Possibilities of Using Ginseng in Diets of Goldfish

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Keywords: *goldfish, carassius auratus auratus, ginseng, growth performance, head growth promoting diet.*

Abstract. *This research was carried out to determine the effects of adding 0, 30, 60 and 120 mg/kg ginseng to the diets (T_1, T_2, T_3 and T_4) on growth performance and head development of goldfish. The trial was randomly divided into four groups, 30 goldfish in each group for 90 days.*

As a result of the research, it was determined that the addition of ginseng (60 and 120 mg/kg) to the diets (T_3 and T_4) significantly increased the specific growth rate, total live weight gains, head and body height of the fish compared with the fish fed with the control diet (T_1) ($P < 0.05$) ($P < 0.01$). However, there was no positive effect on live weight gain, head height, and body height in fish fed the T_2 diet. All ginseng feeds positively affected head widths, feed consumption, and feed efficiency of fish. On the other hand, in this study, the body lengths of the fish were not significantly affected by ginseng application. Especially because of the risk caused by the use of ginseng, it seems that 60 mg/kg ginseng can be used as an appropriate dose in goldfish.

Introduction

Goldfish care has been a popular hobby for centuries, with steady expansion in its trade, growing interest, and over 125 countries. Over 2500 species are involved in the global ornamental fish industry, of which over 60% are of freshwater origin (Dey, 2016). Global imports of ornamental fish also increased from US$247.9 million in 2000 to US$ 275.2 million in 2016 (Anonymous , 2016a). The goldfish is the top freshwater seller in the Netherlands. Goldfish ranks second in sales of fish in the US (Anonymous, 2016 b). Goldfish (*Carassius auratus auratus*) belongs to the family *Cyprinidae* and is one of the most loved aquarium fish because of its color, body shape, and simple breeding that can be seen in ponds and aquariums in the world (Degirmencioglu, 2021). The head of some fish has a uniform texture, just like a blackberry. However, head texture is rough like cauliflower and is known as the tiger head (Smart, 2001). Goldfish are omnivorous fish. Trout feeds with excessive oil and protein content cause goldfish digestive disorders and developmental disorders. That is why cold-water fish have a balanced diet (Degirmencioglu, 2021). Crude protein and crude fat of a goldfish diet are respectively 30–35% and 5–7%. For reproductively active, breeding fish or juveniles, a diet higher in protein and fat needs to be selected (Anonymous, 2021). Goldfish puppies have increased protein requirements due to rapid tissue development. With an ideal feeding and soil pond, fry reaches their selling length in 3–4 months. It takes 2 years for the head to develop (Degirmencioglu, 2021). Therefore, goldfish feeds also need natural aromatic plants, growth-promoting as well as rich nutrient content. Among these aromatic plants, ginseng can be given as an example. Some studies have reported that adding ginseng to fish rations can reduce the death rate by stimulating the immune system, and positively affect the live weight, weight gain and feed conversion ratio of the animal by promoting growth; (Ashraf and Goda, 2008; Tawwab. 2012; Li et al., 2022; Mehrim et al., 2022).

Studies on the use of ginseng as a growth promoter in ornamental fish are rare. Therefore, reliable doses of ginseng in fish feed need to be investigated. The aim of the study was to determine the optimal ginseng dose in diets of goldfish.

Materials and methods

Study site

Twins aquarium, a commercial pet store located in the Bursa-sehreküstü district, was chosen as the experimental area. The experiment was conducted between September and November 2021 and lasted 90 days.

Animals, treatments, and experimental design

As the animal material of the research, a total of 120 of oranda (goldfish) (the age of about 2 months) were used. The trial was randomly divided into four groups, 30 goldfish in each group for 90 days. In this study, 600 mg of Panax Ginseng (G)containing ginseng root extract as a ginseng source were used. During the 90-day trial period, the goldfish in the 1st, 2nd, 3rd and 4th groups, were fed with diets supplemented with 0, 30, 60 and 120 mg/kg ginseng, respectively.

The concentrate feed mixture CFM consisted of 10% fish meal, 10% wheat gluten, 21% krill meal,

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15% soybean meal, 20% oat, 10% wheat germ, 3% spirulina, 9% wheat bran, 0.5% molasses, 0.5% vitamins and minerals mix, 0.5% probiotic, 0.4% Beta-xylanase + Phytase and 0.1% garlic powder (Table 1).

During the experiment, the fish in the 1st, 2nd, 3rd and 4th groups were fed with the respective diets (T_1: 35.99 CP % and 4495.28 Kcal kg^{-1}DM; T_2: 36.50 CP % and 4513.39 Kcal kg^{-1}DM: T_3: 35.48 CP % and 4447.13 Kcal kg^{-1}DM; and T_4: 36.28 CP % and 4537.54 Kcal kg^{-1}DM) (Table 1). While preparing concentrate feed mixes, it was aimed that the ratios of nutrients were close to each other. Before the experiment, the fish were photographed and individually numbered.

The fish were randomly divided into 4 groups, with 30 fish in each aquarium (90 × 40 × 50). In the determination of the nutrient contents of the ration used in the research, the nutrient limits of the cold water fish feed ration produced by a feed company of Far East origin were taken as the basis (CP min 32%, EE min 4%, CELL max 4% and crude ash max 12% moisture max 10%) (Anonymous, 2021b). The feed was brought to a dough consistency with a mixture of water and molasses, then the dough was passed through a meat grinder, and then left to dry in an oven at 65°C. The length and the diameter of the pellet were adjusted to 1–1.5 inches so that the fish could easily eat the prepared food mixture (shown in Figure 1). The body weights, feed consumption, and body forms of the fish were determined every 15 days throughout the experiment (shown in Figure 2).

Scales capable of measuring 0.001 g were used to determine fish weights. During the experiment, the live weights and live weight gains of the fish were determined by control weighing every two weeks. Daily feed consumption of fish was determined at the level of 2% of live weight. The feed was given by soaking in a small bowl so that bubbles do not form

Table 1. The composition of feed mixtures used in the research

Feed			**Diet**			
	100	Nutrient[3] composition	T_1 0.00 mg kg^{-1}	T_2 30.00 mg kg^{-1}	T_3 60.mg kg^{-1}	T_4 120 mg kg^{-1}
Fish meal	10	DM	96.88	96.44	96.78	97.09
Wheat gluten	10	OM	89.8	89.39	89.68	90
Krill meal	21	CP	35.99	36.50	35.48	36.28
Soya meal	15	EE	6.97	7.36	6.44	7.63
Wheat bran	9	CEL	2.86	2.71	3.03	3.00
Oat	20	CA	7.08	7.05	7.10	7.09
Wheat germ	10	NFE	43.98	42.82	44.73	43.09
Spirulina	3	ME[4] Kcal kg^{-1} DM	4495.28	4513.39	4447.13	4537.54
Molasses	0.5					
Vitamin + Mineral[1]	0.5					
Probiotic[2]	0.5					
Beta-xylanase + Phytase[3]	0.4					
Garlic powder	0.1					
TOTAL	100.					

[1]Trace minerals and vitamins (per kg): Dicalcium phospote, Sodium chloride, Magnesium oxide, Calcium carbonate Analyze: Calcium 17.90%, Phosphorus 10.80%, Natrium 5.5%; Retinolpalmitaat (Vitamin A) 2000.000 IE; Cholecol-ciferol (Vitamin D3) 200.000 IE; α Tocopherolacetat (Vitamine E) 8.000 mg; Asccorbinebinezuur (Vitamin C) 20.000 mg; Thiamine (Vitamine B1) 2.000 mg; Riboflovine (Vitamine B2) 4500 mg; Phyridoxine (Vitamine B5) 1500 mg; Nicotinumide (Vitamine pP) 5000 mg; calcium-D-pentothenote 1500 mg; Foliumzuur 400 mg; Menadion (Vitamine K3) 250 mg; Vitamin B12 30.000 mcg; Biotin (Vitamin H) 25.000 mcg; Magnesiumoxide 22.000 mg; Zinkoxide 50.000 mg; Nikkel (II)-Sülfat 10 mg; Natriumfluoride 50 mg; Borax 100 mg; Kaliumiodide 110 mg; Natriumbromid 100 mg; Mangan (II)-sulfaat 500 mg; Aluminisulfaat 500 mg; Litniumcarbonaat 500 mg; Kaliumsulfaat 5000 mgLizer (II)-Sulfaat 1500 mg Koper(II)-Sulfaat 400 mg.

[2](Saccharomyces cerevisiae) + lactobacillus acidophilus)

[3] **4a1617** Endo-1.4-beta-xylanase (EC 3.2.1.8) was obtained from Trichoderma citrinoviride Bisset (IM SD 135) 1.100.000 EPU/kg, **4a12** 6-Phytase (EC 3.1.3.26) was obtained from Trichoderma reset (CBS 122001) 83.400 PPU/Kg.

[3]DM: dry matter; OM: organic matter; CP: crude protein; EE: ether extract; CELL: cellulose; CA: crude ash; NFE: nitrogen free extract;

[4]ME: metabolizable energy.

Figure 1. Goldfish food (Degirmencioglu, 2021)

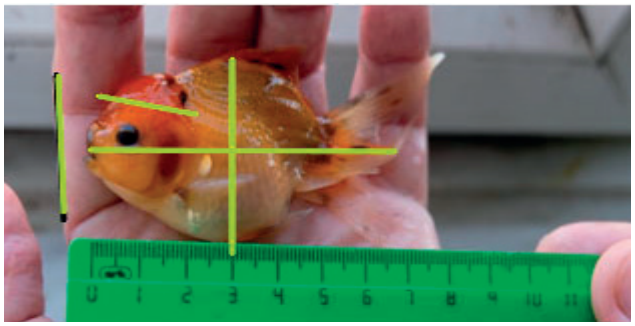

Figure 2. Calico oranda (Degirmencioglu, 2021)

in the air sacs while the fish are eating. Experimental groups were fed three times a day at 8:00 am, at 13:00 pm, and 6:00 pm. The feed and residual feed amounts to each aquarium were weighed and recorded daily. The individual feed consumption was not determined because a group feeding protocol was used in the study. The feed consumption was obtained by dividing the total fish number in each aquarium.

Growth performance values

Specific growth rate (SGR) = [(Final live weight (FLW) – İnitial live weight (ILW) / 90 day] × 100, Weight gain (WG) (g) = (FLW) (g) – (ILW)(g);

Feed conversion Ratio (FCR) = Feed intake (g) / Weight gain (g) (Mahghani et al., 2014)

Quality water and high protein feed positively affect the head and color development of fish. In essence, feed residues and fish excrement increase harmful gases such as ammonia, nitrate, and hydrogen sulfur in the water over time. 30% water withdrawal was drawn from the aquariums with a bottom siphon 4 times a week to eliminate such formations. Tap water was added to aquariums after resting for three days. Oxygen was supplied to the aquarium with a hose and air stone assembly connected to the air motor. Water temperature, pH, and micro siemens measurements in aquariums were made daily with the Hanna device. See Figures 3, 4, and 5.

Chemical composition

The metabolizable energy (ME) value of the diet was calculated based on chemical analyses according to the National Research Council (NRC 1981) and Halver (1973). The following main ME formula was:

Total ME (Kcal kg^{-1}) = 5.65 × (CP%) + + 9.45 × (EE%) + 4.10 × (NFE) × 10.

The nutrient contents of the diet were analyzed according to the AOC method (1990).

Statistical analysis

Data for growth performance and head development in the aquarium were tested by analysis of variance using the SPSS version 15.0 Statistical Package (2006) and the means were analyzed with the general linear model procedure using the following model described by Cochran and Cox (1957):

$Yijk = \mu + Ti + Dj + Eijk$

where:

Yijk – observation, μ – population mean, Ti – Dietaries (I = T1, T2, T3 or T4),

Dj – animals (k = 1, 2, 3,....119 or 120),

Eijk – residual error.

Means were separated by Duncan's multiple range test.

Results and Discussion

In nature, due to plant respiration and photosynthesis, pH generally drops at night and rises during the day. Juvenile fish are extremely sensitive to pH fluctuations. Amazonian fish such as discus and neon lay eggs in slightly acidic and soft fish. In contrast, goldfish prefer neutral waters (pH: 7.0–7.5). The metabolism of fish is affected by water temperature (Degirmencioglu, 2021). The warmer the water, the hungrier the fish will be. With water temperatures below 70F (21°C), feed goldfish at least once a day. Above this, goldfish need to be fed twice a day. Give the fish as much food as they will eat in 3–5 minutes.

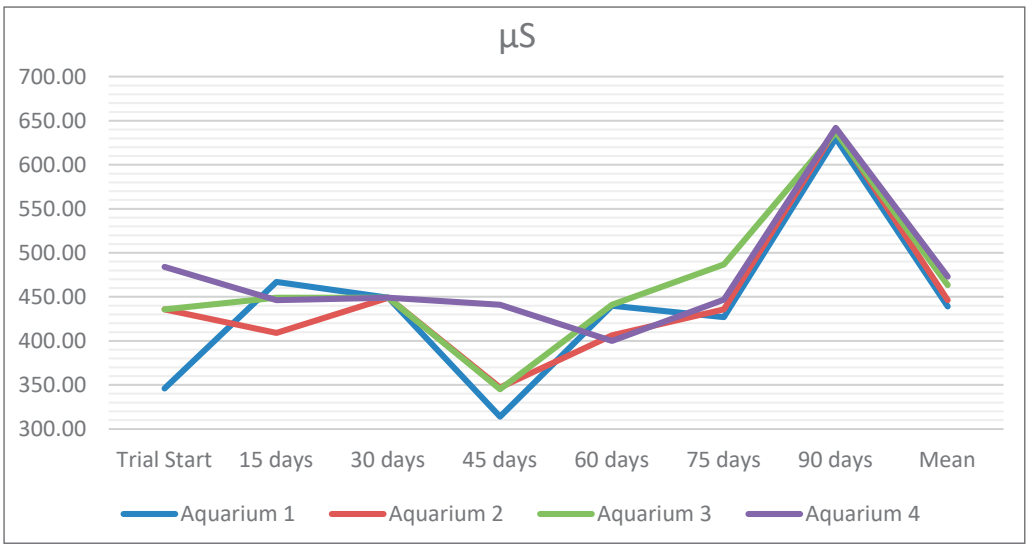

Figure 3. Micro siemens measurements in experimental aquariums

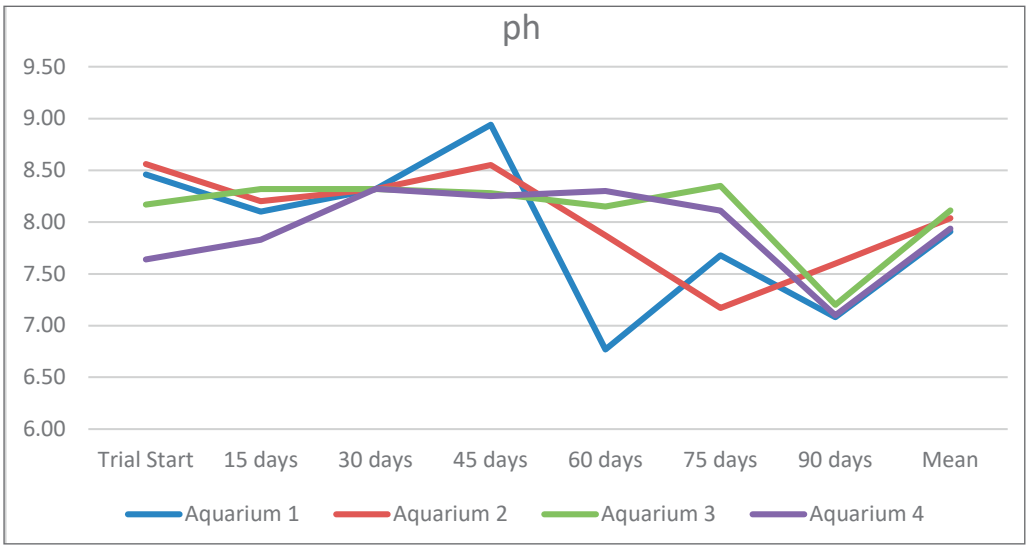

Figure 4. pH measurements in experimental aquariums

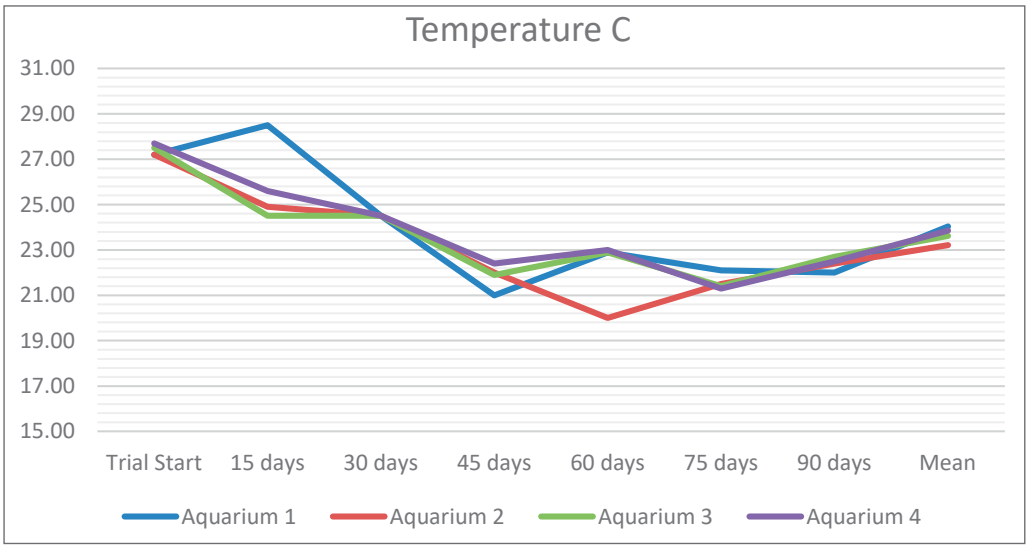

Figure 5. Temperature °C measurements in experimental aquariums

When the temperature of the water drops below 4°C, the fish stop consuming the feed (Anonymous, 2021). The MS (micro siemens), pH and temperature values in the fish aquarium recorded during the experimental period varied within 314–663, 7.08–8.94, and 20–28.5, respectively. According to the previous literature, values for pH and temperature were within the normal limits (7.0–7.5 and 4–27, respectively) (Anonym, 2021) and can be considered as not dangerous for fish.

The effects of ginseng on feed consumption

The results of the live weights of the fish at various growth periods and the total live weight increases, specific growth rate, and feed intake during the trial period are reported in Table 2.

As seen in Table 2, in the present experiment, the live weights for goldfish fed the T_1, T_2, T_3 and T_4 diets were 3.49 ± 0.20, 3.23 ± 0.20, 3.60 ± 0.19 and 3.50 ± 019 g/day, respectively, at the beginning of the study ($P > 0.05$). At the end of the 90-day trial, their live weights increased and ranged from 13.00 ± 0.85 to 17.94 ± 1.51 g. The highest live weight was determined in the 4th group and the lowest live weight was determined in the 1st group. The live weights of the other groups were similar to each other. The total live weight gains for fish fed the T_1, T_2, T_3, and T_4 diets were 9.51 ± 0.66, 12.03 ± 0.94, 12.74 ± 1.10, and 14.44 ± 1.39 g/day, respectively, during the trial (Table 2). In the present study, the live weight gains in fish fed treatments T_3 (G 60 mg/kg) and T_4 (G 120 mg/kg) were greater ($P < 0.05$) than those in fish

Table 2. Results on performance growth of ornamental fish

Groups	1st Group		2nd Group		3rd Group		4th Group	
Parameters	n	$\overline{X} \pm S_{\overline{X}}$	n	$\overline{X} \pm S_{\overline{X}}$	n	$\overline{X} \pm S_{\overline{X}}$	n	$\overline{X} \pm S_{\overline{X}}$
İnitial live weight (g/fish)	30	3.49 ± 0.20	30	3.23 ± 0.20	30	3.60 ± 0.19	30	3.50 ± 019
15. day	30	4.15 ± 026^{a}	30	4.17 ± 0.24^{a}	30	4.55 ± 0.25^{a}	30	5.01 ± 0.20^{b}
30. day	30	4.38 ± 0.26^{a}	30	4.88 ± 0.31^{a}	30	5.11 ± 0.29^{a}	30	5.44 ± 0.27^{b}
45. day	30	5.39 ± 0.36	30	5.44 ± 0.41	30	5.82 ± 0.35	30	5.99 ± 0.38
60. day	30	5.84 ± 0.40^{a}	30	6.21 ± 0.49^{ab}	30	7.03 ± 0.44^{ab}	30	7.43 ± 0.62^{b}
75. day	30	7.44 ± 0.43^{a}	30	8.24 ± 0.62^{ab}	30	8.51 ± 0.57^{ab}	30	9.21 ± 0.79^{b}
90. day Final live weight	30	13.00 ± 0.85^{a}	30	15.26 ± 1.12^{ab}	30	16.34 ± 1.25^{ab}	30	17.94 ± 1.51^{b}
Total live weight gain	30	9.51 ± 0.66^{a}	30	12.03 ± 0.94^{ab}	30	12.74 ± 1.10^{b}	30	14.44 ± 1.39^{b}
Specific growth rate (%/d)		10.55 ± 0.73^{a}		13.36 ± 1.04^{ba}	30	14.15 ± 1.23^{b}	30	16.04 ± 1.55^{b}
Daily live weight gain (g/fish)								
0–15.day	30	0.043 ± 0.047^{c}	30	0.062 ± 0.044^{c}	30	0.063 ± 0.008^{c}	30	0.100 ± 0.008^{d}
16–30 day	30	0.015 ± 0.001^{c}	30	0.047 ± 0.005^{d}	30	0.036 ± 0.004^{cd}	30	0.028 ± 0.005^{c}
31–45. day	30	0.067 ± 0.007^{a}	30	0.037 ± 0.006^{b}	30	0.047 ± 0.006^{ab}	30	0.036 ± 0.008^{b}
46–60. day	30	0.030 ± 0.04^{c}	30	0.051 ± 0.06^{c}	30	0.080 ± 0.008^{cd}	30	0.096 ± 0.017^{d}
61–75. day	30	0.106 ± 0.004^{a}	30	0.135 ± 0.009^{a}	30	0.098 ± 0.009^{ab}	30	0.118 ± 0.012^{a}
76–90. day	30	0.370 ± 0.030^{c}	30	0.467 ± 0.034^{cd}	30	0.522 ± 0.046^{c}	30	0.582 ± 0.048^{c}
Mean	30	0.105 ± 0.005^{a}	30	0.133 ± 0.006^{a}	30	0.141 ± 0.005^{a}	30	0.160 ± 0.005^{b}
Feed intake (g/fish)								
0–15. day		0.055		0.061		0.069		0.072
16–30 day		0.067		0.095		0.096		0.110
31–45. day		0.087		0.085		0.102		0.139
46–60. day		0.106		0.123		0.125		0.115
61–75. day		0.124		0.134		0.096		0.106
76–90. day		0.136		0.136		0.136		0.128
Mean		0.095		0.105		0.104		0.111
FCR		0.904		0.789		0.737		0.693

FCR; Feed conversion ratio,
a–b, c–d–e: (P < 0.05), (P > 0.01), Different letters in the same line are significantly different.

fed treatments T_1 (0.0 mg/kg) and T_2 (G 30 mg/kg), respectively, during the trial.

In a study on the subject, Ashraf and Goda (2008) reported that the live weight in Nile tilapia fish ranged widely from 254.8 to 252.3 g/fish/ginseng 200–250 mg/kg. These values are different to those for 12.74–14.44 g/fish/60–120 mg/kg. However, goldfish showed better performance in low dosage than that in Tilapia (ginseng 60 mg versus 200 mg). As seen in Table 2, The specific growth rates (SGR) (%/d) were higher in goldfish fed T_3 and T_4 diets than in goldfish fed T_1 and T_2 diets (25.44%, and 34.22%; $P > 0.05$). Significant differences were observed between T_3, T_4 diets and T_1, T_2 diets ($P < 0.05$).

Experimental results in fish showed that the highest daily live weight gain value during the trial was obtained from the T_4 diet with 0.160 ± 0.005 g day^{-1}; this was followed by the T_3 diet, T_2 diet, and T_1 diet with 0.141 ± 0.005, 0.133 ± 0.006, and 0.105 ± 0.005, respectively. The differences between the means of diet T_4 and the other diets were found statistically significant ($P < 0.05$). The findings of this study are different from those of Ashraf and Goda (2008) who found that the highest live weight gain in Nile tilapias ranged from ginseng 200 to 250 mg/kg DM, and those of Mehrim et al. (2022) who noted that the highest live weight gain in African catfish (*Clarias gariepinus*) was with a dose of 200 mg ginseng/kg diet.

The variations observed were due to differences in fish species and diet used in the trial, the characteristics of the soil in which ginseng was grown, the drying process, leaf-branch ratio, and climate, etc.

The average daily feed consumption of fish showed a continuous increase during the trial period. It ranged within 0.095–0.111 g. The highest feed consumption was determined in the 4th group and the lowest feed consumption was determined in the 1st group. It was observed that the average daily feed consumption of fish increased due to the increase in the ginseng level added to the ration. It was determined that the average FCR of the experimental fish varied within 0.904–0.693, respectively, during the trial (Table 2). The highest FCR was determined in the 4th group and the lowest FCR was determined in the 1st group. Ginseng administration increased FCR (0.904, 0.789, 0.737 and 0.693 for T_1, T_2, T_3 and T_4, respectively). The dietary supplementation with ginseng extract did not affect growth performance and feed utilization. Since group feeding was applied in the experiment, statistical analyses of the results obtained regarding the feed consumption and FCR of fish in different groups could not be performed. The obtained results were similar to the results reported by Ashraf and Goda (2008) and Mehrim et al., (2022) who reported that the FCR increased in fish fed with different levels of ginseng. However, Bulfon et al. (2017) reported that there was no significant difference in growth performance and feed utilization in rainbow trout (*Oncorhynchus mykiss*) fed with a dietary containing 0.0%, 0.01%, 0.02%, 0.03% of ginseng ethanolic extract. The observed response variance may be related to several factors, such as ginseng type, feeding strategy, animal differences, the trial length tested, the amount of ginseng added, the source of the ginseng product and seasonal effects.

The effects of developmental body

When the effects of using ginseng at different levels in concentrate feed on the developmental body of fish were examined, it was determined that the average body lengths of the experimental animals varied between 3.28 ± 0.099 and 3.35 ± 0.075, respectively, at the beginning of the trial (Table 3).

At the end of the 90-day trial, their body lengths increased and ranged from 6.1 0 ±0.132 to 6.35 ± 0.166 cm. Differences between diets in terms of body lengths were statistically insignificant. In the current study, an increase in head and body heights was observed during the development periods of fish (Table 3). The highest body height was determined in the 4th group fed with the T_4 diet, and the lowest body height value was determined in the 1st group fed with the T_1 diet, as in Table 2. The differences between the means of 3rd and 4th groups and 1st and 2nd groups were found statistically significant. As a result of the research, it was determined that adding ginseng at the level of 60 or 120 mg/kg to the ratio significantly increases the body height lengths in fish ($P < 0.01$; 2.69 ± 0.060, 2.76 ± 0.061, 2.93 ± 0.070 and 3.03 ± 0.072 for T_1, T_2, T_3, and T_4, respectively). The differences between the means of 3rd and 4th groups and 1st and 2nd groups were found statistically significant. As shown in Table 3, the head heights of the fish in the groups at the beginning of the experiment were determined to vary between 1.04 ± 0.033 and 1.05 ± 0.029 cm ($P > 0.05$). At the end of the 90-day trial, the head height of goldfish were positively affected with increasing levels of ginseng. It was determined that the head height increased by 0.35 cm in the fish fed T_4 diet compared with the fish fed T_1 diet. Similarly, while the head height was 0.28 cm in the fish fed the T_3 diet, this increase was only 0.13 cm in the fish fed the T_2 diet. In the present study, the head height of goldfish in treatments T_3 and T_4 were greater ($P < 0.01$) than those in T_1 and T_2, respectively. Similarly, at the end of the 90-day trial, the head widths were higher in fish fed the diets with ginseng (T_2, T_3, and T_4) than in fish fed the control diet (11.32%, 14.02% and 12.96%, $P < 0.01$). The differences between the means of diet T_1 and diets with ginseng (T_2, T_3, and T_4) were significant ($P < 0.01$).

The present trial results showed that adding ginseng of 60 and 120 mg/kg to the diet could positively affect the total live weight, specific growth rate, feed consumption, and FCR of fish. It can be said that this condition is a result of the positive effect

Table 3. Results on developmental body of ornamental fish

Groups	1st, Group		2nd Group		3rd Group		4th Gr0up	
Parameters	n	$\overline{X} \pm S_{\overline{x}}$	n	$\overline{X} \pm S_{\overline{x}}$	n	$\overline{X} \pm S_{\overline{x}}$	n	$\overline{X} \pm S_{\overline{x}}$
İnitial body lengths (cm)	30	3.28 ± 0.099	30	3.33 ± 0.077	30	3.35 ± 0.075	30	3.28 ± 0.067
15. day	30	3.61 ± 0.107	30	3.57 ± 0.068	30	3.64 ± 0.077	30	3.71 ± 0.063
30. day	30	3.87 ± 0.091	30	3.82 ± 0.078	30	389 ± 0.086	30	3.87 ± 0.076
45. day	30	4.01 ± 0.078^{a}	30	4.05 ± 0.089^{ab}	30	3.99 ± 0.089^{a}	30	4.19 ± 0.081^{b}
60. day	30	4.27 ± 0.077^{a}	30	4.30 ± 0.107^{ab}	30	4.50 ± 0.106^{b}	30	4.47 ± 0.091^{b}
75. day	30	5.54 ± 0.131	30	5.51 ± 0.125	30	5.76 ± 0.153	30	5.68 ± 0.152
90. day	30	6.10 ± 0.132	30	6.10 ± 0.138	30	6.35 ± 0.166	30	6.29 ± 0.152
İnitial body height of goldfish (cm)		1.82 ± 0.041		1.84 ± 0.061		1.85 ± 0.046		1.79 ± 0.079
15. day	30	2.04 ± 0.047	30	2.07 ± 0.053	30	2.08 ± 0.057	30	2.01 ± 0.045
30. day	30	2.17 ± 0.043^{a}	30	2.21 ± 0.056^{ab}	30	2.30 ± 0.061^{b}	30	2.30 ± 0.056^{b}
45. day	30	2.34 ± 0.051^{a}	30	2.36 ± 0.063^{a}	30	2.46 ± 0.061^{b}	30	2.47 ± 0.055^{b}
60. day	30	2.49 ± 0.051^{a}	30	2.47 ± 0.070^{a}	30	2.63 ± 0.066^{b}	30	2.68 ± 0.063^{b}
75. day	30	2.61 ± 0.055^{a}	30	2.64 ± 0.071^{a}	30	2.81 ± 0.067^{b}	30	2.88 ± 0.071^{b}
90. day	30	2.69 ± 0.060^{c}	30	2.76 ± 0.061^{c}	30	2.93 ± 0.070^{d}	30	3.03 ± 0.072^{d}
İnitial head height of goldfish (cm)	30	1.04 ± 0.033	30	1.05 ± 0.029	30	1.04 ± 0.029	30	1.04 ± 0.018
15. day	30	1.27 ± 0.037	30	1.27 ± 0.033	30	1.28 ± 0.042	30	1.30 ± 0.024
30. day	30	1.38 ± 0.038^{c}	30	1.40 ± 0.028^{cd}	30	1.43 ± 0.034^{d}	30	1.59 ± 0.032^{e}
45. day	30	1.55 ± 0.034^{c}	30	1.53 ± 0.042^{c}	30	1.56 ± 0.040^{c}	30	1.77 ± 0.041^{d}
60. day	30	1.67 ± 0.050^{c}	30	1.67 ± 0.048^{c}	30	1.79 ± 0.046^{c}	30	2.00 ± 0.047^{d}
75. day	30	1.86 ± 0.057^{c}	30	1.86 ± 0.059^{c}	30	2.02 ± 0.059^{d}	30	2.10 ± 0.038^{d}
90. day	30	2.59 ± 0.067^{c}	30	2.72 ± 0.066^{cd}	30	2.87 ± 0.075^{d}	30	2.94 ± 0.077^{d}
İnitial head width (cm)	30	0.82 ± 0.028	30	0.81 ± 0.024	30	0.80 ± 0.024	30	0.082 ± .019
15. day	30	0.99 ± 0.021	30	1.00 ± 0.023	30	1.02 ± 0.024	30	1.04 ± 0.028
30. day	30	1.06 ± 0.029^{a}	30	1.14 ± 0.026^{ab}	30	1.16 ± 0.030^{b}	30	1.15 ± 0.031^{b}
45. day	30	1.17 ± 0.031c	30	1.24 ± 0.033^{cd}	30	1.33 ± 0.037^{d}	30	1.30 ± 0.036^{d}
60. day	30	1.24 ± 0.034^{c}	30	1.42 ± 0.041^{d}	30	1.44 ± 0.035^{d}	30	1.45 ± 0.040^{d}
75. day	30	1.30 ± 0.030^{c}	30	1.51 ± 0.035^{d}	30	1.54 ± 0.038^{d}	30	1.55 ± 0.041^{d}
90. day	30	1.41 ± 0.033^{c}	30	1.59 ± 0.035^{d}	30	1.64 ± 0.036^{d}	30	1.62 ± 0.040^{d}

a-b, c-d-e: ($P < 0.05$), ($P < 0.01$) Different letters in a same line are significantly different.

of saponin on fish due to the increase in the level of ginseng included in the ratio.

Francis et al. (2002a) reported that the main components found in ginseng roots were a series of triterpene saponins called ginsenosides. Johnson et al. (1986) found that some saponins positively affected nutrient absorption by increasing the size of intestinal mucosal cells (Attele et al., 1999; Briskin, 2002).

Francis et al. (2001a, 2001b, 2002b, and 2002c) reported that increasing saponin in the diet promotes growth and feed consumption of fish such as *Cyprinus carpio* and Nile tilapia. Similarly, Tawwab (2012) stated that Nile tilapia (*Oreochromis niloticus*) fed with mixed feed with 1.0–5.0 g ginseng /kg diet obtained a higher growth than tilapias fed with mixed feed with control 0.0 /kg diet. Another study (Mehrim et al. 2022) reported that African catfish (*Clarias gariepinus*) fed 200 mg/kg ginseng /kg diet significantly ($P < 0.05$) increased growth performance and feed efficiency, compared with other treatments. Another study by Li et al. (2022) found that Tilapia *(Oreochromis niloticus)* fed with a diet supplemented with 0.4–0.8‰ of ginseng water extract improved the growth performance and increased the specific growth rate (SGR). Ginseng contains a sufficient amount of ginsenosides (*triterpene saponins*). These substances affect the nutrient absorption positively by changing the villi permeability of the intestine. In addition, it is believed that ginseng prevents the colonization of pathogenic microorganisms in the digestive tract,

increasing the population of beneficial microorganisms and promoting growth due to its positive contribution to microbial enzyme activity (Hu et al., 2003).

Another subject on the developmental body of goldfish may help to explain the positive effect in nutrition intake (Table 3). Findings obtained from the research regarding the growth performance of fish are consistent with the research findings conducted on a similar topic (Francis et al., 2001a, 2001b, 2002a, 2002b; Francis et al., 2002c; Ashraf and Goda, 2008; Tawwab, 2012; Mehrim et al., 2022; Li et al., 2022).

Conclusions

In the light of the scientific results obtained in this research, the following main conclusions can be drawn. It has been observed that the application of ginseng in goldfish increases FCR, body height, and head development compared with body length. Essentially among hobbyists, egg-shaped fish with the ability to develop heads and bodies are preferred. The obtained results indicated that the optimal dosage of ginseng to a diet of goldfish was 60 mg/kg on a DM basis. Therefore, ginseng had the potential to be used as an alternative aromatic plant source for goldfish without a negative impact on the digestive system and growth.

Ethics approval and consent to participate

No blood sample was taken because the fish were small. There was no loss of death from the trial animals.

Acknowledgment

Grant and thank the Matlı A.Ş Feed Labrotory for providing support in facilities and also Dr Mucahit Palaz, Erdinç Değirmencioğlu.

References

1. AOAC (1990) Official methods of analysis. 15th ed. Assoc. Off. Anal Chem. Arlington, VA, USA. (73)1: 189 – 191, https://doi.org/10.1093/jaoac/73.1.189.
2. Anonymous (2016 a) Catfish, [Online]. Available: http://www.factfish.com/statistic/ornamental%20fish%2C%20live%2C%20export%20value
3. Anonymous (2016b) The global ornamental aquarium industry: Facts and figures – Part 2. [Online]. Available: https://www.bassleer.com/ornamentalfishexporters/wp-content/uploads/sites/3/2016/11/GlobalAquariumIndustryPart2OFI-Journal-78_029g14-16.pdf
4. Anonymous (2021) https://www.thesprucepets.com/aquarium-water-ph-1378801.
5. Attele AS, Wu JA & Yuan CS (1999) Ginseng pharmacology: multiple constituents and multiple actions. Biochemical Pharmacology, 58:1685–1693, https://doi.org/10.1016/s0006-2952(99)00212-9.
6. Ashraf MA& Goda S (2008) Effect of Dietary Ginseng Herb (Ginsana_ G115) Supplementation on Growth, Feed Utilization, and Hematological Indices of Nile Tilapia, *Oreochromis niloticus* (L.), Fingerlings. journal of the World Aquaculture Society,39:2 205-214, https://doi.org/10.1111/j.1749-7345.2008.00153.x.
7. Briskin DP (2002) Production of Phytomedicinal Chemicals by Plants. Book Chapter published 18 Sep 2001 in Handbook of Plant and Crop Physiology on pages 507 to 522. https://doi.org/10.1201/9780203908426-26.
8. Bulfon C, Bongiorno T, Messina M, Volpatti D, Tibaldi E & Tulli F (2017) Effects of Panax ginseng extract in practical diets for rainbow trout (*Oncorhynchus mykiss*) on growth performance, immune response and resistance to Yersinia ruckeri. Aquaculture Research, (48)5:2369-2379 https://doi.org/10.1111/are.13072
9. Cochran WG & Cox GM (1957) In Experimental Designs. 22nd ed. Pp. xiv, 611. 82s. (John Wiley and Sons, New York; Chapman and Hall, London). https://doi.org/10.2307/3610494.
10. Dey VK (2016) The Global Trade in Ornamental Fish." Infofish International vol. 4, pp. 52-55. [Online]. Available: https://www.bassleer.com/ornamentalfishexporters/wp-content/uploads/sites/3/2016/12/GLOBAL-TRADE-IN-ORNAMENTAL-FISH.pdf.
11. Degirmencioglu T (2021) Pet Animals' s Nutrition. Lecturer Note. 125 Page. Unpublished.
12. Francis G (2021)Effects of low dietary levels of saponins on two common culture fish—common carp (*Cyprinus carpio* L.) and Nile tilapia (*Oreochromis niloticus* L.). Ph.D. thesis, University of Hohenheim, Stuttgart, Germany.
13. Francis G, Makkar HPS & Becker K (2001 a) Antinutritional factors present in plant-derived alternate fish feed ingredients and their effects in fish. Aquaculture, 199:197–227.
14. Francis G, Makkar HPS & Becker K (2001 b) Effects of Quillaja saponins on growth, metabolism, egg production, and muscle cholesterol in individually reared Nile tilapia (*Oreochromis niloticus*). Comparative Biochemistry and Physiology 1 Part C: Toxicology & Pharmacology, 129:105–114. https://doi.org/10.1016/s1532-0456(01)00189-2.
15. Francis G, Kerem Z, Makkar HPS & Becker K (2002a) The biological action of saponins in animal systems: a review. British Journal of Nutrition, 88 (6):587–605. https://doi.org/10.1079/bjn2002725.
16. Francis G, Makkar HPS & Becker K (2002b)Dietary supplementation with a Quillaja saponin mixture improves growth performance and metabolic efficiency in common carp (*Cyprinus carpio L*). Aquaculture, 203:311–320. https://doi.org/10.1016/s0044-8486(01)00628-7.
17. Francis G, Makkar HPS & Becker K (2002c) Effects of cyclic and regular feeding of Quillaja saponin supplemented diet on growth and metabolism of common carp (*Cyprinus carpio L).* Fish Physiology and Biochemistry, 24:343–350.
18. Halver JE (1973) Fish nutrition. Academic Press XII+713. London https://doi.org/10.1126/science.180.4092.1270-a.
19. Hu S, Concha C, Lin F & Waller KP (2003) Adjuvant effect of ginseng extract on the immune responses to immunization against Staphylococcus aureus in dairy cattle. Veterinary Immunology and Immunopathology, 91:29–37. https://doi.org/10.1016/s0165-2427(02)00264-7.
20. Johnson T, Gee JM, Price K, Curl C & Fenwick GR (1986). Influence of saponins on gut permeability and active nutrient transport in vitro. J. Nutri. 116: 2270-2277.
21. Li M. Qiang J, Zhu X, Bao J, Tao Y & Zhu H (2022) Effect of Siberian Ginseng Water Extract as a Dietary Additive on Growth Performance, Blood Biochemical Indexes, Lipid Metabolism, and Expression of PPARs Pathway-Related Genes in Genetically Improved Farmed Tilapia (*Oreochromis niloticus*). Fishes, 7(4): 149. https://doi.org/10.3390/fishes7040149.
22. Mahghani F, Gharaei A, Ghaffari M & Akrami R (2014) Dietary synbiotic improves the growth performance, survival, and innate immune response of Gibel carp (*Carassius auratus gibelio*) juveniles, International Journal of Aquatic Biology, 2: 99-104. https://doi.org/10.22034/ijab.v2i2.37.
23. Mehrim AI, Refaey MM, Hassan MAE, Zaki MA & Zenhom OA (2022) Ginseng® as a reproductive enhancer agent for African catfish, *Clarias gariepinus* (Burchell, 1822). Fish Physiol Biochem, 48(1):15-32. https://doi.org/10.1007/s10695-021-00969-y
24. NRC (1981) (National Research Council) Nutrient Requirements of Coldwater fishes National Academy Press Washington, D.C. https://doi.org/0.17226/19731.
25. Siegel RK (1979) Ginseng abuse syndrome, problems

with the panacea. Jama, 241(15):1614–1615. https://doi.org/10.1001/jama.1979.03290410046024.
26. Smart J (2001) Gold Fishes Varieties and Genetics Hand-Book for Breeders Printed and bound in Great Britain by MPG Books Ltd, Bodmin, Cornwall ISBN 0-85238-265-0. 139-157. https://doi.org/10.1002/9780470999790.ch6.
27. SPSS (2006). Statistical package for social sciences, book Chapter published 24 Mar 2006 in Handbook of Univariate and Multivariate Data Analysis and Interpretation with SPSS on pages 11 to 24. https://doi.org/10.1201/9781420011111.ch2.
28. Tawwab MA (2012) The Use of American Ginseng (Panax quinquefolium) in Practical Diets for Nile Tilapia (*Oreochromis niloticus*): Growth Performance and Challenge with *Aeromonas hydrophila*. 24(4):366-376. https://doi.org/10.1080/10454438.2012.733593
29. Van Soest PJ, Robertson JB & Lewis BA.(1991) Methods for Dietary Fiber, Neutral Detergent Fiber, and Nonstarch Polysaccharides in Relation to Animal Nutrition Journal of Dairy Science, 74 (10): 3583 -3597.https://doi.org/10.3168/jds.s0022-0302(91)78551-2.

Received 8 October 2022
Accepted 27 September 2022