EUROPEAN ACADEMIC RESEARCH
Vol. II, Issue 3/ June 2014

ISSN 2286-4822
www.euacademic.org

Impact Factor: 3.1 (UIF)
DRJI Value: 5.9 (B+)

Assessment of Physico-Chemical & Microbiological Quality of Angoori Barrage Water Bodies at Datia with Special Reference to Human Health

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Abstract:

Water plays a pivotal role in human life. Physico - chemical & bacteriological parameters affects human to a greater extent of coming various water borne diseases. Water samples in various seasons & three years were collected from Angoori barrage Datia during 2009-11 were analyzed for Physico-chemical & Microbiological parameters. The physical (Colour, pH, Temperature, Conductivity, Turbidity, TDS, Alkalinity, &Total Hardness) and chemical parameters (DO, BOD and COD) of the samples were studied for pre monsoon & post monsoon season. The colour of Angoori Barrage water samples was found transparent green in pre monsoon and post monsoon was observed turbid. pH, Temperature, TDS, Alkalinity, Conductivity, Total

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Hardness, BOD & COD were found higher during pre monsoon while Turbidity & DO was found higher in post monsoon. MPN value of water increases during post monsoon. Maximum value of total coliform, faecal coli form and faecal streptococcal coli form was observed during Post monsson. Maximum value of TPC was observed 42×10^4 *cfu/ml during post monsoon. IMViC test differentiate the member of Enterobacteriaceae family. This research work indicates that the water is highly contaminated and not found suitable for drinking purposes.*

Key words: Do, BOD, COD, Coli forms, MPN, & TPC

Introduction:

Water is extremely essential for survival of all living organisms and is one of the most important compounds of the ecosystem. Better quality of water described by its physical, chemical and biological characteristics. These characteristics signify the quality of water to be utilized by the people for the drinking, irrigation and also for industrial purposes.

Good quality of water is the key to increase human productivity and long life (Urbansky and Magnuson, 2002). The good quality drinking water is often regarded as an important means of improve health. According to World Health Organization (WHO, 2002), there are billion cases of diarrhea and 2.2 million deaths annually due to the consumption of unsafe water has been identified. Deterioration of water quality is due to increasing human population and urbanization. As water pollution is getting serious, houses especially in the urban area started to equip with a water filter system. As water physically looks colorless, odorless and even tasteless it is very difficult to say about its quality, therefore, its quality measurement is very much required to determine safe water for consumption. The drinking water should be examined for its microbiological and physicochemical quality.

Limnology is the comprehensive study of fresh water bodies. Water has two dimensions that are closely linked-quantity and quality. The urban pond is influenced by several extrinsic factors which may alter the structural and functional components of such ecosystem (Parikh and Mankodi, 2012). Water is one of the most essential needs for the continued existence of all living organisms on earth. It is effectively and efficiently put into use by plants, animals, microorganisms and man (Sohani and Iqbal, 2012). The modern civilization, industrialization, urbanization and increased population have led to fast pollution in our environment. Water, food and fresh air are the basic necessities for the survival of all living beings and no life can exist without water (Shivaraju, 2012).

Material & Methods:

Collection of water sample: Water samples were collected in sterilized polypropyleine bottles from Angoori Barrage (Datia) for pre monsoon and post monsoon were collected from three successive years viz., 2009, 2010 and 2011.

All the collected water samples were immediately examined and the physico-chemical & Microbiological properties of samples were recorded. Following methods were adopted for the various tests to examine the physico-chemical & microbiological properties of drinking water as described by (BIS, 1984), (APHA, 1995), and Cappucino Sherman, (2007). The chemicals and media used for this study were from Hi Media, Qualigen and Merck and the glasswares from Borosil.

Results & Discussions:

Water samples (05 samples for each season & year) collected from Angoori barrage Datia for pre monsoon & post monsoon during 2009-11 were analyzed for Physico-Chemical &

Microbiological parameters. The results & Discussions are as follows:

Physico-chemical study of water:

Colour

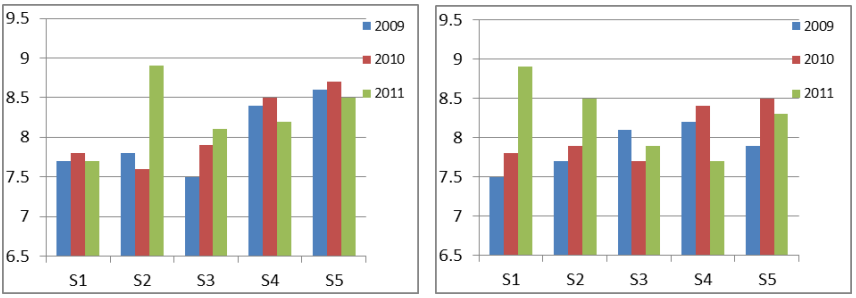
The results of colour of the water samples are shown in (Table: 1). The Angoori Barrage water colour was investigated and found transparent green in pre monsoon and in post monsoon it was turbid. The green colour shows the planktonic production in water bodies. Water acquires greenish colour because of the excess growth of microcystes algae (Bhalla *et al.,* 2006). Colour in water may be due to the inorganic ions, such as iron and manganese, humus and peat materials, plankton, weeds and industrial wastes. The water colour was turbid due to soil particles introduced in to the lake water along the runoff water during rainy season. Similar seasonal variations were also observed by Garg *et al.,* (2010).

pH

The mean pH value of water in Angoori Barrage was observed 8 (±0.47), 8.1(±0.47) & 8.28 (±0.44) in year 2009, 10 & 11 respectively in pre monsoon and post monsoon 7.88 (±0.28), 8.06 (±0.36) & 8.26 (±0.47) were observed (Table: 1 & Fig. 1). It was observed that pH of water increases during pre monsoon and decreases during post monsoon. Increase in pH during summer may be due to increased photosynthesis of the algal blooms resulting into the precipitation of carbonates of calcium and magnesium from bicarbonates causing higher alkalinity (Agrawal & Rajwar, 2010). The decrease in pH during post monsoon may be due to decrease in photosynthesis, while during monsoon it may be due to greater inflow of water.

Higher pH value is normally associated with the high photosynthetic activity in water (Hujare, 2008). The largest variety of aquatic animals prefers a range of 6.5-8.0. When pH

is outside this range, diversity within the water body may decrease due to physiological stresses and reproduction (Raveen and Daniel, 2010).

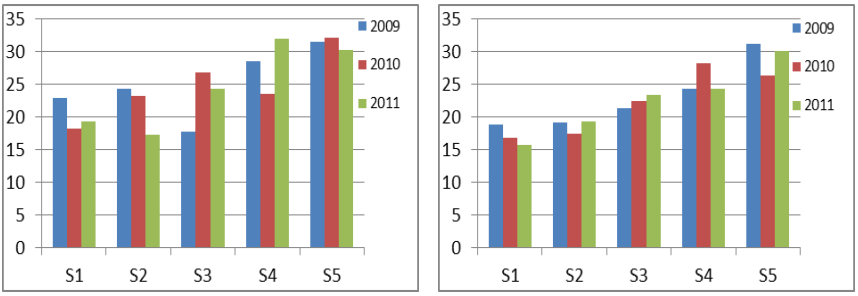


(A) **(B)**

Fig.1: pH of water for pre & post monsoon at Angoori Barrage (During 2009-11).

Temperature

25.02 (±5.26) ^{0}C was the mean temperature value obtained in water of Angoori Barrage in year 2009, 24.75 (±5.12) in year 2010 & 24.64 (±6.44) in year 2011 in pre monsoon and post monsoon 22.98 (±5.07), 22.24 (±5.15) & 22.58 (±5.40) were observed (Table: 1 & Fig. 2). High summer temperature and bright sunshine accelerate the process of decay of organic matter resulting in the liberation of large quantities of CO_2 and nutrients (Agrawal & Rajwar, 2010). The variation in the water temperature may be due to different timing of collection and influence of season (Jayaraman *et al.,* 2003).

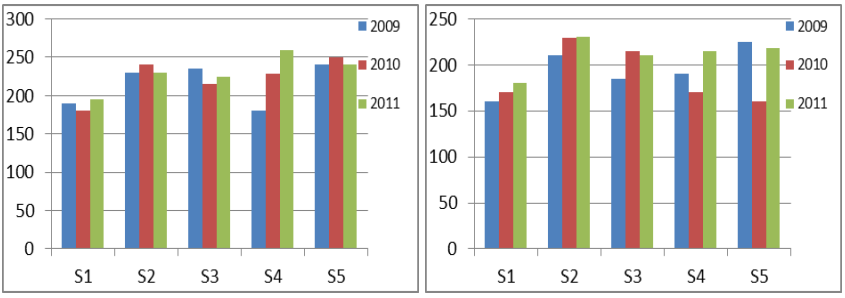


(A) **(B)**

Fig.2: Temperature of water for pre & post monsoon at Angoori Barrage (During 2009-11).

Conductivity

The mean conductivity value of water in Angoori Barrage was observed 215 (±27.83), 222.6 (±27.18) & 230 (±23.71) in year 2009, 10 & 11 respectively, in pre monsoon and whereas in post monsoon 194 (±24.84), 189 (±31.30) & 210.8 (±18.88) were observed (Table: 1 & Fig. 3). In favor of the results of present study, the relative high conductivity recorded during another study showed that it may be attributed to the predominance of non leached substratum and the large size of the catchments area (Kadiri, 2000). A high level of conductivity reflects the pollution status as well as tropic levels of the aquatic body (Ahluwalia, 1999). Conductivity of water depends upon the concentration of ions and its nutrient status and variation in dissolve solid content.



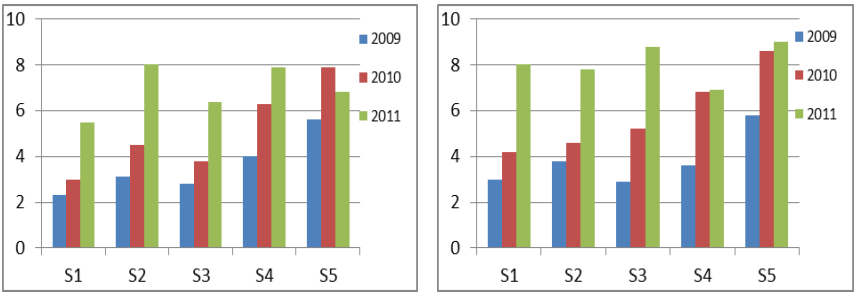
(A) **(B)**

Fig.3: Conductivity of water for pre & post monsoon at Angoori Barrage (During 2009-11).

Turbidity

The mean Turbidity value of water in Angoori Barrage was observed 3.56 (±1.29), 5.1 (±1.98) & 6.91 (±1.05) in year 2009.10 & 11 respectively in pre monsoon and during post monsoon 3.82 (±1.71), 5.88 (±1.81) & 8.1 (±0.84) were observed (Table: 1 & Fig. 4).

The increased turbidity during post monsoon was attributed due to soil erosion in the nearby catchment and massive contribution of suspended solids from sewage. Surface runoffs and domestic wastes mainly contribute to the increase in turbidity of the reservoir (Agrawal & Rajwar, 2010).



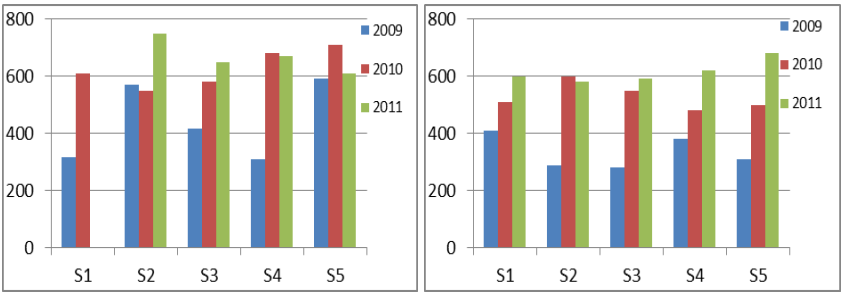
(A) **(B)**

Fig.4: Turbidity of water for pre & post monsoon at Angoori Barrage (During 2009-11).

Total Dissolved Solids (TDS)

The mean TDS value of water in Angoori Barrage was observed 279 (±9.61), 325(±36.74) & 310 (±23.18) in year 2009, 10 & 11 respectively in pre monsoon and post monsoon were observed 240 (±7.90), 265 (±25) & 263 (±11.51) (Table: 1 & Fig. 5).

Due to contamination of domestic waste water, garbage, fertilizer, etc in the natural surface body the values of TDS was reported to be high. Indeed, high concentration of TDS enriches the nutrient status of water body which were resulted into eutrophication aquatic ecosystem. The cattle pollution and human interference also contribute to the enrichment of dissolved solids (Ram *et al.,* 2007). Total dissolved solids denote mainly the various kinds of minerals present in the water.

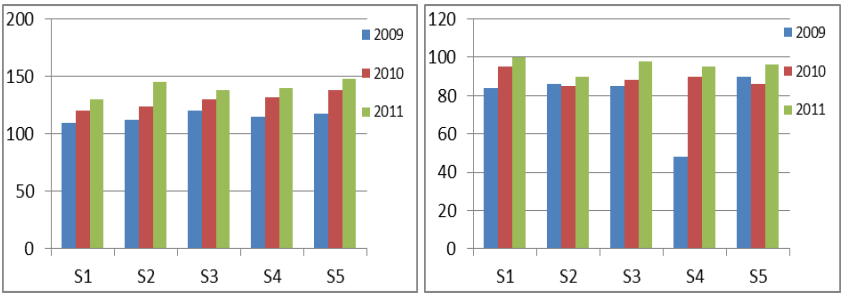


(A) **(B)**

Fig.5: TDS of water for Pre & Post Monsoon at Angoori Barrage (During 2009-11).

Alkalinity

The mean Alkalinity value of water in Angoori Barrage was observed 115 (±4.12), 128.8 (±7.01) & 140.2 (±6.94) in year 2009, 10 & 11 respectively in pre monsoon and post monsoon 78.6 (±17.25), 88.8 (±3.96) & 95.8 (±3.96) were observed (Table: 1 & Fig. 6). During pre monsoon the water level in many number of lake decreases resulting in the death and decay of plants and living organism. Highly alkaline waters are usually unpalatable. Excess alkalinity in water is harmful for irrigation which leads to soil damage and reduce crop yields. The alkalinity varies in accordance with the fluctuation in the pollution load (Parashar *et al.*, 2006). Katariya *et al.,* (1996) measured maximum value of alkalinity due to confluence of industrial and domestic waste.



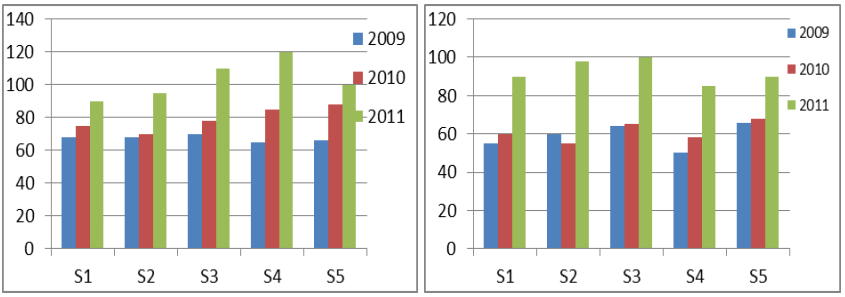
(A) **(B)**

Fig.6: Alkalinity of water for pre & postmonsoon at Angoori Barrage (During 2009-11)

Total Hardness

The mean Hardness value of water in Angoori Barrage was observed 67.4 (±1.94), 79.2 (±7.32) & 103 (±12.04) in year 2009, 10 & 11 respectively in pre monsoon and during post monsoon 59 (±6.55), 61.2 (±5.26) & 92.6 (±6.22) were observed (Table: 1 & Fig. 7).

The high value of hardness during pre monsoon may be due to evaporation of water and addition of calcium and magnesium salts by mean of plants and living organism.



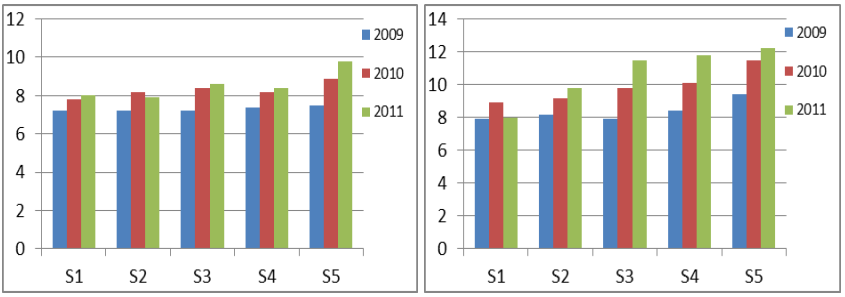
(A) **(B)**

Fig.7: Hardness of water for pre & post monsoon at Angoori Barrage (During 2009-11).

Dissolved Oxygen (DO)

The mean value of DO of water for Angoori Barrage was observed 7.3 (±0.14), 8.3(±0.4) & 8.54 (±0.76) for three consecutive years 2009 - 11 respectively in pre monsoon and post monsoon 8.36 (±0.61), 9.9 (±1.01) & 10.66 (±1.74) were observed (Table: 1 & Fig. 8). Seasonal variation of the DO content was maximum observed during post monsoon may be due to the cumulative effect of higher wind velocity joined with heavy rainfall and the resultant freshwater mixing and the minimum during pre monsoon due to higher rate of decomposition of organic matter and limited flow of water in low oxygen holding environment due to high temperature.

DO level between 5.0 and 8.0 mg/l are satisfactory for survival and growth of flora and fauna in an aquatic ecosystem (Das, 2000, Khatavkar *et al*., 2004, Veeresha and Hosmani, 2006, Raveen and Daniel, 2010). When BOD level is high, DO level decrease because the oxygen available in the water is being consumed by the bacteria (Sawyer *et al*., 2003 and Rahman *et al.,* 2012).

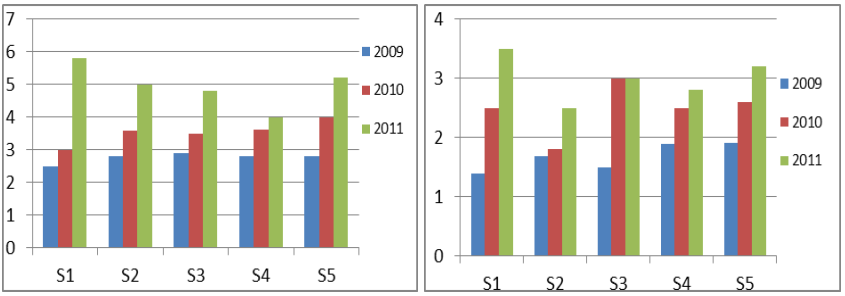


(A) **(B)**

Fig.8: DO of water for pre & post monsoon at Angoori Barrage (During 2009-11).

Biological Oxygen Demand (BOD)

The mean value of BOD of water for Angoori Barrage was observed 2.76 (±0.15), 3.53(±0.35) & 4.96 (±0.65) for years 2009, 10 & 11 respectively in pre monsoon and post monsoon 1.67 (±0.22), 2.48 (±0.43) & 3 (±0.38) were observed (Table: 1 & Fig. 9). High BOD in pre monsoon might be due to high rate of organic decomposition and the entry of agricultural runoff and high concentration of dissolved and suspended solids in water. Similar variations in BOD during pre & post monsoon season observed by Garg *et al.*, (2010), Devaraju *et al.,* (2005), Bhatt *et al.,* (1999) and Jameel, (1998).



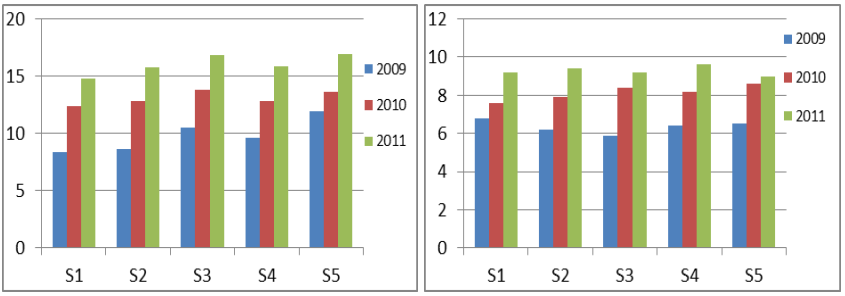
(A) **(B)**

Fig.9: BOD of water for pre & post monsoon at Angoori Barrage (During 2009-11).

Chemical Oxygen Demand (COD)

The mean COD value of water in Angoori Barrage was observed 9.8 (±1.44), 13.08 (±0.59) & 16.04 (±0.85) for three consecutive years (2009 – 2011) in pre monsoon and post monsoon 6.36 (±0.33), 8.14 (±0.39) & 9.28 (±0.22) were observed (Table: 1 & Fig. 10).Higher concentration of COD in pre monsoon season may be due to high temperature and higher concentration of suspended and dissolved solids. The COD of water increases with increasing concentration of organic matter (Boyd, 1981). The highest COD during summer may be due to use of high amount of worship materials and throwing coins to water. The range of values of COD was found 5.9 - 39.4 mg/l (Agrawal and Rajwar, 2010).

In present study, the COD of water was observed below the permissible limit of drinking water in pre monsoon and in post monsoon during 2009-11. Similar seasonal variations were also observed by Garg *et al.*, (2010) and Shaikh and Mandre, (2009) have also observed COD value similar to the present study.



(A) **(B)**

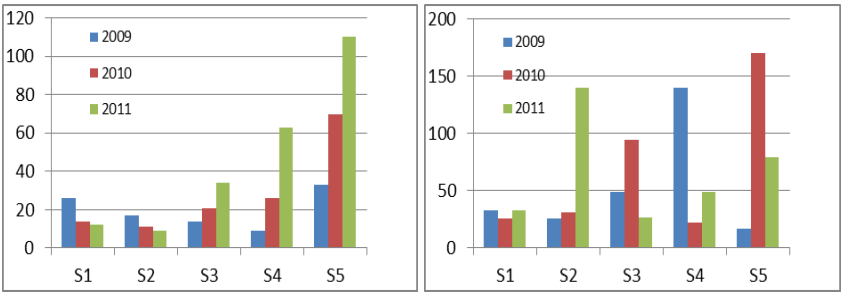
Fig.10: COD of water for pre & post monsoon at Angoori Barrage (During 2009-11).

Microbiological analysis of water:

Qualitative estimation of bacterial population

Bacterial flora of the water samples was evaluated by MPN method.

The mean MPN value of water in Angoori Barrage was observed to be 19.8 (±9.26) in the years 2009, 28.4 (±23.98) in the years 2010 & 45.6 (±41.99) in the years 2011, in pre monsoon and in post monsoon was observed to be 53 (±50.02) in the years 2009, 68.6 (±63.88) in the years 2010 & 65.6 (±46.21) in the years 2011 (Table: 1 & Fig. 11 & 12).The Most Probable Number of coli form is more during the post monsoon season followed by pre monsoon season. The reason is that during post monsoon the flow of water and the mixing up of the domestic sewage with aquatic water body is more and also there is more mixing up of sediment which is rich in nutrients. In present study, the MPN value of water was observed beyond the permissible limit of drinking water in pre monsoon and in post monsoon during 2009-11. Similar high value of MPN value were also observed by Sapkota *et al.,* (2012), Shivayogimath *et al*., (2012) and Mishra and Bhatt, (2008)



(A) **(B)**

Fig.11: MPN of water for pre & post monsoon at Angoori Barrage (During 2009-11).

Fig.12: MPN Test result Angoori Barrage water sample

Evaluation of TC, FC & FSC

The Membrane filter method was used to analyze Coli forms in water samples collected from Angoori Barrage water bodies. In pre monsoon the Total coliform (TC), faecal coliform (FC) and faecal streptococcal coliform (FSC) of Angoori Barrage water ranged between 12×10^4, 1.0×10^4 and 2.4×10^4 - 110×10^4, 92×10^4 and 72×10^4 cfu/100ml during 2009 - 2011 and in post monsoon it ranged between 33×10^4, 2.3×10^4 and 12×10^3 - 22×10^5, 9×10^5 and 8×10^5 cfu/100ml. Minimum value of total coliform, faecal coliform and faecal streptococcal coliform was observed to be

12×10^4, 1.0×10^4 and 2.4×10^4 cfu/100ml and maximum value of total coliform, faecal coliform and faecal streptococcal coliform was observed 22×10^5, 9×10^5 and 8×10^5 cfu/100ml (Table: 1).

Higher bacterial population during post monsoon due to increased land run off and higher faecal inputs in to water bodies from various sources, an increase in the faecal coliform level after rainfall. The reasons for the high number of total coliforms were due to the discharge of human and animal faeces into the water bodies. *Escherichia coli* and *Klebsiella pneumoneae* are included in the faecal coliforms. The faecal streptococci group comprises of *Streptococcus faecalis, S. bovis, S. equinus* and *S. avium,* since they commonly inhabit the intestinal tract of human and warm blooded animals. Similar seasonal variations were also observed by Bhattaraj *et al.*, (2008), Shehane *et al.,* (2005) and Rajkumar *et al.*, (2003).

Total Bacterial Count

The Total Plate Count of Angoori Barrage water ranged between 2.8×10^4-23.0×10^4 cfu/ml in pre monsoon and in post monsoon it ranged between 1.5×10^4 - 42×10^4 cfu/ml during 2009-2011. Minimum value of TPC was observed 1.5×10^4cfu/ml and maximum value of TPC was observed 42×10^4 cfu/ml (Table: 1 & fig. 13). In post monsoon season the bacterial count was high due to mixing of domestic sewage and surface run off water in water bodies. The total plate count indicates the presence of high organic and dissolved salts in the water. Bhargava *et al.*, (2009), Shittu *et al.*, (2008), Surve *et al.*, (2006), Sundari *et al.*, (2004), and Begum *et al.*, (2004), revealed higher total plate count in the water samples included in their study.

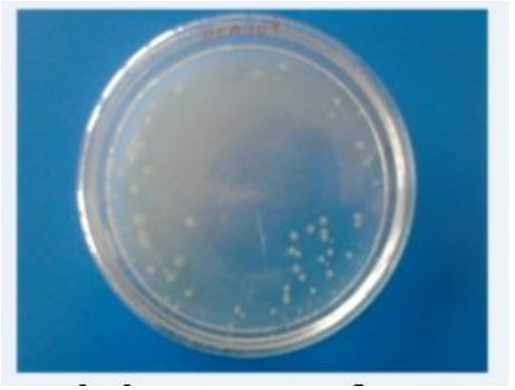


Fig. 13: Total plate count of Angoori Barrage water

Biochemical analysis

Occurrence and seasonal variation of bacteria in water samples were detected on the basis of biochemical analysis. Five types of bacteria were isolated and identified from the various water samples collected from water sources included in the study. These bacterial isolates are mainly gram negative bacteria namely, *E. coli, E. aerogenes, Pseudomonas species* and *Salmonella species* and *Streptococcus species* is only gram positive bacteria reported in our study. 75% of gram negative and 25% gram positive bacteria were isolated from all samples. (fig. 14,15 & 16)

Fig.14: *E. Coli* on Mac Conkey Agar

Fig.15: Salmonella colony on brilliant agar

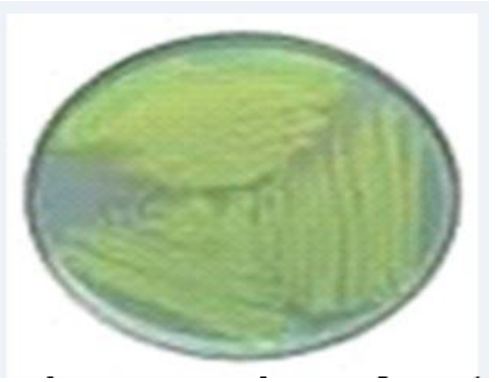


Fig. 16: Pseudomonas colony of cetrimide agar

In pre monsoon, 33.3% *E. coli*, 26.64% *E. aerogenes*, 19.98% *Streptococcus species,* 13.32% *Salmonella species* and 6.66% *Pseudomonas species* were isolated and identified in Angoori Barrage water samples. Whereas, in post monsoon, 39.96% *E.coli*, 53.28% *E.aerogenes,* 19.98% *Streptococcus species* and 6.66% *Salmonella species* were identified.The presence of *E. coli* is used by public health officials as an indicator of fecal contamination of food and water supplies. While *Enterobacter* and *Klebsiella* resemble *E.coli* in being lactose fermenters, their presence does not necessarily indicate fecal contamination because they are wide spread in soil and grass. The high

number of *Enterobacter aerogenes*, *E. coli* and *Pseudomonas species* were found in all water samples. Other bacteria isolated from water samples such as *Streptococcus species* and *Salmonella species*. *Streptococcus species* is only gram positive bacteria reported in our study. *Enterobacter aerogenes* isolated from the water samples are examples of non fecal coli forms and can be found in vegetation and soil which serves as sources by which the pathogens enter the water (Schlegel, 2002)

Conclusions:

At the end, this study concluded that physico-chemical parameters and bacterial profile have variation in pre and post monsoon period. Seasonal changes observed in various microbial groups in sampling sites could be related to the influence of the physico-chemical properties of water. But human activities could also affect the microbial growth in pre and post monsoon season. This work may help us to estimate the suitability of water of the studied area mainly for drinking & irrigation purpose. This study has found a treatment path for water pollutants and also adding a new and remarkable chapter to the knowledge of science and its role for the welfare of the mankind and society.

Acknowledgement

The authors are grateful to the Dr. B.R. Shrivastav, Director, CHRI Gwalior, MP, India for providing the laboratory facility to conduct this work.

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Annex

Table: 1. Mean & SD Value of Physico – Chemical & Microbiological parameters of Angoori Barrage water sample during 2009-2011

Parameters	Sample	2009		2010		2011	
		Pre-Monsoon	Post-Monsoon	Pre-Monsoon	Post-Monsoon	Pre-Monsoon	Post-Monsoon
Colour	S1- S5	Transparent green	Turbid	Transparent green	Turbid	Transparent green	Turbid
pH (mg/l)	S1- S5	8 (±0.47)	7.88 (±0.28)	8.1 (±0.47)	8.06 (±0.36)	8.28 (±0.44)	8.26 (±0.47)
Temperature (^{0}C)	S1- S5	25.02 (±5.26)	22.98 (±5.07),	24.75 (±5.12)	22.24 (±5.15)	24.64 (±6.44)	22.58 (±5.40)
Conductivity (mho/cm)	S1- S5	215 (±27.83)	194 (±24.84)	222.6 (±27.18)	189 (±31.30)	230 (±23.71)	210.8 (±18.88)
Turbidity (NTU/ml)	S1- S5	3.56 (±1.29)	3.82 (±1.71)	5.1 (±1.98)	5.88 (±1.81)	6.91 (±1.05)	8.1 (±0.84)
TDS (mg/l)	S1- S5	279 (±9.61)	240 (±7.90)	325(±36.74)	265 (±25)	310 (±23.18)	263 (±11.51)
Alkalinity (mg/l)	S1- S5	115 (±4.12)	78.6 (±17.25)	128.8 (±7.01)	88.8 (±3.96)	140.2 (±6.94)	95.8 (±3.96)
Total Hardness (mg/l)	S1- S5	67.4 (±1.94)	59 (±6.55)	79.2 (±7.32)	61.2 (±5.26)	103 (±12.04)	92.6 (±6.22)
DO (mg/l)	S1- S5	7.3 (±0.14)	8.36 (±0.61)	8.3(±0.4)	9.9 (±1.01)	8.54 (±0.76)	10.66 (±1.74)
BOD (mg/l)	S1- S5	2.76 (±0.15)	1.67 (±0.22)	3.53(±0.35)	2.48 (±0.43)	4.96 (±0.65)	3 (±0.38)

COD (mg/l)	S1- S5	9.8 (±1.44)	6.36 (±0.33)	13.08 (±0.59)	8.14 (±0.39)	16.04 (±0.85)	9.28 (±0.22)
MPN (CFU/100ml)	S1- S5	19.8 (±9.26)	53 (±50.02)	28.4 (±23.98)	68.6 (±63.88)	45.6 (±41.99	65.6 (±46.21)

Data are presented in Mean ± SD, (n=5)