Original Paper

Effect of grape pomace feeding on fattening parameters and fatty acids profile in geese

Stanislava Drotárová, Jakub Vyšlan, Branislav Gálik, Milan Šimko, Miroslav Juráček, Ondrej Hanušovský, Mária Kalúzová, Eva Mixtajová, Pavol Brek, Michal Rolinec*

Slovak University of Agriculture in Nitra, Faculty of Agrobiology and Food Resources, Institute of Nutrition and Genomics, Slovakia

Article Details: Received: 2021-12-28 | Accepted: 2021-12-31 | Available online: 2022-06-30

https://doi.org/10.15414/afz.2022.25.02.85-90

It was published, that grape pomace has a positive effect on the animal organism and is also a rich source of fatty acids. The inclusion of grape pomace in the geese feed mixture was the main objective of the following experiment. The addition of grape pomace into the feed mixture was used to investigate to what extent will affect the fattening parameters of geese and the profile of fatty acids analysed from the abdominal fat of geese. The experiment was carried out on 20 geese (Czech goose breed). Two groups were formed to obtain the same average weight. The average weight of the experimental group at the beginning was 1857 ±196 g. The average weight of the control group was 1872 ±248 g. For 49 days, both groups were fed a commercial complete feed mixture for geese fattening while in the experimental group 1% of the feed mixture was replaced by dried grape pomace. The average weight of geese of the control group at the end of fattening was 5579 ±770 g and of the experimental group 5752 ±752 g. The addition of dried grape pomace to the feed mixture in the fattening of geese increased the average daily weight gain of geese by 5.2% (P >0.05), liver weight by 22.5% (P <0.05) and increased the content of monounsaturated fatty acids by 2.5% (P >0.05), especially oleic acid by 3.0% (P >0.05). A reduced content of polyunsaturated fatty acids by 1.5% (P >0.05) and decreased saturated fatty acid content by 3.2% (P >0.05) was detected in the experimental group. It can be concluded that the addition of grape pomace affected the liver weight of fattened gees, while the effect on fatty acids composition was insignificant.

Keywords: grape pomace, fatty acids, geese, abdominal fat

1 Introduction

Nowadays we are witnessing a trend of increasing goose meat consumption worldwide, although the increase within European countries is much slower compared to China (Nemati et al., 2020; Liu et al., 2013). In goose farming the current trend is primarily to achieve economic efficiency of farming, but also to produce high quality meat and quality products with high protein and low-fat content (Biesiada-Drzazga, 2014) in addition to optimal polyunsaturated (PUFA) and saturated (SFA) fatty acid content (Tao, 2015). Fatty acids in the body are primarily a source of energy, a component of cell membranes, influence cellular metabolism, hormone function as well as play an important role in intracellular signalling pathways and gene expression (Calder, 2015). Due to the absence of desaturases, not all fatty acids can be produced endogenously in the body; they need to be supplemented exogenously with an appropriate diet. In human nutrition, poultry products are among the suitable sources of monounsaturated fatty acids (Thapa, 2020) and long-chain polyunsaturated fatty acids (LC-PUFAs). The fatty acid content of animal products can be influenced by changes in fatty acid concentration in the diet (Alagawany et al., 2019). Grape pomace is one possible source, rich in essential fatty acid content and natural antioxidants (catechin, resveratrol, β-carotene) (Hosseini-Vashan et al., 2020; Yu and Ahmedna, 2013). Grape pomace is produced as a by-product of wine and fruit juice production (Gómez-Brandón et al., 2019) and represents approximately 20% by weight of the processed grapes (de Souza et al., 2015). They consist of skin, seeds and stems left as residues after grapes have been pressed (Russo et al., 2017). The production of grape pomace is high worldwide and multiple questions have

***Corresponding Author:** Michal Rolinec, Slovak University of Agriculture in Nitra, Faculty of Agrobiology and Food Resources, Institute of Nutrition and Genomic, Trieda Andreja Hlinku 2, 949 76 Nitra, Slovakia; e-mail: michal.rolinec@uniag.sk ORCID https://orcid.org/0000-0003-4966-7909

been raised about how to handle this antioxidant-rich raw material properly and ecologically (Gómez-Brandón et al., 2019). Grape pomace is rich in phenolic compounds with antioxidant activity (Pertuzatti et al., 2020; Gil-Sánchez et al., 2017) and equally contains lipids, proteins, non-digestible fibre and minerals (Bravi et al., 2007). Grape seeds are particularly rich in extractable phenolic antioxidants (phenolic acid, flavonoids, procyanidins), containing 13–19% oil rich in essential fatty acids (Gómez-Brandón et al., 2019). The most abundant fatty acid in grape kernels is linoleic acid, accounting for 60 to 70% of the total fatty acids present (Gómez-Brandón et al., 2019). There is a high concentration of anthocyanins in the skin (Yu and Ahmedna, 2013). There is also a high concentration of polyphenol resveratrol in red grape varieties (Sanders et al., 2000; Yu and Ahmedna, 2013). Resveratrol is a phytoestrogen with antioxidant, anti-inflammatory, cardioprotective and anticancer properties (Ko et al., 2017). Feeding elevated doses of resveratrol in fattening poultry favourably increases the final weight of poultry, improves animal growth and reduces the effects of stress (Zhang et al., 2017). Inclusion of grape pomace in fattening poultry at up to 3% of the feed mixture positively affects carcass and meat yield and the amount of abdominal fat of broilers. They have a positive effect on the quality of animal products and on the health of the consumers (Azizi et al., 2018). The inclusion of grape pomace likewise increases feed intake during pre-fattening and fattening periods and reduces blood triglyceride and cholesterol concentrations in fattening poultry (Hosseini-Vashan et al., 2020). Based on the rich nutrient composition of grape pomace we hypothesized, that by addition of grape pomace to the diet of fattening geese a positive result on the fattening parameters of geese as well as changing the fatty acid profile of goose fat could be achieved.

2 Material and methods

The experiment was conducted between 22 May and 10 July 2020 (49 days). The location was the village of Čierna in the district of Čadca (north-west part of Slovakia, EU). The research was carried out on 20 geese of the Czech goose breed, and at the time of inclusion in the experiment (day 0) they were 28 days old with the weight of the goslings ranging between 1502 g and 2250 g. Two groups, experimental and control were formed at the beginning of the experiment. Care was taken to form the groups with the same average weight. In the experimental group, the average weight of the goose was 1857 ±196 g and in the control group, 1872 ±248 g. The equal gender ratio was assured in both groups. The geese were cared for by an experienced caretaker with several years of experience. The geese were housed in standard housing conditions with *ad libitum* access to feed and water during the experiment. Animal care was carried out in compliance with Directive 2010/63/EU of the European Parliament and of the Council of 22. September 2010 on the Protection of Animals Used for Scientific Purposes.

2.1 Feeding of animals at the time of the experiment and analysis of the feed

Both groups were fed a commercial feed mixture for geese fattening HYD-25 (HD Hlučín, Czech Republic) composed of wheat, maize, soybean meal, wheat bran, rapeseed meal, rapeseed meal, soybean oil, calcium carbonate, calcium dihydrogen phosphate, sodium chloride, L-lysine monohydrochloride, D, L-methionine, sodium bicarbonate. During the experiment, the HYD-25 feed mixture was fed in the control. On the contrary, in the experimental group, 1% of the HYD-25 feed mixture was replaced by dried ground grape pomace. The feed in the feeders was loaded 3 times during the day in both groups to ensure *ad libitum* feed intake. Throughout the duration of the experiment, the geese had access to drinking water which was provided by a 20 L container. The water was changed 3 times a day. All geese had access to a natural water source (stream), grazing and grit throughout the experiment. The feed mixture without the addition of grape pomace (HYD-25) contained the following nutrients in 1 kg of feed mixture: crude protein 17.5%, crude fats and oils 4.1%, crude fibre 3.5%, crude ash 4.9%, calcium 0.72%, sodium 0.16%, phosphorus 0.56%, lysine 8.9 g/kg, with the following additives: vitamin A 10000 m.j., vitamin D3 3000 mg, vitamin E 34 mg, ferrous sulphate monohydrate 106 mg, manganese oxide 108 mg, zinc oxide 90 mg, copper sulphate pentahydrate 12.6 mg, potassium iodide 1.0 mg, sodium selenite 0.28 mg. At the beginning of the experiment, the nutritional parameters of grape pomace from the white wine variety (Pinot Gris) were analysed. The nutritional characteristic of the dried grape pomace used in this experiment was previously published in the articles of Kolláthová et al. (2020 and 2021), and Vašeková et al. (2020) and are shown in Table 1.

2.2 Parameters monitored throughout the experiment and statistical evaluation

During the whole experiment (49 days), we recorded the weight of each animal four times. At the beginning of the experiment (day 0), on day 14, day 32 and the last day 49. On the last day, in addition to the live weight, to carcass weight of the geese was also recorded and then the average daily gains within each group were calculated. For each individual liver weight was weighed in the same manner and a sample of abdominal fat was

Table 1 Nutritional characteristic of grape pomace used in experiment

Item	Quantity
Dry matter	92.8%
Crude protein	88.9% of DM
Acid detergent fibre	25.0% of DM
Neutral detergent fibre	28.4% of DM
Ash	11.1% of DM
Calcium	0.35% of DM
Phosphorus	0.24% of DM
MUFA	16.69 g 100 g^{-1} of FA
PUFA	69.13 g 100 g^{-1} of FA
SFA	12.61 g 100 g^{-1} of FA
Total polyphenols	27.38 mg GAE g^{-1}
Total phenolic acids	13.27 mg CAE g g^{-1}
Total flavonoids	0. 12 mg QE g g^{-1}
Antiradical activity DDPH	9.17 mg TEAC g g^{-1}

Source: Kolláthová et al., 2020; 2021; Vašeková et al., 2020
DM – dry matter; FA – fatty acids; MUFA – monounsaturated fatty acids; PUFA – polyunsaturated fatty acids; SFA – saturated fatty acids; GAE – equivalent gallic acid; CAE – equivalent caffeic acid; QE – equivalent quercetin; DPPH – 2,2-diphenyl-1-picrylhydrazyl; TEAC – trolox equivalent antioxidant capacity

Table 2 Fatty acid composition of diets feed during experiment (g 100 g^{-1} of FA)

Fatty acid	Name of fatty acid	Control diet	Experimental diet
C 16:0	palmitic acid	11.69	12.74
C 18:0	stearic acid	3.65	3.98
C 18:1 cis n9	oleic acid	27.88	27.61
C 18:2 cis n6	linoleic acid	49.02	48.19
C 18:3 n3	linolenic acid	4.65	4.42
C 20:0	arachidic acid	0.48	0.47
C 20:1 n9	cis-11-eicosenoic acid	0.50	0.48
C 22:0	behenic acid	0.42	0.39
ΣMUFA	monounsaturated fatty acids	28.36	28.09
ΣPUFA	polyunsaturated fatty acids	53.68	52.61
ΣSFA	saturated fatty acids	16.24	17.57
Σn3/Σn6	ratio omega 3/omega 6 fatty acids	0.09	0.09
Σn6/Σn3	ratio omega 6/omega 3 fatty acids	10.54	10.89

Control diet contains 100% of commercial feed mixture for geese fattening; experimental diet contains 99% of commercial feed mixture for geese fattening + 1% of powder of dried grape pomace

collected in a 50 ml sterile tube. The collected, labelled and frozen samples were then transferred to the Institute of Nutrition and Genomics, Department of Animal Nutrition, Slovak University of Agriculture in Nitra, where the fatty acid profile was determined from the samples using an Agilent 6890A GC system gas chromatograph. The concentration of fatty acids was also determined in both feed mixtures, which were fed during experiment. Fatty acids characteristic of diets fed during experiment is shown in Table 2.

Statistical evaluation was performed using the IBM SPSS v.20.0 statistical program. With one-factor analysis of variance ANOVA. The differences between average values were tested using Tukey's HSD Test.

3 Results and discussion

3.1 Fattening parameters

At all the weighting days of the experiment, we observed insignificant (P >0.05) differences in goose live weight between the experimental and control groups (Table 3).

The average daily gain achieved throughout the experiment averaged 5.2% higher values in the experimental group (79.5 g) versus 75.6 g in the control group (Table 3). Positive results of feeding higher doses of resveratrol also present in grape pomace were also obtained by Zhang et al. (2017). The authors included 360 broilers in the experiment. They included 400 mg kg^{-1} of an external source of resveratrol in the experimental group. In the resveratrol supplemented group, they monitored the weight gain of broilers on day 42. Positive results with grape meal feeding were also observed by Wang et al. (2010). The inclusion of a 9% grape meal in the feed mixture positively affected the average daily gain of geese, similar results were also observed by Haščík et al. (2021) with the inclusion of 3% grape pomace in the broiler feed mixture. Improvements in growth and fattening parameters were also noted by Pascariu et al. (2017).

The weight of the liver obtained in the experimental group was 22.5% higher than that of the control group (P <0.05). The weight of the liver in the experimental group was 125.2 ±18.77 g, while that in the control group was 102.2 ±18.64 g. The average carcass weight in the experimental group was 3775 ±554 g and in the control group was 3708 ±545 g (Table 3). Statistically significant results (P <0.05) of inclusion of grape pomace in the diet of broiler chickens were also reported by Brenes et al. (2008) and vice versa, they did not observe any statistically significant effect on the size of the liver.

3.2 Fatty acids content of abdominal fat

In terms of fatty acid concentration, an insignificant (P >0.05) difference between the control and experimental group was observed (Table 4). In contrast, Uhlířová et al. (2019) reported in their study an increase in ΣSFA values with the highest abundance (C 16:0) followed by stearic acid (C 18:0). The addition of grape pomace in the experimental group resulted in an insignificant (P >0.05) increase of MUFA and a decrease of PUFA and SFA (Table 4). A statistically significant increase (P <0.05) in PUFA and MUFA in geese was observed by Sari et al. (2015). The Σn6/Σn3 ratio was found to be insignificant (P >0.05) higher in the experimental group than in the control group without the addition of grape pomace (Table 4). Uhlířová et al. (2019) and likewise Sari et al. (2015) reported lower Σn6/Σn3 values.

Table 3 Fattening parameters determined during experiment

Parameter	Day of experiment	Group	Mean ±S.D.
Live weight (g)	0. day	E	1857 ±196
		C	1872 ±248
	14. day	E	3416 ±370
		C	3346 ±333
	32. day	E	5010 ±643
		C	4890 ±504
	49. day	E	5752 ±752
		C	5579 ±770
Average daily gain during the experiment (g)		E	79.5 ±15.23
		C	75.6 ±15.75
Feed consumption per kg of live weight gain (kg)		E	2.94
		C	2.94
Carcass weight (g)		E	3775 ±554
		C	3708 ±545
Carcass yield (%)		E	65.6 ±3.59
		C	66.4 ±2.24
Liver weight (g)*		E	125.2 ±18.77
		C	102.2 ±18.64

E – experimental group fed with an addition of grape pomace; C – control group without grape pomace; S.D. – standard deviation; * mean values between groups differ significantly at P <0.05

Table 4 The fatty acid content in abdominal fat (g 100 g^{-1} of FA)

Fatty acid	Name of fatty acid	Group	Mean ±S.D.
C 14:0	myristic acid	E	0.31 ±0.04
		C	0.26 ±0.04
C 16:0	palmitic acid	E	20.41 ±1.31
		C	21.27 ±1.03
C 17:0	heptadecanoic acid	E	0.11 ±0.02
		C	0.12 ±0.01
C 18:0	stearic acid	E	6.50 ±0.64
		C	6.50 ±0.43
C 18:1 cis 9	oleic acid	E	45.73 ±2.62
		C	44.41 ±1.96
C 18:2 cis 6	linoleic acid	E	19.08 ±2.40
		C	19.09 ±0.95
C 18:3 n-3	linolenic acid	E	3.19 ±0.75
		C	3.50 ±0.64
C 20:4 n-6	eicosanoic acid	E	0.29 ±0.03
		C	0.28 ±0.02
ΣMUFA	monounsaturated fatty acids	E	47.80 ±2.70
		C	46.63 ±1.99
ΣPUFA	polyunsaturated fatty acids	E	22.40 ±3.17
		C	22.74 ±1.52
ΣSFA	saturated fatty acids	E	27.30 ±1.08
		C	28.20 ±1.27
Σn3/Σn6	ratio omega 3/omega 6 fatty acids	E	0.16 ±0.02
		C	0.18 ±0.03
Σn6/Σn3	ratio omega 6/omega 3 fatty acids	E	6.18 ±0.74
		C	5.63 ±0.85

E – experimental group with grape pomace; C – control group without grape pomace; S.D. –standard deviation

4 Conclusions

The result of this experiment confirmed the positive effect of grape pomace feeding on the fattening parameters of geese. In the group with the addition of grape pomace, we observed an insignificant increased live weight of geese at the end of the experiment ($P > 0.05$) and increased weight of the liver with significance ($P < 0.05$). No significant effect was found in terms of PUFA, MUFA and SFA content in the abdominal fat of geese.

Acknowledgments

This experiment was financially supported by the Slovak Research and Development Agency under contract no. APVV-16-0170 (By-products from grape processing as a bioactive substance source in animal nutrition).

References

Alagawany, M., Elnesr, S. S., Farag, M. R., El-Hack, A., Mohamed, E., Khafaga, A. F., ... & Dhama, K. (2019). Omega-3 and omega-6 fatty acids in poultry nutrition: effect on production performance and health. *Animals*, 9(8), 573. https://doi.org/10.3390/ani9080573

Azizi, M., Seidavi, A. R., Ragni, M., Laudadio, V., & Tufarelli, V. (2018). Practical applications of agricultural wastes in poultry feeding in Mediterranean and Middle East regions. Part 1: Citrus, grape, pomegranate and apple wastes. *World's Poultry Science Journal*, 74(3), 489–498. https://doi.org/10.1017/S0043933918000478

Biesiada-Drzazga, B. (2014). Growth and slaughter value of W11, W33 and W31 White Kołuda geese®. *European Poultry Science*, 78. https://doi.org/10.1399/eps.2014.44

Bravi, M., Spinoglio, F., Verdone, N., Adami, M., Aliboni, A., d'Andrea, A., ... & Ferri, D. (2007). Improving the extraction of α-tocopherol-enriched oil from grape seeds by supercritical

CO_2. Optimisation of the extraction conditions. *Journal of Food Engineering*, 78(2), 488–493.
https://doi.org/10.1016/j.jfoodeng.2005.10.017

Brenes, A., Viveros, A., Goñí, I., Centeno, C., Sayago-Ayerdy, S. G., Arija, I., & Saura-Calixto, F. (2008). Effect of grape pomace concentrate and vitamin E on digestibility of polyphenols and antioxidant activity in chickens. *Poultry science*, 87(2), 307–316. https://doi.org/10.3382/ps.2007-00297

Calder, P. C. (2015). Functional roles of fatty acids and their effects on human health. *Journal of parenteral and enteral nutrition*, 39, 18S–32S. https://doi.org/10.1177/0148607115595980

de Souza, V. B., Thomazini, M., de Carvalho Balieiro, J. C., & Fávaro-Trindade, C. S. (2015). Effect of spray drying on the physicochemical properties and color stability of the powdered pigment obtained from vinification byproducts of the Bordo grape (*Vitis labrusca*). *Food and Bioproducts Processing*, 93, 39–50. https://doi.org/10.1016/j.fbp.2013.11.001

Gil-Sánchez, I., Ayuda-Durán, B., González-Manzano, S., Santos-Buelga, C., Cueva, C., Martín-Cabrejas, M. A., ... & Bartolomé, B. (2017). Chemical characterization and *in vitro* colonic fermentation of grape pomace extracts. *Journal of the Science of Food and Agriculture*, 97(10), 3433–3444.
https://doi.org/10.1002/jsfa.8197

Gómez-Brandón, M., Lores, M., Insam, H., & Domínguez, J. (2019). Strategies for recycling and valorization of grape marc. *Critical reviews in biotechnology*, 39(4), 437–450.
https://doi.org/10.1080/07388551.2018.1555514

Haščík, P., Čech, M., Čuboň, J., Bobko, M., Arpášová, H., Pavelková, A., ... & Čeryová, N. (2021). Effect of grape pomace supplementation on meat performance of broiler chicken ross 308. *Journal of Microbiology, Biotechnology and Food Sciences*, 2021, 140–144.
https://doi.org/10.15414/jmbfs.2020.10.1.140-144

Hosseini-Vashan, S. J., Safdari-Rostamabad, M., Piray, A. H., & Sarir, H. (2020). The growth performance, plasma biochemistry indices, immune system, antioxidant status, and intestinal morphology of heat-stressed broiler chickens fed grape (*Vitis vinifera*) pomace. *Animal Feed Science and Technology*, 259, 114343. https://doi.org/10.1016/j.anifeedsci.2019.114343

Ko, J. H., Sethi, G., Um, J. Y., Shanmugam, M. K., Arfuso, F., Kumar, A. P., ... & Ahn, K. S. (2017). The role of resveratrol in cancer therapy. *International journal of molecular sciences*, 18(12), 2589.
https://doi.org/10.3390/ijms18122589

Kolláthová, R., Gálik, B., Halo, M., Kováčik, A., Hanušovský, O., Bíro, D., ... & Šimko, M. (2020). The effects of dried grape pomace supplementation on biochemical blood serum indicators and digestibility of nutrients in horses. *Czech Journal of Animal Science*, 65(2), 58–65. https://doi.org/10.17221/181/2019-CJAS

Kolláthová, R., Gálik, B., Juráček, M., Hanušovský, O., Bíro, D., Rolinec, M., & Šimko, M. (2021). The impact of the year of harveting and lyophylization of the mineral profile of grape pomace. *Journal of Hygienic Engineering and Design*, 34, 161–166.

Liu, H. W., & Zhou, D. W. (2013). Influence of pasture intake on meat quality, lipid oxidation, and fatty acid composition of geese. *Journal of Animal Science*, 91(2), 764–771.
https://doi.org/10.2527/jas.2012-5854

Nemati, Z., Alirezalu, K., Besharati, M., Amirdahri, S., Franco, D., & Lorenzo, J. M. (2020). Improving the quality characteristics and shelf life of meat and growth performance in goose fed diets supplemented with vitamin E. *Foods*, 9(6), 798.
https://doi.org/10.3390/foods9060798

Pascariu, S. M., Pop, I. M., Simeanu, D., Pavel, G., & Solcan, C. (2017). Effects of wine by-products on growth performance, complete blood count and total antioxidant status in broilers. *Brazilian Journal of Poultry Science*, 19, 191–202.
https://doi.org/10.1590/1806-9061-2016-0305

Pertuzatti, P. B., Mendonça, S. C., Alcoléa, M., Guedes, C. T., da Encarnação Amorim, F., Beckmann, A. P. S., ... & Américo, M. F. (2020). Bordo grape marc (*Vitis labrusca*): Evaluation of bioactive compounds *in vitro* and *in vivo*. *LWT*, 129, 109625.
https://doi.org/10.1016/j.lwt.2020.109625

Russo, V. M., Jacobs, J. L., Hannah, M. C., Moate, P. J., Dunshea, F. R., & Leury, B. J. (2017). *In vitro* evaluation of the methane mitigation potential of a range of grape marc products. *Animal Production Science*, 57(7), 1437–1444.
https://doi.org/10.1071/AN16495

Sanders, T. H., McMichael, R. W., & Hendrix, K. W. (2000). Occurrence of resveratrol in edible peanuts. *Journal of agricultural and food chemistry*, 48(4), 1243–1246.
https://doi.org/10.1021/jf990737b

Sari, M., Onk, K., Sisman, T., Tilki, M., & Yakan, A. (2015). Effects of different fattening systems on technological properties and fatty acid composition of goose meat. *European Poultry Science*, 79. http://doi.org/10.1399/eps.2015.79

Tao, L. (2015). Oxidation of polyunsaturated fatty acids and its impact on food quality and human health. *Adv. Food Technol. Nutr. Sci*, 1, 135–142.
http://dx.doi.org/10.17140/AFTNSOJ-1-123

Thapa, P. (2020). Application of micro algae in poultry nutrition; a review. *Journal of Agriculture and Natural Resources*, 3(2), 241–256. https://doi.org/10.3126/janr.v3i2.32512

Uhlířová, L., Tůmová, E., Chodová, D., Volek, Z., & Machander, V. (2019). Fatty acid composition of goose meat depending on genotype and sex. *Asian-Australasian journal of animal sciences*, 32(1), 137. https://doi.org/10.5713/ajas.17.0672

Vašeková, P., Juráček, M., Bíro, D., Šimko, M., Gálik, B., Rolinec, M., ... & Ivanišová, E. (2020). Bioactive compounds and fatty acid profile of grape pomace. *Acta Fytotechn. Zootechn*, 23, 230–235.
https://doi.org/10.15414/afz.2020.23.04.230-235

Wang, B., Zhang, L., Jiang, X., Wang, W., Wang, N., Sun, P., & Huang, G. (2010). Evaluation of nutritional value of grape seed meal in goose. *Chinese Journal of Animal Nutrition*, 22(2), 466–473

Yu, J., & Ahmedna, M. (2013). Functional components of grape pomace: their composition, biological properties and potential applications. *International Journal of Food Science & Technology*, 48(2), 221–237.
https://doi.org/10.1111/j.1365-2621.2012.03197.x

Zhang, C., Wang, L., Zhao, X. H., Chen, X. Y., Yang, L., & Geng, Z. Y. (2017). Dietary resveratrol supplementation prevents transport-stress-impaired meat quality of broilers through maintaining muscle energy metabolism and antioxidant status. *Poultry Science*, 96(7), 2219–2225.
https://doi.org/10.3382%2Fps%2Fpex004