OPEN ACCESS Potravinarstvo Slovak Journal of Food Sciences

potravinárstvo® Slovak Journal of Food Sciences

Potravinarstvo Slovak Journal of Food Sciences
vol. 11, 2017, no. 1, p. 145-150
doi: https://dx.doi.org/10.5219/753
Received: 13 February 2017. Accepted: 15 March 2017.
Available online: 22 March 2017 at www.potravinarstvo.com

ISSN 1337-0960 (online)

THE EFFECT OF FEEDING WHEAT VARIETIES WITH DIFFERENT GRAIN PIGMENTATION ON GROWTH PERFORMANCE, TEXTURE, COLOUR AND MEAT SENSORY TRAITS OF BROILER CHICKENS

Ondřej Šťastník, Filip Karásek, Miroslav Jůzl, Eva Mrkvicová, Leoš Pavlata, Šárka Nedomová, Václav Trojan, Tomáš Vyhnánek, Petr Doležal, Petr Martinek

ABSTRACT

The feeding effect of of three spring wheat genotypes (Vánek, Konini and UC66049) with different grain colour on growth performance, body composition and meat quality parameters of broiler chickens was tested. Ninety chickens were divided into three groups (control, Konini and UC) with 30 chickens in each. The tested genotypes were compares with standard variety Vánek (control) with common (red) grain colour. The two experimental groups received feed mixtures containing 38.2% of wheats with different grain colour: groups Konini (n = 30) and UC (n = 30) with. The third group (n = 30) had 38.2% of common wheat Vánek cultivar (Control group). The live weight of chickens between the experimental groups and control group was not significant different, as well as body composition and chemical analysis of breast and thigh meat of chickens. The feeding of wheat with different grain colour had no effect on performance parameters of broiler chickens. Breast meat tenderness according to the Razor Blade Shear Force was higher in control group against experimental groups. The colour change was not significantly different in all coordinates. pH values (measured after 1-hour *post mortem*) were found significantly higher in the group fattening with Konini wheat than control and UC groups. Chickens meat from the experimental group was characterised by steady overall quality. The effect of various feeding had no effect on meat quality in terms of relevance to consumers.

Keywords: blue aleurone; purple pericarp; poultry nutrition; growth; meat quality

INTRODUCTION

The large scale of phenolic compounds in wheat grain contains simple molecules such as phenolic acids to highly polymerised compounds such as tannins and proanthocyanidins **(Yang et al., 2009)**. The polyphenols possess a number of beneficial properties and its antioxidant effect is very important. The antioxidant compounds have already been identified as phenolic acids, derivatives of stilbene, flavan-3-ols (catechin and epicatechin), flavonols and anthocyanidins **(Caillet et al., 2006)**. Positive effects of phenolic compounds used in small doses in animal diet observed which can act as health promoters rather than inhibitors **(Starčević et al., 2015)**.

The purple colour of wheat grains is caused by anthocyanins accumulated in the pericarp, while the blue colour is generated by anthocyanins in the aleurone layer of the endosperm **(Zeven, 1991)**. Anthocyanins are the largest group of water soluble natural pigments that give red, violet, and blue colour to many fruits, vegetables and also in cereal grains. Anthocyanins have some beneficial health effects concerning oxidative damage, detoxification enzymes, and the immune system **(Choia et al., 2007; Prior and Wu, 2006)**.

The broiler chickens are the most popular among poultry species in the world, because of the simplicity of cooking. The chicken meat is considered to be a healthy food due to its relatively low fat, saturated fatty acid and cholesterol content **(Haščík et al., 2016; Starčević et al., 2015)**. The nutritional properties of poultry meat are highly valued **(Starčević et al., 2015)**.

The development of the food industry leads to the search for new raw materials with improved nutritional properties. The coloured grains of some cereals have potential in production of functional food with added health benefits **(Li et al., 2004; Garg et al., 2016)**. Testing of influence of different grain colour has been going for several years and the results have been published continuously **(Karasek et al., 2014; Stastnik et al., 2014; Mareš et al., 2015; Mrkvicová et al., 2016)**.

The effect of feeding wheat varieties with different grain colour on growth performance, texture, colour, and sensory traits of broiler chicken's meat was evaluated.

MATERIAL AND METHODOLOGY

Animals, nutrition and growth performance

The animal procedures were reviewed and approved by the Animal Care Committee of the Mendel University in Brno. The experiment was performed with 90 cockerels of Ross 308 hybrid. The conventional deep litter system with wood shavings was used. The trial was performed from day 12 to day 37 of chickens age. Room temperature and humidity were controlled according to requirement for actual age of chickens in **Aviagen Group (2014)**. Lighting system was 16 hours light and 8 hours dark. Cockerels were divided into three equal groups. The two experimental groups received feed mixtures containing 38.2% of wheats with different grain colour: groups Konini (n = 30) with Konini wheat cultivar and UC (n = 30) with UC66049 cultivar, respectively. The third group (n = 30) had 38.2% of common wheat Vánek cultivar (C). The rations were calculated according to the "*Recommended nutrient content in poultry diets and nutritive value of feeds for poultry*" **(Zelenka et al., 2007)**.

The basic chemical composition of used experimental wheats is presented in Table 1.

The total content of anthocyanins was measured according to **Varga et al. (2013**) and expressed as the cyanidin-3-glucoside. The experimental wheats Vánek, Konini and UC66049 contained 5.09, 7.90 and 47.63 $mg.kg^{-1}$ cyanidin-3-glucoside, respectively.

The composition and nutrient content of diets are shown in Table 2 and Table 3, respectively.

The chickens were fed *ad-libitum*. Health status was evaluated daily and live weight measured every week during the trial.

At the end of the experiment fifteen birds were selected randomly from each group, weighed and slaughtered by decapitation. Feathers were removed and chickens were eviscerated. Carcass yield was calculated. Breast and thigh meats without skin were separated from carcasses after cooling. All visible external fat was removed from sample meats. The breast and thigh meat was weighed and their percentage of live body weight was calculated.

One half of breast (fillets) and muscles from one thigh were pack up in aluminium foil, marked and stored at -20 °C until sensory analyses. Another half of breast and deboned thigh meat were milled (Moulinex Moulinette; France). Dry matter content of meat was determined by a method with sea sand and the total nitrogen according to Kjeldahl using OPSIS Liquid Line (KjelROC Analyser; KD 310-A-1015; Sweden). The crude protein content was calculated using the factor 6.0 (N*6) pertinent to meat. The content of ether extract was determined gravimetrically after extraction with diethylether under reflux for 6 hours.

Table 1 Chemical composition of used experimental wheats in dry matter.

	Vánek (C)	Konini	UC66049
Gross energy ($MJ.kg^{-1}$)	17.61	17.85	17.72
Crude protein (%)	13.43	15.64	18.54
Ether extract (%)	1.52	1.37	1.41
Crude fibre (%)	2.72	2.67	2.58
Ash (%)	1.39	2.07	2.19

Table 2 Composition of diets ($g.kg^{-1}$).

Component	C	Konini	UC
Wheat	382	382	382
Maize	247	255.5	272.5
Soybean extruded	190	190	190
Soybean meal	105	102	94.5
Premix*	30	30	30
Rapeseed oil	20	20	20
Wheat gluten	15	9.5	0.0
Monocalciumphosphate	7	7	7
$CaCO_3$	4	4	4

Note: * Premix contains (per kg): lysine 60 g; methionine 75 g; threonine 34 g; calcium 200 g; phosphorus 65 g; sodium 42 g; copper 500 mg; iron 2,500 mg; zinc 3,400 mg; manganese 4,000 mg; cobalt 7 mg; iodine 30 mg; selenium 6 mg; tocopherol 450,000 mg; calciferol 166,700 international unit (IU); phylloquinone 50 mg; thiamine 140 mg; riboflavin 230 mg; cobalamin 1,000 mg; biotin 7 mg; niaciamid 1,200 mg; folic acid 57 mg, calcium pantothenate 450 mg; choline chloride 6,000 mg; salinomycin sodium 2,333 mg.

Table 3 Nutrients content of diets in dry matter.

	C	Konini	UC
AME ($MJ.kg^{-1}$) *	12.81	12.83	12.87
Crude protein (%)	21.29	21.46	21.63
Ether extract (%)	8.09	8.25	8.15
Crude fibre (%)	3.27	3.14	3.03
Ash (%)	5.89	6.20	6.33

Note: * Apparent Metabolisable Energy, calculated value.

Texture, colour and pH of meat

The tenderness of the fillets was determined through the application of the Meullenet-Owens razor shear (MORS) test, using a texture analyser (Model TA-XT2Plus, Texture Technologies, Scarsdale, N.Y., U.S.A.) as described by **Meullenet et al. (2004)** and **Cavitt et al. (2005)** during which Razor Blade Shear Force (N) and Razor Shear Energy ($N.mm^{-1}$) were recorded. Tests using the MORS blade are conducted on whole intact right fillets with 5 replicates. The sharp blade was replaced every 80 measurements for optimum shearing performance. Test Settings: test speed 10 $mm.s^{-1}$ and distance 20 mm.

Colour measurement was performed by CIE L*a*b* colour space. L* (lightness), a* (redness) and b* (yellowness) values from the breast meat sample surface on the dorsal side were measured using a Spectrophotometer CM-3500d (Konica Minolta Sensing Inc., Japan) in SCE mode (specular component excluded), angle 8 °, 8 mm slot. Each sample was measured at three places 1-hour *post-mortem.* Average value was taken as the final result. ΔE*ab **(CIE, 2007)** was calculated according next formulas **(Valous et al., 2009)**:

$$\Delta L* = L*_{control} - L*_{group}$$

$$\Delta a* = a*_{control} - a*_{group}$$

$$\Delta b* = b*_{control} - b*_{group}$$

The samples were measured using pH meter Portavo 907 Multi (Knick Elektronische Messgeräte GmbH & Co. KG, Berlin, Germany) with a needle-type electrode (SE104N; Knick Elektronische Messgeräte GmbH & Co. KG, Berlin, Germany) immediately (initial pH, abbreviation pH_1) after chicken´s slaughter and 1-hour *post-mortem* (abbreviation pH_2).

Sensory analysis

Sensory analyses of breast and thigh meat samples were evaluated by 10 panellists in special sensory laboratory (Department of Food Technology, Mendel University) according ISO 8589. Each sample (breast and thigh) was packed into plastic case and frozen (-18 °C). These samples were thawed (cold storage room, 4 °C) and boiled in convection oven (200 °C, 60% humidity, 1 hour). Professional evaluation group was represented by a panel of trained panellists under ISO 8586-1. We used a graphic non-structured scale (100 mm) to compare experimental group of descriptors (odour, colour, fibriness, chewiness, juiciness, flavour, fatty taste) with control group.

Statistical analysis

Data were processed by Microsoft Excel (USA) and Statistica version 12.0 (CZ). One-way analysis (ANOVA) was used. To ensure evidential differences Scheffe´s test was applied and $p < 0.05$ was regarded as statistically significant difference.

Experiments and analyses were performed in new Biotechnology Pavilion M at Mendel University which was built in the frame of OP VaVpI CZ.1.05/4.1.00/04.0135 project.

RESULTS AND DISCUSSION

Grow performance and body composition

The mean live weight of chickens was not different among groups at the end of experiment (Table 4). The differences between the experimental groups and control group was not significant ($p > 0.05$). Also, it was found feed conversion ratio (FCR) in amount 1.68 $kg.kg^{-1}$, 2.00 $kg.kg^{-1}$ and 1.76 $kg.kg^{-1}$ per group for Vánek, Konini and UC, respectively. Our findings confirm studies of **Pop et al. (2015)** and **Lichovnikova et al. (2015)** who fed grape

Table 4 Live weight (g) of broilers at 37th day of age.

Group	n	Mean ±standard error
C	30	2,255 ±20.55
Konini	30	2,193 ±44.14
UC	30	2,232 ±47.49

Note: Differences between the groups are not significant ($p > 0.05$).

Table 5 Body composition (%) of chickens.

Group	n	Carcass %	Breast meat %	Thigh meat %
		Mean ±standard error		
C	15	71.42 ±0.963	21.38 ±0.628	14.84 ±0.325
Konini	15	70.64 ±0.456	21.30 ±0.296	15.11 ±0.279
UC	15	71.49 ±0.991	21.35 ±0.507	14.90 ±0.398

Note: Differences between the groups are not significant ($p > 0.05$).

Table 6 Chemical analysis of breast and thigh meat (%) of broilers chickens.

		n	C	Konini	UC
			Mean ±standard error		
Dry matter	Breast meat	6	23.97 ±0.624	24.04 ±0.383	24.15 ±0.297
	Thigh meat	6	24.62 ±0.373	23.62 ±0.257	23.64 ±0.265
Crude protein (N*6)	Breast meat	6	20.94 ±0.765	21.80 ±0.189	21.77 ±0.184
	Thigh meat	6	18.68 ±0.194	18.51 ±0.317	18.57 ±0.180
Ether extract	Breast meat	6	1.24 ±0.190	1.34 ±0.078	1.24 ±0.133
	Thigh meat	6	4.17 ±0.255	4.18 ±0.385	3.70 ±0.255

Note: Differences between the groups are not significant ($p > 0.05$).

Table 7 Effect of feeding wheat varieties with different grain pigmentation on texture, pH and colour of breast meat (means ±standard error).

Parameter	n	C	Konini	UC
Razor Shear Force (N)	30	11.23 ±0.470^{b}	9.91 ±0.274^{a}	8.80 ±0.335^{a}
Razor Shear Energy (N.mm^{-1})	30	104.46 ±3.898^{b}	96.94 ±2.626^{ab}	87.69 ±2.553^{a}
L*	12	60.89 ±1.406^{a}	61.47 ±0.772^{a}	63.46 ±0.715^{a}
a*	12	3.52 ±0.646^{a}	2.63 ±0.519^{a}	3.37 ±0.332^{a}
b*	12	9.70 ± 1.388^{a}	9.39 ±0.913^{a}	10.42 ±0.343^{a}
C*	12	10.40 ±1.478^{a}	9.82 ±0.985^{a}	10.98 ±0.404^{a}
h^0	12	74.31 ±4.345^{a}	77.45 ±2.938^{a}	72.36 ±1.320^{a}
ΔE^*_{ab}		0.00	1.11	2.67
pH_1	6	6.40 ±0.072^{a}	6.52 ±0.121^{a}	6.44 ±0.054^{a}
pH_2	6	6.15 ±0.073^{a}	6.40 ±0.053^{b}	6.11 ±0.045^{a}

Note: pH_1 values were measured just after slaughter in breast, likewise pH_2 values were measured after 1-hour post mortem. ΔE^*_{ab} is compared with control group. ^{a,b} Means in a row within effect with no common superscript differ significantly (p <0.05).

pomace containing polyphenols. These diets had no effect on the growth of broiler chickens. On the other hand, **Ruckschloss et al. (2010)** observed in their experiment with wheat with purple colour of grain higher average live weight of laying hens for experimental group. Hens in the experimental group laid larger eggs in comparison with control group and the colour of yolk was not influenced by purple wheat feeding.

The Table 5 showed percentage of body composition of chickens. There were non-significant (p >0.05) differences in carcass yield.

The chemical analyses of breast and thigh meats are shown in Table 6. Differences between groups are not significant (p >0.05).

Texture, colour and pH of meat

The Razor Blade Shear Force results (n = 30) are presented in Table 7. There were significantly (p <0.05) higher breast meat tenderness in control group against Konini and UC group.

The colour change is not significant in all parameters (lightness L*, a* and b*) as it is shown in Table 7. There were found no significant differences (p >0.05) among all three groups. The total colour change (ΔE*ab from 1.11 to 2.67) is clearly perceptible but not yet discordant and it is acceptable for consumers **(Saláková, 2012)**.

The pH values from control and both experimental groups are shown in Table 7. Initial pH_1 was not significant (p >0.05) in all three group. pH_2 values were measured after 1-hour *post mortem*. The significantly higher (p <0.05) pH_2 value was in the Konini group in comparison with Vánek and UC groups. Differences were not observed between Vánek and UC groups.

There are no published studies on the effect of feeding wheat varieties with different grain pigmentation on

Table 8 Sensory analysis of breast meat of chickens (mm in 100 mm scale).

Group		C	Konini	UC
		Mean ±standard error		
Sensory trait	n	60	60	60
Odour		63.97 ±2.746^{a}	73.77 ±1.527^{b}	69.50 ±1.224^{ab}
Colour		73.18 ±1.450^{a}	76.02 ±1.427^{a}	72.82 ±1.758^{a}
Fibriness		55.18 ±2.615^{a}	52.15 ±1.970^{a}	52.95 ±1.760^{a}
Chewiness		62.75 ±2.513^{b}	48.43 ±2.501^{a}	52.67 ±2.213^{ab}
Juiciness		51.22 ±2.766^{a}	45.23 ±2.340^{a}	48.95 ±2.546^{a}
Flavour		74.00 ±1.499^{a}	71.53 ±2.218^{a}	71.37 ±1.700^{a}
Fatty taste		78.77 ±2.091^{a}	83.70 ±0.920^{a}	82.63 ±1.453^{a}

Note: ^{a,b} – different letters on one line – statistically significant differences (p <0.05).

Table 9 Sensory analysis of broilers thigh meat (mm in 100 mm scale).

Group		C	Konini	UC
		Mean ±standard error		
Sensory trait	n	60	60	60
Odour		70.98 ±1.941^{a}	73.55 ±1.763^{a}	72.10 ±1.678^{a}
Colour		50.08 ±1.190^{b}	57.03 ±2.148^{a}	63.28 ±2.101^{a}
Fibriness		56.67 ±1.393^{a}	61.92 ±1.721^{b}	61.43 ±1.194^{ab}
Chewiness		64.83 ±1.588^{b}	57.88 ±1.528^{a}	59.65 ±1.968^{ab}
Juiciness		66.90 ±1.965^{a}	64.62 ±1.744^{a}	60.82 ±2.058^{a}
Flavour		74.25 ±1.871^{a}	69.77 ±2.240^{a}	67.65 ±2.297^{a}
Fatty taste		76.35 ±2.560^{a}	79.37 ±1.870^{a}	77.35 ±2.532^{a}

Note: ^{a,b} – different letters on one line – statistically significant differences (p <0.05).

texture, colour and pH of meat or sensory analysis to compare to these findings. However, it has been reported that grape seed pomace or extracts, milk thistle seed cakes or extracts (contained, inter alia, polyphenols) added to ground poultry feed mixture have caused variable alterations in colour parameters and sensory evaluation **(Kasapidou et al., 2016; Šťastník et al., 2016)**. In **Kasapidou et al., (2016)** study differences in meat colour lightness and yellowness or sensory attributes in broilers breast meat were not observed.

Although, there was no significant difference in the results, it is positive tendency to consumer perception. Consumers have a clear preference for lighter coloured, poultry breast meat compared to darker thigh/thigh meat **(Wideman et al., 2016)**.

Sensory analysis

The significantly (p <0.05) more intense odour of breast meat was found in the Konini group against control group. Significantly better chewiness of breast meat was in Konini than control group confirms the results of the Razor Shear Force and Razor Shear Energy.

According to sensory analysis thigh meat had significantly (p <0.05) more intense colour in experimental groups. The control group had significantly lowest rating for this parameter. The Konini group was significantly (p <0.05) more evaluated for thigh meat fibriness parameter compared to control. The thigh meat was significantly (p <0.05) better for chewiness parameter in Konini group versus control group, like as the breast meat.

CONCLUSION

The feeding of wheat with different grain colour had no effect on performance parameters of broiler chickens. The chemical composition of breast and thigh meat was balanced among all three groups. The higher breast meat tenderness was found in control group than in experimental groups according to the Razor Blade Shear Force results. The color change did not significantly differ in all coordinates. In the pH2 (measured after 1-hour post mortem) there was found significantly higher (p <0.05) value in the Konini group than C and UC groups. The effect of various feeding had no effect on meat quality in terms of relevance to consumers.

REFERENCES

Aviagen Group, 2014. Technological procedure for broiler Ross [online] Aviagen Group 2014 [cit. 2017-01-02] Available at: http://en.aviagen.com/ross-308.

Caillet, S., Salmieri, S., Lacroix M. 2006. Evaluation of free radical scavenging properties of commercial grape phenol extracts by a fast colorimetric method. *Food Chemistry*, vol. 95, no. 1, p. 1-8. https://doi.org/10.1016/j.foodchem.2004.12.011

Cavitt, L. C., Meullenet, J. F., Xiong, R., Owens, C. M. 2005. The relationship of razor blade shear, Allo-Kramer shear, Warner-Bratzler shear and sensory tests to changes in tenderness of broiler breast fillets. *Journal of Meat Foods*, vol. 16, no. 3, p. 223-242. https://doi.org/10.1111/j.1745-4573.2005.00001.x

CIE. 2007. *Colorimetry, part 4: CIE 1976 L*a*b* Colour space. CIE Central Bureau, Vienna, CIE DS 014-4.3/E:2007*.

Garg, M., Chawla, M., Chunduri, V., Kumar, R., Sharma, S., Sharma, N. K., Kaur, N., Kumar, A., Mundey, J. K., Saini, M. K., Singh, S. P. 2016. Transfer of grain colors to elite wheat cultivars and their characterization. *Journal of Cereal Science*, vol. 71, no. 1, p. 138-144. https://doi.org/10.1016/j.jcs.2016.08.004

Haščík, P., Trembecká, L., Bobko, M., Kačániová, M., Čuboň, J., Kunová, S., Bučko, O. 2016. Effect of diet supplemented with propolis extract and probiotic additives on performance, carcass characteristics and meat composition of broiler chickens. *Potravinarstvo*, vol. 10, no. 1, p. 223-231. https://doi.org/10.5219/581

Choia, Y., Jeonga, H., Lee, J. 2007. Antioxidant activity of methanolic extracts from some grains consumed in Korea. *Food Chemistry*, vol. 103, no. 1, p. 130-138. https://doi.org/10.1016/j.foodchem.2006.08.004

ISO 8586-1. 2015. *Sensory analysis – General guidelines for the selection, training and monitoring of selected assessors and expert sensory assessors (in Czech)*.

Karasek, F., Mrkvicova, E., Stastnik, O., Trojan, V., Hrivna, L., Mrazkova, E. 2014. The influence of colored wheat Konini feeding on antioxidant activity parameters in rats. In *Proceeding of the International PhD Student Conference MendelNet 2014*. Brno : Mendel University in Brno, pp. 160-162.

Kasapidou, E., Sossidou, E. N., Zdragas, A., Papadaki, C., Vafeas, G., Mitlianga, P. 2016. Effect of grape pomace supplementation on broiler meat quality characteristics. *European Poultry Science*, vol. 80, no. 135, p. 1-12.

Li, W. D., Sun, S. C., Ren, G. X. 2004. Study on characteristic of black wheat and its exploitation and utilization. *China Condiment*, vol. 1, p. 9-11.

Lichovnikova, M., Kalhotka, L., Adam, V., Klejdus, B., Anderle, V. 2015. The effects of red grape pomace inclusion in grower diet on amino acid digestibility, intestinal microflora, and sera and liver antioxidant activity in broilers. *Turkish Journal of Veterinary and Animal Sciences*, vol. 39, no. 4, p. 406-412. https://doi.org/10.3906/vet-1403-64

Mareš, J., Brabec, T., Vyhnánek, T., Trojan, V., Štiasna, K., Presinszká, M., Mrkvicová, E., Hřivna, L., Havel, L. 2015. The effect of feeding wheat with purple pericarp on the growth of carp. *Potravinarstvo*, vol. 9, no. 1, p. 262-267.

Mrkvicová, E., Pavlata, L., Karásek, F., Šťastník, O., Doležalová, E., Trojan, V., Vyhnánek, T., Hřivna, L., Holeksová, V., Mareš, J., Brabec, T., Horký, P., Ruttkay-Nedecký, B., Adam, V., Kizek, R. 2016. The influence of feeding purple wheat with higher content of anthocyanins on antioxidant status and selected enzyme activity of animals. *Acta Veterinaria Brno*, vol. 85, no. 4, p. 371-376. https://doi.org/10.2754/avb201685040371

Meullenet, J. F., Jonville, E., Grezes, D., Owens, C. M. 2004. Prediction of the texture of cooked poultry pectoralis major meats by near-infrared reflectance analysis of raw meat. *Journal of Texture Studies*, vol. 35, no. 6, p. 573-585. https://doi.org/10.1111/j.1745-4603.2004.35510.x

Pop, I. M., Pascariu, S. M., Simeanu, D. 2015. The grape pomace influence on the broiler chickens growing rate. *Lucrări Ştiinţifice-Universitatea de Ştiinţe Agricole şi Medicină Veterinară, Seria Zootehnie*, vol. 64, no. 1, p. 34-39.

Prior, R. L., Wu, X. 2006. Anthocyanins: Structural characteristics that result in unique metabolic patterns and biological activities. *Free Radical Research*, vol. 40, no.10, p. 1014-1028. https://doi.org/10.1080/10715760600758522 PMid:17015246

Ruckschloss, Ľ., Matúšková, K., Hanková, A., Jančík, D. 2010. Influence of winter wheat with purple colour of the corn on laying hens` efficiency and eggs quality. *Potravinarstvo*, vol. 4, Special issue, February 2010, p. 231-235. Available at: http://www.potravinarstvo.com/dokumenty/mc_februar_2010/pdf/2/Ruckschloss.pdf

Saláková, A. 2012. Instrumental measurement of texture and color of meat and meat products. *Maso International Brno*, vol. 2, no. 2, p. 107-114.

Starčević, K., Krstulović, L., Brozić, D., Maurić, M., Stojević, Z., Mikulec, Ž., Bajić, M., Mašek, T. 2015. Production performance, meat composition and oxidative susceptibility in broiler chicken fed with different phenolic compounds. *Journal of the Science of Food and Agriculture*, vol. 95, no. 6, p. 1172-1178. https://doi.org/10.1002/jsfa.6805 PMid:24995966

Stastnik, O., Mrkvicova, E., Karasek, F., Trojan, V., Vyhnanek, T., Hrivna, L., Jakubcova, Z. 2014. The influence of colored wheat feeding on broiler chickens performance parameters. In *Proceeding of the International PhD Student Conference MendelNet 2014*. Brno: Mendel University in Brno, pp. 196-198.

Šťastník, O., Jůzl, M., Karásek, F., Štenclová, H., Nedomová, Š., Pavlata, L., Mrkvicová, E., Doležal, P., Jarošová, A. 2016. The effect of feeding milk thistle seed cakes on quality indicators of broiler chickens meat. *Potravinarstvo*, vol. 10, no. 1, p. 248-254. https://doi.org/10.5219/579

Valous, N. A., Mendoza, F., Sun, D. W., Allen, P. 2009. Colour calibration of a laboratory computer vision system for quality evaluation of pre-sliced hams. *Meat Science*, vol. 81, no. 1, p. 132-141. https://doi.org/10.1016/j.meatsci.2008.07.009 PMid:22063973

Varga, M., Bánhidy, J., Cseuz, L., Matuz, J. 2013. The anthocyanin content of blue and purple coloured wheat cultivars and their hybrid generations. *Cereal Research Communications*, vol. 41, no. 2, p. 284-292. https://doi.org/10.1556/CRC.41.2013.2.10

Wideman, N., O'Bryan, C. A., Crandall, P. G. 2016. Factors affecting poultry meat colour and consumer preferences - A review. *Worlds Poultry Science Journal*, vol. 72, no. 2, p. 353-366. https://doi.org/10.1017/S0043933916000015

Yang, M. Y., Peng, C. H., Chan, K. C., Yang, Y. S., Huang, C. N., Wang, C. J. 2009. The hypolipidemic effect of Hibiscus sabdariffa polyphenols via inhibiting lipogenesis and promoting hepatic lipid clearance. *Journal of agricultural and food chemistry*, vol. 58, no. 2, p. 850-859. https://doi.org/10.1021/jf903209w PMid:20017484

Zelenka, J., Heger, J., Zeman, L. 2007. *Recommended nutrient content in poultry diets and nutritive value of feeds for poultry (in Czech)*. Brno: MZLU. 77 p. ISBN 978-80-7375-091-6.

Zeven, A. C. 1991. Wheats with purple and blue grains: a review. *Euphytica*, vol. 56, no. 3, p. 243-258. https://doi.org/10.1007/BF00042371

Acknowledgments:

The research was financially supported by the project NAZV QJ1510206.

Contact address:

Ondřej Šťastník, Mendel University in Brno, Faculty of AgriSciences, Department of Animal Nutrition and Forage Production, Zemědělská 1, 613 00 Brno, Czech Republic, E-mail: ondrej.stastnik@mendelu.cz

Filip Karásek, Mendel University in Brno, Faculty of AgriSciences, Department of Animal Nutrition and Forage Production, Zemědělská 1, 613 00 Brno, Czech Republic, E-mail: karasek89@seznam.cz

Miroslav Jůzl, Mendel University in Brno, Faculty of AgriSciences, Department of Food Technology, Zemědělská 1, 613 00 Brno, Czech Republic, E-mail: miroslav.juzl@mendelu.cz

Eva Mrkvicová, Mendel University in Brno, Faculty of AgriSciences, Department of Animal Nutrition and Forage Production, Zemědělská 1, 613 00 Brno, Czech Republic, E-mail: eva.mrkvicova@mendelu.cz

Leoš Pavlata, Mendel University in Brno, Faculty of AgriSciences, Department of Animal Nutrition and Forage Production, Zemědělská 1, 613 00 Brno, Czech Republic, E-mail: leos.pavlata@mendelu.cz

Šárka Nedomová, Mendel University in Brno, Faculty of AgriSciences, Department of Food Technology, Zemědělská 1, 613 00 Brno, Czech Republic, E-mail: sarka.nedomova@mendelu.cz

Václav Trojan, Mendel University in Brno, Faculty of AgriSciences, Department of Plant Biology, Zemědělská 1, 613 00 Brno, Czech Republic, E-mail: vaclav.trojan@mendelu.cz

Tomáš Vyhnánek, Mendel University in Brno, Faculty of AgriSciences, Department of Plant Biology, Zemědělská 1, 613 00 Brno, Czech Republic, E-mail: tomas.vyhnanek@mendelu.cz

Petr Doležal, Mendel University in Brno, Faculty of AgriSciences, Department of Animal Nutrition and Forage Production, Zemědělská 1, 613 00 Brno, Czech Republic, E-mail: petr.dolezal@mendelu.cz

Petr Martinek, Agrotest fyto, s.r.o., Havlíčkova 2787/121, 767 01 Kroměříž, Czech Republic, E-mail: martinek@vukrom.cz