

The Use of Grape Pomace in Feeding Common Carp (*Cyprinus carpio* L.)

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Abstract

This study investigated the effects of incorporating grape pomace into fish diets on the growth performance, physiological parameters, and biochemical composition of carp (*Cyprinus carpio* L.). A total of 100 carp, with an average initial weight of 50 g, were reared in a recirculating aquaculture system. They were divided into a control group, fed with a diet containing 0% grape pomace, and two experimental groups (R1 and R2), fed with diets containing 5% and 10% grape pomace, respectively.

The experiment lasted for ten weeks; results revealed that most growth parameters were not significantly affected by grape pomace inclusion. The biochemical evaluation of carp meat confirmed considerable variations in moisture, fat, protein, salt and collagen. Furthermore, the oxidative response evaluation indicated that grape pomace supplementation modulates oxidative strain and lipid peroxidation pathways in carp, improving their antioxidant defences and ordinary health.

Keywords: aquaculture, carp, diets, grape pomace

1. Introduction

Aquaculture production has been increasing in recent years, showing a positive trend. It is the sector with the highest growth. Grape pomace is the leftover from making wine and consists of squashed grape skins, grape pulp, and seeds. The percentage of grape pomace generated from wine production is 30% [1]. The primary benefit of using grape pomace in carp food are its antioxidant properties, fatty acid and protein content, fiber and mineral content, affordability, and contribution to promoting a circular economy [2]. The primary drawbacks of using grape pomace in carp feed include the existence of antinutrients, decreased palatability, and the requirement for it to be dehydrated prior to being added to feeds. Numerous studies have indicated

that grape pomace can prevent the growth of bacteria, fungi, and protozoa in different animal species, and it also has anti-viral properties. Grape pomace is utilized in feeding ruminant animals along with other higher-value feeds due to its elevated fiber content and decreased digestibility. Nonetheless, its actual worth has only recently been acknowledged as a possible supplier of important bioactive substances, particularly antioxidants like anthocyanins [3].

Grape pomace is preserved for animal nutrition by either making silage or drying it, considering the seasonal availability. One important part of using grape pomace in fish food is getting out bioactive substances like polyphenols and antioxidants, and then using them to make growth, health, and immunity better [4]. Utilizing grape pomace is important not just for its antioxidant substances but also for encouraging circular economy methods in sustainable handling of agricultural by products and minimizing waste. In fish, grape pomace is being studied for its healthy compounds

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and its potential use as additives [4, 7]. Using grape pomace had positive impacts on the growth and survival of carp.

This research aims to investigate how grape pomace can be used in carp feed recipes. This will help meet the increasing need for new and environmentally friendly methods to improve carp growth and productivity.

2. Materials and methods

We carried out a controlled natural breeding experiment using *Cyprinus carpio* L., parent fish, obtained from our research facility. The fry that hatched were raised for four months in a pond made of earth. After this time, in September 2023, 150 samples were chosen for additional testing. The chosen fish were moved to a recirculating aquaculture system furnished with fiberglass tanks. The RAS system consisted of fiberglass tanks, pipes for supplying water, a channel for water drainage, and a mechanical filter in the shape of a drum.

Before starting the trial, the fish were given a two-week period to get used to the new environment.

After this, the fish didn't eat for two days to make sure they were all in the same condition before the experiment started. Afterward, the fish were each measured and weighed. The trial for the feed started on September 2023 at a water temperature was 21.0°C, HIS values ranged from 0.4% for the control group, 0.6% for R1, and 0.3% for R2, and ended in November 2023, when the water temperature was 15.0°C. Fish were randomly selected. We had 8 tanks, and each tank had around 19 fish allocated to it. The levels of oxygen that has been dissolved and the temperature were checked every day. Weekly evaluations were done using the spectrophotometer to measure the pH, ammonia, nitrites, nitrates, phosphorus, and conductivity. The data were statistically processed by ANOVA followed by a Tukey Test ($p < 0.05$) using the SPSS software version 21 (IBM Corp, Armonk, NY, USA). The results were reported as means±standard errors.

The chemical composition of dried and fresh grape pomace, analyzed by DA 7250 NIR Analyzer, is shown in Table 1, highlighting its richness in protein, fiber, and fat, which supports its potential as a feed additive.

Table 1. Chemical Composition of Grape Pomace

%	Grape Pomace	
	Dried	Fresh
Protein	17.00%	18.50%
Moisture	8.86%	21.04%
Ash	9.92%	0.80%
Fat	7.34%	8.95%
Fiber	8.97%	5.06%
Starch	19.21%	13.85%
Sugar	10.21%	5.14%
Ca	0.53%	5.89%

The grape leftover was dried, crushed, and mixed with the main feed in the ratios indicated above, and it came from white grapes of different types. The chemical makeup of grape pomace was examined using the DA 7250 NIR Analyzer to identify the percentages used in making the test feeds.

The components were first pushed through, then crushed and blended based on the specified measurements. The blend was then formed into pellets at our feed manufacturing plant. The tool was set up for meat, ingredients for feed, ready-made feeds, and oils. The samples were placed on

a small revolving tray for the testing, the settings were adjusted, and the outcome was available in five seconds. The specimen was blended and scanned on eight occasions. The amount of food given to the fish each day was 4% of their total weight, considering the water temperature. Meals were given three times a day to make sure the feeding was done in the same way throughout the entire experiment. The biochemical study of carp meat showed notable differences in moisture, protein, fat, and collagen levels among the different diets (Table 2, Tale 3). Specifically, the highest amount of GP (10%) increased the protein

level in carp meat, suggesting it might improve its nutritional value. On the other hand, a lower amount of GP (5%) resulted in more fat content, which could impact the taste and fat profile of carp meat.

These results match other findings on carp [5] and highlight the potential of GP addition to changing the nutritional makeup of carp meat, thus affecting its quality and how much consumers like it.

Table 2. Experimental diets recipes with grape pomace for carp

Ingredient (%)	Control (%)	R1 (5%)	R2 (10%)
Corn	15	10.5	8.6
Sunflower meal	40	40	39.5
Peas	17	17	17
Soybean oil	3	3.3	3.5
Barley	5	4.5	4.5
DDGS	9	9	9
Grape pomace	0	5	10

Table 3. Chemical composition of carp meat

Diets	Control (0%)	R1 (5%)	R2 (10%)
Protein	13.5	12.34	15.2
Fat	7.23	12.98	7.93
Moisture	73.4	71.2	72.34
Salt	2.96	2.39	2.48
Ash	1.32	1.9	2.4
Collagen	0.6	1.30	0.3

The biochemistry tests included measuring superoxide dismutase SOD, using the nitro blue tetrazolium method, CAT, using the Sinha method, GPX using the spectrophotometry method with GSH, and MDA. The activities of SOD, CAT, and GPX, as well as the levels of GSH and MDA, were adjusted based on the total amount of soluble proteins determined using the Bradford method [6].

3. Results and discussion

The growth characteristics and physical reactions were examined under different conditions using grape pomace, as outlined in Table 3. In general, there were no major differences noted in most of the measures. However, there was a noticeable difference in hepatosomatic index among treatments, with a significant variation being found. More precisely, HIS values ranged from 0.4% for the control group, 0.6% for R1, and 0.3% for R2, showing a clear effect of the treatments on liver size compared to body weight. The chemical makeup of carp meat changed depending on the diet that included grape pomace (Table 3).

Control group, acting as the control without grape pomace addition, showed the highest moisture 73.4%, and salt level 2.96%. Diet R2, containing the most grape pomace 10%, had the highest protein 15.2% and ash 2.4% levels. Diet R1, with a smaller amount of grape pomace 5%, had the highest fat level 14.12%, whereas diet R2 had the lowest collagen level 0.3%. The results emphasize how adding grape pomace can affect the makeup of carp meat.

Figure 1 shows the findings of the evaluation of the levels of oxidation in carp samples when they were given different diet with added grape pomace. The patterns seen indicate that adding grape pomace could change oxidative stress and lipid peroxidation processes in carp, perhaps improving their antioxidant defences and overall health. The changes in levels of important antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) in various tissues show how the body's defence against antioxidants is constantly changing in carp. For example, in the liver tissues, the highest SOD activity was observed in the control group. In contrast, SOD activity decreased in the experimental group R1, and it decreased further in group R2.

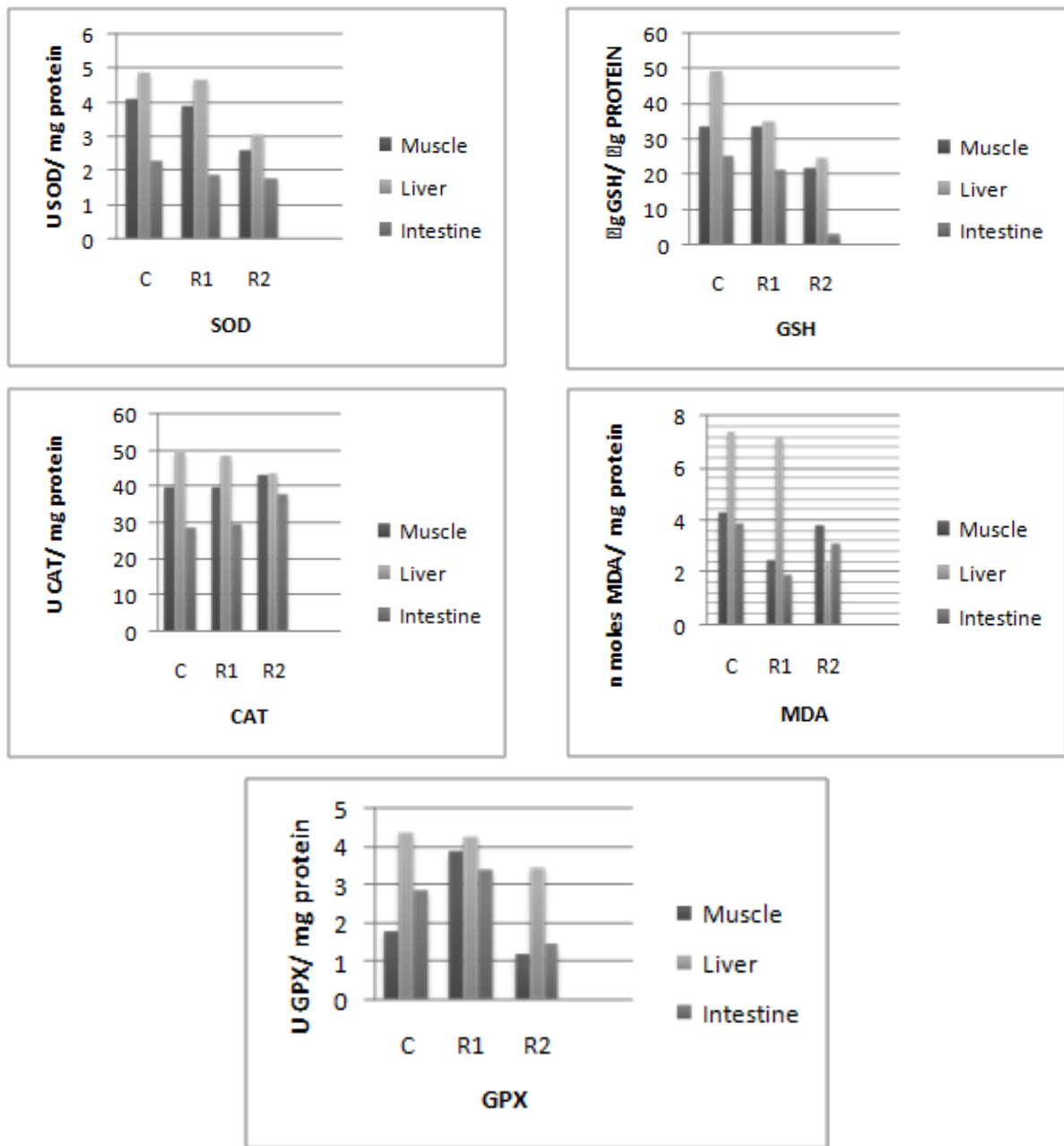


Figure 1. The impact of grape pomace on the levels of oxidation in the muscle, liver, and intestine tissues of *Cyprinus carpio*. The enzyme factors included measuring superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) particular activities, while the non-enzymatic factors included estimating the levels of GSH and MDA

Similarly, CAT function differed in different tissues, with the highest activity seen in the experimental group R2 for muscle tissue and intestines [8]. Experimental group R2 for muscle tissue and intestines. The variations in glutathione (GSH) amounts and malondialdehyde (MDA) levels show changes in the body's ability to fight off harmful substances and in the breakdown of fats. Notably, the control group had a higher

concentration of GSH in the liver tissue compared to the R1 and R2 experimental groups. On the other hand, the GSH level in muscle tissue was highest in experimental group R1, showing tissue-particular reactions to grape pomace addition [9]. In the same way, the level of MDA, the indicator of lipid oxidation showed differences in different tissues and groups in the experiment [10, 12]. There were notable decreases in group R1

compared to the control group, especially in muscle tissue.

According to Figure 1, we can see that giving grape pomace to *Cyprinus carpio* L. in their daily diet. Had a diverse impact on the substance of this biochemical marker in the examined samples [11]. The chemical study of carp meat showed notable differences in water, protein, collagen, and fat levels in different diets. Significantly, the greatest addition 10% resulted in a higher protein content in carp flesh, suggesting a possible improvement in nutritional value. Fish is widely recognized as a vital protein source in the human diet, and its nutritional value is largely attributed to its high protein content. On the other hand, reducing the amount to 5% led to increased fat content in carp meat, possibly impacting its sensory qualities and lipid profile. These results are similar to other studies on carp and highlight the possibility of adding supplements to change the nutritional content of carp meat, which could affect its quality and appeal to consumers [12].

According to the literature, various methods can boost antioxidant capacity. One such method involves using synthetic antioxidants or antioxidants from natural sources.

In the last few years, people have been using ecological food sources more often, and aquaculture is now the fastest-growing food production sector. Moreover, it is understood that managing the nutrition of fish is important for reducing expenses and increasing growth in sustainable fish farming methods.

When discussing the findings, we need to consider how the weather and surroundings can pollute the soil and decrease the amount of necessary nutrients for growing top-quality grapes and, as a result, a high concentration of beneficial compounds in the grape residue [13, 14].

4. Conclusions

Adding grape pomace to carp diets had different effects on their growth, physiological measurements, and biochemical makeup. The chemical makeup of carp meat changes as well, with variations in the wetness, protein, collagen, fat, and salt levels observed between the control and experimental groups. Additionally, using grape pomace as a supplement has shown promise in controlling oxidative stress. This indicates that

it may help to improve antioxidant defenses and have an impact on intestinal health. These results emphasize the significance of grape pomace as a sustainable ingredient in fish farming, providing information on its possible advantages for the health and nutrition of fish. More research is needed to understand the basic reasons and improve the amount of grape pomace in fish food to maximize its nutritional and health benefits.

References

1. Garcia-Lomillo, J., Gonzalez-SanJosé, M. L., Application of wine pomace in the food industry: Approaches and functions, *Compr. Rev. Food Sci. Food Saf.*, 2017, 16, 3-22.
2. Pulgar, R., Mandakovnic, D., Salgado, P., Venegas, L., Ortiz, D., Pena-Neira, A., Wacyk, J., Micro-encapsulated grape pomace extract (MGPE) as a feed additive improves growth performance, antioxidant capacity, and shifts the gut microbiome of rainbow trout, *Aquaculture*, 2021, 544, 737129.
3. Heuzé, V., Tran, G., Grape Pomace. Feedipedia, a Programme by INRAE, CIRAD, AFZ and FAO. 2020 Available online: <https://www.feedipedia.org/node/691>
4. Moate, P. J., Williams, S. R. O., Torok, V. A., Hannah, M. C., Ribaux, B. E., Tavendale, M. H., Eckard, R. J., Jacobs, J. L., Auld, M. J., Wales, W. J., Grape marc reduces methane emissions when fed to dairy cows, *J. Dairy Sci.*, 2014, 97, 5073-5087.
5. Mahmoodi, B., Aberoumand, A., Ziaei-nejad, S., Seyyedi, S., Effects of diets containing grape pomace on the growth, nutrition indices, and the quality traits of common carp (*Cyprinus carpio*), *Food Sci. Nutr.*, 2023, 11, 6660-6669.
6. Bradford, M. M., Arapid and sensitive for the quantitation of microgram quantities of protein utilizing the principle of proteindye binding, *Anal. Biochem.*, 1976, 72, 248-254.
7. Tarricone, S., Iaffaldano, N., Colonna, M. A., Giannico, F., Effects of dietary red grape extract on the quality traits in juvenile European sea bass, *Animals*, 2023.
8. Odajima, N., Betsuyaku, T., Nagai, K., Moriyama, C., Wang, D. H., Takigawa, T., Ogino, K., Nisihimjura, M., The role of catalase in pulmonary fibrosis, *Respir. Rev.*, 2010, 11, 183.
9. Flohé, L., Toppo, S., Orian, L., The glutathione peroxidase family: Discoveries and mechanism, *Free Radic. Biol. Med.*, 2022, 187, 113-122.
10. Hassan, Y. I., Kosir, V., Yin, X., Ross, K., Diarra, M.S. Grape Pomace as a Promising Antimicrobial Alternative in Feed: A Critical Review, *J. Agric. Food Chem.*, 2019, 67, 9705-9718.

11. Morales, M., Munné-Bosh, S., Malondialdehude: Facts and artifacts, *Plant. Physiol.*, 2019, 180, 1246-1250.
12. Sukhovskaya, I. V., Borvinskaya, E. V., Smirnov, L. P., Kochneva, A. A., Role of Gluthione in Functioning of the System of Antioxidant Protection in Fish (Review), *Inland Water Biol.*, 2017, 10, 97-102.
13. Pena, E., Badillo-Zapata, D., Viana, M. T., Correa-Reyes, G. Use of grape pomace in formulated feed for the rainbow trout fry. *Oncorhynchus mykiss* (Walbaum, 1792), *J. World Aquacult. Soc.*, 2020, 51, 540-550.
14. Walton, J. M., Metabolic effects of feeding a high protein/low carbohydrate diet as compared to a low protein/high carbohydrate diet to carp, *Fish Physiology and Biochemistry* 1986, 1, p 7-15.