Water Quality Assessment and its impact on shrimp in Rupnarayan River: A comparative study on the basis of February to May of 2022-2024

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Abstract

Rupnarayan River is the heart of Purba Medinipur district of West Bengal as it is the habitat of huge number of aquatic species and also the main resource of drinking, agricultural work, irrigation, cultivation and many more. We have collected the river water sample from Kolaghat, Alinan, Siuri and Deemari villages near Tamluk in Purba Medinipur district. Then assessed the different water quality parameters such as temperature, turbidity, pH, DO, BOD, salinity, alkalinity, hardness etc. We have studied basically for the premonsoon phase (Feb- May) and also assessed the impact of these parameters on the production of shrimp species. We have identified *M.rosenbergi, M.brevicornis, M.monoceros, Penaeus vennamei* of shrimp species. We also compared the data from 2022 to 2024 (Feb-May) and observed the production as 40%, 60%, 30% in 2022, 2023 and 2024 respectively.

Introduction

West Bengal has a river called the Rupnarayan. It originates as the Dhaleswari (Dhalkisor) in the slopes of Chhota Nagpur, northeast of Purulia town. In Bankura, it is called the Darakeswar River. The river Darakeswar, which is named Rupanarayan, is joined by the Shilaboti River in the Pachim Medinipur district, close to the town of Ghatal. The Rupnarayan River flows for 70–80 km before joining the Hoogli River near Geokhali in the Purba Medinipur district. It is well-known for the Hilsa fish, which is endangered because of the water's quality. The West Bengal Power Development Corporation Limited (WBPDCL) and the Water Treatment Plant, which were constructed along its bank near Kolaghat, West Bengal, are also noteworthy(1, 2). The lower portion of the Rupnarayan River affected by tidal actions from the Bay of Bengal. The tidal actions range about 3 meters in kolaghat during rainy season of July to August month. The river's average water speeds at this location are 1.8 m/s during midtide and 1.6 m/s during full tide. Purba Medinipur District is similarly affected by the Rupnarayan River's tides. The Rupnarayan River's Kolaghat station is about 135 kilometers from the ocean (3, 4).

The Rupnaran River is crucial for aquatic life, including fish species. After treatment, this water is also usable for drinking. This water is also utilized for agriculture, however it is polluted because of waste water from Haldia Industrial Area and effluents from KTP Plant,

which mix with the Rupnarayan River's tidal water. As a result, the water has turned somewhat saline.Water is the most valuable resource and has a major role in shaping the globe and regulating the climate. For all living things, water pollution treatment is essential. Due to increased industrialization, widespread use of pesticides, and chemical pollutants from fertilizers discharged from agricultural areas, the aquatic environment of living species is more polluted. As a result, water quality and the reduction of aquatic life span are greatly threatened (2, 5).

The most precious resource, water is essential to both forming the world and controlling the climate. Treatment of water contamination is vital for all living organisms. The aquatic habitat of living things is more contaminated as a result of growing industrialization, widespread pesticide usage, and chemical

pollutants from fertilizers released from agricultural areas. Water quality and the shortening of aquatic life span are consequently seriously endangered (5).

Aims and objective

- To assess the quality of the water parameters and study their impact on the aquatic inhabited species.
- To assess the different measures and concentrations of different minerals in the water sample in different areas.
- To assess the changes in water quality parameters after the contamination with industrial, agricultural and other effluents.
- To study the impact on shrimp species (*M. monopheros, M. rosenbergi, M. brevicornis, Penaeus vennemei)* and their identifications.
- To study the impact on prawn growth and also their socio-economic impact.
- To compare and contrast the data from 2022 to 2024 during premonsoon phase (Feb- May).

Method

Study Location-

In the Sahid Matangini Block of Purba Medinipur, large-scaled cultivation of these marine shrimps is carried out in the villages of Kolaghat, Alinan, Siuri, and Deemari. These villages are located close to Tamluk town, which is the district capital of Purba Medinipur.

The study has been done from February to May of the year of 2022 to 2024.

Table 1
Study site details

Area name	Latitude & Longitude
Kolaghat	22°26’08”N 87°52’59”E
Tamluk	22°17’25”N 87°56’05”E

Method for Analysis

1. Temperature

With a mercury-filled Celsius thermometer that ranged from 0 to 50°C, the temperature of the water was measured. After being submerged in the sample water for a minute, the thermometer was ultimately retrieved with a reading. Temperature has a major role in shrimp growth. Increased temperature has an impact on shrimp growth as well. The ideal temperature for shrimp is between 26 and 30°C (6–8).

2. pH

A digital pH meter (EUTECH pH 700) was used to measure the water pH of the samples that were collected. The instruments were calibrated using buffer solutions with pH values of 7 and 10 before to use. Without going beyond the maximum immersion level, the pH probe was submerged in the water samples that were going to be examined. After giving the sample a little shake and waiting for the reading to stabilize, the final pH value was noted. The pH range that shrimp species need to survive is between 7 and 8.5. In addition to causing stress and a soft shell, higher or extreme pH also impacts the survival rates of shrimps (6, 9).

3. Turbidity

The measurement of turbidity has a significant impact on water quality. The ability of light to enter the water is affected by turbidity, which in turn affects algae growth and photosynthetic activity. Lovibond TB 210 IR equipment for measuring turbidity. For species of shrimp, turbidity is also crucial. The shrimp species' ability to grow is also impacted by higher turbidity water.The discharge of various industrial pollutants and effluents into the Rupnarayan River affects both the turbidity of the river and the survival of shrimp species(8–10).

4. Alkalinity

The titration method was used to measure the water's alkalinity (APHA, 1992). After rinsing the burette with distilled water, 0.1N sulfuric acid (H□SO□) was added to normalize the pH level using Na2CO3. A 250 ml conical flask was filled with a 10 ml sample and five drops of the phenoptheline indicators solution. The volume of the titrate was measured after adding five drops of methyl orange indicator to the sample and titrating it with 0.1N sulfuric acid (H□SO□) until it turned pale pink.Elevated alkalinity influences not only the water's pH but also the types of shrimp that inhabit it. An ideal range for alkalinity is 150–180 ppm (9, 11, 12).

5. Hardness

Measures of the total hardness parameter are also significant for water quality. Elevated levels of hardness also have an impact on shrimp species and water quality. First, note the EDTA measurement. Next, take the sample and add 1–2 ml of the ammonia buffer solution to one pinch. When the wine-red Eriochrome Black T Indicator color appears, titrate it. EDTA: The titration stops and the reading is obtained when the color turns royal blue. Using the titration method of ethylenediaminetetraacetic acid (EDTA), the hardness of the water was determined (11, 13).

6. Nitrate

An essential component of water quality is nitrate, Nitrate concentration measurement is crucial for water quality. The photometer instruments employ the chromotropic acid technique to test nitrate (14).

7. Dissolve oxygen (DO)

DO is a crucial indicator of water quality. Do is primary indication of water. For the shrimp species to survive, DO is crucial. Sample extracted from DO bottle; tightly cap; add 2 ml alkaline azide and 2 ml manganous sulphate; let settle for 30 minutes; invert 5–6 times; transfer sample to conical flask; titrate with sodium thiosulphate solution. Using the Winklers modified technique, dissolve oxygen is determined (15).

8. Iron

One crucial indicator of water quality is iron. There are two major states of iron: ferrous and ferric. The water turns reddish-brown when ferrous ions move from ferric to ferrous. The accuracy with which iron is estimated is crucial. A photometer is used to measure it. Using the 1, 10 phenanthroline technique, estimate iron (16).

9. BOD

BOD, or biological oxygen demand, is a crucial indicator of water quality. It is the type of dissolved oxygen needed for aerobic bacteria to stabilize the decomposable organic matter present in water. Once the DO concentration has been obtained, the bottle needs to be stored within the "BOD incubator." Whereas other parameters like humidity and pressure should be maintained, the temperature should be set at 20°C. The bottle should be taken out of the "incubator" after the five days have passed, and the final DO concentration should be measured at the same temperature. The amount of dissolved oxygen used by the bacteria over the course of the five days to break down the organic materials in this diluted water is indicated by the difference between the starting and final DO values(7, 17).
Table-1 PHYSICOCHEMICAL PARAMETER OF RUPNARAYAN RIVER FEBRUARY TO MAY 2022

Parameters	FEBRUARY	March	APRIL	May
pH	7.77	7.7	7.71	7.63
Temperature (°C)	20.7	29.1	30.2	30.8
Turbidity (NTU)	150	150	230	220
TDS (mg/lit)	177	353	526	331
Conductivity(µS/Cm)	355	706	1051	663
Hardness as CaCo3 in (mg/lit)	126	160	190	150
Alkainity CaCo3 in (mg/lit)	130	144	176	134
Chloride (mg/ltr)	35.45	130.456	321.886	192.928
Iron (mg/ltr)	0.3	.56	1.10	.67
Nitrate(mg/ltr)	4.43	4.43	5.759	3.987
Dissolve oxygen(mg/ltr)	4.5	4.2	4.7	5
Biological oxygen Demend (BOD) as (mg/ltr)	4	4	4	4.6

Table-2 PHYSICOCHEMICAL PARAMETER OF RUPNARAYAN RIVER FEBRUARY TO MAY 2023

Parameters	FEBRUARY	March	APRIL	May
pH	7.70	7.7	7.65	7.58
Temperature (°C)	24.5	26.7	29.8	31.6
Turbidity (NTU)	230	450	590	470
TDS (mg/lit)	310	583	1018	1110
Conductivity(µS/Cm)	621	1165	2037	2220
Hardness as CaCo3 in (mg/lit)	178	220	465	308
Alkainity CaCo3 in (mg/lit)	158	196	428	204
Chloride (mg/ltr)	92.17	241.06	490.628	581.38
Iron (mg/ltr)	.58	.6	1.3	1.35
Nitrate(mg/ltr)	3.987	4.873	7.531	9.303
Dissolve oxygen(mg/ltr)	4.5	4.7	4.3	5.3
Biological oxygen Demend (BOD) as (mg/ltr)	4.1	4.2	3.7	4.7

Table-3 PHYSICOCHEMICAL PARAMETER OF RUPNARAYAN RIVER FEBRUARY TO MAY 2024

Parameters	FEBRUARY	March	APRIL	May
pH	8	7.59	7.5	7.7
Temperature (°C)	22.2	26.2	33	32.3
Turbidity (NTU)	100	250	500	600
TDS (mg/lit)	250	459	1140	1600
Conductivity (µS/Cm)	500	919	2280	3210
Hardness as CaCo3 in (mg/lit)	170	210	334	420
Alkainity CaCo3 in (mg/lit)	150	156	184	180
Chloride (mg/ltr)	75.154	120.53	595.56	801.17
Iron (mg/ltr)	0.3	0.5	1.58	1.8
Nitrate(mg/ltr)	6.645	5.316	13.29	19.935
Dissolve oxygen(mg/ltr)	5	4.3	4.8	4.3
Biological oxygen Demend (BOD) as (mg/ltr)	4.8	4	4	3.6

SAMPLING OF SPECIES

Juvenile shrimp seed collection method from the river

A significant number of people, mostly women, gather junenile shrimp seed on the riverbank in the Purba Mednipur district, particularly in the kolaghat to tamluk area, between the months of March and May, from 10 p.m. to 7 a.m. When the water flow reaches its greatest during high tide, they employ nets to gather the young seeds, which happens two hours later during low tide. In particular, kolaghat, sahid matangini, and Tamluk blocks shrimp seed harvesting for the past two years has provided local communities with an extra revenue stream. The natives of this region made nets out of triangles of bamboo, which they called "kolle jal" in the vernacular. Additionally, circular scoop nets are utilized. For the next three months, the folks collecting are making every effort to gather this immature seed because they are not fishermen in this area and this is their additional source of income. We spoke with some locals in Kolaghat during our survey, and they told us that we may ship these young seeds to Bangladesh and make good money doing so. He obtained these young seeds from the locals and gave them a portion for 0.75–1/-. We saw locals who live along the riverbank gathering 800–1000 immature seeds every day. They also used to sell fish in retail fish markets in Kolaghat, Tamlulk, Kakatia, and Mecheda for 200–300/-per kg, although sometimes they would sell it for 400–500/-per kg. Some Kolaghat fishermen use this jal and gather these shrimp. Numerous other thare in this region, from Kolaghat to Tamluk, also

benefitted from using the water from the Rupnarayan River. It is evident that some individuals utilized mughri to catch shrimp. Retail prices for M. rosenbergi and M. brevicornis range from RS 400 to RS 500 per kg (18–20).

White leg shrimp (Penaeus vennamei) Previous two years, the Rupnarayan River has increased rapidly (2022–2024). The people that reside on the Rupnarayan River's bank have also made a great effort to gather shrimp. Our survey area in the Purba Medindipur district extends from Kolaghat to Tamluk, but we also collected a lot of useful information from a lot of people, especially Kathi and Nandigram, who helped gather the shrimp before selling them and making money from the market. This "vennami" prawn is becoming more and more in demand. When we conduct surveys in this field, we get comprehensive and informative news. Several varieties of "Veri" from the Purba Medinipur district also use the Rupnarayan River for shrimp cultivation. These shrimp also grow Nandigram, Khejuri, and Kathi-3 blocks (20).

Identification of Shrimp species

• Macrobrachium rosenbergi-

It is a freshwater shrimp. The length of this shrimp 30cm. The colour of this shrimp is brounish, but some species is greenish.This type of shrimp contains 11–14 drosal teeth and 8–11 ventral teeth.The first pair legs are very thin but seconed pair legs are most powerful. Female and male differentiate by their abdomen (21, 22).

• Michrobrachium bravicornis-

It is also a freshwater shrimp. The colour of the shrimp is brownish or pinkish. Joint appendages also present. It is also found in Rupnarayan River near Kolaghat(23).

• Microbrachium monoceros-

It is also a freshwater shrimp. It is found in Rupnarayan River. The colour of this species is slightly brownish. Thin hairy coverage found over the body (24).

Discussion

Impact of water quality parameter on growth and production of shrimp species in Rupnarayan River

Shrimp species growth and productivity are also influenced by water quality parameters. The growth of the shrimp species is also influenced by the water's ph, total dissolved solids, total hardness, alkalinity, and chloride content. We were also provided a water quality analysis chart, which displays additional water parameters (25) such as temperature, turbidity, pH, alkalinity, and hardness increases that affect shrimp species growth and productivity. The water of the Rupnarayan River has an increased iron

content as well. April and May see an increase in the concentration of chloride as well. Salinity in this river has increased as a result of the rise in chloride concentration. This pre-monsoon season (February to May) is when we survey. Temperature, iron, and chloride concentration all affect how quickly organisms grow.

- The comparative study conducted in 2022–2024 from February to May revealed that the shrimp species is also impacted by the water quality.
- We also demonstrate that the temperature rises in April and May of each year during our study period. The temperature will rise even more in 2024. Elevated temperatures have an impact on the survival of shrimp species and increase the organic load.
- April and May are two months when the temperature rises as well. The growth and output of shrimp species are also influenced by temperature in the months of April and May in 2024.
- The amount of dissolved oxygen (DO) decreases as a result of rising temperatures. DO level is a crucial component of water quality that aquatic life depends on. DO drop has an impact on aquatic life. As a result, a significant number of shrimp species were affected in 2024.
- Compared to the previous two years, 2024 had an impact on growth and production as well. Although the Rupnarayan River is a freshwater river, pollution causes waste materials to mingle with the water during high tide, increasing turbidity. Shrimp species were similarly impacted by high turbidity. The Rupnarayan river water enriches with turbidity during April and May about 1000 NTU which also affect the shrimp production.
- Other crucial parameters for water are pH and alkalinity. The pH level of water rises during February, 2024 (pH 8.5), and consequently the shrimp growth is likewise decreased by highly poisonous and alkaline water.
- We also observed during April and May there is a significant increase in chloride concentration. A rise in chloride content also affect the concentration of iron, hardness, conductivity, and total dissolved solids (TDS). Shrimp gills are similarly affected by hard water if the hardness level rises. In this two month of every year due to high TDS value, the nitrate level concentrations has also been increased which also reduces the shrimp growth. Besides high level of conductivity represents high amount of ions in river water. As a result there is a significant reduction shrimp production and growth has been observed.
- Every year, during the month of May and April a significant increase in iron concentration has been also observed. Iron content rise is a significant determinant of water quality in the Rupnarayan River. Over the course of the three-year trial, there is a discernible change in iron concentration. Aquatic creatures are similarly impacted by changes in iron concentration, particularly fish and shrimp species. This iron concentration rises in the trophic chain and affect human health after consumption.
- Numerous human activities also impose on river water hydrology and ecosystem. Shrimp growth is also impacted by numerous chemical contaminants. Pollution causes harm to species, such as gill damage, white spots, tail rot, etc.

- Although the Rupnarayan River is a freshwater river, the water became saline for the next two months, which has a significant impact on the shrimp species. Because of pollution and waste water discharge, there are changes in water quality that has a significant impact on growth of shrimp species. The temperature of the water has been raised rapidly in 2024, which has an impact on species survivality (6, 8).

Conclusion

- Maintaining water quality is crucial for aquatic life as well. Changes in the Rupnarayan River's water quality also affect the aquatic ecology. Following treatment, sewage waste is released, which also enhances the quality of the water. The current study demonstrates that parameters related to water quality, including pH, temperature, turbidity, harness, alkalinity, TDS, chloride, iron, DO, and BOD concentration levels, also fluctuate. If these variations persist throughout the year, it may have an effect on the development and yield of the shrimp species found in this river.
- Additionally, locals gathered young shrimp species that have an impact on the river's native shrimp ecosystem. This kind of gathering also has an impact on the shrimp species' natural habitat for growth.
- Some unscrupulous people employ methyl parathion and cypermethrin, which also affect aquatic organisms, to trap shrimps in the dark. These chemicals have devastating effects on the shrimp's natural ecology and water quality. The natural environment of the shrimp species will be restored if the government takes proactive steps and increases its initiatives in this area to stop this behavior.
    - Raising community awareness of this goal, encouraging people to dispose of household garbage properly and to recognize the value of water in restoring the quality of the water. If the government took greater steps to maintain the water's quality.
    - Should the aforementioned actions be taken, the ecosystem supporting shrimp species will be enhanced and the water quality of the Rupnarayan River will be restored.
- Some unscrupulous people employ methyl parathion and cypermethrin, which also affect aquatic organisms, to trap shrimps in the dark. These chemicals have devastating effects on the shrimp's natural ecology and water quality.
- The natural ecosystem of the shrimp species will be restored if the government stops this activity and takes positive action in this area. Raising community awareness of the need to recover the water quality and encouraging residents not to discharge domestic waste will also help in this activity.

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Figures

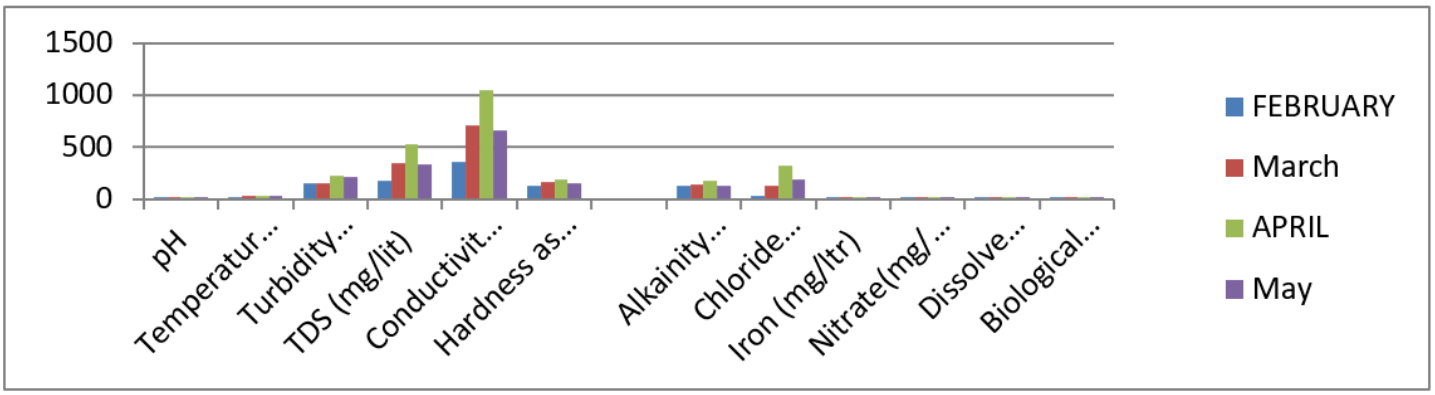


Figure 1

PHYSICOCHEMICAL PARAMETER OF RUPNARAYAN RIVER FEBRUARY TO MAY 2022

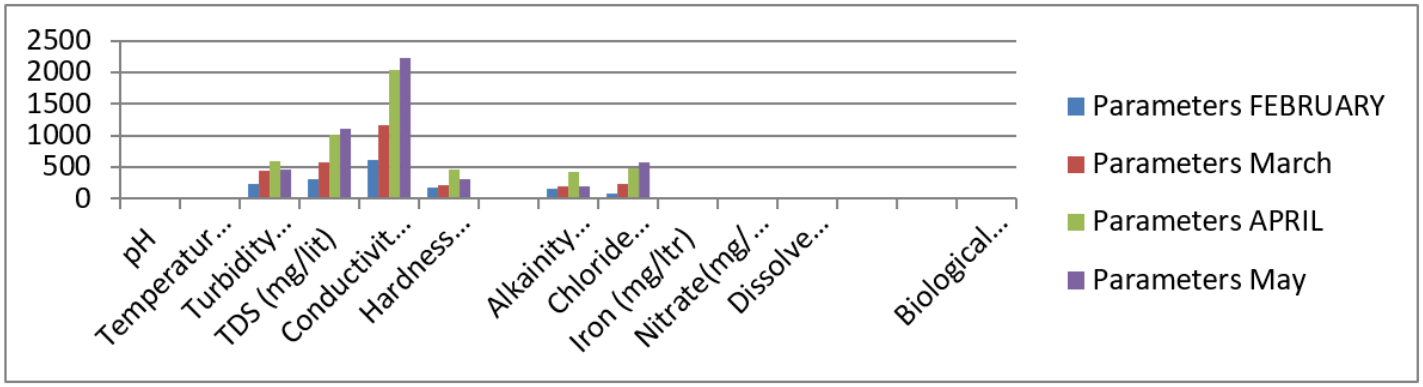


Figure 2

PHYSICOCHEMICAL PARAMETER OF RUPNARAYAN RIVER FEBRUARY TO MAY 2023

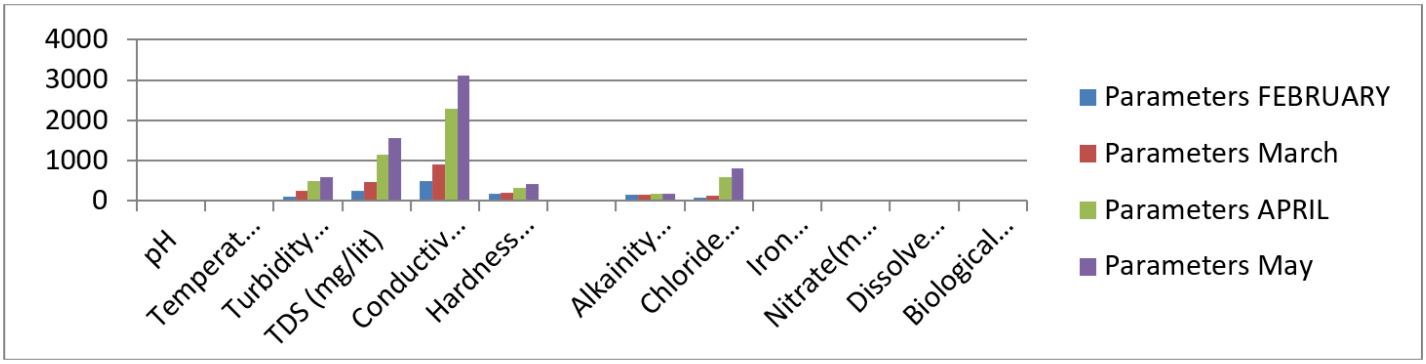


Figure 3

PHYSICOCHEMICAL PARAMETER OF RUPNARAYAN RIVER FEBRUARY TO MAY 2024

Figure 4

Penaeus vennamei

Figure 5

Shrimp catching at Kolaghat

Figure 6

M. rosenbergi

Figure 7

M. brevicornis and M. monoceros

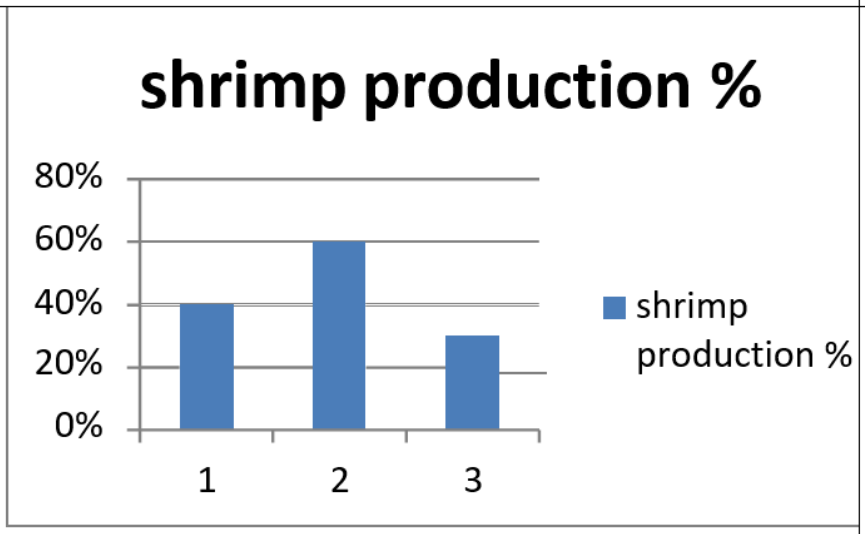
Year	Shrimp production %
 2022	40%
2023	60%
2024	30%

Figure 8

Comparative Study of data of shrimp production in 2022, 2023, 2024 (Feb-May)