

ASSESSMENT OF GROUNDWATER QUALITY AND STABILITY IN TEHSIL SHAKARGARH, NAROWAL DISTRICT: IMPLICATIONS FOR HUMAN HEALTH AND LONG-TERM STORAGE

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ABSTRACT

Seven groundwater samples were analyzed in order to create a database on the quality of water used in various locations in the Tehsil Shakargarh district of Narowal. To establish the precise amount of different chemicals present in water, a qualitative and quantitative analysis of water samples from various locations was performed. The groundwater samples were collected from the primary water sources that the majority of people drank from. The results of many parameters, such as COD, BOD, heavy metals, Na^+ , K^+ , NO_3^- , SO_4^{2-} , etc., show that groundwater samples collected from areas of Narowal district were found to be suitable for human health and also physically and chemically stable, and can be stored for a long time.

INTRODUCTION

The combination of hydrogen and oxygen gases in 2: 1 makes a unique colorless, odorless and tasteless compound known as water (Moradi *et al.*, 2020). Water is essentially present in every living body (Arshad *et al.*, 2020). It is the most abundant compound which exists on this planet (Goufo *et al.*, 2020). It plays a vital role in the existence of life. The concept of life is impossible without it. Water is unique in properties as compared to other compounds, i.e., its density at 4°C is 1.00g/cm³ and at 0°C 0.98 g/cm³. It has the highest heat capacity (4.2 Kg⁻¹K⁻¹), which is six times greater than rock, and is responsible for the maintenance of the temperature of the earth. Distribution of H₂O all over the world (97 %) in Ocean, Glasser's and ice capes (2.1 %), Atmosphere (0.001%), Groundwater (0.6%) and inland water (0.2%) (Skeie *et al.*, 2014).

It is used in every field of domestic as well as commercial life. Underground water is only used for drinking purposes without treatment (Verlicchi and Grillini, 2020). Water plays a significant role in human health because more than 65 % of the human body mass consists of water (D'Inverno *et al.*, 2018). So, the quality of the water has a prime effect on the human health (Westall and Brack., 2018).

The requirement for water in all lives, from unicellular organisms to human beings, is increasing day by day due to the increasing population, but it is a serious problem to provide quality water (Koul *et al.*, 2022). Due to unplanned urbanization and industrialization, the quality of the water is deteriorating daily due to human activities, which affects human health catastrophically (Jackson, 2017).

Water quality parameters are to be ensured, so alternative ways of safe water must be used. This study aims to determine underground water quality in Tehsil Shakargarh, district Narowal, province of Punjab, Pakistan.

MATERIAL AND METHODS

The Study Area

Narowal is a city located in the Punjab province of Pakistan. It is situated in the northeastern part of the province, close to the border with India. The geographical coordinates of Narowal are approximately 32.1064°N latitude and 74.8765°E longitude (Figure 1). It is a part of the Narowal District and is known for its historical and cultural significance in the region (Asim *et al.*, 2022).

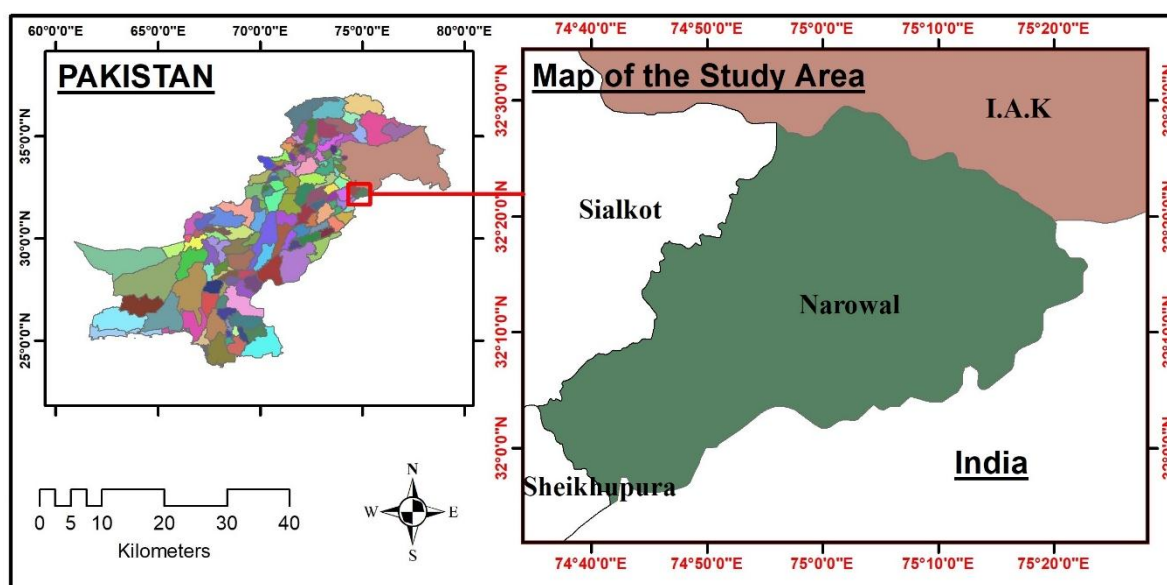


Figure 1: Map of the Study Area

Determination of Chloride in water

The chemicals used in this method are water sample, AgNO_3 solution, K_2CrO_4 as an indicator, reagents and apparatus 20-25 ml Burette, Titrating flask, beakers, pipette etc. take 10 ml of water to be tested and pour into titrant flask add 2 or 3 drops of K_2CrO_4 and titrate this solution against AgNO_3 solution till end point and record volume used (Pontes *et al.*, 2021).

Determination of PH

The PH of the solution is determined by using a pH meter with a buffer solution of PH 4,7 & 10. The water sample was taken in a beaker, the electrode was immersed in the solution for a few seconds then, the reading is noted from the PH meter and recorded to the nearest deviation of 0.01 PH.

Determination of total hardness

Chemical required is a buffer solution of (PH 10) Erichrom black-T and standard EDTA take a sample in a conical flask add buffer solution 1-2 ml and 2-3drops of indicator, and then titrate it with EDTA till endpoint which is blue color of the solution.

Determination of calcium ion

Chemical required for this is EDTA, Erichrom Black-T (indicator) Buffer (PH10) take 50ml sample of water containing content in a conical flask, Boiled sample to convert bicarbonate into carbonate and filtered it. Remaining sample is diluted with water and now take 50ml of sample water and Buffer to maintain (PH10) add 2-3 drops of indicator and titrate it with EDTA till end point.

Determination of Alkalinity

Chemical required for this process are H_2SO_4 , Sample (H_2O) and Methyl Orange (indicator); the procedure adopted for this is to clean the burette and fill almost to top with N/50 H_2SO_4 . Then run some acid through the burette until the zero mark is reached. Measured out 10 ml sample to be tested and pour into a clean evaporating dish and add 2-3 drops of methyl Orange(indicator) to the sample if alkalinity is present the solution becomes yellow, titrate it against N/50 H_2SO_4 until endpoint appears which is faint pink or until the color of the solution is no longer yellow. Read the volume to be used of sulfuric acid to reach the end point.

Determination of TDS

Filter 100 ml sample solution by using Whitman filter paper. Evaporate the filtrate and dry the residue in the electric oven at $110^{\circ}C$. Allowed to cool in a desiccator and weighted to get the TDS in the sample.

Determination of Na and K

Apparatus used are flame photometer, compressor, burette and volumetric flask a gas cylinder and a lighter.

Prepare the sample of different known concentrations of Na and K which are of 20ppm, 40ppm, 60ppm, 80ppm and 100pp. Check these samples with the help of flame photometer one by one and then the unknown sample is last used. The absorbance readings are compared with a calibration curve. Determine the concentration of k and Na in the given sample.

Determination of Fe , NO_3^- and NO_2^-

The concentration of iron, nitrate and nitrite is determined by using the spectrophotometric method (Fang *et al.*, 2021; Harvey *et al.*, 1955). Prepare the required solution of the following separately and check all these by adjusting absorbance at different wavelengths of the spectrophotometer according to the sample. Take the absorbance of the sample and note reading for results. The absorbance readings are compared with the calibration curve prepared separately, determining the amount of iron, nitrate and nitrite in the sample.

Estimation of heavy metals

With the help of AAS, the following metals are found. First of all, prepare 5ppm, 10ppm, 15ppm and 20ppm of a standard solution of Cr, Pb and Cd. Check these samples with the

help of AAS and then check the sample of different ground water and find the results of the unknown sample.

Determination of biological oxygen demand (BOD)

Chemicals and apparatus required for the detection of BOD in sample are CaCl_2 , MgSO_4 , FeCl_3 , Na_2HPO_4 , KH_2PO_4 , NH_4Cl , MgSO_4 , KOH , KI , NaN_3 , H_2SO_4 , $\text{Na}_2\text{S}_2\text{O}_3$ and H_2O and Apparatus required is BOD incubator, Burette and Burette stand, 300 ml glass stopper BOD bottles, 500ml conical flask, pipette bulb, 250ml graduate cylinder and washed bottles. Fill two BOD bottles with dilution water until they are completely full. Carefully mix the correct volume of sample into additional BOD bottles that have been partially filled with dilution water. Fill the bottles with diluting water until they are totally full. As you insert the bottle stoppers, be careful not to trap air bubbles inside the bottles. Dilution water should be poured into the top of each bottle neck around the stopper. Determine the initial DO content of each set of duplicate bottles, including the water blank for dilution. Incubate the remaining bottles for five days at 20°C in the incubator.

Determination of chemical Oxygen demand (COD)

The chemical required for this is $\text{K}_2\text{Cr}_2\text{O}_7$, H_2SO_4 , $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$, Ag_2SO_4 , $\text{C}_{36}\text{H}_{24}\text{N}_{62}$, H_2O and apparatus required is COD digester, Burette & burette stand, COD vials with stand, 250ml Erlenmeyer flask, pipette bulb, tissue paper and Wash bottles. Take reflex flask and add 0.4 g H_2SO_4 and 20 ml of sample and mix them well. Add 10ml of 0.25N $\text{K}_2\text{Cr}_2\text{O}_7$ and add sulfuric acid -silver sulfate reagent. Mix the contents thoroughly and connect the flask to a condenser. Reflux for 2 hours. Dilute the mixture to 150 ml by adding distilled water. Add 3 drops of ferroin indicator and titrate with N/10 ferrous ammonium sulphate solution till the color change from green to red wine. Note the endpoint.

RESULTS

The samples were collected from different areas of Tehsil Shakargarh (district Narowal) and after experiments, the following results were found (Table 1-10).

Table 1: Parameters of Ground's water sample

Parameters (ppm)	Sample Maqam	Sample Baghrian	Sample Chhamal	Sample Bukhsha	Sample Karail	Sample Noor Kot	Sample Sangran	NEQS
PH	7.245	7.511	7.265	7.086	6.92	7.9	7.403	6.5-8.5
TDS	4.6	2.7	3.7	3.2	4.7	4.8	3.8	<1000
Total Hardness	35	70	65	60	50	120	90	<500
Ca^{+2}	85	90	90	60	80	53	64	<500
Total Alkalinity	95	110	99	104	115	109	105	<300
Cl^-	9	13	15	18	30	45	52	<250
COD	108	102	124	130	118	126	140	150gm/l
BOD	66	58	72	80	78	69	76	80gm/l
Depth of Sample (Feet)	90	100	120	135	160	180	190	

Table 2: Metals Detections

Parameters (ppm)	Sample Maqam	Sample Baghrian	Sample Chhamal	Sample Bukhsha	Sample Karail	Sample Noor Kot	Sample Sangran	NEQS
Na ⁺	39	24	36	8	25	31	23	250mg/l
K ⁺	3	2	2	2	3	4	2	12mg/l

Table 3: Visible Spectrophotometer

Parameters (ppm)	Sample Maqam	Sample Baghrian	Sample Chhamal	Sample Bukhsha	Sample Karail	Sample Noor Kot	Sample Sangran	NEQS
NO ₃ ⁻	3.277	1.051	0.232	0.88	0.393	0.099	0.85	12
NO ₂ ⁻	15.09	12.63	0.000	0.237	17.00	0.00	0.00	12
SO ₄ ⁻²	7.485	1.578	1.387	6.236	8.963	33.47	1.056	1000
Fe ⁺³	0.000	0.000	0.744	0.026	3.289	0.000	0.279	2.0
Cr ⁺²	0.039	0.000	0.000	0.839	0.000	0.000	3.081	0.05

Table 4: Atomic Absorption spectroscopy and metals Detection

Metals	Sample Maqam	Sample Baghrian	Sample Chhamal	Sample Bukhsha	Sample Karail	Sample Noor Kot	Sample Sangran	NEQS
Fe	0.619	0.913	0.679	0.203	0.674	0.347	0.734	2.0
Cd	0.023	0.010	0.075	0.191	0.165	0.015	0.024	0.01
Pb	0.037	0.041	0.028	0.034	0.039	0.043	0.00	<0.05
Cr	0.024	0.031	0.181	0.0347	0.0282	0.046	0.0392	<0.05

Table 5: Parameters of Maqam sample

Sample Maqam	Parameters(ppm)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day7
1	PH	7.245	7.45	7.55	7.6	7.5	7.52	7.45
2	TDS	4.7	4.98	3.2	3.7	2.4	3.2	2.8
3	Total Hardness	35	45	42	37	53	50	48
4	Ca ⁺²	85	62	68	72	70	66	71
5	Total alkalinity	95	84	91	88	80	82	84
6	Cl ⁻	9	20	09	16	11	08	13

Table 6: Parameters of Sample Bagrian

Sample Bagrian	Parameters(ppm)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day7
1	PH	7.511	7.8	7.95	7.75	7.92	7.85	7.91
2	TDS	2.7	3.8	3.7	2.1	4.2	4.7	3.1
3	Total Hardness	70	76	72	81	79	84	82
4	Ca ⁺²	90	82	78	90	88	84	85
5	Total alkalinity	110	105	120	115	100	108	112
6	Cl ⁻	13	17	11	14	17	18	16

Table 7: Parameters of sample Bukhsha

Sample Bukhsha	Parameters(ppm)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day7
1	PH	7.086	7.18	7.253	7.068	7.932	7.8	7.242
2	TDS	3.2	3.5	2.98	4.02	3.89	3.02	4.12
3	Total Hardness	60	59	63	62	66	67	65
4	Ca ⁺²	60	66	64	67	63	65	60
5	Total alkalinity	104	106	98	102	100	108	104
6	Cl ⁻	18	21	17	19	24	22	20

Table 8: Parameters of sample Karail

Sample Karail	Parameters(ppm)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day7
1	PH	6.92	6.89	6.023	6.65	6.7	6.86	6.68
2	TDS	4.7	3.98	4.8	4.2	3.01	3.47	4.2
3	Total Hardness	50	48	52	54	44	46	49
4	Ca ⁺²	80	84	78	82	86	76	78
5	Total alkalinity	115	118	114	112	110	120	116
6	Cl ⁻	30	24	32	34	28	30	32

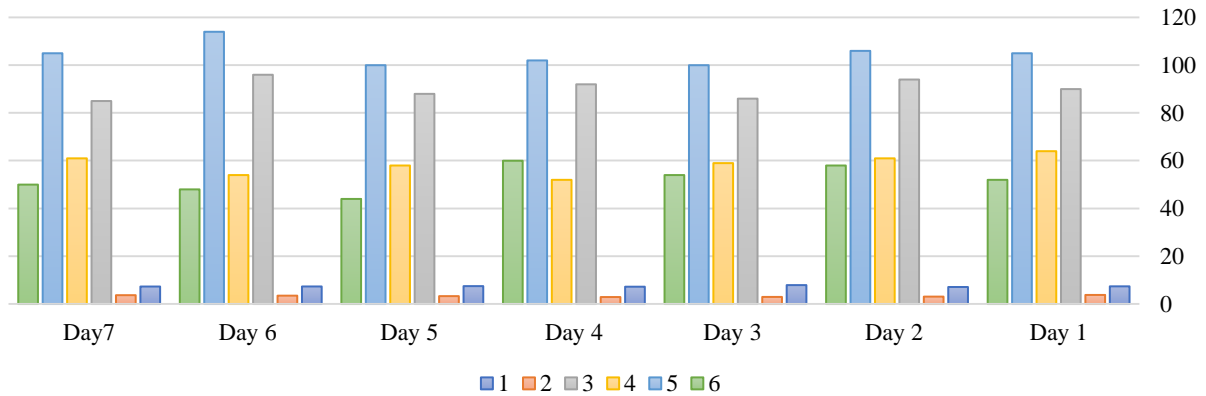
Table 9: Parameters of sample Noor Koat

Sample Noor Koat	Parameters(ppm)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day7
1	PH	7.9	8.1	8.1	7.8	7.9	7.8	7.92
2	TDS	4.8	4.9	3.98	3.91	2.99	4.7	3.82
3	Total Hardness	120	124	118	119	121	124	118
4	Ca ⁺²	53	57	52	48	50	54	52
5	Total alkalinity	109	106	100	102	100	114	116
6	Cl ⁻	45	48	44	50	54	40	43

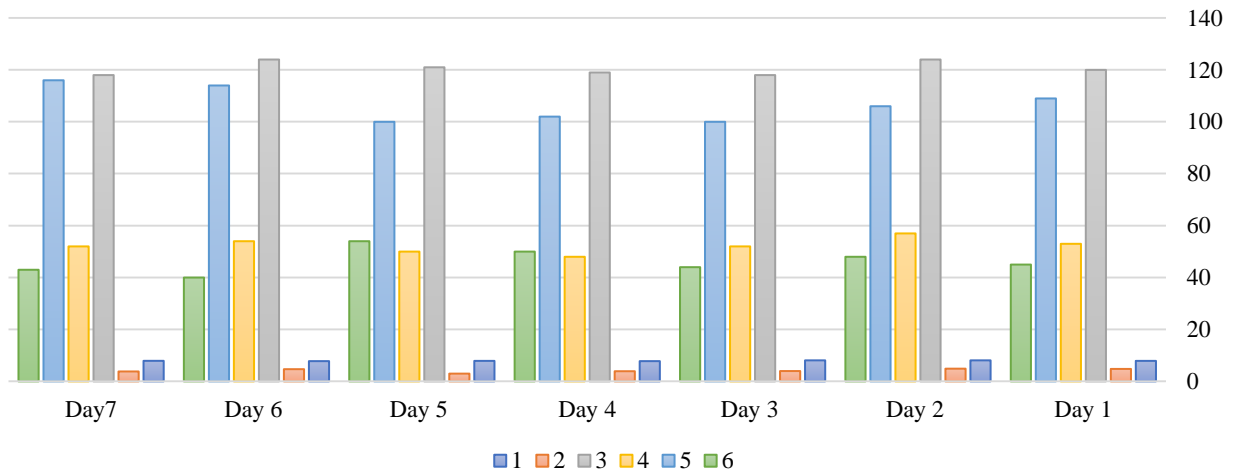
Table 10: Parameters of Sample Sangran

Sample Sangran	Parameters(ppm)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day7
1	PH	7.403	7.125	7.92	7.25	7.493	7.35	7.323
2	TDS	3.8	3.10	2.97	2.92	3.3	3.5	3.7
3	Total Hardness	90	94	86	92	88	96	85
4	Ca ⁺²	64	61	59	52	58	54	61
5	Total alkalinity	105	106	100	102	100	114	105
6	Cl ⁻	52	58	54	60	44	48	50

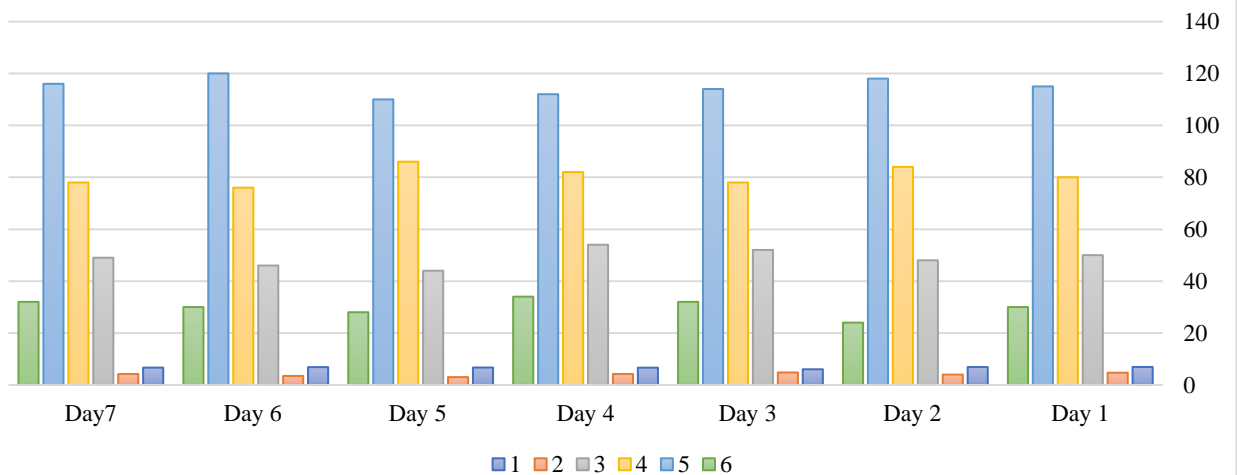
Parameters of Sample Sagan



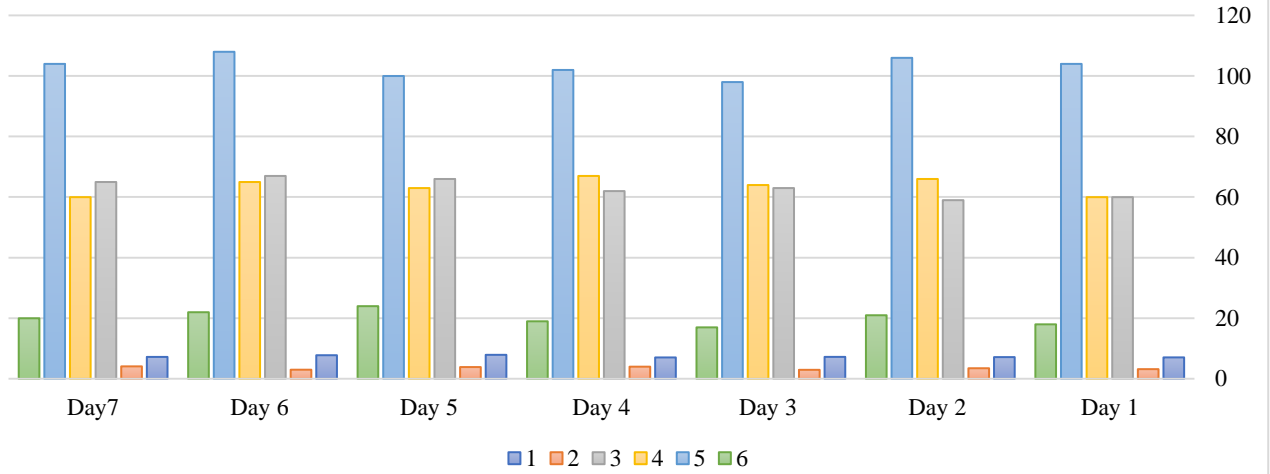
Parameters of sample Noor Koat



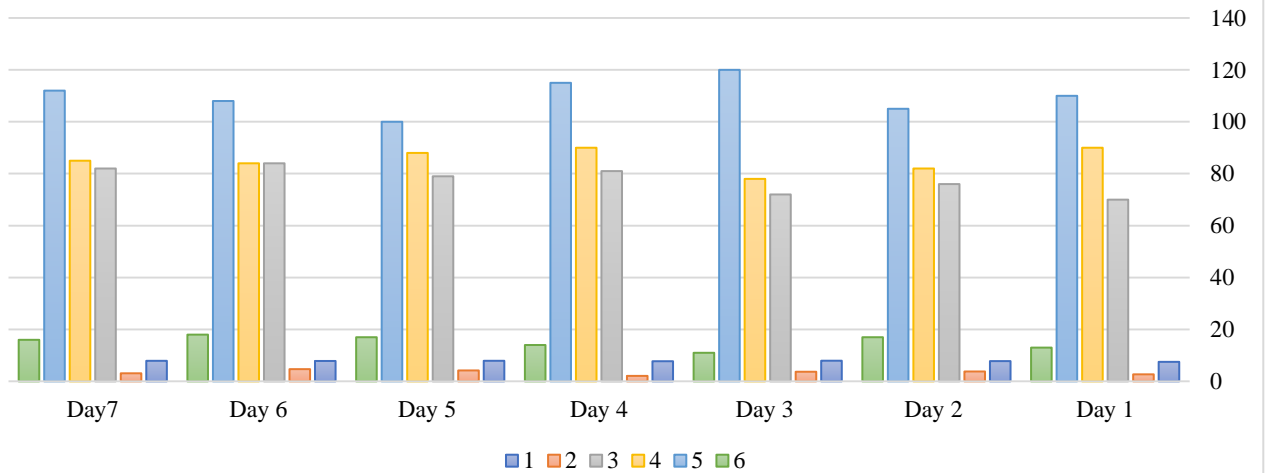
Parameters of Sample Karail



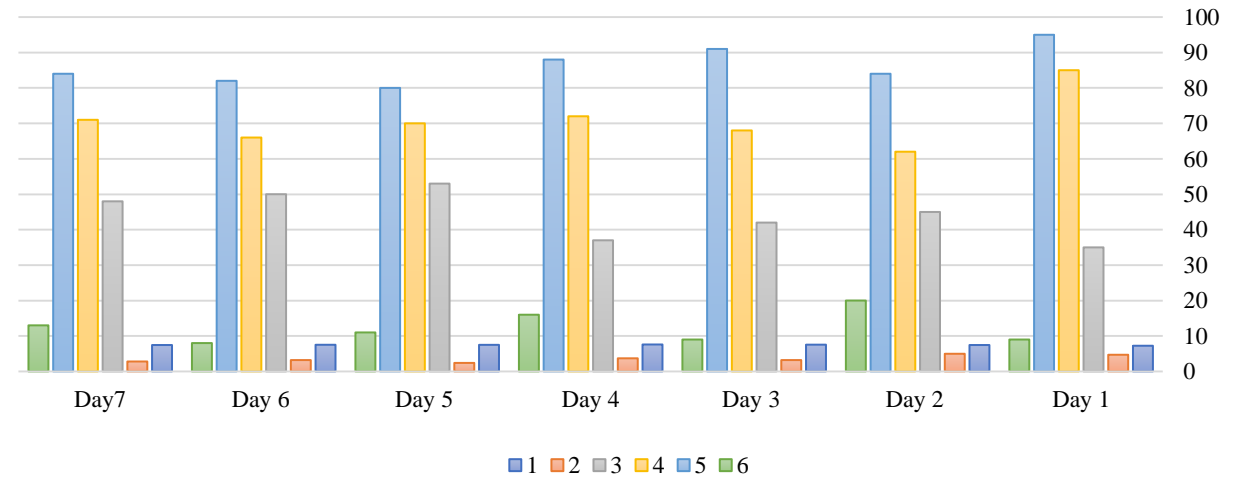
Parametrs of Sample Bukhsha



Parametrs of Sample Bagrain



Parametrs of sample Maqam



DISCUSSION

The topic of research is ground water analysis of different areas of Tehsil Shakargrah (Narowal Punjab) for this purpose, 7 different samples from different locations were collected. All samples were collected from different depths. For example, all samples were taken from 90 feet to 180 feet respectively. The actual purpose of this work is to check the quality of drinking water of these areas and aware the habitants of these areas about the quality of drinking water used by them. Different types of instrumentation were used to check different parameters. The main instrumentation is listed below.

AAS (for determination of heavy metals). U. V-Visible spectrophotometer (for determination of NO_3^{-1} , NO_2 , SO_4^{-2} , Cr etc.) Flame Photometer (For determination of Na^+ and K^+). Other laboratory instruments were also used. Parameters include biological oxygen demand (BOD) chemical oxygen demand (COD) chloride determination, Alkalinity, PH, turbidity, detection of heavy metals, determination of (NO_3^{-1} , NO_2 , SO_4^{-2} , Na^+ , K^+ , TDS, TSS, Ca^{+2} etc.

After experimentation performance, the obtained values of these parameters were compared with national environmental quality standards (NEQS). By comparing, it was found that values obtained by present work are very close to NEQS. The results are similar as found by Rafique *et al.*, 2022; Panhwar *et al.*, 2022; Fatima *et al.*, 2022; Ahmed *et al.*, 2022; Raza *et al.*, 2017 and Azizullah *et al.*, 2011. Some of these were also deviate but not in excess. So, these samples of different areas of Tehsil Shakargrah indicated that water of this area is suitable for drinking, washing, and agriculture purpose and also physically and chemically stable. Further experimental work enables us to find and check the quality of this water.

CONCLUSION

Clean water is not just a basic necessity; it is the foundation for human health, economic development, environmental sustainability, and overall quality of life. Ensuring universal access to clean water requires collective efforts in water management, infrastructure development, pollution control, and sustainable practices. So, after analyzing the water quality of the study area, it is concluded that parameters, such as COD, BOD, heavy metals, Na^+ , K^+ , NO_3^- , SO_4^{-2} , etc., of Narowal district were found to be suitable for human health and also physically and chemically stable and can be stored for a long time.

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