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Optimum size and shape of plots for field experiments on sesame (sesamum indicum)

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ABSTRACT

A uniformity trial on sesame crop was carried out at Seed Technology, S. D. Agricultural University, Sardarkrushinagar during *kharif* season in the year 2023 to find out optimum plot size, plot shape and number of replications. The popular variety GT 3 was grown for this purpose and yield data were collected from 600 basic units. The dimension of one basic unit was 1 m x 1.20 m constituting 2 rows each of 1 meter length. The Maximum curvature method and Fair field Smith's variance law were used for the same. The variability as judged by coefficient of variation per unit area decreased from 24.24 to 1.94 per cent with increase in plot size from 1 basic unit to 300 basic units. Based on experimental research, it was concluded that, a plot of 18 m^2 size having shape of 6 rows each of 5 m length (5 m × 3.6 m) found optimum (net plot) with minimum 3 replications at 5 per cent standard error is recommended for filed experiments on sesame crop.

Key words : Optimum plot size, coefficient of variation, sesame

INTODUCTION

In agricultural experimentation, the use of adequate plot size and shape is an important experimental technique to increase the precision of the experiment. Thus, the objective of this study was to determine the appropriate size and shape of the plot for field experimentation with sesame. Agricultural research workers are mainly concerned with field experimentation, the use of adequate plot size and shape is an important experimental technique to increase the precision of the experiment. Efficient planning of precise field experiments largely depends on adoption of principles of experimental design (Replication, Randomization and Local control), choice of experimental design and suitable size and shape of plot. Each experimental site has an inherent variation *i.e.* soil variability which could be accessed through uniformity trial. The studies of such variation help in proper choice in size and shape of plots and blocks, experimental design and number of replications etc. Thus, the objective of this study was to determine the appropriate size and shape of the plot for field experimentation with sesame. Such studies based on uniformity trials in Indian conditions

were undertaken on various annual crops like Bajra (Patel and Patel, 1967); Paddy (Agrawal and Deshpande, 1967), Tobacco (Prajapati and Patel, 1984) and Mungbean (Singh and Singh, 1989). Information on optimum size and shape of plot on various cereals, oilseeds and leguminous crops are available in India and abroad in plenty, but such an information however, is very scanty with respect to sesame crop which is an important commercial crop for farming community of North Gujarat. Moreover, such information will be useful to scientific community working with sesame crop for planning their research experiments to bring out precise estimate.

MATERIAL AND METHODS

An uniformity trial was planned on sesame crop with variety GT 3 at at the Seed Technology, Sardarkrushinagar Dantiwada Agricultural University, Sradarkrushinagar during the *kharif* season in the year 2022-23



Fig. 1: Geographical map of study area

to collect required information (Fig. 1). The crop was sown at a spacing of 60 cm between rows. A plot of 1 m x 1.20 m = 1.20 m^2 constituting 2 rows each of 1 m length was taken as one basic unit. A block of 20 m x 36 m was harvested and seed yield data were recorded separately for 600 basic units (Fig. 2). The other crop cultivation practices in vogue were followed.

Border areas were excluded from each side of experimental plot. The different sized plots of size 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 20, 24, 25, 30, 40, 50, 60, 75, 100, 120, 150, 200 and 300 were formed by combining neighboring units both length-wise as well as width-wise. The coefficient of variation for different combinations of above sized plots was calculated separately for seed yield data using the following formula.

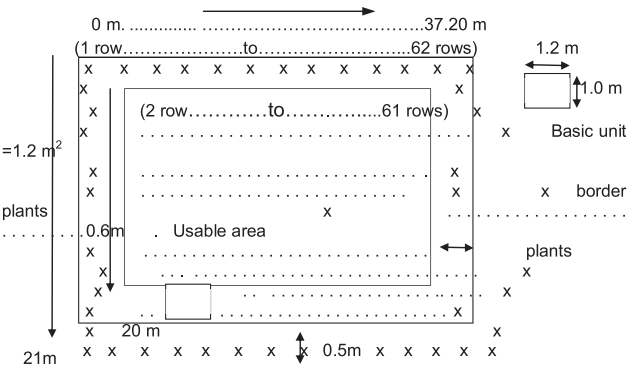


Fig. 2: Detail of the experimental plot, usable area and basic unit

variation for different combinations of above sized plots was calculated separately for seed yield data using the following formula.

$$C.V.\% = \frac{\text{Standard deviation}}{\text{General Mean}} \times 100$$

The optimum plot size was determined using maximum curvature method (Federer; 1955) and Fair-field Smith's variance law (Smith, 1938). The minimum number of replications (r) and area required for 5 % Standard error of mean (SEm.) for different plot size were calculated using following the formula (Nigam and Gupta, 1979).

$$r = \frac{(C.V.\%)^2}{(5\%SEm)^2}$$

The relative land use efficiency was also calculated for different plot sizes by dividing the amount of land used by the basic unit to the amount of land used by other plot sizes.

RESULTS AND DISCUSSION

The comparisons were made among different sizes and shapes of plots using C.V.% obtained for seed yield of sesame. The results are given in Table 1 : Per unit decrease in CV(%) for seed yield of sesame

No. of units	Combinations (basic unit)	CV(%)	Average CV(%) Per unit
1	1 × 1	24.24	24.24
2	2 × 1	18.32	
	1 × 2	15.83	17.08
3	1 × 3	14.07	14.07
4	4 × 1	14.5	
	2 × 2	11.83	13.17
5	1 × 5	12.72	
	5 × 1	11.73	12.23
6	2 × 3	10.98	
	1 × 6	10.45	10.72
8	4 × 2	9.52	9.52
10	10 × 1	10.02	
	5 × 2	8.84	
	2 × 5	9.26	
	1 × 10	8.54	9.17
12	4 × 3	9.22	
	2 × 6	8.08	8.65
	5 × 3	8.61	
	1 × 15	6.22	7.42
20	20 × 1	8.16	
	10 × 2	7.22	
	4 × 5	7.96	
	2 × 10	6.74	7.52
24	4 × 6	6.66	6.66
25	5 × 5	7.66	7.66
30	10 × 3	7.19	5
	5 × 6	6.9	
	2 × 15	4.59	
	1 × 30	4.53	5.80
40	20 × 2	5.44	
	4 × 10	5.74	5.59
50	10 × 5	6.46	
	5 × 10	5.97	6.22
60	20 × 3	5.6	
	10 × 6	6.01	
	4 × 15	3.62	
	2 × 30	3.46	4.67
75	5 × 15	3.39	3.39
100	20 × 5	5.28	
	10 × 10	5.38	5.33
120	20 × 6	4.64	
	4 × 30	2.6	3.62
150	10 × 15	2.95	
150	5 × 30	2.86	2.91
200	20 × 10	3.93	3.93
300	20 × 15	1.22	
300	10 × 30	2.65	1.94

Table 1 and depicted by Fig.3. The results (Table 1) revealed that the value of Coefficient of Variation (CV) decreased with increase in plot size. The average value of CV(%) decreased from 24.24% to 1.94% with increase in plot size from 1 unit to 300 units. Initially the decrease in CV(%) was more rapid but after 15 units plot

size the reduction was marginal. These results are in agreement with the results reported by Patel and Patel for Bajra (1967), Prajapati *et al.* in bidi tobacco (1984), Kumar and Singh for wheat (1986), and Chaudhary *et al.* for isabgul (2015).

The difference between in CV(%) of the consecutive points (plot size) may help to estimate per unit decrease in C.V. % thereby point of maximum curvature. The per unit decrease in CV(%) (Table 2) was observed from 7.17% to 0.02% with increase in plot size from 1 unit to 300 units plot size. Beyond 12 unit plot size, the per unit decrease in CV(%) was not proportional to the amount of land used in forming the large sized plot. Therefore, 12 units plot size could be taken as point of maximum curvature. The optimum plot size is just beyond the point of maximum curvature (Federer, 1995). Therefore, 15 units plot size *i.e.* 5.0 m x 3.6 m (6 rows each of 5 meter length) was considered as an optimum plot size for conducting field experiments on sesame crop. The data were also presented graphically and depicted in Fig. 3, also showed the similar trend. Therefore, 15 units plot size was taken as point of maximum curvature and could be considered an optimum plot size for field experiment on sesame crop.

Table 2 : Per unit decrease in CV (%) for seed yield of sesame Plot

Plot size in basic unit	Average CV(%)	Difference in CV(%)	Per unit decrease in CV(%)	Plot size in basic unit	Average CV(%)	Difference in CV(%)	Per unit decrease in CV(%)
1	24.24			25	7.66	-1.00	-1.00
2	17.07	7.17	7.17	30	5.80	1.86	0.37
3	14.07	3.00	3.00	40	5.59	0.21	0.02
4	13.65	0.42	0.42	50	6.22	-0.63	-0.06
5	12.22	1.43	1.43	60	4.67	1.55	0.16
6	10.72	1.50	1.50	75	3.39	-0.66	-0.04
8	9.52	1.20	0.60	100	5.33	1.71	0.07
10	9.16	0.36	0.18	120	3.62	0.72	0.04
12	8.65	0.51	0.26	150	2.90	-1.03	-0.03
15	7.41	1.24	0.41	200	3.93	1.99	0.04
20	7.52	-0.11	-0.02	300	1.94	1.94	0.02
24	6.66	0.86	0.22				

The number of replication and required area for different plot size at 5% standard error of mean were compare from the estimated CV% for seed yield of sesame by using the formula (Nigam and Gupta, 1979). The results

Table 3 : Number of replications, area required for 5 per cent S. Em. and relative land use efficiency for seed yield with respect to unit plot size

Basic unit plot size	CV(%)	No. of replications	No. of basic units	Sq. m.	Relative land use efficiency (%)
1	24.24	24	24	28.80	100.00
2	17.07	12	24	28.80	100.00
3	14.07	8	24	28.80	100.00
4	13.65	8	32	38.40	75.00
5	12.22	6	30	36.00	80.00
6	10.72	5	30	36.00	80.00
8	9.52	4	32	38.40	75.00
10	9.16	4	40	48.00	60.00
12	8.65	3	36	43.20	66.67
15	7.41	3	45	54.00	53.33
20	7.52	3	60	72.00	40.00
24	6.66	2	48	57.60	50.00
25	7.66	3	75	90.00	32.00
30	5.80	2	60	72.00	40.00
40	5.59	2	80	96.00	30.00
50	6.22	2	100	120.00	24.00
60	4.67	1	60	72.00	40.00
75	3.39	1	75	90.00	32.00
100	5.33	2	200	240.00	12.00
120	3.62	1	120	144.00	20.00
150	2.90	1	150	180.00	16.00
200	3.93	1	200	240.00	12.00
300	1.94	1	300	360.00	8.00

(Table 3) revealed that the number of replication and relative land use efficiency decreased as the size of plot increased. Agricultural operation in field experiment with smaller plot size, a plot size having relatively high land use efficiency with less number of replications should be considered for field experimentation. Such situation was observed with the 15 units plot

size which is having considerably smaller number of replications and relatively high land use efficiency for seed yield. Therefore, 3 replications could be considered optimum for 15 units plot size at 5% probability level for sesame crop.

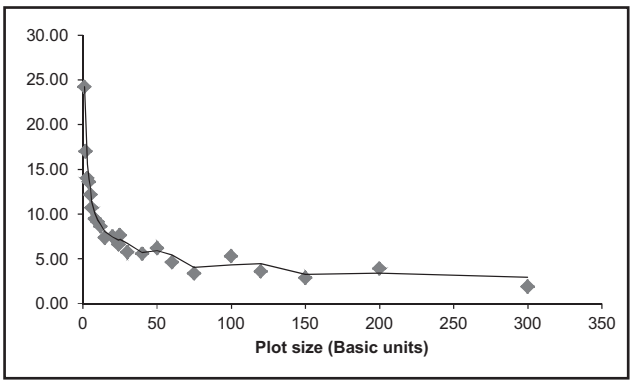


Fig. 3: Coefficient of variation in per cent for different sized plots

Among all combinations of 15 units plot, a plot of 1×15 (1 units towards length and 15 units toward width) showed the lowest CV (6.22%). Taking into consideration the requirement of agronomical operation, handling of experimental material and the average variability, 15 unit plot (6 rows each of 5 meter length, *i.e.*, 5.0 m × 3.6 m) is optimum net plot with 3 replications for sesame crop.

CONCLUSION

A plot of 15 basic units (18 m^2) size having shape of 6 rows each of 5 meters length (5.0 m × 3.6 m) was found as optimum plot size (net plot) with minimum 3 replications for field experiments on sesame at the Seed Technology, S. D. Agricultural University, Sardarkrushinagar

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Growth Response of Juvenile Rohu (*Labeo Rohita*) Exposed to Varying Amounts of Peppermint diet with Protein

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ABSTRACT

The goal of the current investigation was to determine how dietary peppermint (Mentha piperita) along with protein affected Labeorohita's growing performance. Following five days of acclimation to the aquarium environment, the fingerlings were split into four equal groups, designated as groups A, B, C, and D. Each aquarium included fifteen fish. The duration of the experiment was for sixty days where one set of animals was fed a control diet devoid of peppermint and another three were fed with test diets containing varying levels of Mentha piperita and protein at 4mg,6mg and 8mg of the diet. The weight gain, body length. specific growth rates were used to evaluate fish growth. The findings showed that in Tank 4, where fish were fed a diet containing 8mg of peppermint, all growth metrics were significantly higher. When compared to the control group, the dietary inclusion of Mentha piperita in all doses increased fish appetite and may be suggested as a safe growth promoter as the outcomes demonstrated that feeding with *Mentha piperita* decreased the fatalities by enhancing fish growth and production.

Keywords : Peppermint, Labeorohita, Growth, Medicinal herbs.

INTRODUCTION

Aquaculture farming is now the fastest-growing food production industry worldwide. It offers premium animal protein, with a rise in worldwide production. Integrated fish management and polyculture are established, fruitful, and dynamic techniques that employ common fish species like mrigal (*Cirrhinus Cirrhosus*), rohu (*Labeo Rohita*), and catla (*Catla Catla*) (Uddin et al., 1994; FAO, 1997). Due to its high market value and consumer preference, rohu are currently quite popular among farmers (Dey et al., 2005; Rahman, 2006) Fresh water fish of the species *Labeo Rohita* are members of the family Cyprinidae and the class actinopterygii order Cypriniformes. It is found in freshwater environments like lakes, streams, rivers, and pools all across the world. This highly adaptable freshwater fish is found throughout Europe, Asia, and the Middle East's eutrophic waterways; it is also found in North America, Canada, and Australia (Faramarzi et al., 2012).The rohu (*Labeo Rohita*) is a highly sought-after species with significant market value. Shete et al. (2015).

Nowadays antibiotic growth promoters are being added to feed in order to achieve high production. However, the public is more receptive to natural substances because of their negative effects (residual buildup in fish tissue and, rise of antibiotic-resistant

bacteria).To deal with this the use of herbal immunostimulants has been shown to improve animal overall health , productivity and feed consumption efficiency. Medicinal plant extracts have been used for a variety of reasons since ancient times, including medications, cosmetics, and food supplements. They've been evaluated for their prospective applications as substitute remedies for the management of numerous infectious disorders and the protection of food from oxidant-induced toxicity (Kelen and Tepe 2008).

Mentha piperita, popularly known as peppermint, is a well-known perennial herb in the Labiatae family.is among the traditional medicinal herbs used worldwide (Iscan et al.,2002) Due to their extensive therapeutic range, plant extracts are frequently used in traditional and ancient medicine, typically in aqueous solutions (Zhang et al., 2002). According to available data and research, numerous studies have examined the use of dietary medicinal herbs and their extracts as possible immunostimulants in aquaculture, with eventually encouraging findings noted regarding varied fish species' disease resistance, growth patterns, feed consumption, chemical body structure, and immune response (Hoseinifar *et al*., 2016). The primary active component found in peppermint is menthol, accompanied by other elements like menthol and menthyl acetate Dried peppermint typically contains volatile oil, with varying percentages of menthol, menthone, menthyl acetate .Peppermint has been recognized for its potential as an immunostimulant and appetite enhancer (Pauli 2006). The current study aims to examine how incorporating dietary peppermint *(Mentha piperita)* affects the growth performance of the Indian major carp, rohu Labio rohita “Barbarestani *et al*. (2017)”. Depending upon the above-mentioned , this study is done to investigate the effects of mint powder dietary supplements on *Labio rohita* growth and health performance performance. Many studies have shown that the rise in feed intake could also be attributed to the effects of peppermint and the improved digestibility of food. Our study aligns with prior research findings, such as those of (Nath *et al*. (2013), which support this notion.

MATERIALS METHOD

Experimental setup

The experiment was done in a laboratory setting. The fish were collected from the adjacent fish farm, and after approximately a week of acclimation, the healthy fish were used for the experiment. The fish were housed in glass aquariums of 100 l capacity filled with regular well water that had been adequately aerated. The tanks were divided into four such as group A, group B, group C, group D where group A is for control and the remaining three are for experimental. Fish fingerlings (10 fish per tank) were added to each aquarium in an equal quantity. To prevent any fungal infection, dechlorinating solutions were added and the water was changed every day. The fish's initial body weight and general composition were established before the experiment. After the experiment growth parameters were studied by analyzing body weight, height etc.

Preparation of Experimental Diet

The Mentha piperita plants were gathered from their natural habitat Following the collection, leaves of M. piperita underwent a drying process in a well-ventilated and dark

room. Subsequently, the dried plants were finely ground using a grinder. For the preparation of experimental diet the powdered plant material in different concentration like 4mg, 6mg and 8mg was mixed with groundnut oil cake, wheat flour, soya flour, fish meal, tapioca flour, and a mix of vitamins and minerals. In all of these groundnut and soya were taken in high proportion as both of them are good sources of protein. It is widely recognized that protein is crucial and often the most costly component that needs to be provided in sufficient quantities to facilitate optimal growth while minimizing expenses (WecKL,1983). The amount of crude protein in the groundnut seed is 25–30% and oil content is 35–50% (Musa *et al.,* 2010). Whereas the control diet, devoid of peppermint, was formulated using the same ingredients.

The resulting diet was made into palette, allowed to sun-dry, and were stored.

Table 1 : Ingredients of experimental diet.

Ingredients (g/100gm)	(Group A) Control	Group B	Group C	Group D
Soya oil cake	45	45	45	45
Groundnut oil cake	25	25	25	25
Wheat flour	20	20	20	20
Corn starch	5	5	5	5
Fish meal	3	3	3	3
Mineralsand Vitamin	2	2	2	2
Peppermint powder	00	0.4	0.6	0.8

Growth performance

Growth parameters such as weight gain, and specific growth rate (SGR) were determined according to the following standard formula (Saufie *et al*., 2015).

Weight gain = Final fish weight (g) - initial fish weight(g)

$$\text{Specific growth rate} = \frac{\text{ln final weight - ln initial weight}}{\text{Number of days}} \times 100$$

Protein estimation

Lowry's technique, a commonly used method for determining total protein content in a sample. (Waterborg, & Matthews, 2002) This method's sensitivity is owed to its utilization of two color-producing reactions. This process involves Biuret Reaction which is the interaction of Cu ions with the peptide bonds of proteins under alkaline conditions. In the presence of a base like sodium hydroxide, Cu ions react with peptide bonds, leading to the reduction of cupric ions (Cu) to cuprous ions (Cu) (Lowry OH 1951). This complex formation contributes to the assay's sensitivity. In this phase, the Folin-Ciocalteu

reagent is utilized. This reagent contains a phosphomolybdic complex, which is a mixture of sodium tungstate, sodium molybdate, and phosphate, alongside copper sulfate solution and the protein sample. Upon reaction with peptide bonds in the protein sample, the Folin-Ciocalteu reagent generates a blue-purple colour. The intensity of this colour correlates directly with the protein concentration in the sample. Typically, the absorbance of the resulting colour is measured spectrophotometrically at wavelengths between 650-700 nm (Wrolstad et al., 2005). By gauging the absorbance of the produced colour in Lowry's reaction, the protein concentration in the sample can be quantified. This approach is favored for its sensitivity and reliability in determining total protein levels in biological specimens like serum.

RESULTS & DISCUSSION

Fish growth parameters

A dietary supplement of Peppermint and protein has been shown to enhance the growth performance in fish showing significant differences ($P < 0.05$) between groups, as indicated by varying superscripts within each row. There was a significant increase in weight gain, length and SGR when the mint treatment was given to the fish. There are many studies that have shown the positive effect of peppermint on aquatic animals like fish (Hong *et al*., 2012).

The body weight (in grams)

The body weight gain of *Labeo rohita* fish exhibited a notable increase in groups (C) and (D) compared to groups (A) and (B) during the initial 30 days. Among these, group (D), which received a high dose of peppermint supplement (8 mg) with their feed, recorded the highest weight in the next 30 days subsequently there was a significant increase in weight observed in groups (B), (C), and (D) in comparison to control group A. Once again, group (D) treated with a high dose of peppermint supplement mixed with feed displayed the maximum weight and length (Table 2) As mint has antioxidant properties it increases the survival rate and increases the growth performance, specific growth rate (VargaSanchez et al., 2019;)

Specific growth rate

Dietary peppermint has a positive effect on specific growth rate (Korzen *et al*., 2016) Highest specific growth rate was observed in group D which were fed with peppermint and high protein diet as compared to controls which had the lowest specific growth rate which was fed with only normal diet (Table 2).The leaves of mint has high digestive properties as also act as a good appetizer hence enhancing the SGR (Asghari *et al*., 2018)

Length of fish

Peppermint has shown a positive impact on the increase in length of fish. There's An increase in length of fish as the weight gain. The length increases gradually as the dose increases. Furthermore, morphological features also change as the fish grow in weight and length (Parvin *et al.*, 2018).

Table 2 : Growth response of juvenile rohu exposed to varying amount of peppermint diet with protein

Group	Weight (gm)	SGR	Length (cm)
Control (A)	4.36 ± 0.54	0.77±0.59	3.06±0.61
Experimental (B)	5.08±0.38	0.72±0.057	5.66±1.09
Control (A)	4.36 ± 0.54	0.77±0.59	3.06±0.61
Experimental (C)	7.44±0.75	0.92±0.071	8.32±0.23
Control (A)	4.36 ± 0.54	0.77±0.59	3.06±0.61
Experimental (D)	9.44±1.00	1.078±0.06	8.58±0.19

Data is presented as mean values with standard deviations, showing significant differences (P < 0.05) between groups as indicated by varying superscripts within each Row.

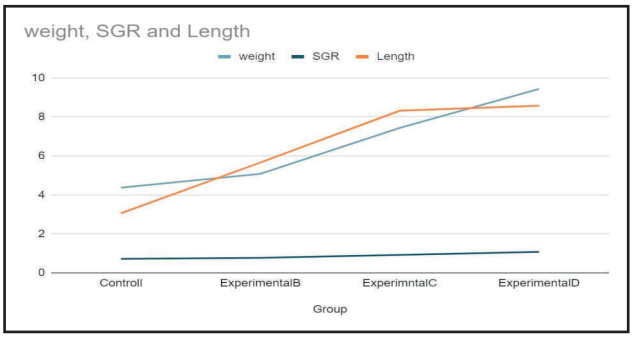


Fig 1 : Mean weight gain of fish under different experimental group

Total protein -There was a significant increase in protein and fat levels when the peppermint was given in the diet. As a result the performance of the fish was found to be enhanced.

Dietary protein plays a key role in the growth of fishes (*Barbarestan et. al. 2017)*

Table 3 : Mean value of protein (g/dL) and lipid in different experimental group

Fish group	Total protein (g/dL)	Total lipid
Control A	2.84± 0.89	2.06±0.17
Experimental B	2.52±0.88	3.70±0.32
Control	2.84± 0.89	2.06±0.17
Experimental C	3.59±0.81	4.01±0.27
Control	2.84± 0.89	2.06±0.17
Experimental D	3.48±0.81	4.20 0±.56

Data is presented as mean values with standard deviations, showing significant differences (P < 0.05) between groups as indicated by varying superscripts within each Row.

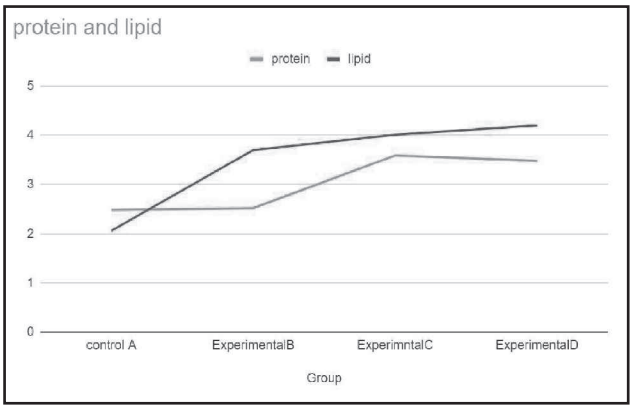


Fig 2 : Amount of protein and lipid in different experimental group

It is imperative to engage in the aquaculture sector given its pivotal role in meeting the rising global demand for seafood. Aquaculture offers a sustainable and efficient means of seafood production, crucial for feeding an expanding population. With wild fish stocks declining due to overfishing and environmental shifts, there is a pressing need for effective disease management and drug application within this important and profitable industry (Aklakur *et al.*, 2015). The discussion revolves around the potential impacts of medicinal herbs, which contain potent bioactive compounds. These compounds can influence the digestive process by either enhancing or inhibiting enzyme activity, thus affecting nutrient absorption (Talpur 2013) A particular study examines the inclusion of peppermint in fish diets, showing notable improvements in weight gain, and specific growth rate. Notably, group 4, which received a diet with 8mg of peppermint and a high protein content, experienced increases in all growth parameters. Similarly, feeding with *Mentha piperita* stimulated appetite, leading to improved weight gain and specific growth rate, as previously observed in the fingerling of *Labeo Rohita* (Adel et al., 2015).

CONCLUSION

Herbs and medicinal plants are more effective growth promoters compared to synthetic alternatives. They are cost-effective, safe, environmentally friendly, and do not have adverse effects on the fish. The study's findings indicate that incorporating Mentha piperita powder or extract into the diet of *Labeo rohita* significantly enhances their growth performance and increases their protein levels. The use of dietary peppermint was shown to positively affect various growth metrics such as weight gain, body length, and specific growth rate. Fish fed with the highest concentration of peppermint exhibited the most notable improvements, suggesting that Mentha piperita can be an effective and safe growth promoter. This herbal supplement not only improved the overall health and growth of the fish but also reduced mortality rates, making it a valuable addition to aquaculture practices.

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