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Ground Water Eminence Chemical Analysis in Gulbarga City: A Physiochemical Perspective

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Abstract: This study aims at assessing the physiochemical variation of groundwater quality in Gulbarga city, rivers state India. The level of chemical concentration in the groundwater sample was analysed using the flame atomic absorption spectrophotometry. The quality of the borehole was analysed using a physical visibility survey. Groundwater samples from 5 locations in Gulbarga city was collected from public boreholes namely Zilla, Kusanoor, Sirasagi, Sultanpur and Nandikoor. Analysis of the groundwater samples was carried out in the Laboratory to ascertain the physical, chemical and microbiological characteristics. After due analysis, it was observed that most of the groundwater samples were still within permissible limits with little differences across the different locations. The temperature of the groundwater samples was different in Zilla and Sultanpur as their temperatures were not within the permissible limits of WHO. PH of the groundwater samples were also slightly different in Zilla, Kusanoor and Nandikoor with PH values of 5.20, 5.34 and 5.28 respectively. It was discovered that little treatment is needed in the study area since most of the values fall within the permissible limits of WHO.

INTRODUCTION

Water is very essential for the sustenance of life; it occupies 71% of the entire Earth surface and biologically makes up a large percentage of the total body fluid of all living things [1]. The importance and need for quality drinking water supplies for all generations cannot be overstressed as its importance outweighs every limitation. Globally, there is a drawback in its availability and this is increasing and duplicating itself thereby, intensifying the struggle for scarce water resources as discussed by [2]. Water has a lot of uses among which are for hydration, cooking and food preparation, personal hygiene and cleaning, Agriculture, Industrial processes, Energy production, recreation, Ecosystem support. Cooling and heat exchanges, healthcare and medical procedures and so on. Groundwater serves as a major source of water resources and readily available in many countries [3]. Increasing demand of surface water supplies has caused enormous pressure on freshwater ecosystems worldwide [4]. It is anticipated that around 50% of the population in developing regions suffer from health concerns due to inadequate water supply and sanitation [5]. Groundwater is typically less polluted than surface water because of its self-cleansing ability and ease of treatment [6], [7]. In the Karnataka Delta, which is surrounded by water, the main source of public water supply in the urban and semi-urban settlements is groundwater [8] . Access to good quality water is placed on number six on the list of Sustainable Development Goals (SDG) [9] yet access to good potable water is still an issue of global concern most especially in Developing Nations such as India[10]. In the Heart of Gulbarga city lays a vital resource that sustains life livelihoods-groundwater. This concealed aquifer, shrouded beneath the surface, holds the promise of purity, yet conceals potential perils. Groundwater as an indispensable natural resource plays a pivotal role in sustaining communities worldwide. In the context of Gulbarga city, a burgeoning urban centre, the reliance on groundwater for domestic, agricultural and industrial purposes is substantial. However, the quality of this vital resource is not always guaranteed as it can be influenced by various natural and anthropogenic factors. As urbanization continues to grow, it becomes imperative to conduct a thorough analysis of the groundwater quality in Gulbarga city to access its suitability for various applications and identify potential contaminants that may pose risks to public health and the environment. This research work aims to comprehensively evaluate the physiochemical groundwater quality in Gulbarga city, utilizing a combination of field measurements, laboratory analysis and statistical modelling techniques. Factors such as pH levels, temperature, turbidity, E-conductivity, total dissolved solids, total suspended solids, level of sulphate, nitrate and zinc will be examined to provide a holistic overview of the groundwater composition.

By gaining a nuanced understanding of the groundwater quality in Gulbarga city, this research seeks to provide valuable insights for policy makers, urban planners, and environmental agencies to implement effective strategies for sustainable groundwater management and safeguarding public health in this rapidly developing urban centre. Furthermore, the findings of this study will serve as a baseline for future monitoring efforts and will contribute to the broader discourse on urban groundwater quality assessment.

II. MATERIALS

2.1 Description of Study Area

Fig. 1: Geographical Maps Showing the Location of the Study Area (Gulbarga). (Google Engine)

2.2 Materials Collection

2.2.1 Materials

The following materials were used; Water samples were collected at 5 different locations in Gulbarga namely;

- Blank; a solution of no metal consisting of 450ml of distilled water and 2ml of nitric acid.
- World health organization limit and Indian standard for drinking water policy. The equipment used during the project work includes;
- Solar 969 AA Spectrometer
- Electric Orion pH Meter
- Turbidity Meter.

2.2.2 Methods

Data was collected in five (5) different locations in Gulbarga local government city. The data was collected through the use of physical assessment and distribution of questionnaires. Information about the depth of the borehole when drilled was gotten and recorded. Information about the yield of the borehole initially recorded was achieved. The period the drilling took place and the static water level of the area was recorded. Analysis of parameters used. 13 parameters were analysed which include Total dissolved solids, total suspended solids, Temperature, pH, Turbidity, Total Hardness, Biological Oxygen Demand, Chemical Oxygen Demand, Dissolved oxygen, Salinity, Zinc, Lead (Pb), Nitrate (NO_3). Digestion of the samples was carried out at Pymotech Laboratory, Enugu state. 80ml of the sample was put in a beaker and 0.2ml of concentrated nitric acid was added, the concentrated sample was subjected to heating in a water bath, this is to keep it warm and reduce its volume. The heating was done at a temperature of 75 C. The reason for heating was to remove its metal molecule bond to a free state. After some time, the volume of the sample being treated reduced to 10ml. it was then removed and subjected to cooling after which it was transferred into a volumetric flask. After the sample was cooled, about 70% of distilled water was added to the sample and the resulting solution was transferred into a bottle and analysed using the infrared spectrophotometer to test for metals. The 13 parameters were analysed according to the standard of WHO. Preparation of standards by using the concentration/volume formula $C_1V_1=C_2V_2$, this is used to calculate quantities in a mixture that are not known. The calculated values are entered into the machine. These values entered into the machine take the form of test standards during the analysis.

III. RESULTS

This research was carried out to investigate the various biological and chemical characteristics of underground water by analysing different boreholes in different parts of Gulbarga to see if they fall within permissible limits of clean portable water with reference to WHO standards. It is also aimed at determining the levels of concentration and the dangers they pose on sitting underground or borehole water in these areas.

Table 1: Laboratory analysis results of water quality parameters of Zilla, Kusanoor and Nandikoor

S/N	PARAMETER	A	B	C	D	E	WHO LIMIT
1	TDS (mg/l)	24.2	17.42	38.5	32.3	29.0	500
2	TSS (mg/L)	0.02	0.013	0.003	0.002	0.008	<10
3	Temp	27.5	25.2	26.4	27.3	27.4	27.0-29.0
4	PH	7.40	5.20	5.34	5.28	6.80	6.5-8.5
5	Turbidity (NTU)	2.43	1.35	2.34	3.56	3.18	10
6	Total Hardness (mg/L)	42.0	11.8	5.0	16.0	57.4	500
7	BOD (mg/L)	7.32	5.33	7.42	5.23	6.74	200
8	COD (mg/L)	14.3	11.00	13.29	9.38	9.22	200
9	DO (mg/L)	4.4	2.5	6.36	7.28	6.3	5.0-7.5
10	Salinity (mg/L)	32.8	15.4	9.3	38.4	27.2	250
11	Zinc	1.38	0.423	0.611	1.042	1.22	5.0
12	Pb(mg/L)	0.002	0.035	0.338	0.004	0.002	350

3.1 Total Dissolved Solid (TDS)

This is used to give an insight into inorganic salts and small amounts of organic matter that are present in a liquid.

Table 2: Laboratory Analysis Results of Quantity of Total Dissolved Solids in the Water Samples.

S/N	LOCATION	TOTAL DISSOLVED SOLIDS
1	Zilla	29.2
2	Kusanoor	17.42
3	Sirasagi	38.5
4	Sultanpur	32.3
5	Nandikoor	29.0

From the analysis underground water samples from Sirasagi has the highest concentration of dissolved solids (38.5), this was closely followed by Sultanpur (32.3), Nandikoor (29.0), Zilla (24.2) and Kusanoor (17.42). Invariably, from the above it is clear that the values of total dissolved solids in all the locations fall below the WHO Limit and as such are fit for drinking Fig 4.1.1 shows the graph of TDS plotted against location. From the graph Sirasagi has the highest concentration of dissolved solids and Kusanoor has the lowest concentration of dissolved solids. Total dissolved solids must be at its barest minimum for the water to be declared fit for drinking in order to prevent among adverse effects.

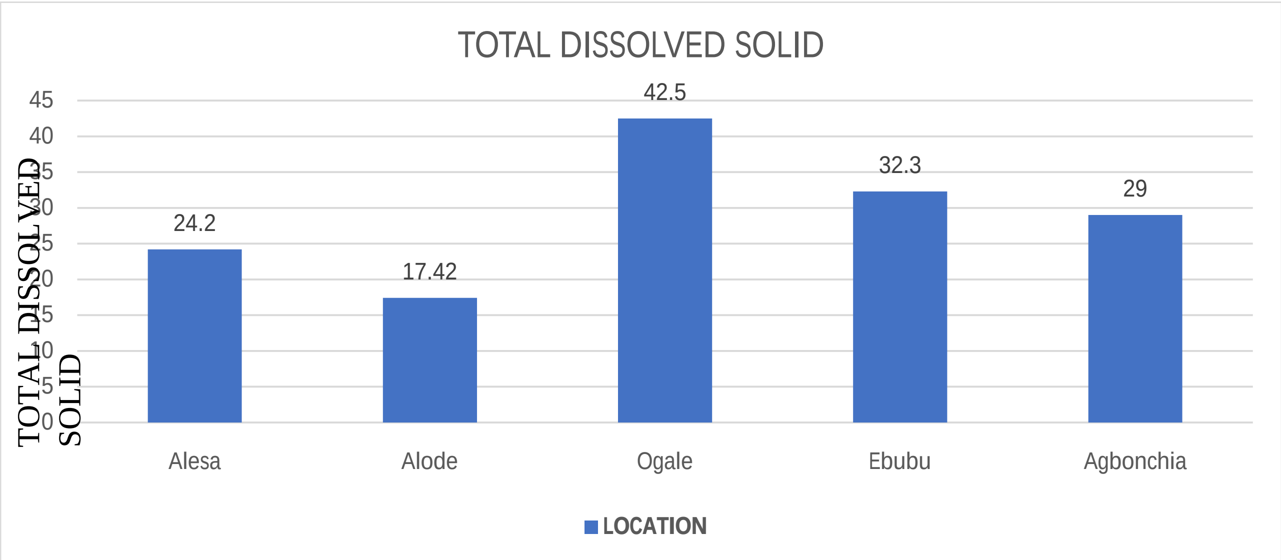

Figure 2: Graphical Representation of Total Dissolved Solids in the Location

3.2 Total Suspended Solids

A total suspended solid (TSS) is regarded as the dry weight of suspended particles that are not dissolved in a sample of water that can be filtered using a filtration apparatus.

Table 3: Laboratory Analysis Results of a Total Suspended Solid.

S/N	LOCATION	TOTAL SUSPENDED SOLIDS
1.	Zilla	0.02
2.	Kusanoor	0.013
3.	Sirasagi	0.003
4.	Sultanpur	0.002
5.	Nandikoor	0.008

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Table 3 shows a tabular presentation of the result gotten from the water quality test for the determination of total suspended solids in underground water of the study area. Samples from Zilla had the highest concentration of total suspended solids whereas samples from Sultanpur had the lowest but all location fall within the permissible limit of WHO and as such are fit for drinking.

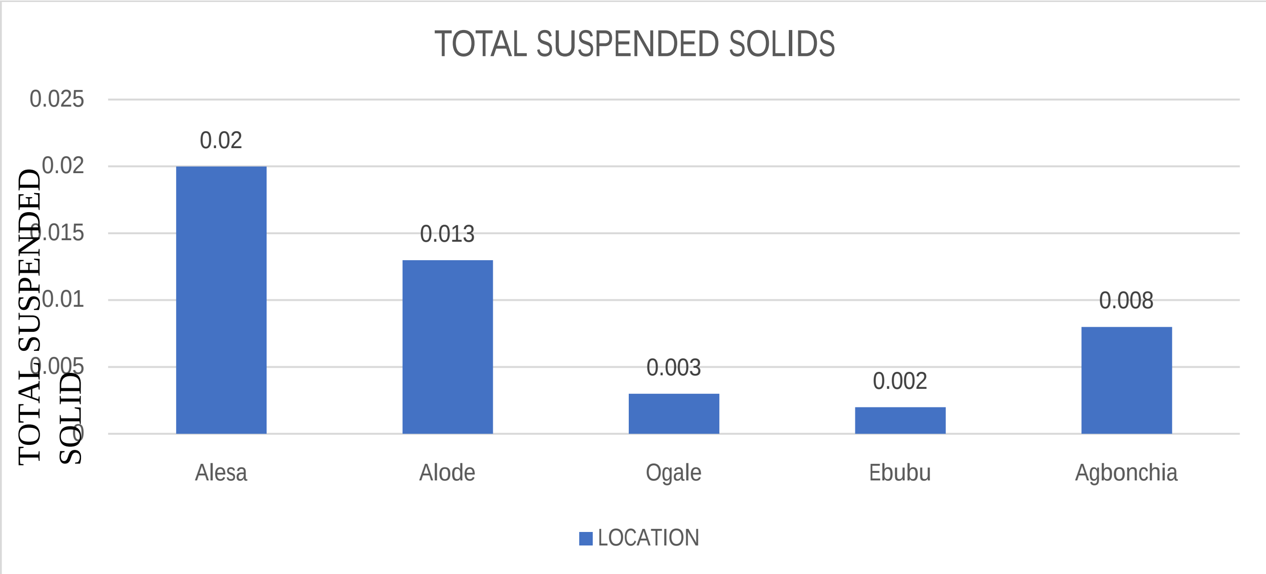


Fig 3: Graphical Presentation of Total Suspended Solids in the Location

3.3 Temperature

From the results collected at the various locations, it was discovered that Kusanoor and Sirasagi did not fall within the permissible limits by WHO and as such need some treatment before drinking.

Table 4: Laboratory Analysis Results Values of Temperature

S/N	LOCATION	TEMPERATURE
1	Zilla	27.5
2	Kusanoor	25.2
3	Sirasagi	26.4
4	Sultanpur	27.3
5	Nandikoor	27.4

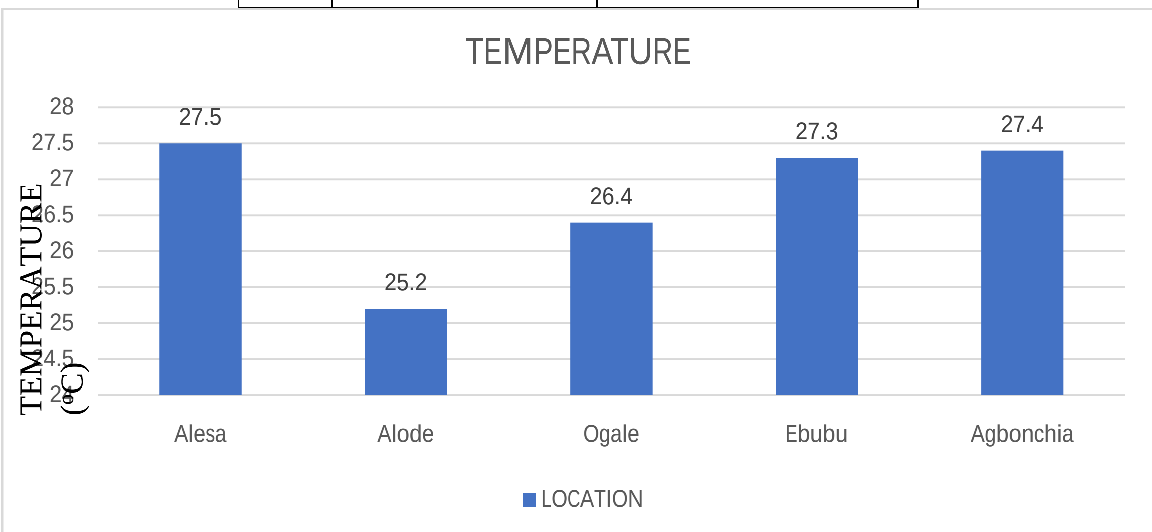


Fig 4: Graphical Presentation of Temperature in the Location

3.4 pH

The PH was within WHO Limits Zilla and Nandikoor. The PH value fell below the permissible limits of WHO in Kusanoor, Sirasagi and Sultanpur.

Table 5: Laboratory Analysis Results Values of pH

S/N	LOCATION	pH
1	Zilla	7.40
2	Kusanoor	5.20
3	Sirasagi	5.34
4	Sultanpur	5.38
5	Nandikoor	6.80

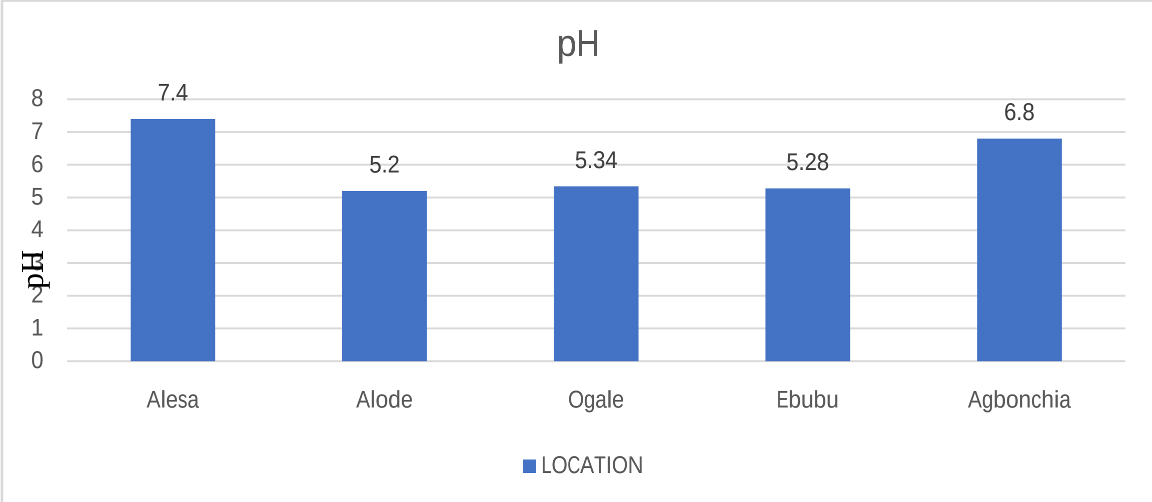


Fig 5: Graphical Presentation of pH in the Location

3.5 Turbidity

Turbidity can be said to be the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye.

Table 6: Laboratory Analysis Results of the Values of Turbidity in Zilla, Kusanoor,Sirasagi, Sultanpur and Nandikoor.

S/N	LOCATION	TURBIDITY
1.	Zilla	2.43
2.	Kusanoor	1.35
3.	Sirasagi	2.34
4.	Sultanpur	3.56
5.	Nandikoor	3.18

Table 6 signifies that Sultanpur has the highest turbidity whereas Kusanoor has the lowest turbidity

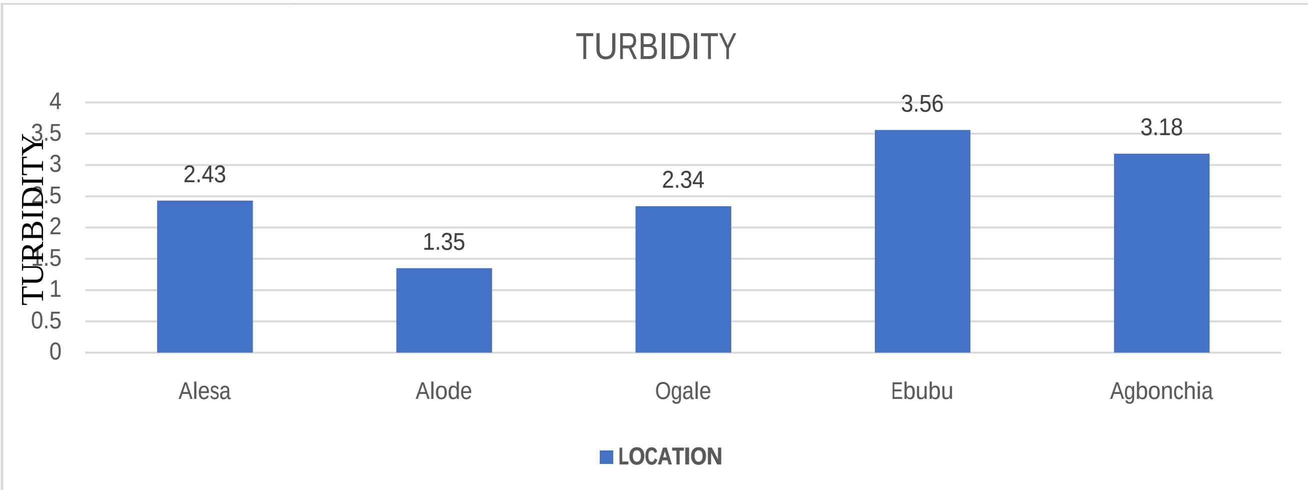


Fig 6: Graphical Presentation of Turbidity in the Location

3.6 Total Hardness

Total hardness can be referred to the overall level of mineral content, present in water. It is a measure of the water's capacity to form insoluble deposits (like scale) when heated or treated with chemicals.

Table 7: Laboratory Analysis Results Values of Total Hardness

S/N	LOCATION	TOTAL HARDNESS
1	Zilla	42.0
2	Kusanoor	11.8
3	Sirasagi	5.0
4	Sultanpur	16.0
5	Nandikoor	57.4

From the table above it can be deduced that total hardness was highest in Nandikoor, followed by Zilla and it was lowest in Sirasagi.

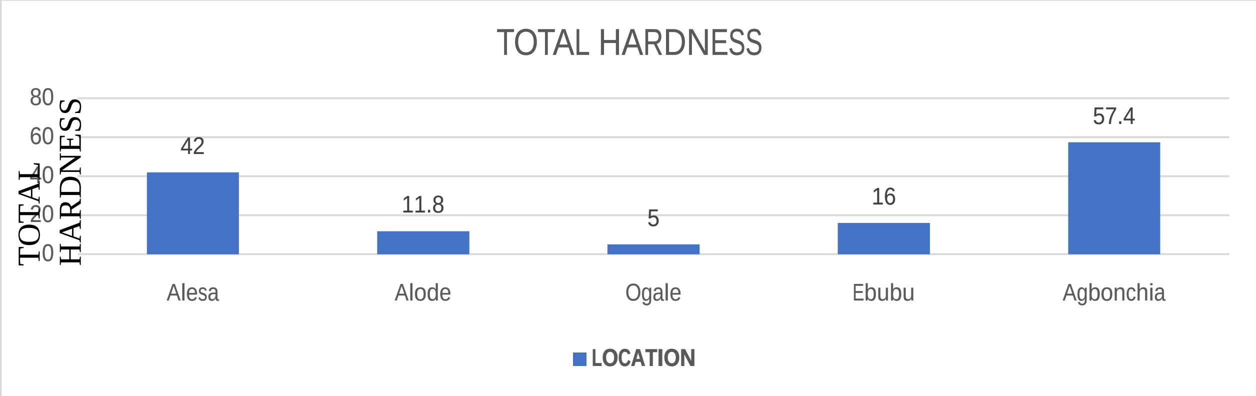


Fig 7: Graphical Presentation of Total Hardness in the Location

It can be deduced from the graph that the highest level of hard water was at Nandikoor. The values of hardwater gotten from the 5 different places all fall below the 500mg /L benchmark for drinking water by WHO, so it is deduced that water obtained in the five areas not hard water.

3.7 Biological Oxygen Demand

This is referred to the amount of oxygen required by aerobic biological organisms in a water samples, at a particular temperature and at a particular period.

Table 8: Laboratory Analysis Results of the BOD Present In the Water Samples.

S/N	LOCATION	BOD
1	Zilla	7.32
2	Kusanoor	5.33
3	Sirasagi	7.42
4	Sultanpur	5.23
5	Nandikoor	6.74

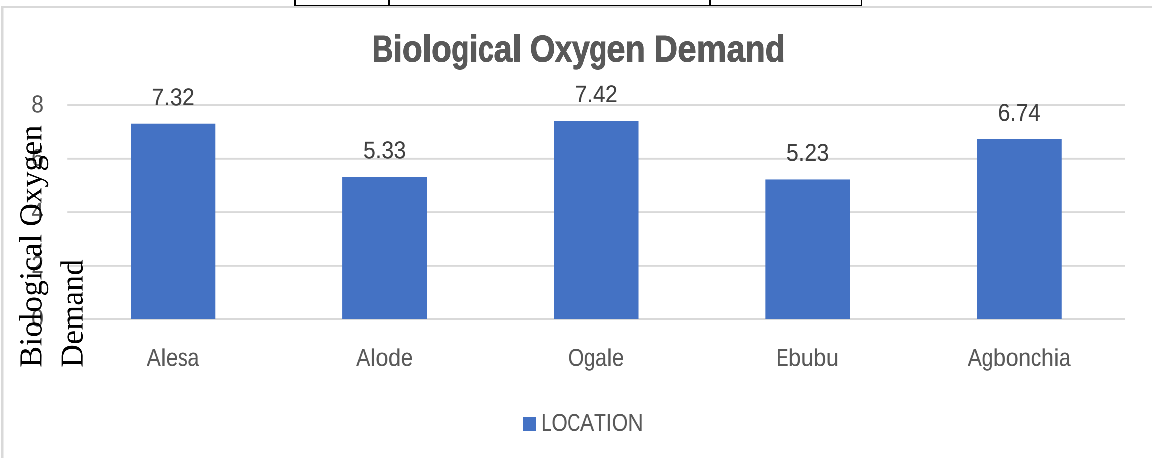


Fig 8: A Graphical Representation of the BOD Presentation the Water Samples

It can be deduced from Fig 4.1.7 that the highest BOD value of 6.74. The underground water at Nandikoor is the most concentrated. It is deduced that in all the five locations the BOD all fell within the permissible limits of WHO standards of drinking water. Though the values fall within the permissible limits of WHO they should still be treated as the amounts of BOD present were not moderate.

3.8 Chemical Oxygen Demand

Chemical oxygen demand (COD) is a measure of water and chemical oxygen demand (COD) is an indicative measure of the amount of oxygen that can be consumed by reactions in a measured solution.

Table 9: Laboratory analysis results of CODs present in the tested water samples.

S/N	LOCATION	COD (mg/L)
1	Zilla	14.3
2	Kusanoor	11.00
3	Sirasagi	13.29
4	Sultanpur	9.38
5	Nandikoor	9.22

From the graphical result, the level of COD is highest in Zilla. All the different locations fall within the permissible limit of COD for drinking water which is 200. Although they all fall within the permissible limit the water should be treated for values of COD greater than 8mg/L.

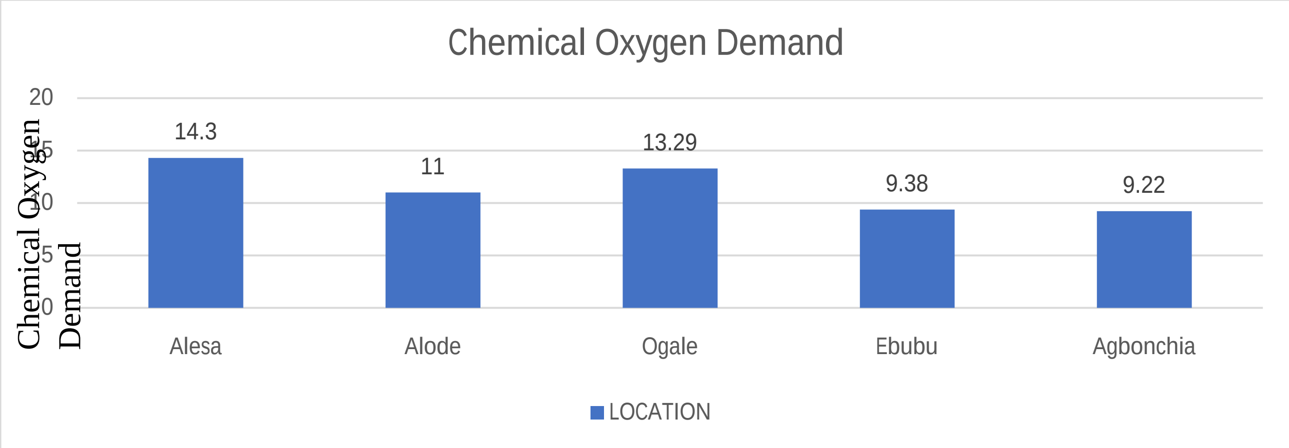


Fig. 9: Graphical Representation of CODs Present in the Water Samples.

3.9 Dissolved Oxygen

Dissolved oxygen is the amount of oxygen that is present in water.

Table 10: Laboratory analysis of Dissolved Oxygen Values between the Locations of the Study Area.

S/N	LOCATION	DISSOLVED OXYGEN
1	Zilla	4.4
2	Kusanoor	2.5
3	Sirasagi	6.36
4	Sultanpur	7.28
5	Nandikoor	6.3

From table 10 Sultanpur has the highest amount of dissolved oxygen followed by Sirasagi. Enough oxygen is required for good water quality. Water samples from Sirasagi, Sultanpur and Nandikoor all from within the permissible limit of dissolved oxygen for good portable water (5-7.5) and so underground water at Zilla and Kusanoor should e subjected to some treatment.

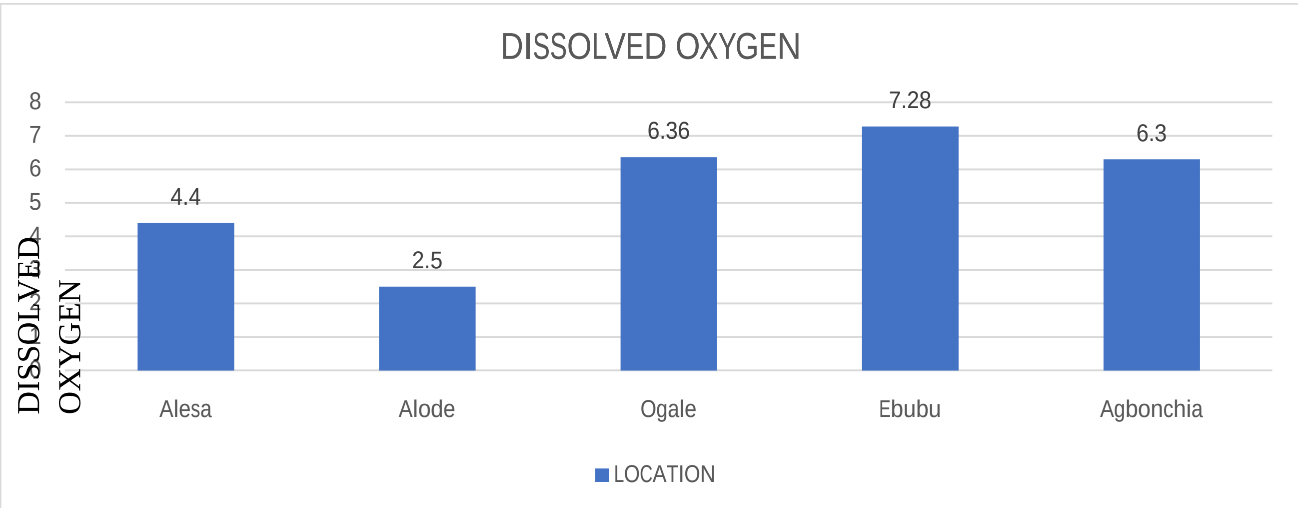


Fig. 10: Graphical Representation of Water Samples.

3.10 Salinity

Salinity is the measure of dissolved salts in water.

Table 11: Laboratory Analysis Results Values of Salinity

S/N	LOCATION	SALINITY
1	Zilla	32.8
2	Kusanoor	15.4
3	Sirasagi	9.3
4	Sultanpur	38.4
5	Nandikoor	27.2

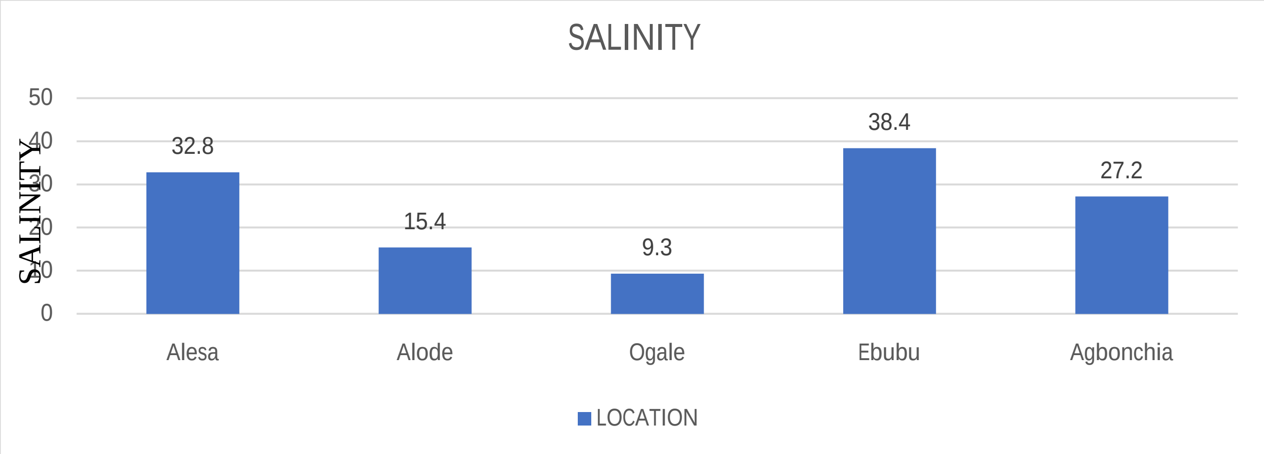


Fig. 12. A graphical representation of the results of salinity in the specified areas.

From the above graph, it can be deduced that Zilla has the highest level of Salinity and the lowest is Sirasagi with a Salinity level of 9.3. all the values of Salinity fall within the permissible limits of drinking water for salinity (250) and as such are fit for drinking.

3.11 Zinc

Table 13: Laboratory analysis of concentration of zine in the specified water samples.

S/N	LOCATION	ZINC
1	Zilla	1.38
2	Kusanoor	0.423
3	Sirasagi	0.611
4	Sultanpur	1.042
5	Nandikoor	1.22

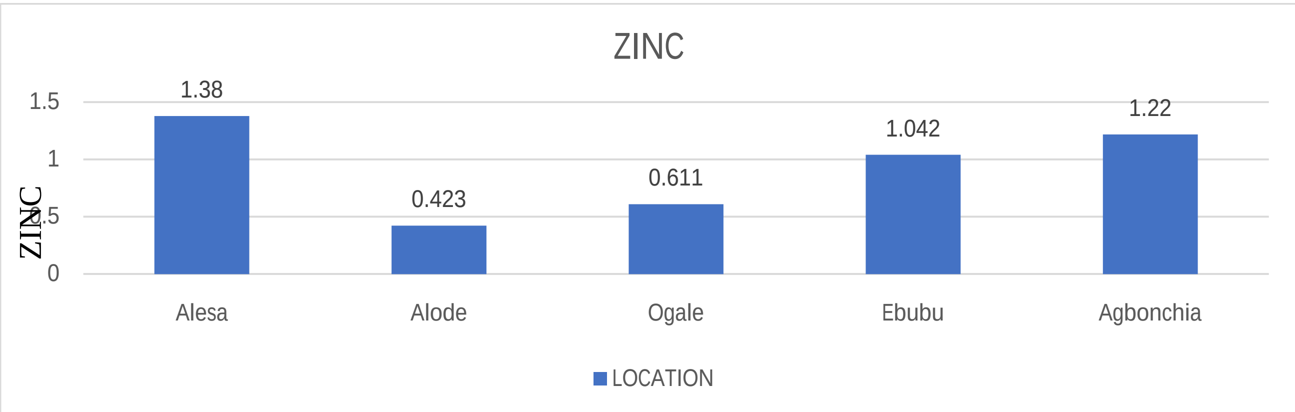


Fig. 13. A graphical representation of the results of Zinc in the specified areas

From the above graph, it is deduced that underground water at Zilla (1.38) had the highest level of zinc and the lowest at Sirasagi (0.611). all the values for zinc fall within the permissible limit of WHO for good quality water.

3.12 Lead (Pb)

Table 14: Laboratory analysis result of concentration of Pb in the specified water samples.

S/N	LOCATION	Pb
1	Zilla	0.002
2	Kusanoor	0.035
3	Sirasagi	0.338
4	Sultanpur	0.004
5	Nandikoor	0.002

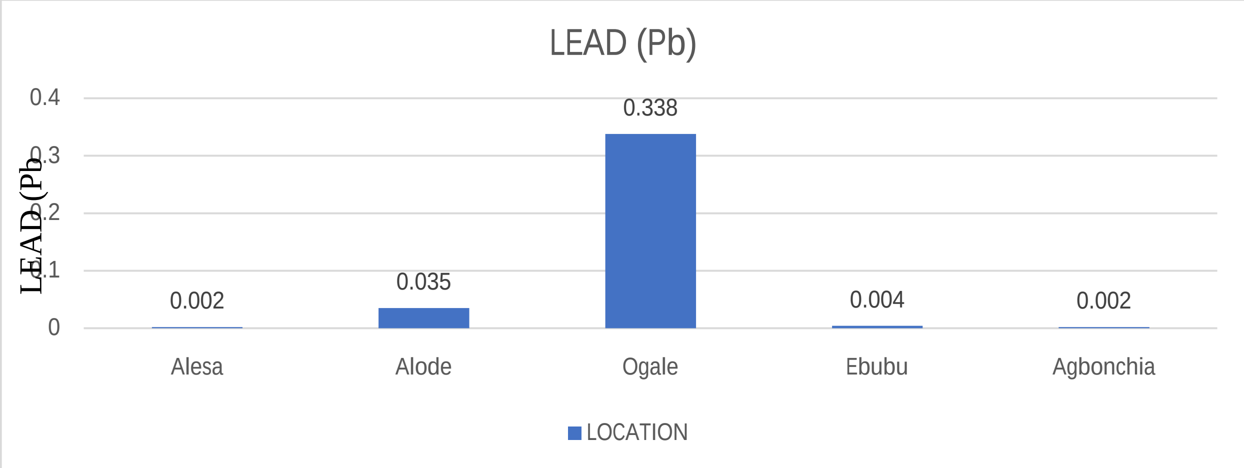


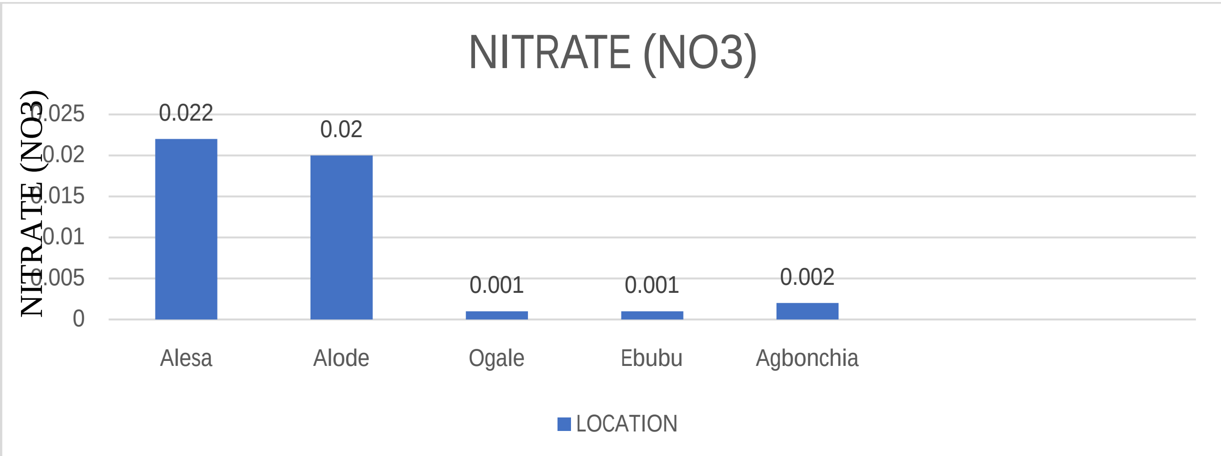
Fig 14: A graphical representation of the Result of Pb concentration in the water samples.

Fig. 4.1.12 indicates that the underground water from Sirasagi was the highest followed by Kusanoor, followed by Sultanpur and lastly by Zilla and Nandikoor with equal levels of lead (Pb). All the values fall within the permissible limits of WHO of good quality water.

3.13. NITRATE (NO_3)

Table 3.13: Laboratory Analysis Result of Concentration of Nitrate in the Water Samples.

S/N	LOCATION	Pb
1	Zilla	0.024
2	Kusanoor	0.01
3	Sirasagi	0.002
4	Sultanpur	0.002
5	Nandikoor	0.003



4.1 CONCLUSION

In conclusion, the outcome of this research work signifies that the majority of the measured parameters align with the stringent standards set by the World Health Organization (WHO). This is a testament to the commendable efforts in maintaining a high level of water quality within the region such a positive assessment holds profound implication for the well-being of the Gulbarga community. Access to ground water that complies with WHO standards ensures that residents have a reliable and safe source of drinking water. Thus, in turn, mitigates the risks associated with water borne diseases and contributes to the overall health and prosperity of the population.

Furthermore, this achievement reflects the efficacy of existing water management and treatment systems in Gulbarga city.

4.2 Recommendations

1. Regular maintenance of infrastructure should be carried out.
2. Sedimentation and filtration processes should be implemented to reduce turbidity and suspended particles in groundwater.
3. coagulation – Flocculation techniques should be employee to reduce heavy metal concentrations (e.g arsenic, lead, mercury) to fall within WHO limits.
4. Awareness campaigns should be conducted to educate residents about responsible chemical use, waste disposal, and practices that safeguard groundwater quality.
5. A contingency plan to address sudden water quality issues should be developed, including procedures for notifying the public and implementing corrective measures.

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