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Dietary effect of turmeric and ginger powder supplementation on growth performance of Common carp (*Cyprinus carpio*)

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ABSTRACT

A study was conducted with the aim to find out the effect of ginger and turmeric supplementation on the growth performance of Common carp fingerlings. A total of 270 fingerlings were divided into 6 groups including control (C). The group C was fed with basal feed and the treatment groups T5, T5B5, G2, G5, G8 were fed with turmeric powder @0.5%, turmeric @0.5% + black pepper powder @0.5 %, ginger powder @2%, 5% and 8%, respectively. The growth parameters, i.e Gain in weight, Feed Conversion Ratio (FCR), Specific Growth Rate (SGR), Relative Growth Ratio (RGR), Protein Efficiency Ratio (PER) and Feed Efficiency Ratio (FER) were recorded for 60 days. Measurements were taken for gain in total length (TL) and body depth (BD) after 60 days of trial. Turmeric powder supplementation @0.5% showed significantly better growth performance in Common carp fingerlings. The fingerlings of T5 group showed highest gain in weight (48.7), SGR (1.35), RGR (126), FER (48.17), PER (1.24) and improved FCR (2.23). This group also gained significantly higher TL (3.74) and BD (1.42). There was no significant difference observed in survival per cent, moisture and acid insoluble ash content of fish muscle. T5 showed the highest crude protein concentration (78.29) and significantly highest total fat concentration (11.59). Fish muscles of all the treatments had significantly higher total mineral content as compared to that of the control group.

Keywords: Common carp, Fingerlings, Ginger, Growth, Turmeric

Fisheries and aquaculture are one of the world's fastest expanding businesses (Tacon 2020) and aquaculture products are in high demand all over the world, hence aquaculture specialists are interested in boosting fish production per area unit (Mirghaed *et al.* 2018). India is the world's third-largest fish producer and the world's second-largest aquaculture fish producer. Feed plays an important role in maintaining fish nutrition (Rama *et al*. 2021). With a growing interest in antibiotic alternatives, research on the use of botanicals, herbs, and enzymes in feed is gaining traction. These natural compounds contain pharmacologically or biologically active molecules which can be used in the development of pharmaceutical drugs.

Turmeric (*Curcuma longa* L.) belongs to the Zingiberaceae family and has been used as a spice and medicinal herb in India for thousands of years. Curcuminoids, turmerone, arturmerone, and zingiberene are some of the antioxidant chemicals found in it (Ruby *et al*. 1995, Selvam *et al.*1995). Turmeric has been shown to have antitoxic, antitumor, anti-inflammatory, hepatoprotective, antimutagenic, antiangiogenic, immunomodulatory, antibacterial, anticancer, and wound healing properties in recent studies (Prasad and Aggarwal 2011).

Ginger (*Zingiber officinale*) belongs to the family Zingiberaceae. Natural antioxidants like as gingerols, shogaols, and Zingerone are abundant in the species (Shakya 2015). Because of its immunostimulant, antibacterial, and antioxidant properties, it is a popular therapeutic herb (Nya and Austin 2009). Ginger extract has been investigated as a potential therapy for a variety of cancers. It contains alkaloids, flavonoids, polyphenols, saponin, steroids, tannin, fibre, carbohydrate, vitamins, carotenoids, and minerals (Otunola *et al*. 2010, Shirin and Prakash 2010), natural antioxidants such as gingerols, shogaols, and zingerone (Hori *et al*. 2003), essential oils which have potent anti-inflammatory effects and oleoresin (Zarate and Yeoman 1996). Black pepper (*Piper nigerium*) contains Piperine, a bioactive alkaloid found in black pepper. When black pepper is mixed with curcumin, the absorption and bioavailability of curcumin is increased (Shobha *et al.* 1998). Several researchers have reported that feed additives have unique functional qualities and their efficacy may vary at different concentrations (Chandran *et al.* 2016, Jahanjoo *et al*. 2018). Therefore, goal of the present study was to determine the best concentrations and ratio of turmeric, ginger and black pepper on the growth performance of Common carp fingerlings, under humid-subtropic condition of India.

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MATERIALS AND METHODS

Rearing conditions and experimental design: Fingerlings were procured from Government Fisheries Farm Gagreat, Una, Himachal Pradesh and were transported in big plastic drums. On arriving at the farm, fish were given prophylactic treatment with 0.2% $KMnO_4$ for 2 min for removing any dermal infection. After that, fish were transferred to tank of length 14 feet, width 7 feet and depth 3 feet containing bore-well water and kept there for 15 days. Any debris or particles were removed from the tank. A water change of 10% was done at 24 h interval to remove metabolic wastes. After acclimatisation of 15 days, healthy fish (40-45 g body weight) were used for the experiment. The feeding experiment was conducted on 270 fingerlings of Common carp of similar body weights. The fingerlings were grouped into six groups (each containing 45 fingerlings) in tanks. Fish were fed @2% of body weight twice a day (morning and evening). The control group was fed with basal feed and the treatment groups T5, T5B5, G2, G5, G8 were fed with turmeric @0.5%, turmeric @0.5% + black pepper @0.5 %, ginger @2%, 5% and @8% respectively. The sampling of water was done three times in a week on Monday, Thursday and Saturday. *p*H of water in the sample was measured using an Eco Tester *p*H 1 electronic *p*H meter. Temperature and TDS was measured using an electronic TDS meter. By immersing the TDS meter directly into the water, a reading was taken and noted down. Alkanity and Dissolved oxygen (DO) were measured by using AQUASOL water test.

Formulation and preparation of pelletised feeds: Physical composition of experimental diets has been presented in Table 1. The feed ingredients, i.e. fish meal, deoiled mustard cake, deoiled soya flakes, maize flour, deoiled rice bran, yeast, vitamin mineral mixture and oil were procured from the feed store, Department of Animal Nutrition, DGCN, COVAS, CSKHPKV, Palampur. Ginger, turmeric and black pepper were purchased from the local market. These were analyzed for proximate composition using the methods described by AOAC (2005). Based on the chemical composition of feed ingredients, fish feeds were formulated as per FAO standards (Fao.org). Turmeric powder was mixed in the basal feed @0.5 % (T5), turmeric powder @0.5% + black pepper @0.5% (T5B5), and ginger powder was mixed in basal feed @2% (G2), 5% (G5) and 8% (G8). All the ingredients were ground and thoroughly mixed. Sufficient quantity of water was mixed with ingredients. The mixture was extruded by extruder machine using dye of 3 mm and pelleted feed was prepared. The pellets were dried in the open and were stored in air tight plastic bags.

Growth and survival study: Growth parameters such as initial and final weight, gain in weight (GIW), specific growth rate (SGR), feed conversion ratio (FCR), survival percentage feed efficiency ratio (FER), protein efficiency ratio (PER) and relative growth ratio (RGR) were measured after 60 days, adopting standard procedures (Tekinay and Davies 2001, Alfaragi and Hassan 2017). The Total length and body depth were measured by using a scale and thread.

Proximate composition of fish muscle and statistical analysis: The proximate principles of feed and fish muscle were determined as per the method given in AOAC (2005) and Graphpad INSTAT 3 software was used to analyze various data collected from trial. It was used to calculate the treatment mean and standard error of the mean. A statistically significant difference was defined at a probability value of $p<0.05$.

RESULTS AND DISCUSSION

Proximate composition of feed: The chemical composition of feed is given in Table 2. The dry matter of diet varied from 92.99 to 92.45%. The CP of feeds ranged from 30.85 to 33.04 %, indicate that they were also nitrogenous. The range of ether extract was found to be 4.20 to 5.60%. So, the feeds conferred to the FAO specifications.

Water quality parameters: The average *p*H of water of fish tanks in the present study was 7.1, which indicated

Table 1. Physical composition of experimental feeds

Item	C	T_5	T_5B_5	G_2	G_5	G_8
Fish meal	12	12	12	12	13	14
Deoiled mustard cake	24	24	24	24	24	24.5
Deoiled soya flake	25	25	25	25	25	24
Maize flour	18	18	18	18	17	17
Deoiled Rice Bran	15.5	15	14.5	13.5	10.5	7.5
Yeast	1	1	1	1	1	1
Vitamin	1	1	1	1	1	1
Mineral mixture	0.5	0.5	0.5	0.5	0.5	0.5
Oil	3	3	3	3	3	2.5
Ginger powder	-	-	-	2	5	8
Turmeric powder	-	0.5	0.5	-	-	-
Black pepper powder	-	-	0.5	-	-	-
Total	100	100	100	100	100	100

C, Basal feed; T_5, Basal feed + turmeric @0.5%; T_5B_5, Basal feed + turmeric @0.5% + black pepper @0.5%; G_2, Basal feed + ginger @2%; G_5, Basal feed + ginger @5%; G_8, Basal feed + ginger @8%.

Table 2. Proximate composition (% on DM basis) of experimental feeds

Item	C	T_5	T_5B_5	G_2	G_5	G_8
DM	92.99	93.78	94.25	93.08	93.05	93.96
CP	31.08	31.52	33.04	32.48	32.74	30.85
EE	4.20	4.30	5.60	4.42	4.45	4.49
CF	5.19	6.60	5.66	6.00	6.34	6.77
TA	9.16	9.39	9.46	9.60	9.46	9.00
Ca	0.4241	0.4598	0.3627	0.3307	0.467	0.6488
P	0.09	0.08	0.08	0.05	0.05	0.05

C, Basal feed; T_5, Basal feed + turmeric @0.5%; T_5B_5, Basal feed + turmeric @0.5% +black pepper @ 0.5%; G_2, Basal feed + ginger @2%; G_5, Basal feed + ginger @5%; G_8, Basal feed + ginger @8%; DM, Dry matter; CP, Crude protein; CF, Crude fibre; EE, Ether extract; TA, Total ash; Ca, Calcium; P, Phosphorus.

that it was optimum for fish rearing. Ekubo and Abowei (2011) reported that *p*H between 7 to 8.5 is ideal for biological productivity. The average dissolved oxygen (DO) in the water tank was 5 mg/L. According to Ekubo and Abowei (2011) DO concentration of 5.0 mg/L are adequate in fish ponds, hence the level of DO of the present study was within the optimum level. The alkanity of the treatment tanks was 50 mg/L ($CaCO_3$) similarly Stone and Thomforde (2004) reported that 50-150 mg/L ($CaCO_3$) was desirable range for pond water. So, the alkalinity of fish ponds during the trial was also with the optimum range. The average temperature of the tank was 22°C. According to Bhatnagar *et al.* (2004) the temperature < 20°C sub lethal for growth and survival for fishes. The average TDS of the tank was 150 ppm. Concentrations of TDS from natural sources have been found to vary from less than 30 mg/L to 6000 mg/L (WHO 1989). So all the water quality parameters were maintained within the specific range for optimal growth of common carp.

Growth performance and survival rate: The growth performance parameters have been given in Table 3. During two months of trial, body weight gain of fingerlings of T5 and T5B5 differed significantly ($p<0.05$) from that of C. The fingerlings of treatment T5 showed highest gain in body weight. The gain in total length and body depth was also the highest ($p<0.05$) in T5. SGR of C, T5B5 and G5 was statistically similar and intermediate whereas that of G2 and G8 showed lowest SGR, while T5 fingerlings showed significantly ($p<0.05$) higher SGR.

The supplementation of turmeric also showed the highest RGR whereas those receiving turmeric + black pepper showed intermediate values of RGR. This meant that turmeric supplementation resulted in significantly ($p<0.05$) higher growth of fingerlings. Ginger supplementation did not show any effect on growth rate and addition of black pepper in turmeric also did not improve growth rate. Better FCR was due to lower feed per unit gain in live body weight as was also observed in T5. The PER was highest in T5 and the lowest in T5B5. The PER of G2, G5 and G8 was not significantly different from that of C and had intermediate values. Higher FER of T5 fingerlings meant that the fingerlings receiving turmeric @0.5% outperformed when compared with the rest of the treatments in terms of efficiency of conversion of feed into body mass. There was no significant difference in per cent survivability of fingerlings of different groups during the trial and the mortality rate was within the normal acceptable range.

The stimulation of digestive enzymes, bile acid secretion, and intestinal flora is most likely responsible for the enhanced feed utilization and growth performance caused by the use of herbal supplements (Platel and Srinivasan 2000, Lee and Gao 2012). It has been reported

Table 3. Growth performance and survival parameters of Common carp

Item	C	T_5	T_5B_5	G_2	G_5	G_8
Initial weight (g)	44.34 ± 1.216^{b}	37.9 ± 0.8205^{a}	34.94 ± 0.9150^{a}	43.78 ± 3.957^{ab}	38.893 ± 2.688^{ab}	36.33 ± 5.288^{a}
Final weight (g)	58.39 ± 1.493^{a}	86.6 ± 3.9^{b}	53.6 ± 3.083^{a}	56.33 ± 5.833^{a}	51.17 ± 4.6^{a}	47 ± 6.158^{a}
Gain in weight (g)	14.05 ± 0.5744^{a}	48.7 ± 3.120^{b}	18.69 ± 2.325^{a}	12.56 ± 2.089^{a}	12.33 ± 2.951^{a}	10.66 ± 1.130^{a}
Gain inlength (cm)	1.94 ± 0.094^{ab}	3.74 ± 0.178^{c}	1.97 ± 0.139^{b}	$0.77\pm0. 148^{a}$	1.25 ± 0.218^{ab}	1.18 ± 0.199^{a}
Gain in BD (cm)	1.26 ± 0.039^{b}	1.42 ± 0.128^{b}	0.41 ± 0.052^{a}	0.48 ± 0.372^{a}	0.55 ± 0.816^{a}	0.98 ± 0.278^{ab}
SGR %	$0.4554\pm.012^{b}$	1.35 ± 0.043^{d}	0.68 ± 0.056^{c}	0.41 ± 0.040^{b}	0.4481 ± 0.081^{b}	0.14 ± 0.019^{a}
RGR	31.56 ± 0.927^{a}	126.36 ± 5.828^{c}	52.00 ± 5.399^{b}	27.86 ± 3.081^{a}	31.64 ± 6.536^{a}	31.09 ± 2.581^{a}
FCR	4.02 ± 0.235^{b}	2.23 ± 0.157^{a}	3.41 ± 0.363^{ab}	3.51 ± 0.510^{ab}	3.72 ± 0.784^{ab}	4.23 ± 0.477^{b}
PER	0.95 ± 0.038^{b}	1.24 ± 0.068^{c}	0.01 ± 0.013^{a}	1.09 ± 0.149^{bc}	0.75 ± 0.170^{b}	1.04 ± 0.149^{bc}
FER	26.91 ± 1.100^{b}	48.17 ± 3.172^{c}	16.01 ± 1.992^{a}	15.93 ± 2.652^{a}	15.65 ± 3.746^{ab}	12.05 ± 1.259^{a}
Survival %	97±4.12	99±3.17	96±3.12	96±3.16	96±4.11	96±2.11

C, Basal feed; T_5, Basal feed + turmeric @0.5%; T_5B_5, Basal feed + turmeric @0.5% +black pepper @ 0.5%; G_2, Basal feed + ginger @2%; G_5, Basal feed + ginger @5%; G_8, Basal feed + ginger @8%; Figures bearing different superscripts within a row are statistically different ($p<0.05$).

that curcumin present in turmeric can increase the activity of intestinal alkaline phosphatase, gamma glutamyl transpeptidase, creatine kinase and Na+/K+ ATPase. Consequently, curcumin could enhance nutrient utilization to a great extent (Jiang *et al.* 2016). Due to the antibacterial, anti-inflammatory, and antiviral properties of turmeric, fish feed with a higher curcumin content experienced faster development rates (Khalil and Emeash 2018). It has been demonstrated that curcumin strengthens fish immunity and functions as a protective agent against the *A. hydrophila* infection (Riauwaty *et al.* 2020). Curcumin is an effective strong antioxidant and functions as an anti-free radical, adversely affecting the fish's physiological processes (Nagpal and Sood 2013). Curcumin, a key ingredient in turmeric, has the ability to boost immunity and raise fish appetite for given food. Essential oils in turmeric can prevent release of stomach acids thereby facilitating the absorption of food substances (Cahyani *et al.* 2021). Further, Chowdhury *et al.* (2021) found increased intestinal enzymes such as protease, amylase and lipase, affecting the absorption of nutrients and increased fish nutrition with crude lipid and carbohydrate in *Labio rohita* after supplementing turmeric, ginger and garlic.

Abdel-Tawwab and Abbass (2017) also reported significantly higher gain in body weight in common carp fingerlings which were supplemented with 1%, 2% and 5% turmeric powder in feed. They reported a significant increase in weight gain up to supplementation level of 2% during study of 10 weeks. Ashry *et al.* (2021) also reported dose dependent (1.5% to 3% curcumin level of addition) increase on gain in weight of Gilthead seabream. Whereas, Mahmoud *et al.* (2014) reported no significant effect of turmeric supplementation @0.25 and 0.50 levels in Nile tilapia.

Lower performance with ginger supplementation in the present study may be due to the presence of antinutrients such as saponin. Saponins have adverse effect on membranes. Ahmadifar *et al.* (2019) reported an increase in enzyme activity in fish fed with 0.1%, 0.3% dietary ginger powder but no effect on the growth was observed. The results of the present study are also in agreement with the reports of Sahan *et al.* (2016) who suggested that despite having appetizing and growth stimulating effect, ginger supplementation showed no significant difference beyond 2% of supplementation level. Similarly conflicting results were also reported by Vahedi *et al.* (2017). Mahmoud *et al.* (2019) also reported significantly lower gain in body weight on supplementation of 1.5% ginger as well as 1.5% garlic in the feeds of Nile tilapia fish as compared to that of control. The variation in results could be attributed to various factors such as species of fish, size, age, sex, feeding program, dose of additives, feed formulation, initial body weight of fingerlings/fish and ambient culturing conditions. Black pepper is known for its bio-enhancing property (Shobha *et al.* 1998). However, the fingerlings receiving black pepper in combination with turmeric did not affect overall gain in the present study. Wojno *et al.* (2021) have also reported compromised growth performance of Common carp upon using black pepper powder as low as 0.02%. It was also reported that the Common carp rejected the feeds containing 0.2% black pepper. So, no positive effect on the overall gain in weight of fingerlings of T_5B_5 group was observed, as the exact amount of feed could not be measured in this trial and fingerlings of all the groups were offered respective feeds @2% of their body weight and it was presumed that 100% feed was consumed by the fingerlings. Ashry *et al.* (2021) and Al-Faragi and Hassan (2017) also reported higher SGR in fish when supplemented with curcumin @3% and turmeric powder @1.25%, respectively. Abdel-Tawwab and Abbass *et al.* (2017) also reported that turmeric supplementation @ 0, 1, 2 and 5 g turmeric powder/kg in Common carp for 10 weeks had significant effect on SGR. In the present study, ginger supplementation did not affect SGR significantly and the findings corroborated with findings of Abbasi *et al.* (2017) and Kanani *et al.* (2013) who also reported no effect of ginger supplementation @2% and @1%, respectively on SGR. Mahmoud *et al.* (2019) also reported that ginger supplementation @1.5% caused significant decrease in SGR in Nile tilapia when fed for 60 days. Whereas contrasting results were reported by Jafarinejad *et al.* (2018) and Hassanin *et al.* (2014) who showed that ginger supplementation resulted in higher SGR when supplemented @5 and 1%, respectively. Al-Faragi and Hassan (2017) also reported significant increase in RGR in Common carp treatment groups than control when given turmeric supplementation @1.25% of feed. However, in contrast to our results, Najem *et al.* (2020) reported significantly increased RGR when ginger was fed in diet @1.5% and 2% in Common carp. Similar to results of the present study, Al-Faragi and Hassan (2017) reported significant increase in FCR in Common carp treatment groups than control when given turmeric supplementation @1.25% of feed. Ashry *et al.* (2021) also reported improvement in FCR with the increasing level of curcumin from 2% to 3% in feed. Whereas Abdel-Tawwab and Abbass (2017) reported that turmeric supplementation @0, 1, 2 and 5 g TP/kg in Common carp for 10 weeks had no significant effect on FCR. Similar to current findings, Mahmoud *et al.* (2019) also reported that ginger supplementation @1.5% caused significant increase in FCR, i.e poor FCR in Nile tilapia when fed for 60 days. Kanani *et al.* (2013) also reported that ginger supplementation @1% had no significant effect on FCR in Huso huso. Contrary to findings of present study, Nyadjeu *et al.* (2021) reported that *Clarias gariepinus* fry fed with ginger and garlic powder @1% and 2% showed significant improvement in FCR when given as feed additive for 56 days. Jafarinejad *et al.* (2018) also reported that 2 and 5% ginger in diet improved FCR of common carp significantly. Hassanin *et al.* (2014) reported that ginger supplementation @0, 0.1, 0.2, 0.3, 0.5 and 1% had significant improvement in FCR in Nile tilapia. Better FCR, i.e. lower feed per unit gain in live body weight was observed in T5 during two months of study. Overall

FCR was also significantly better in T5 treatment group as compared to rest of the treatments.

Al-Faragi and Hassan (2017) reported a significant increase in FER in Common carp treatment groups than control when fed with turmeric supplementation @0.25, 0.50, 0.75, 1.0, 1.25% of feed. Whereas, Mahmoud *et al.* (2014) reported that turmeric supplementation @0.25 and 0.5% has no significant effect on FER in Nile tilapia when fed for 3 months. Nyadjeu *et al.* (2021) reported that *Clarias gariepinus* fry fed with ginger and garlic powder @1% and 2% showed increase in FER when given as feed additive for 56 days. Ashry *et al.* (2021) reported no effect of curcumin compared to control on PER at up to 2% supplementation level of curcumin. However, they reported significant improvement on an addition level of 3% curcumin in Gilthead seabream. Whereas, Abdel-Tawwab and Abbass (2017) reported that turmeric supplementation @0, 1, 2 and 5 g/kg in Common carp for 10 weeks had no significant effect on PER. Mahmoud *et al.* (2014) also reported that turmeric supplementation @0.25 and 0.5% had no significant effect on PER in Nile tilapia when fed for 3 months. Whereas Nyadjeu *et al.* (2021) reported that *Clarias gariepinus* fry fed with ginger and garlic powder @1% and 2% showed significant increase in PER when given as feed additive for 56 days.

Proximate composition of muscles: The chemical composition of fish muscles has been given in Table 4.

Table 4 shows that there was no significant difference in moisture and acid insoluble ash level of fish muscles. Whereas, CP, EE and total ash concentration varied significantly ($p<0.05$). Treatment G5 had the lowest CP concentration and it did not vary significantly from the control as well as T5B5, G2 and G8 treatments. Similarly, the muscle of fingerlings of group T5 showed the highest CP concentration. This treatment also had significantly ($p<0.05$) highest EE concentration as compared to rest of treatments which did not vary significantly from each other.

Muscles of all the treatments had significantly ($p<0.05$) higher total mineral content as compared to that of the control group. The higher EE concentration of T5 group indicated higher deposition of crude fat in fish muscle. The crude fat is composed of simple fat, compound fat, fatty acid, glycerol, pigments and fat-soluble vitamins. The fish muscle predominantly have higher concentration of polyunsaturated fatty acids especially omega fatty acids/essential fatty acids and fat-soluble vitamins mainly vitamin A, D and E. The higher deposition (57% more than C) of ether extract in the muscles of fingerlings of T5 could pave a way towards having designer fish meat with high amount of omega fatty acids as well as fat soluble vitamins. Normal changes in lipid and protein content in body of fish are generally associated with changes in their deposition rate, synthesis and difference in growth rate (Smith 1981, Fauconneau 1985, Abdel-Tawwab *et al.* 2006). Mahmoud *et al.* (2014) reported significant increase in CP content and decrease in EE in Nile tilapia challenged with *Pseudomonas flourosecence* on feeding turmeric powder, with increasing turmeric supplementation level.

Ashry *et al.* (2021) reported CP ranging from 53.35% to 54.43% in Gilthead seabream receiving 1.5% to 3.5% curcumin in their feeds which was lower than that found in the present study. They reported the ether extract range from 28.22% to 28.45% and ash from 16.5 to 17.27% which were higher than those found in present study. They also reported an increase in the DM, CP, EE and TA concentration with increase in age of the fish. The difference could be attributed to age and size of the fish. Jiang *et al.* (2016) reported 69.4% and 69.3% moisture, 17.9 and 28% protein, 13.5 and 13.8% EE and 3.90 and 3.83% total ash in Crucian carp fed with 1% and 5% curcumin, respectively.

Abdel-Twaab and Abbass (2017) reported no significant effect of turmeric powder supplementation on moisture, CP, EE and total ash concentration of Common carp fed diet containing up to 5 g /kg diet. Hwang *et al.* (2013) reported decrease in EE and total ash content in black rock fish and *Seabastes schlegeli* on supplementation of turmeric powder. Nyadjeu *et al.* (2021) reported moisture content ranging from 63.30% to 64.97%, ash content from 1.42% to 2.21%, protein content ranging from 21.63% to 24.60%, lipid content ranging from 2.89% to 3.73%, energy content ranging from 6.21% to 6.978%. They reported significant increase in body protein, lipid and total ash with the feeding of ginger and garlic. Mahmoud *et al.* (2019) reported increase in protein and total ash in Nile tilapia on feeding 1.5% ginger and garlic, respectively.

Srivastava *et al*. (2020) also reported that supplementation of Ashwagandha root powder in fish feed improved flesh quality significantly. The improvement in nutrient composition of fish meat on using turmeric powder in the present study could be attributed to physiological and pharmacological properties of bioactive molecules present in turmeric than to its nutritional effect. As observed in

Table 4. Proximate composition of muscle of Common carp fingerlings fed with different experimental feed

Item	C	T_5	T_5B_5	G_2	G_5	G_8
Moisture	77.88±0.7639	78.7±0.3165	78.88±.4911	78.08±.5267	78.26±.2646	79.48±.1589
CP (%)	$77.17±0.1874^{ab}$	$78.29±0.5340^{b}$	$75.60±2.00^{ab}$	$74.47±.903^{ab}$	$71.42±2.26^{a}$	$73.15±1.042^{ab}$
EE (%)	$7.345±0.1498^{a}$	$11.59±0.9156^{b}$	$7.62±0.1362^{a}$	$6.38±0.4340^{a}$	$6.30±0.4340^{a}$	$8.13±0.9548^{a}$
TA (%)	$5.04±0.2068^{a}$	$5.81±1702^{b}$	$5.90±0.268^{b}$	$6.86±.2367^{c}$	$6.68±.516^{c}$	$6.31±.09331^{bc}$
AIA (%)	0.36±0.1259	0.25±0.02175	0.14±0.01124	0.178±0.03017	0.177±0.01710	0.174±0.004858

C, Basal feed; T_5, Basal feed + turmeric @0.5%; T_5B_5, Basal feed + turmeric @0.5% +black pepper @0.5%; G_2, Basal feed + ginger @2%; G_5, Basal feed + ginger @5%; G_8, Basal feed + ginger @8%; Figures bearing different superscripts within a row are statistically different ($p<0.05$); DM, Dry matter; CP, Crude protein; EE, Ether extract; TA, Total ash; AIA, Acid insoluble ash.

growth and feed utilization parameters in the present study, the content of protein lipid and ash as well as their retention might be high upon feeding of these phytoadditives. This has been reported (Syahailatua *et al.* 2017, Limbu 2020) that there is direct link between feed utilization efficiency by fish and their retention in the body. This could be the reason behind higher concentration of CP and EE in fingerlings which received turmeric powder @0.5% group in the present study. This could also very well be correlated with the higher body weight gain and higher gain in TL and body depth of T5 group.

Hence, it could be concluded that turmeric powder supplementation @0.5% in feed of Common carp fingerlings under the conditions of Himalayan sub-tropical region significantly ($p<0.05$) increased their growth rate. Turmeric mixed with black pepper (@ 0.5% each) and ginger @2, 5 and 8% had no significant effect on any of the growth parameters under the conditions of the study. Supplementation of turmeric @0.5% through feed resulted in 57% higher total fat content and 15% higher total mineral content of fish meat of common carp.

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