E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 76.37
(GIF) Impact Factor: 0.549
IJFAS 2023; 11(3): 28-34

www.fisheriesjournal.com
Received: 19-01-2023
Accepted: 04-03-2023

Antara Mahapatra
PG Department of Zoology, Tamralipta Mahavidyalaya, Tamluk, Purba Medinipur, West Bengal, India

Dr. Paritosh Biswas
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Corresponding Author:
Antara Mahapatra
PG Department of Zoology, Tamralipta Mahavidyalaya, Tamluk, Purba Medinipur, West Bengal, India

Study on the fish polyculture practices in accordance with economic aspect at Tamluk, East Medinipur, West Bengal, India

Antara Mahapatra and Dr. Paritosh Biswas

DOI: https://doi.org/10.22271/fish.2023.v11.i3a.2804

Abstract
Polyculture is a composite fish culture which is a mixed fish farming with the compatible fishes, such as Khalisa, Nados and the Gangetic Koi in one pond a time. The quantitative growth of the fishes in the tank by the use of the manures is in high rate of percentage of the produces with these herbivorous, omnivorous and the detritus feeding fishes. The proper combination of these three friendly fishes minimises the inter and intra specific competitions and allow them the proper growth in size and weight. The differences in the feeding habits of these fishes in different layers of the tank causes higher yield. The eggs, larvae and pupas of the mosquitoes of the pond are the palatable food of these three fishes. As a result, people are achieving relief from the invasion of the dangerous mosquito borne diseases like Dengue, Malaria, Chikungunya, Encephalitis etc.

Keywords: Khalisa, Nados, Gangetic Koi, Polyculture, Fish Feed, Mean Growth.

1. Introduction
The rapid human population growth causes many challenges for the food shortages, mal nutrition, housing, shrinkage of land resources, etc. The global population is expected to reach 9.6 billion by the year 2050. The demand of the animal protein is increasing day by day. It is a difficult challenge to provide the quality protein for the future generations. With this context, fish culture plays a key role to supply the quality protein to the human beings at present scenario. India is the second largest fish producing country in the world. India contributes about 7% to the Global fish production. The total fish production during 2017-2018 is estimated to be 1260 million metric tonnes of which nearly 70% is from the Inland sector and about 50% of the total production is from cultured fishes. Fish and fish products have presently engaged as the largest group of Agricultural exports from India with 13.77 lakh tonnes in terms of quantity and Rs 45, 106.89 crores in the value (Sarker *et al*., 2012) [39]. Fisheries and Aquaculture have been considered as an important means of poverty elevation and food security besides promoting health and well-being. Fishes continue to be one of the most traded food commodities worldwide. It contributes to around 17% of the global population's animal protein intake. Around 125 - 210 million tonnes of fish is projected to be required by 2050 to meet the annual per capita requirement of 15-20 kg/head.
Fish is often referred to as "Rich Food for Poor People" as it provides essential nourishment with both macronutrients and micronutrients. Fish contains low-fat high-quality protein with Omega -3- fatty acids and vitamins. Fish is rich in calcium, phosphorus and a great source of minerals such as iron, zinc, iodine, magnesium and potassium. On a fresh - weight basis, fish contains a good quantity of protein, about 18 -20% and all the eight essential amino acids including the sulphur containing lysine, methionine and cysteine. In general, fish have less fat than red meats and the fat content ranges from 0.2% to 25%. However, fats from fatty fish species contain the polyunsaturated fatty acids (PUFAs) namely EPA (Eicosapentaenoic acid) and DHA (Docosahexaenoic acid) which are essential for the proper growth of the children, proper brain development in unborn babies, reduced risk of preterm delivery and low birth weight. The fat also contributes to energy supplies and assists in the proper absorption of the fat-soluble vitamins namely A, D, E and K.

Fish is a rich source of vitamins, particularly vitamin A and D from fatty species as well as thiamine, riboflavin and niacin (Vitamin B1, B2 and B3). Vitamin D present in fish liver and oil is crucial for bone growth since it is essential for the absorption and metabolism of calcium.

Fish is also called "Brain Food" as it helps in development and function of the Brain and Heart. Food as it contributes to lower risks of heart attacks and strokes. Consumption of fish reduces the risk of auto immune diseases, including Type - 1 Diabetes, prevents and treats depression, protect from age related brain deterioration. It also help to prevent Asthama in children, protect vision in old age by lowering risk of muscular degeneration. It also improves sleep quality, lower risk of cancer, blood pressure, Alzheimer's disease, etc. Fish is soft, easy to cook and more easily digested than meat. So, even young children can be fed fish, contributing to improve nutrient intake. For the fish Polyculture, a combination of both organic and inorganic manure used in the tank keeps the metabolic cycle in operation in the water of the tank. As a result, the effects of these manures enhances the fish production (Huet, 1975; Swingle and Smith, 1938; Hepher, 1962, Chaudhuri, 1971, Chakraborty *et al*., 1975 (b) [23, 43, 19, 10, 5].

Chakraborty *et al*., 1973, 1975 (b), 1979 a, b; 1980 [3, 5, 7, 8] showed that on the use of fertilizer and supplementary feeds are good for enhancing the fish production by the Composite Fish Culture in India. He had developed few techniques for the Composite Fish Culture also. Moreover, Chaudhuri *et al*., 1975, 1980 [5, 8] recorded fish production through the intensive fish culture in a pond. He also found high fish production by the Composite Fish Culture in fresh water ponds.

Various species of fish cultured in the ponds fulfill the desired cultivable qualities (Jhingram, 1975, Huet, 1975) [25, 23]. The Fish Polyculture is nothing but mixed fish farming. Basically, it is a fish culture in which more than one type of compatible fishes are cultured simultaneously in one pond at a time without hampering one another (Sinha *et al*., 1973, Chakraborti. S, 2020, Prakash Bhanu CH, *et al*. 2018, Azad, et al., 2004, Panda S. 2016) [41, 2, 36, 1, 34].

The selection of the fish species is very important as it decides the ultimate fish production (Huet, 1975) [23]. The fishes of the various species can thrive well in much less space once their respiratory and food requirements are met. The differences in the feeding habits of the certain fishes can be taken advantage in this mixed fish culture. Proper combination of the species in the suitable numbers minimises the inter and intra - specific competitions allowing the growth of all the species to the desired marketable size with proper weight (Huet, 1975; Jhingram, V.G 1975) [23, 25].

The quantitative fish production is the highest with the herbivorous, omnivorous, zooplankton, phytoplankton and detritus feeding fishes (Hora and Pillay, 1962) [21]. Lots of research works are observed in the Composite Fish Culture of Indian and Exotic fish species (Chakraborty, R.D. *et al*. 1975 (b), Azad *et al*., 2004, Choudhuri, 1971) [5, 1, 10]. But the research work on the composite fish culture with the combination of the Indian originated of Khalisa, Nados and Gangetic Koi fish are not noticed.

Depending on the compatibility and the feeding habits of the fishes, the following three fishes are selected for this composite fish Polyculture in one pond. The fishes are:

i. Khalisa (*Trichogaster fasciata;* Bloch and Schneider, 1801).
ii. Nados (*Nandus nandus*; F. Hamilton, 1822).
iii. Gangetic Koi Fish (*Anabas cobojius*; Hamilton, 1822).

Khalisa fish is surface feeder, Nados is middle zone feeder and Gangetic Koi Fish is the mud loving bottom feeder.

The Khalisa fishes are available in India, Bangladesh, Nepal, Pakistan, Mayanmar and other Asian countries. These are the inhabitants of the natural water reservoirs, mainly tanks, canals, rivers, paddy fields etc. This fish survives mainly depending on the vegetable matter (85%). Algae and the decaying organic matter are the mostly favourite feed of this fish (Oldalin *et al*., 2017, Gupta, 2015) [33, 18]. This fish can be cultured in a tank singly or jointly with other fishes in layer basis as it is very compatible fish. Khalisa fish lays egg 2 to 3 times in a year. It can be cultured within very short period (Mitra *et al*., 2007, Khongngain *et al*., 2016) [30, 26].

A full grown Khalisa fish is of 8 to 10 cm in length and the weight is 15 to 20 gram per fish. A healthy full grown mother Khalisa lays 5000 to 13000 eggs at a time. The laying period is from the month of April to September. This period is their mating time also. But the best time is June to August (Das and Kalita, 2006; Mitra *et al*., 2007 & Gupta S.2015) [15, 30, 18].This fish is very tasty, palatable and nutritious and easily digestible. It is rich in Protein, Vitamins and Minerals. The amino acid content is very high. Due to presence of Vitamin A in high quantity, we are safe from the attack of the disease, Night Blindness. The physicians advised the sick and the ailing patients to consume the small fishes like the Khalisa (Mookherjee *et al*., 1946) [31].

Khalisha fishes can be cultured in the small tanks. As a result, lesser land area is required in the highly populated country (Mitra *et al*., 2007) [30]. There is high demand of the yellowish red coloured Khalisa in the Aquarium market (Mitra *et al*., 2007) [30]. The price is as high as supply is less. As a result, the Khalisa culture is a very profitable business. There is a great scope to earn money for the unemployed youths (Panda S, 2016, Prakash Bhanu C.H *et al*., 2018 and Chakraborti S. 2020) [34, 36, 2]. Moreover, Khalisa fish controls mosquitoes by eating the eggs, larvae, etc. So, this fish is a friend of the human being since long. So, we get relief from the attack of the Dengue fever (Oldalin *et al*., 2017) [33]. The relationship between the food and the feed habits of this fish was studied by Das and Moitra, 1963[13].

There are beautiful colour combination on the body of the Khalisa fishes. Accordingly, three varieties are identified: Red, Chuna and Big Khalisa. The male fishes are bright in colour and big in size. The females are generally whitish green and lesser or short in figure (Islam *et al*., 2016, Mitra *et al*., 2007) [24, 30]. The Khalisa fishes are in the group of "Super Food" due to its high nutritious value. This small fish protects the pregnant and milching mothers from the anaemia disorder. The rural poors get the main nutrition source from the consumption of these small fishes. As a result, demand is high, supply is less. So, price is high of this fish.

Nados is known as Meni, Nayna, Royna, Bheda, Abro, Nados in India and Bangladesh and Dalahai in Nepal. It is distributed throughout the Indian Sub-Continent including India, Bangladesh, Malayasia, Mayanmar, Pakistan, Thailand and Vietnam (Forese and Pauly, 2016) [16]. This fish mainly inhabits in streams, rivers, pools, lakes, canals, and reservoir (Rainboth, 1996) [37]. The Nados is important for food fish and Aquarium trade. They have high market need (Talwar and Jhingran, 1991) [44]. The natural population of the Nados is declining fatally due to reckless fishing, habitat destruction, housing, pollution and other ecological changes to their territory (Mukherjee *et al*., 2002; Hossain, 2014; Chakraborti,

S. 2020) [32, 22, 2].

The information on the population parameters i.e., growth, reproduction, mortality of the Nados fishes is the vital issues for implementation of the sustainable management strategies for their better conservation. The pathological investigation study is also conducted for the better management of this fish (Marma *et al*., 2007) [29].

The Nados fishes can be cultured in smll tank singly or mixedly with other compatible fishes. The healthy, matured mother fishes lay eggs 2 to 3 times per year. The fishes can be cultured within short period (Talwar and Jhingran, 1991) [44]. A fully grown Nados fish is 8 to 15 cm in length and 15 to 35 gram in weight. A matured fully grown female fish lays egg 5000 to 15000 eggs at a time. The mating period or laying period is from the month of April to September. But the best time is June to August (Md. Yeasmin *et al*., 2017) [46]. The male Nados fishes are more in length and breadth in comparision with the female. The male fishes are deeply blackish white, and there is one black spot on the body near the tip. The females are lesser in size and coloured like blackish white with yellowish in appearance (Das *et al*. 2002) [14]. This fish is a freshwater fish and predator in nature (Das and Moitra, 1963) [13]. They preffered the temperature of water from 20 °C to 28 °C and pH 6.9 to 8.0. They are the habitat of paddy field, pasture land, swampy water bodies. Their eggs are jelly like, glassy-yelowish in colour. The Nados is rich in protein, vitamins and minerals. No fat is present in this fish. So Doctors prescribed this fish for the sick people (Goswami and Dasgupta.2007) [17]. Great scope exits for the business (Panda S, 2016 and Prakash Bhanu C.H *et al*., 2018) [34, 36].

The Gangetic koi fish is popularly known as Koi. It is a species of climbing gourami native to India and Bangladesh. This fish is very tasty, palatable and nutritious. Heavy demand is in the hotel and restaurants as ‘Tel Koi’ as ‘Jhal Koi’. It is highly demanded and costly fish also (Herre, 1924, Vidtyhayanam, 2002) [20, 45]. It is mud loving fish found in the small river, swamp, canal, pond, tank, Bangor, lagoon, confined water of any marshy land. This fish is very hardy. It can tolerate adverse conditions of the environment (Sarma *et al*., 2010. Pethiyagoda, 1991) [40, 35]. It has special arrangement in the lung system. This fish can survive a long time outside of the water. It can walk by the help of the thorny gill and support of the tail, just like dancing in the rainy days. So this fish is called ‘climbing perch’ of ‘climbing fish’. It can survive long time. Marketable and salable withn 110-120days, can be cultured three times in a year. Mortality of the Koi fish is very less. Market demand is high. The Koi fish is rich in iron and copper which are the vital components for the haemoglobin synthesis (Sarma *et al*., 2010) [40]. It also contains an easily digestible poly unsaturated fatty acids (PUFA) and essential amino acids (EAA) (Kohinoor *et al*., 1991) [27]. This Koi fish is an important diet for the sick and convalescent patients due to its high nutritive value (Saha *et al*., 2009) [38].

The demand of this Koi fish is increasing among the fish growers in West Bengal. It is an important source of income to the small and large scale fishermen due to its high demand for its commercial trade value. It has great potential to develop a prominent fishery business due to its strong vital force and hardy life (Panda S, 2016, Prakash Bhanu C.H *et al*., 2018) [34, 36]. These fishes are threatened day by day by the siltation from the deforestation, habitat destruction by the hydropower and the dam development, housing, indiscriminate uses of pesticides, ecological degradation and fishing pressure (Chakraborti S, 2020 and Mahapatra and Biswas, 2023) [2, 28].

2. Materials and Methods

2.1. Materials required.

1. Tank – 2
2. Net - 2
3. Drum – 2 (Small & Big)
4. Pumps – 2
5. Lamp – 2
6. Transport – 1
7. Manures
8. Medicines: Lime, Potassium Permanganate (KMnO4).
9. Fingerlings.

2.2 Tank Preparation

Two tanks were selected for our experiment at Tamluk (Latitude - 22.2858° N, Longitude - 87.9189° E), East Medinipur, West Bengal, India. The tanks were not selected in the flooded area. The depth of the tank is preferably about 6ft in depth. The sunlight must be present on the tank for 12 hours. There was not any big tree or bushes on the bank of the pond. If there is a tree, it will hamper the cultivation of the fishes by shadow and by falling leaves in the tank, poisoned the water by rotting. If there are any bush on the bank of the tank, then the snakes, frogs, birds, otters, civer-cats etc. finishes the fishes (Jhingram VG 1975, Hora and Pillay 1962) [25, 21]. The nylon sheet of the height of one meter will be surrounded the tank on the all sides so that koi fishes can not run away on the land by walking with the help of their pointed gill in the rainy days as Koi fish is a "Gechho Machh" i.e. "Climbing Gourami Fish" (Mahapatra and Biswas, 2023) [28].

In the month of March - April, the pond was dried up. In accordance with the decimal in area of land, it was applied Cowdung - 10kg, Mustard Cake – 8 Kg, Lime – 6 Kg (where pH of soil is 6.5), Triple Super Phosphate – 6 kg, Urea – 2 kg and micronutrients -500 gm in the soil of the bottom of the pond. Then plowed the soil twice properly followed by the stagnation of water in the pond (Chakraborty, *et al*., 1975b., Sinha, 1979, Mukherjee and Gupta, 1946) [5, 42, 31]. After 15 days, algae, fungi, bacteria, protozoa, phytoplankton, zooplankton etc were grown profusely in the water. The colour of the water would be changed from the colourless to light green. Now the pond was ready for the fish cultivation. Then we poured the fingerlings of the fishes in the water of the pond (Chaudhuri, 1971) [10].

2.3 Selection of the fingerlings

The offsprings were healthy, disease-free, vigorous, always jumping up and down and brightened in colour of appearance. The fingerlings were purchased from a reputed fish farm from Tamluk, East Midnapore, West Bengal, India.

2.4 Feeding

After the fingerings were freed in the prepared pond, some amount of rice bran dust powder with the protein powder were to be sprayed on the water surface as a feed to them. After three days, the formulated feed (Table No. I) in the form of pellets were given on the trays in various sides and corners in the water of the pond. The feeds were given twice a day in the morning and in the afternoon (Mukherjee HK, *et al*. 1946, Chakraborty *et al*., 1975b, Sinha, 1979 & Oldalin *et al*., 2017) [31, 5, 42, 33].

2.5 Sanitation of the Pond
If foul - smell is discharged from the water of the tank, it is understood that the water is highly acidic in nature. So, immediately lime water solution is to be sprayed in the pond. In the winter season, potassium permanganate solution (KMnO4) was sprayed in the pond, as a result the fishes were be free from the attack of the insects and diseases (Hora and Pillay, 1962; Chandra, 2006 and Marma *et al*., 2007) [21, 9, 29].

2.6 Exercise
For the purpose of the good growth of the fishes, exercise is essential. So netting or cow swimming in the tank was done once in a week. As a result, the fishes of the tank would run and their health would be improved due to exercise. Their growth would be enhanced satisfactorily. (Mahapatra and Biswas, 2023; Hora and Pillay, 1962; Chakraborty *et al*., 1974) [28, 21, 4].

2.7 Harvesting
Periodic harvesting of fishes enhanced the production in the fish Polyculture. On the use of supplementary feeds caused enhancement of the fish production in the fish Polyculture also (Chakraborty *et al*., 1974; Chaudhuri *et al*., 1975) [4, 11].

3. Results and Discussion
The experiment was conducted on the basis of our own formulation of the feed for the Polyculture of the three fishes in the composite culture in the pond. Here, the ingredients of the feed used for the fishes were as such: Fish meal powder - 25%, Mustard Oil Cake - 20%, Rice bran powder - 18%, Bhusi/Chaff of Wheat Powder - 10%, Wheat flour - 11%, Gram Powder - 9%, Molasses (Gur) - 5%, Snail/Jhinuk Powder - 1% and Salt (NaCl) - 1%. This feed was used in the pellet form which was convenient for the consumption of the fishes. The pellets were offered to the fishes by keeping these on the hanging trays in the water in several places of the tank. Sometimes, the feed was used in the form of powder, as per the requirement in the initial stage of the fingerling growing (Table I).

Table I: Study on the formulation of the fish feed for the Polyculture of the three fishes.

SL. No.	Ingredients	%
1	Fish meal powder	25
2	Mustard cake powder	20
3	Rice bran powder	18
4	Chaff of Wheat Powder	10
5	Wheat flour	11
6	Gram Powder	09
7	Molasses	05
8	Snail/Jhinuk Powder	01
9	Salt/NaCl	01
	Total	100

Table II: Preparation of the cultured tank by the use of organic and inorganic manures.

SL No.	Manures	Types	Cultured Tank (Kg)	Control Tank (Kg)
1	Cowdung	Organic	10	NIL
2	Mustard Cake	Organic	8	NIL
3	Lime	Inorganic	6	NIL
4	Triple Super Phosphate	Inorganic	6	NIL
5	Urea	Inorganic	2	NIL
6	Micronutrients	Inorganic	0.5	NIL
	Yield of Koi fish		300	200

The study was conducted to find out the effectiveness of the use of the organic and inorganic manures in the preparation of the fish tank in comparision with the Control tank. The experiment revealed that the yield of the Koi fish in the cultured tank was 300kg in comparision with the Control tank which was 200kg. The performances of the use of the Organic and Inorganic manures in the treated tank were better than the untreated tank.

Table 3: Productivity of the fishes by average body weight per fish by the use of organic and inorganic manures in the fish tank.

SL No.	Cultured Fishes	Treated Tank (gm)	Control Tank (gm)	Difference per fish (gm)
1.	Khalisha	17	15	2
2.	Nados	22	18	4
3.	Gangetic Koi	50	30	20

The Results of the Table III revealed that the average body weight of Khalisha fish is enhanced 2gm/fish, Nados is 4gm/fish and Gangetic Koi is 20 gm/fish in the treated pond. The better performances are noticed in the all three fishes of the treated tank with comparison to the control tank (Table 3).

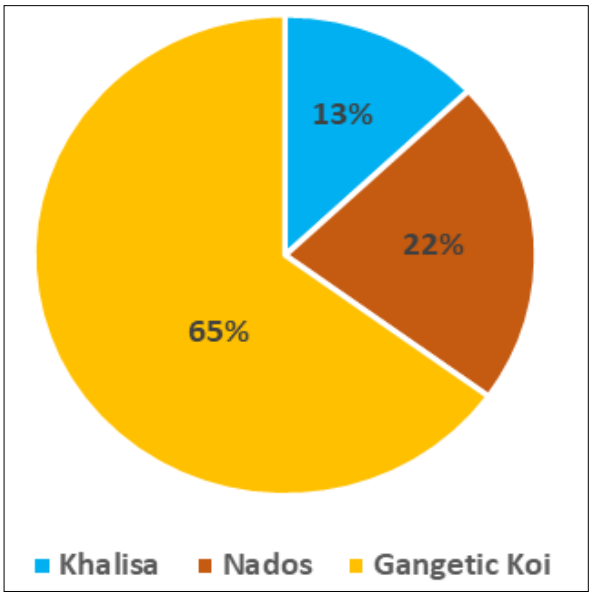

Fig I: Pie chart of the comparative study of the average growth percentage (%) of all the three fishes.

Fig 2: Fish Polyculture of Khalisa, Nados and Gangetic Koi at Tamluk

Table 4: Study on the performances of the three fishes by the Feed Treatment during three successive years, 2020-2022.

Fishes	Khalisa		Nados		Gangetic Koi		Total Growth (%)
Year	Control (gm)	Treated (gm)	Control (gm)	Treated (gm)	Control (gm)	Treated (gm)	
2020	14	16	17	21	30	50	100
2021	15	17	18	22	30	49	
2022	16	18	19	23	31	51	
Mean	15	17	18	22	30	50	
Enhancement per fish (Average)	2		4		20		
Growth %	13		22		65		

The study in the Table IV showed that the consecutive trials in the year 2020, 2021 and 2022 in the pond at Tamluk, the average body weight per fish is enhanced significantly. Such as Khalisa - 2 gm/fish, Nados - 4 gm/fish & Gangetic Koi - 20 gm/fish. The growth percentage of the fishes, Khalisa - 13%, Nados - 22%, & Gangetic Koi - 65%. The better result is observed in the Treated Tank in comparison with the control tank (Table No. - IV, Figure I, II & Figure III).

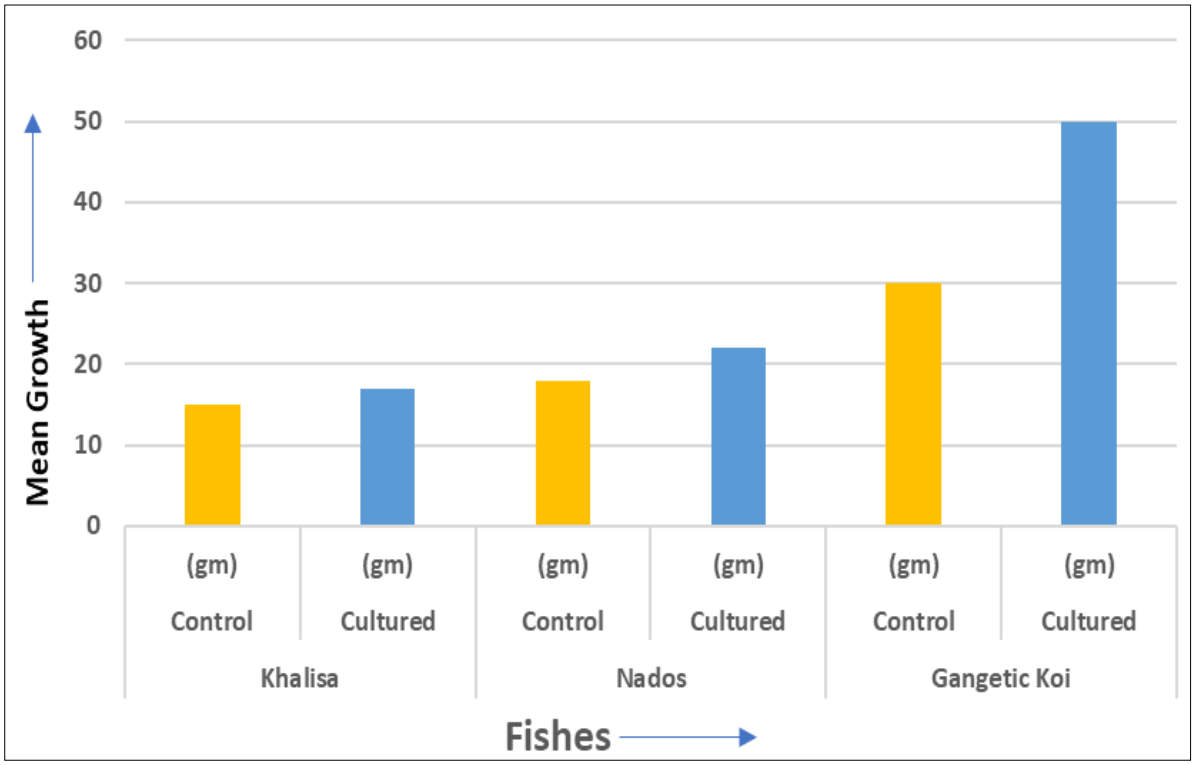

Fig 3: Comparative study of the Mean growth of the three fishes by column chart.

The differences in the feeding habits of the different fishes are different. Among the three fishes of our experiment, Khalisha is the surface dweller of the tank. This fish survives mainly depending on the vegetative matter (85%). Algae and the decaying organic matters are the mostly favourite feed of this fish. (Gupta, 2015, Oldalin *et al*., 2017) [18, 33].

The Nados is the middle column dweller. This fish utilizes the decaying macro-vegetation, filamentous algae, periphyton, zooplankton, etc. As this fish is an omnivorous, it behaves like a predator also (Das and Moitra, 1963; Talwar and Jhingran, 1991) [13, 44].

The Gangetic Koi fish is a bottom dweller, mud loving and hardy fish. It is also an omnivorous. As a result, it is herbivorous cum predator also. It consumes the unused feed and other materials of the other fishes of the same tank and keeps the water clean of the tank (Hora and Pillay, 1962; Chakraborty *et al*., 1979; Sarma *et al*., 2010; Pethiyagoda, 1991) [21, 6, 7, 40, 35].

The above mentioned three fishes are eco-friendly fishes. So, they are selected for this Polyculture in the same tank at a time, so that there will not be any confrontation among them for their growth purpose. Every fishes of this group have to achieve sufficient space for the movement and to collect the sufficient food materials (Huet, 1975 & Hora and Pillay, 1962) [23, 21].

The organic and inorganic manures used in this tank produces the in-situ microorganisms which help the three fishes for their better growth (Chakraborty *et al*., 1975b; Sinha, 1979) [5, 42].

It is the suspended growth in the tank which is the aggregate of the living and non - living particulates of the organic matter, phytoplankton, zooplankton, fungi, bacteria, algae and the grazers of the bacteria. This process acts as a ' Water Treatment Remedy ' of the tank. It is the active suspension pond for the fish culture. It increases the natural feeds for these fishes of the tank. As a result, it causes the profuse growth of the fishes (Swingle and Smith, 1938; Chakraborty *et al*., 1975b; Sinha, 1979) [43, 5, 42].

An additional help in the artificial feeding of the fishes enhances the fish production. The quantitative fish production of the tank is the highest with the herbivorous, omnivorous, phytoplankton, zooplankton and detritus feeding fishes (Chakraborty *et al*., 1975b; Sinha, 1979) [5, 42]. Here, the growth of Khalisa -13%, Nados - 22%, Gangetic Koi - 65%.

An association of the three species of the fishes ensures the proper exploitation of the foods of the niches in the tank. The three fish species survive well in much lesser space when their respiratory and food requirements are met sufficiently at different water layers of the tank.The above mentioned three fishes; Khalisa, Nados, and Gangetic Koi are an important diets for the sick and convalescent patients due to their high nutritive value and easy for digestion. So, commercially market value is high (Saha *et al*., 2009; Goswami and Dasgupta, 2007) [38, 17].

The composite fish Polyculture is economically profitable business. It is gainful employment for the rural people for the unemployed youths (Panda S. 2016, Prakash Bhanu C.H. *et al*. 2018 and Chakraborti S. 2020) [34, 36, 2].

There is a high demand of the yellowish red coloured Khalisa and blackish white coloured Nados in Aquarium market (Mitra *et al*. 2007, Gupta S. 2015 and Islam *et al*. 2016) [30, 18, 24]. The price is as high as supply is less. As a result, the culture of these fishes is mostly profitable business.

The eggs, larvae etc. of the mosquitoes of the ponds are the palatable food of these three fishes. So, people are getting relief from the attack of the poisonous mosquitoes. On the other hand, we are in safe side from the invasion of the mosquito - vector diseases like Dengue, Malaria, Encephalitis, Chikungunia etc. (Oldalin *et al*. 2017) [33].

These three fishes can be harvested within 110 - 120 days, can be cultured three times in a year. They can be cultured in small tank or pond or in cistern. Lesser land area is required in the highly populated country. Employment scope is more to culture of these fishes (Panda, S. 2016) [34].

4. Conclusion

Polyculture is a mixed fish farming with the compatible, eco-friendly fishes such as Khalisa, Nados, and Gangetic Koi in one pond at a time. The proper combination of these three friendly species minimises the inter and intra species competitions and allow them for the proper growth in size and weight. The differences in the feeding habits of these selected species in different layers of the water can be taken an advantage in this joint fish Polyculture-venture. The quantitative growth of these fish production in the tank by the use of the manures is in the higher percentage with the herbivorous, omnivorous and the detritus feeding fishes, such as Khalisa - 13%, Nados - 22%, and Gangetic Koi - 65% which are encouraging result. The eggs, larvae and pupa of the mosquitoes of the ponds are the palatable food of these three fishes.

As a result, people are getting relief from the attack of the poisonous mosquitoes. On the other hand, we are able to be in safe-side from the invasion of the dangerous diseases like Dengue, Malaria, Encephalitis, Chikungunia etc. Besides this, there is a great scope for the employment considering the high market value and the high demand in the fish food market and also in the Aquarium business particularly Khalisa and Nados.

5. Acknowledgement

Authors are highly grateful to the members of our Research Team for their kind help and spontaneous support.

6. References

1. Azad MAK, Rahman MR, Rahman Z, Kader MA, Haque ME, Alam MJ. Polyculture of Carp, Tilapia and Pangas Using Low Cost Inputs. Pakistan Journal of Biological Sciences. 2004;7:1918-1926.
2. Chakrabarti S. Composite fish culture-an ecologically viable and economically profitable fish culture technique-A Review. International Journal Life Sciences. 2020;8(2):397-403.
3. Chakraborty RD, Sen PR, Chatterjee DK, Kowtal GV. Observation on the relative usefulness of different feeds for carp spawn and fry. J. Inland Fish. Soc. India. 1973;5:182-188.
4. Chakraborty RD, Murty DS, Sen PR, Nandy AC, Chakraborty DP. Periodic harvesting to enhance production in composite culture of Indian and Exotic Carps. J. Inland Fish. Soc. India. 1974;45B,III:192-196.
5. Chakraborty RD, Sen PR, Chatterjee DK, Jena S. On the use of fertilizer and supplementary feed for enhancing fish production in composite fish culture of Indian and Exotic Carp sp. Proc. Nat. Acad. Sc, India. 1975;45B, III:192-196.
6. Chakraborty RD, Rao NGS, Sen PR. Culture of fish in ponds with fertilization. In: CIFRI/IDRC/Workshop of Rural Aquaculture Project. Central Inland Fisheries Research Institute, Barrackpore; c1979 Feb. p. 6-7.
7. Chakraborty RD, Singh SB, Rao NGS. The evolution of the technique of composite fish culture at CIFRI. In: Souvenir of CIFRI, Golden Jubilee year of ICAR; c1979.
8. Chakraborty RD, Sen TR, Rao NGS, Ghosh SR, Jena S, Jankiram, K. Observation of intensive composite fish culture. Proc. Indo – Pacific Fish. Countries. 1980;19(3):515-520.
9. Chandra KJ. Fish Parasitolgical studies in Bangladesh - A Review. Journal of Agriculture and Rural Development (ISSN 1810-1860). 2006;4(1&2):9-18.
10. Chaudhuri H. Stocking pond management, In: Combined workshop on AICRP on Air Breathing Fishes for swamps and composite culture of Indian and Exotic Carps. CIFRI, Cuttack, 17-20th; c1971 Sep. p. 8.
11. Chaudhuri H, Chakraborty RD, Sen PR, Rao NGS, Jena S. A new high in fish production in India with record yields by composite fish culture in freshwater ponds. Aquaculture. 1975;6 (4):343-355.
12. Chaudhuri H, Lakshman MAV, Rao NGS, Saha GN, Raut M, Kanauja DR. Record fish production through intensive fish culture in a farmer's pond. J.Inland Fish Society. India. 1978;10:19-27.
13. Das SM, Moitra SK. Studies on the food and feeding habits of some freshwater fishes in India Part IV: A review on the food and feeding habits with general conclusion, Ichthyologica. 1963;11 (1-2):107-115.
14. Das M, Tarafdar MK, Pal S. Early developmental stages of *Nandus nandus (Hamilton)* Bangladesh Fish. Res. 2002;6:11-18.
15. Das SK, Kalita N. Seed production technology of ornamental Gourami, *Colisa fasciata* and *Colisa lalia* under captive conditions – an experience in Assam, India. Agriculture Asia, Magazine. 2006;11 (4):13-14 & 32.
16. Froese R, Pauly D. Fish Base. World Wide Web Electronic Publication; c2016.
17. Goswami S, Dasgupta M. Analysis of the morphometric and meristic characters of the fish *Nandus nandus* (Hamilton) from the new alluvial zone of West Bengal. Rec. Zool. Surv. India. 2007;107:183-185.
18. Gupta S. A note on feeding and reproductive biology of Banded Gourami, *Trichogaster fasciata* (Bloch and Schneider, 1801). International Journal of Research in Fisheries and Aquaculture. 2015;5(4):147-150.

19. Hepher B. Ten years of research in fish ponds fertilization in Israel. The effect of fertilization on fish yields. Bamidgeh. 1962;14(2):29-38.
20. Herre AWCT. Distribution of the true freshwater fishes in the Philippines.II. Philippine Labyrinthici, Claridae, Philippines Journal Science. 1924;24:683-709.
21. Hora, S.L, Pillay, T.V.R. Hand book on fish culture in the Indo-Pacific Region. FAO Fish Biol. Tech. Paper. 1962;14:204.
22. Hossain MY. Threatened Fishes of World: *Mystus vittatus* (Bloch, 1794). (Siluriformes: Bagridae). Croatian J. Fish. 2014;72 (4):183-185.
23. Huet M. Text Book of Fish Culture- Breeding and Cultivation of Fish. Fishing News (Books) Ltd. England, 1975, 436.
24. Islam MS, Aktar S, Hasan MR, Shiba SS. Some aspects of biology of Banded Gourami, *Trichogaster fasciata* (Bloch & Schneider, 1801) in Jessore, Bangladesh. International Journal of Bioscience. 2016;9(4):72-80.
25. Jhingran VG. "Fish and Fisheries of India". Hindusthan Publishing Corporation, Delhi, India; c1975. p. 954.
26. Khongngain O, Das SK, Bhakta D. Studies of biological parameters of *Trichogaster fasciata* (Bloch & Schneider, 1801) from a leantic water body, Shanti Jheel, West Bengal, India. J. Indian Fish Association. 2016;43(2):01-06.
27. Kohinoor AHM, Akhteruzzaman M, Hussain MG, Shah MS. Observation on the induced breeding of *Mystus cavasius* (Hamilton) in Bangladesh. Bangladesh Journal of Fisheries. 1991;14:73-77.
28. Mahapatra A, Biswas P. Studies on the culture practices and growth performances of the Gangetic Koi fish, *Anabas cobojius* (Hamilton, 1822) at Tamluk, Purba Medinipur, West Bengal. India. International Journal of Creative Research Thoughts (IJCRT). 2023;11(1):144-150.
29. Marma K, Ahmed GU, Faruk MAR, Ghosh K. Clinical and pathological investigation of *Nandus nandus* collected from the fish market of Mymensingh. Progress Agric. 2007;18:167-174.
30. Mitra K, Suresh VR, Vinci GK, Mazumder NN, Biswas DK. Biology and Fishery of Banded gourami, *Colisa fasciata* (Bloch & Schneider, 1801) in a foot plain wetland of Ganga river basin. Asian Fisheries Science. 2007;20 (4):409-423.
31. Mukherjee HK, Gupta SNS, Chowdhury PKR. Food and its percentage composition of the Adult food fishes of Bengal. Science and Culture. 1946;12:247-249.
32. Mukherjee M, Praharaj A, Das S. Conservation of endangered fish stocks through artificial propagation and larval rearing technique in West Bengal, India, Aquaculture Asia. 2002;7(2):8-11.
33. Oldalin K, Das SK, Bhakta D. Study on food and feeding biology of *Trichogaster fasciata* (Bloch and Schneider, 1801) from a wetland of Nadia District of west Bengal, J. Inland Fish. Soc. India. 2017;49(2):3-9.
34. Panda S. Composite fish culture for gainful employment. International Journal of Bioassays; c2016. p. 4593-4596.
35. Pethiyagoda R. Freshwater Fishes of Srilanka. The Wildlife Heritage Trust of Srilanka, Colombo; c1991. p. 362.
36. Prakash B, Khairnar S, Mandal A, Kumar A, Kumar B. Composite fish farming: A review on economic enterprise for rural empowerment and livelihood generation; c2018.
37. Rainboth WJ. Fish of the Combodian Mekong. FAO species identification field guide for fishery purpose. FAO, Rome; c1996. p. 265.
38. Saha A, Kabir MR, Ali MM. Breeding performances of Thai Koi, *Anabas testudineous* (Bloch, 1792) in different months of the breeding season under two sex ratios. Bangladesh Research Publications Journal. 1999;2:667-673.
39. Sarkar UK, Jena JK, Singh P, Singh AK, Rebello SC. Documenting coastal fish biodiversity of India: Status Issues and Challenges. Conference paper. International Day for Biological Diversity, Marine Biodiversity. Uttar Pradesh State Biodiversity Board, Lucknow; c2012. p. 22-28.
40. Sarma, *et al*. Acclimatisation of *Anabas testudineous* (Bloch) to three test temperatures influences thermal tolerance and oxygen consumption. Fish Physiology and Biochemistry. 2010;36:85-90.
41. Sinha VRP, Gupta MV, Banerjee MK, Dhirendra K. Composite fish culture at Kalyani, West Bengal. J., Inland Fish. Soc. India. 1973;5:201-207.
42. Sinha VRP. On the contribution of supplementary feeding in increasing fish production through composite fish culture in India. Proc. World Symp. On Fin Fish Nutrition and Fish Feed Technology., Hamburg W, Germany. 1979;2:567-571.
43. Swingle HA, Smith EV. Fertilizers for increasing the natural food for fish ponds. Trans. Am, Fish, Soc. 1938;68 (1):126-135.
44. Talwar PK, Jhingran AG. Inland fishes of India and adjacent countries. Volume 2, AA Balkema, Rotterdam; c1991. p. 541.
45. Vidthayanon C. Peat Swamp Fishes of Thailand. Office of Environmental Policy and Plannng. Bangkok, Thailand; c2002. p. 136.
46. Yeasmin, *et al*. Growth, condition, maturity and mortality of the Gangetic Leaf fish (*Nandus nandus*) (Hamilton, 1822) in the Ganges River (North Western Bangladesh). Jordan Journal of Biological sciences. 2017;10(1):57-62.