Eco. Env. & Cons. 28 (October Suppl. Issue) : 2022; pp. (S361-S366)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i06s.061

Study on the impact of industrial pollutants on the quality of surface water of Agyara Dam, Alwar (Rajasthan)

Archana Kumari and Akhalesh Kumar*

Department of Chemistry, Government Raj Rishi Autonomous College, Alwar 301 001, Rajasthan, India

(Received 25 February, 2022; Accepted 12 April, 2022)

ABSTRACT

In this research work, the author has studied the quality parameters and the effect of industrial pollutants on the quality of surface water of Agyara Dam, Alwar (Rajasthan). Agyara Dam is a surface water reservoir situated near the Agyara village of Ramgarh tehsil (Alwar) and it is surrounded by number of industrial units including Matsya Industrial Area (MIA). The water of Agyara Dam has greatly been affected and polluted by the industrial solid waste and liquid effluents. The surface water specimens were bottled throughout the period of October-December, 2021 and analyzed by the numerous quality parameters following the standard operating procedures (SOPs). The mean of the quality parameters has showed the considerable variations and indicated that the surface water of Agyara Dam has been polluted due to the industrial activities near it. The water of Agyara Dam was found to be unsafe for human drinking and domestic purposes as most of the quality parameters do not imitate with the standards of Bureau of Indian Standards (BIS).

Key words: *Agyara Dam (Alwar), Industrial Pollutants, Water pollution, Surface water, Water quality parameters.*

Introduction

Potable water is the most essential element for the nourishment of human beings and on the earth surface, it is generally accomplished by the numerous resources, i.e., surface water, groundwater, and glaciers (Anslyn and Dougherty, 2006; De, 2000; Kershaw and Cundy, 2000). The groundwater is existing below the earth surface while remains are available on the earth surface. Surface water is the most significant and easily available resource among the other potable water resources (Kumar *et al.*, 2005; Kundzewicz *et al.*, 2007). It is partially originated through the rain that has been run-off over the earth surface to the main receiving surface water bodies such as ponds, lakes, rivers, dams, etc. (Kundzewicz *et al.*, 2007). The potability of surface water has greatly been affected and contaminated by the untreated domestic and industrial disposals (Bougherira *et al.*, 2014). Indiscriminate disposal of domestic and industrial solid waste and liquid effluents can directly enter into the run-off water and causes surface water pollution which than broadly affect the aquatic and surrounding natural ecosystems.

Alwar is a north-east district of Rajasthan and has many developing economic industrial zones throughout the district. Numerous literature reports have been carried out on the impact of untreated domestic and industrial disposals on the quality of

surface water. Hussain and Rao has reported the effect of industrial run-offs on surface water of Patancheru (Andhra Pradesh) and found significantly reduced quality of surface water (Hussain and Rao, 2013). The surface water of Jojari River of Jodhpur (Rajasthan) has been polluted due to direct disposal of industrial waste and effluent in the catchment area of the river and affect the surrounding ecosystems broadly (Meena and Meghwal, 2019). Therefore, the surface water resources near industrial areas are greatly affected due to industrial and domestic activities and the water is not safe for human consumptions and domestic purposes as well. The surface water of Agyara Dam is not so far reported and therefore, it is required to evaluate the quality parameters and the impacts of industrial activities near Agyara Dam (Alwar).

In this research work, the researcher has reported the physicochemical and biochemical parameters of surface water of Agyara Damand inventing the impact of industrial pollutants on the quality of surface water. For the quality assessment, about 50 surface water specimens were bottled from the Agyara Dam throughout the period of October-December, 2021. The surface water specimens were estimated by the various physicochemical and biochemical parameters following the SOPs of American Public Health Association (APHA, 1989). The study revealed that the surface water of Agyara Dam has been found to be polluted with toxic industrial constituents which are discharged directly into the flowing rain water course without any prior treatment. Thus, the surface water of Agyara Dam was found unsafe for human drinking and domestic purposes as most of the quality parameters do not imitate with the standards of BIS (BIS, 2012).

Materials and Methods

Description of Agyara Dam (Alwar): This research was focused on the quality analysis of surface water ofAgyara Dam, Alwar, Rajasthan (Fig. 1). Agyara Dam is a surface water reservoir situated near Agyara village of Ramgarh tehsil of Alwar (Rajasthan). Agyara Dam is geographically coordinated between 27.517° North latitude and 76.744° East longitude. The water of Agyara Dam spread over the 20 hectares area and has the depth of about 10 to 12 feet. There are numbers of industrial units including Matsya Industrial Area (MIA) situated near the Agyara Dam and therefore, the surface water of Agyara Dam became polluted due to disposal of untreated industrial pollutants in the canals of the Agyara Dam.

Description of the surface water sampling: Surface water samples were bottled from various locations ofAgyara Dam, Alwar (Rajasthan) throughout the period of October-December, 2021 by applying the previously stated standard sampling procedures. In this study, the surface water specimens were carefully sampled from various locations of Agyara Dam with different time periods. The locations were selected carefully, and it must be characteristic of whole dam water. All the surface water specimens were preserved in fresh screw capped polyethylene bottles of 2L capacity. The surface water samples were then stored in the refrigerator for further analysis in the research laboratory. The surface wa-

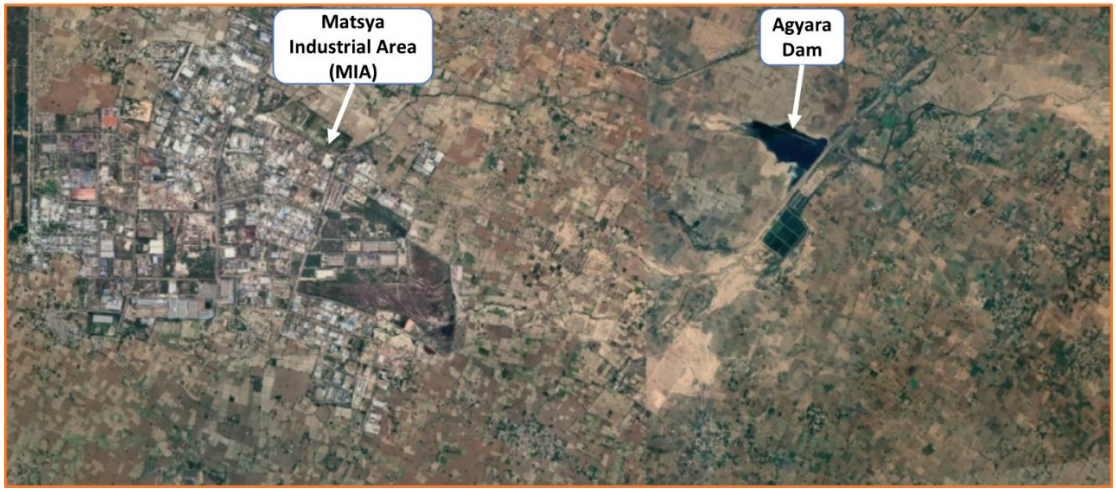

Fig. 1. Satellite view of surroundings of Agyara Dam, Alwar (Rajasthan) with highlighted industrial areas.

ter samples were then characterized in research laboratory to obtain the experimental data and discuss the impact of industrial pollutants on the quality of surface water of Agyara Dam. See Fig. 1 for the satellite view of the Agyara Dam from where the surface water specimens were bottled for further analysis.

Physico-chemical and biochemical characterization of surface water: The surface water specimens were bottled by applying the previously stated procedures and were then estimated for various physicochemical and biochemical parameters. The characterization was performed in research laboratory to determine the degree of contamination in comparison to BIS standards (BIS, 2012). Both physicochemical and biochemical parameters are important to sustain the quality and potability of water. The bottled surface water specimens were preliminarily analyzed for pH, electrical conductivity (EC) and total dissolve solid (TDS) at the time of bottling using a pH meter and a portable Water Quality Analyzer kit. For the remaining analysis, the surface water specimens were brought to the research laboratory and analyzed for numerous parameters such as fluoride (F^-), chloride (Cl^-), nitrate (NO_3^-), total hardness (TH), phenolic compounds (PC), biochemical oxygen demand (BOD), chemical oxygen demand (COD), iron (Fe) and othertoxic industrial contaminants. F^- and Cl^- were analyzed by Ion selective method, NO_3^- were analyzed by spectrophotometric method, and toxic heavy metal elements were analyzed by ICP-AES method. All parameters were analyzed as per the SOPs of APHA (APHA, 1989). The mean of characteristic data of the surface water specimens given in the Table 1. The experiential results of surface water specimens were also compared with the BIS standards (BIS, 2012).

Results and Discussion

Agyara Dam (Alwar, Rajasthan) is an artificial surface water reservoir situated near Agyara village of Ramgarh tehsil of Alwar (Rajasthan) and it is also known as Hans Sarowar Dam. Agyara Dam is the only surface water reservoir in this area. It is geographically coordinated between 27.517° North latitude and 76.744° East longitude. The water of Agyara Dam spreads over 20 hectares area and has the depth of about 10 to 12 feet. It is about 15 km from the Alwar city situated at the Alwar-Bharatpur road. Agyara Dam is surrounded by number of industrial units including MIA. MIA is a growing industrial area and generally roofed with a large number of industrial units such as vegetable oils, chemicals, detergents, pharmaceuticals, engineering, electronics, food processing, construction materials, etc. (Meena *et al.*, 2018). Owing to the industrial units, the surface water of Agyara Dam is broadly polluted due to the discharge of industrial toxic waste and effluents directly into the flowing rain water course without any prior treatment. The industrial pollution is the major problem for the local populates and surrounding agricultural activities. Therefore, it is necessary to assess the quality of surface water of Agyara Dam with special reference to the impact of industrial pollutants on the quality of surface water of Agyara Dam.

For the quality assessment of surface water of Agyara Dam (Alwar), about five surface water specimens were bottled each time from five different locations of Agyara Dam after every 10 days of time span throughout the period of October-December, 2021. During this time period, we gathered about 50 surface water specimens from the Agyara Dam. The surface water specimens were primarily analyzed for pH, EC and TDS, and later analyzed in the research laboratory for the F^-, Cl^-, NO_3^-, TH, BOD, COD, Fe and other toxic heavy metal elements using SOPs of APHA (1989). The mean of observed parameters of surface water specimens of Agyara Dam are demonstrated in Table 1. All the quality parameters were compared with the standards of BIS (2012).

Quality parameters of surface water of Agyara Dam (Alwar)

pH **:** The pH of surface water of Agyara Dam (Alwar) varied in the range of pH 6.85 to pH 7.56 (Table 1) with a mean of pH 7.14. The mean of surface water of Agyara Dam is slightly alkalinein nature and the pH values of all surface water specimens of Agyara Dam throughout the sampling period are in the range of acceptable limit as prescribed by BIS (BIS, 2012).

EC **:** The EC of surface water of Agyara Dam (Alwar) varied in the range of 1106µS/cm to 1669µS/cm (Table 1) with a mean of 1406.25 µS/cm. The higher EC of surface water of Agyara Damis because of higher concentration of dissolved ionic salts and industrial and domestic pollutants in surface water.

TDS **:** The TDS of surface water of Agyara Dam

(Alwar) varied in the range of 487 mg/l to 815 mg/l (Table 1) with a mean of 588.32 mg/l. The TDS of 42% surface water specimens of Agyara Dam throughout the sampling periodand their mean exceeds the maximum acceptable limit as prescribed by the BIS (2012). Therefore, the surface water of Agyara Dam found to have higher concentration of dissolved inorganic componentsand industrial pollutants and owing to this, the surface water of Agyara Dam is not safe for human drinking.

Fluoride (F^-) : F^- in surface water of Agyara Dam varied in the range of 0.12 mg/l to 0.76 mg/l (Table 1) with a mean of 0.52 mg/l. The values of F^- of all surface water specimens of Agyara Dam throughout the sampling period and their mean are in the range of acceptable limit as prescribed by BIS (2012).

Chloride (Cl^-) : Cl^- in surface water of Agyara Dam varied in the range of 35.10 mg/l to 272.70 mg/l (Table 1) with a mean of 88.39 mg/l. The concentration of Cl^- in 8% surface water specimens of Agyara Dam throughout the sampling period exceeds the maximum acceptable limit as prescribed by the BIS (2012) while the mean of Cl^- doesn't exceed the acceptable limit.

Nitrate (NO_3^-) : NO_3^- in surface water of Agyara Dam varied in the range of 26.49 mg/l to 80.82 mg/l (Table 1) with a mean of 42.47 mg/l. The concentration of NO_3^- in 64%surface waterspecimens of Agyara Dam throughout the sampling period exceeds the maximum acceptable limit as prescribed by the BIS (2012) while the mean of NO_3^-doesn't exceed the acceptable limit. The major sources of nitrate contamination in surface water are the human domestic waste, animal wastes, industrial waste, fertilizers used in agricultural activities, chemicals, etc. (Agrawal *et al.*, 1999).

Total hardness (TH) : TH in surface water of Agyara Dam varied in the range of 56.30 mg/l as $CaCO_3$ to 105.20 mg/l as $CaCO_3$ (Table 1) with a mean of 71.56 mg/l as $CaCO_3$. The hardness in all surface water specimens of Agyara Dam throughout the sampling period and their meanare in the range of acceptable limit as prescribed by the BIS (2012).

Phenolic compounds (PC) : PC in surface water of Agyara Dam varied in the range of 0.06 mg/l as C_6H_5OH to 0.89 mg/l as C_6H_5OH (Table 1) with a mean of 0.357 mg/l as C_6H_5OH. The concentration

Table 1. Quality parameters of surface water of Agyara Dam, Alwar (Rajasthan) bottled and analyzed throughout the period of October-December, 2021 and their comparison with BIS drinking water standards.

Quality Parameters	Observed range	Mean	BIS (IS-10500: 2012)* Maximum Limits		Percent Samples exceeding acceptable limits of standards (%)
			Acceptable Limit	Permissible Limit	
pH	6.85 – 7.56	7.14	6.5-8.5	NR	0%
EC	1106 – 1669	1406.25	-	-	-
TDS	487 – 815	588.32	500	2000	42%
Fluoride (F^-)	0.12 – 0.76	0.52	1.00	1.50	0%
Chloride (Cl^-)	35.10 – 272.70	88.39	250	1000	8%
Nitrate (NO_3^-)	26.49 – 80.20	42.47	45	NR	64%
TH as $CaCO_3$	56.30 – 105.20	71.56	200	600	0%
PC as C_6H_5OH	0.06 – 0.89	0.357	0.001	0.002	100%
COD	18.70 – 149.08	80.56	<20	-	94%
BOD	10.98 –69.66	31.95	<5	-	100%
Iron (Fe)	0.25 – 0.91	0.437	0.30	NR	68%
Arsenic (As)	0.01 – 0.12	0.075	0.01	0.05	84%
Cadmium (Cd)	0.023 – 0.081	0.049	0.003	NR	100%
Chromium (Cr)	0.044 – 0.102	0.067	0.05	NR	94%
Lead (Pb)	0.00 – 0.028	0.013	0.01	NR	54%
Zinc (Zn)	0.85 – 10.40	6.952	5.00	15.00	48%

Note: EC measure in µS/cm; and TDS, F^-, Cl^-, NO_3^-,TH, PC, DO, COD, BOD, Fe, As, Cd, Cr, Pb and Zn measures in mg/l; NR = No Relaxation; EC = Electrical Conductivity; TDS = Total dissolve solids; TH = Total Hardness; PC = Phenolic compounds;COD = Chemical oxygen demand; BOD = Biochemical oxygen demand;and * BIS-2012 (IS 10500: 2012) drinking water standards (BIS, 2012).

of phenolic compounds of all surface water specimens of Agyara Dam throughout the sampling period and their mean exceeds the maximum acceptable limit as prescribed by the BIS (2012). Therefore, the surface water of Agyara Dam found to have higher concentration of dissolved phenolic compounds and owing to this, the surface water is not safe for human consumption.

Chemical oxygen demand (COD) : COD in surface water of Agyara Dam varied in the range of 18.70 mg/l O_2 to 149.08 mg/l O_2 (Table 1) with a mean of 80.56 mg/l O_2. For human drinking water, the satisfactory limit of COD should be <20.0 mg/l O_2 at room temperature and the higher values of COD indicates the presence of large amount of oxidizable organic chemicals. The higher COD indicates the presence of oxidizable organic chemicals in the surface water of Agyara Dam and it isowing to the industrial and domestic pollution near Agyara Dam. About 94% surface water specimens of Agyara Dam indicated to have higher values of COD and therefore, itis not safe for human consumption and also harmful for aquatic ecosystems.

Biochemical oxygen demand (BOD) : BOD in surface water of Agyara Dam varied in the range of 10.98 mg/l O_2 to 69.66 mg/l O_2 (Table 1) with a mean of 31.95 mg/l O_2. For human drinking water, the satisfactory limit of BOD should be < 5.0 mg/l O_2 at room temperature and the higher values of BOD indicates the presence of large number of microorganisms and organic matters in water (Connor, 2016; EPA, 2001). The higher BOD indicates the presence of organic pollutants or microorganisms in surface water of Agyara Dam and it is due to the industrial and domestic pollutions near Agyara Dam. All surface water specimens of Agyara Dam indicated to have higher values of BOD and therefore, it is not safe for human consumption and also harmful for aquatic ecosystems.

Iron (Fe) : Fe in surface water of Agyara Dam varied in the range of 0.25 mg/l to 0.91 mg/l (Table 1) with a mean of 0.437 mg/l. The concentration of Fe of 68% surface water specimens of Agyara Dam throughout the sampling period and their mean exceeds the maximum acceptable limit as prescribed by the BIS (2012).

Arsenic (As) : Asin surface water of Agyara Dam varied in the range of 0.01 mg/l to 0.12 mg/l (Table 1) with a mean of 0.075 mg/l. The concentration of As of 84% surface water specimens of Agyara Dam throughout the sampling period and their mean exceeds the maximum acceptable limit as prescribed by the BIS (2012).

Cadmium (Cd) : Cd in surface water of Agyara Dam varied in the range of 0.023 mg/l to 0.081 mg/l (Table 1) with a mean of 0.049 mg/l. The concentration of Cd of all surface water specimens of Agyara Dam throughout the sampling period and their mean exceeds the maximum acceptable limit as prescribed by the BIS (2012).

Chromium (Cr) : Cr in surface water of Agyara Dam varied in the range of 0.044 mg/l to 0.102 mg/l (Table 1) with a mean of 0.067 mg/l. The concentration of Fe of 94% surface water specimens of Agyara Dam throughout the sampling period and their mean exceeds the maximum acceptable limit as prescribed by the BIS (2012).

Lead (Pb) : Pb in surface water of Agyara Dam varied in the range of 0.00 mg/l to 0.028 mg/l (Table 1) with a mean of 0.013 mg/l. Pb was not detected in 12% surface water specimens of Agyara Dam. The concentration of Pb of 54% surface water specimens of Agyara Dam throughout the sampling period and their mean exceeds the maximum acceptable limit as prescribed by the BIS (2012).

Zinc (Zn) : Zn in surface water of Agyara Dam varied in the range of 0.85 mg/l to 10.40 mg/l (Table 1) with a mean of 6.952 mg/l. The concentration of Zn of 48% surface water specimens of Agyara Dam throughout the sampling period and their mean exceeds the maximum acceptable limit as prescribed by the BIS (2012).

Discussion

The surface water of Agyara Dam (Alwar) was evaluated for numerous water quality parameters. The surface water quality parameters are pH, EC, TDS, TH, PC, Cl^-, F^-, NO_3^-, COD, BOD, Fe, As, Cd, Cr, Pb, and Zn. The average results of the surface water quality parameters of the current study has shown that the averages of the surface water quality parameters such as TDS, PC, COD, BOD, Fe, As, Cd, Cr, Pb, and Zn exceeds the agreeable limits of drinking water standards as prescribed by BIS (2012) while the averages of pH, Cl^-, F^-, NO_3^- and TH doesn't exceeds the agreeable limits. The exceeded amount of TDS, PC, COD, BOD, Fe, As, Cd, Cr, Pb, and Znmay cause several negative impacts on the human beings. Therefore, the surface water of Agyara Dam (Alwar) is unsafe for human drinking

as per the guidelines of BIS owing to the industrial pollution near the Agyara Dam (Alwar).

Conclusion

Agyara Dam is in the core focus for the study of quality parameters of surface water of Agyara Dam and the impact of industrial pollutants on the quality of surface water of Agyara Dam. In this research work, about 50 surface water specimens were bottled from Agyara Dam throughout the period of October-December, 2021 and investigated for the various water quality parameters. The current study determined that most of the quality parameters of surface water of Agyara Damwas not matched with the drinking water standards of BIS (BIS, 2012). The surface water quality parameters such as total dissolve solids (TDS), nitrate (NO_3^-), phenolic compounds, chemical oxygen demand (COD), biochemical oxygen demand (BOD), iron (Fe), arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb) and zinc (Zn) were recorded above the maximum acceptable limits of drinking water standards. The parameters such as pH, fluoride (F^-), chloride (Cl^-) and total hardness (TH) fall under the prescribed limit. Some quality parameters were not detected in few samples. The current study has exposed that the surface water ofAgyara Dam (Alwar) is severally polluted due to the industrial pollutants of Matsya Industrial Area (MIA) and some domestic pollutants and found unsafe for human consumptions.

Acknowledgement

The authors are thankful to Dr. Hukam Singh, Principal, Government R. R. College, Alwar, Rajasthan (India) and Dr. Seema Gulati, HOD, Department of Chemistry, Government R. R. College, Alwar, Rajasthan (India) for providing overall financial support and necessarylaboratory facilities to fulfil the present research work. Authors are extremely grateful to Dr. M.P.S. Chandrawat, Ex-Director, Applied Sciences, Eternal University Baru Sahib, Sirmour, Himachal Pradesh (India) for co-operation and constant suggestions throughout the research work. Authors are also grateful to Dr. O.P. Singh, Dr. R. Yadav and Dr. R.N. Yadav to help in preparation of manuscript and suggestions.

References

Agrawal, G. D., Lunkad, S. K. and Malkhed, T. 1999. Diffuse agricultural nitrate pollution of groundwater in India. *Water Sci. Tech.* 39(3) : 67-75.

Anslyn, E.V. and Dougherty, A.D. 2006. *Modern Physical Organic Chemistry.* University Science Books, USA.

APHA, 1989. Standard methods for the examination of water and waste water (17th Edition). *American Public Health Association (APHA)*, New York, USA.

BIS, 2012. Indian Standard, Drinking Water–Specification (2nd Revision). *Bureau of Indian Standards (BIS)*, IS 10500: 2012.

Bougherira, N., Hani, A., Djabri, L., Toumi, F., Chaffai, H., Haied, N., Nechem, D. and Sedrati, N. 2014. Impact of the urban and industrial waste water on surface and groundwater, in the region of Annaba, (Algeria). *The International Conference on Technologies and Materials for Renewable Energy, Environment and Sustainability, (TMREES14)*, *Energy Procedia*. 50 : 692-701.

Connor, R. 2016. *The United Nations World Water Development Report 2016: Water and Jobs, Chapter 2: The Global Perspective on Water*. Paris: UNESCO. p. 26.

De, A.K. 2000. *Environmental Chemistry.* (4th Edition). New Age International (P) Ltd., New Delhi, India.

EPA, 2001. Parameters of Water Quality: Interpretation and Standards. Environmental Protection Agency (EPA), Ireland.

Hussain, M. and Prasad Rao, T.V.D. 2013. Effect of Industrial Effluents on Surface Water Quality - A Case Study of Patancheru, Andhra Pradesh, India. *Current World Environment.* 8(3) : DOI: 10.12944/CWE.8.3.14.

Kershaw, S. and Cundy, A. 2000. *Oceanography: An Earth Science Perspective*. Stanley Thornes (Publishers) Ltd., United Kingdom.

Kumar, R., Singh, R.D. and Sharma, K.D. 2005. Water resources of India. *Current Science.* 89(5) : 794-811.

Kundzewicz, Z. W., Mata, L. J., Arnell, N., W., Döll, P., Kabat, P., Jiménez, B., Miller, K. A., Oki, T., Sen, Z. and Shiklomanov, I. A. 2007. Freshwater resources and their management. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M. L. Parry, O. F. Canziani, J. P. Palutik of, P. J. van der Linden and C. E. Hanson (Eds.), Cambridge University Press, Cambridge, UK, 173-210.

Meena, A. L. and Meghwal, B. L. 2019. Jojari River Water: Pollution and its impact on the Human Health. *International Journal of Research in Engineering, IT and Social Sciences.* 9(5) : 352-357.

Meena, R. S., Mathur, R. and Chandrawat, M.P.S. 2018. Analysis of water quality of Agyara Dam (Hans Sarowar Dam) at Matsya Industrial Area, Alwar (Rajasthan) in month April 2017. *Indian Journal of Applied Research.* 8(1) : 1-3.