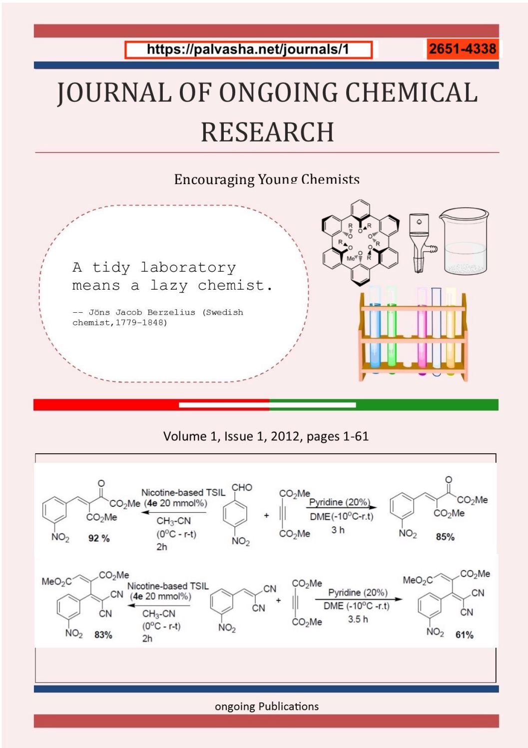
EVALUATION OF DRINKING AND IRRIGATION WATER QUALITY FOR SELECTED PHYSIOCHEMICAL PARAMETERS OF DARRA PEZU AND ITS NEIGHBOURING AREAS OF THE DISTRICT LAKKI MARWAT PAKISTAN



JOURNAL OF ONGOING CHEMICAL RESEARCH

2020
Volume: 5
Issue: 2
Pages: 71-77
Document ID: 2020JOCR49
DOI: 10.5281/zenodo.3996645

J Ong Chem Res, 2020, **5**(2): 71-77, Document ID: 2020JOCR49, doi:10.5281/zenodo.3996645
Research Article

Evaluation of Drinking and Irrigation Water Quality for Selected Physiochemical Parameters of Darra Pezu and Its Neighbouring Areas of the District Lakki Marwat Pakistan

Sayyar Muhammad*, Anwar Saeed Khan, Adnan Jalil, Sidra Bibi, Junaid Ihsan, Saad Anwar, Khushnood Ur Rehman
For affiliations and correspondence, see the last page.

Abstract

For the protection of human health, clean and safe drinking water supply is important. In connection with this, the drinking and irrigation water of village Darra Pezu and its neighboring areas of district Lakki Marwat, Pakistan was evaluated for different physical and chemical constraints including pH, electrical conductivity (EC), alkalinity, turbidity, hardness, total dissolved solids (TDS) and total suspended solids (TSS). The standard analytical procedures were adopted for the study of each of these parameter. The obtained results of each parameter were compared to the standard permissible limits given by the National Drinking Water Quality Standard (NDWQS) as well as World Health Organization (WHO) standards for drinking water and were found to be according to the safe limits prescribed by NDWQS and WHO except well water. The two well water samples of Wanda Sharbat and Wanda Gulmir have high pH, turbidity, EC, hardness, alkalinity, TDS, TSS values than that given by WHO and NDWQS. It is because the well water is open to atmosphere so due to which there is contamination by chemicals pollutants and high growth of algae. Overall, water from all the sources is reported irrigation while well water of the area is not fit for drinking and needs the government attention.

Keywords: Water Quality, Hardness, Turbidity, Alkalinity, Drinking Water Standards, Physiochemical Parameters

INTRODUCTION

Water is of prime importance as life without water is impossible. Water is needed for irrigation, industries, transport, drinking, and many other purposes in everyday life. Our earth contains 70 % water and in our body the percentage of water is 65 % [Kulshreshtha, 1998]. The availability of pure water is an essential element to protect life from diseases and to improve health [SHaRma et al, 2017]. Drinking water of good quality is necessary for life. For any country the fresh water resources are very necessary for increased population rate and other economic activities. Agriculture is the foremost source of food for us. Water is necessary for the food crops. Fish which make up a large portion of our food also depends on water for survival. Forests which benefits us in many ways and maintain our ecological balance also need water for their growth and other purposes [cracolice2006basics].

Water is universal solvent that can dissolve many organic and inorganic substances resulting in its contamination that is harmful for both human beings and aquatic life. Water is contaminated by discharge of industries, livestock, domestic wastes, viruses, bacteria, fungi, algae and other anthropogenic activities [Qureshimatva et al, 2015]. A survey of WHO and United Nations International Children's Emergency Fund (UNICEF) shows that about 884 million people of the world are living without getting clean water for drinking. Due to unsuitable drinking water, insufficient sanitation and bad hygiene condition about 88 % of diarrheal disease is caused in human beings. As a result of this problem every day about 4,500 children are dying from diarrhea and many other diseases. The global water crisis claims that more peoples are dying by diseases than in any war [Jensen, 2003; Wagener, 2010].

In Pakistan contamination of water by bacteriological activity (pathogens) is a potential problem of water pollution [6]. About 70000 tons of pesticides are used every year in Pakistan, which increases the annual rate about 6 % World Wildlife Fund (WWF, 2007). About 0.1 % of the pesticide used reach to the target while the rest 99.9 % of applied pesticides is dispersed in air, soil, water and thus causing environmental pollution [Dagdelen, 2009]. Trace amount of heavy metal dissolved in natural water pollute water reservoirs as a result of excessive use of chemicals in agriculture by human beings as well as through inappropriate disposal of municipal and industrial wastes. Some of these heavy metals under certain limits are necessary for human health but their concentration above the permissible limit causes water pollution that has severe health implications on living organisms including human beings [Ullah et al, 2009]. The permissible limits set by WHO and NSDWQ of different physiochemical parameters for drinking and irrigation water are given in the Table 1. The values of these parameter that exceeds the limits in each case can affect water quality.

Table 1. WHO & NSDWQ criteria for water quality fit for drinking and irrigation [9].

Parameters	WHO Standards (drinking water)	WHO Standards (irrigation water)	NSDWQ Standards for water Quality
pH	6.5-8.5	4.5-9.0	6.5-8.5
Electrical conductivity	500-800	500-800	500-800
Turbidity	< 5	< 5	< 5
Total Hardness	< 500	---------	< 500
Alkalinity	< 500	----------	< 500
Total dissolve solids	< 1000	1500-5000	< 1000
Total suspended solids	< 25	-----------	< 25

* EC are measured in µS/cm, turbidity in Nephelometric Turbidity Unit (NTU), and total hardness, alkalinity, TDS and TSS are in mg/L.

The pH which is the most important parameter of water quality determination, is the negative logarithm of H-ions concentration of a medium. It give information about the acidic and basic nature of water under analysis. Water having low pH (< 7) is acidic and have corrosive nature, while water having pH > 7 is alkaline showing disinfection in water. Moreover, alkaline water lowers the natural pH value of stomach and also causes alkalosis, a condition in which the free calcium concentration in the body decreases. The alkaline water make soil basic due to which there is reduced absorption of minerals and nutrients from the soil. The acidic water make soil acidic causing deficiency of calcium and magnesium due to which photosynthetic activity is disturbed [Haydar et al, 2016]. Electrical conductivity is the ability of water to allow the passage of current and is directly related to the ions present in the medium. Dissolved electrolytes and inorganic compounds like chlorides, sulfates and carbonate are the sources of ions responsible for water conductivity. Water having high EC value will have high TDS and high salinity [Haydar et al, 2016]. The measurement of concentration of dissolved ions in water is known as Total dissolved solids. Sewage, agriculture run-off, urban, industrial wastewater and industrial chemicals causes TDS of drinking water [Ullah et al, 2009; Federation et al, 2005]. The TDS analysis only gives information about the qualitative aspect of dissolved ions and not the quantitative information of it. Indicators for high TDS are scale formation, bitter taste and hardness of water [raw_1_who200globalworld]. A chemical measurement of the ability of water to nuetralize acid or its buffering capacity is known as alkalinity of water. Water with high alkalinity will buffers acid rain. The objection of alkaline water is the reason that it react with cations and result into precipitate which can damage water supply pipes and other equipments [Simpi et al, 2011; Cunha et al, 2011]. The presence of $CaCO_3$ and $MgCO_3$ in water causes temporary hardness that can be removed simply by boiling water. While $CaCl_2$, $CaSO_4$, $MgCl_2$ and $MgSO_4$ presence in water make it permanently hard which is difficult to be eliminated by simple boiling and require estimation of the Ca^{2+} and Mg^{2+} ions concentration to measures the hardness of water. According to the International Journal of Preventative Medicine, cardiovascular diseases are one of the major problem of hard water [raw_1_who200globalworld]. According to international studies, high blood pressure and heart diseases can be caused by drinking hard water [Amir et al, 2019]. Hard water has high pH value and so it has negative effects on plants. It is the measure of suspended/colloidal particles which is not settled in water by gravity. It includes floating substances and sand, sediment, silt, algae etc. TSS affects water clarity and so increases the turbidity of water. Suspended solids exclude light, thus reducing the oxygen producing plants [Simpi et al, 2011].

Description of Area

In this work we collected the water samples from different water sources of main town Darra Pezu and its neighboring villages of Lakki Marwat, Pakistan and were analysed for different physiochemical analysis. The water samples collection was done from rural areas including Wanda Ahmad Khan (WA), Wanda Sharbat (WS), Wanda Gulmir (WG), Station (ST). Darra Pezu is small town of district Lakki Marwat (Khyber Pakhtunkhwa, Pakistan) which is located at an altitude of 1040 feet. The distance of other villages from Darra Pezu is about 4 to 5 kilometers. Wanda Ahmad khan is located near to cement factory known as Lucky Cement Factory. Two water samples were collected from main town Darra Pezu and one sample is collected from other villages each. The images of the sources from which the water samples were collected are given in Fig. 1.

J Ong Chem Res, 2020, **5**(2): 71-77, Document ID: 2020JOCR49, doi:10.5281/zenodo.3996645
Research Article

Figure 1. Digital photographs of the sources for the collected water samples **(a)** Tube well (Darra Pezu) **(b)** Pressure pump (Station) **(c)** Well water (Wanda Sharbat) **(d)** Internal image of Well water (Wanda Sharbat) **(e)** Well water (Wanda Gulmir) **(f)** Tube well (Wanda Ahmad Khan) **(g)** Pond (Darra Pezu)

Various physiochemical parameter like taste, odor, colour, pH, turbidity, alkalinity, hardness, EC, TDS and TSS were employed to assess for the first time the quality of water of Darra Pezu and its neighboring villages of the district Lakki Marwat, Pakistan by a number of scientific procedures and tools. To the best of our knowledge, the analysis of water quality of the specific area of Darra Pezu has not been under the study so far and it is our first attempt. The main highlights of the study is that the well water of the area under study was found fit for irrigation but needs government attention for its suitability for drinking purposes.

RESULTS AND DISCUSSION

Odor, colour and taste of each water sample was noted physically and it was confirmed that all water samples were odorless, colorless and tasteless except well water samples which has salty taste and slightly turbid color. The other parameters measured for the six water samples are summarized in Table 2 and are plotted individually in figures shown below.

pH

The pH measured for the water samples are shown in Fig. 2. The pH of four water samples (Tube well water Wanda Ahmad Khan, tube well water Darra Pezu, pond water Darra Pezu and pressure pump water station) were found to be in the range of 6.92-8.89 and the well water samples of Wanda Gulmir and Wanda Sharbat has pH value of 8.78 and 8.89, respectively. According to the WHO guidelines (Table 1), the four samples were in the safe and allowable limits and are non-fatal. Well water of the two localities are not according to standard guidelines and are not suitable for drinking due to high alkalinity. The results are comparable to [Cunha et al, 2011, karjagi2017breeding]. While for irrigation all the water samples were suitable as per permissible values.

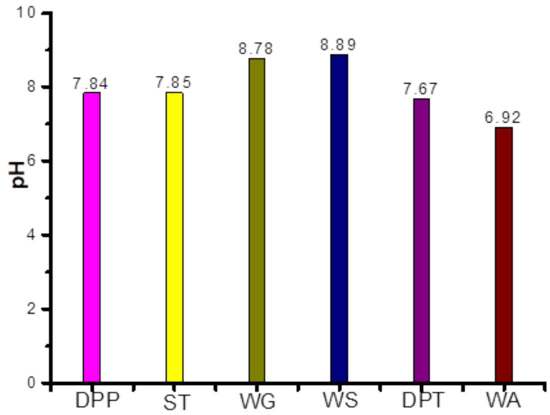


Figure 2. pH of the water samples

Electrical conductivity

The EC values obtained for each water sample was in the range of 5.96-378.6 µS/L. The results of EC obtained for each water sample is within the allowable limits of WHO and NSDWQ (Table 1). The results obtained for EC of the samples are shown in the Fig. 3. The EC value for well water samples are slightly high from other samples, it is because of its high pH value and more dissolved salts.

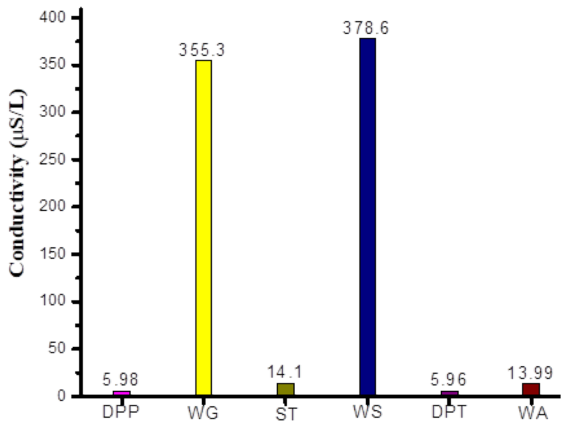


Figure 3. Electrical conductivity of the water samples

Alkalinity

The alkalinity of water samples was found to be in the range 160-830 mg/L and are shown in Fig. 4. The results of four water samples are within allowable

J Ong Chem Res, 2020, **5**(2): 71-77, Document ID: 2020JOCR49, doi:10.5281/zenodo.3996645

limits as given by WHO and NSDWQ, (Table 1). The result for the well water samples of WG and WS are higher than WHO and NSDWQ limits. So, the four water samples are fit for drinking while well water is not. However, all the samples were suitable for irrigation purposes.

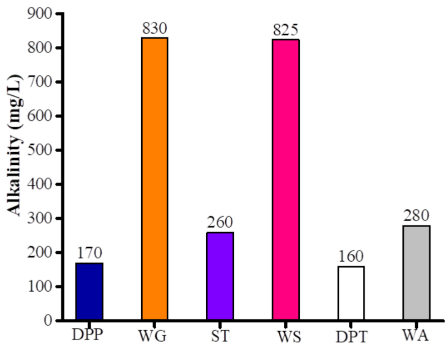


Figure 4. Alkalinity of the water samples

Total hardness

The values obtained for total hardness of the six water samples are shown in the Fig. 5(a). The values for temporary hardness were in the range 64-1099 mg/L. The results are shown in Fig. 5(b). The values obtained for permanent hardness of all water samples were in the range of 14-536 mg/L. The value of permanent hardness of each water sample is given in Fig. 5(c).

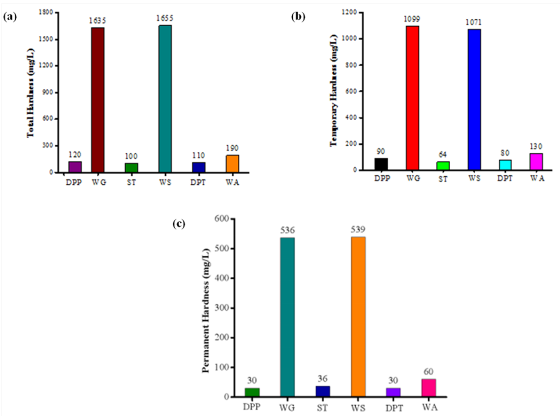


Figure 5. Physiochemical parameters of collected water samples (a) Total Hardness (b) Temporary Hardness (c) Permanent Hardness

The results obtained for four water samples were within the allowable limits of WHO and NSDWQ while for the samples collected from wells of the two localities the results are not within the safe limits for drinking. The results of total, temporary and permanent hardness shows that all the water samples are fit for irrigation purposes.

Total dissolved solid

The results of TDS obtained for each of the water sample are shown in Fig. 6 and were in the range of 384-6178 mg/L. According to the WHO and NSDWQ guidelines the values obtained for DPP (384 mg/L), DPT (390 mg/L), ST (866 mg/L) and WA (895 mg/L) are within allowable limits. While the value obtained for well water samples of WS (1170 mg/L) and WG (1175 mg/L) were higher than WHO and NSDWQ limits. The results are in accordance to the reported literature values [Rani et al, 2014; Kumar et al, 2018].

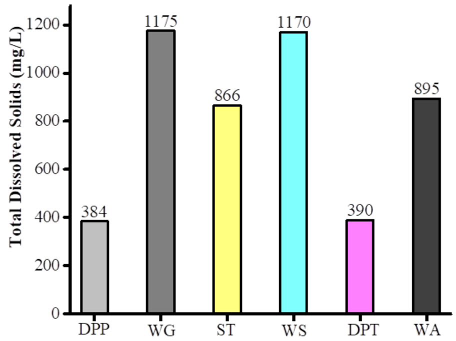


Figure 6. TDS of the water samples.

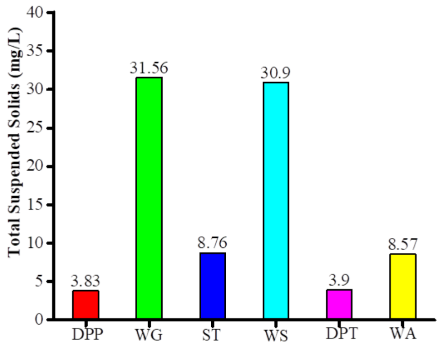


Figure 7. TSS of the water samples

Total suspended solid

The values of TSS obtained were in the range of 3.83-31.56 mg/L Tare are shown in Fig. 7. All the values obtained for water samples were within

J Ong Chem Res, 2020, **5**(2): 71-77, Document ID: 2020JOCR49, doi:10.5281/zenodo.3996645
Research Article

permissible limits given by WHO and NSDWQ except the two well water samples. The results were comparable to literature value [Mandal et al, 2012; Rahmanian, 2015].

Turbidity

The values of Turbidity obtained were in the range of 1.80-7.71 NTsU. The WHO and NSDWQ guidelines of turbidity for drinking water is < 5 NTU. The data in the table 2 and Fig. 8 shows that the turbidity of the four samples areas WA, DPT, DPP and ST were within permissible limits while the well water from WS and WG have high values for turbidity.

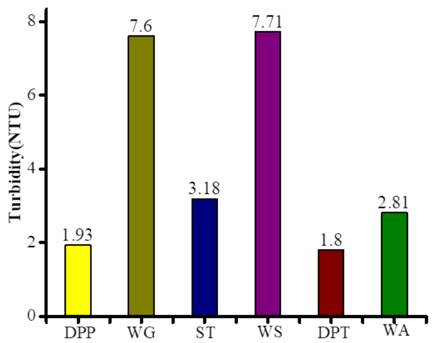


Figure 8. Turbidity of the water samples

Table 2. Different parameters measured for water samples of six sources

Parameter	Sample source					
	DPP	**WG**	**ST**	**WS**	**DPT**	**WA**
pH	7.84	7.85	8.78	8.89	7.67	6.92
Electrical Conductivity	5.98	355.3	14.1	378.6	5.96	13.99
Alkalinity	170	830	260	825	160	280
Total hardness	120	1635	100	1655	110	190
Temporary hardness	90	1099	64	1071	80	130
Permanent hardness	30	536	36	539	30	60
Total dissolved solid	384	1175	866	1170	390	895
Total suspended solids	3.83	31.56	8.76	30.9	3.9	8.57
Turbidity	1.93	7.6	3.18	7.71	1.8	2.81

* EC are measured in µS/cm, turbidity in Nephelometric Turbidity Unit (NTU), and total hardness, alkalinity, TDS and TSS are in mg/L.

After the analysis of above physiochemical parameters for the selected six water samples, it was confirmed that all the collected water samples are safe and suitable for drinking except well water samples (Wanda Sharbat and Wanda Gulmir) which show high values of the above physiochemical parameters than that given by WHO and NSDWQ. The reason for these high values of studied physiochemical parameters of well water samples (Wanda Sharbat and Wanda Gulmir) is that well is open to the atmosphere (as shown in Fig. 1c and e) and as a result so many salts and other chemicals are directly or indirectly entering into it**.** Other reason is due to high productivity of algal growth production which utilizes CO_2 through photosynthetic activity [Wall et al, 2017]. The reason for high value of hardness for well water is pollutants and high content of calcium and magnesium salts [Cunha et al, 2011, Cunha et al, 2011].

EXPERIMENTAL

Materials and apparatus

The samples, stored in clean plastic bottles, were properly labeled with the name of the source; Tube well water Wanda Ahmad Khan by WA, well water Wanda Sharbat by WS, tube well water Darra Pezu by DPT, pond water Darra Pezu by DPP, pressure pump water Station by ST, and well water Wanda Gulmir by WG. The reagents used were standard H_2SO_4 (purity 95-98%), ethyl alcohol (purity 95%), NH_4Cl, NH_4OH, $MgSO_4$, standard solutions (1000, 10 and 0.2 NTU, hydrazine sulfate and hexamethylenetetramine, buffer solutions of pH 4, 7, and 10, Indicators phenolphthalein, Erichrome black T (EBT), ethylenediaminetetracetic acid (EDTA), mixed indicator (bromocresol green and methyl red). All these chemicals were purchased from BDH, UK and were used as received. All the solutions were prepared in distilled water produced from home made distillation plant. The apparatus used in the analysis were evaporating dish, oven, desiccator, water bath and vacuum pumps.

Physiochemical Constraints

The supply of safe and clean water is the fundamental right of human development (WHO, 2001) for better life, improve health and well being. It is very essential to examine the water quality to check, weather it is suitable for drinking and irrigation purposes by using different physical and chemical techniques, before its provision to the community. Water must be tested for different physiochemical constraints including odor, color, taste, pH, hardness, turbidity, alkalinity, EC TDS, TSS etc. The selection of physiochemical parameter depends upon the purpose of water for which it is used [Kahlown et al, 2003]. All the collected water samples were brought to Islamia College Peshawar, Pakistan for analysis.

Laboratory Analysis

Different parameters like pH, electrical conductivity, alkalinity, total, temporary and permanent hardness, turbidity, TDS and TSS were measured in laboratory using different calibrated instruments keeping in view the standard protocol and methods [10].

pH measurements

pH meter (JENWAY Model 3505 Serial number 31182) was applied for pH measurement of the water samples after calibrating the pH meter according to reported literature [raw_1_who200globalworld] by using pH 4.01, 7.01 and 10.01 buffers. After calibration the pH reading were taken by dipping the pH probe in water sample one by one. To obtain concordant values the reading of each sample was taken three times and then the mean value is taken into account.

Measurement of EC

To measure EC of the samples, electrical conductivity-meter (JENWAY Model- 4510 serial number 03622) was used. The Conductometer was calibrated according to reported literature [raw_1_who200globalworld; Cunha et al, 2011] using KCl solution. After calibration electrode of digital Conductometer was dipped in water samples one by one. The electrical conductivity of water sample was measured in micro Siemen (µS) at 25 °C.

Measurement of TDS

TDS of collected water samples were measured using the above mentioned EC meter. The calibrated EC meter was then adjusted for the measurement of TDS in water samples. Electrode of conductometer was dipped in each water sample and readings were noted. The TDS was measured in unit of mg/L at 25 °C. The readings were taken three times for each water sample and then their mean value was taken into account [Wagener, 2010, Amir et al, 2019].

Measurement of alkalinity

Alkalinity of water samples was determined by using test procedure [raw_1_who200globalworld, Cunha et al, 2011] via titration method in mg/L of $CaCO_3$ scale.. First 0.1 N H_2SO_4 solution was prepared. Mixed indicator (100 mg of bromocresol green and 25 mg methyl red in 100 ml distilled water) was used during titration to note the color change. Each water sample was titrated then against 0.1 N H_2SO_4 and volume of H_2SO_4 used and noted from graduated burette. To obtain accurate result, each water sample was titrated against H_2SO_4 solution three times and then mean value of reading of volume of H_2SO_4 used taken in calculation.

Measurement of total hardness

EDTA titration method using EBT indicator employed for measurement of total hardness of the samples. During the titration, EDTA make complex with Ca^{2+} and Mg^{2+} ions and make water free from these impurities. The reading for each water sample taken three time and then their mean value taken into account. Permanent hardness in water sample calculated from the above-mentioned titration method; however, the water samples first boiled at 100 °C for 15 minutes in order to remove temporary hardness. After boiling the water sample, the boiled sample was titrated by same method and reading noted. From the difference of total and permanent hardness, temporary hardness evaluated.

Measurement of turbidity

Turbidity of each water sample was determined according to reported literature [Kahlown et al, 2003] by using turbid meter (Scientific, Inc. FT.MYERS, FL. Catalog No. 20,000). The readings taken three times for each water sample and then their mean value taken in calculation.

Measurement of TSS

TSS was determined by weighting method [raw_1_who200globalworld]. First, weight the filter paper (W_1) and then pass 75 mL of water sample. After that filter paper was place in oven at 103 °C for one hour. After one hour filter paper placed in desiccators for drying, and then after drying weight filter paper again (W_2). Now the suspended solids in water sample determined by formula:

$$Total\ suspended\ solids(mg) = \frac{(W_2 - W_1)}{(Volume\ of\ sample\ taken)} \times 1000$$

CONCLUSION

After analysis of selected physiochemical parameters of the water samples of village Darra Pezu and its neighboring areas of Lakki Marwat, Pakistan, it was observed that the values of pH, EC, turbidity, hardness, TDS, and TSS of water samples collected from Tube well Wanda Ahmad Khan (WA), tube well Darra Pezu (DPT), pond Darra Pezu (DPP) and pressure pump Station (ST) were under the permissible limits given by WHO and NSDWQ and are considered suitable both for drinking and irrigation purposes. However the values of water quality parameters for the water samples of Wanda Sharbat (WS) and Wanda Gulmir (WG) were found unfit for drinking. However, the water from the well sources of WS and WG were found to be suitable for irrigation purposes.

Acknowledgements

The Authors are highly thankful to Islamia College Peshawar for providing laboratory facilities for this research work.

Bibliography

Amir, Rai Muhammad; Randhawa, Muhammad Atif; Nadeem, Muhammad; Ahmed, Anwaar; Ahmad, Asif; Khan, Moazzam Rafiq; Khan, Muhammad Asif; Kausar, Rukhsana; (2019). "Assessing and Reporting Household Chemicals as a Novel Tool to Mitigate Pesticide Residues in Spinach (Spinacia oleracea)", *Scientific reports*, **9**, 1125

Cunha, Davi G F; Dodds, Walter K; Carmo Calijuri, Maria do; (2011). "Defining nutrient and biochemical oxygen demand baselines for tropical rivers and streams in São Paulo State (Brazil): a comparison between reference and impacted sites", *Environmental management*, **48**, 945-56

Dagdelen, N. (2009). "Determination of water quality parameters of Büyük Menderes river, Turkey", *Asian Journal of Chemistry*, **21**, 287-298

Federation, Water Environmental; American Public Health Association; others (2005). "Standard methods for the examination of water and wastewater", *American Public Health Association (APHA): Washington, DC, USA*, ,

Haydar, S; Haider, H; Bari, AJ; Faragh, A (2016). "Effect of Mehmood Booti dumping site in Lahore on ground water quality", *Pakistan Journal of Engineering and Applied Sciences*, ,

Jensen, P.K. (2003). "Effect of chlorination of drinking-water on water quality and childhood diarrhoea in a village in Pakistan", *JOURNAL OF HEALTH POPULATION AND NUTRITION*, **21**, 26-31

Kahlown, Muhammad Akram; Majeed, Abdul (2003). "Water-resources situation in Pakistan: challenges and future strategies", *Water Resources in the South: present scenario and future prospects*, **20**, 33-45

Kulshreshtha, S. (1998). "A global outlook for water resources to the year 2025", *Water Resources Management*, **12**, 167-184

Kumar, Vinod; Kumar, Sanjay; Srivastava, Sachin; Singh, Jogendra; Kumar, Pankaj (2018). "Water quality of River Ganga with reference to physico-chemical and microbiological characteristics during Kanwar Mela 2017, at Haridwar, India: A case study", *Archives of Agriculture and Environmental Science*, **3**, 58-63

Mandal, Himangshu Shekhar; Das, Amrita; Nanda, Ashis Kumar (2012). "Study of some physicochemical water quality parameters of Karola River, West Bengal-An attempt to estimate pollution status", *International Journal of Environmental Protection*, ,

Qureshimatva, Umerfaruq M; Maurya, Rupesh R; Gamit, Sandip B; Patel, Rikinkumar D; Solanki, Hitesh A (2015). "Determination of physico-chemical parameters and water quality index (Wqi) of Chandlodia Lake, Ahmedabad, Gujarat, India", *J Environ Anal Toxicol*, **5**, 2161-0525

Rahmanian, N. (2015). "Analysis of physiochemical parameters to evaluate the drinking water quality in the state of perak, Malaysia", *Journal of Chemistry*, **2015**, 0-0

Rani, Pushpa; Tiwari, Anurag; Navin, Rahul; Sood, Shivani (2014). "Studies in determination of some parameters of ‘Ganga river’water, Kanwar Mela 2013, Haridwar", *Journal of Innovative Biology June*, **1**, 122-125

SHaRma, NaveNdu; WalIa, YogeSH KumaR (2017). "Water quality investigation by physicochemical parameters of Satluj River (Himachal Pradesh, India)", *Current world environment*, **12**, 174

Simpi, Basavaraja; Hiremath, SM; Murthy, KNS; Chandrashekarappa, KN; Patel, Anil N; Puttiah, ET; others (2011). "Analysis of water quality using physico-chemical parameters Hosahalli Tank in Shimoga District, Karnataka, India", *Global Journal of Science Frontier Research*, **11**, 31-34

Ullah, Rizwan; Malik, Riffat Naseem; Qadir, Abdul (2009). "Assessment of groundwater contamination in an industrial city, Sialkot, Pakistan", *African Journal of Environmental Science and Technology*, **3**,

Wagener, T. (2010). "The future of hydrology: An evolving science for a changing world", *Water Resources Research*, **46**, 0-0

Wall, Ellis L; Hartley, Matt; (2017). "Assessing enclosure design and husbandry practices for successful keeping and breeding of the Burmese brow antlered deer (Eld's deer, Rucervus eldii thamin) in European zoos", *Zoo biology*, **36**, 201-212

World Health Organization, Global water supply and sanitation assessment report. World Health Organization 2000.

Affiliations and Corresponding Informations

Corresponding: Sayyar Muhammad
Email: sayyar@icp.edu.pk
Phone:

Sayyar Muhammad:
Department of Chemistry, Islamia College Peshawar, Peshawar, Pakistan

Anwar Saeed Khan:
1: Department of Chemistry Islamia College Peshawar-25120, Pakistan
2: Department of Chemistry, Quaid-i-Azam University Islamabad, 45320 , Pakistan

Adnan Jalil:
Department of Chemistry, Islamia College Peshawar-25120, Pakistan

Sidra Bibi:
Department of Chemistry, Quaid-i-Azam University Islamabad, 45320 , Pakistan

Junaid Ihsan:
Department of Chemistry, Quaid-i-Azam University Islamabad, 45320 , Pakistan

Saad Anwar:
Department of Chemistry, Quaid-i-Azam University Islamabad, 45320 , Pakistan

Khushnood Ur Rehman:
Department of Botany Islamia College Peshawar-25120, Pakistan