Physicochemical Assessment of Potable Water Sources of Colleges of Patna, Bihar (India)

Dr. Surendra Kumar Prasad[1], Rozy Kumari[2]

[1]Associate Professor, Department of Botany, Magadh Mahila College, Patna University, Patna, Bihar, India,
[2]Research Scholar, Department of Botany, Patna University,Patna,Bihar,India

ABSTRACT
The aim of this research was to assess the physiochemical analysis of potable water sources of colleges of Patna, Bihar (India).A total of 15 samples were analyzed for parameters including pH,turbidity,conductivity,TDS,calcium,magnesium,chloride,alkalinity,fluoride,nitrate,sulphate and heavy metals, including Fe and As, following APHA (2017) guidelines between January 2025 and Febuary 2025. The findings obtained for each parameter were compared with the standard values established by the WHO, BIS(IS:10500:2012).The values of each parameter were found to be within the safe limits set, while samples 1 and 4, which were collected from B.D College and Patliputra University, respectively, showed somewhat higher conductivity, TDS, hardness, and alkalinity values, indicating mineral contamination and anthropogenic influence.Samples 1 and 4 had 982.50 and 1046.00 µS/cm conductivity and 678 and 638 mg/L TDS, respectively, slightly higher alkalinity levels (342 mg/L and 372 mg/L) and 400 mg/L (sample 1) and 364 mg/L (sample 3B) hardness. Although these values exceeded the ideal limits, they remained below the permissible levels, indicating that the water is still safe for drinking.To evaluate the total water quality of colleges of Patna, it is necessary to look into various possible water contaminants, including chemicals, microbiological and fluids of the human body over an extended period of time.

Keywords:*Physiochemical ,potable,WHO, APHA,BIS,Anthropogenic,Microbiological*.

ABBREVIATIONS
WHO:-World Health Organisation
BIS:- Bureau Of Indian Standards
APHA:-American Public Health Association
Fe-Iron
As-Arsenic
TDS-Total Dissolve Solids
EC-Electrical Conductivity
TH-Total Hardness
µS/cm-Milligram per litres

NTU-Nephelometric Turbidity Unit

1.INTRODUCTION

Water occupies a unique place among renewable resources and is essential for sustaining life on Earth. 70% of our body is made up of water, which helps to make our tissues and transports the greatest range of substances throughout the body. Additionally, it is considered a unique natural resource and a universal solvent (Ovonramwen et al. 2020). Drinking water is regarded as safe and suitable for consumption (Sojobi, 2016) .The surface of the planet and its atmosphere have enough water to constitute up to 70% of the earth's total mass. Less than 3% of the whole storage of water is available for freshwater consumption.

Water resources are at serious risk of pollution due to human activity and insufficient agricultural drainage into rivers (Jin et al., 2020a, 2020b). Additionally, anthropogenic activities and geogenic contaminants that contain rocks and soils pollute groundwater resources (Saha et al., 2018). Sources of freshwater contamination are domestic sewage, mining sources, agriculture sources, natural sources, industrial sources, and urbanization.

Colleges and other educational institutions are dependent upon supplied water or groundwater for their daily needs. Thus, making regular assessments is crucial for maintaining the health of staff members and students. Physicochemical analysis offers significant data about the chemical stability and possible levels of contamination in water. Inorganic compounds constitute more of the contaminants than organic ones. Groundwater quality is assessed using physicochemical parameters such as arsenic, fluoride, pH, bicarbonates, chlorine, and total dissolved solids (Kannel et al., 2007; Ijumulana et al., 2020, 2021; Ligate et al., 2021).

Worldwide, drinking water contamination causes 1.2 million deaths annually, primarily from waterborne diseases (WHO).The mineral form of heavy metals makes up a portion of inorganics. Individuals tend to acquire heavy metals, which affect the nervous systems and organs' normal processes.The current study evaluates whether the potable water at the colleges in Patna, Bihar, India, complies with standard limits through assessing its physicochemical parameters.Results for every parameter were compared with local norms such as BIS and WHO guidelines and standards.

2. MATERIAL AND METHODS

2.1 Study Site And Sampling

Patna, the capital city of Bihar, is located on the bank of river Ganga. The total geographical area of Patna district is 3,202 sq km. It is the most populous city of Bihar, it is geographically located between 25^{O} 36 ˙40” north and 85^{0} 08’ 38” East longitude at an elevation of approximately 129 meters above mean sea level. It is approximately 35 km long (east to west) and 16-18 km wide (north to south). The Ganga River flows north of the city. (Fig :1)

15 tap (groundwater) water samples were collected from different college campuses (TABLE 1) across Patna. Samples were collected at morning time in a sterile container of 1000 ml using standard sampling techniques (e.g., APHA guidelines). A few drops of 1:1 nitric acid (HNO_3) are added immediately after water sample collection for heavy metal analysis (such as arsenic, iron, etc.).

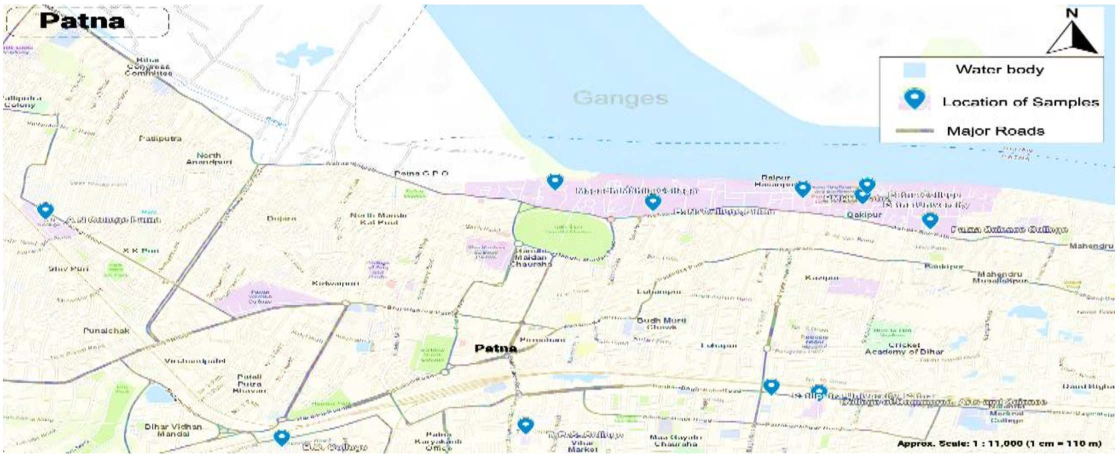

Fig:1 Map of Study Area

Sources: https://mymaps.google.com

Table:1 Location Details, Sample Code, Sources of sample

S.No	Location Details	Sample Code	Sources of Sample
1.	Bhuwaneshwari Dayal College (B.D College),Patna	1	Tap Water
2.	Thakur Prasad College, (T.P.S College), Patna	2	Tap Water
3.	College Of Commerce, (C.O.C),Patna	3A	Tap Water
4.	College Of Commerce,(C.O.C) , Patna	3B	Tap Water
5.	Patliputra University,Patna	4	Tap Water
6.	Anugarh Narayan College,Patna	5	Tap Water
7.	Magadh Mahila College,Patna	6A	R.O Water
8.	Magadh Mahila College, Patna	6B	Tap Water
9.	Bihar National College,(B.N College),Patna	7	Tap Water
10.	Patna Medical College and Hospital, Patna	8A	Tap Water
11.	Patna Medical College and Hospital,Patna	8B	Tap Water
12.	Patna College,Patna	9	Tap Water
13.	Patna University,Patna	10	Tap Water
14.	Patna Science College,Patna	11A	TapWater
15.	Patna Science College,Patna	11B	Tap Water

2.PHYSIOCHEMICAL ANALYSIS:

2.2.1 *Determination of pH, conductivity, and TDS:* The digital pH meter (Oaklon pH 2700, USA) with a glass combination electrode was used to electrometrically measure the pH of the water sample. A conductivity meter (of the model Oaklon 2700, USA) was used to measure conductivity of the samples as per APHA (2017). Total Dissolved Solids (TDS) were estimated using TDS (mg/l)=0.65×EC (µs/cm).

2.2.2 Determination of total hardness: The EDTA titrimetric method was used to measure total hardness (as $CaCO_3$) following APHA 23rd Edition, 2300-Total Hardness-C.2-3 drops of Eriochrome Black T (EBT) indicator and 1-2 milliliters of ammonium-ammonia buffer (pH 10) were added to a conical flask containing 25 mL of sample. The wine-red solution was titrated with 0.01 M EDTA until it turned blue, which indicated the endpoint. The total hardness (mg/L as $CaCO_3$) was calculated using analytical formula.

2.2.3 Determination of calcium and magnesium: The EDTA titration method (APHA 23rd Edition, Methods 2340 C, 3500-Ca B) was used to measure calcium. A 50 mL water sample was treated with 1-2 mL of 1 N NaOH to achieve a pH of ~12, followed by 2-3 drops of murexide indicator. Until a purple-violet endpoint was achieved, the solution was titrated against 0.01 M EDTA after turning pink. Ca hardness (mg/L as $CaCO_3$) was determined by using analytical calculation. Magnesium hardness was determined by subtracting calcium hardness from overall hardness.

***2.2.4 Determination of Chloride (Mohr's Method)*:** APHA 23rd Ed., Method 4500-Cl-B, was used to measure the concentration of chloride. A conical flask containing 25 mL of the water sample was used for analysis. 0.5 mL of 5% K_2CrO_4 indicator was then added, and the sample was titrated with 0.0141 N $AgNO_3$ until the color turned reddish-brown. Distilled water was also used for a blank titration. Chloride concentration (mg/L) was determined by using analytical calculation.

***2.2.5 Determination of Alkalinity*:** Alkalinity was measured using the titration method according to the APHA's standard (23rd Edition, 2320B). For phenolphthalein alkalinity (P value), 2 to 3 drops of phenolphthalein indicator were applied to 50 mL of sample in a conical flask. If the solution became pink, it was titrated against 0.02N H_2SO_4 until it turned colorless. For total alkalinity (M value), 2 to 3 drops of methyl orange indicator were added to 50 mL of the same sample. 0.02 N

H_2SO_4 was used to titrate the sample until the color turned red from yellow. Finally, using the analytical calculation, alkalinity was determined in terms of mg/L.

2.2.6 Determination of Fluoride: Fluoride was measured using an ion meter with a fluoride ion-selective electrode (ISE) according to APHA (23^{rd} edition, Method 4500-F^- B, C, & D). Two to three standard fluoride solutions combined with TISAB in a 20:2 mL ratio were used to calibrate the ion meter. 20 mL of water sample with 2 mL of TISAB to maintain constant ionic strength and pH was swirled, and examine using a fluoride electrode. The fluoride concentration was shown directly in mg/L.

2.2.7 Determination of Nitrate : A UV-Visible spectrophotometer was used to measure the nitrate using the APHA 23rd Edition (4500 NO_3^- B) technique. Filtered water samples (50 mL) were mixed with 1 mL of concentrated HCl and analyzed at 220 nm (nitrate absorption) and 275 nm (for organic interference correction). The nitrate concentration (mg/L as NO_3^-) was determined from the slope of the calibration curve using conversion factor of 4.43.

2.2.8 Determination of Sulphate (SO_4^{2-}) (Turbidimetric Method): (APHA, 23rd Ed., Method 4500–SO_4^{2-} E) is used to measure the amount of sulfate ions (SO_4^{2-}) in water. For analysis, 25 mL of the water sample was mixed with 5 mL of buffer solution and $BaCl_2$ crystals and stirred for a minute to form barium sulphate turbidity. A spectrophotometer was used to evaluate the absorbance of the resultant suspension at 420 nm after five minutes, comparing it to a reagent blank. A calibration curve using sulfate standards (0–40 mg/L) was used to determine the sulfate concentration in the samples.

2.2.9 Determination of Iron (Phenanthroline Method): (APHA, 23rd Edition, 3500-Fe-B) is used to measure the amount of iron (Fe) in water. For analysis, 25 ml of sample mixed with 1 ml of concentrated HCL and 0.5 ml of hydroxylamine solution was heated to one-third volume. Iron, when cooled is converted to the ferrous state when treated with 2 ml of 1,10-phenanthroline reagent and 5 ml of ammonium buffer, and an orange-red iron-phenanthroline complex is formed. For color development, the liquid was diluted to 25 mL and left to stand for 10 to 15 minutes, and absorbance was measured at 510 nm against a reagent blank.

2.2.10 Determination of Arsenic (SDDC method): According to the APHA, 23rd Edition, 3500 As-B, the Silver Diethyldithiocarbamate spectrophotometric method was used to measure the amount of arsenic in water samples. 35 mL of the sample was placed in an arsenic generator for estimation; 5mL of concentrated HCl, 2 mL of 15% KI solution and 8 drops of stannous chloride solution were added after shaking. After adding 3 g of zinc granules, the system was left for 30 minutes to generate all the arsine gas. The gas was absorbed in 5 mL of SDDC solution. After transferring the red-colored complex to a cuvette, the absorbance at 520 nm was measured, using a blank for calibration. Concentration of arsenic was determined from a standard calibration curve.

3. RESULT AND ANALYSIS

3.1. *pH*: Readings were within WHO and BIS limits (Table 2). All of the potable water samples had pH values between 7.0 and 7.97 (Table 3), with sample 11A and sample 10 having the lowest and highest values, respectively. *Ocheli et al. (2020)* discovered that the majority of water samples were within the WHO-recommended pH limits. The findings are also comparable with those of *Osayande et al. (2015*). According to their investigation, there was no risk from pH-related impacts. There is no risk associated with drinking extremely acidic or alkaline water, but it is still true that drinking acidic water is linked to gastritis and other gastrointestinal conditions like Helicobacter pylori.

3.2. Turbidity: *Turbidity* is the cloudiness of water caused by different particles and also linked to the presence of pathogenic organisms in water, which could originate from soil runoff. Results were below the WHO/BIS limit of 5 nephelometric turbidity units (NTU). Sample 6A had the lowest value of 0.8 NTU, and sample 4 had the highest value of 3.9 NTU (Table 3). Similar findings reported by *Patil et al. (2010) were* also within permissible limits.

3.3. Conductivity: According to *Jayalakshmi et al. (2011) and Osayande et al. (2015*), electrical conductivity (EC) is directly correlated with the concentrations of the ionized component in the water and is related to the measurement of water's current. The EC values ranged from 430.90 to 1046.00 µS/cm (Table 3). While samples having 982.50 and 1046.00 µS/cm with samples 1 and 4, respectively, were moderate but still fell within the BIS permissible limit of 2000 µS/cm. Due to reverse osmosis treatment, which eliminates pollutants and dissolved particles, sample 6A had the lowest conductivity.

***3.4. TDS*:** TDS is the total amount of all organic and inorganic materials present in water, including dissolved ions such as Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, and HCO_3^{-}.The present study had TDS ranging from 280 mg/L to 678 mg/L (Table 3), indicating acceptable quality. Samples 1 and 4 had higher values (678 and 638, respectively, still below the upper permissible limit but above the ideal limit) Table 2, which may be due to anthropogenic and mineral dissolution.

3.5.*Total hardness:**Total* hardness of the examined samples ranged from 188 mg/L to 400 mg/L (Table 3) and falls within the permissible range. Samples 1, 3B, and 4 showed values above 300 mg/L, indicating moderately hard water. While samples (7, 11A, and 6A) had lower hardness levels (around 188–250 mg/L), indicating softer water with less mineral content. Overall, the results showed that the drinking water in the majority of Patna's colleges is moderately hard but still within acceptable limits, as per BIS (10500:2012) and WHO (2017) limits (200-600 mg/L). The observed moderate hardness levels are consistent with data from urban Patna (*Kumar & Sinha,2021)* and similar to those reported by *Sharma et al. (2022)* in Varanasi, demonstrating carbonate dominance in Indo-Gangetic plain aquifers.

3.6. Calcium: Calcium (Ca^{2+}) concentrations ranged from 41.68 mg/L to 88.17 mg/L (Table 3). (WHO, 2017) and the (BIS 10500:2012) acceptable limit of calcium is 200 mg/L, while the ideal level is 75 mg/L. Samples 1 and 4 had increased values (88.17 mg/L and 83.36 mg/L, respectively), but they were still within the top permitted range. Overall, Patna colleges' potable water sources have calcium concentrations that are within safe and acceptable bounds *Eze and Madhumere (2012)*found very low calcium in their water sample. Because of this, these waters are soft.

3.7. Magnesium: Magnesium ranged from 13.99 mg/L to 43.94 mg/L, also within the permissible range (30-100 mg/L) (Table 3). Samples 1 and 3B had somewhat higher values, 43.74 mg/L and 40.82 mg/L, respectively, suggesting considerable hardness caused by magnesium salts.

3.8.Chloride:The concentration of chloride (Cl^{-}) ranged from 13.99 mg/L to 93.95 mg/L, with samples 3A and 4 having the lowest and highest values respectively (Table 3). The chloride concentrations were far below the acceptable threshold, indicating water is safe for human consumption and free of salinity risks.

TABLE 2:Safe limits of WHO and NDWQ For Drinking Water.

Parameters	WHO Permission Limit	NDWQS /BIS 10500	Remarks
pH	6.5-8.5	6.5-8.5	Acceptable range for drinnking water
Turbidity	≤5NTU	1NTU(Acceptable),5NTU((Permissible)	High tubidity affects disinfection efficiency
Total Dissoloved Solids (TDS)	≤1000mg/L	500mg/L (Acceptable), 2000mg/L (Permissible)	Affects taste and palatability
Electrical Conductivity	≤1500 µS/cm	Not specified(related to TDS)	Indicates dissoloved ionic content
Total Hardness (as $CaCO_3$)	≤500 mg/L	200mg/L (Acceptable), 600mg/L(Permissible)	Caused by calcium &magnesium salts
Calcium (Ca^{2+})	≤100 mg/L	75mg/L(Acceptable),200mg/L (Permissible)	Contributtes to hardness
Magnesium (Mg^{2+})	≤50 mg/L	30mg/L(Acceptable),200mg/L (Permissible)	Excess causes scaling
Fluoride (F^-)	0.5-1.5 mg/L	1.0mg/L(Acceptable),1.5mg/L (Permissible)	Exess causes florosis
Chloride (Cl^-)	≤250 mg/L	250mg/L(Acceptable),1000mg/L(Permissible)	High value gives salty taste
Alkalinity(as $CaCO_3$)	200 mg/L	200 mg/L(Acceptable)600 mg/L(Permissible)	Affects taste ,causes scaling
Sulphate (SO_4^{2-})	≤250 mg/L	200mg/L(Acceptable). 400mg/L(Permissible)	Causes gastrointestinal irritation
Nitrate(No_3^-)	45 mg/L	45 mg/L (Acceptable)/45 mg/L(Permissible)	Cause blue baby syndrome
Iron (Fe)	≤0.3mg/L	0.3(Permissible)	Staining and taste issue
Arsenic (As)	≤0.01 mg/L	0.01mg/L(Acceptable),1.5mg/L(Permissible)	Carcinogenic even at low level

3.9. Alkalinity**:** Alkalinity ranged from 212 mg/L to 372 mg/L, with samples 6A and 4 having the lowest and highest values, respectively (Table 3). Most samples were within the BIS (10500:2012) and WHO (2017) limits (200–600 mg/L), indicating acceptable quality. Samples 1 and 4 had slightly higher alkalinity levels (342 mg/L and 372 mg/L, respectively) due to geological reasons. *Shyamala et al. (2008*) state that the alkalinity value of water gives an indication of the natural salts that are present in the water: bicarbonate, hydroxide, phosphate, borate, and organic acids derived from soil.

TABLE 3 :Results of Physicochemical Parameter Of Potable Water Sources Of Colleges Of Patna.

Sample code of colleges	pH -	Turbidity NTU	EC µs/cm	TDS mg/l	TH mg/l	Ca mg/l	Mg mg/l	Cl mg/l	Alka mg/l	Fe mg/l	No3 mg/l	So4 mg/L	F mg/l	As mg/l
1	7.57	3.5	982.50	638	400	88.17	43.74	91.95	342	<0.01	21.48	30.50	0.35	<0.005
2	7.90	3.2	723.50	470	292	62.52	33.04	63.96	288	<0.01	5.03	19.90	0.52	<0.005
3A	7.77	2.9	496.20	322	280	57.71	33.04	13.99	250	<0.01	0.61	8.80	0.74	<0.005
3B	7.84	3.2	904.60	586	364	78.55	40.82	81.95	320	0.07	15.76	39.60	0.53	<0.005
4	7.74	3.9	1046	678	356	83.36	35.96	93.95	372	<0.02	6.22	36.60	0.54	<0.005
5	7.91	3.2	718.40	466	292	60.92	34.02	51.97	280	<0.01	12.31	21.70	0.34	<0.005
6A	7.95	0.8	430.90	280	220	41.68	28.18	13.99	212	<0.01	0.98	7.10	0.48	<0.005
6B	7.10	1.4	589.60	382	252	54.50	28.18	25.98	276	0.07	6.74	11.90	0.65	<0.005
7	7.75	2.2	596.20	386	188	41.68	20.41	17.99	294	<0.01	1.09	11.60	0.92	<0.005
8A	7.92	1.8	529.50	344	220	43.28	27.21	15.99	274	<0.01	0.32	9.20	0.77	<0.005
8B	7.91	1.2	537.30	348	208	49.69	20.41	13.99	266	<0.01	1.23	7.50	0.81	<0.005
9	7.96	1	526.30	342	236	51.30	26.24	13.99	266	<0.01	0.07	10.50	0.78	<0.005
10	7.97	1.4	515.90	334	220	49.69	20.32	13.99	258	<0.01	0.24	10.40	0.73	<0.005
11A	7	2.2	597.10	388	188	43.28	19.44	15.99	292	<0.01	1.94	12.00	0.66	<0.005
11B	7.91	3	652.90	424	240	54.51	25.27	25.98	280	<0.01	2.55	36.00	0.58	<0.005

3.10. Nitrate: (NO_3^-) : Nitrate concentrations ranged from 0.07 mg/L to 21.48 mg/L, with sample 9 and sample 1 having the lowest and highest values, respectively (Table 3). Results are below the (WHO, 2017) and (BIS 10500:2012) permissible limit of 45 mg/L, and above this limit may cause methemoglobinemia (blue baby syndrome) in infants within 3 *months (Jain et al.2010*). Constant ingestion of nitrate may also cause carcinogenic diseases *(Jain et al.2010*).

3.11. Sulphate (SO_4^{2-}) **:** Sulphate concentrations ranged from 7.10 mg/L to 39.60 mg/L, with samples 6A and 3B having the lowest and highest values, respectively (Table 3). The main sources of sulfate are industrial or agricultural wastes and the dissolving of minerals such as gypsum ($CaSO_4 \cdot 2H_2O$) and anhydrite ($CaSO_4$). WHO (2017) and BIS (10500:2012) state that 200 mg/L of sulfate is the permissible limit and 150 mg/L is the preferred level for drinking water. Indicating that there was no sulfate pollution in the study area, all recorded values were much below the allowable level.

3.12 .Fluoride (F^-): Fluoride concentrations ranging from 0.34 mg/L to 0.92 mg/L, with samples 5 and 7 having the lowest and highest values, respectively (Table 3). All of the examined samples in this study are below the desired level (Table3) suggesting that the water sources are safe and non-toxic for consumption.

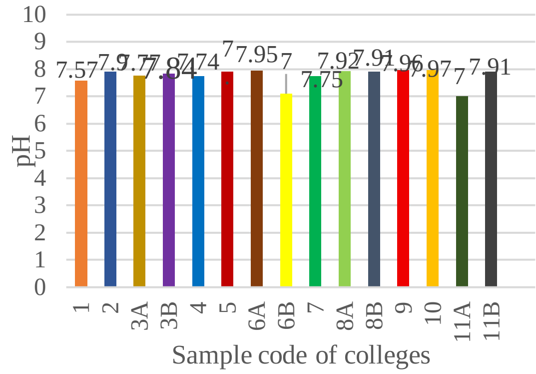

Fig.2.pH values of colleges water

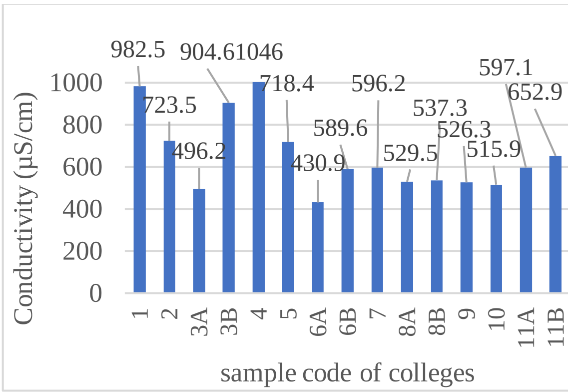

Fig.3.Conductivity values of colleges water

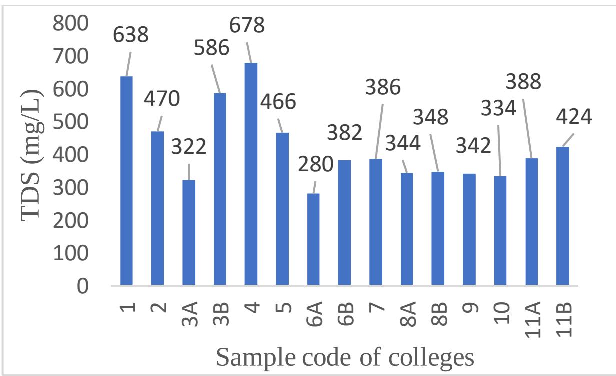

Fig.4. TDS values of colleges water

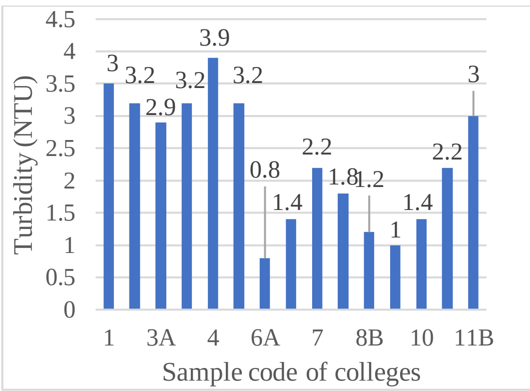

Fig.5. Turbidity values of colleges water

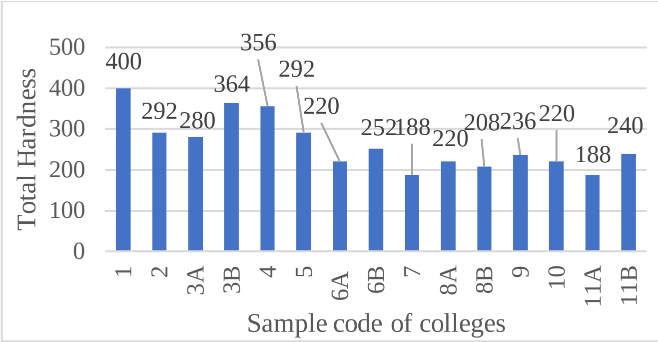

Fig.6.Total hardness values of colleges water

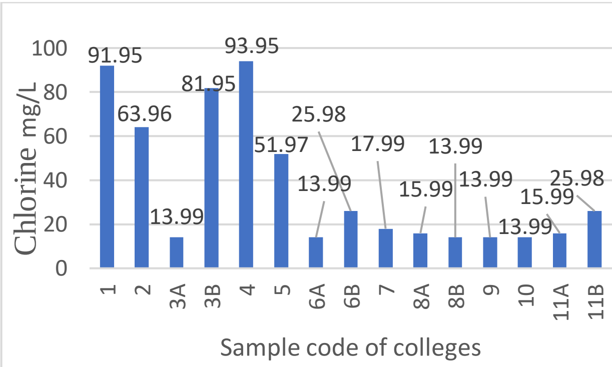

Fig.7.Chloride values of colleges water

Heavy metal analysis:

3.13. Iron: Iron concentrations ranged from 0.01 to 0.07 mg/L (Table 3). All the samples were below acceptable bounds, (Table 2) indicating adequate water quality. In contrast, *Eze and Madumere (2012)* reported high levels of iron variation in all the samples. This could be because the metal is strongly absorbed in soil and dissolves more readily in minute levels.

3.14. Arsenic:*The* samples had arsenic contents between 0.001 and 0.007 mg/L (Table 3), which is less than the 0.01 mg/L BIS/WHO allowable level. This suggests that potable water sources of colleges of Patna are free of arsenic contamination and are safe to drink.

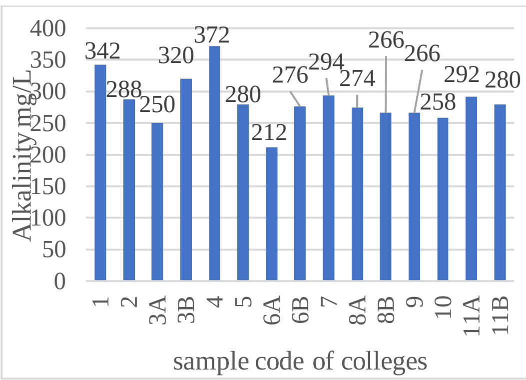

Fig.8.Alkalinity values of colleges water

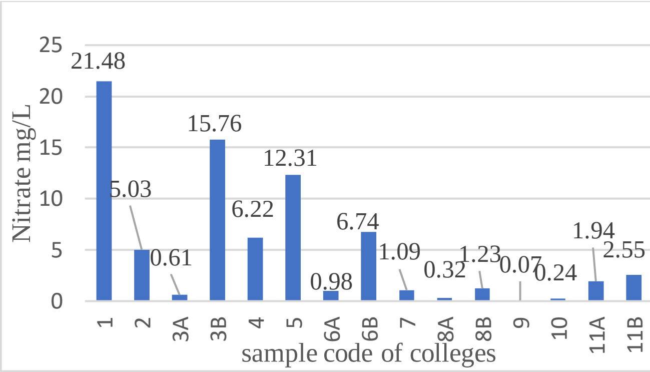

Fig.9.Nitrate values of colleges water

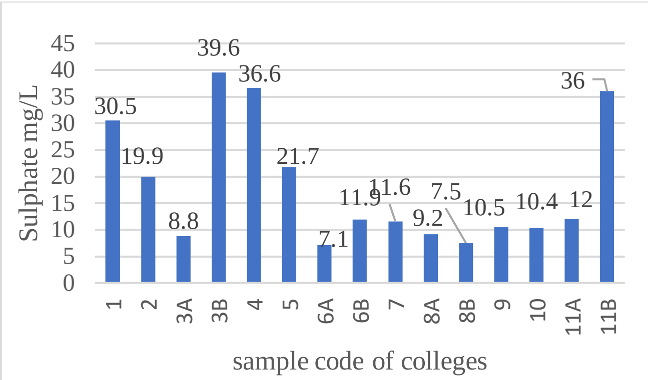

Fig.10.Sulphate values of colleges water

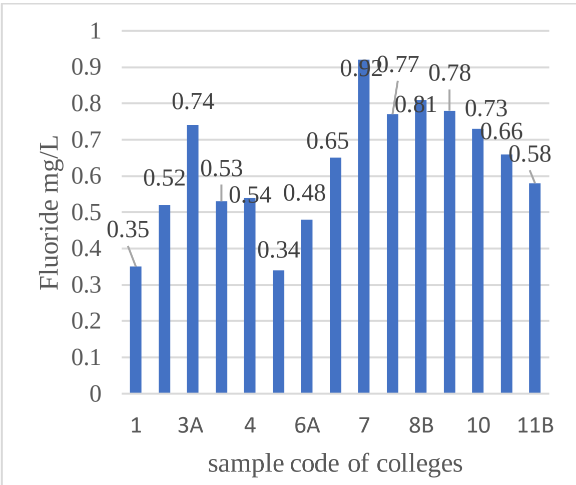

Fig.11.Fluoride values of colleges water

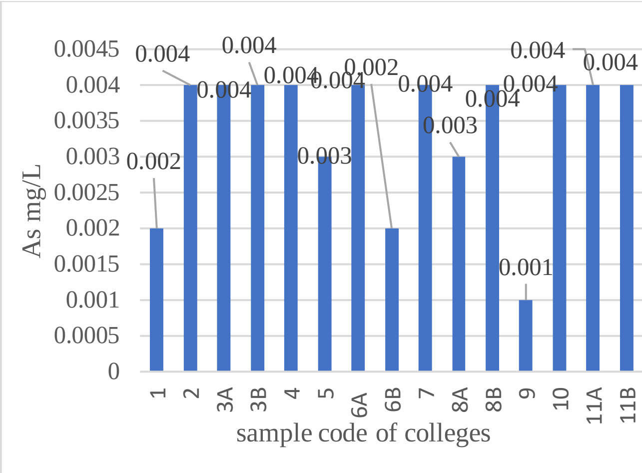

Fig.12.Iron values of colleges water

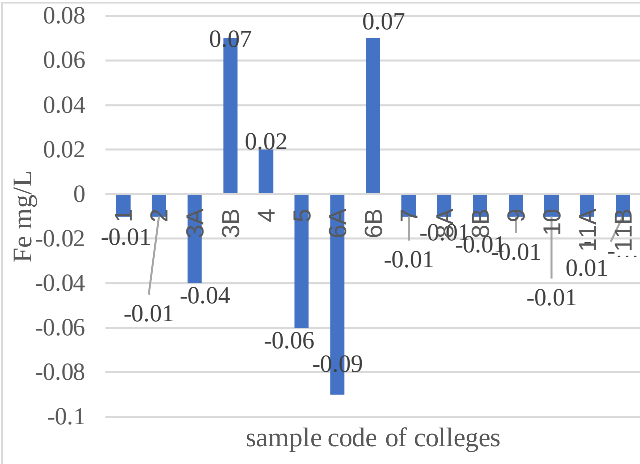

Fig.13. Arsenic values of colleges water

Discussion:

Several authors have shared their perspectives on the physicochemical analysis of water samples: *Gupta, S.,et al.(2004)* studied the groundwater quality in the Sanganar area of Jaipur, Rajasthan. The parameters measured include pH, conductivity, TDS, calcium, magnesium, total hardness, COD, alkalinity, Cl^-, F^-, PO_4^{3-}, Na^+, K+, SO_4^{2-}, NO^{3-}, Cd^{2+}, Pb^{2+}, and Fe^{2+}. According to the observed data, measurements such as conductivity, TDS, alkalinity, and F^- have high levels in this location, whereas other parameters are close to or below the limit. *Saravanakumar and Ranjith Kumar (2011)* present research analyzing about groundwater quality of Ambattur industrial sector in Chennai City. pH, total alkalinity, total hardness, turbidity, chloride, sulphate, fluoride, total dissolved solids, and conductivity were among the variables they examined. It was discovered that there was a little variance in the physico-chemical characteristics among the water samples analyzed. The groundwater is extremely contaminated and poses health risks for human use, according to a comparison of the physico-chemical parameters of the water sample with WHO and ICMR

guidelines. *Namita Saxena and Alka Sharma(2017)* have measured physical and chemical parameters such as Colour, Odour, Temperature, pH, electrical conductivity, total dissolved solid, total Alkalinity, total hardness, calcium, magnesium, chloride, and dissolved oxygen. Almost all these parameters satisfy the guidelines of drinking water at many places except a few. *Gupta et al.(2009)* investigated water samples from 20 sampling stations of Kaithal for their physicochemical parameters. Analysis of samples for pH, colour, odour, hardness, chloride, alkalinity, TDS etc.
On comparing the results against drinking water quality standards laid by Indian Council of Medical Research (ICMR) and World Health Organization (WHO), it is found that some of the water samples are non-potable for human being due to high concentration of one or the other parameter. Thus, an attempt has been made to find the quality of ground water in and around Kaithal City town, acceptable for drinking purposes or not.
Highly contaminated water affects people in different ways and is used for both household and commercial purposes. Water quality guidelines by the World Health Organization (WHO), the Standards Organization of Nigeria (SON), and the Federal Ministry of Environment (FME) have been used for appraising the acceptability of public drinking water supplies (Okuofu et al. 1990; Osayande et al. 2015; Ocheli et al. 2017, 2018). To obtain comprehensive data on Nigeria's water quality, this study focused on the physicochemical and micro-bacteriological twin water contaminant appraisal. It also documents the effects of contaminants in drinking and household water and suggests methods for enhancing water quality. *Shittu et al. (2008)*, who stated that most drinking and swimming water sources in Abeokuta exceeded WHO and EPA requirements, Only isolated deviations were reported in turbidity and magnesium levels at specific sites, indicating localized contamination rather than widespread deterioration of water quality. Patil and Patil (2010) discovered that most of the groundwater samples from Amalner town normally met WHO and ISI (10500–91) drinking water criteria; however, certain sites revealed contamination as a result of anthropogenic and local environmental variables.

CONCLUSION : Water quality parameters from colleges of Patna samples met WHO and BIS recommendations. While samples 1 and 4, which were collected from B.D. College and Patliputra University, respectively, showed somewhat higher conductivity, TDS, hardness,and alkalinity values ,indicating mineral contamination and anthropogenic influence. Although these values exceeded the ideal limits, but they remained below the permissible levels, indicating that the water is still safe for drinking. Heavy metal concentrations (Fe and As) were determined to be significantly lower than the standard maximum. As a result, the tap drinking water quality in colleges of Patna is satisfactory.To evaluate the total water quality of colleges of Patna, it is necessary to look into various possible water contaminants, including chemicals, microbiological and fluids of the human body over an extended period of time.

FUTURE WORKS

Include both detailed physiochemical and bacteriological analyses of potable water sources across colleges in Patna to obtain a more comprehensive assessment of water quality.

REFERENCES

1. Abdulsalam, Z. B.,& Sule, I.O. (2020). Assessment of the Potability of water sources In Some Rural Communities In Ilorin East, Kwara, Nigeria . Science World Journal.15(1).
2. American Public Health Association (2017) and Water pollution control Federation . Standard methods for the examination of water and wastewater(23rd Edition), Washington D.C.APHA.
3. Asionye, E.l, Bariweni ,A.P.,& Idome, J.E .(2023). Assessment of physicochemical and microbiological qualities of potable water sources in Okorenkoko,Delta State. Nigeria Journal of Life and Bio Sciences Research 4 (01),31-39.
4. Bureau of Indian Standards.(2012).Indian Standard (IS 10500:2012): Guidelines for Drinking Water New Delhi : Bureau of Indian Standards.
5. Chindo, Y.I., Karu, E.,Ziyok,I.,& Amanki D.E. (2013). Physicochemical Analysis of Ground Water of Selected Areas of Dass and Ganjuwa Local Government Areas,Bauchi State,Nigeria. World Journal of Analytical Chemistry, Vol.1,No. 4, 73-79.
6. Eze, O.S., & Madhumere C.I.(2012).Physicochemical and Microbiological Analysis of water bodies in Uturu ,Abia State -Nigeria .Asian Journal of Natural & Applied Sciences ISSN:2186-8476 1(4).
7. Gupta, S.; Kumar, A.; Ojha, C.K. & Seth, G.: Chemical analysis of ground water of Sanganer area, Jaipur in Rajasthan. Journal of Environ. Science & Engg. 46(1), 74-78 (2004).
8. Jin et al., 2020a, G.Q. Jin, Z.T. Zhang, Y.H. Yang, S.H. Hu, H.W. Tang, D.A. Barry, L. Li,Mitigation of impact of a major benzene spill into a river through flow control and in-situ activated carbon absorption.
9. Jin et al., 2020b,G.Q. Jin, J. Xu, Y.M. Mo, H.W. Tang, T. Wei, Y.G. Wang, L. Li,Response of sediments and phosphorus to catchment characteristics and human activities under different rainfall patterns with Bayesian Networks,J. Hydrol., 584 (2020), 10.1016/j.jhydrol.2020.124695
10. Jain,C.K., Bandyopadhyay, A., & Bhadia, A. (2010). Assessment of groundwater quality for drinking purposes, district Nainital, Uttarakhand,India.Environmental Monitoring and Assessment, 166, 663–676. https://doi.org/10.1007/S10661-009.1031-103.

11. Jayalakshmi, V., Lakhmi, N., & Singar chary, M. A. (2011).Assessment of physicochemical parameters of water and wastewaters in and around Vijayawada. International Journal of Research in Pharmaceutical and Biomedical Sciences, 2(3), 1040–1046.
12. Kannel, P. R., Lee, S., Kanel, S. R., Khan, S. P., and Lee, Y.-S. (2007). Spatial–temporal variation and comparative assessment of water qualities of urban river system: a case study of the river Bagmati (Nepal). Environ. Monit. Assess. 129,433–459. doi: 10.1007/s10661-006-9375-6
13. Kumar R, Singh S, Kumar R and Sharma P (2022) Groundwater Quality Characterization for Safe Drinking Water Supply in Sheikhpura District of Bihar, India: A Geospatial Approach.Front. Water 4:848018.doi: 10.3389/frwa.2022.848018.
14. Ijumulana, J., Ligate, F., Bhattacharya, P., Mtalo, F., and Zhang, C. (2020). Spatial analysis and GIS mapping of regional hotspots and potential health risk of fluoride concentrations in groundwater of northern Tanzania. Sci. Total Environ. 735:139584. doi: 10.1016/j.scitotenv.2020.139584.
15. Ijumulana, J., Ligate, F., Irunde, R., Bhattacharya, P., Ahmad, A., Tomašek, I.,et al. (2022). Spatial variability of the sources and distribution of fluoride in groundwater of the Sanya alluvial plain aquifers in northern Tanzania. Sci. Total Environ. 810:152153. doi: 10.1016/j.scitotenv.2021.152153.
16. Nayar, R. (2020). Assessment of water quality index and monitoring of pollutants by physico-chemical analysis in water bodies: A review. International Journal of Engineering Research & Technology (IJERT), 9(1), Article IJERTV9IS010046.
17. Patil, V.T., & Patil, P.R .(2010). Physicochemical analysis of selected groundwater samples of Amalner Town in Jalgaon District, Maharashtra, India. E-Journal of Chemistry, 7(1), 111–116. http://www.e-journals.net.
18. Patil. P.N., Sawant. D.V., Deshmukh,R.N. (2012), Physico-chemical parameters for testing water -A review International Journal of Environmental Sciences, 3(3),1194-1207.
19. Rahmanian .N,Ali S.H.B,Homayoonfard .M,Ali N.J ,Rehan M, Sadef .Y and Nizami A.S ,(2015) . Analysis of Physiochemical Parameters to evaluate the drinking water quality in the State of Perak,Malaysia, Journal of Chemistry.Article ID 716125.
20. Saravanakumar,K., & R.Ranjith., Kumar. (2011), Analysis of water quality parameters of groundwater near Ambattur industrial area, Tamil Nadu, India,Indian Journal of Science andTechnology, 4(5), pp 1732-1736.
21. Saha, D., Marwaha, S., and Mukherjee, A. (2018). "Groundwater resources andsustainable management issues in India," in Clean and Sustainable Groundwater in India, eds D. Saha, S. Marwaha, and A. Mukherjee (Singapore: Springer). doi: 10.1007/978-981-10-4552-31.
22. Sharma,V.,Walia,Y.K.,&Kumar,A.(2015).Assessment of physico-chemical parameters for analysing water:A review.Journal of Biological &ChemicalChronicales,2(1),25 .

23. *Shittu, O.B., Olaitan, J.O. and Amusa, T.S(2008)Physico-Chemical and Bacteriological Analyses of Water Used for Drinking and Swimming Purposes in Abeokuta, Nigeria,African Journal of Biomedical Research, 11(3) ; 285-290.
24. Sojobi, A. O. (2016). Evaluation of groundwater quality in a rural community in North Central of Nigeria. Environmental monitoring and assessment, 188(3), 1-17.
25. Shyamala, R., Shanthi, M., & Lalitha., P. (2008). Physicochemical analysis of borewell water samples of Telungupalayam area in Coimbatore District, Tamil Nadu, India. E-Journal of Chemistry, 5(4), 924–929.
26. Singh,S.K., Kanth,M.K.,Kumar,D.,RaJ, R.,Kashyap.A.,Jha,.PK.,Anand,A,.Kumari,P.,Kumari, S.,Ali .Yusuf.,Lokesh R.S,&Kumar Shivam.(2017). Physicochemical and Bacteriological Analysis of Drinking Water Samples from Urban Area of Patna District, Bihar, India. Int. J. Life. Sci. Scienti. Res., 3(5): 1355-1359. DOI: 10.21276/ijlssr.2017.3.5.15
27. Ocheli, A., Otuya, O. B and Umayah, S. T. (2020).Appraising the risk level of physicochemical and bacteriological twin contaminants of water resources in part of the western Niger Delta region. Environ Monit Assess 192: 324. https://doi.org/10.1007/s10661-020-08302-5
28. Osayande, A. O., Emofurieta, W. O., Obayabona, O. N. and Anegbe, B. (2015). Physicochemical and bacteriological quality assessment of hand-dug well waters in Igarra tour Edo State. Nigerian Journal of Applied Science, 33, 1–13.
29. Ovonramwen, O. B. (2020). Physicochemical Analysis of Surface and Ground Water in Ugbomro and Iteregbi, Delta State, Nigeria. Journal of Applied Sciences and Environmental Management, 24(3), 511-517.