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DRINKING QUALITY ASSESSMENT OF GROUNDWATER USED IN FARMING VILLAGES OF DISTRICT VEHARI, PAKISTAN

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ABSTRACT

Water is one of the most basic and life sustaining requirement of the humans. Accessibility to safe drinking water is essential for the people's health and welfare. But in Vehari which is one of the significant agrarian districts of the South Punjab and where major part of population is inhabited in villages, clean drinking water is not available everywhere. For drinking and for other different domestic uses, almost whole residents of this district depend on pumped aquifer water. Because of increasing population pressure, spreading human accomplishments and rising consumption, the underneath water-table is going down and concentration of impurities in it is on the rise. The availability of clean drinking water for rural population is turning to be a big issue. Because of the unavailability of clean or treated water, the inhabitants are forced to use contaminated groundwater obtained through water pumps. This may cause numerous health issues. For that reason, the drinking quality evaluation of groundwater is necessary that can be useful for future planning. This study was carried out with the objective to make a purposeful evaluation of the quality of groundwater used for drinking by the rural inhabitants and to fix out the most problematic contaminants carried in it. The study was conducted in six villages, choosing two villages from each of the three tehsils of Vehari district. The water samples were collected from each of the six villages which were handled by the skilled technicians and analysed in the labs of Public Health Engineering Department (PHED) and Pakistan Council of Research in Water Resources (PCRWR) Bahawalpur. The findings were matched with the WHO values fixed for safe drinking water. The results demonstrate that aquifer water of all the studied villages is unhealthy for household uses and for drinking as majority of the assessed factors deviated from the standards set by WHO. The study concludes that consumption of groundwater without any sort of treatment is unsafe and to keep pace with the government's health related policies, installation of water filtration plants in all rural areas is direly needed.

KEYWORDS: Drinking quality, drinking water, groundwater, quality assessment, sample villages, Vehari district.

1. INTRODUCTION

Safe drinking water is a prime human requirement. About 20 to 50 liters of water are consumed per day by every human being for drinking, cooking and washing (WHO, 2019). The United Nations confesses that availability of pure drinking water is a basic right of every human being and leading stride for rising the standard of living. Nevertheless, almost four-fifth of the global community is confronting with some level of water scarceness and nearly half is inhabited in the places having no approach to pure water (WHO, 2021). Not only the impure water is contaminated, it is hazardous as well and can spread a number of lethal diseases including diarrhea, intestinal worms, gastro, cholera, typhoid, hepatitis, polio, and so on. Globally, thousands of the humans pass on every year due to the diseases spread by drinking polluted water (WHO, 2019). Therefore, access to clean drinking water is vital for the assurance of healthy life. Water is an essential human need for all routine domestic usages like meal cooking, washing and personal cleanliness (WHO, 2011). Round about 97.5% of the earthly water is contained in oceans which is not drinkable due to high salinity whereas just about 2.5% consists of fresh water out of which below 01% can be accessed and used (PCRWR, 2006). Nearly 30% of all fresh water and 97% of the liquid fresh water is contained in aquifers which are the basic source of drinking water for over 1.5 billion humans worldwide (Oskin, 2018; SDWF, 2017). According to Safe Drinking Water Foundation (SDWF), at present, aquifers fulfill almost 33% of the Asia's whole drinking water needs. Like the study area, several rural parts of the world use groundwater sources to meet their all drinking water requirements (SDWF, 2017). In the preceding century, world's water usage has augmented at a speed twice the speed of population growth (Khan et al., 2020). Supply of healthy drinking water at all times has been one of the topmost challenges of the societies. Ancient societies also faced numerous problems concerning water as a basis of their existence (Mays, 2007). Water, indeed, is a life supporting physical item but is scarce in many areas over the globe. Though. various South American, Asian and African countries are facing physical shortage of water but some countries, like Pakistan, are experiencing economic scarcity where water resources are ill-managed due to lack of infrastructure and institutional incompetency. Mismanagement of water resources in such countries gives birth to the problems of water shortage and water pollution. The influence of climate change is an extra danger for the water resources of these countries (Khan et al., 2020). According to Water Scarcity Clock (WSC), presently above two billion humans are living in high water stress countries and their population will carry on to grow (WSC, 2020). However, awareness regarding the worth of water and influence of its quality admirations on human's healthiness is increasing in the world over and majority of the humans are cognizant of the reality that water can be one of the exceptionally critical natural commodities in future (Daud et al., 2017; Dixit & Tiwari, 2008; Arain et al., 2008). At present, world's population has reached to about eight billion (World Population Clock, 2021). Its water demands for household consumption, agriculture, industry, hydel power generation and for other different sectors are also increasing. Consequently, water scarcity and pressure on existing water resources is also increasing damaging its quality. It thus seems that supply of clean drinking water can be a big problem of the current era.

Undoubtedly, without the supply of pure drinking water, health of people cannot be assured. A number of earlier studies express a close association between human health and groundwater pollution (Zhang et al., 2019; Rehman et al., 1997). Consumption of unclean water for any domestic purpose or for drinking may cause health complications, turns the life quality inadequate and lessens the life expectancy. It is a widely accepted view that use of unsafe water is one of the major reasons of spreading several diseases particularly in less developed parts of the world like the study area. In the world over, several infectious diseases are water-borne that spread because of using unhygienic water and may result in miserable health or demises. In majority of the developing countries including Pakistan, deteriorating water quality is a big cause of spreading diarrhea (Thompson & Khan, 2003; WHO, 2000 & 2004; Fewtrell et al., 2005; Clasen et al., 2007), decline in brain working and intelligence in teenagers (Dillingham & Guerrant, 2004), anemia in kids (Stephenson et al., 2000), and dental carries and oral cleanliness (Ishaque & Khan, 2001). Various past researches indicate that round about 68% of the rural dwellers of Pakistan consume unhygienic water and every year, a large number of diarrheal patients are documented in health centers (Tahir et al., 1998; Tahir & Rashid, 1997). In such areas, infants, teenagers, weakened and old age individuals, particularly those living in insanitary environments are seriously vulnerable to water borne diseases and mortality rates of infants are exceedingly high. On the other hand, attempts made for the improvement of drinking water quality prove exceedingly useful for people’s health (WHO, 2011). Appropriate use of healthy drinking water every day can minimize the danger of numerous diseases including various kinds of cancer (PCRWR, 2007). Lifetime consumption of healthy drinking water, suggested by the WHO, is not risky noticeably for human health. For this reason, quality of water in developed nations is not compromised and considered very seriously. Drinking water quality parameters are checked before it is supplied to the consumers (PCRWR, 2006).

Because of rapid population growth and change in ways of life, water consumption in Pakistan has increased immensely during the last few decades. Numerous areas of the country, together with the study area, are confronting serious problems of clean drinking water. More than two-third of the country's population depend upon groundwater for domestic consumption which is declining in quantity and worsening in its healthiness. Intensive agricultural activities in arid and semiarid regions, like Vehari, are another threat to aquifers (Zhang, Xu & Qian, 2019; Daud et al., 2017). In view of such ground realities, the appraisal of water quality has emerged an important field of inquiry in a number of countries (Hameed et al., 2010). Numerous studies in various parts of the world, hitherto, have been carried out regarding the accessibility, management and drinking suitability of the water. However, in case of Pakistan only a handful studies, concerning basically to the extent and appropriateness of the water resources have been accomplished up till now (such as Adamou et al., 2020; Khan et al., 2020; Zulfiqar, Abbas, Raza & Ali, 2016; Hussain et al., 2016; Shahid et al., 2015; Safdar, Mohsin & Khan, 2014; Khan, Fatima & Khan, 2014; Mohsin, Safdar, Asghar & Jamal, 2013; Memon, Soomro, Akhtar & Memon, 2011). In 2006, groundwater quality was appraised by PCRWR in 25 cities of Pakistan including Vehari, where due the dominance of arid climate water needs are comparatively high. Again in 2021, PCRWR evaluated the quality of water in 29 cities of Pakistan and just 39% of the water resources were found fit and 61% unfit for human drinking (Hifza, Fauzia, Kiran & Ashraf, 2021).

Another reasonable option is filtered surface water which is also consumed for various household purposes in numerous areas of the world and in Pakistan as well. However, because of scarce rainfall and shortage of surface water in Vehari district, the people had to be more dependent on the aquifer water for various domestic uses. As a result, underground water-table is tumbling and its quantity and quality is deteriorating over time. Almost alike situation is found in other parts of the country too, where, due to the consumption of contaminated water, numerous mortalities happen each year. Presently, almost all residents of the district depend upon ground water for domestic uses. The drinking water achieved through turbines and pumps is utilized directly without any type of treatment that may cause several health problems. Thus, comprehensive research on the topic is certainly required, basically for the estimation of upcoming drinking water related trends and problems of the area. Such kind of researches can be helpful for the preparation of effective plans and sustainable management of available water resources. The study in point can be a tread forward to achieve this goal. It is intended to appraise the drinking suitability of groundwater according to the WHO approved limits of its physical, chemical and microbiological aspects.

2. Material and Methods

The study area comprises six villages of the district Vehari which is situated in the south eastern part of the Punjab province of Pakistan (Fig 1 & 2). A brief description of the salient features and absolute location of sample rural settlements is given in Table 1. Major part of the population of this area is involved in agricultural activities making reasonable contribution to the agro-based economy of the region. Although, in terms of development, the region has caught considerable attention of the provincial government during the previous few decades, yet it is confronting a number of problems together with the lack of safe drinking water.

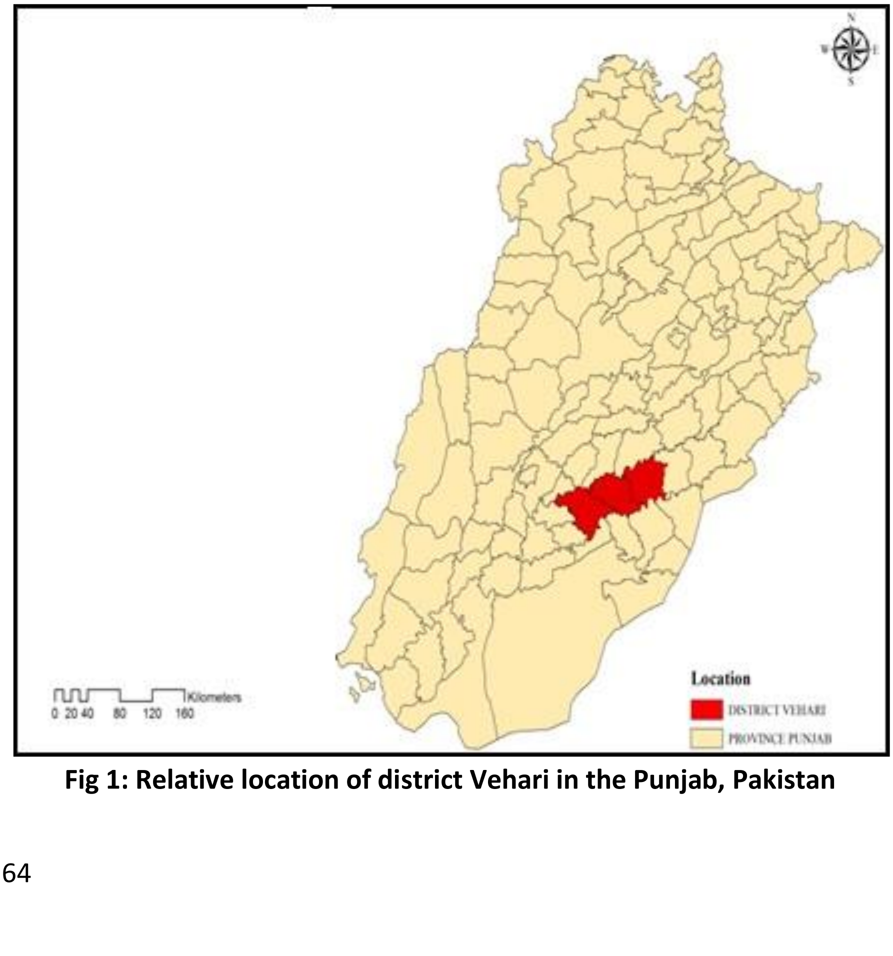

Fig 1: Relative location of district Vehari in the Punjab, Pakistan

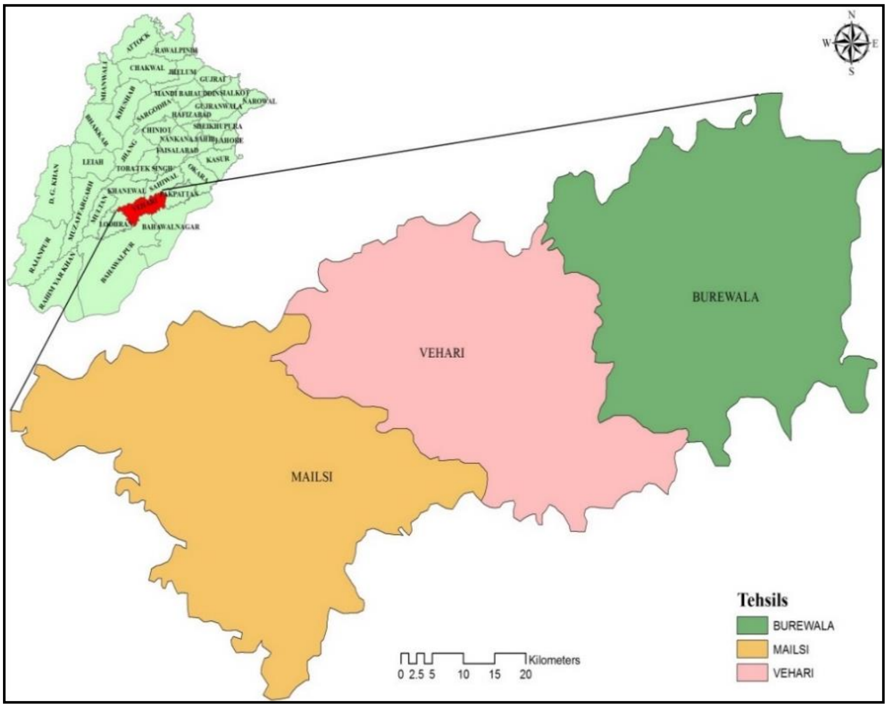

Fig 2: Three tehsils of district Vehari where the study was carried out

Three dimensional approach was used to determine the drinking suitability of water (Fig 3). This approach helps in assessing the physical, chemical and biological properties of water. Employing case study design and depending upon cross sectional data, the analysis was made to assess the suitability of groundwater of the chosen villages (locally known as Chaks) of the Vehari district consumed for drinking and for various other usual home needs. The quality of groundwater was examined with the objectives to determine its suitability for drinking according to the limits of various parameters approved by WHO. In addition, making a mention of the healthy and contaminated drinking water locations was also the objective of this study. To come across these goals, water samples from 06 selected rural localities (two from each of the 03 tehsils of the district) were gathered for laboratory analysis (Table 1). The Samples were analyzed in the labs of Pakistan Council of Research in Water Resources (PCRWR) and Public Health Engineering Department located at Bahawalpur.

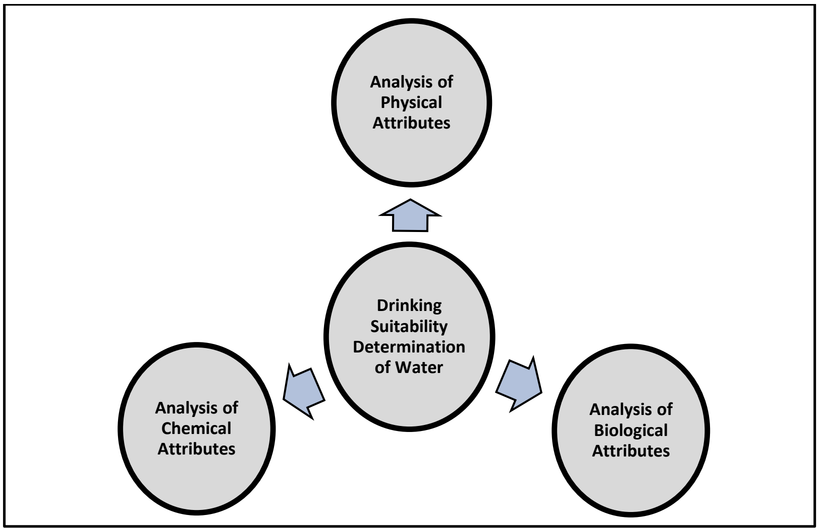

Fig 3: Three dimensional strategy to assess the drinking suitability of water

Table 1: Salient features of the sample rural areas

Sample rural areas & location tehsils	Location tehsil & main economic activity in the village	Absolute position		Land in acres	Total population	Density (No. of people per acre)
		Longitudinal	Latitudinal			
Chak No. 365/EB	Boray Wala Farming	72. 85626545°E	30. 28816941°N	6,375	5,600	0. 87
Chak No. 373/EB	Boray Wala Farming	72. 82272524°E	30. 32015174°N	4,625	3,600	0. 77
Chak No. 531/EB	Vehari Farming	72. 52482906°E	30. 11842702°N	2,925	1,100	0. 37
Chak No. 539/EB	Vehari Farming	72. 56224378°E	30. 05662334°N	5,750	2,700	0. 46
Chak No. 71/KB	Malsi Farming	72. 08982455°E	29. 92980218°N	675	1,230	1. 82
Chak No. 125/KB	Malsi Farming	71. 95070618°E	30. 00328145°N	3,800	1,900	0. 5

Some of the salient features of the sample rural settlements where the study was carried out are given in table 1. Quality of the drinking groundwater samples collected from these settlements was evaluated in the labs (Tables 3 & 4). The samples from all the localities were gathered in replica as it was the lab requirement. The sampling and lab examination plan was made in advance as per lab prerequisites. The plan comprised sampling sites, kinds and amount of the samples, and quality control needs of the research. While doing all this, the guidelines provided by the laboratory staff were brought into practice and the samples were taped from the most often used water outlets. All the samples were put into three-time carefully rinsed plastic bottle measuring 1000 ml in size. The water taps were kept flowing for at least 05 to 07 minutes and then the bottles were filled in with sample water. Every bottle containing sample water was fixed with a cap, rechecked cautiously, and labelled before bringing it to the lab for further process. All the prepared samples were sent instantly to the labs of PCRWR and PHED situated at Bahawalpur for the examination of aesthetic, chemical and biological characteristics of the water with standard methods. Besides, the tests were also made for the detection of trace and toxic materials. The checked factors determined the fitness or unfitness of the water for ingestion. The lab analysis outcomes were equated with the drinking water quality criteria approved by WHO (Table 2) and finally the conclusions were made.

Table 2: Acceptable limits of the physical, chemical and bacteriological parameters for healthy drinking water set by WHO

Sr. No.	Parameters	Assessing unit	Acceptable limits (WHO, 2011)
01.	pH-value	Numeric Scale (0-14)	6.5-8.5
02.	Electrical conductivity (EC)	uS/cm^2	2150 uS/cm^2
03.	Turbidity (Tb)	NTU (Nephelometric Turbidity Units)	5 NTU
04.	Alkalinity (Alk)	Ppm	200 Ppm
05	Hardness	Ppm	500 Ppm
06.	Calcium (Ca)	Ppm	75 Ppm
07.	Sodium (Na)	mg/l	30-60
08.	Magnesium (Mg)	Ppm	150 Ppm

09.	Chloride (Cl)	Ppm	200 Ppm
10.	Sulphate (SO4)	Ppm	200 Ppm
11.	Total dissolved solids (TDS)	Ppm	1000 Ppm
12.	Iron (Fe)	Ppm	0.3 Ppm
13.	Fluoride (Fl)	Ppm (mg/L)	1.5 Ppm (1.5 mg/L)
14.	Arsenic (As)	Ppb	10 Ppb
15.	Occurrence of bacteria	Absence/Presence	Absence
	No. of colonies	No./100ml	0/100ml

3. RESULTS AND DISCUSSION

3.1. FINDINGS

A widely held perception about the purity of drinking water is that it should have no colour, no odour and no taste. It should be transparent and free from suspended contaminants and harmful microbes. It must also contain certain dissolve gasses to increase flavor and some minerals and salts essential for the human body. It is a proven point that some trace elements are crucial for human health. However, excessive occurrence of certain elements such as copper (Cu), cadmium (Cd), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), zinc (Zn) etc. in drinking water and their consumption in large quantities may cause serious health complications (Mastoi et al., 2008; WHO, 2004; Goldhaber, 2003).

To assess the drinking suitability of water, basic physical tests of the samples were performed. These tests primarily comprised checking of temperature, foaminess (occurrence of soaps, detergents etc.), odour, colour, taste, EC, turbidity, and TDS. All the water samples showed normal temperature that was almost 25^{o}C. Every sample was found almost foamless, odourless, colourless and tasteless whereas EC, turbidity and TDS fluctuated markedly from case to case (Table 3). During the field survey, the existence of a widely held view among the local people regarding the groundwater flavour and quality was noticed. That is, most of the natives orated that the water obtained from the 80 to 90 feet deep aquifers is reasonably good in taste and drinkability as compared to the water pumped from the locations shallow or deeper from these ranges. Some elderly inhabitants told that underground water-level of the region is also dropping quickly and its recent quality is not as fine as it was some years back. Continuous enhancement in water consumption, associated primarily to the rapid growth of population and unprecedented increase in farming and various other accomplishments, is causing deterioration of the groundwater resources both in terms of quantity and quality.

Furthermore, crop growers of the region certainly use various agro-chemicals for plants protection and for the enhancement of yields. Most of them believe that because of over-fetching of the fields, certain quantity of the dissolved substances seep into the ground water. Their incessant accumulation over time may deteriorate ground water quality making it unusable. That is why, in addition to the lab analysis of water samples, 300 agriculturists, 50 from every sample rural settlement were questioned and their opinions regarding the influence of agro-chemicals on the quality of groundwater were documented (Table 5).

3.2. Lab evaluation of the groundwater utilized for domestic purposes in the study area

The results of lab tests conducted to determine the properties of drinking water using three dimensional approach (Fig 3) are presented in table 3. The parameters deviating from the WHO acceptable limits are given in bold. According to the criteria approved by WHO, the pH level, hardness, amount of fluorides and magnesium were found within acceptable limits in almost all the water samples. Bacterial contamination was not found in any of the samples. But the levels of other parameters such as, EC, TDS, alkalinity, arsenic, calcium, iron, and chlorides for different samples were found in excess of the standard limits. It thus revealed from the analysis that the groundwater of all the sample settlements was contaminated and unhygienic for human consumption if WHO standards are applied (Table 4). The groundwater of Chak No. 365 EB, situated in Boray Wala tehsil was found harmful for human health due to high EC and occurrence of high amounts of arsenic, sodium, TDS, and chloride. Drinking such type of contaminated water can cause serious health complications. Similarly, the water of Chak No. 373 EB, situated in Boray Wala tehsil was found unhealthy for human intake because of the contamination of iron and sodium, and high turbidity. Although, compared to all other sample villages of the district, the groundwater of Chak No. 531 EB, located in Vehari tehsil was found less unhygienic, but due to the occurrence of high amount of sodium was unhealthy for human consumption. The groundwater of Chak No. 539 EB, situated in Vehari tehsil was also found unfit for drinking due to the high turbidity and occurrence of the high amounts of arsenic, sodium, iron, and sulfates. The lab assessment of the water samples of Chak No. 71 KB, located in Malsi tehsil showed high alkalinity and high turbidity, and occurrence of iron, calcium and sodium beyond the acceptable limits. Thus, the groundwater of this village was also unfit for drinking. The lab tests conducted to determine the drinking suitability of groundwater of the Chak No. 125 KB, situated in Malsi tehsil, pointed out the occurrence of arsenic and sodium in the samples beyond the acceptable levels making the water unhealthy for human consumption (Table 3 & 4).

In sum, it revealed from the physico-chemical and bacteriological study of the water samples that residents of the villages of district Vehari in general and of the sample settlements in specific are currently taking unhygienic water. While conducting field survey, it was also observed that the village dwellers cannot afford buying bottled or processed clean water because of the low purchasing capacity of their families. So, they do not have any other choice except for the drinking unhealthy groundwater. They are thus serving a meager life in this regard and under such kind of circumstances they are constantly threatened by water related health issues.

Table 3: Results of the physical, chemical and bacteriological analysis of groundwater samples used for drinking and other household activities in rural areas of the Vehari district

Sample Villages	Chak No. 365/EB Boray Wala	Chak No. 373/EB Boray Wala	Chak No. 531/EB Vehari	Chak No. 539/EB Vehari	Chak No. 71/KB Malsi	Chak No. 125/KB Malsi
pH-value	7.60	7.23	7.29	7.13	7.24	7.41
EC	**2840**	1075	1045	1282	1291	1250
Turbidity	0.59	**40.20**	0.19	**6.35**	**18.52**	1.43
Alkalinity	130	140	160	60	**200**	100
Hardness	450	400	490	370	460	250
Calcium	30	45	40	60	**140**	25
Sodium	**450**	**65**	**82**	**116**	**138**	**165**
Magnesium	80	60	100	30	110	40
Chloride	**249.0**	64.68	46.20	46.20	69.10	69.30
Sulphate	**662**	123	112	**211**	122	166
TDS	**1817**	688	669	820	826	800
Iron	0.20	**1.78**	BDL	**0.92**	**2.18**	0.10
Fluoride	0.25	0.45	0.50	0.30	0.20	0.70
Arsenic	**25**	05	05	**25**	05	**10**
Bc/CC	NP	NP	NP	NP	NP	NP

Data Source: Samples of water gathered by the authors and analysed by the labs of PCRWR & PHED at Bahawalpur.

Acronyms: EC= Electrical conductivity, TDS= Total dissolved solids, BDL= Below detection limit, Bc= Bacteria, CC= Colonies of coliforms per 100 ml of water, NP= Not present.

Table 4: Findings of the lab analysis of groundwater samples used for drinking and other household activities in rural areas of Vehari district

Sr. No of sample	Settlement name	Location tehsil	Parameters above the WHO acceptable limits	Observations
1.	Chak No. 365/EB	Boray Wala	EC, Na, Cl, SO4, TDS & As	Unhygienic & unfit for drinking
2.	Chak No. 373/EB	Boray Wala	Tb, Na & Fe	Unhygienic & unfit for drinking
3.	Chak No. 531/EB	Vehari	Na	Unhygienic & unfit for drinking
4.	Chak No. 539/EB	Vehari	Tb, Na, SO4, Fe & As	Unhygienic& unfit for drinking
5.	Chak No. 71/KB	Malsi	Tb, Alk, Ca, Na & Fe	Unhygienic & unfit for drinking
6.	Chak No. 125/KB	Malsi	Na & As	Unhygienic/unfit for drinking

Data Source: Samples of water gathered by the authors and analysed by the labs of PCRWR & PHED at Bahawalpur.

Acronyms: EC= Electrical conductivity, Tb= Turbidity, Alk= Alkalinity, Ca= Calcium, Na= Sodium, Cl= Chloride, SO4= Sulphate, TDS= Total dissolved solids, Fe= Iron, As= Arsenic.

3.3. Opinion of farmer's regarding the impact of agro-chemicals application on physical characteristics of groundwater

Since agriculture is the dominating economic activity of the region and its land area is chiefly covered by crops, various agro-chemicals including variety of fertilizers, pesticides, insecticides, fungicides and herbicides are widely applied to the fields as an essential farming input. Among the residents, it was a common belief that after application, some part of agro-chemicals remains unused by the plants and gradually seeps into the earth. On reaching and accumulating in underground water-table, these chemicals deteriorate the quality of aquifers. Table 5 shows summery of the results of farmer's interviews about the impact of agro-chemicals use on groundwater quality. Most of them (98%) argued that the application of agro-chemicals certainly damage the quality of groundwater and just 2% viewed adversely. A large proportion of respondent farmers (64%) viewed that use of nitrogenous fertilizers can cause change in the taste of water, 29% opined about alteration in colour, and only 7% opined about the alteration in odour. Regarding the impact of fertilizers containing phosphorous as a major constituent, 60% of the farmers opined that it may cause change in the flavour, 35% viewed that it can alter the odour, and just 4% were of the opinion that it may alter the colour of groundwater. Forty percent of them opined that the accumulation of the fertilizers containing potassium as a basic constituent may cause alteration in the taste, 48% viewed about the alteration in odour, and 12% viewed about the modification in colour of the groundwater. The foremost issues of the farmers resulting from groundwater contamination caused by agro-chemicals were also probed and their views were documented. Majority (66%) of them told that the aquifers, which at present are the only main source of drinking water in the region, are getting polluted and unsafe for human use, 16% responded that polluted water damages the filters of water pumps, cause their blockage and put extra financial burden of repairs on the farmers, and 18% answered that the water contaminated by agro-chemicals cause both of these problems. From these views, it appears that the farmers are conscious of the fact that the excessive application of agro-chemicals may cause serious damages to groundwater.

Table 5: Farmer's view about the effects of agro-chemicals application on the physical characteristics of the groundwater (N = 300)

Aspects investigated	Farmer's view	No of respondents	%age
Does the groundwater quality is effected by agrochemical application?	No	06	02
	Yes	294	98
Impact of Nitrogen on groundwater	Alteration in colour	88	29
	Alteration in odour	20	07
	Alteration in taste	192	64
Impact of Phosphorus on groundwater	Alteration in colour	12	04
	Alteration in odour	106	35
	Alteration in taste	182	61
Impact of Potassium on groundwater	Alteration in colour	36	12
	Alteration in odour	144	48
	Alteration in taste	120	40
Main issues originating due to groundwater contamination associated to the use of agro-chemicals	Water is changing into undrinkable item	198	66
	Obstruction in the filters of water-pumps	48	16
	Both of the above problems	54	18

3.4. DISCUSSION

Examination of the water quality is necessary before its utilization for different envisioned requirements. Occurrence level of water quality parameters is determined to decide about its health and suitability for drinking. Customarily, it is likely that any of the water samples will indicate dissimilar quantities of pollutants of different parameters examined (Abbasi, 1999). Various physico-chemical and microbial properties that determine the quality of water vary significantly from region to region all over the world. A number of physical characteristics are probed using the human senses of smell, sight, touch and flavor. For instance, odour through smell; colour, floating wreckage, turbidity and suspended materials through sight; foaminess through touch; and flavor by tasting through tongue. Some of the key features of water, like solubility of gasses, thermal characteristics, surface tension, specific conductivity, specific weight, density, salinity and viscosity, are effected by its temperature. Rate of biological and chemical reactions fasters with rise in temperature. Colour is another important concern of water quality primarily because of aesthetic intentions. Coloured appearance of water is generally perceived as being unhealthy for human consumption, even though it may be completely fit for drinking. On the other hand, coloured appearance is a sign of the occurrence of algae, organic or humic substances. Odour and flavor, indeed, are community feelings about the drinking suitability of water. Salty and sour tastes are usually associated to the occurrence of simple compounds whilst sweet and unpleasant tastes are associated to the existence of complex compounds. Majority of the people consider that drinking suitability of water is observed by its colour, flavor and odour. They think that unclear or darker appearance, saline taste and unpleasant odour indicates inappropriateness of water quality. However, such physical characteristics are not the outright way of water quality determination. Chemical and bacteriological parameters are rather more essential considerations of water quality determination. Since, form and nature of drinking water vary from place to place, criterions of its quality may also vary, to a certain degree, between global communities and regions. It is intrinsically hard to develop an all-encompassing and universally acceptable approach for the detection of water quality. Because of great disparities in the geographic backgrounds of the areas, the approach that may apply in one country or region will not surely similarly apply and prove appropriate in other countries and regions. It is, therefore, obligatory for each country to consider and define its requirements and abilities in framing a guiding principle (WHO, 2011). This is essential, indeed, for Pakistan which has markedly varied geographic setup and currently holds 225.4 million inhabitants ranking fifth largest country of the world (PRB, 2021).

Analogous to other parts of the country, demands of the villages of district Vehari for water are also rising quickly and its groundwater resources are under an enormous stress. The rate of water pumping from aquifers is much higher than the rate of their recharging. Even though, the study area is located in Indus lowlands, but due to the deterioration of neighboring streams and sporadic rainfall, recharging of the aquifers is extremely sluggish. Consequently, water resources of the area are declining and contamination of impurities in the groundwater is rising above the WHO standard limits. Thus, the issue of obtainability of pure drinking water is cropping up rapidly. Results of the study demonstrate that groundwater in all the settlements covered in the study is unhygienic and unfit for human intake. Drinking this form of water without filtration can be hazardous for people’s health because it does not qualify the criteria fixed by WHO for pure drinking water. It is evident from the data given in table 4 that with the exception of Chak No. 531 EB located in tehsil Vehari where only sodium in groundwater was found in excess of Who recommended amount, water of all other villages was found polluted with a number of contaminants. In all the villages, almost every household possess own water pumping system, customarily installed inside the house to pull groundwater which is utilized for drinking and for various other domestic purposes without purification. The normal deepness of the water-pumps ranges between 80 to 100 feet. As the area is situated in the ‘salt sink region’ of the Upper Indus Plains, the concentration of salts in water and soils is obviously high all over the district. This is evident from the study of water samples also. Almost all the cases indicate somewhat over the ideally normal amount of salts. The analysis out comes help to comprehend the water associated health risks that local dwellers are facing. In such areas, several health issues including typhoid, hepatitis, gastritis, diarrhea, dysentery, and abdominal cramps have been recorded to spread primarily due to drinking polluted water (Khan, Fatima & Khan, 2014). Therefore, the health of drinking water needs to be examined consistently and properly at suitable intervals of time. As health is the foremost and key requisite of happy life, the supply of filtered water is indispensable to keep the people fit and blissful.

4. CONCLUSION AND SUGGESTIONS

It is concluded from the findings and foregoing discussion of the results that rural population of the district Vehari primarily rely on groundwater for various domestic needs. The analysis outcomes comprising physical, chemical and microbial status of water were matched with the guidelines provided by WHO for healthy drinking water. It revealed that groundwater of all the sample sites is contaminated and unsafe for human drinking. The level of some of the parameters was found beyond the acceptable limits. High electrical conductivity and occurrence of turbidity, alkalinity, TDS, calcium, sodium, chloride, sulphate, iron and arsenic beyond the allowable limits was detected in different samples. These impurities have made the water risky for human health. The rural inhabitants, thus, should take care in consuming groundwater without filtration. The foremost lessons that can be learned from this study and suggestions include;

1. Cognizance about the risks of drinking contaminated water and revenges of drinking clean water among the consumers should be created. Use of purified water in rural areas should be promoted by highlighting its benefits through public awareness programs and realisation campaigns.
2. In addition to the conservation of water resources, water purification plants are required to be installed and maintained properly to provide free of cost clean water to all rural communities.
3. Only creating the awareness among rural communities about the benefits of using clean drinking water can never be a complete solution of the problem, the effective input of concerned government departments is rather more crucial. They should thus play their role efficiently in managing water resources of the region and to make the filtered water accessible to every rural inhabitant of the district.
4. For those people of the region who can afford, the study suggests that they should get installed small sized portable water filtration units at domestic level and use purified water because health is the real wealth.

5. All in all, the residents of the study area can protect themselves from several health problems by drinking just clean water. Doing this, they can save the money also which they will expend on the treatment of water related diseases.

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