samples within the set was determined randomly, with the following possible combinations: ABA, AAB, BAA, BAB, BBA, and ABB. The tasters had to consume bread and water after tasting each set-in order to neutralize their mouths and recover their sense sensitivity. The hedonistic test comprised of the three sets of samples determined to represent all pairs of researched treatments, as follows: K:P–1, K:P–2, P–1:P–2. As previously mentioned, the sets in the triangle test were determined in a random order, while the hedonic test offered the three samples of eggs, marked with a three–digit code, to the tasters, and each sample represented one treatment. The tasters rated their liking of egg color, smell, and taste by marking the grades on a hedonic scale, from 1, meaning "I do not like it at all," to 9, meaning "I like it completely." After tasting each egg sample, the tasters also consumed bread and water to neutralize their mouths and recover their sense sensitivity. The order of samples was determined in a randomized design, offering the following possible combinations: ABC, ACB, BAC, BCA, CAB and CBA.

Statistical data analysis

The results of sensory analysis obtained by the hedonic test were processed in the *SAS Studio University Edition* 3.71 (SAS Institute, 2018) using the NPAR1WAY for a non–parametric analysis with the Kruskal–Wallis test and the DSCF method (Dwas, Steel, Critchlow–Flinger) for the sake of a comparison of treatments at a significance level of $P<0.05$. The data obtained by the triangle test were processed by calculating a statistical significance based on the number of correct responses, whereby at least 25 out of 52 responses had to be correct in the selection of a different egg sample in order to reject the H0 hypothesis at a significance level of $P<0.05$ (Lawless and Heymann, 2010).

RESULTS AND DISCUSSION

Table 2 overviews the results of sensory analysis of eggs obtained within the triangle test. The tasters (n = 52) determined that there was a statistically significant difference (P<0.05) between the treatment pairs K : P1 and K : P2, while they did not confirm a statistically significant difference for the treatment pair P1 : P2. Therefore, it was concluded that the tasters determined the differences between the control (K) and experimental groups (P1 and P2), whereas the difference between the experimental groups was not established.

Table 2. The results of sensory analysis of eggs obtained by the triangle test

Tablica 2. Rezultati senzorske analize jaja dobiveni triangl-testom

Treatment pairs / *Parovi tretmana*	**Number of correct responses[2] /** *Broj točnih odgovora[2]*	**Percentage of correct response (%) /** *Postotak točnoga odgovora (%)*	**P value /** *P vrijednost*
K : P1	31	59.62	P<0.05
K : P2	33	63.46	P<0.05
P1 : P2	24	46.15	P>0.05

K = 5 % soybean oil, P1 = 1.5 % fish oil + 3.5 % linseed oil, P2 = 2 % fish oil + 3 % linseed oil /
K = 5 % sojina ulje, P1 = 1,5 % ribljega ulja + 3,5 % lanenoga ulja, P2 = 2 % ribljega ulja + 3 % lanenoga ulja

[2]Minimum number of correct responses required to reject the H0 hypothesis and to confirm the sensory difference within the triangle test for n = 52 and α=0.05 was 25. /
[2]*Minimalan broj točnih odgovora potrebnih za odbacivanje hipoteze H0 i potvrđivanje senzorske razlike unutar triangl-testa za n = 52 i α=0,05 bio je 25.*

Table 3 presents the detected frequency of different characteristics in the cases when the tasters selected a different sample correctly. The most frequently detected difference between the treatment pairs referred to taste (32.79 – 46.81 %), then to color (19.15 – 27.95 %) and smell (18.18 – 22.95 %), while the difference in egg texture between pairs was the rarest detected difference (14.89 – 18.18 %).

It was noticed that the assessment of sensory characteristics of eggs of the control and experimental groups resulted in a shift in the frequency of distinguishing taste and smell. The frequency of differences in smell was increased (+4.77 %), while the frequency of differences in taste was decreased (–5.39 %), proportional to an increase in fish oil added to the laying hen diet. This can be related to the fact that less fish oil added to the hens' diet resulted in a greater frequency of differences in the egg taste, because heating, moisture, and mechanical processing of the sample caused a more pronounced taste sensitivity. On the other hand, the addition of a larger quantity of fish oil to the hen diet affected a greater perception of differences in the egg smell caused by the fish oil. Such findings lead to a conclusion that the hen diet with an increased fish oil content has a greater influence on the egg smell sensitivity; yet, it decreases the effect of taste sensitivity.

Although the tasters did not find a significant difference between the experimental treatments, it is worth mentioning that the most frequently detected difference between the samples referred to the taste (almost 50% of all detected differences). Therefore, it is concluded that the differences between the experimental groups can be sensed more often only subsequent to a mechanical processing, moistening, and heating of the sample in the mouth.

Table 3. The frequency of detected differences in the sensory characteristics within the triangle test (%)

Tablica 3. Učestalost otkrivenih razlika u senzorskim svojstvima unutar triangl-testa (%)

Treatment pairs/ *Parovi tretmana*	**Sensory characteristic /** *Senzorska svojstva*			
	Color / *Boja*	**Smell /** *Miris*	**Taste /** *Okus*	**Texture /** *Tekstura*
K : P1	25.45	18.18	38.18	18.18
K : P2	27.87	22.95	32.79	16.39
P1 : P2	19.15	19.15	46.81	14.89

K = 5 % soybean oil; P1 = 1.5 % fish oil + 3.5 % linseed oil, P2 = 2 % fish oil + 3% linseed oil/
K=5 % sojina ulje, P1=1,5 % ribljega ulja + 3,5 % lanenoga ulja, P2 = 2 % ribljega ulja + 3 % lanenoga ulja

Table 4 shows the main statistical indicators of egg likability obtained within the hedonic test. The data are presented in the form of average values and medians, and the coefficient of variation is expressed as a percentage. There is a slight decrease in the average liking of color and smell, related to the increased content of fish oil in hen diet. However, there is no change in the median, so the median of all treatments for both characteristics amounted to 7, which indicates a balanced liking of that characteristic between the treatments. Referring to the taste liking, there is a marked decrease in the average value, as well as in the median, from 7 in the K control over the median of 6 in the experimental group P–1 to the median of 5 in the experimental group P2. Such a decrease can be related to a possible unfavorable influence of dietary fish oil supplementation on the taste liking of eggs. Furthermore, the coefficient of variation increased along with the increased amount of supplemented fish oil, approaching the border values of the scale (i.e., the values closer to 0 and 9). The highest values of the coefficient of variation were determined for the taste liking, being 46.97 % in the P2 group, which suggests the great differences between the tasters' grading.

Table 4. The main statistical indicators of sensory characteristics of eggs within the hedonic test

Tablica 4. Glavni statistički pokazatelji senzorskih svojstava jaja unutar hedonističkoga testa

Treatment/ *Tretman*	**Color liking /** *Dopadljivost boje*		
		Med.	Vk, %
K	7.23	7	19.10
P1	6.96	7	26.07
P2	6.67	7	26.83
	Smell liking / *Dopadljivost mirisa*		
		Med.	Vk, %
K	6.94	7	23.07
P1	6.54	7	27.34
P2	6.29	7	31.07
	Taste liking / *Dopadljivost okusa*		
		Med.	Vk, %
K	6.71	7	31.13
P1	5.69	6	40.20
P2	4.94	5	46.97

K=5 % soybean oil; P1=1.5 % fish oil + 3.5 % linseed oil, P2 = 2 % fish oil + 3 % linseed oil /

K=5 % sojina ulje, P1=1,5 % ribljega ulja + 3,5 % lanenoga ulja, P2 = 2 % ribljega ulja + 3 % lanenoga ulja; = mean / *srednja vrijednost*; Med=median / *medijan*; Vk= coefficient of variation / *koeficijent varijacije*

Table 5 and Figure 1 present the mean values and standard deviations of eggs' sensory characteristics obtained by the hedonic test. A statistical data analysis proved no significant differences ($P>0.05$) between the treatments referring to the color and smell liking, although the average values decreased with an increase in the fish oil content. Taste liking differed statistically significantly between the treatments ($P<0.05$). It was determined that the taste liking of eggs from treatment K scored a statistically significantly higher value than the experimental treatments P1 and P2, respectively. The differences between the experimental treatments P1 and P2 were not established. The obtained results were in accordance with the results of the triangle test, which also determined significant differences between the pairs of control and experimental treatments, since the taste of the eggs was most often marked as a distinguishing sensory characteristic. Gonzalez–Esquerra and Leeson (2000), Lawlor et al. (2010) as well as Škrtić et al. (2007) also reported the occurrence of fishy smell and taste of eggs that contained a higher concentration of n–3 PUFA. As noted by the tasters performing the triangle test, the most common difference between the treatments was sensed in the taste, color, and smell of eggs, and the least difference was noted concerning the egg texture. The aforementioned authors also determined that the content of oil in the feeding mixtures (1.5% in P1; 2% in P2) had the greatest effect on the egg smell. Schreiner et al. (2004), and Carrillo–Dominguez et al. (2005) also pointed out that there was a connection between the occurrence of undesirable sensory characteristics of eggs and the amount of fish oil added to the laying hens' feed.

Table 5. The mean values and standard deviations of treatments with respect to the liking of some sensory characteristics of eggs

Tablica 5. Srednje vrijednosti i standardne devijacije tretmana s obzirom na dopadljivost nekih senzorskih svojstava jaja

Characteristic/ *Svojstvo*	**Treatment /** *Tretman*		
	K	**P1**	**P2**
Color liking / *Dopadljivost boje*	7.23 ± 1.38	6.96 ± 1.81	6.67 ± 1.79
Smell liking / *Dopadljivost mirisa*	6.94 ± 1.60	6.54 ± 1.79	6.29 ± 1.95
Taste liking / *Dopadljivost okusa*	6.71 ± 2.09[a]	5.69 ± 2.29[b]	4.94 ± 2.32[b]

K = 5% soybean oil; P1 = 1.5 % fish oil + 3.5 % linseed oil, P2 = 2 % fish oil + 3 % linseed oil / *K=5 % sojina ulje, P1=1,5 % ribljega ulja + 3,5 % lanenoga ulja, P2 = 2 % ribljega ulja + 3 % lanenoga ulja;*

The mean values in the rows labelled with a superscript [a,b] differ significantly at $P<0.05$/ *Srednje vrijednosti u redovima označene eksponentom [a,b] značajno se razlikuju pri P<0,05.*

However, some researchers, such as that by Cloughley et al. (1997), Marshall et al. (1994), and Yalcin et al. (2017), argued that the addition of fish oil to the laying hens' feed up to 1.5% resulted in the satisfactory sensory characteristics of eggs. Petrović et al. (2016) stated that the supplementation of linseed oil to laying hens' feed in the amount of 1% to 4% had no adverse effects on the sensory characteristics of eggs, which was also confirmed by Scheideler et al. (1997) and Mazalli et al. (2004).

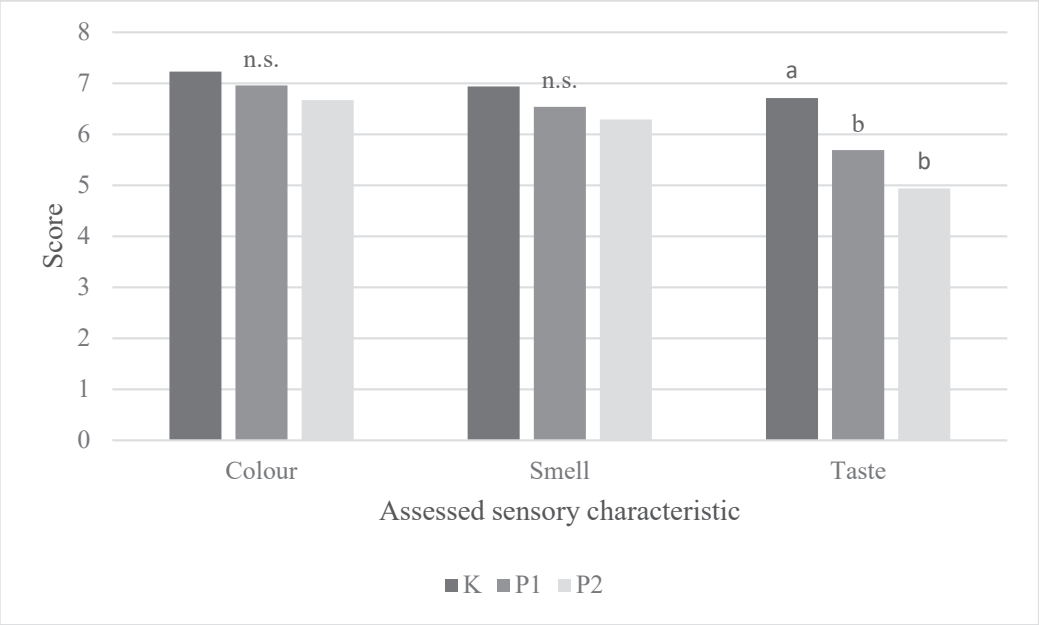

Figure 1. The mean values of sensory characteristics of eggs obtained by a hedonic test.

Grafikon 1. Srednje vrijednosti senzorskih svojstava jaja dobivene hedonističkim testom.

The authors analyzed the color, taste, smell, texture, and general likeability of eggs, which is partially aligned with the analysis of sensory characteristics of eggs researched in this study. According to Škrtić et al. (2007), a combination of fish and linseed oils, as well as of fish and rapeseed oils, affected the assessment of general likeability of eggs. The influence of fish oil added to the laying hens' feed on the occurrence of undesirable sensory characteristics of eggs is explained by the initiated oxidative processes that is, by the creation of products that cause a rancid taste and fishy smell of eggs. Referring to the sensory assessment of eggs, the results obtained in our research can be compared with the results published by the cited authors only in the parts referring to the acceptability of lower amounts of fish oil supplemented to the laying hens' feed.

CONCLUSION

A sensory analysis of eggs (color, smell, taste, and texture) performed within the triangle test proved a statistically significant difference between the pairs of treatments K : P1 and K : P2. The most frequently detected difference between the pairs of treatments was in the egg taste, then in color and smell, while the least difference between the pairs was sensed in the egg texture. Within the hedonic test, the eggs of the K treatment scored a statistically significantly higher value for the taste liking than the treatments P1 and P2 ($P<0.05$).

Referring to the triangle test results, it is concluded that the fish oil supplemented to the laying hens' feed affects the sensory characteristics of eggs. Such an influence mostly refers to the change in the egg taste, which causes a statistically significant decrease of the egg taste liking. Further research will be focused on the assessment of consumers' readiness to buy such enriched eggs if they are preformed about the benefits of their consumption.

ACKNOWLEDGEMENT

This research is supported by the European Structural and Investment Funds within the grant KK.01.1.1.01.0010, awarded for the Croatian National Scientific Center of Excellence for Personalized Health Care.

REFERENCES

1. Carrillo–Dominguez, S., Carranco–Jauregui, M.E., Castillo–Dominguez, R.M., Castro–Gonzalez, M.I., Avila–Gonzalez, E., & Perez–Gil, F. (2005). Cholesterol and n–3 and n–6 fatty acid content in eggs from laying hens fed with red crab meal (*Pleuroncodes planipes*). *Poult. Sci., 84*(1), 167–172. https://doi.org/10.1093/ps/84.1.167
2. Cloughley, J., Noble, R., Speake, B., & Sparks, N. (1997). Manipulation of docosahexaenoic (22:6 n–3) acid in chicken's egg. *PLEFA*, *57*(2), 222. https://doi.org/10.1016/S0952–3278(97)90155–1
3. Feng, J., Long, S., Zhang, H.J., Wu, S.G., Qi, G.H., & Wang, J. (2020). Comparative effects of dietary microalgae oil and fish oil on fatty acid composition and sensory quality of table eggs. *Poult. Sci., 99*(3), 1734–1743. https://doi.org/10.1016/j.psj.2019.11.005
4. Fraeye, I., Bruneel, C., Lemahieu, C., Buyse, J., Muylaert, K., & Foubert, I. (2012). Dietary enrichment of eggs with omega–3 fatty acids: A review. *Food Res. Int., 48*(2), 961–969. https://doi.org/10.1016/j.foodres.2012.03.014
5. Friganović, E., Čalić, S., Maleš, V., & Mustapić, A. (2011). Funkcionalna hrana i potrošači. *Praktični menadžment: stručni* časopis *za teoriju i praksu menadžmenta, 2*(1), 51–57.

6. Gonzalez–Esquerra, R., & Leeson, S. (2000.). Effect of feeding hens regular or deodorized menhaden oil on production parameters, yolk fatty acid profile, and sensory quality of eggs. *Poult. Sci., 79*(11), 1597–602. https://doi.org/10.1093/ps/79.11.1597

7. Hayat, Z., Cherian, G., Pasha, T.N., Khattak, F.M., & Jabbar, M.A. (2010). Oxidative stability and lipid components of eggs from flax–fed hens: effect of dietary antioxidants and storage. *Poult. Sci., 89*(6), 1285–1292. https://doi.org/10.3382/ps.2009–00256

8. Kartikasari, L.R., Geier, M.S., Hughes, R.J., Bastian, S.E.P., & Gibson, R.A. (2021). Omega–3 fatty acid levels and sensory quality of eggs following consumption of alpha–linolenic acid enriched diets. *Food Res., 5*: 57–64. https://doi.org/10.26656/fr.2017.5(S2).010

9. Lawlor, J.B., Gaudette, N., Dickson, T., & House, J.D. (2010). Fatty acid profile and sensory characteristics of table eggs from laying hens fed diets containing microencapsulated fish oil. *Anim. Feed Sci. Technol., 156*(3–4), 97–103. https://doi.org/10.1016/j.anifeedsci.2010.01.003

10. Marshall, A.C., Kubena ,K.S., Hinton, K.R., Hargis, P.S., & Van Elswyk, M.E. (1994). n–3 fatty acid enriched table eggs: A survey of consumer acceptability. *Poult. Sci., 73*(8), 1334–1340. https://doi.org/10.3382/ps.0731334

11. Mazalli, M. R., Faria, D.E, Salvador, D., & Ito, D.T. (2004). A comparison of the feeding value of different sources of fat for laying hens: 2. Lipid, cholesterol, and vitamin E profiles of egg yolk. *JAPR, 13*(2), 280–290. https://doi.org/10.1093/japr/13.2.280

12. Parpinello, G. P., Meluzzi, A., Sirri, F., Tallarico, N., & Versari, A. (2006). Sensory evaluation of egg products and eggs laid from hens fed diets with different fatty acid composition and supplemented with antioxidants. *Food Res. Int., 39*(1), 47–52. https://doi.org/10.1016/j.foodres.2005.05.010

13. Petrović, M., Karačić, V., Mazija, H., Vahčić, N., & Medić, H. (2016). Stability and sensory evaluation of eggs produced by addition of different amount of linseed oil into feed. *HDPBN, 11*(1–2), 41–48.

14. Scheideler, S.E., Froning, G., & Cuppett, S. (1997). Studies of consumer acceptance of high omega–3 fatty acid–enriched eggs. *JAPR, 6*(2), 137–146. https://doi.org/10.1093/japr/6.2.137

15. Schreiner, M., Hulan, H.W., Razzazi–Fazeli, E., Böhm, J., & Iben, C. (2004). Feeding laying hens seal blubber oil: effects on egg yolk incorporation, stereospecific distribution of omega–3 fatty acids, and sensory aspects. *Poult. Sci., 83*(3), 462–473. https://doi.org/10.1093/ps/83.3.462

16. Sedoski, H.D., Beamer, S.K., Jaczynski, J., Partington, S.N., & Matak, K.E. (2012). Sensory evaluation and quality indicators of nutritionally–enhanced egg product with ω–3 rich oils. *Lwt – Food Science and Technology, 47*(2), 459–464. https://doi.org/10.1016/j.lwt.2012.02.006

17. Singh, V.P., Sachan, N., & Singh, R. (2010). Egg as a nutraceutical. *Hind Poultry, 9*: 15–18.

18. Škrtić, Z., Kralik, G., Gajčević, Z., Hanžek, D., & Bogut, I. (2008). Effect of different source of oils on fatty acid profile and organoleptic traits of eggs. *Acta Agric Slov, 92*, 129–134.

19. Yalcin, H. (2017). Supplemental fish oil and its impact on n–3 fatty acids in eggs. In P. Hester (Ed.), Egg Innovation and Strategies for Improvement (pp.373–381). London, UK: Elsevier Inc. Oxford/Amsterdam. https://doi.org/10.1016/B978–0–12–800879–9.00035–4

SENZORSKA SVOJSTVA JAJA OBOGAĆENIH RIBLJIM I LANENIM ULJEM

SAŽETAK

Ovo istraživanje proučava utjecaj ribljega i lanenog ulja dodanog u hranu kokoši nesilica na senzorske karakteristike konzumnih jaja. Pokus je proveden na 480 kokoši nesilica TETRA SL hibrida, koje su bile podijeljene u tri skupine (K: 5 % sojina ulja, P1: 1,5 % ribljega ulja i 3,5 % lanenoga ulja, P2: 2 % ribljega ulja i 3 % lanenoga ulja). Senzorska analiza jaja obuhvaćala je procjenu boje, mirisa, okusa i teksture jaja, a proveo ju je panel kušača (n=52) koji je koristio triangl i hedonistički test. Panel je utvrdio da postoji značajna razlika (P<0,05) u okusu jaja između parova tretmana K : P1 i K : P2, ali nema značajne razlike između para tretmana P1 : P2. Najčešće uočena razlika između parova tretmana odnosila se na okus, zatim na boju i miris, no razlika u teksturi jaja između parova nije bila toliko izražena. Povećana količina ribljega ulja u hrani za kokoši povećala je osjetilnu percepciju mirisa jaja, a smanjila osjetilnu percepciju okusa. Dopadljivost okusa jaja značajno se razlikovala između tretmana (P<0,05). Što se tiče senzorskih svojstava dopadljivosti boje i mirisa jaja, nisu utvrđene značajne razlike (P>0,05) između tretmana.

Ključne riječi: jaja, senzorska svojstva, riblje ulje, laneno ulje

(Received on July 3, 2023; accepted on February 2, 2024 – *Primljeno 3. lipnja 2023.; prihvaćeno 2. veljače 2024.)*