ASSESSMENT OF FLUORIDE CONCENTRATIONS IN THE GROUNDWATER OF JHUNJHUNU, RAJASTHAN, INDIA REGION

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ABSTRACT

Fresh water is a lifeline of all living organisms because freshwater is mostly stored in glaciers, rivers, lakes, and the underground of the earth. According to the ICMR standard, a 0.6 mg/l fluoride concentration is required for human teeth and bones while more than 1.5 mg/l fluoride concentration is responsible for various human diseases. All water samples of groundwater and deep wells have been collected from the Chirawa, Buhana, and Surajgarh of the Jhunjhunu district for the assessment of fluoride concentration. All water samples are analyzed through physiochemical methods. Fluoride concentration was determined with the help of the APHA-23nd 2017 method. The highest concentration of fluoride was found at 1.4 mg/l of Kakoda (Sample no 16) while the lower concentration of fluoride was found at 0.7 1.4 mg/l of three places as Pilani water box, Morva, and Chirawa CHC (Sample no 1, 10, 30). The fluoride concentration of the remaining places was found suitable for the human being.

KEYWORDS: Groundwater, Overexploitation, Fluoride, Physicochemical properties, Jhunjhunu

Introduction

water quality is a major challenging issue due to increasing population, industrialization, and over-exploitation. Few countries are not providing quality water for their citizens due to a lack of facilities. Few places in any country have excellent qualities of water (people can drink without treatment) while few places have impurities included in the water, therefore, People cannot drink it directly because arsenic, fluoride, and some heavy metals, organic and inorganic chemicals dissolved it.

The current research work is the basis of the fluoride concentration in the groundwater of various villages and three tehsils, including Chirawa, Buhana, and Surajgarh of Jhunjhunu district. All water samples were collected from the bore well and deep well and analyzed by APHA-23nd Ed.2017 methods were used for physicochemical parameters. Fluoride is a common constituent of groundwater. Natural sources are connected to various types of rocks and to volcanic activity. Agricultural (use of phosphatic fertilizers) and industrial activities (clays used in ceramic industries or burning of coals) also contribute to high fluoride concentrations in groundwater. The presence of low or high concentrations of fluoride ions is a major issue as they make the groundwater unsuitable for various purposes. Fluoride ion causes health problems in people in about 25 countries around the world. A fluoride concentration of at least 0.6mg/l is required for human consumption as it will heat to have stronger teeth and bones. A fluoride concentration of more than 1.5mg/l in groundwater results in acute to chronic dental fluorosis where the tooth becomes colored from yellow to brown. Skeletal fluorosis which causes weakness and bending of the backbone also called “Hunch back disease”. In this research authors want to find; That Pearson’s correlation coefficient s(r)was calculated among fluoride and other parameters. It was observed that fluoride content is exhibiting a statistically significant positive correlation with Sodium, Iron, and Copper contents.

The area of Chirawa, Buhana, and Surajgarh tehsil (Jhunjhunu district) comprise different types of Archaean

crystalline formation. The water provided for human consumption is regularly directly sourced from groundwater and should be free from toxic content, excessive amounts of minerals, and living and non-living organisms that may be harmful to health. The quality of groundwater in Suraj Garh tehsil was analyzed for common water quality. Hence, it is compulsory to examine the presence of toxic substances in the distribution of water for drinking purposes. In the study area, there are no more surface water sources, but still, the main sources of drinking water bore well, open deep wells, and tube wells. Different Physico chemical characteristics such as pH, Electrical Conductance (EC), Total Hardness (TH), Total alkalinity (TA), chloride, nitrate, fluoride, Total dissolve solid (TDS), sodium, potassium, iron, copper, total phosphate, turbidity, and sulfate, etc. was carried out to APHA-23nd Ed. 2017. The statistical analyses were carried out with the help of Pearson's coefficient and the results were examined in graphic images.

Fresh and pure water is a lifeline of all living animals and plants but freshwater is stored in glaciers, rivers, lakes, and the underground of the earth. In this research area, there is no other facility (no river, no lakes) without groundwater.

MATERIAL AND METHODOLOGY: *Ground-water samples were collected randomly and precleaned poly ethylene (thermo-plastics) bottles from 42 villages and town of three tehsils such as Chirawa, Buhana and Surajgarh (Jhunjhunu district) of Rajasthan as given in table-1. All water samples collectedin 2 litters plastic bottles and brought to the laboratory for analysis, using standard technique for physicochemical parameters were determined with water testing kit (APHA-23ND. 2017)as per standard methods given in APHA, 2005. Listed in table -2.*

Fluoride concentration was determined with the help of APHA-23nd 2017 and statistical analysis was carried out by Karl Pearson's coefficient which listed in table –3 and table -4.

Table -1 Physico-chemical properties of the ground water of different sampling sites

Code	Sampling Site	Tehsil	pH	EC	Turb.	TDS	TH	TA	SO_4^{-2}	NO_3^{-1}	T.P.	Cl^{-1}	F^{-1}	Na^{+1}	K^{+1}	Fe^{+2}	Cu^{+2}
S-1	Pilani Water Box	Surajgarh	7.61	568	2	426	120	296	28.5	4.8	1.1	152	0.7	128	132	0.44	1.95
S-2	Pilani Bus Stand	Surajgarh	7.63	616	2	462	126	286	29.6	4.9	1.2	160	0.8	132	120	0.65	1.97
S-3	Pilani Birla Hospital	Surajgarh	7.65	605	2	454	122	280	32.2	5.1	1.1	148	0.9	124	140	0.66	1.75
S-4	Jherli	Surajgarh	7.7	580	2	435	128	286	31.2	5.3	1.2	156	0.8	134	140	0.45	1.88
S-5	Hameenpur	Surajgarh	7.61	624	2.5	468	148	290	32.4	4.9	1	160	0.9	134	130	0.82	2.05
S-6	Bangothari Kalan	Surajgarh	7.63	680	2	510	168	300	30.6	5.5	1.1	148	0.8	148	152	0.82	2.88
S-7	Beri	Surajgarh	7.65	710	2	532	148	290	33.5	5.2	1.2	160	1	150	140	0.82	3.19
S-8	Dulania	Surajgarh	7.75	596	1.5	450	142	302	35.6	5	1	150	0.8	152	155	0.77	3.08
S-9	Dheendhwa Aguna	Surajgarh	7.61	624	1.5	468	158	290	29.8	5.2	1	162	0.9	148	136	0.85	2.74
S-10	Morwa	Surajgarh	7.61	590	1.5	442	138	278	28.5	4.9	1	152	0.7	160	158	0.52	2.22
S-11	Kherla	Surajgarh	7.68	620	3.5	465	160	194	30.5	5.3	1	156	0.9	120	126	0.69	2.15
S-12	Devrod	Surajgarh	7.68	660	3.5	465	166	202	30.5	5.3	1	156	0.9	126	132	0.73	2.95
S-13	Lakhu	Surajgarh	7.68	690	4	522	240	212	30.5	5.3	1.1	186	0.9	107	91	0.79	3.12

S-14	Chorodi Auguni	Surajgarh	7.68	1180	5.5	926	296	380	58.8	6.9	1.6	486	1.3	186	170	1.22	3.88
S-15	Khedaro ki Dhani	Surajgarh	7.72	1060	5.5	856	280	390	49.8	6.3	1.5	390	1.3	186	170	0.98	3.81
S-16	Kakoda	Surajgarh	7.68	1048	5	786	270	342	53.9	5.9	1.4	460	1.4	176	146	1.02	3.68
S-17	Surajgarh R. Station	Surajgarh	7.73	1068	5.5	801	276	350	48.9	6.3	1.4	420	1.2	168	148	1.01	3.88
S-18	R.K.J.K. College	Surajgarh	7.68	980	5.5	842	290	330	53.6	6.4	1.5	490	1.1	162	142	1.12	3.86
S-19	Surajgarh Mandi	Surajgarh	7.68	980	5	780	276	296	48.7	6.3	1.4	420	1.2	182	152	1.08	3.55
S-20	Jakhod	Surajgarh	7.72	960	4.5	720	226	290	45.9	6.8	1.4	412	1.3	168	148	0.88	3.45
S-21	Farat	Surajgarh	7.7	940	4.5	705	186	260	48.7	6.3	1.4	326	1.2	152	130	0.85	3.12
S-22	Pilod	Surajgarh	7.68	962	4.5	720	190	268	43.9	6.4	1.4	302	1.2	162	126	1.01	3.16
S-23	Bhavthari	Surajgarh	7.71	920	5	690	142	268	49.6	6.8	1.1	296	1.3	148	152	0.93	2.85
S-24	Bijoli	Surajgarh	7.7	920	4.5	690	180	275	50.9	6.8	1.2	268	1.3	152	148	0.77	2.34
S-25	Kajara	Surajgarh	7.52	912	5	684	140	290	45.2	7.1	1.2	252	1.3	152	160	0.82	2.55
S-26	Jeeni	Surajgarh	7.46	896	4.5	672	134	276	48.6	7.4	1.1	242	1.2	148	152	0.93	2.87
S-27	Narhar	Chirawa	7.7	640	3.5	480	180	225	30.5	5.3	1.2	168	0.8	126	116	0.56	2.97
S-28	Ojtu	Chirawa	7.68	702	3.5	520	180	190	35.6	5.5	1.2	162	1	145	126	0.76	2.17
S-29	Chirawa Water Box	Chirawa	7.8	710	3.5	530	166	190	31.5	4.5	1.4	160	0.8	142	136	0.81	2.29
S-30	Chirawa CHC	Chirawa	7.68	670	3	510	152	236	39.8	5.3	1.3	156	0.7	124	105	0.66	2.73
S-31	Chirawa Station	Chirawa	7.68	720	3.5	540	196	230	32.6	5.3	1	68	1.2	116	100	0.78	2.44

S-32	Ardawata	Chirawa	7.68	720	3.5	580	210	210	33.8	5.3	1	168	1.2	126	105	0.67	2.42
S-33	Chirawa RIICO	Chirawa	7.68	620	3	465	160	212	30.5	5.3	1	156	0.9	117	105	0.54	2.35
S-34	Gadakhera	Chirawa	7.68	710	3	532	232	220	30.5	5.6	1.1	192	1.2	112	95	0.72	3.09
S-35	Bhasawata Kalan	Buhana	7.8	710	3.5	540	226	226	36.5	5.3	1	186	0.9	126	98	0.65	3.15
S-36	Singhana	Buhana	7.71	740	3.5	512	252	236	38.4	6.2	1.1	196	0.8	112	92	0.77	3.22
S-37	Pacheri Khurd	Buhana	7.68	896	4	692	264	280	30.5	6.2	1.2	360	0.9	142	120	0.82	3.15
S-38	Pacheri Bari	Buhana	7.9	912	4.5	726	270	320	39.6	6.5	1.2	400	1.1	170	152	0.96	3.55
S-39	Bhirr	Buhana	7.68	1013	4.5	760	286	326	42.5	5.8	1.1	426	1.3	176	148	1.18	3.68
S-40	Buhana	Buhana	7.68	1026	5	780	290	340	44.8	5.8	1.4	442	1.2	180	160	1.12	3.55
S-41	Dhaka Mandi	Buhana	7.7	1060	6	800	286	326	50.1	6.9	1.5	460	1.3	180	158	0.92	3.85
S-42	Badbar	Buhana	7.68	1216	6	912	290	380	55.9	6.8	1.5	460	1.3	186	170	1.15	4.01

Annotation: *In the above table, the unit of the physico-chemical properties are presented as, EC (µS/cm), Turbidity (NTU), TDS (mg/l), Total Hardness (mg/l), Total Alkalinity (mg/l), Sulphate Content (mg/l), Nitrate (mg/l), Total Phosphate (mg/l), Chloride Content (mg/l), Fluoride Content (mg/l), Sodium Content (mg/l), Potassium Content (mg/l), Iron Content (mg/l), and Copper Content (mg/l).*

Table -2: Physico-chemical parameters and their refereed methods

S.No.	*Biochemical Attribute*	*Refereed Method*
1.	*pH*	*IS-3025(P-11)*
2.	*Conductance*	*IS-3025(P-14)*
3.	*Turbidity, NTU.*	*IS-3025(P-10)*
4.	*Total Dissolved Solids*	*IS-3025(P-16)*

5.	*Total Hardness*	*APHA-23nd Ed-2017*
6.	*Total Alkalinity*	*IS-3025(P-23)*
7.	*Sulphate Content*	*APHA-23nd Ed-2017*
8.	*Nitrate Content*	*IS-3025(P-34)*
9.	*Total Phosphate Content* ($PO_{4_{3-}}$, $HPO_{4_{2-}}$, $H_2PO_{4)}$	*APHA-23nd Ed-2017*
10.	*Chloride Content*	*APHA-23nd Ed-2017*
11.	*Fluoride Content*	*APHA-23nd Ed-2017*
12.	*Sodium Content*	*IS-3025(P-45)*
13.	*Potassium Content*	*IS-3025(P-45)*
14.	*Ferrous Content*	*IS-3025(P-53)*
15.	*Copper Content*	*3111 B. Direct Air-Acetylene Flame Method (APHA, 2005)*

Statistical Analysis: *To approach the precise and concluding results, Correlation was calculated among different physico-chemical parameters. Correlation refers to the statistical relationship between two entities. In other words, it is how two variables move in relation to one another, or correlation denotes the association between two quantitative variables. The correlation is one of the most common and most useful statistics. A correlation is a single number that describes the degree of relationship between two variables. The degree of association is measured by a correlation coefficient, denoted by "r" and measure the linear association. The correlation coefficient is measured on a scale that varies from +1 through 0 to -1. Complete correlation between two variables is expressed by either + 1 or -1. In the present research work the correlation among the various water quality parameters were analysed to know the relationship and status of an individual water quality parameter. Generally, water quality parameters exhibit the relationship with other water quality parameters due to a chemical or physical affinity. For such purpose Pearson's correlation coefficients (r) were calculated through statistical software. The Pearson's correlation coefficient (r) values varied from "+1 to -1". The "+1" value reveal a strong positive correlation and "-1" value reveal a strong negative correlation. Based on statistical significance, the Pearson's correlation coefficient (r) values are expressed as per the table.*

Table -3.: The Pearson's correlation coefficient (r) values and its statistical significance

S. No.	*r -value*	*Statistical Conclusion*
1.	*0.9 - 1.0*	*Very high positive (negative) correlation*
2.	*0.7 - 0.9*	*High positive (negative) correlation*
3.	*0.5 - 0.7*	*Moderate positive (negative) correlation*
4.	*0.3 - 0.5*	*Low positive (negative) correlation*

5.	*0.0 - 0.3*	*Negligible correlation*

Table -4: Correlation coefficient (r) value among different physico-chemical parameters

r Value	pH	EC	Turbidity	TDS	TH	TA	SO_4^{-2}	NO_3^{-1}	T.P.	Cl^{-1}	F^{-1}	Na^+	K^+
pH	1												
EC	0.122	1											
Turbidity	0.173	0.911	1										
TDS	0.141	0.989	0.906	1									
TH	0.402	0.765	0.738	0.782	1								
TA	-0.038	0.677	0.419	0.695	0.485	1							
SO4-2	0.049	0.908	0.844	0.905	0.578	0.638	1						
N03-1	-0.087	0.816	0.799	0.796	0.473	0.471	0.823	1					
T.P.	0.195	0.776	0.700	0.791	0.594	0.590	0.746	0.531	1				
Cl-1	0.206	0.928	0.833	0.941	0.812	0.727	0.833	0.714	0.780	1			
F-1	0.007	0.839	0.797	0.824	0.561	0.459	0.790	0.755	0.503	0.709	1		
Na+	0.099	0.807	0.598	0.816	0.556	0.816	0.746	0.567	0.713	0.831	0.612	1	
K+	-0.100	0.560	0.363	0.564	0.179	0.763	0.574	0.463	0.490	0.573	0.420	0.852	1

Correlation among Fluoride Content and other Water Quality Parameters

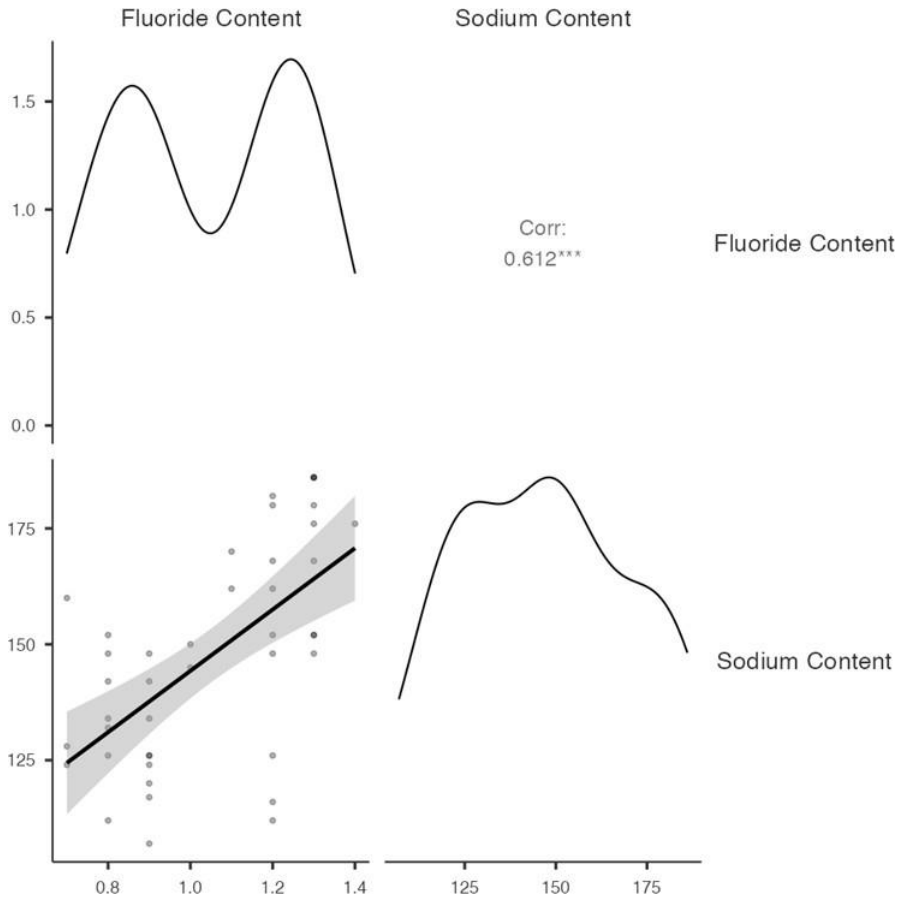

Figure 5.1: Correlation curve between Fluoride Content and Sodium Content

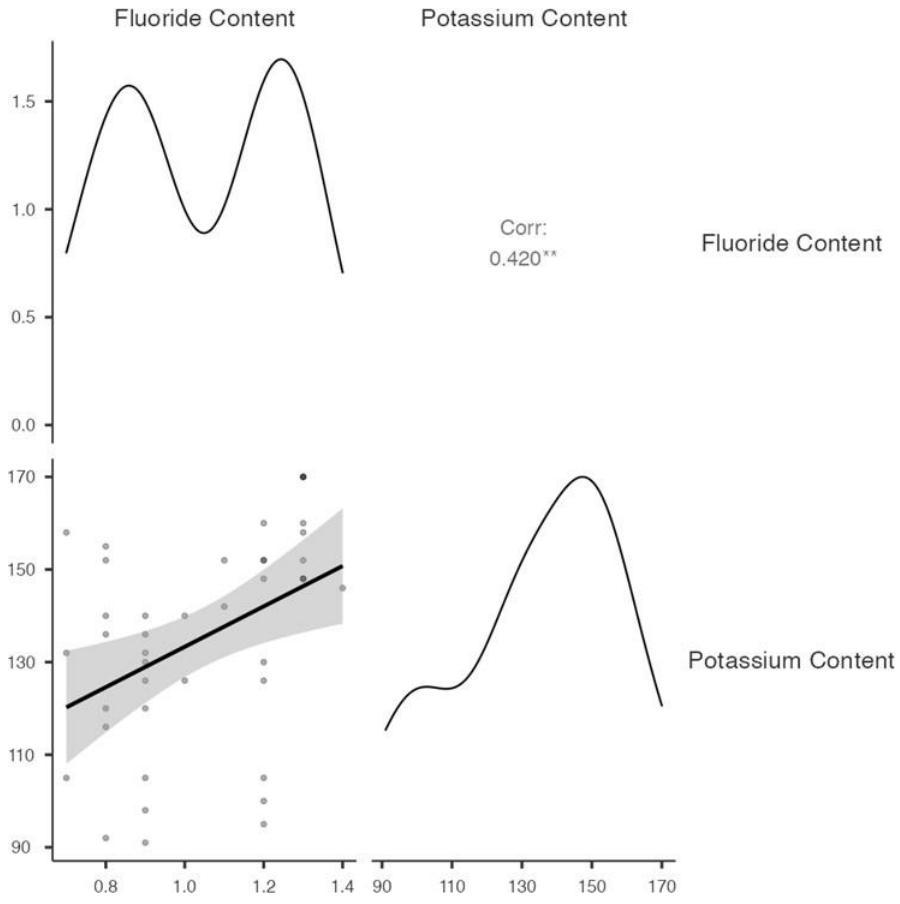

Figure 5.2: Correlation curve between Fluoride Content and Potassium Content

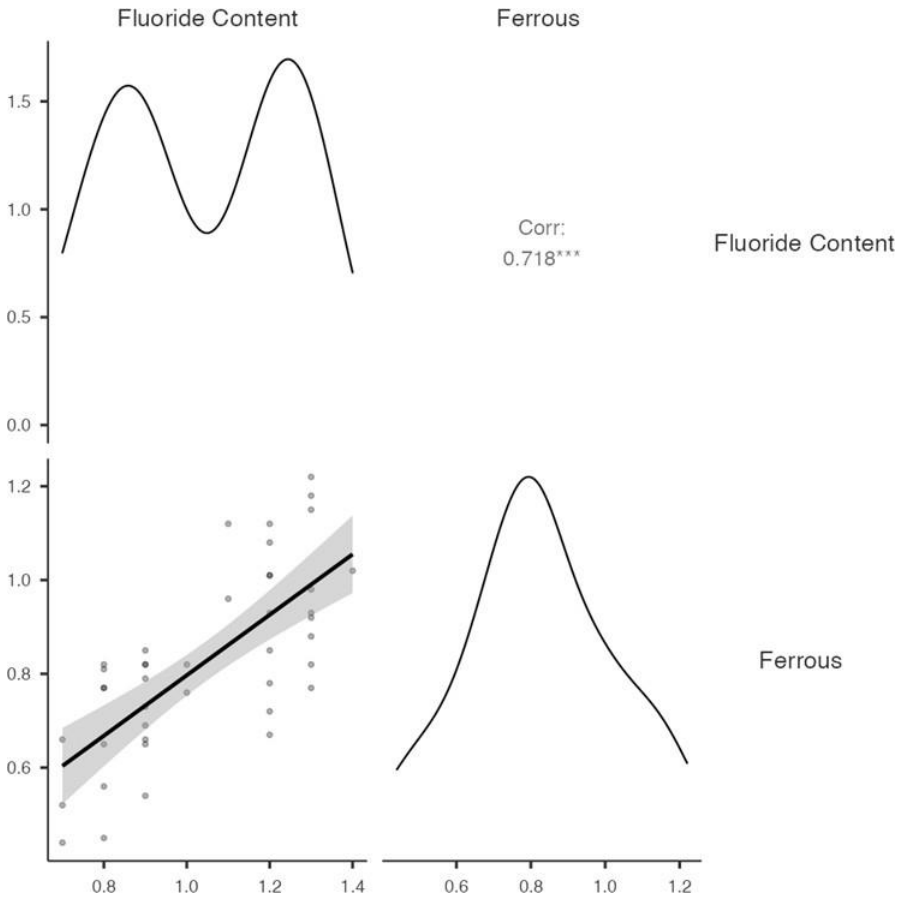

Figure 5.3: Correlation curve between Fluoride Content and Ferrous Content

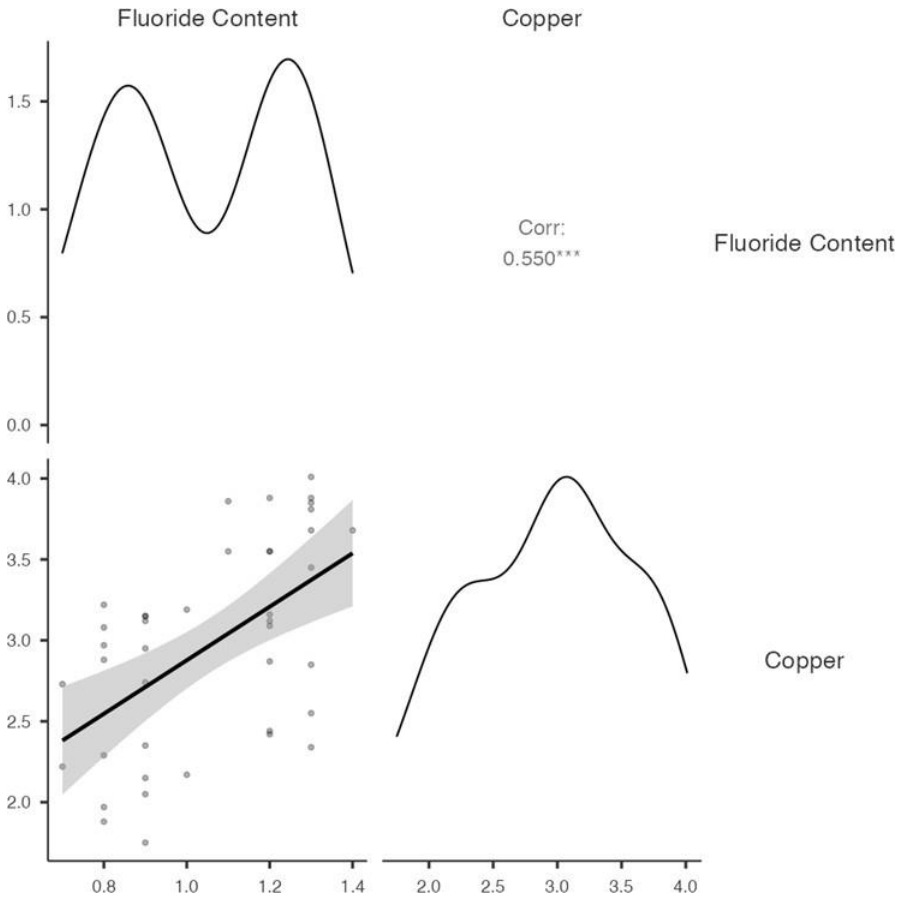

Figure 5.4: Correlation curve between Fluoride Content and Copper Content

Result and Discussion: *In the present research work, correlation coefficient values are calculated in sequential manner by keeping stable a physico-chemical property or water quality parameter against the other physico-chemical properties. The detailed analysis of various physico-chemical properties is covered in the successive headings.*

The Pearson's correlation coefficients (r) were calculated among fluoride content and other water quality parameters (Table 5). It was observed that fluoride content is exhibiting the statistically significant positive correlation with sodium content, iron content, and copper content.

The Pearson's correlation coefficients (r) were calculated among pH and other water quality parameters. It was observed that on the first place pH does not express any statistically significant correlation with other physico-chemical parameters. Since pH directly does not affect the several physico-chemical parameters.

The Pearson's correlation coefficients (r) were calculated among EC and other water quality parameters. It was observed that EC is exhibiting the statistically significant positive correlation with

all the physico-chemical parameters including turbidity, total dissolved solids, total hardness, total alkalinity, sulphate content, nitrate content, total phosphate content, chloride content, fluoride content, sodium content, potassium content, iron content, and copper content.

The Pearson's correlation coefficients (r) were calculated among turbidity and other water quality parameters. It was observed that turbidity is exhibiting the statistically significant correlation with total dissolved solids, total hardness, sulphate content, nitrate content, total phosphate content, chloride content, fluoride content, sodium content, iron content, and copper content.

The Pearson's correlation coefficients (r) were calculated among total dissolved solids and other water quality parameters. It was observed that total dissolved solids are exhibiting the statistically significant positive correlation with total hardness, total alkalinity, sulphate content, nitrate content, total phosphate content, chloride content, fluoride content, sodium content, potassium content, iron content, and copper content.

The Pearson's correlation coefficients (r) were calculated among total hardness and other water quality parameters. It was observed that total hardness is exhibiting the statistically significant positive correlation with sulphate content, total phosphate content, chloride content, fluoride content, sodium content, iron content, and copper content.

The Pearson's correlation coefficients (r) were calculated among total alkalinity and other water quality parameters. It was observed that total alkalinity is exhibiting the statistically significant positive correlation with sulphate content, total phosphate content, chloride content, sodium content, potassium content, iron content, and copper content.

The Pearson's correlation coefficients (r) were calculated among sulphate content and other water quality parameters. It was observed that sulphate content is exhibiting the statistically significant positive correlation with nitrate content, total phosphate content, chloride content, fluoride content, sodium content, potassium content, iron content, and copper content.

The Pearson's correlation coefficients (r) were calculated among nitrate content and other water quality parameters. It was observed that nitrate content is exhibiting the statistically significant positive correlation with total phosphate content, chloride content, fluoride content, sodium content, potassium content, iron content, and copper content.

The Pearson's correlation coefficients (r) were calculated among total phosphate content and other water quality parameters. It was observed that total phosphate content is exhibiting the statistically significant positive correlation with chloride content, fluoride content, sodium content, iron content, and copper content.

The Pearson's correlation coefficients (r) were calculated among chloride content and other water quality parameters. It was observed that chloride content is exhibiting the statistically significant positive correlation with fluoride content, sodium content, potassium content, iron content, and copper content.

The Pearson's correlation coefficients (r) were calculated among sodium content and other metallic ions. It was observed that sodium content is exhibiting the statistically significant positive correlation potassium content, iron content and copper content.

The Pearson's correlation coefficients (r) were calculated among potassium content and other metallic ions. It was observed that potassium content is exhibiting the statistically significant positive correlation iron content and copper content.

The Pearson's correlation coefficients (r) were calculated among iron content and other metallic ions. It was observed that iron content is exhibiting the statistically significant positive correlation iron content and copper content.

Conclusion: The present research work carried out to know the water quality parameters of the groundwater of the tehsils Surajgarh, Chirawa and Buhana of districts Jhunjhunu, Rajasthan. The study found the following conclusions:-

• The groundwater of the study area exhibiting the values higher than the permissible limit, specified by the BIS for various physico-chemical parameters including EC, Turbidity, TDS, Total Hardness, Total Alkalinity, Sulphate, Nitrate, Total Phosphate, Chloride, Fluoride, Sodium, Potassium, Iron, and Copper.

• The high concentration of Fluoride, Iron, and Copper in all the samples reveals that the study area is suffering from the toxicity of such chemical substances.

• The tehsil-wise analysis of the physico-chemical parameters reveals that Surajgarh tehsil (Sampling sites S-1 to S-26) is exhibiting the more diverse values for the various physico-chemical parameters. Besides, Chirawa tehsil (Sampling sites S-27 to S-34) is exhibiting the modest values and Buhana tehsil (Sampling sites S-35 to S-42) is exhibiting the higher values for the various physico-chemical parameters. Accordingly, the groundwater of the Buhana tehsil is less suitable for the drinking purpose.

• It is predicted that the rich contents of the nitrate and total phosphate in the sampling sites of the Surajgarh and Buhana tehsils is being influenced by the agriculture practices of the nearby Haryana state.

• A possible reason is predicted that with unlawfully, sewage of the urban areas is being disposed to the groundwater. It is a popular practice, where proper disposal facility of the sewage is not maintained. This action may be causing the hike in total phosphate content in the study area.

• The correlation study for the physico-chemical analysis is indicating that conductance keeps the positive relation with other water quality parameters. Therefore, measurement of EC can reveal the water quality on first place.

• The correlation study for the physico-chemical analysis reveals that all the studied metallic ions (Na, K, Fe, Cu) keeps the strong association with chloride instead of fluoride.

Remedial Suggestion: The remedial action is suggested for the conservation of the groundwaters after carried out the research work.

• All the sampling sites are exhibiting the values higher than the permissible limit, specified by the BIS for various physico-chemical parameters, it is indicating that region is under the sever water stress. The mass public of the region should be educated for the water treatment and conservation strategies.

• Largely, all the sampling sites are exhibiting the diversified values for the fluoride content. It can be inferenced that entire region are rich in the fluoride content in the drinking water, and it is suggested for remedial measure such as pre-treatment of water before consumption.

• The high concentration of the various physico-chemical parameters has several environmental and human health implications; thus, it is suggested that further intensive systematic scientific study is required to understand the region.

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