JMBFS
Journal of Microbiology, Biotechnology and Food Sciences
International peer-reviewed scientific online journal
Published by Faculty of Biotechnology and Food Sciences

EFFECT OF SUPPLEMENTAL RED GRAPE POMACE ON TECHNOLOGICAL PROPERTIES OF ROSS 308 BROILER CHICKENS MEAT

Matej Čech[*1], *Peter Haščík*[1], *Peter Herc*[1], *Juraj Čuboň*[1], *Lukáš Jurčaga*[1], *Andrea Mesárošová*[1], *Ondřej Bučko*[2], *Miroslav Kročko*[1]

Address(es): Matej Čech,
[1]Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Sciences, Institute of Food Sciences, Tr. Andreja Hlinku 2, 94976 Nitra, Slovakia.
[2]Slovak University of Agriculture in Nitra, Faculty of Agrobiology and Food Resources, Institute of Animal Husbandry, Tr. Andreja Hlinku 2, 949 76 Nitra, Slovakia.

*Corresponding author: xcech@uniag.sk

https://doi.org/10.55251/jmbfs.9915

ARTICLE INFO

Received 21. 2. 2023
Revised 20. 4. 2023
Accepted 3. 5. 2023
Published 1. 6. 2023

Regular article

OPEN ACCESS

ABSTRACT

The purpose of this study was to ascertain the effects of adding red grape pomace (RGP) of variety Alibernet to the diet of broiler chickens Ross 308 on the technological properties of their meat. 200 one-day Ross 308 broiler chicks of mixed gender were initially split into 4 groups at random (n = 50). The control group (Group C) did not get any extra supplements. The feed for experimental group E1 was enhanced with 1% RGP per 1 kg of feed mixture (FM), 2% RGP per 1 kg of FM in group E2, and 3% RGP per 1 kg of FM in group E3, respectively. The 42-day fattening period was conducted without the use of any coccidiostats or antibiotics in FMs. After slaughter and processing, chicken halves were tested for weight losses by cooling, freezing, respectively defreezing and cooking. Breast and thigh meat was subjected for analysis – pH of fresh meat 45 and 120 minutes *postmortem*, its color by CIEL*a*b* system and shear force after cooking. Based on the results, we can conclude that the addition of GPA negatively affected weight loss after freezing, as these were the lowest (P≤0.05) in the control group – 2.74% compared to groups E1 – 3.64 and E2 – 3.94%. Losses by cooling and baking were similar in all groups (P≥0.05). pH values in breast muscle were not significantly affected by selected feed supplement, what is in the contrary with pH of thigh muscle, where we detected significant differences after 45 and also 120 minutes *postmortem* (P≤0.05). The highest shear force (P≤0.05) was recorded in control group (breast – 4.40, thigh – 3.68 $kg.cm^{-2}$), while the lowest and therefore softest meat was found after application of 2% RGP (breast – 3.63, thigh – 2.52 $kg.cm^{-2}$). Color characteristics were the most influenced by selected feed supplement, as we did not detect significant differences (P≤0.05) only in L* of thigh meat. The highest differences were observed in a* and b* in both breast and thigh muscle (P≤0.05) – highest values were found in group with 3% of supplemental RGP (breast – -0.88 and 9.78, respectively; thigh – 4.09 and 13.42, respectively).

Keywords: feed supplements, meat colour, weight losses, pH, shear force

INTRODUCTION

The amount of meat produced worldwide is anticipated to increase by 1.4% in 2022 to reach 361 million tonnes (carcass weight equivalent), however at a slower rate than the 4.5% rise experienced in 2021. As expected, increases in the Americas, Asia, Africa, and Oceania are likely to be offset by declines anticipated in Europe. The world's output of poultry meat is predicted to reach 139 million tonnes in 2022, rising at a moderate rate of 0.8%. However, the war's commencement in late February 2022 caused exports of poultry meat from Ukraine to be disrupted, which increased market instability **(FAO, 2022)**.
Poultry consumption has been on the rise, thanks to two major reasons. In high-income countries, poultry meats are regarded as easier to cook, perceived as a healthier food option with a reduced risk of cardiovascular illnesses, and are less expensive in low-income developing nations than other meats **(Marangoni et al., 2015; Falkovskaya and Gowen, 2020; OECD-FAO Agricultural Outlook 2021–2030)**.
An increasing number of consumers are interested in poultry goods such as sausages, patties, and hamburgers because they are easy to prepare (ready to cook), handle, and store. Poultry meat is mainly the meat of domesticated birds such as turkey and chicken **(Kennedy et al., 2004; Barbut, 2012)**.
Because they are an affordable and reliable source of high-quality protein, broilers have been the most common type of poultry consumed worldwide. However, several buyers also desire various poultry types and their products **(U-chupaj et al., 2017)**.
It has been said that consumers' acceptance of cooked meat is most strongly influenced by texture **(Szczesniak et al., 1963)**. Meat texture can be judged using instrumental analysis, sensory evaluation, or a combination of the two. Although descriptive sensory analysis uses either a large group of untrained consumers or a panel of expert assessors, it directly represents human perception of the samples **(U-chupaj et al., 2017)**.
Meat from poultry is more perishable than meat from other animals, such beef or hogs. As a result, gauging freshness is crucial for ensuring the quality of the meat in chicken processing plants. A vital component of the contemporary chicken processing sector is high quality. The way that poultry meat is stored and prepared has a direct impact on its functional and sensory qualities. It is necessary to adopt meat quality control to enhance the functional and sensory qualities of meat samples, reduce financial losses, and increase the efficiency of the poultry business **(Lee et al., 2022)**.
Consumers are much more aware of certain meat attributes, such as color, texture (tenderness), and drip loss, which were formerly mostly inconsequential when most chickens were sold as whole carcasses, as a result of the dramatic growth in the consumption of processed goods **(Barbut et al., 2008)**. An increasing worry in the poultry business is pale, soft, and exudative meat (PSE), which relates to rapid breeding and high demand for chicken meat **(Woelfel et al., 2002)**. Paleness, low water holding capacity (WHC), and enhanced cook and drip loss are traits of chicken breast meat that resemble PSE **(Barbut et al., 2005)**. Higher lightness (L*) levels are apparently linked to lower muscle pH and WHC, which causes more cook and drip loss and less softness in the meat **(Qiao et al., 2001; Petracci et al., 2004)**.
Animals must be fed grains and soybean meal as their primary sources of energy and crude protein, respectively, to produce meat. Due to increased food competition, the reliance of monogastric animals on these feed crops has become problematic. Additionally, the agro-industrial sectors generate about 1.3 billion tons of processing waste and postharvest losses each year, which has significant negative effects on the environment, society, and the economy **(Kumar and Kalita, 2017)**. Although most of these agro-industrial byproducts are frequently underutilized, they have the potential to serve as a promising substitute feed ingredient for the partial replacement of maize-soybean in monogastric nutrition **(Alfaia et al., 2022)**.
In order to lower the cost of feeding monogastric animals with traditional crops (such maize and soybean meals) and enhance the quality of their meat, grape by-products may be included in their diet. Grape pomace, grape seed, grape seed oil, and grape skins are the principal grape by-products with the greatest global expression **(Alfaia et al., 2022)**.
Grape pomace is thought to make up 20–25% of the weight of the total grapes crushed for wine production **(Yu and Ahmedna, 2012; Romero et al., 2021)**. Even though they are used the least, grape stems are removed prior to winemaking and account for about 5% of wine by-products **(Ruiz-Moreno et al., 2015)**. Grape

seed oil is occasionally extracted from stem **(González-Centeno et al., 2013; Brenes et al., 2016)**. Even though grape by-products are environmentally unfriendly, they are a rich source of bioactive chemicals such polyphenols, which are well known for their anti-inflammatory, anticarcinogenic, cardioprotective, and vasodilatory effects. Due to the inclusion of oil-rich seeds, the protein content of GP is approximately 14% and the lipid content is 4% – 11% **(González-Centeno et al., 2013; Teixeira et al., 2014; Averilla et al., 2019)**.

Since 2006, feed antibiotics and other growth hormones were forbidden in livestock production. Thereafter, many authors began investigating effects of natural feed supplements in broiler chickens' production. Thanks to the rich composition of grape pomace, authors aimed at its effect on broiler chickens' meat performance **(Tekeli, RuStu Kutlu and Celik, 2014; Ebrahimzadeh et al., 2018; Kumanda, Mlambo and Mnisi, 2019; Turcu et al., 2020)**, meat quality **(Turcu et al., 2019; Bennato et al., 2020; Reyes et al., 2020)** or its storage stability **(Jurčaga et al., 2021)**. For example, **Aditya et al. (2018)** reported, that without negative effects on growth performance and carcass traits, the dietary grape pomace induced an improvement in meat quality.

In spite of our previous work and the abovementioned, the aim of this study was to explore if selected feed supplement (ARGP) has any effect on technological and sensory properties of broiler chicken meat.

MATERIAL AND METHODS

Fattening process

The experiment was carried out at the Test Poultry Station at the Slovak University of Agriculture (SUA) in Nitra. The animals were housed in the same conditions during the 42-day fattening period. 200 mixed-sex one-day-old chicks (Ross 308) were used in the experiment, and they were randomly assigned to 4 groups (each containing 50 chickens). One group of chicks' pen measured 3.2 x 2.4 meters. The broiler chicks were raised in a temperature-controlled environment on breed litter (wood shavings); the ambient temperature in the test poultry station was kept at 33 °C for the first week, then gradually dropped by 2 °C, before being set at 23 °C going forward. Controls were in place for the temperature and relative humidity. The chickens were maintained under a consistent light schedule and allowed unlimited access to water and feed (in the form of shreds) throughout the whole fattening phase.

In accordance with the required reference values (Bulletin of MARD SR, 2005), diets were created to meet the nutritional needs of broilers. The diets consisted of starter HYD-01 (1–21 days) and grower HYD-02 (22–42 days) diets. Table 1 lists the ingredients in basal diets. The starter and grower feed combinations were made by Biofeed, Inc. (Kolárovo, Slovak Republic) without the use of antibiotics or coccidiostatics. The experimental groups were set up as follows: the control group (C) consisted of a basal diet without supplements; the first experimental group of chickens (E1) received a basal diet plus 1%.100 kg^{-1} of RGP; the experimental group E2 received a complete FM plus 2%.100 kg^{-1} of RGP and the experimental group E3 received a complete FM plus 3%.100 kg^{-1} of RGP.

Table 1 Composition of FMs

Ingredients (%)	Starter (HYD-01) (1st – 21st day of age)	Grower (HYD-02) (22nd – 42nd day of age)
Wheat	34.50	30.00
Maize	28.00	39.00
Soybean meal (48% N)	31.00	26.00
Fodder lime	0.65	0.60
Calcium formate	0.80	0.80
Monocalcium phosphate	0.90	0.55
Fodder salt	0.20	0.20
Sodium bicarbonate	0.20	0.20
Lysine	0.10	0.05
Methionine	0.15	0.15
Soybean oil	3.00	1.95
Premix Euromix BR 0.5%*	0.50	0.50
Nutrient content ($g.kg^{-1}$)		
Linoleic acid	27.82	24.04
Fibre	28.71	27.84
Crude protein	209.68	189.60
Ash	45.45	39.59
Ca	8.12	7.27
P	6.04	5.13
Na	1.61	1.58
ME_N ($MJ.kg^{-1}$)	11.92	11.92

*active substances per kilogram of premix: vitamin A 2,500,000 IU; vitamin E 50,000 mg; vitamin D3 800,000 IU; niacin 12,000 mg; D-pantothenic acid 3,000 mg; riboflavin 1,800 mg; pyridoxine 1,200 mg; thiamine 600 mg; methadione 800 mg; ascorbic acid 50,000 mg; folic acid 400 mg; biotin 40 mg; cobalamin 10.0 mg; choline 100,000 mg; betaine 50,000 mg; Mn 20,000 mg; Zn 16,000 mg; Fe 14,000 mg; Cu 2,400 mg; Co 80 mg; I 200 mg; Se 50 mg.

Slaughter and measurements

At 42 days old, 20 mixed-sex chickens (10 of each sex) were chosen from each group based on average weight, weighed, and murdered at the Department of Technology and Quality of Animal Products' experimental slaughterhouse (SUA, Nitra). The chickens were conventionally killed by neck cutting, bleeding, plucking, and eviscerating them.

pH

Determination of pH was carried out 45 minutes after slaughter at a carcass temperature of approximately 30 °C and 2 hours after slaughter at a carcass temperature of approximately 22 °C, to determine the technological quality and maturation process of the breast and thigh meat with use of pH-meter Gryf 209 L (Gryf HP, Prague, Czech Republic) according to the methodology of **Garrido et al. (1995)**.

Meat colour

Breast and thigh muscle samples instrumental color measurements were made using a spectrophotometer (Konica Minolta CM-2600d, Osaka, Japan) with the setting Specular Component Included (SCI). D65 light source and a 10° observer, with a port 8 mm in diameter was used. The white plate calibration was performed at 23 °C, as suggested by the manual. The results were coordinates in the color interface of the Commission International de l'Eclairage (CIE) L* a* b* system (L*=0, black; L*=100, white; 100 +a*=redness; -a*=greenness; +b*=yellowness; -b*=blueness). Using the optically passive glass aperture cover that came with the colorimeter to ensure a consistently level sample surface, color measurements were made at three random positions on each sample **(Bianchi, Fletcher and Smith, 2005)**. A white tile was used to calibrate the colorimeter (Minolta calibration plate: C: Y = 93.66, = 0.3150, y = 0.3217).

Storage and cooking losses

Storage losses were defined as the weight loss of chicken carcass halves after they were cooled to 4 °C after 24 hours (chilling losses) and after freezing to -18 °C and storage for 2 months at this temperature. To determine cooking losses, heat treatment was chosen by baking covered carcass halves at a temperature of 200 °C for 60 minutes with the addition of 20 ml of water and another 15 minutes to finish baking the uncovered roasters as adapted and modified from the methodology of **Trembecká et al. (2017)**. Losses were calculated as a percentage loss after cooling, freezing, and baking from the original fresh weight of carcass halves.

Shear force

Four chicken halves from each group were selected and cooked at 200 °C for 60 minutes to measure the shear force. Shear force is the amount of force required to sever the fibers of a beef sample with a 1 cm^2 cross section. According to the method of **Goodson et al. (2002)** the Warner-Bratzler apparatus (Chatillon Brandt, USA) measured the shear force of culinary prepared breast and thigh meat.

Statistical analysis

The collected results were statistically analyzed using the analysis of variance (ANOVA) method using the XLSTAT program (Addinsoft, Paris, France, 2017), which produced baseline values that are displayed as mean standard deviation. Duncan test was employed to assess the statistical evidence between each experimental group, and differences were deemed significant at $P \leq 0.05$.

RESULTS AND DISCUSSION

The obtained results of technological properties of chicken meat from broiler chickens fed with supplemental are divided into two parts, firstly the weight losses during storage and heat treatment and secondly selected instrumentally analyzed technological properties of meat.

Chicken meat weight losses

The results of calculated percentage losses in chicken meat weight of broiler chickens Ross 308 during its storage (cooling and freezing) and after its heat treatment (cooking) are shown in Table 2.

Based on the results of the meat weight losses of Ross 308 broiler chickens fed with the addition of 1, 2 and 3% RGP of the Alibernet variety, we can conclude that the cooling and freezing losses were not significantly affected by this feed supplement.

Cooling losses ranged from 1.06% in group P3 to 1.49% in group P2. After heat treatment by baking, we observed the lowest losses in group P1 (33.18%) and the highest weight losses in group P3 (35.33%). However, from a statistical point of view, these differences were not significant ($P \geq 0.05$).

Table 2 Storage and processing losses of chicken halves

Group	Cooling losses (%)	Freezing losses (%)	Baking losses (%)
C	1.131 ± 0.240	2.739 ± 0.280^{c}	34.690 ± 1.590
E1	1.346 ± 0.550	3.644 ± 0.680^{ab}	33.181 ± 3.220
E2	1.487 ± 0.770	3.942 ± 0.660^{a}	34.738 ± 1.880
E3	1.064 ± 0.460	3.246 ± 0.800^{bc}	35.327 ± 4.480
p-value	0.293	0.001	0.442

Legend: mean ± S.D. (standard deviation); C = control group; E1, E2, E3 = experimental groups with 1, 2 and 3% RGP supplementation; a, b, c = means statistically significant differences between groups (P≤0.05)

We observed significant differences (P≤0.05) in freezing losses, when the lowest losses were in the control group (2.74%) compared to experimental groups P1 (3.64%) and P2 (3.94%). Compared to the control group, we observed higher freezing losses in the third experimental group as well.

Authors in other studies mainly focused on drain losses during storage (ability of meat to bind water, respectively) and after heat treatment of chicken meat by its baking. Drainage loss reflects the release of intramuscular components, especially organic osmolytes from muscle tissue **(Bennato et al., 2020)**. Losses after heat treatment are caused by evaporation of water and dripping of water and fat. Most of the chicken fat comes from the skin and a small amount of fat adheres as intermuscular fat to the muscle tissue **(Gunter and Peter, 2007)**. Losses during heat treatment of meat are also significantly influenced by the age at slaughter, on which the nutritional composition of the meat depends **(Northcutt et al., 2001)**.

In a study by **Bennato et al. (2020)** was investigated the effect of adding grape pomace in different concentrations (P1 – 2.5, P2 – 5 and P3 – 7%) to the FM of broiler chickens. Drainage loss was significantly lowest (P≤0.05) in the control group (2.30%) compared to experimental groups P2 (2.60%) and P3 (2.89%), which is also consistent with our losses after defreezing chicken halves. Like our results, these authors did not observe significant differences between individual groups after heat treatment. **Lee et al. (2008)** reported 21.4% loss after cooking fresh chicken breast fillets in a convection oven at 176 °C, which is a lesser loss compared to our defreezed whole carcass halves. Cooking losses can be reduced by special treatments such as wrapping meat with edible films, as reported in a study by **Küçüközet and Uslu (2018)**. Wrapping chicken meat with edible films significantly (P≤0.05) reduced the loss by baking at 200 °C; in the control samples it was 35.27%, while in the coated samples it was about 24.93 – 28.65%.

Selected technological properties of chicken meat

The results of selected technological properties (pH, shear force and meat colour) of breast and thigh meat form broiler chickens fed with supplemental RGP are shown in the Table 3 and 4, respectively.

Table 3 Technological properties of chicken breast meat

Group	pH 45min/30 °C	pH 120min/22 °C	Shear force (kg.cm^{-2})	L*	a*	b*
C	6.352 ± 0.200	5.988 ± 0.170	4.400 ± 0.450	55.873 ± 3.834^{ab}	-1.769 ± 0.606^{c}	8.459 ± 1.085^{c}
E1	6.166 ± 0.160	6.104 ± 0.390	4.170 ± 0.990	57.623 ± 2.749^{a}	-1.506 ± 0.556^{bc}	8.820 ± 0.911^{bc}
E2	6.217 ± 0.230	6.000 ± 0.190	3.630 ± 0.910	56.601 ± 3.169^{a}	-1.316 ± 0.381^{b}	9.285 ± 0.926^{ab}
E3	6.139 ± 0.220	5.922 ± 0.230	3.950 ± 1.070	53.722 ± 4.152^{b}	-0.879 ± 0.570^{a}	9.775 ± 1.454^{a}
p-value	0.115	0.482	0.268	0.006	< 0.001	0.002

Legend: mean ± S.D. (standard deviation); C = control group; E1, E2, E3 = experimental groups with 1, 2 and 3% RGP supplementation; a, b, c = means statistically significant differences between groups (P≤0.05)

Table 4 Technological properties of chicken thigh meat

Group	pH 45min/30 °C	pH 120min/22 °C	Shear force (kg.cm^{-2})	L*	a*	b*
C	6.308 ± 0.120^{b}	6.194 ± 0.150^{b}	3.680 ± 1.130^{a}	57.573 ± 5.536^{ab}	2.397 ± 1.260^{c}	12.034 ± 1.804^{b}
E1	6.472 ± 0.110^{a}	6.403 ± 0.130^{a}	3.650 ± 1.060^{a}	56.814 ± 4.670^{b}	3.185 ± 1.529^{b}	13.272 ± 1.937^{a}
E2	6.370 ± 0.130^{ab}	6.387 ± 0.130^{a}	2.520 ± 0.470^{b}	55.365 ± 2.229^{b}	2.622 ± 0.822^{bc}	11.937 ± 1.765^{b}
E3	6.259 ± 0.130^{b}	6.186 ± 0.140^{b}	3.410 ± 1.060^{a}	56.184 ± 3.446^{b}	4.089 ± 0.926^{a}	13.420 ± 1.482^{a}
p-value	0.001	0.003	0.036	0.260	< 0.001	0.010

Legend: mean ± S.D. (standard deviation); C = control group; E1, E2, E3 = experimental groups with 1, 2 and 3% RGP supplementation; a, b, c = means statistically significant differences between groups (P≤0.05)

The pH values in the chicken meat of broiler chickens ranged in the breast muscle from 6.139 (experimental group E3) to 6.352 (control group) after 45 minutes *postmortem* and from 5.922 (experimental group E3) to 6.104 (experimental group E1) after 120 minutes *post mortem*. The differences in pH in the breast muscle were therefore minimal and not statistically significant (P≥0.05).

In the thigh muscle, we observed the lowest pH after 45 minutes *postmortem* (P≤0.05) in the control group (6.308) and the experimental group E3 with the addition of 3% RGP to the FM (6.259). After 120 minutes *postmortem*, similar results were obtained, as we again observed significantly lower pH (P≤0.05) in the control group (6.194) and group E3 (6.186) compared to the experimental groups E1 (6.403) and E2 (6.387).

The pH of meat after slaughter falls due to the degradation of glycogen and production of lactic acid. It has a profound effect on functional properties and storage quality of meat. The addition of grape industry by-products may change the pH of meat products depending on its source **(Apoorva, Suman and Ahlawat 2017)**. According to **Zhang et al. (2005)**, meat with a high pH (6.10–6.79) has higher functional qualities in terms of water holding capacity, protein solubility, or yield when compared to meat with a normal pH (5.40–5.79). Our breast muscle pH results at 2 h *postmortem* are comparable to those of **Bennato et al. (2020)**, who added 2.5%, 5% and 7% grape pomace per 1kg of FM of broiler chickens. The authors monitored the pH in the meat samples at the level of 5.88 – 6.05, while the differences between the individual groups were not significant, as was observed in our study with RGP. The use of GP in study of **Turcu et al. (2020)** in broilers diets led to the significant pH (measured 24 hours *postmortem*) value decrease (P≤0.05) of thigh meat in experimental groups fed with (5.97 and 6.07, respectively) and 3 and 6% supplemental RGP (5.96 and 6.04, respectively), compared to the control group. Authors did not detect significant differences in pH of breast muscle after RGP supplementation what is coherent with our results. Results achieved by **Hassanin et al. (2017)** indicated that the minimum and the maximum values of pH in the examined chicken meat samples collected from local commercial retail shops were as follow: breast (5.7 to 5.96) and thigh (5.65 to 5.84), what is lower compared to our results of pH examined after 45 and 120 minutes *postmortem*. Among other poultry species, **Ao and Kim (2020)** observed significantly higher pH in the samples of Pekin duck meat fed with supplemental grape seeds extract.

When evaluating the shear force of roasted chicken meat, we can state that the quality of the breast muscle was not significantly affected in this respect. However, we observed the smallest shearing force and therefore the softest meat in the experimental group E2 (P≥0.05) after the addition of 2% RGP to the chickens' diet (3.63 kg.cm^{-2}). A lower shear force compared to the control group (4.40 kg.cm^{-2}) was also observed in the other experimental groups (P≥0.05).

When measuring the shear force in the thigh muscle of Ross 308 broiler chickens, we observed the significantly lowest value (P≤0.05) also in group E2 (2.52 kg.cm^{-2}) compared to all other groups (C – 3.68, E1 – 3.65, E3 – 3.41 kg.cm^{-2}).

Our results of shear force are comparable to cooked chickens breast meat between 12 hours (4.36 kg.cm^{-2}) and 24 hours (2.57 kg.cm^{-2}) *postmortem* observed by **Li, Xu and Zhou (2012)**. **Kumanda et al. (2019)** observed application of differently treated RGP into broiler chickens' diet; differences between experimental groups were not significant and were slightly higher compared to our results ranging around Ø 4.93 kg.cm^{-2}. Lower shear force was described by **Bobko et al. (2009)** after addition of cinnamon essential oil into broiler chicken diet in amount 0.1, 0.05 and 0.025% ranging from 2.37 to 3.07 kg.cm^{-2} in breast muscle and from 1.52 to 2.56 kg.cm^{-2} in thigh muscle. Also, lower shear force was described by **Haščík and Kulíšek (2005)** when broilers fed with pure plant-based FM had slightly softer breast (2.71 kg.cm^{-2}) and thigh (2.22 kg.cm^{-2}) meat compared to those fed with nowadays forbidden FM with meat-bone meal and feed antibiotics (breasts – 2.84 kg.cm^{-2} and thighs – 2.34 kg.cm^{-2}). Even softer chicken meat was found by **Elimam et al. (2013)** after addition of different amounts of Slovak bee pollen in their FM, with shear force ranging around Ø 1.89 kg.cm^{-2} in breast muscle and Ø 1.18 kg.cm^{-2} in thigh muscle. Other factors also affect the softness of chicken meat; for example, industrial chickens tend to have softer breasts (2.52 kg.cm^{-2}) compared to free-range chickens (2.95 kg.cm^{-2}) **(da Silva, de Arruda and Gonçalves, 2017)** or thawing before heat treatment, which leads to softer cooked breast fillets (3.06 kg.cm^{-2}) compared to unfrozen (3.70 kg.cm^{-2}) **(Zhuang and Savage, 2013).**

The color, texture, and general appearance of the meat are a few aspects that draw attention to the shift in meat quality. Meat discolouration is related to the meat's ability to sustain metmyoglobin levels through oxidation and enzymatic reduction processes **(Shahidi and Wanasundara, 1996)**.

Color characteristics were probably the most influenced by selected feed supplement to the broiler chickens FM. In breast muscle, we observed significant differences between experimental groups in all parameters (P≤0.05). Significantly highest lightness was observed in the E1 (57.623) and E2 (56.601) group compared to the E3 group (53.722). Redness of breast meat was significantly lowest in the control group (-1.769) compared to the group supplemented with 3% of RGP (-0.879) and yellowness was also significantly lowest in the control group (8.459) compared to the E3 group (9.775).

In thigh muscle, lightness was not significantly affected (P≥0.05), with minimal differences between experimental groups ranging between 55.365 (E2) and control group (57.573). However, we observed significant differences (P≤0.05) in redness and yellowness. Redness was significantly highest in the group with the 3% RGP supplementation (E3 – 4.089) compared with control group (2.397). Redness was higher also in experimental groups E1 and E2, what is probably associated with natural colorings present in RGP. Although differences in yellowness were significant (P≤0.05), they were minimal, ranging from 11.937 (E2) to 13.420 (E3). Similar color values in breast and thigh muscles were observed by **Turcu et al. (2020)** after adding 3 and 6% of white and RGP to broiler chicken FM. Compared to our results, the authors found similar L* values. The authors clearly state the highest values of b* (18.21) in breast muscle, respectively a* (7.63) and b* (17.20) in thigh muscle after the addition of 3% RGP, which is in accordance with our results. Regarding the color characteristics of the chicken meat, a* and b* saw considerable (P<0.05) alterations, whereas L* showed no variations in study of **Bennato et al. (2020)**. The use of grape pomace specifically caused an increase in the chromaticity coordinates a* and b*, what is in accordance also with our results. It is remarkable, nonetheless, that none of the broiler chicken groups that consumed the experimental diets (2.5, 5 and 7% of supplemental RGP) showed any appreciable color changes among them.

The samples' levels of sanity are revealed to be higher by the meat lightness decrease **(Bozkurt and Bayram, 2006)**. The most frequent component of hemoglobin, the red color in blood, haem oxidation may be responsible for the increase in meat's yellowness **(Sánchez-Alonso and Borderías, 2008)**. When RGP (2%) was used in chicken burgers, **Sáyago-Ayerdi, Brenes and Goñi (2009)** analyzed the results and found that the lightness loss was related to the dilution of the meat pigment. The meat samples from the E4 group (7.16), which contained 6% RGP, had the highest value of the total color difference. This information showed that, when compared to the control samples, the meat samples from the E4 group had the most pronounced color differences, which may be related to the anthocyanins in RGP **(Jongberg et al., 2011)**.

The breast meat samples' darker appearance is explained by the fact that the breast meat is primarily made up of white muscle fibers, which have low myoglobin levels, as opposed to red fibers, which have higher myoglobin levels, in the thigh meat **(Barbut, Zhang and Macrone, 2005)**. Studies of literature have revealed that the color of the meat has a favorable effect on how consumers perceive it **(Mainente et al., 2018)**. According to reports, adding 1% of the phenols from grapes to meat improves its redness value, although this is not seen negatively **(Rojas and Brewer, 2007)**.

CONCLUSION

This study was aimed on determination of selected technological properties of meat from Ross 308 broiler chickens fed with supplemental RGP of variety Alibernet to their FM. From the weight loss results, we can conclude a negative effect of the supplementation with RGP to the FM of chickens' halves after defreezing was found, as these were significantly lowest in the control group, which was also confirmed by the study of other authors. Losses by cooling and baking were similar between individual groups and without demonstrable differences. pH of breast meat was not affected, while pH of thigh muscle was significantly different among the experimental groups. It seems like that selected supplement improved softness of muscle compared to control group, when the softest breast and thigh muscle was found after 2% of RGP (E2 group) with the lowest shear force in both breast and thigh meat. The highest observed differences were observed in meat redness and yellowness in both breast and thigh muscle, as we found significantly highest values in group fed with the highest used supplementation of 3% RGP (E3 group), what is probably associated with polyphenols and anthocyanins present in Alibernet RGP. Overall, it seems that selected feed supplement can improve some technological characteristics of chicken meat, as also discussed with other authors.

Acknowledgments: This work was supported with KEGA 034SPU-4/2021 and VEGA 1/0402/23. This work was also supported with Demand-driven research for the sustainable and innovative food, Drive4SIFood 313011V336, cofinanced by the European Regional Development Fund.

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