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Screening of Trace Elements and Heavy Metals during the Pre and Post Monsoon Season in the Villages of District Champawat (India)

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Abstract Good water quality is a basic need for human health and water is naturally or artificially overlying with different trace and heavy metals. These metals have an important physiological role with the body, but the bio-toxic effects of many metals are of great health concern. Therefore, contamination of water by heavy metals could be a major concern for human health and as well as for the ecosystem. The present study deals with the elemental screening of drinking water and to compare the seasonal variation of trace and heavy metals in natural source water and their corresponding tap supply from habitat sites of Champawat district, Uttarakhand, (India). The detection of trace and heavy metals were assessed in ppm according to official method by using an Atomic absorption spectrometer. The study revealed that the concentration of trace metals such as iron, copper, manganese, zinc, and heavy metals like chromium, lead, and mercury was found within the permissible limits as prescribed by the WHO. Hence, it is concluded from the study that the amount of essential trace elements is within the permissible limit while the heavy metal was below the detectable limit. Therefore water from natural sources and their corresponding tap supplies are safe as far as trace and heavy metals are concerned.

Keywords: *natural source, supply water, seasonal variation, trace and heavy metals*

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1. Introduction

Water is one of the essential and precious natural resources. On the earth, only 1% of water is available as fresh drinking water, 2% of water is present in glaciers and rest of 97% water is saline. Water maintains the ionic equilibrium and balances all form of life as it is a universal solvent. Water is naturally or artificially overlying with different heavy metals [1,2]. The heavy metals belong to the loosely defined subset of metals having the metallic nature. Generally, it is in the form of transition metal, actinoids and lanthanoids [3]. These trace metals play an important role in the normal physiology of the human body and imbalance of any of these elements affects the normal function [1]. Some metals like Zn, Fe, Cu and Cr are essential for human as well as for plant growth in small quantities and few metals like Cd, Hg, Pb and As are toxic to human. The Excess quantities of these heavy metals cause health-related risks [4,5] such as heart diseases, hypophosphatemia, liver injury, cardiovascular disease, neurological and sensory disturbances [6,7,8]. According to the WHO report, 70-80 % of the diseases are waterborne [9,10]. These heavy metals contaminate the drinking water, some sources are domestic waste, Industrial waste and mining, so there is a need to reduce the contamination by the efficient and economical technique [3]. The metal ions present in water in low concentration and their detection is relatively difficult. The symptoms of these metals is also appears very late by consuming the contaminated water [11]. Due to the rapid increase in human activities and industrialisation, the discharge of waste containing heavy metals has exaggerated to surroundings. Therefore, contamination of water by heavy metals could be a major concern for human life and as well as for ecosystem [9,12,13]. Good water quality is a basic need of human health and the present study deal with the trace elemental screening of drinking water in natural sources, the seasonal variation of pre and post-monsoon of trace and heavy metals in the natural source of Champawat district and their corresponding tap supply from habitat sites.

2. Material and Methods

2.1. Study Area

Champawat district, Uttarakhand, (India) having latitude 28˚31'00" and 29˚31'00" North and Longitude 79◦46'00" and 80◦16'30". The total population of the district is 25 lakh approx. The hilly areas (villages) of Champawat district were chosen for the study [14].

2.2. Collection and Preparation of Water Samples

The collection of drinking water samples were carried out from the natural sources (20 samples) and their corresponding tap supplies (20 samples) in the pre and post-monsoon seasons (2017) from the habitat areas of Champawat district. In the study, each sample collected in double capped 500 mL pre-washed polyethylene bottles and the metal elements were screened in ppm according to official method by using Atomic absorption spectrometer (AAS, Shimadzu AA-6300). Three replicate taken in the experiment and average values reported. The AAS calibrated with relevant standards. Significantly seven metals were analysed in these water samples, i.e. iron, copper, manganese, zinc, cadmium, chromium, and lead. The permissible limit of these heavy metals was compare with standards limits of WHO & BIS [9,15]. The sampling location with GPS co-ordinates(Garmin modal no- Montana 680) is cited in Table 1.

Table 1. Location and Co-ordinate of Collected supply water

S.No.	Samples Collected from Natural Sources		Samples Collected from supply Water (Supplies by Jal Sasthan Champawat)	
	Name of Natural source Location	**GPS coordinate**	**Name of Supply water Location**	**GPS coordinate**
S-1	Barakot Source	N-29.46756◦, E-080.06055◦	Barakot supply	N-29.46395◦, E-080.06486◦
S-2	TalliBarakot Source	N-29.45387◦, E-080.07365◦	Talli Baralot supply	N-29.46985◦, E-080.07676◦
S-3	Majhera Source	N-29.25329◦ ,E-080.09160◦	Majhera supply	N-29.26029◦, E-080.08833◦
S-4	Chatar Source	N-29.34198, E-080.09412◦	Chatar supply	N-29.34340◦, E-080.09574◦
S-5	Laluapani Source	N-29.32238◦, E-080.07051	Laluapani supply	N-29.32193◦, E-080.06178◦
S-6	Selakhola Source	N-29.32517◦, E-080.07168	Selakhola supply	N-29.33487◦, E-080.08399◦
S-7	Khuna Source	N-29.37668◦, E-080.10542◦	Khuna supply	N-29.26987◦, E-080.09929◦
S-8	Bhingrara Source	N-29.30384◦, E-079.92771◦	Bhinagrara supply	N-29.30196◦, E-080.08674◦
S-9	DevidhuraSource	N-29.41018◦, E-079.86433◦	Devidhura supply	N-29.40885◦, E-080.08958◦
S-10	Pati Source	N-29.41617◦ ,E-079.89074◦	Pati supply	N-29.40751◦, E-080.93916◦
S-11	Lohaghat forest Sorce	N-29.39166◦, E-080.08958◦	Lohaghat Forest Supply	N-29.391814◦, E-080.089833◦
S-12	Furti Source	N-29.38299◦, E-080.07483◦	Furtisupply	N-29.38510◦, E-080.08086◦
S-13	Mayawati Source	N-29.37312◦, E-080.06143◦	Mayawati supply	N-29.36360◦, E-080.06049◦
S-14	Choumail Source	N-29.43046◦, E-080.12585◦	Chaumail supply	N-29.42652◦, E-080.12178◦
S-15	Mangoli Source	N-29.41122◦, E-080.12261◦	Mangoli supply	N-29.41427◦, E-080.12834◦
S-16	Leunghar Source	N-29.41285◦, E-080.12639◦	Leunghar supply	N-29.38497◦, E-080.53718◦
S-17	Near PTC Source	N-29.40568◦, E-080.11745◦	Near PTC supply	N-29.40367◦, E-080.11045◦
S-18	Maneshwar Tap	N-29.34813◦, E-080.08576◦	Maneshwar supply	N-29.34813◦, E-080.08576◦
S-19	Kapalekh Source	N-29.36971◦, E-080.10465◦	Kapalekh supply	N-29.37019◦, E-080.08576◦
S-20	Pancheshwar Source	N-29.44838◦, E-080.20463◦	Pancheshwar supply	N-29.44692◦, E-080.20629◦

3. Result and Discussion

The results obtained from the trace and heavy metal analysis in the drinking water sample collected from a natural source and their corresponding tap supply are shown in Table 2 and Table 3, respectively.

3.1. Iron

It is evident from the data that iron content of natural source water varied 0.06 to 1.85 ppm in pre-monsoon samples and 0.05 to 0.78 ppm in post-monsoon season (Table 2), while in a water sample collected from the tap water supply, iron content ranged 0.08 to 1.04 ppm in pre-monsoon and 0.06 to 1.52 ppm in post-monsoon respectively (Table 3). According to WHO, permissible iron limit in potable water is 1.0 ppm. Being the main component of haemoglobin, myoglobin, ferritin and transferring, iron is an important element for human growth [16]. Figure 1, showing the iron content of various samples in Champawat district. It enters into the water by the extraction process of metal from its ore and Corrodes pipe-lines. Another source of Fe concentration into water is the discharge of aluminium waste products which contains iron is discharge into water [17]

3.2. Manganese

The concentration Mn found from 0.002-0.007 ppm in pre-monsoon and 0.001-0.08 ppm in post-monsoon in the analysis of natural source water (Table 2) and it's the concentration in supply water in pre-monsoon, and post-monsoon it ranged from 0.003-0.12 and 0.002-0.10 ppm respectively (Table 3). According to WHO, Mn permissible limit in potable water is 0.5 ppm. Manganese is the most abundantly occurring element in the earth crust and found in the form of different oxides and hydroxides [18]. During pre and monsoon seasons, the concentration of manganese in all analyzed samples are within permissible limits (Figure 2). Suspended particulates resulting from industrial emissions, soil erosion, volcanic emissions and the burning human activities are the reason for the high concentration of Mn into water [19].

3.3. Copper

The concentration of Cu in the natural source found in the range of 0.00002-0.0095 ppm in pre-monsoon, and 0.00012-0.00136 ppm in post-monsoon (Table 2) and corresponding supply water analysis it varied 0.0002-0.0018 ppm in pre-monsoon and from 0.0003-0.0021 ppm in post-monsoon season (Table 3). According to WHO, copper permissible limit in potable water is 1.0 ppm. The value of the few samples in both pre-monsoon and the post-monsoon season is below the detectable limit. It enters into water from industrial wastage, agriculture pesticides and through corrosion of copper pipes [20].

3.4. Zinc

In the present study, the value of Zn in pre and post-monsoon season in the natural source was found from 0.01-0.06 ppm and 0.01-0.08 ppm respectively (Table 2). The range in corresponding supply water varied from 0.01-0.08 and 0.01-0.09 ppm in pre and post-monsoon respectively (Table 3). Zinc permissible limit of WHO in potable water is 5.0 ppm. Zinc is an essential component for all living organism; it plays a vital role in replication and translation process as a part of protein and enzymes [21]. Zn concentration of pre and post-monsoon season was present in (Figure 3). It enters into the water from Industrial wastewaters, galvanic industries, and via battery production. [17]

3.5. Chromium

The concentration Cr was found 0.01-0.47 ppm in pre-monsoon and from 0.01-0.05 ppm in post-monsoon in the natural source water (Table 2). Supply water samples were below the detectable limit in pre-monsoon and 0.01-0.10 in the post-monsoon season. The maximum chromium concentration in tap supply water samples observed is 0.12 ppm (S-20) in the post-monsoon season (Table 3). Majorities of the samples show the concentration below the permissible limit (0.05 ppm) during both the seasons. The concentration of chromium was below the detectable limit in maximum samples. Cr is present only in trace quantity in water and released through alloy and metal refinery industry [17].

3.6. Lead

During pre-monsoon seasons the Pb concentration in natural source water was found in the range of 0.00001-0.00012 ppm in pre-monsoon and from 0.00001-0.00013 ppm in post-monsoon (Table 2). Water samples collected from tap supply was range of 0.00001-0.00028 ppm in pre-monsoon and 0.00001-0.00022 ppm in post-monsoon. Some of the values are below the detectable limit during pre and post-monsoon seasons in samples collected from natural sources and their respective tap supplies. The permissible limit for Pb; according to WHO is 0.05 ppm. The higher concentration of lead causes permanent injury to the brain [22]. It enters into the water through the corroded pipes, waste batteries, and insecticides [20].

3.7. Mercury

Mercury occurs naturally and from inorganic mercury compounds with other elements. In high concentration, it will cause neurological, renal disturbances and changes in hearing or vision [23]. It is evident from the data that the concentration of mercury is below the detectable limit in most of the samples during pre and post-monsoon seasons. During pre and post-monsoon season, the maximum mercury concentration in natural source water sample observe is 0.01 ppm (S-1,8,17 & 20) and 0.1 ppm (S-16), respectively. The maximum mercury concentration in tap supply water samples observed is 0.02 ppm (S-9) and 0.05 ppm (S-20) in pre and post-monsoon seasons. Majorities of the samples showed the concentration below the permissible limit (0.001ppm) during both the seasons. The data reported from the study are cited in Table 2 and Table 3. Mercury is released by burning of coal in power plants and hazardous waste, breaking mercury products, and spilling mercury improper treatment and disposal of products waste which containing mercury. It reaches into the water via runoff. [17]

Table 2. Concentration Of Heavy Metals In Drinking Water Samples Collected From Natural Source During Pre And Post Monsoon

Sample	Fe(ppm)		Mn(ppm)		Cu (ppm)		Zn(ppm)		Cr(ppm)		Pb (ppm)		Hg (ppm)	
	Pre-mon	**Post-Mon**	**Pre-mon**	**Post-Mon**	**Pre-mon**	**Post-Mon**	**Pre-mon**	**Post-Mon**	**Pre-mon**	**Post-Mon**	**Pre-mon**	**Post-Mon**	**Pre-mon**	**Post-Mon**
S-1	0.54	0.4	0.004	0.002	0.00095	0.00111	0.02	0.03	BDL	0.01	0.00003	0.00001	0.01	BDL
S-2	1.01	0.6	0.002	0.005	0.00083	0.0013	0.03	0.04	BDL	BDL	0.00003	0.00001	BDL	BDL
S-3	0.37	0.5	0.006	0.04	0.0005	0.0006	0.01	0.06	0.03	BDL	0.00001	BDL	BDL	BDL
S-4	1.03	0.78	0.002	0.01	0.00034	0.00041	0.02	0.02	BDL	BDL	BDL	0.00002	BDL	BDL
S-5	0.74	0.47	0.001	0.006	0.0006	0.00112	0.02	0.03	BDL	0.05	BDL	0.00001	BDL	BDL
S-6	0.64	0.12	0.004	0.05	0.00094	0.00136	0.03	0.02	BDL	0.01	0.00004	0.00006	BDL	0.01
S-7	0.84	0.47	0.004	0.02	0.0005	0.00056	0.06	0.04	0.05	0.02	BDL	0.00009	BDL	0.01
S-8	0.31	0.32	0.003	0.003	0.00042	0.00074	0.01	0.08	BDL	0.01	0.00003	0.00004	0.01	BDL
S-9	0.43	0.58	0.004	0.001	BDL	0.00034	0.05	0.02	BDL	0.05	BDL	0.00002	BDL	BDL
S-10	0.11	0.12	0.003	0.006	0.00002	0.00012	0.01	0.04	0.47	BDL	0.00001	0.00005	BDL	0.01
S-11	0.09	0.41	0.005	0.004	0.00052	0.00078	0.02	0.06	BDL	BDL	0.00002	BDL	BDL	BDL
S-12	0.23	0.05	0.003	0.009	0.00043	0.00026	0.04	0.02	BDL	BDL	0.00009	BDL	BDL	BDL
S-13	0.64	0.09	0.004	0.001	0.0007	0.00015	0.02	0.01	BDL	0.02	BDL	0.00001	BDL	BDL
S-14	0.92	0.15	0.007	0.02	0.00076	0.00035	0.02	0.05	0.04	BDL	0.00022	0.00013	BDL	BDL
S-15	0.06	0.07	0.004	0.04	BDL	0.00074	0.01	0.01	BDL	0.03	0.00006	0.00006	BDL	BDL
S-16	1.07	0.31	0.003	0.06	BDL	0.00012	0.02	0.02	BDL	0.01	0.00001	0.00006	BDL	0.1
S-17	0.26	0.22	0.005	0.02	0.00082	BDL	0.01	0.02	BDL	BDL	BDL	0.00005	0.02	BDL
S-18	0.25	0.13	0.002	0.01	0.00007	BDL	0.01	0.04	BDL	BDL	0.00001	BDL	BDL	BDL
S-19	**1.85**	0.15	0.005	0.08	BDL	0.0012	0.02	0.06	0.01	0.01	0.00006	0.00004	BDL	BDL
S-20	0.64	0.06	0.008	0.02	0.00012	0.00154	0.03	0.02	BDL	BDL	0.00012	0.00015	0.02	BDL

Table 3. Concentration Of Heavy Metals In Drinking Water Samples Collected From Tab Water Supply During Pre And Post-Monsoon

S. No	**Fe(ppm)**		**Mn(ppm)**		**Cu (ppm)**		**Zn(ppm)**		**Cr(ppm)**		**Pb (ppm)**		**Hg (ppm)**	
	Pre-mon	**Post-Mon**	**Pre-mon**	**Post-Mon**	**Pre-mon**	**Post-Mon**	**Pre-mon**	**Post-Mon**	**Pre-mon**	**Post Mon**	**Pre-Mon**	**Post-Mon**	**Pre-mon**	**Post-Mon**
S-1	1.04	**1.52**	0.005	0.003	0.00171	0.00141	0.08	0.01	BDL	0.02	0.00006	0.00006	BDL	0.01
S-2	0.83	0.87	0.003	0.06	0.00094	0.00102	0.07	0.05	BDL	BDL	0.00005	0.00001	BDL	0.01
S-3	0.25	0.64	0.006	0.005	0.00053	0.00021	0.03	0.09	BDL	BDL	0.00002	BDL	BDL	BDL
S-4	1.0	0.74	0.07	0.05	0.00039	0.00064	0.05	0.01	BDL	BDL	BDL	BDL	BDL	BDL
S-5	0.74	**1.12**	0.004	0.009	0.00098	0.00152	0.02	0.04	BDL	0.05	0.00001	0.00005	0.02	BDL
S-6	0.74	0.52	0.080	0.06	0.0018	0.0021	0.01	0.02	BDL	BDL	BDL	0.00001	BDL	BDL
S-7	0.54	0.11	0.005	0.002	0.00067	0.00062	0.06	0.02	BDL	0.03	0.00009	0.00006	BDL	BDL
S-8	0.23	0.52	0.005	0.006	0.00055	0.00058	0.02	0.04	BDL	0.04	0.00005	0.00006	BDL	BDL
S-9	0.23	0.14	0.006	0.001	0.00094	0.00102	0.05	0.05	BDL	BDL	BDL	0.00001	0.02	0.02
S-10	0.09	0.06	0.12	0.09	0.00005	0.00002	0.03	0.02	BDL	0.10	0.00001	0.00003	BDL	BDL
S-11	0.21	0.26	0.004	0.08	0.00028	0.00021	0.05	0.09	BDL	0.01	0.00001	0.00001	BDL	BDL
S-12	0.33	0.21	0.06	0.003	BDL	0.00005	0.01	0.01	BDL	BDL	BDL	BDL	BDL	0.04
S-13	0.54	0.84	0.004	0.006	0.00129	0.00184	0.06	0.03	BDL	BDL	BDL	0.00003	BDL	BDL
S-14	0.71	0.45	0.005	0.002	0.00047	0.00093	0.06	0.02	BDL	BDL	0.00028	0.00022	BDL	BDL
S-15	0.08	0.08	0.006	0.008	BDL	BDL	0.02	0.01	BDL	0.06	0.00009	0.00004	0.01	BDL
S-16	0.84	**1.11**	0.003	0.003	0.00056	0.00115	0.02	0.02	BDL	BDL	0.00002	0.00002	BDL	BDL
S-17	0.43	0.59	0.09	0.10	0.00006	0.00003	0.04	0.03	BDL	BDL	BDL	0.00006	BDL	0.01
S-18	0.91	0.65	0.003	0.009	BDL	0.00006	0.05	0.01	BDL	BDL	0.00003	BDL	BDL	BDL
S-19	0.64	**1.2**	0.005	0.006	0.00002	0.00021	0.01	0.02	BDL	0.05	0.00008	0.00003	BDL	BDL
S-20	**0.42**	**1.2**	**0.06**	**0.08**	0.00009	0.00134	0.01	0.05	BDL	0.12	0.00015	0.00018	BDL	**0.05**

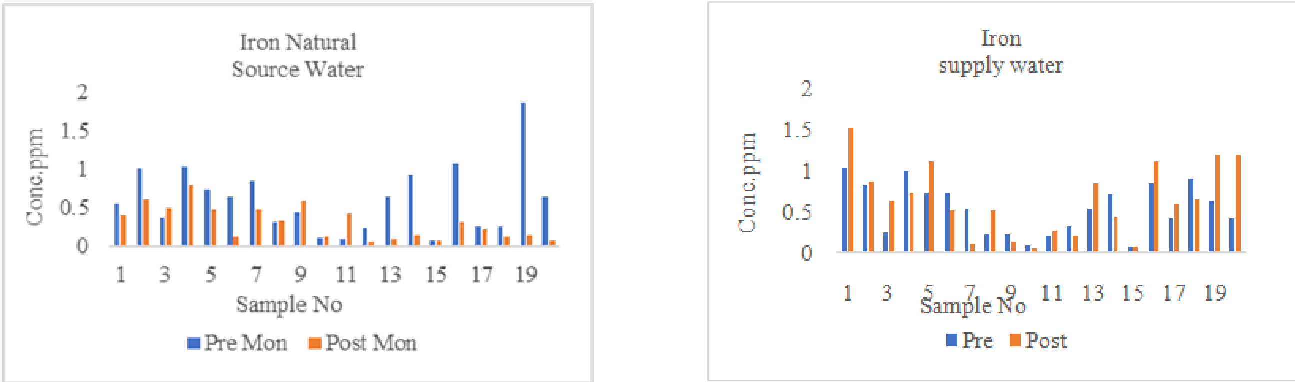

Figure 1. Seasonal change of Fe in natural source water and supply water

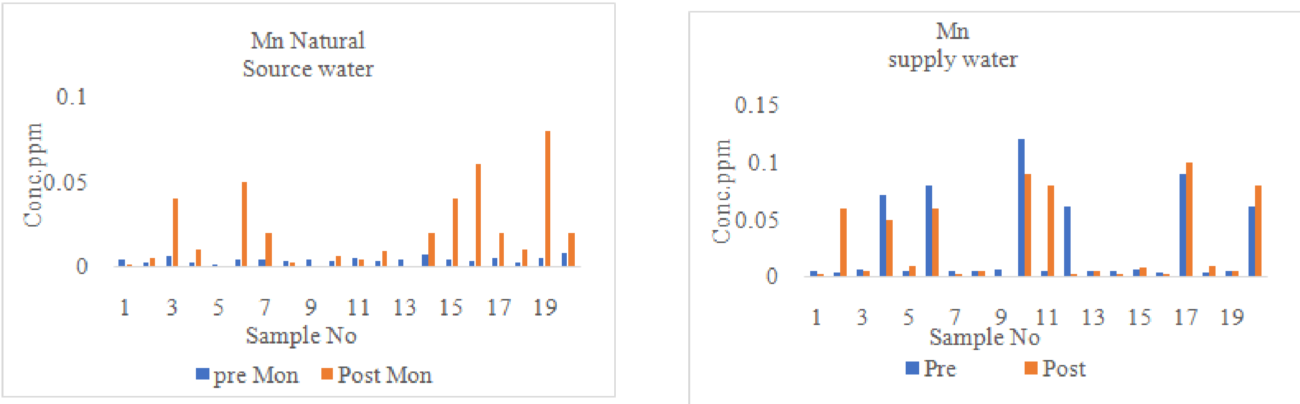

Figure 2. Seasonal change of Mn in natural source water and supply water

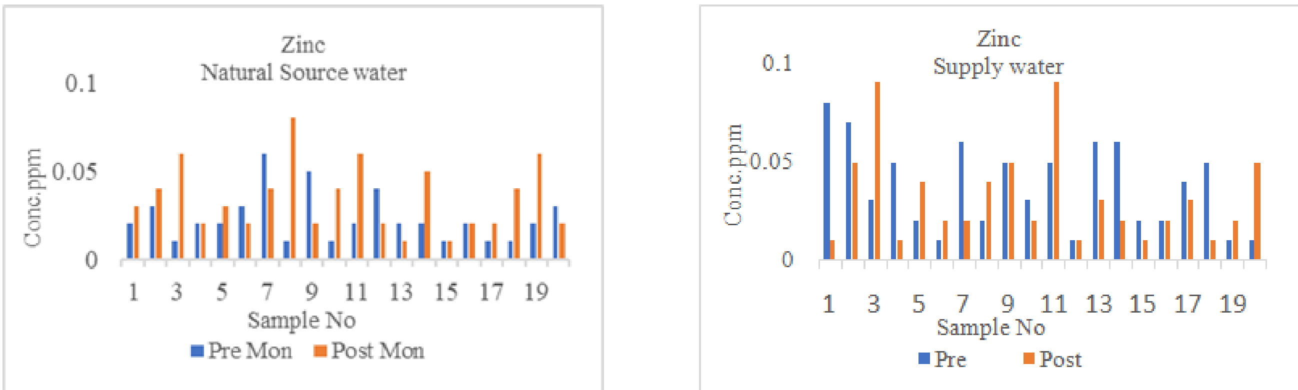

Figure 3. Seasonal change of Zn in natural source water and supply water

4. Conclusion

The trace metals concentration in various samples collected from a natural source and their respective tap supplies show the minor variations. If the concentration of trace elements in drinking water present beyond the permissible limits, it may be toxic to a living organism. In the present study, the trace metal contents analysed in the samples collected from the natural sources and their respective tap supplies in the pre and post-monsoon seasons (2017) from the habitat areas of Champawat district. It may be conclude from the study that the concentration of trace metals did not show significant variation during pre and post-monsoon seasons in the samples of natural source and their respective tap supply. The concentration of heavy metals was also under the prescribed limit set by WHO, and most samples found below the detectable limit. Hence, it concluded that the drinking water supply in habitat area of Champawat district is suitable for drinking. Preventative measures should be followed to avoid the contamination of water. Therefore, Regular monitoring of the water quality should be carried out by Jal Sansthan so that any form of water contamination should be avoid.

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Statement of Competing Interests

The authors have no competing interest.

Abbreviations

BDL- Below detection limit, Mon- Monsoon, ppm- part per million

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