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THE STUDY OF DDGS AS FOOD COMPONENT FOR COMMON CARP (*Cyprinus carpio*)

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Abstract

Dried distillers grains with solubles(DDGS), is a product from the ethalon production sector that is effectively used in feed for cattle and pigs because of its relatively high protein and nutrient value and lower cost that grains. The purpose of this research was to determine the best DDGS level that could be added to the diet of common carp. A six-week trial was conducted with common carp starting at a weight of 84 g, using three test diets:P0 (0%), P1 (25%) and P2 (35%). The chemical makeup of DDGS examined with Fourier Transform Near-Infrared spectroscopy revealed a protein level of 28.45% and oil content of 5.86%. the diets containing DDGS did not lead to notable changes in growth measures and meat quality. In terms of oxidative state in the muscle tissue, P1 and P2 significantly decreased, in a dose-dependent way, the specific activity of SOD and GSH, while CAT and GPX remained unchanged. The objective of this study was to evaluate the impact of substituting sunflower meal with DDGS in the common carp diet on key growth measures, meat quality, and oxidative stress.

Key words*: common carp, diets, growth, oxidative stress, protein.*

INTRODUCTION

The common carp ranks across Asia and Central and Eastern Europe (EuroStat, 2022). In these cultivation environments, the diet mainly consists of naturally occurring live organisms found in water alongside additional grains (Rahman, 2015). Grains are primarily processed through methods such as grinding to decrease particle size and enhance nutrient accessibility or to make them more palatable and remove anti-nutritional substances (Shipton et al., 2021). Due to significant upfront investment costs, the processes of grain extrusion and granulation are typically employed in intensive farming systems (Rahman, 2015). In Romania, given that common carp is an inexpensive fish feed accounts for approximately fifty percent of overall production expenses, it is crucial to source feed ingredients at a low cost (FAO, 2022).

DDGS are a secondary product created during the process of making ethanol from grains (Stein et al., 2009). It is accessible at a favourable price based on protein content in comparison to other protein options. DDGS is regarded as a viable source of protein and energy in the global feed market, featuring a moderately high protein level. It is effectively utilized in the diets of rabbits, cattle, sheep, and pigs (Sobczak et al., 2021). Additionally, it has been evaluated for various fish species. When combined with phytase, DDGS shows excellent results in terms of growth metrics. The inclusion of DDGS in the diets of omnivorous fish is particularly appealing due to its protein levels aligning closely with the nutritional requirements of these species (Abouel et al., 2022).

In this context, this research focused on examining the impact of substituting sunflower meal with DDGS in the diet of common carp on primary growth metrics, biochemical characteristics, flesh quality, and oxidative conditions.

MATERIALS AND METHODS

The living organisms utilized in this research included a one-year-old common carp *Cyprinus carpio* L., which was caught from a pond and

then moved to the Recirculating Aquaculture System. There, they were given a period of two and a half weeks to adjust. Following this adjustment phase, the fish were fasted for 24 hours, weighed, and of 85 grams were chosen.
The animals were divided into their dietary categories (P0, P1, P2). The duration of the study was six weeks. The animals were fed by hand there times daily. The feeding amount was based on the fish's weight and the temperature of the water. Measurements of temperature and dissolved oxygen levels were taken using a portable oxygen meter, while pH and conductivity were assessed with a portable multiparameter device. Table 1 illustrates the water conditions.

Table 1. The physical-chemical properties of water

Parameters	Measure Units	Values
Temperature	°C	21.00
pH	Units	8.20
Dissolved oxygen	mg/L	6.30
NO_3-	mg/L	29.00
NO_2-	mg/L	0.12
NH_3^+	mg/L	0.10
NH_4^+	mg/L	0.08
PO_4^{3-}	mg/L	0.03

To evaluate the influence of DDGS on common carp, there distinct diets P0, P1, and P2 were created. The initial diet, P0, is composed of sunflower meal, wheat, corn, and fish meal. P0 serves as the control diet due to its lack of DDGS. The subsequent diets, P1 and P2, include DDGS at levels of 25% and 35%, in addition to the previously mentioned components. Table 2 displays the components utilized in the experimental diets. The diets were prepared through a process of extrusion, followed by mixing, grinding, and pelleting.

Table 2. The mixture of components utilized in the trial feeds containing DDGS for common carp

Ingredients	P0 %	P1 %	P2 %
DDGS	0	25	35
Sunflower meal	35	20	5
Wheat	20	15	20
Corn	25	20	20
Fish meal	20	20	20

The data regarding growth performance, meat quality, blood biochemical profile, and intestinal microbiota were analysed using statistical methods, specifically analysis of variance ANOVA and subsequently the Tukey Test.

RESULTS AND DISCUSSIONS

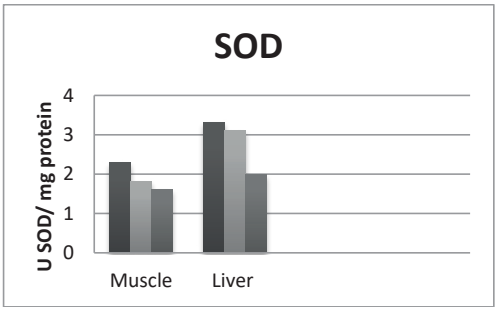
The Table 3 displays the nutritional makeup of the diets. The components utilized in this research are frequently found in the feeding of common carp. The protein level was notably reduced in P2, dropping 6% in relation to P0, whereas the fat content showed a significant rise in P2 and P1, with increases of 60% and 49%, respectively, when compared to P0. A larger variance in dietary composition was observed in P2, leading to a considerable reduction in starch, fibre, and calcium levels compared to P0, while sugar and phosphorus levels increased significantly in comparison to P0.

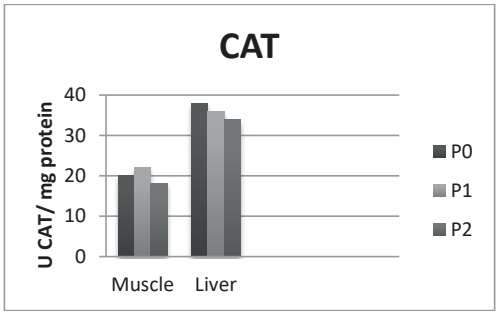
Table 3. The results obtained regarding the chemical composition of diets for common carp containing DDGS

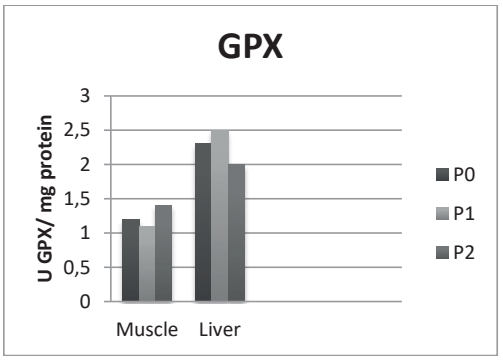
Parameters	P0 %	P1 %	P2 %
Protein	27.34	27.25	25.79
Fat	3.22	4.42	4.89
Fibre	6.68	5.13	4.96
Moisture	8.97	9.11	10.73
Amidon	43.94	40.98	40.15
Sugar	1.22	2.46	2.96
Calcium	1.82	1.59	1.38
Phosphorus	0.3	0.61	0.8
Ash	7.7	7.84	7.43

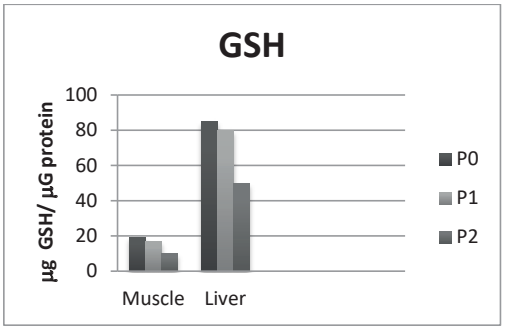
The development metrics of *Cyprinus carpio*. The differences observed were minimal and not significant from a statistical perspective for every metric. Nonetheless, it is important to highlight that the feed conversion ratio, a crucial indicator of how effectively feed is utilized, fell by 40% in P1 and by 29% in P2 when compared to P0.
The immediate makeup of meat. The differences were minimal, hence, adding DDGS to the diet had no impact on meat quality. The fat level was reduced by 21% in P2 and increased by 13% in P1 in comparison to P0, yet these variations were insignificant. The only noteworthy changes observed in relation to P0 were for the salt and ash

measurements, with salt content declining by 51% in P1 and ash content rising by 34% in P2. After conducting biochemical examinations on muscle and liver tissue samples, we observed that the diet containing DDGS affected the oxidative condition. In muscle tissue, this diet resulted in a notable decrease, following a dose-dependent trend, in the specific activity of superoxide dismutase (SOD), while the specific activities of catalase (CAT) and glutathione peroxidise (GPX) remained unchanged (Rajoka et al., 2021). Conversely, carp that consumed the DDGS diet showed a reduction solely in the liver tissue's CAT specific activity when compared to those that received a standard diet. Both diets that included DDGS, particularly the one with a higher DDGS content, significantly reduced the glutathione (GSH) levels in muscle and liver when compared to the standard diet. Additionally, low amounts of malondialdehyde (MDA) and carbonylated proteins were found in the muscle tissue across all subjects, while in the liver, only the diet with higher DDGS content significantly decreased these levels when compared to the control group (Figure 1).









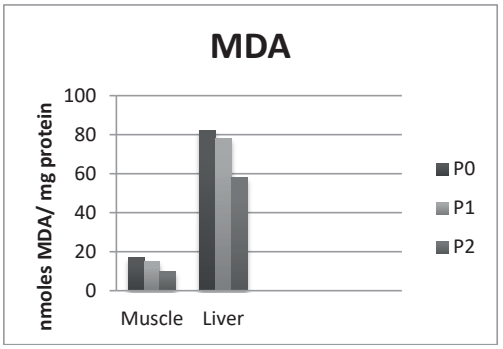


Figure 1. The impact of various dietary options on both enzymatic and non-enzymatic indicators of oxidative stress assessed in the muscle and liver tissues of carp. The enzymatic measurements involved determining the specific activities of SOD, CAT, and GPX, whereas the non-enzymatic evaluations included assessing the concentrations of GSH, MDA, and carbonylated proteins

The purpose of this research was to determine the best amount of DDGS to substitute sunflower meal in the diet of common carp while promoting normal growth without impacting the species' growth and physiological measures. To meet this objective, factors such as growth metrics, meat quality, blood biochemical profile, oxidative condition, and gut microbiome were examined (Dediu et

al., 2021). A significant concern regarding the sustainability of feed formulation and ingredient choice is the necessity to fulfill the species' nutritional needs to support optimal and healthy growth at the intended density and within the cultivation system.

The nutrient composition in DDGS can differ based on the research, the manufacturing plants, or even the specific batch from the same manufacturer. Thus, it is advisable to evaluate the makeup of every new batch intended for use as a component in feed production.

The sunflower meal analyzed in this research exhibited a significant amount of protein and a minimal amount of fat. Consequently, substituting it with DDGS resulted in a 6% reduction in protein levels in P2 and a 61% rise in fat content when compared to the control P0. Nevertheless, adding DDGS to the diet did not produce any statistically meaningful alterations in growth measurements, emphasizing the potential for incorporating DDGS into the diet of common carp.

Concerning the effect of DDGS on the composition of flesh, the differences observed in this study were minimal, particularly from a nutritional standpoint when it is intended for human consumption (Welker et al., 2014). For instance, the level of fat is a critical quality measure for fish flesh, which can be affected by both dietary and technological influences. In certain European nations, carp meat can only be sold if it contains a reduced fat level, as an increased fat content can have an adverse impact on the flavor of the meat. Concerning oxidative state, this research indicated that DDGS results in a decrease in the activity of SOD in muscle, CAT in liver tissue, and GSH in both examined tissues in a dose-dependent manner. Additionally, levels of MDA and carbonylated proteins were lower in the liver of subjects consuming the DDGS diet.

The imperative to boost production densities in aquaculture for better profitability may negatively impact animal welfare due to the onset of oxidative stress on a physiological level (Ruane et al., 2002).

The enzymes SOD, CAT, GPX, and GSH are involved in the body's response to oxidative stress by transforming superoxide radicals and hydrogen peroxide into $O_2$and H_2O, while markers like MDA indicate oxidative stress.

To mitigate oxidative stress resulting from elevated cultivation densities or adverse environmental factors, diets rich in antioxidants can be beneficial.

Consequently, studies focused on discovering ingredients with antioxidant properties are relevant. Generally, heightened activity of antioxidant enzymes reflects stress levels. As noted with the previously mentioned parameters, the influence of diet on oxidative status in fish can differ, influenced by both the tested ingredients and the specific species involved (Firas et al., 2020).

The microbiological analysis involved measuring the quantity of microorganisms present in the intestinal material of the carp, which included counting the overall number of aerobic microorganisms, the total count of anaerobic microorganisms, the cumulative quantity of sulphite-reducing Clostridia, and the overall number of Enterobacteriaceae (Rîmbu et al., 2020).

The assessment of the intestinal microorganisms in common carp included: the overall count of aerobic bacteria (TNA), the overall count of anaerobic bacteria (TNAN), the total amount of sulfite-reducing clostridia (TNC), and the overall count of Enterobacteriaceae (TNE). It was observed that the density of microorganisms fluctuated based on the type of feed provided.

The statistical examination of the logarithmic figures indicated a continuous rise in microbial density linked to the amount of DDGS present in the feed. Noteworthy differences were observed at P2 when compared to P0, showing increases of 12% at TNA and 14% at TNE (Figure 2).

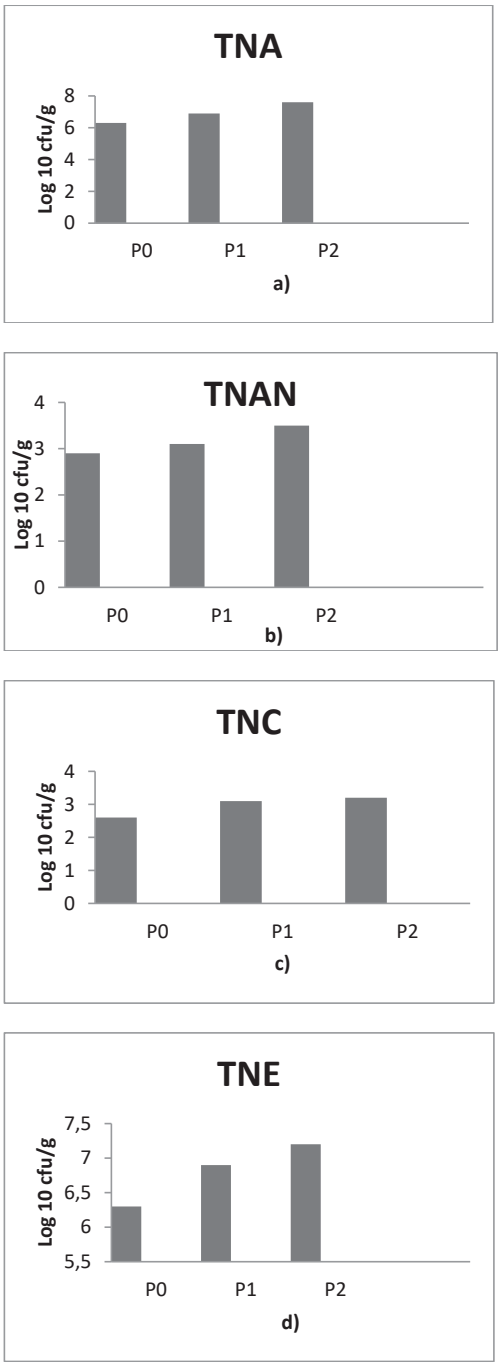


Figure 2. Illustration of the logarithmic averages of: a) overall count of aerobic bacteria (TNA); b) overall count of anaerobic bacteria (TNAN); c) overall count of sulfite-reducing clostridia (TNC); d) overall count of Enterobacteriaceae (TNE) in the intestine of common carp that consumed test diets containing DDGS

As organic pollution rises, the processes of proteolysis and ammonification in sulphite reducing clostridia can become activated, resulting in substantial production of hydrogen sulphite and ammonia. The introduction of new pollutant substances brings about significant alterations in the dynamics of all oceanic biocenosis and disrupts the natural balance of this ecosystem (Oliveira et al., 2017).

A notable increase 13% was observed in the levels of Enterobacteriaceae, indicating a statistically significant change. These Gram-negative microorganisms, which thrive in the presence of oxygen, are typically found in the microbiota of fish (Cahill, 2024).

A recent investigation revealed a link between the presence of enterobacteria and decreased digestibility in fish subjected to alternating diets containing both animal and plant protein sources (Rîmbu et al., 2020). The study concluded that enterobacteria disrupted the symbiotic equilibrium within the gut, facilitating the growth of opportunistic bacteria and resulting in a decline in nutrient digestibility (Ofek et al., 2021). Our research has demonstrated that a rise in the population of Enterobacteriaceae did not adversely impact the metabolism and digestibility of the proteins in the feed provided, nor did it affect the growth and health of fish consuming DDGS.

CONCLUSIONS

The findings from this research indicated that incorporating 35% DDGS into the diet had no impact on growth metrics or the quality of the flesh. Specifically, the differences observed between P0, P1, and P2 were not statistically significant. In terms of flesh quality, the fat levels in the P2 group showed a decrease, yet this was not significant, while P1 exhibited a notable increase. Meanwhile, there was an improvement in oxidative status, and the intestinal microbiota experienced positive effects. This research illustrates that the inclusion of 35% DDGS and the reduction of sunflower meal from 35% to 5% in the diet does not interfere with the growth and development of carp. These findings can inform the development of effective feed formulations with DDGS for common carp.

To sum up, this research focused on examining the impact of substituting sunflower meal with DDGS in the feeding regimen of common carp.

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