EFFICACY OF GINGER SUPPLEMENTATION IN SUNFLOWER MEAL BASED DIETS ON MEAT QUALITY AND GROWTH PERFORMANCE OF *LABEO ROHITA* FINGERLINGS

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Abstract

The goal of the current research was to determine the efficacy of diets enriched with ginger powder, ginger peels and mixture in sunflower meal-based diets on growth performance and meat quality of *Labeo rohita* fingerlings. Ginger powder, ginger peel powder and mixture were added in the diet at the levels of 0%, 1.5%, 3% and 4.5%. The 0% was considered as control group. The experiment was conducted in triplicate. Fingerlings were fed 5% of their live wet body weight. Seventy days were spent on the experiment. Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE) was used to determine how each treatment affected the quality of the meat. The data was subjected to one-way Analysis of Variance (ANOVA). The results of this research revealed that, compared to the control group, a sunflower meal-based diet supplemented with ginger powder, peel powder, and mixture enhanced *L. rohita* growth and meat quality, and in all diets, T_2 levels demonstrated superior growth and meat quality. If we compare T_2 of these diets, mixture show better growth, higher SGR, low FCR and higher number of protein bands.

Keywords**:** *Labeo rohita;* SDS PAGE; Meat quality; Growth; Ginger peel and ginger powder

INTRODUCTION

Freshwater and marine food resources are pivotal for fulfilling the goals of food and nutrition security and supplying eco-friendly sources of animal food. Nowadays, this field is used to provide edibles to humans at a larger rate, the amount of which is multiplied within previous years, notably in the economically struggling nations. In contrast, the other foods reflected little to no mobility in the respective field. The enormous potential in the field of aquaculture is showing a dynamic surge in the overall aquatic world (New, 1999). *Labeo rohita* also known by the words Rohu, within Indian language, Rui, in Bangla, as well as Rou, in Assam, has been among three major carp fish species within Indian sub-continent for aquaculture (Debnath et al., 2007). Uttar Pradesh, West Bengal, Assam, Thailand, Pakistan, Bangladesh, Orissa, and Konkan region of India, all countries have been culturing this fish. Rohu, a quasi-fish, is indeed widely known with in North Indian Punjab province (Froese & Pauly, 2005). In aquaculture, major problem of culturing fish is the common spread of fish diseases (Boonthai et al.,2011).

In order to provide aqua feeds that are both inexpensive and ecologically responsible, plants' byproducts may serve as a reliable supply of protein and energy (Hardy, 2010). Because plant byproducts including seeds, leaves, and other botanical feed materials have a high protein content, researchers are evaluating these sources of unconventional protein to find the most affordable, environmentally friendly, and practical sources of protein (Abo-state et al., 2021). Vegetation by-products have been considered a better FM replacement for past two decades (Hussain et al., 2019).Various plants as well as the particular components, including canola, cottonseed, corn, barley, peas, soybeans and wheat, have been used in aquaculture (Naylor et al., 2009). Plant-based proteins remain dominant throughout fish farming dietary habitat but will most likely becoming primary substitute for FM (Olsen et al., 2012).

One of the plant protein sources is sunflower meal (SFM). The crude protein content of SFM ranges between 36–40%, in addition it has high methionine and tryptophan content compared to other plant protein sources. It is also a rich source of choline, niacin, riboflavin, biotin, pantothenic acid, pyridoxine, and vitamin E. Additionally, iron, zinc; magnesium, potassium, and selenium are also available in SFM at high concentrations. Unlike other plant protein sources, no known antinutritional components are present in SFM (Iqbal et al., 2022).

Ginger (*Zingiber officinale*) as well as ginger seems to be ingredients that add to provide flavor as well as aroma, encompass variety of active ingredients which have wide range of applications in sciences and technology (Yanishlieva et al., 2006). Furthermore, antioxidant and anti-natural compounds have potential advantages in extending shelf life (Uhar et al., 2006). Ginger is revealed to have positive advantages in fish farming administration, including rapid multiplication as well as immune-regulatory properties throughout fish, as well as the ability to handle an *Aeromonas hydrophila* infectious disease, particularly in rainbow trout (Masoud & Mostafa, 2013).

The extracted and/or segregated fraction of meat proteins and/or (poly) peptides is typically evaluated by the technique of harvesting and/or extraction. However, it isn't always clear which part of the two (poly) peptides inside the meat specimen is being extracted. Polypeptides as tiny as 10 kDa may be differentiated using SDS-PAGE extraction techniques (Weber & Osborn, 1969). HeBothe & Simonis (1985) used SDS-PAGE with a polyacrylamide gradient separation gel and a transient medium-glycine buffer system. They also used SDS-PAGE to tricine within a cathode buffer. These SDS-PAGE detachment techniques normally provide a clear differentiation from size-exclusion HPLC; however they are frequently used based on personal preference. Few more documents on food peptides utilizing tricine SDS–PAGE were also authored within descriptive form (Mikami et al., 1999; Tajima & Ito, 1999). With consumer priorities as well as economic importance for *L. rohita* in country, the current research is designed to evaluate the impact and qualitative modifications in the protein substances of meat of *L. rohita* fingerlings supplemented with ginger by utilizing SDS PAGE.

MATERIALS AND METHODS

Feeding experiment was carried out in V-shaped tanks to test the impact of ginger peel, ginger powder and their combination in *L. rohita* fingerlings growth and meat quality by SDS PAGE.

3.1 Sampling of Fish and Experimental conditions

L. rohita fingerlings were purchased from the Government Fish Seed Hatchery on Satiana road, Faisalabad and transported to the Government College University Faisalabad, where they were acclimatized for two weeks. Before the experiment began, *L. rohita* was given a NaCl (5g/L) treatment to make sure they were clear of ectoparasites and fungal infections (Rowland & Ingram,

1991). We used an oxygen pump to keep the amount of dissolved oxygen (DO) constant. Daily measurements of the water temperature, pH and dissolved oxygen were done. Before the start of experiment, fish fingerlings' wet weight and total length were measured.

3.2 Experimental Design

One control and nine experimental diets were formulated, divided into three major diet groups with group I (ginger powder), group II (ginger peel) and group III (ginger peel and ginger powder). Fingerlings were distributed in 50 liter water carrying capacity tanks. Each tank contains 15 fingerlings. Total duration of the experimental period was 70 days. These test diets were then compared with control diet and with each other to assess results.

3.3 Ginger peel and ginger powder formulation

Fresh ginger was purchased from local market. Ginger was washed with normal tap water to remove dirt and dust particle. The ginger were drained appropriately and dried for six days under shady place to avoid the damage of organosulfur compounds. Dried peels were separated from cloves. Ginger powder and peel powder were prepared in grinder.

3.4 Feed formulation

Firstly, basal diet was prepared by mixing dietary feed ingredients. All the dietary ingredients of feed were bought from local market and chemical analysis were done according to AOAC (1995). Ingredients were grinded to powder form in grinding machine and sieved through a mesh size of 0.5mm. Ingredients were then mixed in an electric mixer to ensure the thorough mixing of all ingredients. Ingredients composition (%) of supplemented diets is shown in table 3.1. After that fish oil and water was added into the ingredients to make suitable dough. Then the dough was transferred into the feed pelleting machine to make feed pellets of 0.2-0.3mm diameter according to size of fish mouth. The long noodles of feed pellets were cut into small pieces. The ginger powder, ginger peel powder of 1.5%, 3%, 4.5% and peel powder + ginger powder of which 0.5% ginger powder + 1% peel powder,1% ginger powder + 2% peel powder and 1.5% ginger powder + 3% peel powder, concentrations mixed with water and sprayed over the pellets. The pellets were placed in oven at 55°C and then at room temperature for 2-3 days after that stored them in separate plastic boxes.

3.5 Feeding protocol and harvesting of fish

Ingredients	Control group	Test diet- I	Test diet – II	Test diet – III	Test diet - IV	Test diet- V	Test diet – VI	Test diet - VII	Test diet - VIII	Test diet - IX
Ginger powder (%)	0	1.5	3	4.5	0	0	0	0	0	0
Ginger peel powder (%)	0	0	0	0	1.5	3	4.5	0	0	0
Mixture (%)	0	0	0	0	0	0	0	1.5	3	4.5
Sunflower meal	52	52	52	52	52	52	52	52	52	52
Fish meal	10	10	10	10	10	10	10	10	10	10
Wheat flour	20	18.5	17	20	18.5	17	20	18.5	17	20
Rice polish	8	8	8	8	8	8	8	8	8	8
Fish oil	7	7	7	7	7	7	7	7	7	7
Vitamins Premix	1	1	1	1	1	1	1	1	1	1
Minerals premix	1	1	1	1	1	1	1	1	1	1
Ascorbic acid	1	1	1	1	1	1	1	1	1	1

L. rohita fingerlings were given their recommended feed at a rate of 5% of their live total wet weight twice daily (morning and afternoon).

Table: Ingredients Composition % of sunflower meal based diets supplemented with ginger peel, powder and their combination

3.6 Protein Profile Analysis-SDS-PAGE (Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis)

The analysis of protein was done with the help of SDS-PAGE. The soluble proteins were characterized on the bases of their molecular weights.

3.6.1 Procedure to extract soluble proteins

Tissue sample gel (1gm) of each fish species was homogenized with pestle and mortal and then put into 15ml falcon tubes containing sample buffer. Homogenization was done under chilled conditions in extractions buffer (0.01M Tris-HCl, pH 6.8, 1M EDTA). Homogenized samples were centrifuged at 10,000 rpm for 30 minutes at 4 ^{0}C and removed the debris and supernatants were collected in separate tubes. Determination of protein contents was done by using spectrophotometer for each of these samples to fix the sample size for their loading into gel wells. Supernatants were further utilized for protein profiling through SDS-PAGE.

3.7 Qualitative and Quantitative Estimation of protein

By using the Bradford method (1976), protein estimation was done to determine how much protein was in the sample solution. The standard protein solution consisting of bovine serum albumin (BSA) was prepared by dissolving 50mg BSA in 100ml distilled water. The standard protein solution was used to make five different solutions. The BSA concentrations ranged from 0.00 to 1mg/ml. Each tube had a volume of up to 0.3 millilitres. Each test tube received 3.0 ML of dye, and the moment Bradford regent was added, each solution was vortexed. With the use of a spectrophotometer (HITACHI-UV-2800), the absorbance of these solutions was measured at 595 nm after about 15 minutes of incubation.

3.8 Growth Study

At the conclusion of the trial, fish in every tank were mass weighed to calculate final weight. The growth performance of *L. rohita* was assessed using standard equations.

$$\text{Weight gain \%} = \frac{(\text{Final weight} - \text{Initial weight})}{\text{Initial weight}} \times 100$$

$$\text{SGR (\%/day)} = \frac{(\text{ln. final wt. of fish} - \text{ln. initial wt. of fish})}{\text{Trial day}} \times 100$$

$$\text{FCR} = \frac{\text{Total dry feed intake (g)}}{\text{Wet weight gain (g)}}$$

3.9 Statistical Analysis

The data was analyzed by ANOVA (two way) using software SPSS. For estimation data of growth was subjected into two way analysis of variance (ANOVA) (Steel et al., 1996). By turkey's honesty significant difference test, the difference among means was matched and considered significant at $p<0.05$ (Sales et al., 1991). The data was analyzed by using software SPSS.

RESULTS AND DISCUSSIONS

The research work was conducted for the evaluation of *L. rohita* meat quality enhancement with the use of ginger powder, ginger peel powder and peel + powder. Sunflower meal based diet supplemented with ginger peel and ginger powder used as levels; 0%, 1.5%, 3% and 4.5% and diet in which both peel + ginger powder used as levels; 0, 1% peel + 0.5% ginger powder, 2% peel + 1% ginger powder and 2% peel + 1.5% ginger powder.

The results of the current research work have proved under the following headings:

4.1 Fish growth performance (weight gain %, FCR, SGR)

4.2 Evaluation of meat quality by using SDS PAGE

4.1 Growth performance

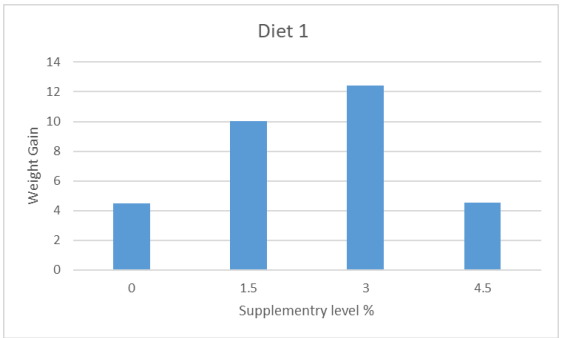
4.1.1 Growth performance of *L. rohita* fingerlings given a diet enriched with ginger powder, peel and mixture based on sunflower meal

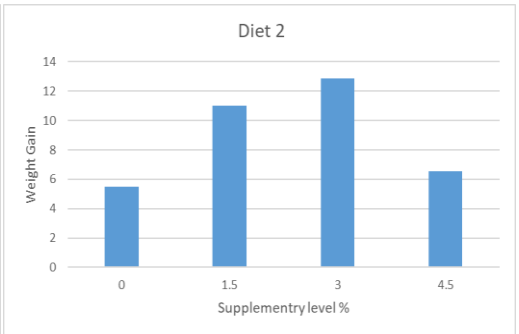
The results of *L. rohita* fingerlings' growth effectiveness on a diet based on sunflower meal supplemented with ginger powder were displayed in (table 4.1). Significant improvements in *L. rohita* fingerlings development were seen at the T_2 diet level when sunflower was supplemented with 3% ginger powder. At this level, there was a significantly ($p<0.05$) enhanced weight gain percentage of (225%), lowest FCR (1.56), and greater SGR (1.31).The second-best outcomes were obtained when sunflower was supplemented with 1.5% ginger extract and given to fingerlings on a T_1 diet level. Weight increase percentage was (184%), FCR was (1.75), and SGR was (1.16). Weight growth increased significantly ($p<0.05$) in correlation with T_2 level. Fish given the T_0 diet, the control group, had the lowest values for growth indices such WG (8g), WG (61%), greatest FCR (5.84), and lowest SGR (0.54).

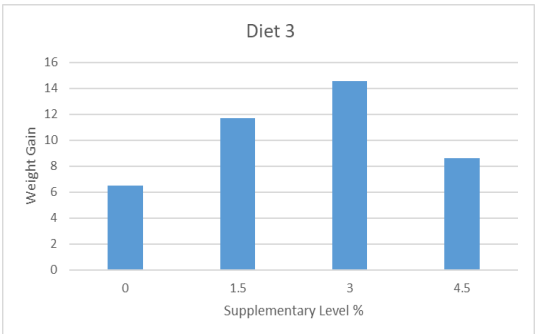
Growth efficacy on a diet based on sunflower meal and supplemented with ginger peel are displayed in (table 4.1). Significant improvements in *L. rohita* fingerling development were seen at the T_2 diet level when sunflower was supplemented with 3% ginger extract. At this level compared to all other levels in the table, there was a significantly ($p<0.05$) enhanced weight gain% (233%), lowest FCR (1.51) was detected, and higher SGR (1.34) was documented. The second-best outcomes were obtained when sunflower was supplemented with 1.5% ginger extract and given to fingerlings on a T_1 diet level. At this stage, weight increase percentage (202%), FCR (1.59), and SGR (1.23). Weight growth increased significantly ($p<0.05$) in correlation with T2 level. The fish given the T0 diet, the control group, had the lowest values for growth indices such WG (10.96g), WG (98%), greatest FCR (3.69), and lowest SGR (0.76).

L. rohita fingerlings' growth efficacy on a diet based on sunflower meal and supplemented with ginger peel are displayed in (table 4.1). Significant improvements in *L. rohita* fingerlings development were seen at the T2 diet level when sunflower was supplemented with 3% ginger peel and 1.5% ginger powder. At this level compared to all other levels in the table, there was a significantly ($p<0.05$) enhanced weight gain% (264%), lowest FCR (1.33), and highest SGR (1.44). When fingerlings were fed on a T1 diet level and sunflower was supplemented with 1.5% ginger peel and 1% ginger powder, the second-best results were obtained. Weight gain percentage was (215%), FCR was (1.50), and SGR was (1.28). Weight growth increased significantly

($p<0.05$) in correlation with T2 level. The fish given the T0 diet, the control group, had the lowest values for growth indices such WG (12.96g), WG (121%), greatest FCR (2.99), and lowest SGR







Treatment	Supplementary Diets	Supplement Levels	Feed intake fish^{-1} day^{-1} (g)	FCR	SGR (%)
T_1	Diet-I GP	0	0.22±0.01^a	4.51±0.18^a	0.65±0.01^c
T_2		1.5%	0.20±0.04^a	1.75±0.05^c	1.16±0.02^a
T_3		3%	0.22±0.02^a	1.56±0.02^d	1.31±0.01^a
T_4		4.5%	0.22±0.03^a	4.43±0.05^a	0.76±0.01^d
T_5	Diet-II GPP	0	0.22±0.03^a	3.69±0.09^a	0.76 ±0.01^d
T_6		1.5%	0.20±0.02^a	1.59±0.04^c	1.23±0.02^b
T_7		3%	0.22±0.01^a	1.51±0.02^c	1.34±0.00^a
T_8		4.5%	0.22±0.04^a	3.07±0.03^b	0.87±0.01^c
T_9	Diet-III Mixture	0	0.22±0.01^a	3.02±0.03^b	0.88±0.01^c
T_{10}		1.5%	0.20±0.03^a	1.50±0.04^d	1.28±0.02^b
T_{11}		3%	0.22±0.05^a	1.33±0.02^c	1.44±0.00^b
T_{12}		4.5%	0.22±0.02^a	2.23±0.02^b	1.05±0.01^b

Table 4.1 Growth performance of *L. rohita* fingerlings fed with sunflower meal based diet supplemented with ginger powder,peel and mixture

Treatments	Supplementary Diets	Supplementary level	Initial weight (g)	Final weight (g)	Weight Gain (g)	Weight Gain (g)
T_1	Diet-I GP	0	5.55±0.02[a]	8.96±0.09[a]	4.47±0.07[d]	61.99±1.03[c]
T_2		1.5%	5.34±0.10[a]	15.44±0.03[a]	10.01±0.09[a]	184.34±4.87[b]
T_3		3%	5.53±0.03[a]	17.91±0.07[c]	12.41±0.06[c]	225.44±1.68[a]
T_4		4.5%	5.51±0.04[a]	10.02±0.02[d]	4.53±0.06[d]	82.58±1.71[c]
T_5	Diet-II GPP	0	5.55±0.02[a]	10.96±0.09[d]	5.47±0.07[d]	98.13±0.09[c]
T_6		1.5%	5.34±0.10[a]	16.44±0.03[b]	11.01±0.09[a]	202.76±5.19[a]
T_7		3%	5.53±0.03[a]	18.38±0.02[a]	12.87±0.01[a]	233.92±1.47[a]
T_8		4.5%	5.51±0.04[a]	12.02±0.02[c]	6.53±0.06[c]	119.01±2.00[b]
T_9	Diet-III Mixtue	0	5.53±0.02[a]	12.23±0.03[c]	6.47±0.05[c]	121.03±1.28[b]
T_{10}		1.5%	5.34±0.10[a]	17.12±0.01b	11.69±0.09[a]	215.29±5.33[a]
T_{11}		3%	5.53±0.03[a]	20.08±0.02[a]	14.57±0.01[a]	264.82±1.64[a]
T_{12}		4.5%	5.51±0.04[a]	14.12±0.02[b]	8.63±0.06 [b]	157.27±2.31[b]

Table 4.2 Evaluations of Feed intake, FCR and SGR of *L. rohita* fingerlings fed on sunflower meal based test diet supplemented with ginger powder, peel and mixture

4.2 Evaluation of meat quality by using SDS PAGE

4.2.1 Evaluation of meat qualityof *L. rohita* fingerlings fed with sunflower meal based diet supplemented with ginger powder by using SDS PAGE

In muscle protein extracts from *L. rohita* fingerlings given a sunflower meal-based diet supplemented with ginger extract, many proteins were seen when the samples were run on SDS-PAGE and compared to the markers (10-250 KDa). The number of protein bands that were visible in *L. rohita* fingerlings fed 0%, 1.5%, 3%, and 4.5% ginger extract was varied (13, 14, and 12). Specifically, isolated proteins from diet T1 *L. rohita* fingerlings supplemented with 1.5% ginger extract had molecular weights of 13, 15, 18, 20, 22, 29, 32, 74, 124, 131, and 202 KDa. *L. rohita* at T2 level demonstrated 14, 15, 18, 21, 25, 29, 36, 74, 124, 132, 198, and 220 KDa when given a

diet based on sunflower meal and containing 3% ginger extract. In diet T3, L. rohita fingerlings were fed a diet based on sunflower meal and supplemented with 12, 13, 20, 35, 45, 60, 71, 82, 98, 99, 123, and 204 KDa of ginger extract, respectively (Table 4.3).

4.2.2 Evaluation of meat qualityof *L .rohita* fingerlings fed with sunflower meal based diet supplemented with ginger peel by using SDS PAGE

When ginger peel was added to the muscle protein extracts of *L. rohita* fingerlings given a sunflower meal-based diet supplemented with the indicators (10-250 KDa). The number of protein bands in *L. rohita* fingerlings fed 0%, 1.5%, 3%, and 4.5% ginger peel was varied (12, 14, and 12). Molecular weights of the extracted proteins in diet T1 *L. rohita* fingerlings with sunflower supplemented with 1.5% ginger extract are 11, 14, 16, 22, 29, 32, 34, 75, 125, 132, 133, and 205 KDa. *L. rohita* at T2 level showed 15, 17, 20, 21, 22, 28, 32, 74,124, 129, 150, 144, 202, and 230 KDa when given a diet based on sunflower meal and containing 3% ginger extract. In diet T3 *L. rohita* fingerlings, ginger extract was added to a diet based on sunflower meal at doses of 12, 21, 29, 34, 45, 61, 73, 84, 93, 96, 123, and 204 KDa, respectively (Table 4.3).

4.2.3 Evaluation of meat qualityof *L .rohita* fingerlings fed with sunflower meal based diet supplemented with ginger extract and peel by using SDS PAGE

When *L. rohita* fingerlings were given a diet based on sunflower meal and supplemented with ginger peel + Extract, various numbers of proteins were seen when they were tested on SDS-PAGE against markers (11-250 KDa). The number of protein bands that appeared in *L. rohita* fingerlings fed with 0%, 1 % peel plus 0.5% extract, 2 % peel plus 1% powder, and 4.5% ginger peel plus 1.75 % extract varied (12, 15, and 11). Isolated proteins in the diet .In the case of diet T1 *L. rohita* fingerlings, the separated proteins have molecular weights of 12, 17, 20, 26, 28, 33, 38, 79, 132, 134, 143, and 203 KDa and are supplemented with 1.5% ginger peel and 1% ginger extract. *L. rohita* at T2 level demonstrated 16, 17, 18, 22, 29, 33, 71, 78, 82, 119, 123, 129, 131, 199, and 249KDa when given a diet based on sunflower meal that included 3% ginger peel and 1.55 ginger extract. In diet T3 *L. rohita* fingerlings, ginger extract was added to a diet based on sunflower meal at doses of 11, 14, 23, 29, 55, 60, 68, 82, 92, 99, 112, and 204 KDa, respectively (Table 4.3).

Markers	Ginger powder fortified diet				Ginger peel supplemented diet				Ginger peel + powder supplemented diet		
	T0	T1	T2	T3	T1	T2	T3	T1	T2	T3	
250				230		205	230		205	249	
			202				202	204	203		204
		180		198						199	
150		131	131	132	135	132	150	135	150	131	
		128	124				129		135	129	
				123			124	123		123	
100				99						119	112
				98							99
								96	97		
				82			78	93		82	93
					75			82			82
75			74	74			74				
		72						73		73	
				71					71	71	
								61			68
				60							60
50				45				45			55
			36	35							
35					34	34				33	
			32	32	32	32			33		
									30		
			29	29	29		29	29		29	29
		28				28		28			
			22		22		22	22		22	
		21		21		21	21		20		21
			20			20				18	
		18	18	18			17		17	17	
		16			16	15				16	
15		15	15	15							
				14	14						14
		13	13	13				12	12		
				12							
10		10			11						11

Table 4.3 Characterization of Isolated Protein on the basis of their molecular weights in muscle of, *L. rohita* fed with sunflower meal base diet supplemented with ginger powder, peel and peel+ powder

DISCUSSION

In order to meet the demands of growing aquaculture industry, fundamental importance has been given to the formulation of commercial diets using affordable and nutritionally balanced ingredients. To overcome the higher prices of fish feed, plant derived ingredients could be used which will be helpful in increasing fish production and reducing the cost of feed. Several researches supported the fact that plant ingredients can be incorporated into fish feed partially or completely. Fishes fed with plant feed showed both positive and negative results.

Our results of the feeding of *L. rohita* fingerlings with a diet based on sunflower meal and supplemented with ginger powder peel powder and their combination showed significant improvement when compared to control diet. The combination of ginger powder and its peel gave the best results in *L. rohita* fingerlings which were fed a diet consisting of sunflower meal. Significant improvements in *L. rohita* fingerlings growth at the T_2 diet level which was supplementing sunflower with 3% ginger peel and 1.5% ginger powder. Significantly ($p<0.05$) greater weight gain percentage (264%), lowest FCR (1.33), and higher SGR (1.44) were found at this level compared to all other levels. When fingerlings were fed on T_1 feed level, sunflower supplemented with 2 % ginger peel and 1% ginger powder, the results were second best. Their weight gain percentage was (215%), FCR was (1.50), and SGR was (1.28). Their weight gain increased significantly ($p<0.05$) in correlation with T_2 level. The fish given the T_0 diet, the control group, had the lowest values for growth indices such as WG (12.96g), WG% (121%), greatest FCR (2.99), and lowest SGR (0.88). In the present study, the *L. rohita* fingerlings fed with ginger peel + powder showed the best growth results. The maximum weight gain of the fish was observed in group fed with diet T_2 when compared with control group and other two diet groups.

Our growth data findings were consistent with those of Mohammadi et al. (2020), who found that feeding fish with varying amounts of ginger at different levels boosted growth, FCR, and SGR of *C. carpio*. The growth findings of our research were comparable to those of Sukumaran et al. (2016), who evaluated the impact of ginger on the development of *L. rohita.* At G8 and G6, greater SGR and lower FCR were observed, while G10 also shown improved growth in comparison to the control group. Our research on weight gain and growth performance was comparable to that of Korni et al. (2017), who found that feeding fish a diet high in ginger promoted fish growth. According to reports, ginger contains trace amounts of anti-nutritional

substances including tannin and phytic acids (Adanlawo & Dairo, 2007), yet these substances are safe for both humans and animals to consume at these levels (Adanlawo & Dairo, 2007; Ajayi et al., 2013). We thus considered that any anti-nutritional component(s) in ginger had no negative effects on fish health. In addition, it is important to remember that plant secondary metabolites like tannins and phytic acids may have therapeutic benefits when used in small amounts (Singh *et al.*, 2003; Makkar *et al.*, 2007). The outcomes of earlier investigation Oh et al. (2022) were similar with our research in which fish growthwas significantly higher when fed by diets supplemented with 0.75–1% ginger. Findings demonstrated that 0.75% ginger dietary supplementation enhanced the growth performance of juvenile black rockfish with no adverse effects. Mustafa & Dikel (2022) proposed that adding garlic to rainbow trout's diet increased their protein ratio while lowering their moisture and fat content. The amounts of fatty acids and monounsaturated fatty acids decreased as a result, whereas growth increased. Naliato et al. (2021) investigated that adding 10 g/kg GgP had been shown to enhance Nile tilapia performance as well as opposition towards *A. hydrophila* infestation. Our growth data findings were consistent with those of Da et al. (2021) who found that ginger oil improves the diet palatability, fish growth, retention of nutrients in the fish carcass, and attenuate the impairment caused by excess starch in nutrient utilization efficiency. If we compare our results with the findings of Jafarinejad et al. (2020) dietary ginger also significantly enhance the health, growth, and antioxidant capacity of common carp.

In our findings, the number of protein bands that appeared in *L. rohita* fingerlings fed with third group diet which includes, 1% peel plus 0.5 %ginger powder , 2% peel plus 1% ginger powder and 3% ginger peel plus 1.5% ginger powder, varied if we compare isolated proteins in all diets and control group. In group 3, the T2 had more number of protein bands when compared to other diets in the same group *L. rohita* fed at T_2 level (ginger peel+ powder) showed 15 protein bands demonstrated 16, 17, 18, 22, 29, 33, 71, 73, 82, 119, 123, 129, 131, 199, and 249KDa number of proteins bands.

Our study's findings on the evaluation of meat quality using SDS PAGE were remarkably similar to those of Sultana et al. (2016), who examined the protein quality of several fish given three different diets. Mahendradatta et al. (2020) finding of fish protein bands using SDS PAGE was similar to our observation of meat quality using SDS PAGE. Our research was similar to that of Doloi et al. (2020), who used the two species (*L. rohita* and *Heteropneustes fossilis*) to examine the protein bands in their study by using SDS PAGE. Doloi et al. (2020) proposed that SDS PAGE

gel electrophoresis determined the electrophoretic consensus sequence of *L. rohita* muscle protein. Proteins were separated as well as visualized using electrophoresis.

CONCLUSIONS

The effects of ginger powder, ginger peel and peel + ginger powder supplementation on growth performance and evaluation of *L. rohita* fingerlings meat quality enhancement by SDS PAGE were observed. Ginger powder, ginger peel powder and their combination were given to the fingerlings in amounts of 0%, 1.5%, 3%, and 4.5%, respectively. 0% was used as the control group. When fingerlings were given the T_2 test diet (a sunflower meal-based diet supplemented with ginger powder, ginger peel powder and ginger peel + ginger powder), *L. rohita* had the greatest growth metrics, including weight increase, weight gain%, SGR and minimum FCR, and if we compare these (Ginger peel powder, ginger powder and peel + ginger powder) diets the T_2 level of ginger peel+ powder showed best growth and highest number of protein bands.

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