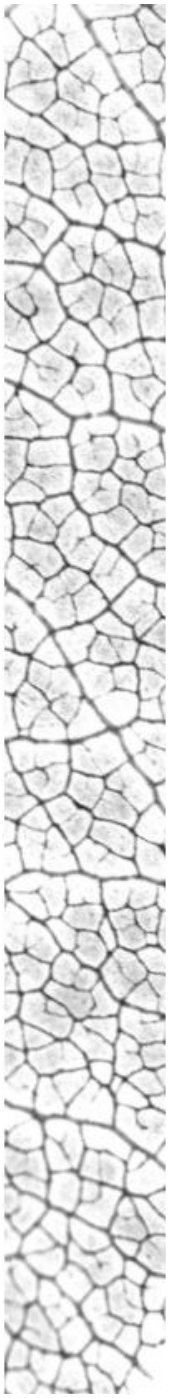

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Effect of using Jerusalem artichoke (*Helianthus tuberosus* L.) and Sprout germinated barley as a prebiotics to the diets of common carp (*Cyprinus Carpio* L.) fingerling on the rates of apparent digestible coefficient and apparent protein digestible

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Abstract
This study was conducted to find out the effect of adding different levels of Jerusalem Artichoke Tubers (Helianthus tuberosus L.) (JAT) powder and Sprout Germinated Barley (SGB) powder to common carp diets (Cyprinus carpio L.) on the rates parameters of Apparent Digestible Coefficient (ADC%) and Apparent Protein Digestible (APD%). 147 fish were distributed to seven treatments, 7 fish in each aquarium with three replications per treatment, for a period of 70 days. It was fed with 3% of weight of the biomass and was given twice a day. The (JAT) powder was added at the rate of 2.5, 5 and 7.5 g/kg, for the first, second, and third treatments respectively, add (SGB) powder 2.5, 5 and 7.5 g/kg for the fourth, fifth and sixth treatments respectively. ADC% Rate, third treatment which was 7.5 g/kg of JAT significantly P≤0.05 outperformed, for ADC (69.915%) on all treatments, It did not differ did not differ significantly P≤0.05 with both the fifth treatment (5 g/kg SGB) and the sixth one (7.5 g/kg SGB), They recorded 69.090% and 69.715% respectively. APD% Rate: The second treatment (5 g/kg SGB) and the third treatments (7.5 g/kg SGB) it recorded (79.215%) (79.650%) respectively, significantly P≤0.05 outperformed for the APD on all treatments. It did not differ significantly P≤0.05 with the fifth treatment (5 g/kg SGB) and sixth (7.5 g/kg SGB) and recorded 75.985% and 76.945% respectively.

Keywords: Jerusalem artichoke, germinated barley, common carp Cyprinus carpio L., apparent digestible coefficient, apparent protein digestible

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INTRODUCTION

Aquaculture projects in general are considered one of the fastest production projects and the most globally developed in particular the aquaculture of all kinds of carp fish, in order to provide food with good quality specifications suitable for human consumption (Pineiro, et al. 2008). This rapid development has been accompanied by an increase in stress on fish in water bodies due to various factors, for example (fish handling, congestion, and low-quality water), Which may be followed by a weak innate immune system and some mortality.

As production in an intensive manner with reduced food quality and low water quality causes an increase in stress that results in an increase in bacterial and viral infections or parasitic infections, which reduces productive growth (Hoseinifar, et al. 2016). The most common method used for a long time to deal with the occurrence of bacterial infections in fish is antibiotic therapy. However, fish faced serious problems due to the anti-drug effects, for example, tissue accumulation, reduced immunity, the development of antibiotic-resistant bacteria and the destruction of the micro-flora environment in the gut (Gonzales, et al. 2012; Ghaseminia, et al, 2016). Common carp (*Cyprinus*

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Table 1. The components of the diet used in the experiment

Ingredients	Ratio %	The contribution of feedstuffs to various nutrients				
		Dry matter	Raw protein	Raw fiber	Fat	Energy Kcal/Kg
Animal Protein Cen.	20	18.58	8.00	0.44	1.00	421.4
Soybean meal	39	24.71	17.16	2.73	0.43	869.7
yellow corn	10	8.90	0.85	0.22	8.90	335.0
Barley	9	8.01	0.99	0.50	0.17	237.6
Wheat bran	20	17.80	3.14	2.20	8.00	260.0
Vit. and minerals	2	-------	-------	-----	-----	-------
Total	100	78.00	30.14	6.09	18.5	2123.7

(NRC, 1994)

carpio L.) is a freshwater fish that is commercially important in warm areas for its rapid growth and withstanding harsh environmental conditions (Mirghaed, Fayaz, & Hoseini, 2019).

Recent studies have provided evidence of Jerusalem Artichoke Tubers (*Helianthus tuberosus* L.) (JAT) it's a plant accumulates high levels of inulin 16–20% (fresh weight) (Khuenpet, Truong, & Polpued, 2020). Sprout Germinated Barley (SGB) is rich in dietary fiber 34.0% and β-Glucan 11.3%, which possesses all aspects aspects of the prebiotic definition (Rico, et al. 2020), including stimulation of Bifidobacterium and Lactobacillus is the beneficial sex of the host, which is the species that are usually targeted by prebiotics and endemic to colon as the primary substance for energy (Iraporda, et al. 2019). Prebiotics are non-digestible nutrients that allow specific changes in the composition and / or activity of the gastrointestinal microflora which have a positive effect on the food and health of the host (Merrifield, & Ringo, 2014), which improves the nutritional value of the diet by improving growth performance, enhancing health, developing the immune system, and significantly raising survival (Han, et al. 2010, Carbone, & Faggio, 2016).

The apparent digestible coefficient (ADC%) is one of the criteria taken into consideration for the evaluation of fodder materials and their components due to poor digestion and absorption of food completely within the digestive system and the disposal of part of it with excreta (Dam, et al. 2019), The absorbed nutrient is measured by the difference between the ingested nutritional component and the excreted nutritional component that shows the proportion of the digested nutritional component (Tran-Tu, et al. 2019).

Our current study aims to find out the effect of adding different levels of JAT powder and SGB powder to diets of young common carp fish (*Cyprinus carpio* L.) on the rates criteria of (ADC%) and (APD%).

MATERIALS AND METHODS

The experiment was completed in the fish laboratory of the College of Agriculture, Anbar University for the months of February, March and April of 2019. Any researcher wishing to conduct research or teaching using animals at University must file an animal use protocol (AUP) for review and approval by the specific college animal care and use committee (ACUC) before the activity begins and before any animals are obtained.

Table 2. Arranging the percentage of additions to experimental treatments

Treatment	Control	T. 1	T. 2	T. 3	T. 4	T. 5	T. 5
Additions	Nothing	GAT 2.5 Gm/Kg	GAT 5 Gm/Kg	GAT 7.5 Gm/Kg	SGB 2.5 Gm/Kg	SGB 5 Gm/Kg	SGB 7.5 Gm/Kg

Fish and Nutrition: The young common carp fish were brought from neighboring farms, and were carried out without anesthesia, The fishes were sterilized by 3% of saline solution NaCl for 3 minutes to get rid of parasite, fungi and bacterial infection. The feed ingredients were obtained from materials available in the local market. A feed provided with a protein ratio of 30.14% for the control treatment, as shown in **Table 1**.

JAT powder was added at 2.5, 5 and 7.5 g / kg for the first, second and third treatments. SGB powder added 2.5, 5 and 7.5 g / kg for the fourth, fifth and sixth treatments, respectively as shown in **Table 2**. A total of 147 fingerlings were randomly distributed in 21 glass aquarium (30×30×60 cm) at the rate of 7 fish (7.58±1.42 g) per glass aquarium (average weight of 53.09±0.67 g biomass per aquarium), three replicates for each experimental diet. Each glass aquarium was supplied with air pump water from a deep tube well with continuous aeration, the temperature was controlled 24 ± 1.5 °C All the fish were fed three time daily at a fixed feeding rate of 3% of body weight per day for 70 days.

The indicator addition: The digestibility experiment was conducted separately in glass aquarium. Chrome Oxide Cr2O3 at 1% was add to ingredient and formulated to pellet. Fishes were fed at the same program of the nutrition experiment with incessant observer during the experiment. From three replicates of each dietary treatment, the feces samples were daily collected in the morning by siphoning after removal of the uneaten feed following the ''immediate pipetting'' method outlined by (Shomorin, et al. 2019). The Feces naturally released by the fish could be easily detected and were immediately removed from the water with a glass canula. After 15 day experiment the fish feces were weighed, desiccated and analyzed. The standard curve conducted to estimation the concentration of Cr2O3 according to (Furukawa, & Tsukahara, 1966).

Statistical analysis of the experiment: The Data Analysis XLSTAT and JMP7 2012, was used to analyze the relevant data which was obtained at the end of the experiment to determine the impact of the experiment coefficients, Using Complete Randomized Design (CRD) to the analysis significant differences between mean averages of parameters studied and at significance level (P≤0.05) were tested by Dunkin Directional Test (Duncan, 1955).

Table 3. Assessment of the digestibility in fish

Treatment	ADC%	APD%
Control	c 1.960±61.455	cd 1.135±68.780
2.5 gm/kg JAT	c 1.220±62.220	bc 0.440±72.790
5 gm/kg JAT	ab 1.005±68.730	a 1.090±79.215
7.5 gm/kg JAT	a 1.570±69.915	a 1.675±79.650
2.5 gm/kg SGB	bc 1.445±63.955	d 0.215±64.425
5 gm/kg SGB	ab 0.545±69.090	ab 1.430±75.985
7.5 gm/kg SGB	ab 2.135±69.715	ab 3.365±76.945

RESULTS

Apparent digestible coefficient: The results, as shown in **Table 3**, showed the superiority significantly P≤0.05 of the third treatment Which was supported by adding JAT powder 7.5 g / kg and recorded 69.915 ± 1.570 on all study treatments, It did not differ significantly P≤0.05 from the second, fifth and sixth treatments.

Apparent Protein Digestible: The results of the statistical analysis, as shown in **Table 3**, showed a significant superiority P≤0.05 for the second treatment (JAT 5 g / kg) and the third one (JAT 7.5 g / kg), and recorded 79.215 ± 1.090 and 79.650 ± 1.675, respectively, for all study treatments. There was no significant P≤0.05 difference between them and the fifth treatment (SGB 5 g / kg) and the sixth (SGB 7.5 g / kg).

DISCUSSION

These results are attributed to the effect of the JAT and SGB addition to the experimental diets and their superiority compared to the control treatment that was free from these additives. JAT contains inulin and soluble dietary fiber (Mensink, et al. 2015) as well as SGB containing β-clucan and hemicellulose rich in dietary fiber (Rico, Det al. 2020, Araki, et al. 2000), As a prebiotics, which is a nonviable natural food ingredient that can be chemically described as resistant to digestion and absorption, and fermentation in the colon. It provides health benefit to the host by modifying the components of the intestinal flora in the gut (Pineiro, et al. 2008). Which improves growth performance and enhances the immune response by modifying the societal formation of intestinal mycroflora in favor of beneficial bacteria (Probiotics) through the creation of an appropriate environment and the basis material for growth and reproduction (Iraporda, et al. 2019). In the test group had significantly better growth performance, which was due to increases in nutrient digestibility and absorption (Tsai, Chi, & Liu, (2019). Inulin is an unusually functional, food with an apparently stable effect increases with increasing dose (Nawaz, et al. 2018), This improvement can be attributed to one of the following reasons, The change that has occurred due to prebiotics may enhance the dominance of beneficial microorganisms, compete with harmful microorganisms for space and food. Or reduced their metabolism by stimulating the host's non-specific immune response (Iraporda, et al. 2019, Mensink, et alk. 2015), As for β-clocane, it works to maintain the digestive system, prevent colitis and boost immunity, as well as it can alter the intestinal flora in favor of the host (Dawood, et al. 2020, Vetvicka, Vannucci, & Sima, 2015), And hemicellulose fibers are among the functional nutrients that can induce a change in the intestinal flora formation beneficial for the benefit of the host (Slavin, 2013, Holscher, 2017), However, prebiotics must either improve the health of the host or provide it with a beneficial physiological effect, or both (Nawaz, Irshad, Hoseinifar, & Xiong, 2018). These benefits are achieved by modifying the composition of the intestinal flora to better intestine (Rastall, & Gibson, 2015). This showed its effect in raising the value of the ADC rate of the diet consistent with the addition ratio, so does the APD rate improved proportionately with improved ADC values. This is because the beneficial intestinal flora bacteria produce protein-digesting enzymes such as *B. subtillus* that can produce protease, amylase and lipase enzyme to digest protein and change the nature of undigested substances to simpler substances, which raises the ABD rate (Al-Dohail, Hashim, & Aliyu-Paiko, 2009). In addition to the fact that it produces some vitamins, such as vitamins B12 and boosts immunity.

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