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Effect of Germinated Barely and Earth Apple (*Helianthus tuberosus)* Powders in Some Physio-biological Indices of Common Carp (*Cyprinus carpio* L.)

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Abstract

BACKGROUND: Germinated Barely and Earth Apple were used as a source of prebiotic to enhance fish health and welfare.

OBJECTIVES: The effect of adding different levels of both germinated barley and earth apple powders in Cyprinus carpio diets was evaluated.

METHODS: First Diet (Control diet free of any additives), diets in treatments of 2, 3, 4, 5, 6 and 7 with 2.5, 5, and 7.5 gr/kg diet of each of barley and earth apple powders respectively on an equivalent basis of protein.

RESULTS: T4 with 7.5 gr Earth apple was higher significantly ($P \leq 0.05$) in Gill index. T5 with 2.5 gr Barley was significantly higher ($P \leq 0.05$) in the Kidney index. Spleen somatic index was higher in all treatments except for T2 and T4. T2 and T5 were significantly higher in the Hepatosomatic index. Using germinated barely and earth apple powder in intestine indices either weight or length, the T7 with 7.5 gr Barley has more impact on the fish intestine. T3 with 5 gr Earth apple was higher significantly ($P \leq 0.05$) in each meat index in terms of Fish weight without viscera and Fish weight without viscera & head.

CONCLUSIONS: Earth Apple powder as a source of prebiotic enhances the health parameters in biological parameters ($P \leq 0.05$).

KEYWORDS: *Cyprinus carpio* L., Earth apple, Germinated barely, Physio-biological indices

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Introduction

Carp is one of the most popular farmed fish in the world. Its breeding distribution in the world includes almost any region that is warm enough. Carp breeding in Asia is developing rapidly. Over the past two decades, production has grown by an average of 12% a year. Carp products more than 70% of aquaculture volume in Asia and the world and is considered the main source of fish protein production. Meanwhile, carp farming can play a decisive role in the prosperity of the communities' economy, and its breeding is of particular importance (Abilov *et al.*, 2021)

Prebiotics are non-digestible food items that have beneficial effects like supporting the survival or continuation of probiotic strains, enhancing host mechanisms for protection, boosting tolerance to multiple health conditions, and complications with the human gastrointestinal tract. Prebiotics are carbohydrates, classifiable according to their molecular size or the number of saccharide units into monosaccharides, oligosaccharides, or polysaccharides. If the use of prebiotics leads to a clearer manifesting of health responses in fish, then prebiotics may be capable of enhancing the efficacy and sustainability of aquaculture production (Ringø *et al.*, 2010).

Prebiotics are new functional food products consisting of oligosaccharides that may stimulate the development of the beneficial microorganism or probiotics known as soluble dietary fiber (Rastall, 2000). Prebiotics are one of the therapeutic substitutes, non-viable food ingredients that are fermented by probiotics or protective bacteria that resist digestion in the upper gut. In a study by Tuohy *et al.*, prebiotics were characterized by their unique property of selective fermentation by bifidobacteria-/lactobacilli inside the gut micro-flora from other dietary fibers (2005). By encouraging bifidobacteria and/or lactobacilli colonies and increasing calcium and mineral absorption, prebiotics may enhance colon health (Gonzalez *et al.*, 2020). Most prebiotics are the non-digestible oligosaccharides, i.e., galacto-oligosaccharides (GOS), fructo-oligosaccharides (FOS), isomalto-oligosaccharides (IMO), xylo-oligosaccharides (XOS), soybean oligosaccharides (SOS), except for polysaccharide-inulin (Vernazza *et al.*, 2006; Wichienchot *et al.*, 2015).

Jerusalem artichoke (*Helianthus tuberosus*) belonging to the family of Asteraceae, used commercially in the production of prebiotics, *J. artichok*e tuber contains 13%–18% carbohydrates, of which about 80% are inulin-type fructans, 10%–13% are sucrose, 3.5%–5% are reducing sugars, 10%–17% are proteins and 0.8%– 0.9% are important minerals including K, Ca, P, Fe, Zn, Mg, Na, Cu and Mn (Barta and Pátkai 2007).

To expand the food industry and enhance host health, H. tuberosus fructo-oligosaccharides can have greater stability in developing probiotics and acids. It can be seen as a possible source of high-yielding oligosaccharides for commercial prebiotic development (Ali *et al.*, 2016). *H. tuberosus* tubers primarily contain two carbohydrate forms, inulin, and sugar (fructose and glucose). They are functional foods that aim to provide more health benefits, as well as basic, which is the nutritional value in foods depending on the specialized products that may be their contribution to disease prevention or improving health or support the structure or function of the body (Agriculture & Agri-Food, 2015).

As a functional food ingredient, inulin is a fascinating compound from a bio-refinery point of view. It adds to the organoleptic properties of food, increases foam, emulsion consistency, and has fat-like characteristics when used as a gel in water. It has been shown that inulin and oligo-fructose stimulate the body's immune systems, increase calcium absorption, and reduce the content of triglycerides and fatty acids in the blood serum. It modulates insulin and glucagon hormone levels and reduces the occurrence of colon cancer (Johansson *et al.*, 2015).

Germinated barley food items are a prebiotic substance derived from germinated barley aleurone and scutellum fractions and consist of insoluble protein rich in glutamine and dietary fiber. The study of Faghfoori *et al.*, (2014) shows that GBF intake along with routine medicine in inflammation attenuates, efficient and healthy therapies and has a biological anti-inflammatory mechanism of GBF action. Using germinated barely and earth apple *Helianthus tuberosus* powders as a source of prebiotic were tested

by the physiological indices in common carp *Cyprinus carpio* L.

Materials and Methods

Experimental Diet

Focused on the proximate composition of the food ingredients, seven groups of diets were prepared. First Diet (Control diet free of any additives), diets in treatments of 2, 3, 4, 5, 6, and 7 with 2.5, 5, and 7.5 gr/kg diet of barley and earth apple powders respectively on an equivalent basis of protein.

Common carp: Aquariums were randomly assigned to *C. carpio* L. with an average weight of 34.71 gr from a fish farm situated in Kirkuk/ Iraq. (Seven fish/aquarium). Each treatment was represented in three aquaria (3 replicates/7 fish in each replicate).

Experimental system: The research facility consisted of 21 aquaria. (60 litter each). Aerated and dechlorinated tap water was supplied to each aquarium, stored in tanks for 24 hours, and aerated by air pumps (Model-Rina 301) during the experimental period. By incorporating new well-aerated fresh water, the water level was held to a set level for 12 weeks.

Physio- Biological Parameters

Fish samples were scarified and the stomach, and liver and other organs to be measured at once were soon opened for removal. The gonad and liver indices were calculated as follow according to Abdulrahman *et al.*, (2018):

Hepatosomatic index (HI) % = 100 x Liver weight (g)/body weight (gr)

Spleen somatic index (SI) = 100 x Spleen weight / body weight (gr)

Gill index (GI) = 100 x Gill weight / body weight (gr)

Kidney index (KI) = 100 x Kidney weight / body weight (gr)

Condition factor (K) = Fish weight/ Total length^3

Intestine index% = 100 x Intestine weight (gr)/body weight (gr)

Intestine length index= 100 x Intestine length / body weight (gr)

Statistical Analysis

Statistical analyses were carried out using the two-way classification of the Analysis of variation (ANOVA) and the multiple Range Evaluation of Duncan, to determine variations between the means of treatment at the relevance rate of P-value < 0.05. The standard errors of treatment means were also estimated. All statistics were carried out using Statistical Analysis System (SAS program, 2004).

Results

T4 with 7.5 gr Earth apple was higher significantly in Gill index, T5 with 2.5 gr Barley was significantly higher in Kidney index, Spleen somatic index was higher in all treatments except T2 and T4. T2 and T5 were significantly higher ($P \leq 0.05$) in Hepatosomatic index as shown in Table 1.

Table 1. Effect of adding germinated barely and earth apple powders in some physio-biological parameters of common carp

Treatments	Gill index	Kidney index	Spleensomatic index	Hepatosomatic index
T1 Control	2.877 abc ± 0.210	0.438 d ±0.017	0.261 b ±0.045	2.397 bc ±0.173
T2 2.5 g Earth apple	3.506 ab ±0.311	0.718 b ±0.079	0.406 a ±0.058	3.242 a ±0.156
T3 5 g Earth apple	2.816 c ±0.146	0.554 cd ±0.028	0.263 b ±0.044	3.034 abc ±0.460
T4 7.5 g Earth apple	3.550 a ± 0.206	0.657 bc ±0.011	0.405 a ±0.023	3.188 ab ±0.318
T5 2.5 g Barley	3.425 abc ± 0.224	0.967 a ±0.027	0.364 ab ±0.045	3.672 a ±0.138
T6 5 g Barley	2.831 bc ±0.023	0.736 b ±0.044	0.350 ab ±0.040	2.202 c ±0.018
T7 7.5 g Barley	2.805 c ±0.185	0.816 b ±0.074	0.378 ab ±0.014	2.872 abc ±0.289

Means with same letters have different significant ($P \leq 0.05$).

Table 2 illustrates the effect of using germinated barely and earth apple powder in intestine indices either weight or length, the T7 with 7.5 gr Barley have the more effect on fish intestine. No significant differences ($P \leq 0.05$) occurred in condition factor.

Table 2. Effect of adding germinated barely and earth apple powders in condition factor, intestine length and weight index of common carp

Treatments	Intestine length index	Intestine weight index	Condition factor
T1 Control	173.775 b ±1.900	4.197 b ± 0.088	1.592 a ± 0.047
T2 2.5 g Earth apple	194.635 ab ± 6.252	3.509 b ± 0.238	1.509 a ± 0.091
T3 5 g Earth apple	197.479 a ± 8.972	3.510 b ± 0.093	1.667 a ± 0.051
T4 7.5 g Earth apple	199.589 a ± 9.934	4.513 ab ± 0.171	1.541 a ± 0.086
T5 2.5 g Barley	200.000 a ± 0.000	3.744 b ± 0.053	1.576 a ± 0.045
T6 5 g Barley	173.398 b ± 5.174	4.203 b ± 0.635	1.438 a ± 0.044
T7 7.5 g Barley	215.445 a ± 2.573	5.256 a ± 0.359	1.607 a ± 0.113

Means with same letters have different significant ($P \leq 0.05$).

T3 with 5 gr Earth apple was higher significantly in each of meat index in term of Fish weight without viscera and Fish weight without viscera & head as mentioned in Table 3.

Table 3. Effect of adding germinated barely and earth apple powders in common carp meat index

Treatments	Fish weight without viscera	Fish weight without viscera & head
T1 Control	81.854 b ± 1.233	51.486 bc ± 1.040
T2 2.5 g Earth apple	79.320 d ± 0.167	50.445 c ± 0.486
T3 5 g Earth apple	83.842 a ± 0.077	55.165 a ± 0.564
T4 7.5 g Earth apple	79.595 cd ± 0.464	51.038 c ± 1.118
T5 2.5 g Barley	78.593 d ± 0.385	54.235 ab ± 2.448
T6 5 g Barley	81.568 bc ± 0.663	50.641 c ± 0.367
T7 7.5 g Barley	80.341 bcd ± 0.753	50.937 c ± 1.150

Means with same letters have different significant ($P \leq 0.05$).

Discussion

The study of Soleimani *et al.*, (2012) and Abdulrahman and Ahmed, (2016) showed that adding of Fructooligosaccharides (FOS) to Caspian roach *Rutilus rutilus* and common carp could modulate the innate immune responses. Stimulation of the growth

of beneficial bacteria can be due to the immunostimulatory nature of prebiotics such as lactic acid bacteria and *Bacillus* spp., which possess cell wall components such as lipopolysaccharides that have immunostimulatory properties (Zhang *et al.*, 2011). The encouraging outcomes of rainbow trout growth and biochemical tests and favorable feed conversion mean that testing higher concentrations of the ProfeedR prebiotic substance would be worthwhile used by Řehulka *et al.*, (2011).

These results are due to the presence of a high-content earth apple of the inulin and FOS (Fructooligosaccharides), which improves growth performance and enhances the immune response by modifying the social formation of the enteric flora in favor of beneficial bacteria through the creation of the appropriate environment and the basis for the growth and reproduction of beneficial bacteria (Iraporda *et al.*, 2019). Inulin is a functional food with varying properties, and its effect appears stable and increases with increasing doses. The change caused by prebiotic may be from the enhancement and domination of beneficial organisms of bacteria lactobacilli or bifidobacterium that have rivaled harmful microorganisms over place and food or have reduced their metabolic processes by stimulating the non-specific immune response of the host (Jirayucharoensak *et al.*, 2018).

Based on the results of Sleman *et al.* (2021), supplementation of Chlorella and germinated barley in diet can affect some blood and biochemical parameters. Their results revealed that adding algae Chlorella and germinated powder in the fourth treatment significantly affects hemoglobin and red blood corpuscles. A significant difference observed in the Hepatosomatic and Gillsomatic indices, T5 with 20 % germinated barely, was significantly different in each of Spleen somatic and Kidney somatic, so *Chlorella* can be considered a good choice a supplement and additive for fish diets. Because of high crude protein levels, it possesses a significant concentration of polysaccharides, lipids, minerals, and other bioactive components involved in many physiological activities.

In a study in Iraq about using of prebiotics and their sources in fish, Al-Asha'ab *et al.* (2014) compared Iraqi probiotics and FOS in common carp. They found significant differences for T5 ($P \leq 0.05$) in growth parameter, food conversion, feed efficiency ratio, and apparent coefficient digestibility ACD. Taher *et al.* (2018) used bay laurel's (*Laurus nobilis*) leaf extract as a source of prebiotic. According to their results, the better results were achieved by T2, where 2% of laurel leaf extract was added to fish food. Abedalhammed *et al.* (2020) added Jerusalem Artichoke Tubers (*Helianthus tuberosus* L.) powder and Sprout Germinated Barley powder to diets of young common carp fish (*Cyprinus carpio* L.) to detect the effect on their growth. The feed utilization criteria significantly outperformed both the third treatment, 7.5 gr/kg Jerusalem and the sixth treatment, 7.5 gr/kg, for FER, PER, and FCR; the same treatments recorded the best ratios for feed transfer significantly on all transactions. At the same time, the worst one was the control significantly for all treatments and all criteria.

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Conflict of Interest

The author declared no conflict of interest for publishing this article.

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