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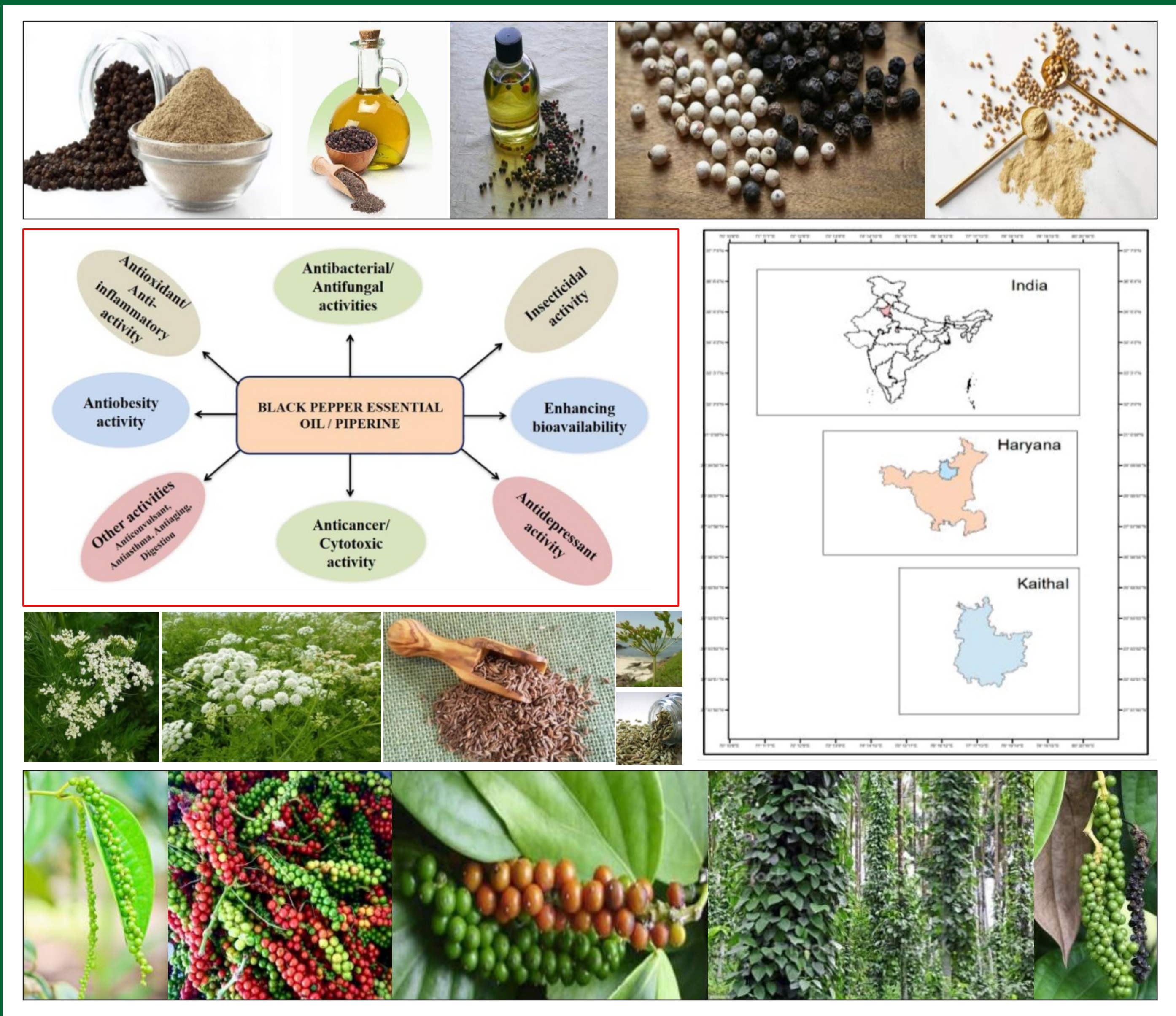

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The IJEHS is an official publication of Save The Environment (STE). It publishes peer reviewed quarterly, original articles (Research paper, Review articles, Short Communication, Case studies, etc.) related to all fields of Environment and Health Sciences. It disseminates the scientific research and recent innovations.

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International Journal of Environment and Health Sciences

From The Editor's Desk…

The year 2021 was a difficult year for the mankind, but at the same time, it made us all realize that the power of unity and discipline is of utmost importance while managing the severest of crises. The COVID-19 pandemic impacted public health and environment alike. However, the year 2021 is being deemed to be the 'Year of Recovery'. All of us need to join hands together to tackle the aftermath of the pandemic and to ensure that we stay firm in our efforts to create a sustainable environment.

Surveys suggest that in order to ensure a better respiratory capacity and overall improved health, the necessity of clean air and pure water needs to be addressed more now than ever before. Perils linked to environmental risk factors have to be managed for a bluer and greener earth. In this outlook, propagating awareness for environmental sustainability has become the need of the hour. Formation of regulatory bodies and authorities to disseminate societal alertness towards environmental safety is on the rise.

With this perspective, the International Journal of Environment and Health Sciences (IJEHS) proposes to provide a reliable platform to discuss technologies and strategies for management of aforesaid environmental matters, especially for the current post-COVID-19 period. IJEHS will be quintessential to academicians, industry professionals and researchers who are actively engaged in the areas of environmental issues and related health effects. We are pleased to inform that ISSN for IJEHS is available as 2582-5283. IJEHS is referenced in Crossref, the official Digital Object Identifier Agency (doi 10.47062). IJEHS is now also indexed in the International Scientific Indexing (ISI).

We invite original research articles, short communications and critical reviews directed towards an academic, clinical and industrial audience. The first section of the journal focuses on burning environmental issues like pollutants and their fate, waste management, resource conservation, remediation technologies, etc. The second section includes all topics relevant to physiological impact of environmental risk factors and application of alternative medicinal approaches as remedial measures. Detailed scope can be found in the home page of the journal (www.stenvironment.org/journals). Notes on development of any novel and validated strategy or tool to address environmental challenges are welcome. Discussion on proceedings of conferences conducted on environmental themes and related health aspects will also be considered.

All submissions will be meticulously scrutinized by pioneers in the field to ensure publication of only articles of high quality and relevance. Authors are requested to take special precautions to avert plagiarism and redundancy. It is high time that we realize the gravity of circumstances and take potent steps to undo the adversities already triggered. In this pursuit, IJEHS expects to be the ideal platform to discuss sustainable ideas and potential solutions.

We thank all authors who have contributed to the journal and have consistently been with us in the past year. With this, I wish all our readers a Very Happy New Year, 2021 and I hope our audience and patrons shall come together in this effort to promulgate their part in resurrecting our valuable environment.

Kshipra Misra

Dr. Kshipra Misra
Editor-in-Chief, IJEHS

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Environmental Sciences Section

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SPATIAL ASSESSMENT OF GROUNDWATER QUALITY FOR DRINKING PURPOSE IN KAITHAL DISTRICT, HARYANA

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Abstract
Water is important for sustaining life. Presently the demand of water is increased for drinking, irrigation and industrial purposes. Excessive use of water leads to the depleting of aquifer as well as deterioration of quality. In these days many techniques are available for searching of groundwater and quality establishment. In the present study Geographical Information System (GIS) has been used to study spatial groundwater quality in Kaithal district, Haryana. Kaithal district is located between the latitudes 29°30" North to 30°11 North and longitudes 76°090 East to 76°41 East and covering area 2,317 sq. km. In the study 62 groundwater samples were collected during field in the month of February 2019. All the groundwater samples were analyzed using Field Water Testing Kit prepared by Tamilnadu Water Supply and Drainage Board, Chennai for twelve chemical parameters-pH, alkalinity, hardness, chloride, total dissolved solids, fluoride, iron, ammonia, nitrite, nitrate, phosphate and residual chlorine. Results of chemical analysis of groundwater samples were put in GIS environment and inverse distance weighted interpolation technique applied to get spatial scenario of each chemical parameter in the study area. Chemical results were categorized in desirable, permissible and non-potable drinking water class as per BIS drinking water standards and area under each drinking water class was calculated. In the study area pH covers 97.45% area under desirable and 2.55% area under non-potable, alkalinity is desirable in 0.18% area, permissible in 99.14% area and non-potable in 0.68% area, hardness covers 63.15% area under desirable, 34.94% area under permissible and 1.91% area under non-potable, chloride is desirable in 85.32 % area and permissible in 14.68% area, total dissolved solids cover 0.15% area under desirable, 98.83% area under permissible and 1.02% area under non-potable, fluoride is desirable in 4.79% area, permissible in 18.88% area and non-potable in 76.33% area, iron is desirable in 94.48% area and non-potable in 5.52% area, ammonia covers 55.29% area under desirable and 44.71% area under non-potable, nitrate covers 100% area under non-potable and nitrite, phosphate and residual chlorine cover 100% area under desirable drinking water class. The spatial groundwater quality scenario in the study area is highly useful for planning, monitoring and management of groundwater for drinking purpose.

Keywords
Groundwater, quality, spatial, Kaithal, Haryana.

INTRODUCTION

Water is important for survival of living beings. Groundwater is utmost importance because of easily available for drinking, irrigation and industrial uses. But the excessive use of groundwater leads depleting and quality deterioration. Groundwater quality is important for drinking purpose because poor quality drinking water leads to many health problems. Knowledge of spatial distribution of chemical

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Color versions of one or more of the figures in this article can be found online at www.stenvironment.org

parameters in an area helps to locate a well at good groundwater quality site. Geographical Information System (GIS) plays vital role in displaying spatial distribution of chemical parameters in an area from point groundwater sample. Many workers have studied groundwater quality using GIS in various types of areas for drinking and industrial purposes (Asadi et al. (2007), Singh and Lawrence. (2007), Arumugam and Elangovan (2009), Balakrishnan et al. (2011), Deshpande and Aher (2012), Krishnaraj et al. (2015), Singhet al. (2015), Ambiga (2016), Nelly et al. (2016), Pandian and Jeyachandran (2014)).

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STUDY AREA

The study area Kaithal district lies between latitudes 29°30" North to 30°11 North and longitudes 76°090 East to 76°41 East and covers 2,317 sq.km area. Slope of the district is from north-east to south-west. Geologically in the district alluvium of Quaternary age and geomorphologically alluvial plain is present.

OBJECTIVE

The main objective was to study spatial groundwater quality in Kaithal district using GIS technique.

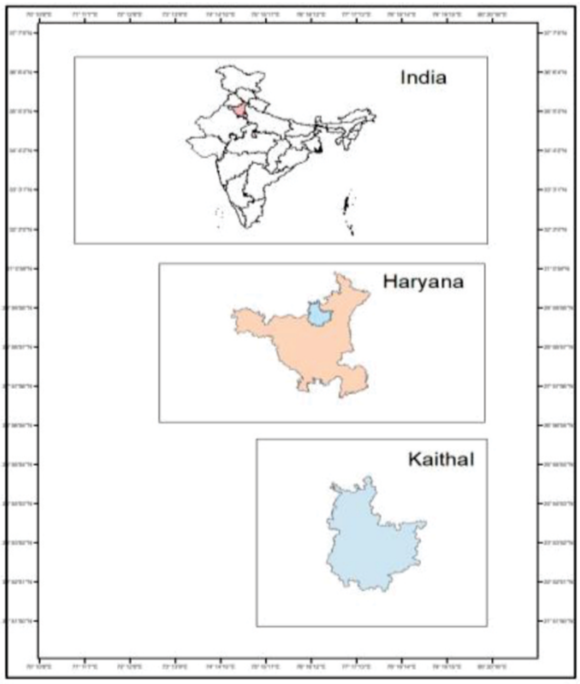

Fig. 1: Location map of the study area.

Table 1: Result of chemical analysis of groundwater samples.

S l. No.	Sample	Latitude	Longitude	Source	pH	Alkalinity (mg/l)	Hardness (mg/l)	Chloride (mg/l)	TDS (mg/l)	Fluoride (mg/l)	Iron (mg/l)	Ammonia (mg/l)	Nitrite (mg/l)	Nitrate (mg/l)	Phosp-phate (mg/l)	Residual Chlorine (mg/l)
	Simla	29.63874	76.21864	Tubewell	7	200	140	50	468	5	0	0	0.5	100	0	0
2	Batta	29.6963	76.29694	Tubewell	8	390	480	500	1371	5	0	2	1.0	100	0	0
3	Kurar	29.72024	76.19895	Tubewell	7.5	310	300	100	852	5	0	1	0.2	45	0	0
4	Dubbal	29.74313	76.22141	Tubewell	7.5	280	200	300	936	3	0	0	0.2	75	0	0.2
5	Kailram	29.7105	76.36057	Tubewell	8	380	390	180	1140	3	0	0.5	0.5	75	0	0
6	Mator	29.62334	76.26354	Tubewell	8	600	1120	700	2904	1	0	1	0.5	75	0	0
7	Vajir Nagar	29.67591	76.34291	Handpump	6.5	150	150	30	396	2	0	1	0.5	100	0	0
8	Kheri Lamba (I)	29.69788	76.23436	Tubewell	7	200	970	730	2280	1.5	0	0.5	0.2	45	0	0
9	Kheri Lamba (ii)	29.69788	76.23436	Tubewell	9	550	300	400	1500	5	0	0	0.5	75	0	0
10	Kharondhi	30.0138	76.29592	Tubewell	7.5	400	270	110	936	2	2	0.5	0.2	100	0	0.2
11	Baupur	30.11075	76.38177	Tubewell	8	370	130	110	732	2	0.3	1	0.5	100	0	0.2
12	Cheeka	30.02875	76.33693	Tubewell	8	330	200	30	672	2	0	0.5	0.5	75	0	0
13	Kangthali	29.96862	76.3512	Tubewell	8	550	220	20	948	2	0	1	0.5	75	0	0
14	Malikpur	30.12894	76.23066	Tubewell	7.5	450	420	50	1104	0	0	0.5	0.5	100	0	0
15	Balbehra	30.03338	76.39411	Tubewell	8.5	570	400	30	1200	1	0	0.5	0.5	150	0	0
16	Bhagal	30.0588	76.41847	Tubewell	7.5	270	280	50	720	1.5	0	0.5	0.5	100	0	0
17	Arnoli	30.17489	76.40315	Tubewell	8	390	270	70	876	1.5	0	1	0.2	45	0	0
18	Peedal	29.99565	76.36029	Tubewell	9	430	270	80	936	1.5	0	0	0.5	75	0	0
19	Nagal	29.89185	76.27684	Tubewell	7	330	230	50	732	1.5	0	0	0.2	75	0	0
20	Sontha	29.92306	76.33577	Tubewell	7.5	290	240	50	696	1	0	0.5	0.5	75	0	0
21	Attela	29.84867	76.29293	Tubewell	8	370	270	70	852	1	0	0	0.5	100	0	0
22	Kasour	29.96419	76.2222	Tubewell	7.5	270	270	70	828	1.5	0	0	0.5	75	0	0
23	Andhli	29.90531	76.25165	Tubewell	7.5	260	200	70	624	1.5	0	0.5	0.5	75	0	0
24	Dohar	29.87388	76.4319	Tubewell	8	510	140	70	864	5	0	0.5	0.5	75	0	0
25	Rasulpur	29.92041	76.4155	Tubewell	7	290	70	70	480	1.5	0	0	0.2	75	0	0

26	Kheri Gulamali	29.88164	76.30083	Tubewell	7.5	420	340	70	996	2	0	0.5	0.2	75	0	0
27	Padla	29.80266	76.28128	Tubewell	7.5	370	570	380	1584	2	0.3	0.5	0.5	75	0	0
28	Budha Khera	29.83435	76.25236	Tubewell	8	570	400	50	1224	0.5	0	1	0.5	100	0	0
29	Titram	29.72043	76.40235	Tubewell	7.5	370	550	420	1340	1	0	0.5	0.2	100	0	0
30	Sangan	29.81144	76.22894	Tubewell	7.5	310	330	50	828	2	0	0.5	0.5	100	0	0.2
31	Deod Kheri	29.76101	76.44096	Tubewell	7	270	190	50	612	2	0	0.5	0.2	75	0	0
32	Sismore	29.7207	76.48488	Tubewell	7	350	260	150	912	1.5	0	0.5	0.5	100	0.5	0
33	Sajuma	29.73822	76.2584	Tubewell	8	420	340	100	1032	3	0	1	0.5	150	0	0
34	Nauch	29.93504	76.4458	Tubewell	8	400	400	90	1068	2	0	0.5	0.2	100	0	0
35	Titram Mod	29.73387	76.40363	Tubewell	8	400	260	90	900	2	0	0	0.5	100	0	0
36	Bhani Majra	29.79622	76.46212	Tubewell	7.5	300	100	60	552	1.5	0	0	0.5	75	0	0
37	Kithana (I)	29.53525	76.38503	Tubewell	8	400	370	490	1512	5	0	5	1.0	150	0	0.2
38	Kithana (ii)	29.55712	76.39981	Tubewell	6.5	340	50	60	540	3	0	0	1.0	100	0	0.2
39	Jakhauli	29.65868	76.43861	Tubewell	8	480	540	420	1725	5	0	1	1.0	100	0	0.2
40	Dudana (I)	29.52993	76.4767	Tubewell	8	530	650	300	1776	3	0	1	0.5	75	0	0.2
41	Dudana (ii)	29.52993	76.4767	Tubewell	8	550	400	200	1380	3	0	0.5	0.5	100	0	0
42	Rohera	29.56386	76.41762	Tubewell	7.5	280	120	140	648	3	0	0	1.0	100	0	0
43	Rajound	29.57551	76.48926	Tubewell	8	380	90	80	660	1.5	0	1	1.0	100	0	0.2
44	Kukarkanda	29.62532	76.51557	Tubewell	7	210	400	450	1272	3	0	1	0.5	100	0	0
45	Barsana	29.71078	76.59603	Tubewell	7.5	650	300	100	1224	1.5	0	0.5	0.5	75	0	0
46	Bakal	29.63015	76.58091	Tubewell	7.5	410	270	130	972	3	0	0	0.2	100	0	0
47	Buchi	29.75846	76.6422	Tubewell	8	450	360	60	1044	0	0	0.5	0.5	100	0	0.2
48	Sirsal	29.69477	76.66947	Tubewell	9	520	340	110	1164	1.5	0	2	0.5	100	0	0.2
49	Pai	29.69989	76.52781	Tubewell	9	680	200	100	1176	5	0	0.5	0.5	100	0	0
50	Pundri	29.77195	76.58157	Tubewell	8	540	350	100	1188	1	0	0.5	0.5	75	0	0.2
51	Rashina (Ahmedpur)	29.76204	76.65521	Tubewell	8	310	230	50	708	2	0	0.5	0.5	75	0	0
52	Bhana	29.66497	76.52564	Tubewell	9	240	250	190	816	2	0	0.5	0.5	100	0	0
53	Sakra	29.8124	76.68484	Tubewell	7.5	350	450	190	1028	0.5	0	0	0.5	100	0	0
54	Kaul	29.83569	76.6246	Tubewell	7.5	450	250	50	900	1.5	0	0	0.2	45	0	0
55	Kheri Matrwa	29.8184	76.60165	Tubewell	7	220	250	30	600	1.2	0	0	0.5	100	0	0.2
56	Meoli	29.81701	76.5673	Tubewell	7.5	550	250	250	1260	1.5	0	0.5	0.5	100	0	0
57	Faral	29.83816	76.58477	Tubewell	7	230	270	30	636	1	0	0	0.5	75	0	0
58	Ahun	29.77973	76.67493	Tubewell	7.5	300	200	30	636	1.5	0	0.5	0.5	45	0	0
59	Dhand	29.87659	76.60654	Tubewell	7	200	130	50	456	0.5	0	0.5	0.5	75	0	0
60	Bandrana	29.87637	76.54446	Tubewell	7.5	650	350	150	1380	0.5	0	0.5	0.2	45	0	0
61	Dherdu	29.8278	76.64606	Tubewell	8.5	350	350	50	900	3	0	0	0.2	45	0	0
62	Sangroli	29.801	76.62802	Tubewell	8.5	550	250	70	1044	0.5	0	0				

MATERIALS AND METHODOLOGY

In the study area 62 groundwater samples were collected in the month of February 2019 in 250 ml plastic water bottle. Geo-coordinates of groundwater sample and location name were noted with the help of mobile GPS. All the 62 groundwater samples were analyzed using Field Water Testing Kit prepared by Tamilnadu Water Supply and Drainage Board, Chennai for twelve chemical parameters- pH, alkalinity, hardness, chloride, total dissolved solids (TDS), fluoride, iron, ammonia, nitrite, nitrate, phosphate and residual chlorine (Table 1). Results of chemical analysis of groundwater samples were put in ArcGIS 10.4.1 software and inverse distance weighted (IDW) interpolation technique applied to get spatial scenario of each chemical parameter in the study area. Chemical analysis results were categorized in three desirable, permissible and non-potable drinking water class as per BIS drinking water standards (IS 10500:2012) (Table 2) and area under each drinking water class was calculated and prepared maps for each chemical parameter.

Table 2: Drinking water parameters (BIS: 10500:2012).

Sl. No.	Parameters	Potable		Non potable
		Desirable	Permissible	
1	pH	6.5-8.5	-	<6.5 and >8.5
2	Alkalinity	200	200-600	>600
3	Hardness	200	200-600	>600
4	Chloride	250	250-1000	>1000
5	TDS	500	500-2000	>2000
6	Fluoride	<1.0	1.0-1.5	>1.5
7	Iron	<0.3	-	>0.3
8	Ammonia	<0.5	-	>0.5
9	Nitrite	<0.1	-	>1.0
10	Nitrate	<45	-	>45
11	Phosphate	<1.0	-	>1.0
12	Residual Chlorine	0.2	0.2-1.0	>1.0

RESULTS AND DISCUSSION

i. pH

pH is desirable in 97.45% area and non-potable in 2.55% area (Table 3, Fig.2). As per BIS drinking water standards pH is desirable 6.5 to 8.5 and non-potable < 6.5 and > 8.5 (Table 2).

Table 3: pH area covered under drinking water class in the study area.

S. No.	pH Drinking Water Class	Area Covered (Km2)	Percentage of Total Area
1	Desirable	2257.88	97.45
2	Permissible	-	-
3	Non-Potable	59.12	2.55
	Total	**2317.00**	**100.00**

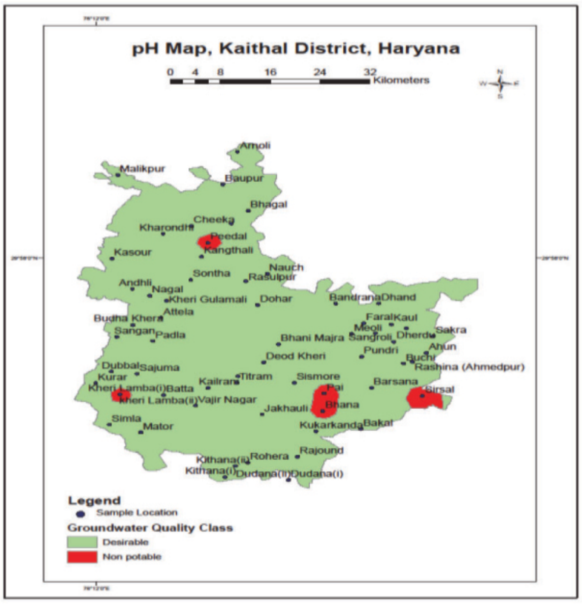

Fig. 2: Spatial distribution of pH in the study area.

ii. Alkalinity

In the study area alkalinity is desirable in 0.18% area, permissible in 99.14% area and non-potable in 0.68% (Table 4, Fig.3). As per BIS drinking water standards alkalinity is desirable < 200 mg/l, permissible 200 mg/l - 600 mg/l and non-potable > 600 mg/l (Table 2).

Table 4: Alkalinity area covered under drinking water class in the study area.

S. No.	Alkalinity Drinking Water Class	Area Covered (Km2)	Percentage of Total Area
1	Desirable	4.17	0.18
2	Permissible	2296.93	99.14
3	Non-Potable	15.90	0.68
	Total	**2317.00**	**100.00**

Fig.3: Spatial distribution of alkalinity in the study area.

iii. Hardness

Hardness is desirable in 63.15% area, permissible in 34.94% area and non-potable in 1.91% area (Table 5, Fig.4). As per BIS drinking water standards hardness is desirable < 200 mg/l, permissible 200 mg/l - 600 mg/l and non-potable > 600 mg/l (Table 2).

Table 5: Hardness area covered under drinking water classes in the study area.

S. No.	Hardness Drinking Water Class	Area Covered (Km^2)	Percentage of Total Area
1	Desirable	1463.28	63.15
2	Permissible	809.45	34.94
3	Non-Potable	44.27	1.91
	Total	**2317.00**	**100.00**

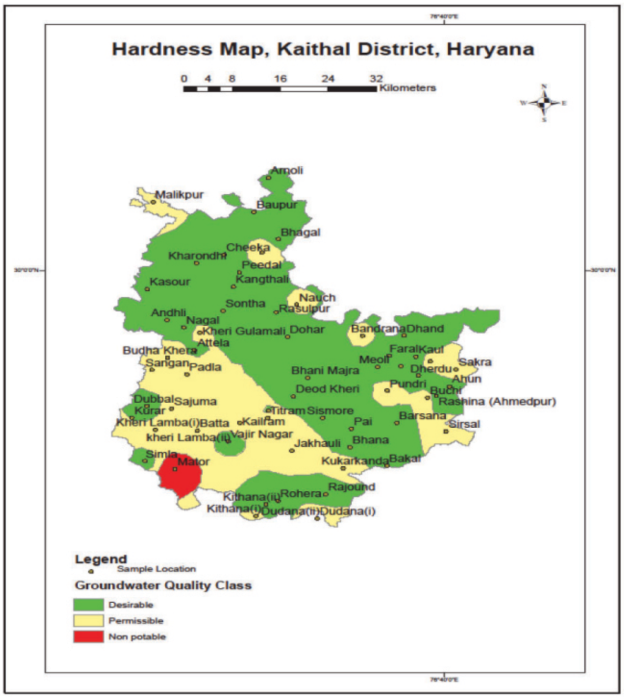

Fig.4: Spatial distribution of hardness in the study area.

iv. Chloride

Chloride is desirable in 85.32 % area and permissible in 14.68% area (Table 6, Fig.5). As per BIS drinking water standards chloride is desirable < 250 mg/l, permissible 250 mg/l - 1000 mg/l and non-potable >1000 mg/l (Table 2).

Table 6: Chloride area covered under drinking water classes in the study area.

S. No.	Chloride Drinking Water Class	Area Covered (Km^2)	Percentage of Total Area
1	Desirable	1976.97	85.32
2	Permissible	339.93	14.68
3	Non-Potable	-	-
	Total	**2317.00**	**100.00**

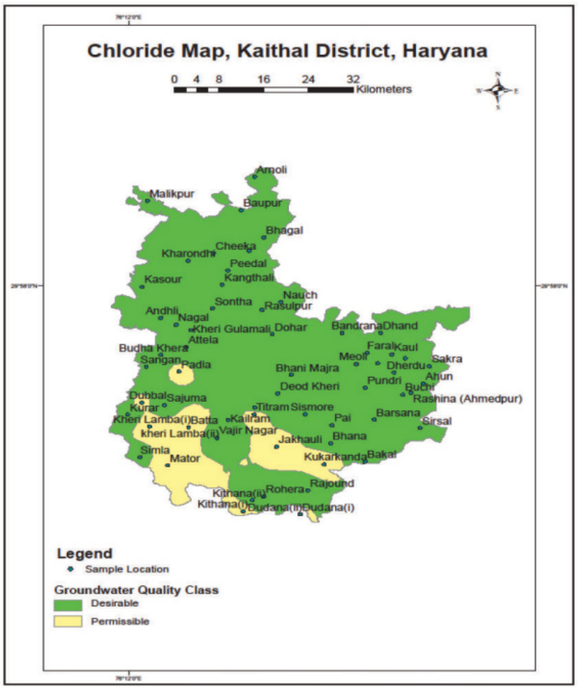

Fig. 5: Spatial distribution of chloride in the study area.

v. Total Dissolved Solids

Total dissolved solids (TDS) cover 0.15% area under desirable drinking water class, 98.83% area under permissible drinking water class and 1.02% area under non-potable drinking water class (Table 7, Fig.6). As per BIS drinking water standards TDS is desirable < 500 mg/l, permissible 500 mg/l -2000 mg/l and non-potable >2000 mg/l (Table 2).

Table 7: TDS area covered under drinking water classes in the study area.

S. No.	TDS Drinking Water Class	Area Covered (Km^2)	Percentage of Total Area
1	Desirable	3.48	0.15
2	Permissible	2289.86	98.83
3	Non-Potable	23.66	1.02
	Total	**2317.00**	**100.00**

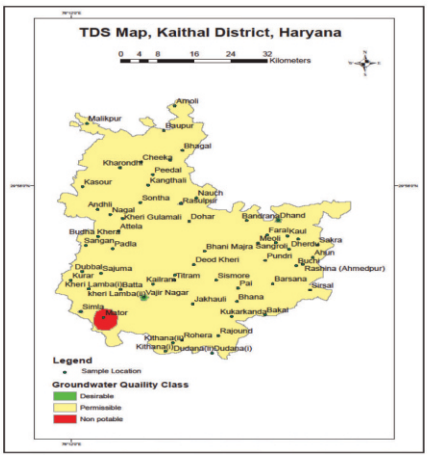

Fig.6: Spatial distribution of TDS in the study area.

vi. Fluoride

Fluoride covers 4.79% area under desirable drinking water class, 18.88% area under permissible drinking water class and 76.33% area under non-potable drinking water class (Table 8, Fig.7). As per BIS drinking water standards fluoride is desirable <1.0 mg/l, permissible 1.0 mg/l -1.5 mg/l and non-potable >1.5 mg/l (Table 2).

Table 8 : Fluoride area covered under drinking water classes in the study area.

S. No.	Fluoride Drinking Water Class	Area Covered (Km^2)	Percentage of Total Area
1	Desirable	110.92	4.79
2	Permissible	437.49	18.88
3	Non-Potable	1768.59	76.33
	Total	**2317.00**	**100.00**

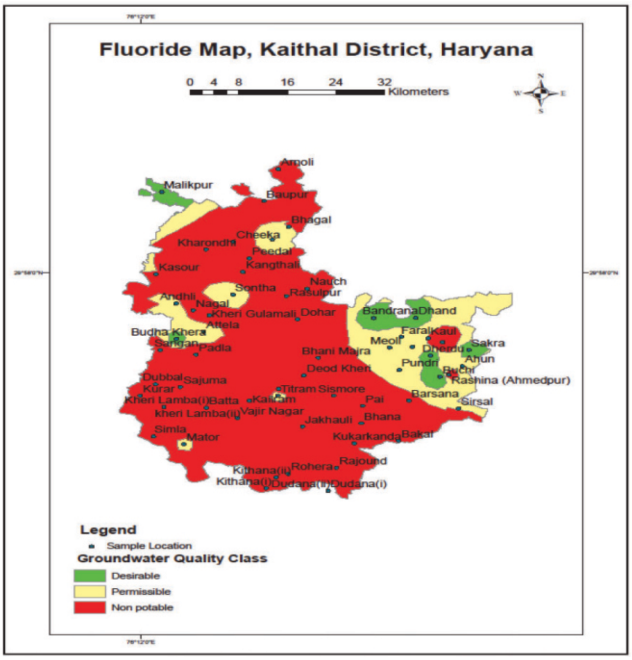

Fig. 7: Spatial distribution of fluoride in the study area.

vii. Iron

Iron is desirable in 94.48% area and non-potable in 5.52% area under drinking water class (Table 9, Fig.8). As per BIS drinking water standards iron is desirable < 0.3 mg/l and non-potable >0.3 mg/l (Table 2).

Table 9: Iron area covered under drinking water classes in the study area.

S. No.	Iron Drinking Water Class	Area Covered (Km^2)	Percentage of Total Area
1	Desirable	2189.08	94.48
2	Permissible	-	-
3	Non-Potable	127.92	5.52
	Total	**2317.00**	**100.00**

viii. Ammonia

Ammonia covers 55.29% area under desirable drinking water class and 44.71% area under non-potable drinking water class (Table 10, Fig.9). As per BIS drinking water standards ammonia is desirable < 0.5 mg/l and non-potable > 0.5 mg/l (Table 2).

Table 10: Ammonia area covered under drinking water classes in the study area.

S. No.	Ammonia Drinking Water Class	Area Covered (Km^2)	Percentage of Total Area
1	Desirable	1281.18	55.29
2	Permissible	-	-
3	Non-Potable	1035.82	44.71
	Total	**2317.00**	**100.00**

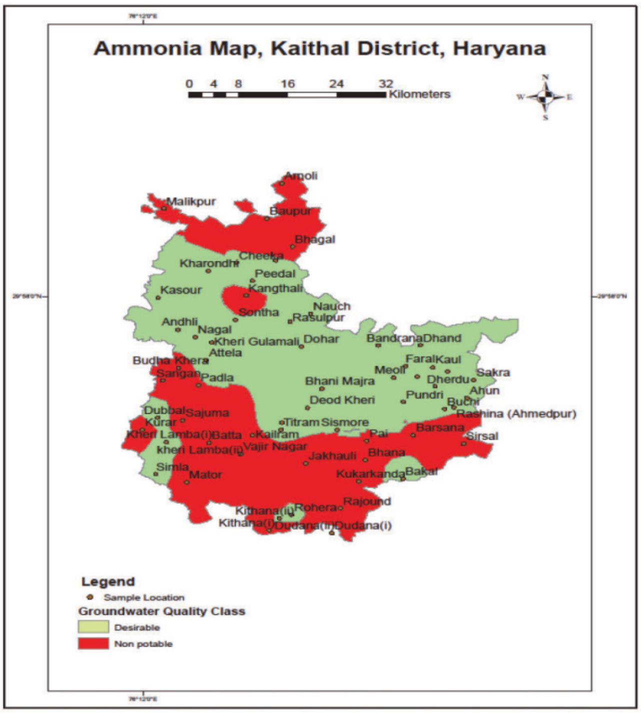

Fig.9: Spatial distribution of ammonia in study area.

ix. Nitrite

Nitrite covers 100% area under desirable drinking water class (Table 11, Fig.10). As per BIS drinking water standards nitrite is desirable <1.0 mg/l and non-potable >1.0 mg/l (Table 2).

Table 11: Nitrite area covered under drinking water classes in study area.

S. No.	Nitrite Drinking Water Class	Area Covered (Km^2)	Percentage of Total Area
1	Desirable	2317.00	100.00
2	Permissible	-	-
3	Non-Potable	-	-
	Total	**2317.00**	**100.00**

Fig.10: Spatial distribution of nitrite in the study area.

x. Nitrate

Nitrate covers 100% area under non-potable drinking water (Table 12, Fig.11). As per BIS drinking water standards nitrate is desirable <45 mg/l and non-potable >45 mg/l (Table 2).

Table 12: Nitrate area covered under drinking water classes in the study area.

S. No.	Nitrate Drinking Water Class	Area Covered (Km^2)	Percentage of Total Area
1	Desirable	-	-
2	Permissible	-	-
3	Non-Potable	2317.00	100.00
	Total	**2317.00**	**100.00**

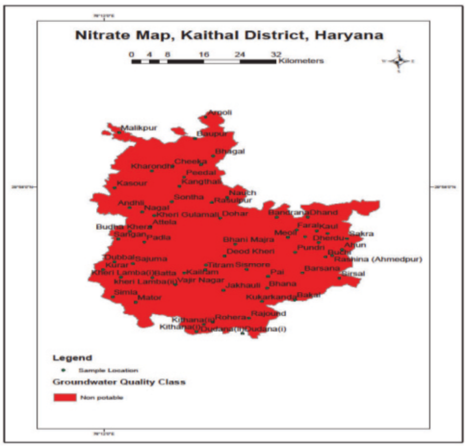

Fig. 11: Spatial distribution of nitrate in the study area.

xi. Phosphate

Phosphate covers 100% area under desirable drinking water class in the study area (Table 13, Fig.12). As per BIS drinking standards phosphate is desirable <1.0 mg/l and non-potable >1.0 mg/l (Table 2).

Table 13: Phosphate area covered under drinking water class in the study area.

S. No.	Phosphate Drinking Water Class	Area Covered (Km^2)	Percentage of Total Area
1	Desirable	2317.00	100.00
2	Permissible	-	-
3	Non-Potable	-	-

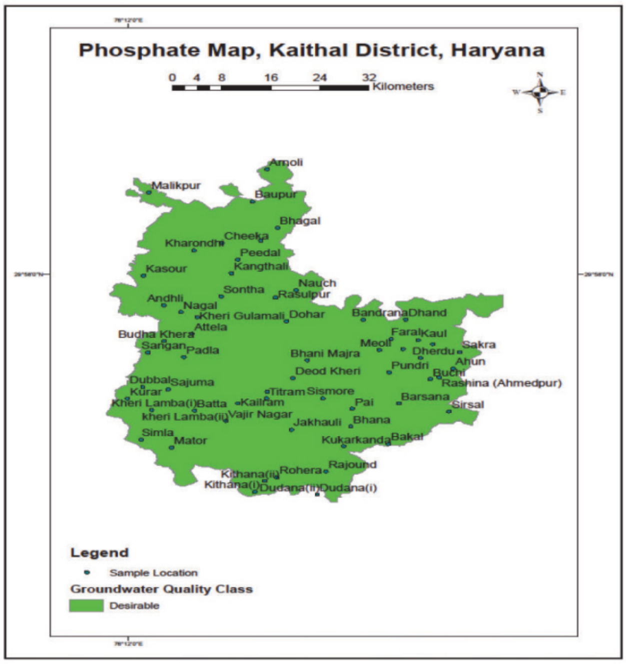

Fig.12: Spatial distribution of Phosphate in the study area.

xii. Residual Chlorine

Residual Chlorine covers 100% area under desirable drinking water class (Table 14, Fig.13). As per BIS drinking water standards residual chlorine is desirable < 0.2 mg/l, permissible 0.2 mg/l-1 mg/l and non-potable >1.0 mg/l (Table 2).

Table 14: Residual Chlorine area covered under drinking water classes in the study area.

S. No.	Residual Chlorine Drinking Water Class	Area Covered (Km^2)	Percentage of Total Area
1	Desirable	-	-
2	Permissible	-	-
3	Non-Potable	2317.00	100.00

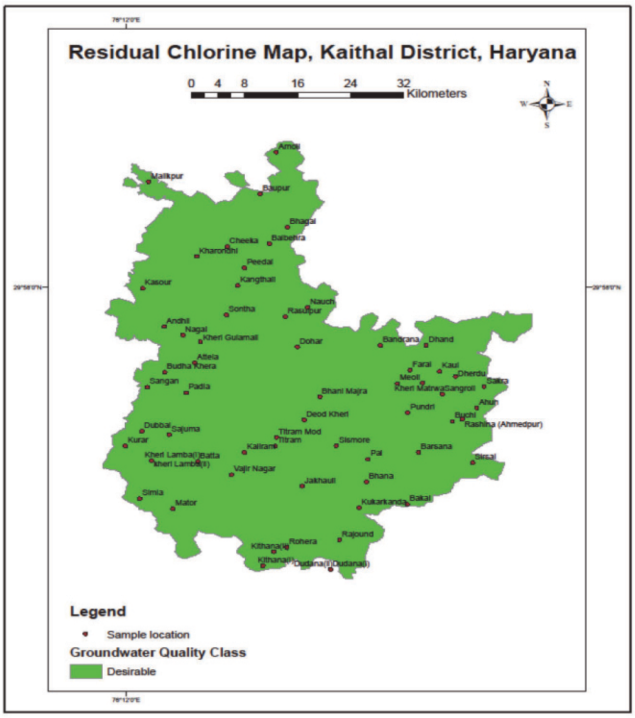

Fig. 13: Spatial distribution of Residual Chlorine in the study area.

CONCLUSIONS

In the study area pH is desirable in 97.45% area and non-potable in 2.55% area, alkalinity is desirable in 0.18% area, permissible in 99.14% area and non-potable in 0.68% area, hardness is desirable in 63.15% area, permissible in 34.94% area and non-potable in 1.91% area, chloride is desirable in 85.32 % area and permissible in 14.68% area, total dissolved solids cover 0.15% area under desirable, 98.83% area under permissible and 1.02% area under non-potable drinking water class, fluoride is desirable in 4.79% area, permissible in 18.88% area and non-potable in 76.33% area, iron is desirable in 94.48% area and non-potable in 5.52% area, ammonia covers 55.29% area under desirable drinking water class and 44.71% area under non-potable drinking water class, nitrate covers 100% area under non-potable drinking water class and nitrite, phosphate and residual chlorine cover 100% area under desirable drinking water class in the study area. The study is highly useful for planning, monitoring and management of groundwater for drinking purpose in the study area.

REFERENCES

Ambiga, K. (2016). Assessment of groundwater quality index using GIS at Tirupathi, India. *International Research Journal of Engineering and Technology*,3 (2):552-564.

Arumugam, K. and Elangovan, K. (2009). Hydrochemical characteristics and groundwater quality assessment in Tirupur Region, Coimbatore District, Tamil Nadu, India. **Environ Geol**, 58:1509-1520.

Asadi, S.S., Vuppala, P. and Reddy, M.A. (2007). Remote sensing and GIS techniques for evaluation of groundwater quality in Municipal Corporation of Hyderabad (Zone-V), India. *Int. J. Environ. Res. Public Health*, 4 (1):45-52.

Balakrishnan, P., Abdul, Saleem and Mallikarjun, N. D. (2011). Groundwater quality mapping using geographic information system (GIS): a case study of Gulbarga City, Karnataka, India, *African Journal of Environmental Science and Technology*, 5 (12):1069-1084.

Deshpande, S.M. and Aher, K.R. (2012). Evaluation of Groundwater Quality and its Suitability for Drinking and Agriculture use in Parts of Vaijapur, District Aurangabad, MS, India. *Research Journal of Chemical Sciences*, 2(1):25-31.

Krishnaraj, S., Kumar, Sanjiv and Elango, K.P. (2015). Spatial analysis of groundwater quality using Geographic Information System-a case study of Karur district of Tamilnadu, IOSR. *Journal of Environmental Science, Toxicology and Food Technology*, 9 (2):01-06.

Nelly, Kiplangat Cherono and Mutua, Felix (2016). Groundwater quality assessment using GIS and remote sensing- a case study of Juja location, Kenya. *American Journal of Geographic Information System*, 5 (1):12-23.

Pandian, M. and Jeyachandran, N. (2014). Groundwater quality mapping using remote sensing and GIS-a case study at Thuraiyur and Uppiliapuram Block, Tiruchirapalli District,Tamil Nadu, India. International Journal of Advanced Remote Sensing and GIS, 3(1):580-591.

Singh, D.S.H. and Lawrence, J.F. (2007). Groundwater quality assessment of shallow aquifer using geographical information system in part of Chennai city Tamilnadu. *J. Geol. Soc.* India, 69: 1067-1076.

Singh, Rajvir, Kumar, Anup and Chakravarti, S. K. (2015). GIS approach for groundwater quality study in Mewat District, Haryana, India. *International Journal of Scientific and Engineering Research*, 6 (9) :650-656.

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ASSESSMENT OF GROUNDWATER QUALITY FOR DRINKING PURPOSE IN BABAIN BLOCK, KURUSHETRA DISTRICT, HARYANA

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Abstract
Water is important for survival of life on the planet Earth. The present developmental activities and increasing population have put stress on availability of water particularly on groundwater. In agriculture dominant areas groundwater is excessively used which caused declining of groundwater and also its quality deterioration. The present study area Babain block is located in Kurukshetra district of Haryana between the latitudes 30.02^0 N to 30.17^0 N and longitudes 76.92^0 E to 77.09^0 E and covers an area of 150.48 sq. km. The main objective of the study was to assess groundwater quality for drinking purpose in the study area. In the study area eight groundwater samples were collected in 250 ml double capped plastic bottles. Geo-coordinates of sample locations were noted with the help of mobile GPS. Chemical analysis of eight groundwater samples were done using Tamilnadu Water Supply and Drainage (TWAD) Board, Chennai prepared Field Water Testing kit for twelve chemical parameters viz. pH, alkalinity, hardness, chloride, total dissolved solids (TDS), fluoride, iron, nitrite, nitrate, ammonia, phosphate and residual chlorine. Results of groundwater samples analysis were compared with BIS (IS10500:2012) drinking water standards to know the suitability of groundwater for drinking purpose. The study shows that pH ranges 7 to 8, alkalinity 210 mg/l to 350 mg/l, hardness 130 mg/l to 350 mg/l, chloride 30 mg/l to 50 mg/l, TDS 456 mg/l to 900 mg/l, fluoride nil to 1 mg/l, iron nil to 2 mg/l, ammonia nil to 0.5 mg/l, nitrite 0.2 mg/l to 0.5 mg/l, nitrate 45 mg/l to 75 mg/l, phosphate and residual chlorine nil in all the eight groundwater samples. The study is highly useful for planning and monitoring of groundwater quality for drinking purpose in the study area.

Keywords
Groundwater, quality, drinking, assessment, Babain, Kurukshetra, Haryana.

INTRODUCTION
Water is important for life on the planet Earth. Increasing demand of water in various uses have reduced its availability per capita. In agriculture dominant areas groundwater is excessively used for irrigation because of easily availability which caused declining of groundwater depth as well as quality deterioration. Many workers have studied groundwater quality in various areas for drinking and other purposes (Shekhar and Sarkar (2013), Shamsuddin et al. (2015), Asadi and Kumar (2017), Nourbakhsh and Yousef (2017), Zidi et al. (2017), Khelif and Boudoukha (2018), Mohamed et al. (2019), Oualid et al. (2019), Popugaeva et al. (2019).

STUDY AREA
Babain block is located in Kurukshetra district of Haryana (Fig.1). The geo-coordinates of the study area are latitudes 30.02^0 N to 30.17^0 N and longitudes 76.92^0 E to 77.09^0 E and covers an area of 150.48 sq. km. Geologically alluvium and geomorphologically alluvial plain is present in the study area.

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Climate of the area is sub-humid type and an agriculture dominant area in the Kurukshetra district.

OBJECTIVE

The main objective of the study was to assess groundwater quality for drinking purpose in the study area.

MATERIALS AND METHODOLOGY

In the study area eight groundwater samples were collected in 250 ml double capped plastic bottles. Geo-coordinates of sample locations were noted with the help of mobile GPS. Chemical analysis of eight groundwater samples were done using Tamilnadu Water Supply and Drainage (TWAD) Board, Chennai prepared Field Water Testing kit for twelve chemical parameters viz. pH, alkalinity, hardness, chloride, total dissolved solids (TDS), fluoride, iron, nitrite, nitrate, ammonia, phosphate and residual chlorine. Chemical analysis of groundwater samples were entered in excel software and represented in the form of bar graphs to get a easy look of each parameter at different sample locations. Results of groundwater samples analysis were compared with BIS (IS 10500:2012) drinking water standards (Table 2) to know the suitability of groundwater for drinking purpose.

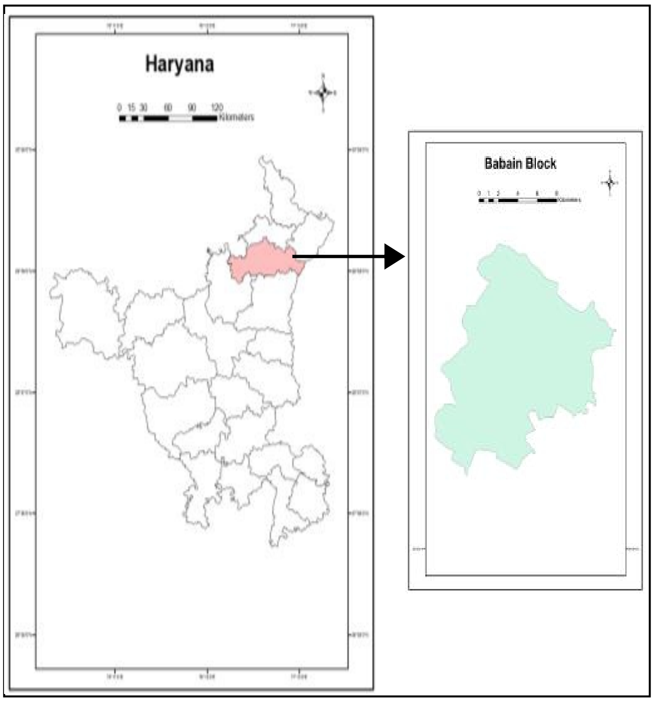

Fig. 1: Location map of the study area.

Table 1: Results of chemical analysis of groundwater samples.

Sl. No.	Sample	Latitude	Longitude	Source	pH	Alkalinity (mg/l)	Hardness (mg/l)	Chloride (mg/l)	TDS (mg/l)	Fluoride (mg/l)	Iron (mg/l)	Ammonia (mg/l)	Nitrite (mg/l)	Nitrate (mg/l)	Phosp-phate (mg/l)	Residual Chlorine (mg/l)
1	Bargat	30.04	76.97	Tube well	7.5	350	350	50	900	0.5	1	0.5	0.5	75	0	0
2	Marcheri	30.05	76.93	Tube well	7	220	200	50	564	1	0	0	0.5	75	0	0
3	Kalal Majra	30.07	76.93	Tube well	7.5	240	200	40	576	1	0	0	0.5	75	0	0
4	Bir Sujra	30.09	76.95	Tube well	7.5	220	130	30	456	0	0	0	0.5	75	0	0
5	Ramsaran Majra	30.08	77.00	Tube well	8	240	150	40	516	0.5	0	0.5	0.2	45	0	0
6	Sanghor	30.10	77.03	Hand Pump	7	250	200	50	600	0.5	2	0.5	0.2	75	0	0
7	Dhanani	30.12	76.99	Tube well	7.5	210	190	40	528	0.5	0	0.5	0.5	45	0	0
8	Berthala	30.13	76.97	Tube well	7.5	220	140	40	480	0	0	0	0.2	45	0	0

Table 2: Drinking water parameters (BIS: 10500:2012).

Sl. No.	Parameters	Potable		Non potable
		Desirable	Permissible	
1	pH	6.5-8.5	-	<6.5 and >8.5
2	Alkalinity	200	200-600	>600
3	Hardness	200	200-600	>600
4	Chloride	250	250-1000	>1000
5	TDS	500	500-2000	>2000
6	Fluoride	<1.0	1.0-1.5	>1.5
7	Iron	<0.3	-	>0.3
8	Ammonia	<0.5	-	>0.5
9	Nitrite	<0.1	-	>1.0
10	Nitrate	<45	-	>45
11	Phosphate	<1.0	-	>1.0
12	Residual Chlorine	0.2	0.2-1.0	>1.0

RESULTS AND DISCUSSION

i. pH

In the study area pH ranges 7 to 8 (Table 1, Fig.2). As per BIS (IS 10500:2012) drinking water standards pH is desirable 6.5 to 8.5 and non-potable <6.5 and >8.5 (Table 2). pH is desirable in all the eight groundwater samples (Bargat, Marcheri, Kalal Majra, Bir Surja, Ramsaran Majra, Sanghor, Dhanani, Berthala).

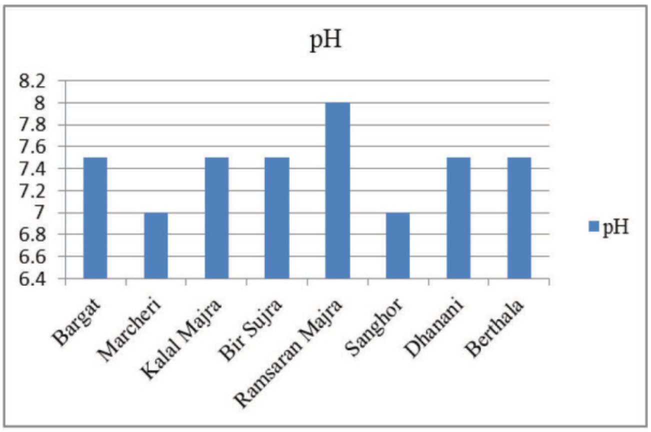

Fig. 2: pH in groundwater samples.

ii. Alkalinity

In the study area alkalinity ranges 210 mg/l to 350 mg/l (Table 1, Fig.3). As per BIS (IS 10500:2012) drinking water standards alkalinity is desirable <200 mg/l, permissible 200 mg/l-600 mg/l and non-potable >600 mg/l (Table 2). Alkalinity is permissible in all the eight groundwater samples (Bargat, Marcheri, Kalal Majra, Bir Surja, Ramsaran Majra, Sanghor, Dhanani, Berthala).

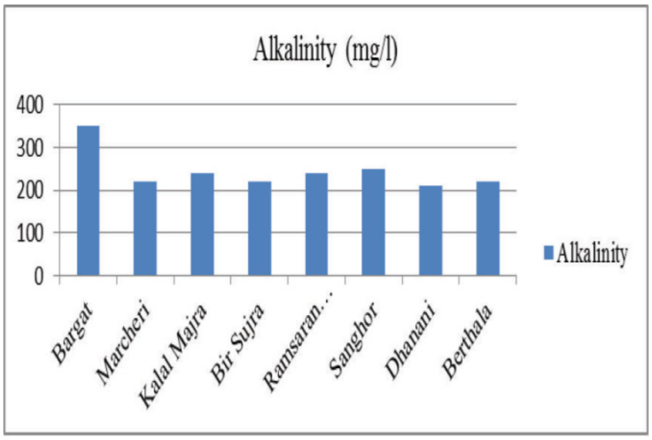

Fig. 3: Alkalinity in groundwater samples.

iii. Hardness

In the study area hardness ranges 130 mg/l to 350 mg/l (Table 1, Fig.4). As per BIS (IS 10500:2012) drinking water standards hardness is desirable <200 mg/l, permissible 200 mg/l - 600 mg/l and non-potable >600 mg/l (Table 2). Hardness is desirable in four groundwater samples (Bir Surja, Ramsaran Majra, Dhanani, Berthala) and permissible in four groundwater samples (Bargat, Marcheri, Kalal Majra, Sanghor).

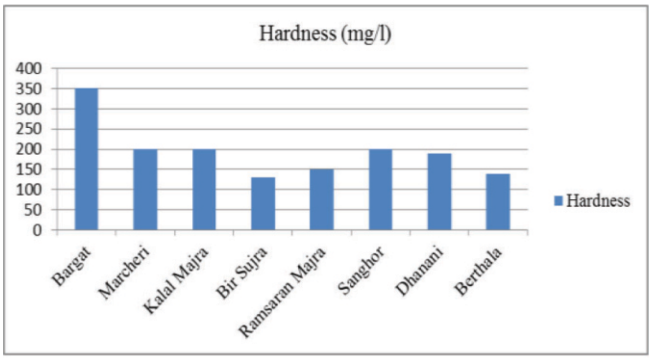

Fig.4: Hardness in groundwater samples.

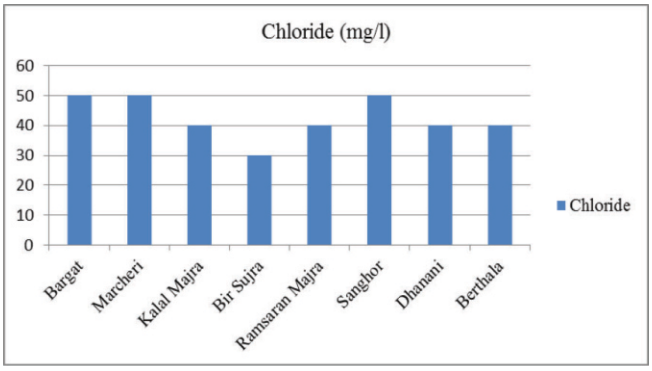

Fig.5: Chloride in groundwater samples.

iv. Chloride

In the study area chloride ranges 30 mg/l to 50 mg/l (Table 1, Fig.5). As per BIS (IS 10500:2012) drinking water standards chloride is desirable <250 mg/l, permissible 250 mg/l - 1000 mg/l and non-potable >1000 mg/l (Table 2). Chloride is desirable in all the eight groundwater samples (Bargat, Marcheri, Kalal Majra, Bir Surja, Ramsaran Majra, Sanghor, Dhanani, Berthala).

v. Total Dissolved Solids (TDS)

In the study area TDS ranges 456 mg/l to 900 mg/l (Table 1, Fig.6). As per BIS (IS 10500:2012) drinking water standards TDS is desirable <500 mg/l, permissible 500 mg/l -2000 mg/l and non-potable >2000 mg/l (Table 2). TDS is desirable in two groundwater samples (Bir Surja, Berthala) and permissible in six groundwater samples (Bargat, Marcheri, Kalal Majra, Ramsaran Majra, Sanghor, Dhanani).

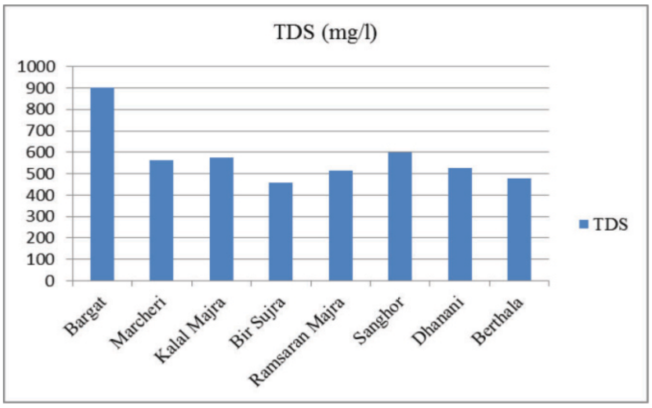

Fig. 5: Chloride in groundwater samples.

vi. Fluoride

In the study area fluoride ranges nil to 1 mg/l (Table 1, Fig.7). As per BIS (IS 10500:2012) drinking water standards fluoride is desirable < 1.0 mg/l, permissible 1.0 mg/l -1.5 mg/l and non-potable >1.5 mg/l (Table 2). Fluoride is desirable in six groundwater samples (Bargat, Bir Surja, Ramsaran Majra, Sanghor, Dhanani, Berthala) and permissible in two groundwater samples (Marcheri, Kalal Majra),

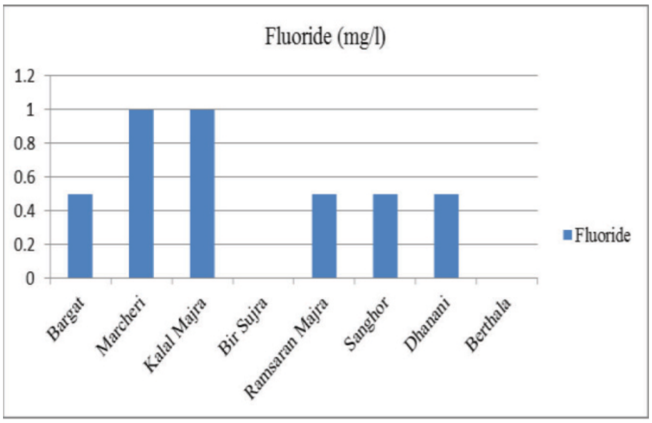

Fig. 7: Fluoride in groundwater samples.

vii. Iron

In the study area iron ranges nil to 2 mg/l (Table 1, Fig.8). As per BIS (IS 10500:2012) drinking water standards iron is desirable <0.3mg/l and non-potable >0.3 mg/l (Table 2). Iron is desirable in six groundwater samples (Marcheri, Kalal Majra, Bir Surja, Ramsaran Majra, Dhanani, Berthala) and non-potable in two groundwater samples (Bargat, Sanghor).

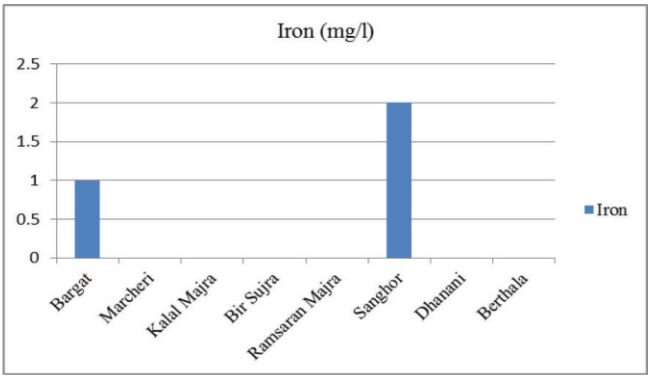

Fig. 8: Iron in groundwater samples.

viii. Ammonia

In the study area ammonia ranges nil to 0.5 mg/l (Table 1, Fig.9). As per BIS (IS 10500:2012) drinking water standards ammonia is desirable <0.5 mg/l and non-potable > 0.5 mg/l (Table 2). Ammonia is desirable in all the eight groundwater samples (Bargat, Marcheri, Kalal Majra, Bir Surja, Ramsaran Majra, Sanghor, Dhanani, Berthala).

ix. Nitrite

In the study area nitrite ranges 0.2mg/l to 0.5 mg/l (Table 1, Fig.10). As per BIS (IS 10500:2012) drinking water standards nitrite is desirable <1.0 mg/l and non-potable >1.0 mg/l (Table 2). Nitrite is desirable in all the eight groundwater samples (Bargat, Marcheri, Kalal Majra, Bir Surja, Ramsaran Majra, Sanghor, Dhanani, Berthala).

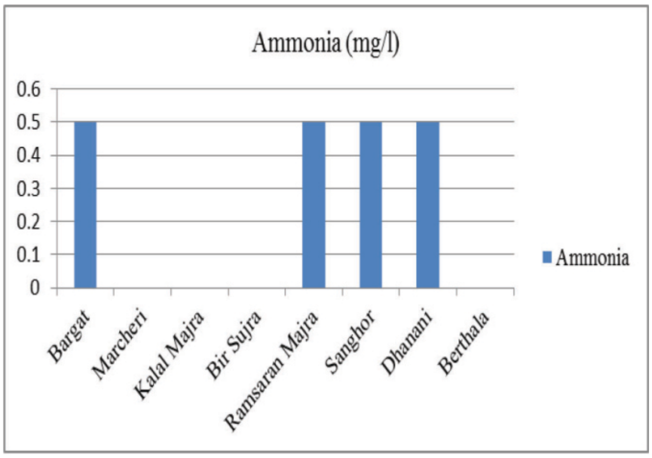

Fig. 9: Ammonia in groundwater samples.

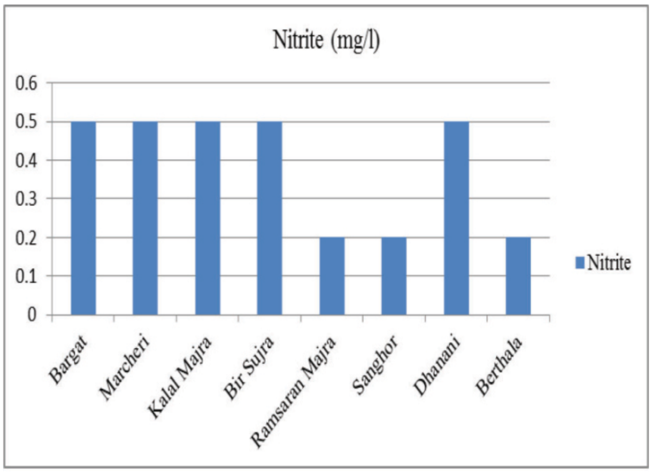

Fig. 10: Nitrite in groundwater samples .

x. Nitrate

In the study area nitrate ranges 45 mg/l to 75 mg/l (Table 1, Fig.11). As per BIS (IS 10500:2012) drinking water standards nitrate is desirable <45 mg/l and non-potable >45mg/l (Table 2). Nitrate is desirable in three groundwater samples (Ramsaran Majra, Dhanani, Berthala) and non-potable in five groundwater samples (Bargat, Marcheri, Kalal Majra, Bir Surja, Sanghor).

xi. Phosphate

In the study area phosphate is nil in all the eight groundwater samples (Table 1, Fig.12). As per BIS (IS 10500:2012) drinking standards phosphate is desirable <1.0 mg/l and non-potable >1.0 mg/l (Table 2). Phosphate is desirable in all the eight groundwater samples (Bargat, Marcheri, Kalal Majra, Bir Surja, Ramsaran Majra, Sanghor, Dhanani, Berthala).

xii. Residual Chlorine

In the study area residual chlorine is nil in all the eight groundwater samples (Table 1, Fig.13). As per BIS (IS 10500:2012) drinking water standards residual chlorine is desirable <0.2 mg/l, permissible 0.2 mg/l-1 mg/l and non-potable >1.0 mg/l (Table 2). Residual Chlorine is desirable in all the eight groundwater samples (Bargat, Marcheri, Kalal Majra, Bir Surja, Ramsaran Majra, Sanghor, Dhanani, Berthala).

CONCLUSIONS

In the study area pH, chloride, ammonia, nitrite, phosphate and residual chlorine is desirable in all the eight groundwater samples while alkalinity permissible in all the eight groundwater samples. Hardness is desirable in four groundwater samples as well as permissible in four groundwater samples. TDS is desirable in two groundwater samples and permissible in six groundwater samples. Fluoride is desirable in six groundwater samples and permissible in two groundwater samples, Iron is desirable in six groundwater samples and non-potable in two groundwater samples. Nitrate is desirable in three groundwater samples and non-potable in five groundwater samples. The study can be used for monitoring of groundwater quality for drinking purpose in the study area.

REFERENCES

Asadi, S.S. and Kumar, M. Satish (2017): Remote sensing and GIS based water quality estimation for Thimmapally watershed, *International Journal of Civil Engineering and Technology*, **8** (8):1626-1635.

Khelif, Safia and Boudoukha, Abderrahmane (2018): Multivariate statistical characterization of groundwater quality in Fesdis, East of Algeria, *Journal of Water and Land Development*, **37** (IV-VI):65-74.

Mohamed, Adam Khalifa, Dan, Liu, Kai, Song, Eldaw, Elsiddig and Abualela, Salma (2019): Evaluating the suitability of groundwater for drinking pur-poses in the North Chengdu Plain, China, E3S Web of Conferences, **81**:1-8.

Nourbakhsh, Zahra and Yousef, Hossein (2017): Presenting a conceptual model of data collection to manage the groundwater quality, *Journal of Water and Land Development*, **35** (X-XII):149-160.

Oualid, Bouteraa, Azeddine, Mebarki, Foued ,Bouaicha, Zeineddine, Nouaceur, Benoit, Laignel (2019): Groundwater quality assessment using multivariate analysis, geostatistical modeling, and water quality index (WQI): a case of study in the Boumerzoug-El Khroub valley of Northeast Algeria, Acta Geochim,**38** (6):796-814.

Popugaeva, Daria, Kreyman, Konstantin, Ray, Ajay K. (2019): Assessment of Khibiny Alkaline Massif groundwater quality using statistical methods and water quality index, *The Canadian Journal of Chemical Engineering*, **98**:205-212.

Shamsuddin, M. K. N., Suratman, S., Ramli, M. F., Sulaiman, W. N. Aa and Sefie, A. (2015): Hydrochemical assessment of surface water and groundwater quality at bank infiltration site, Soil Engineering International Conference 2015 (SEIC2015), IOP Conf. Series: *Materials Science and Engineering*, **136**:1-13.

Shekhar, Shashank and Sarkar, Aditya (2013): Hydrogeological characterization and assessment of groundwater quality in shallow aquifers in vicinity of Najafgarh drain of NCT Delhi, *J. Earth Syst. Sci.* **122** (1): 43-54.

Zidi, C., Jamrah, A., Al-Issai, L. (2017): Assessment of groundwater quality in Al-Buraimi, Sultanate of Oman, *Journal of Materials and Environmental Sciences*, **8** (4):1266-1276.

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MICROPLASTICS: CLINICAL TRIALS PERSPECTIVES

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Abstract
Plastic pollution has emerged as one of the global challenges for the humanity. Plastics particles of millimeter and micrometer dimensions have been detected everywhere in the environment. Detection of tiny plastic particles in human blood and different organs has caused serious concerns and awareness in the society. Research activities have been initiated globally for better understanding the possible routes of entry and translocation of micro- and nano-plastics in human body. In vitro and in vivo studies have generated some primary data on these aspects. However, the major challenges in gathering data from clinical studies are lack of established methodology for designing ethically correct experiments, detection and identification of plastic particles and regulatory guidelines that needs to be designed specifically for micro- and nano-plastics. In this mini review article, readers are navigated through the recent updates on the clinical studies with microplastics and current challenges with some critical inputs.

Keywords
Microplastics, Clinical Trials, Placenta, Blood, IMTOX project, Regulatory Guidelines.

INTRODUCTION

Recent findings on the possible impact of microplastics (MPs) on human and environmental health have strongly suggested that MPs are already in the food chain and made entry to animal body including humans. This fate of MPs is perhaps one of the most unintended but serious consequences of environmental pollution that originates from anthropogenic activities. In this regard, it is pertinent to think that the globally recognized regulatory guidelines on plastic pollution have failed in all aspects. However, conclusive evidences of the fate of different MPs and interactive zone with animals are missing. The World Health Organization (WHO) has made some recommendations on the possible sources and monitoring of MPs in the drinking water. WHO in its report mentioned that routine monitoring of MPs in drinking water is not required and this was based on the lack of evidences to indicate a human health concern caused by MPs in drinking water (Marsden et al, 2019). From the regulatory point of view, such guidelines can be considered as the result of the findings of the majority of studies carried out across the globe. Talking about MPs pollution in general and making sense of the hazardous validity of MPs at cellular level are two different extremities of research domain. MPs are in air, water and earth and their final fate is determined by many biotic and abiotic factors. These aspects have been well explored with conclusive evidences (Das et al. 2021; Alimi et al. 2018). The recently developed interest in the research domain of MPs can be mostly attributed to the human health concerns reported by researchers from across the world. In particular, human physiological and anatomical presence of MPs has raised serious concerns in society. The unexpected discovery of MPs in human blood samples has proved that MPs are already in human body [Heather et al. 2022). This finding has actually opened new avenue of clinical research on MPs. This is of course a case where entry of MPs into human body was not under a clinical setting or voluntarily tested. A number of in vitro, in vivo and preclinical studies have been carried out by different research group on possible toxicity of MPs (Marko et al. 2021). A relevant question that arises is the availability and validity of clinical data of MPs based toxicity studies. Interventional or observational clinical studies with MPs are important for better understanding the possible health hazards at molecular level. However, administration of MPs to human participants is

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impractical and this is irrespective of the chemical composition, size, shape and surface properties of MPs. It is also obvious that data obtained from in vivo studies on the possible toxicity of MPs can not be extrapolated for clinical settings. A major challenge will be to establish the relationship between the variation in toxicity (acute or chronic) against the relevant changes in the dose and/or properties (size/shape/surface properties etc.) of a specific type of MPs under a clinical setting. In stark contrast, medical plastic engineering and manufacturing industries have revolutionized the biomedical application of plastics in the form of defect-free intelligent single use products under International Standard ISO 10993-1 safety regulations (Das et al. 2021). However, such regulation might not be applicable to MPs and this can be attributed to micro level size and changes in physicochemical properties of MPs. Some recent reports on the presence of MPs in human organ can guide clinical studies. The findings are indicative of exposure of MPs by ingestion or inhalation.

Some Case Studies of MPs of Clinical Significance

The case of Plasticenta

The first evidence of MPs in human placenta has been reported by Ragusa et al. In this study, vaginally delivered human placentas were collected from consenting women with physiological pregnancies and later analyzed for the presence of MPs (Ragusa et al. 2021). After Raman Microspectroscopy analysis of the samples, 12 fragments MPs of different sizes (5-10µm) were located in the fetal side, maternal side and the chorioamniotic membranes of the analyzed placentas. Chemical composition analysis of MPs showed them to be as stained polypropylene a thermoplastic polymer. Interestingly, around 3.8% (by mass) of the total mass (~600 g) of each placenta was only analyzed for each sample and this strongly suggested that total number of MPs within each placenta will be much higher. Presence of MPs in human placentas has raised two serious concerns regarding the possible roots of entry of MPs to the placental site and the possible consequences on pregnancy outcomes and foetus development. Respiratory and gastric organs were hypothesized as the sources of entry of MPs into blood stream and localization in the placental tissues. The study concluded that MPs may impart several adverse effects at cellular level during pregnancies. However, further studies are warranted to access if presence of MPs is harmful for pregnancies.

The case of placenta and meconium

Detection of MPs in human placenta and fetal meconium samples was reported recently (Braun et. al. 2021). A thorough protocol was developed under real-life clinical setting for the detection MPs. The placenta samples collected were from cesarean delivery and peripheral and central placental tissues were analyzed for the presence of MPs. Fourier-transform infrared (FTIR) analysis of the samples confirmed the presence of ten different types MPs including polyethylene, polypropylene, polystyrene and polyurethane within the size of 50µm. One of the significant finding of this study was the detection of MPs in the meconium samples that strongly suggested transplacental movement and ingestion of MPs to the fetus.

Some Ongoing Clinical Studies

Comparison of MPs levels in placenta and cord blood samples

Started in March 2022, this clinical trial has been undertaken for a comparative study of MPs levels in placenta and cord blood samples of pregnant women with fetal growth retardation (FGR) and healthy pregnant women (www.clinicaltrials.gov). The study will involve a total of 40 pregnant women. The methodologies are being optimized for the collection of blood sample from the vein of the umbilical cord and the maternal side of the placenta. The MPs extracted (if any) from the samples will be analyzed by µ-Raman spectroscopy for identification and quantification. The estimated completion date of this clinical study is March, 2023. The study will generate very important data on the possible role of MPs in causing FGR as compared to the control group.

MPs in ovarian and testicular tissue in humans

For the first time, a clinical study on the possible effects of MPs on human fertility and overall mammalian health has been initiated very recently (June, 2022) and expected to be completed within two years (www.clinicaltrials.gov). The study aims to generate data on the detection, identification and impacts of MPs in human granulosa cells and in the follicular fluid of women undergoing intracytoplasmic sperm injection (ICSI) treatment. In this observational type of clinical study, a total of 50 woman of above 18 years of age will participate. Raman spectroscopy and scanning electron microscopy will be used to analyze the samples for the detection of MPs.

The IMPTOX project

As a part of the European Research Cluster (CUSP) to understand the health impacts of MPs and nanoplatics (NPs) and under the European Union's Horizon 2020 program, the IMPTOX project in one of its objectives will specifically study the effects of environmental or dietary exposure to MPs and NPs on allergy and asthma using clinical studies in allergic schoolchildren living in cities and by the seaside (www. imptox.eu). Started in the last January, this projected is expected to be completed by February 2025. A total of 630 participants will be involved in this observational type clinical study. The expected outcome of this study is better understanding of the role of high concentrations of MPs and NPs in the environment and its link to the increased number of allergic people or worsens their allergies.

Current Challenges in Clinical Trials with MPs

Toxicity of MPs is being studied on animal model organisms belonging to different taxonomic groups. Most of the model organisms are of aquatic environment origin, while studies with freshwater and terrestrial organism are scanty at best (Marko et al. 2021). From safety and regulatory points of view, designing of interventional or observational clinical studies with MPs is impractical. Routes of entry of MPs into human body and the mechanisms of their translocation to bloodstream and different organs first need to be investigated with animal studies. However, it will be difficult to extrapolate the data for clinical settings as biophysico-chemical properties of MPs might change significantly with the changes in volumetric changes in tested organ or tissues. In particular, absorption and distribution kinetics of MPs might differ significantly in human body as compared to other animals used for clinical testing. Overall, the obvious and immediate problem related to the clinical study of MPs seems to be the reverse data fitting or modeling obtained from the animal studies. As contrary to the common practices of clinical trials, ethically-designed experiments for interventional/observational/feasibility studies with MPs will need a different set of regulatory guidelines. With the existing regulatory guidelines, Absorption, Distribution, Metabolism and Excretion (ADME) studies for MPs are not feasible. Results from animal studies on the toxicity of MPs might be highly inconsistent predictors of toxic responses in humans. There are many reports on the limitation of extrapolating the average positive predictive value from animal to human tested for drug development (Gail, 2019). This necessitates the design of innovative experimental approaches for the clinical trials with MPs within the regulatory restrictions (Nuremberg code and Helsinki Declaration) of clinical trials (www.nih.gov; www.wma.net).

Declaration of competing interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

Alimi, O.S., Farner Budarz, J., Hernandez, L.M. and Tufenkji, N. (2018). Microplastics and nanoplastics in aquatic environments: aggregation, deposition, and enhanced contaminant transport. *Environmental Science & Technology*. 52(4):1704–1724.

Braun, T., Ehrlich, L., Henrich, W., Koeppel, S., Lomako, I., Schwab, P. and Liebmann, B. (2021). Detection of Microplastic in Human Placenta and Meconium in a Clinical Setting. *Pharmaceutics*. 13(7):921.

Das, R.K., Sanyal, D., Kumar, P., Pulicharla, R. and Brar, S.K. (2021). Science-society-policy interface for microplastic and nanoplastic: Environmental and biomedical aspects. *Environmental Pollution*. 290 (December):117985.

Leslie, H.A., Van Velzen, M.J.M., Brandsma, S.H., Vethaak, A.D., Garcia-Vallejo, J. J. and Lamoree, M. H. (2022). Discovery and quantification of plastic particle pollution in human blood. *Environment International*. 163(May):107199

Marsden, P., Koelmans, A., Bourdon-Lacombe, J., Gouin, T., D'Anglada, L., Cunliffe, D., Jarvis, P., Fawell, J. and De France, J. (2019). Microplastics in Drinking Water. World Health Organization.

Prokic, M.D., Gavrilovic, B.R., Radovanovic, T.B., Garvic, J.P.,Petrovic, G.P., Despotovic, S.G. and Faggio, C. (2021). Studying microplastics: Lessons from evaluated literature on animal model organisms and experimental approaches. *Journal of Hazardous Materials*. 414(July):125476.

Ragusa, A., Svelato, A., Santacroce, C., Catalano, P., Notarstefano, V., Carnevali, O., Papa, F., Rongioletti, M.C.A., Baiocco, F., Draghi, S., D'Amore, E., Rinaldo, D., Matta, M. and Giorgini, E. (2021). Plasticenta: First evidence of microplastics in human placenta. *Environment International*. 146(January):106274.

Van Norman, G. A. (2019). Limitations of Animal Studies for Predicting Toxicity in Clinical Trials Is it Time to Rethink Our Current Approach? *JACC: Basic to Translational Science*. 4(7): 845-854.

www.clinicaltrials.gov (Accessed June 30, 2022).

www.imptox.eu (Accessed June 30, 2022).

www.nih.gov (Accessed 30 June, 2022).

www.wma.net (Accessed June 30, 2022).

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A SYSTEMATIC REVIEW ON THE TRADITIONAL USES, PHYTOCHEMICAL COMPOSITION AND PHARMACOLOGICAL PROPERTIES OF BLACK PEPPER (P. *NIGRUM* L.)

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Abstract
Black pepper (*Piper nigrum* L.) is an important healthy food owing to its antioxidant, antimicrobial potential and gastro-protective modules. Black pepper, with piperine as an active ingredient, holds rich phytochemistry that also includes volatile oil, oleoresins, and alkaloids. It has also been extensively explored for its biological properties and its bioactive phyto-compounds. In addition to its culinary uses, pepper has important medicinal and preservative properties, and, more recently, piperine has been shown to have fundamental effects on p-glycoprotein and many enzyme systems, leading to biotransformative effects including chemoprevention, detoxification, and enhancement of the absorption and bioavailability of herbal and conventional drugs The alkaloid piperine improves the therapeutic value of several drugs, vaccines and nutrients by enhancing bioavailability through inhibiting numerous digestive enzymes. Piperine also aids in digestion through stimulating pancreatic and intestinal enzymes, and enriches cognitive skills and fertility. Furthermore, piperine is recognized as delivering several therapeutic activities distinct from other chemical components. This study endeavors to systematically review précised data on the traditional uses and pharmacological properties of black pepper. Besides, this review presents a summary of the data on the chemical composition of black pepper, including minerals, vitamins, carotenoids and flavonoids, and various therapeutic benefits. Up to date existing information, various metabolites have been isolated from P. nigrum. Among them, biologically active alkaloid piperine and the main essential oils constituents including β-caryophyllene, limonene, sabinene, α-pinene, β-bisabolene and α-copaene can serve as a new natural source for use in food, aroma, cosmetics and pharmaceutical industries.

Keywords
Natural bioactives, Oleoresins, Piperine.

INTRODUCTION

Black pepper, (*Piper nigrum* L.), is a widely used spice, known for its pungent odour. Piper nigrum it is a perennial shrub native to southern India, and has been extensively cultivated there and in other tropical regions. Due to its strong pungency, it has valuable medicinal potency. It is one of the world most common kitchen spices and well known for its pungent chemical constituent piperine (1-peperoyl piperidine, which has diverse pharmacological activities. It is commonly known as Kali mirch in Urdu and Hindi, Marich in Nepali, Pippali in Sanskrit, Milagu in Tamil, and Black Pepper, Peppercorn, Green pepper, White pepper, Madagascar pepper in English. P. nigum is a woody climbing vine growing to 30 ft and the grayish stem may reach 1.2 cm diameter. Numerous rootlets grow from swollen stem nodes. [1-2]Leaves dark green above and pale green beneath, glossy, ovate and acutely tipped, and range in size from 13–25cm in length. Elongated, slender spikes or catkins (1.6–2cm in

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length) bear minute, white flowers. The flower spikes, each producing from 50–60 single-seeded dark red berries, ~5mm in diameter, always appear on stems opposite the leaves. Different parts of the plant are used for medicinal purposes; however, the part commonly used as the spice black pepper is the cooked and dried unripe berry. Due to some religious value of black pepper, its being popular from ancient time to modern generation. This review is aimed to provide a literature review on recent advancement of chemistry, pharmacognosy, pharmacological activities other general use of Piper nigrum. It is widely accepted and most used in different traditional systems of medicine, like the Unani and Ayurvedic systems. Recent scientific researchers have established the presence of many active compounds in this spice that are known to possess specific pharmacological properties.

Almost all spices have aromatic features, regular grindings of spices lead to loss of important aroma compounds and accordingly resulted to considerable loss of aroma and flavor components and deterioration of quality. The dried black pepper fruit is rich in bioactive phytochemical compounds. Piperine is one of the most abundant chemical alkaloids in the black pepper. Other similar alkaloids are also isolated from black pepper such as piperanine, piperettine, piperylin A, piperolein B, and pipericine. However, the pungency of these piperine's analogs are less than the Piperine.). Black pepper was also found to have a good quantity of polyphenols. The interesting findings are that, black pepper contains more polyphenols compared with white pepper (White pepper is made from fully ripe pepper berries. They are soaked in water for about 10 days, leading to fermentation. Then their skins are removed, which also removes some of the hot piperine compound, as well as volatile oils and compounds that give black pepper its aroma. As a result, white pepper has a different flavor and heat component than black pepper. The process used and handling of white pepper can introduce different flavor notes as well.). [3-5] Moreover, it is believed that, after eating Black pepper, it hydrolyzed in the gut and liberating these bound polyphenols. Even some studies stated that the Black pepper contains aromatic compounds, flavonoids, alkaloids, amides and lignans. The volatile oils of the Black pepper fruits were analyzed using column chromatography, high resolution gas chromatography and gas chromatography mass spectrometry (GC-MS); up to 46 compounds were identified including δ-cadinol, δguaiene, (Z) (E)- farnesol, (E)-β-ocimene and guaiol. In another study, five phenolic amides were isolated from the black pepper, which revealed high antioxidant activity more effective than some naturally occurring antioxidants of the black pepper in bioactive phytochemical components of promising medicinal importance. The therapeutic efficacy of this individual spice for specific pharmacological actions has also been established by experimental and clinical studies. [6-9]

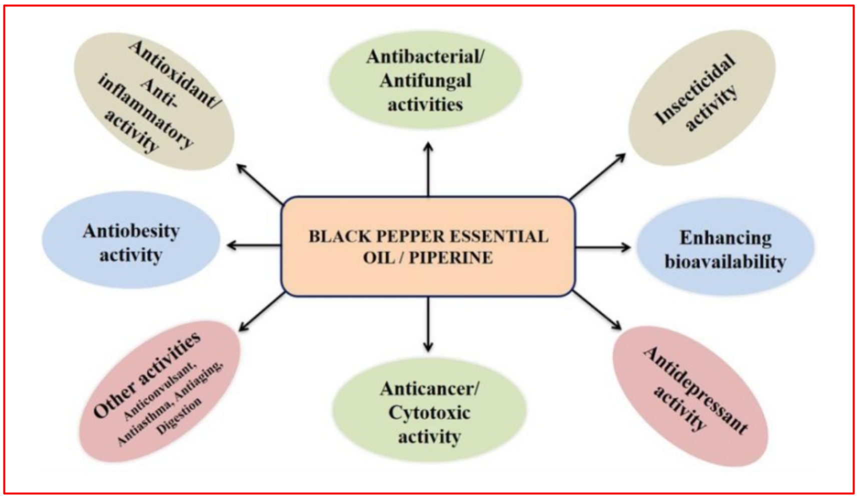


Fig. 1: Some reported bioactivities of black pepper.

Fig. 2: Green and Pink black pepper seeds on vine.

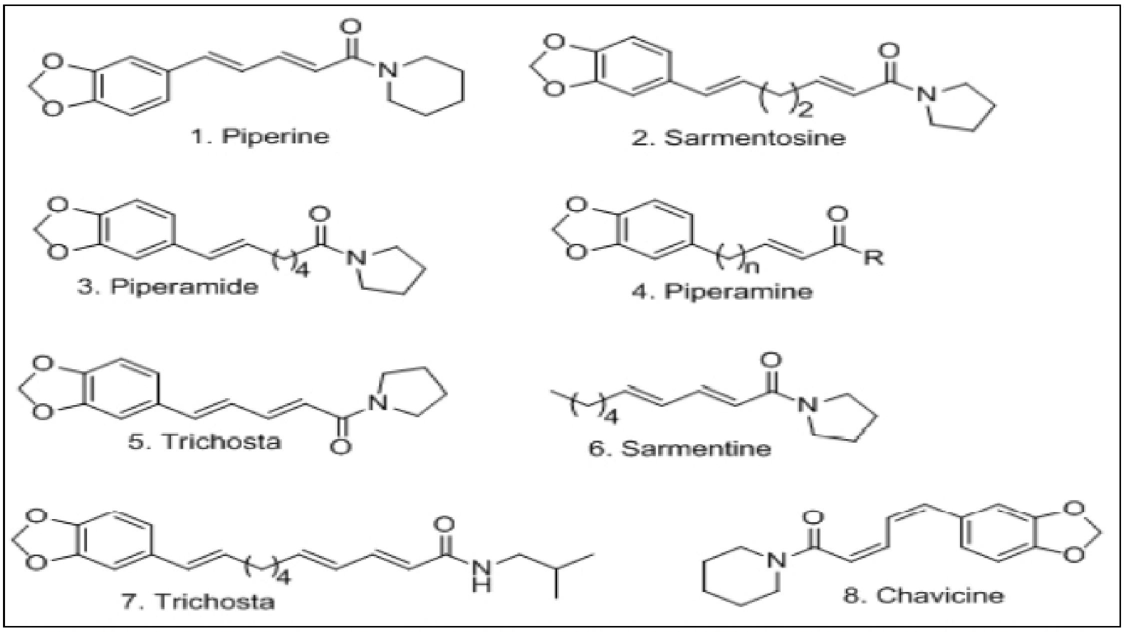
Bioactive chemical compounds of the black pepper

Black pepper is rich in minerals, vitamins and nutrients. The chemical composition of 100 g of black pepper seeds includes carbohydrate 66.5 g, protein 10 g, and fat 10.2 g, as well as a relatively high concentration of minerals such as calcium (400 mg), magnesium (235.8-249.8 mg), potassium (1200 mg), phosphorus (160 mg), and the lower concentration of sodium, iron and zinc. These minerals are essential elements for day-to-day activities of humans. Besides, black pepper also has a significant concentration of vitamins such as Vitamin C, B1, B2 and B3. Nine accessions of Nigeria grown black pepper had a concentration of tannin ranging from 2.11 to 2.80 mg /100 g. In a recent study on black pepper, catechin, Quercetin, myricetin, and carotenoids, namely lutein and β-carotene have also been detected in significant concentration. Several researchers evaluated essential oils (EO), oleoresin and piperine in various parts of black pepper. The EO yield of black pepper berries and leaves have varied from 1.24 to 5.06 %, and 0.15–0.35 %, respectively. It has been observed that variability of volatile oil and oleoresin content in 14 black pepper accessions ranged from 2.7 − 5.1 % and 7.6 − 9.4 %, respectively. The oleoresin content of black pepper ranged between 4.27 and 12.73 % and the characteristic natural alkaloid of black pepper “piperine” ranged from 2.13 − 5.80 % and 0.12 − 20.86 %, in seeds and leaves correspondingly. [10-34]

Table 1: Nutritional composition of Black Pepper [Nutrient concentration/100g].

Chemical composition	Concentration
Proximate	
Water (g)	8.0
Energy (Kcal)	400.0
Carbohydrate (g)	66.5
Protein (g)	10.0
Fat (g)	10.2
Total Ash (%)	3.43–5.09
Crude fibre (%)	10.79–18.60
Minerals	
Calcium (mg)	400.0
Magnesium (mg)	235.8–249.8
Phosphorus (mg)	160.0
Sodium (mg)	10.0
Potassium (mg)	1200.0
Iron (mg)	17.0[36]
Zinc (mg)	1.45–1.72
Vitamins	
Vitamin C (mg)	27.46–32.53
Vitamin B1 (mg)	0.74–0.91
Vitamin B2 (mg)	0.48–0.61
Vitamin B3 (mg)	0.63–0.78
Metabolites	
Tannin (mg)	2.11–2.80
Flavonoids	
Catechin (μg)	410.0
Myricetin (μg)	56.0
Quercetin (μg)	13.0
Carotenoids	
Lutein (μg)	260.0
β-carotene (μg)	150.0

Table 1: Nutritional composition of Black Pepper [Nutrient concentration/100g].



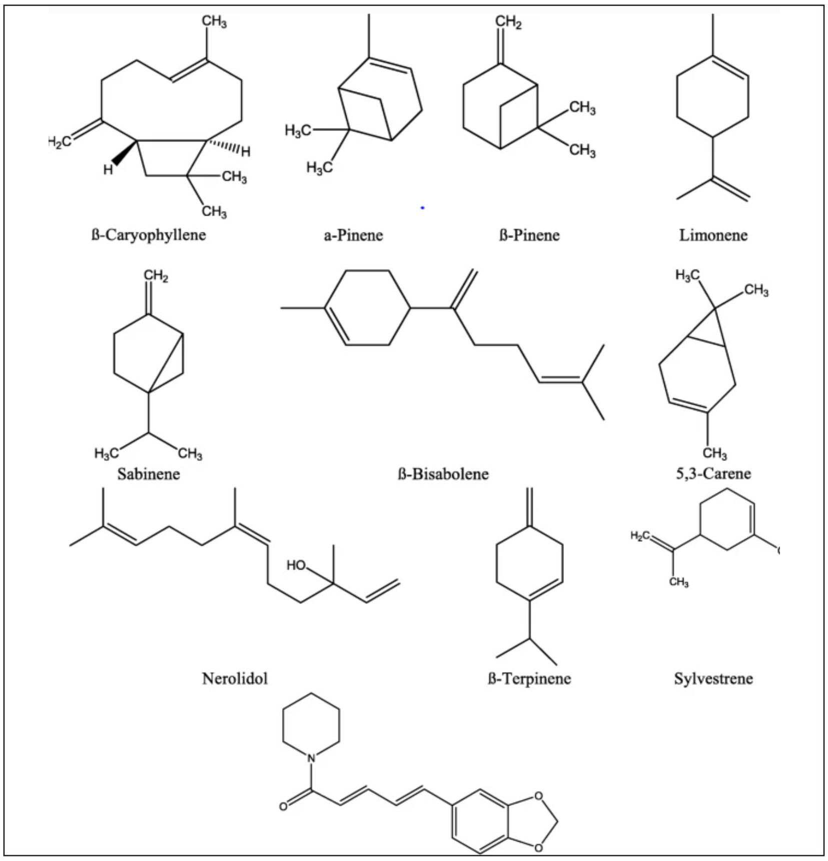


Figure 3: Major chemical constituents of Black pepper seed and essential oil. [15-18].

Traditional Medicinal uses

Traditionally, black pepper has been used in a variety of different remedies and for different purposes. According to Ayurveda, the pungency and heating properties of black pepper work to help metabolize food as it is digested in our system. Its heat works as a stimulant like lighting a fire might. Like many aromatic kitchen herbs, black pepper is considered a carminative in Western herbalism, and in Ayurveda black pepper is known to enkindle *agni*, the digestive fire. These actions are likely due to the taste of black pepper on the tongue triggering the stomach to release hydrochloric acid, which is needed to digest protein, and pepper's ability to stimulate digestive enzymes in the pancreas This stimulating quality is also used to clear congestion in the respiratory system as well as other processes. In the classical literature, many Unani scholars have mentioned various medicinal uses of black pepper. It has been described for its efficacy in cholera, dyspepsia, flatulence, diarrhea, and other gastrointestinal ailments. It is also a useful ingredient in tooth powders. In "Ilaj-ul-Ghurba" a pill is recommended for syphilis, which is prepared by taking black pepper (P. nigrum), Calotropis gigantea, and jaggery. Externally, it is applied to boils. It is also used in case of sore throat, alopecia, skin disorders, and piles etc. Finely powdered black pepper and seasame oil well mixed and heated, when applied over the paralytic area, is proved to be very effective. A preparation made with black pepper and leaves of Cassia occidentalis is even good for night blindness. It is also used in the treatment of gonorrhea. The drug is used as an antidote for scorpion sting. plant Cissampelos pareira, in combination with black pepper, has been claimed to be useful in birth control when given immediately after delivery. In Cambodia, it is also used as cure for dysentery. In reference with Dioscorides,. It is beneficial for the treatment of cough and chest pain when given in the form of sharbat (Syrup) or lauq (Paste). Along with honey, it is good for diphtheria. The combination of black pepper, onion, and salt, when applied on the bald area, is effective for curing alopecia. When used along with vinegar, it is also good for teethache. [10-14}]

Health Benefits of Black Pepper

Just a pinch of black pepper when added to any food preparation can enhance its flavor. It is a spice that is known to offer many health benefits. It helps to promote weight loss and even aids in digestion. It is believed that this amazing spice prevents cancer as black pepper detoxifies the body, cleanse the intestine and stomach. Black pepper releases hydrochloric acid in stomach which helps in cleaning the intestines. It prevents constipation and helps to combat occurrence of common cold. Black pepper is used for combating skin exfoliation, skin deformation and helps to keep wrinkles at bay. It is used to combat dandruff, helps in restoring hair growth and makes the hair shiny. Mentioned below are the best health benefits of Black Pepper. Black pepper helps to prevent the occurrence of cancer. Black pepper is credited with piperline and this when combined with turmeric can help in preventing cancer. Black pepper is also loaded with antioxidants, and presence of vitamins like Vitamin A, flavonoids and carotenes helps in combating cancer causing free radicals. Black pepper aids in digestion problem, and when a person consumes raw black pepper, hydrochloric acid is released by the stomach, and this helps in breaking down of proteins. The release of hydrochloric acid in black pepper also helps in cleaning the intestines and helps in combating gastrointestinal diseases. Stomach disorders such as constipation, colon cancer, diarrhoea and other bacterial diseases are prevented when black pepper is consumed daily. Cold and cough can be cured by adding this spice to herbal tea and consumed two or three times a day. Having dishes prepared with black pepper are useful in winter and facilitate removal of phlegm from the body. Black pepper with honey prevents chest congestion. One can add crushed black pepper to warm water along with eucalyptus oil drops and inhale the steam to get rid of chest congestion. Black pepper prevents a skin pigmentation disease called vitiligo. This condition makes the skin turn white. There are many chemical rich medicines available in the market to restore skin color. However, one should know that black pepper is loaded with piperline that helps in restoring the natural color of the skin. This also ensures that the chances of occurrence of skin cancer due to overexposure to chemicals are reduced. Black pepper used for skin rash and skin allergy, you also uses black pepper as scrup to remove dead skin. Skin deformation, like wrinkles, is kept at bay if one adds black pepper to their diet since young age. The occurrence of premature ageing, dark spots are also kept in control if one eats black pepper in raw or cooked form. Eating black pepper makes sure that blood circulation to different parts of the body is improved. This also ensures that skin is rejuvenated. Skin disorders like acne are controlled if one adds black pepper to their diet. The skin exfoliation can be done by crushing some black pepper and applying it over skin. Black pepper is used in the treatment of dandruff in hair. Add curd with black pepper for hair loss problem, one of the effective home remedy. Even black pepper oil used to prevent hair loss and hair regrowth. Black pepper aids in weight loss. The reason is that black pepper is rich in phytonutrients and this helps in breaking down excess fat and improves the metabolism of the body. Black pepper is used in the treatment of depression. When one chews raw black pepper, a mood-inducing chemical is released from the brain, and this fills the mind with a soothing, calm mood. Black pepper is good for prevention of arthritis and joint pains. Black pepper has medicinal properties that help to combat gout. It is useful for people suffering from joint and spinal pain. This wonder spice helps to promote sweating and urination. Thus help to get rid of toxins in the body. Black pepper is good for prevention of arthritis and joint pains. Black pepper has medicinal properties that help to combat gout. It is useful for people suffering from joint and spinal pain. Black pepper is used in many cuisines as a spice globally. It is used extensively during cold and winter seasons and helps to combat respiratory problems. It is used as an aphrodisiac and also in the treatment of erectile dysfunction. Black pepper is found to cause stomach burns when taken in large quantities. When large quantities of black pepper enter the lungs, it may cause death. Black pepper is known to cause burning sensation inside the stomach in certain people, and they should check the quantity of black pepper being consumed before discarding it fully. There are certain cases in which black pepper reacts with medicines. Black pepper may cause some irritation to pregnant women, and may cause some allergies to breast feeding mothers. [31-34]

DISCUSSION AND CONCLUSIONS

For millennia, spices have been an integral part of human diets and commerce. Recently, the widespread recognition of diet-health linkages bolsters their dietary importance. The bioactive components present in them are of considerable significance owing to their therapeutic potential against various ailments. They provide physiological benefits or prevent chronic ailment in addition to the fundamental nutrition and often included in the category of functional foods. Black pepper (Piper nigrum) is one of the most widely used among spices. It is valued for its distinct biting quality attributed to the alkaloid, piperine. Black pepper is used not only in human dietaries but also for a variety of other purposes such as medicinal, as a preservative, and in perfumery. Many physiological effects of black pepper, its extracts, or its major active principle, piperine, have been reported in recent decades. Dietary piperine, by favorably stimulating the digestive enzymes of pancreas, enhances the digestive capacity and significantly reduces the gastrointestinal food transit time. Black pepper essential oil constitutes approximately 0.4–7 % of the berry dry weight and is beneficial for the management of rheumatism, cold, tiredness, muscular pains and infection. It was also used as a nerve stimulant to enhance blood circulation. Both white pepper and black pepper contained 2–7 % piperine. The volatile oil constituent piperamides and nerolidol exhibited insecticidal activities. β-caryophyllene displayed anaesthetic effects, and piperine was used in perfumes. Black pepper has been used for millennia, including plant breeding activities for the development of superior varieties with improved organoleptic and nutritional properties. It has been used in traditional as well as modern medicine. Based on the reviewed literature, *Piper nigrum* (L.) has many favourable chemical properties and beneficial effects. Besides, this review presents a summary of the data on the chemical composition of black pepper, including minerals, vitamins, carotenoids and flavonoids, and various therapeutic benefits. Up to date existing information, > 80 metabolites have been isolated from *P. nigrum.* Among them, biologically active alkaloid piperine and the main essential oils constituents including β-caryophyllene, limonene, sabinene, α-pinene, β-bisabolene and α-copaene can serve as a new natural source for use in food, aroma, cosmetics and pharmaceutical industries. Piperine also has a broad spectrum of therapeutic potential and potential for improving the bioavailability of therapeutic drugs and nutrients. BPEO and piperine have many biological effects such as antioxidant, antiobesity, antitumor, antipyretic, anticonvulsant, anti-thyroid, antifungal, antibacterial, insecticidal, hepatoprotective, anti-asthmatic, larvicidal, antihypertensive, anti-inflammatory, antidiabetic, antidiarrheal, bioavailability enhancer, immunomodulator, antiepileptic, antifertility, GI stimulant, lipid metabolism accelerator, anticancer, CNS stimulant, diuretic, aphrodisiac, blood purifier and antiplatelet activities, etc. For centuries, black pepper has been used for traditional medicines to cure cuts and wound injuries. Piperine stimulates a dose-dependent increase in the secretion of gastric acid and interruption of gastrointestinal motility. The oral administration of piperine activates the liver, pancreas and digestive enzymes in the small intestinal mucosa. Furthermore, the addition of piperine in food materials as food flavours may increase the protease, lipase, and pancreatic amylase activities.

REFERENCES

1. **Parthasarathy VA, Sasikumar B, Nair RR, George KJ**. Black Pepper: *Botany and Horticulture*. In; Hort Rev. 2007;33:173–266.
2. **Acharya SG, Momin AH, Gajjar AV**. Review of Piperine as A Bio- Enhancer. *Am J Pharm Tech Res*. 2012; 2:32-44-48.
3. **Agbor GA,Vinson JA, Oben JE**, et al. Comparative analysis of the in vitro antioxidant activity of white and black pepper. *Nut Res*. 2005; 26(12):659−663.
4. **Ahmad N, Fazal H, Abbasi BH, Farooq S, Ali M**, *et al*. Biological role of Piper nigrum L. (Black pepper): A review. *Asian Pacific J Trop Biomed*: 2012;S1945-S1953.
5. **Damanhouri ZA, Ahmad A.** A review on therapeutic potential of Piper nigrum L. (Black Pepper): The King of Spices. *Medicinal and Aromat Plants*. 2014; 3(3): 1-6.
6. **Elizabeth TJ, Gassara F, Kouassi AP**, et al. Spice use in food: Properties and benefits. *Crit Rev Food Sci Nutr*. 2015; 57(6):1078−1088.
7. **Gorgani L, Mohammadi M, Najafpour GD,** et al. Piperine-The bioactive compound of black pepper: From isolation to medicinal formulations. *Comprehensive Review in Food and Food Safety*; 2017;16:124−140.
8. **Khan M, Siddiqui M.** Antimicrobial activity of Piper fruits. Nat prod Rad 2007;6:111-113.
9. **Liu Q, Meng X, Li Y,** et al. Antibacterial and Antifungal Activities of Spices. *Int J Mol Sci*. 2017;18(6):1283.
10. **Meghwal M, Goswami TK**. Piper nigrum and piperine: An Update. Phytother Res. 2013;27:1121-1130.
11. **Murthy CT, Bhattacharya S.** Cryogenic grinding of black pepper. *J Food Eng*. 2008; 85(1):18−28.
12. **Nakatani N, Inatani R, Ohta H,** et al. Chemical constituents of peppers (Piper spp.) and application to food preservation: Naturally occurring antioxidative compounds. *Env Health Persp*. 1986; 67:135−142 .
13. **Pino J, Feo GR, Borges P,** et al. Chemical and sensory properties of black pepper oil (*Piper nigrum* L.). Mol Nut Food Res. 1990;34(6):555−560.
14. **Sabina EP, Nasreen A, Vedi M, Rasool M**. Analgesic, antipyretic and ulcerogenic effects of piperine: An active

ingredient of pepper. *J pharm Sci Res.* 2013;5(10): 203-206.

15. **Sapam R, Kalita PP, Sarma MP, Talukdar N and Das H.** Screening of phytochemicals and determination of total phenolic content, anti-oxidant, and antimicrobial activity of methanolic extract of Piper nigrum leaves. *Indo Am J Pharmaceut Res*. 2018;8(2): 1354-1360.
16. **Shamkuwar PB, Shahi SR, Jadhav ST.** Evaluation of anti-diarrheal effect of Black pepper (*P. nigrum* L). *Asian J Plant Sci Res.* 2012;2: 48-53.
17. **Srinivasan K.** Black pepper and its pungent principle-piperine: a review of diverse physiological effects. *Crit Rev Food Sci Nutr*. 2007;47: 735- 748.
18. **Sunila ES, Kuttan G.** Immunomodulatory and antitumor activity of Piper longum Linn. and piperine. *J Ethnopharmacol*. 2004;90: 339-346. 98I9 -9998.
19. ***Butt MS, Imran Pasha, Sultan MT, Randhawa AR, Saeed F. Waqas Ahmed***. Black pepper and health claims: a comprehensive treatise *Crit Rev Food Sci Nutr*. 2013;53(9):875-86. doi: 10.1080/ 10408398. 2011.571799.
20. **Meghwal M, Goswami TK.** Piper nigrum and piperine: an update. *Phytother Res*. 2013;27(8):1121-1130. doi: 10.1002/ptr.4972.
21. **Srinivasan K.** Black pepper and its pungent principle-piperine: a review of diverse physiological effects. *Crit Rev Food Sci Nutr*. 2007;47(8):735-48. doi: 10.1080/10408390601062054.
22. **Savina**. A review on bioactive chemical compounds, traditional medicinal uses and pharmacological activities of *Piper nigrum* L. seeds: Demand of the time. 2021;8(6):b847-b857.
23. **Ashokkumar K, Murugan M, Dhanya MK.** et al. Phytochemistry and therapeutic potential of black pepper [*Piper nigrum* (L.)] essential oil and piperine: a review. Clin Phytosci. 2021;7: 52-54. (https://doi.org/ 10.1186/s40816-021-00292-2.
24. **Nair KP.** Agronomy and economy of black pepper and cardamom. The King and Queen of Spices: Elsevier press; 2011. p.380.
25. **Damanhouri ZA, Ahmad A.** A review on therapeutic potential of *Piper nigrum* L. (Black Pepper): the king of spices. *Med Aromat Plants*. 2014;3:161-164. doi:https://doi.org/10.4172/2167-0412.1000161.
26. **Wong CM, Ling JJ**. In Vitro Study of Wound Healing Potential in Black Pepper (*Piper nigrum* L.). UK *J Pharmaceut Biosci*. 2014;2:05–9.
27. **Gülçin İ.** The antioxidant and radical scavenging activities of black pepper (*Piper nigrum*) seeds. *Int J Food Sci Nutr*. 2005;56:491–499.
28. **Szallasi A**. Piperine. Researchers discover new flavor in an ancient spice. *Trends Pharmacol Sci*. 2005;26:437–439.
29. **Srinivasan K.** Black pepper and its pungent principle-piperine: a review of diverse physiological effects. *Crit Rev Food Sci Nutr*. 2007;47:735–748.
30. **Taqvi SI, Shah AJ, Gilani AH.** Blood pressure lowering and vasomodulator effects of piperine. *J Cardiovasc Pharmacol*. 2008;52:452–458.
31. **Joshi DR, Shrestha AC, N. Adhikari N.** A Review on diversified use of the king of spices: : Piper nigrum (Black pepper). *J Pharmaceut Sci Res.* 9(10): 4089-4101 doi: 10.13040/IJPSR.0975-8232.9(10).4089-4001.
32. **Takooree H, Aumeeruddy MZ, Rengasamy KRR, Katharigatta N Venugopala, Jeewon R, Zengin G, Mahomoodally MF.** A systematic review on black pepper (*Piper nigrum* L.): from folk uses to pharmacological applications Crit Rev Food Sci Nutr. 2019;59(sup1):S210-S243. doi: 10.1080/ 10408398.2019.1565489.

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NUTRITIONAL ATTRIBUTES AND THERAPEUTIC IMPORTANCE OF CARAWAY SEEDS

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Abstract
Strongly aromatic, caraway is a member of the parsley or Umbelliferae family; a large family of plants that also includes commonly known herbs and spices such as dill, anise, fennel, and . Caraway (*Carum carvi* L.) contains health benefiting essential oils. These compounds indeed work as powerful antioxidants by removing harmful free radicals from the body and thus protect from cancers, infection, aging and degenerative neurological diseases. Principle health benefiting volatile compounds are flavonoids antioxidants viz. carvone, limonene, carveol, pinene, cumuninic aldehyde, furfural, and thujone. These active principles in the caraway seeds known to have antioxidant, digestive, carminative, and anti-flatulent properties. Also, dietary fibers occurring in caraway bind to the toxins in the food and helps protect the colon mucosa from cancers. Further, dietary fibers bind to bile salts (produced from cholesterol) and decrease their re-absorption in the colon, and thus help in reducing serum LDL cholesterol levels. Caraway spice is an excellent source of minerals like Fe, Cu, Ca, K, Mn, se, Zn and Mg. The plant's roots can be eaten, but most people use the caraway fruit, which is mistakenly called seed as a result of its size and texture.

Keywords
Carminative, Crptoxanthin, Carvone, Carveol, Emmenagogue, Thujone, IBS.

INTRODUCTION

Although frequently mistaken for a seed, this small, brown pod is really the dried fruit of the caraway plant (*Carum carvi* L.) belonging to Umbellifarae family. Caraway is a widely cultivated spice native to Europe, Asia and North Africa. It also appears wild in Iceland, Scandinavia, throughout Russia, in Siberia, Persia, the Caucasus and the Himalayas. Caraway grows extensively all over the Europe, North Africa, and Asia Minor regions. It is a biennial, herbaceous plant which blooms once in every two years. Its creamy flowers appear in umbels. The plant grows to about two feet in height and bears small feathery leaves. [1-2]Caraway seeds, having similar in appearance as that of cumin, have a crescent shape, dark brown, with up to five stripes (ribs) running lengthwise on their surface. Studies have shown that caraway oil has antibacterial and larvicidal properties. Caraway has a long history of use as a household remedy especially in the treatment of digestive complaints where its antispasmodic action soothes the digestive tract and its carminative action relieves bloating caused by wind and improves the appetite. It is often added to laxative medicines to prevent griping. The seed is antiseptic, aromatic, anaesthetic, anodyne, antianxiety, diuretic, mildly expectorant, fungicidal, muscle relaxant, soporific, tonic, emmenagogue, expectorant, galactogogue and stimulant. It can be chewed raw for the almost immediate relief of indigestion and can also be made into infusions. The seed is also used in the treatment of bronchitis and are an ingredient of cough remedies, especially useful for children and for mothers for increasing breast milk . A tea made from the seeds is a pleasant

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stomachic and carminative, it has been used to treat flatulent colic. [3-4] The seed is used in Tibetan medicine where it is considered to have an acrid taste and a heating potency. It is used to treat failing vision and loss of appetite. Caraway boasts a wide variety of essential nutrients, several of which are lacking in Western diets. These include Fe, Zn, Ca and fibre. Caraway boasts a rich supply of health-promoting antioxidants, including limonene and carvone. This plant is also referred to as meridian fennel or Persian cumin. The plant's roots can be eaten, but most people use the caraway fruit, which is mistakenly called seed as a result of its size and texture. They are often compared to fennel, and both make a good substitute for the other, although there is an obvious difference in the taste. Fennel is very heavily licorice-flavored, while caraway tends to have more peppery and citrus notes to it. [5-6].

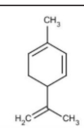
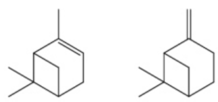
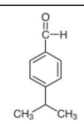
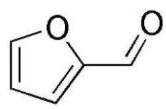
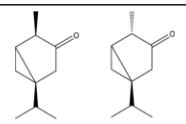
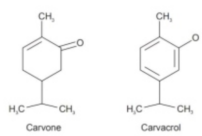
Fig. 1: Flowers and Seeds of Caraway.

Fig. 2: Seed powder, Tea and Oil of Caraway.

Phytoconstituents

Principle volatile compounds are carvone, limonene, carveol, pinene, cumuninic aldehyde, furfural, and thujone. These active principles in the caraway seeds known to have antioxidant, digestive, carminative, and anti-flatulent properties. Caraway has health benefiting flavonoid antioxidants such as lutein, carotene, cryptoxanthin, and zeaxanthin. Caraway spice is an excellent source of minerals like Fe, Cu, Ca, K, Mn, se, Zn and Mg.

An essential oil from the seed is used in perfumery, for scenting soap, as a parasiticide etc. The main components of C. carvi oil are carvone, limonene, germacrene D, and trans –dihydrocarvone. Gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS) studies showed the presence of carvone and limonene as the major chemical constituents of the essential oil of C. carvi. The herb oil of caraway was found to consist of germacrene D with â-caryophyllene, â-elemene, humulene, germacrene A and B, and two cadinenes. Caraway seeds contained the main components divided into carvone and limonene. [4-7]

Limonene	
α & β-pinene	
Cumuninic aldehyde	
Furfural	
α & β-thujone	
Volatile chemical constituents of Caraway (Carum carvi L.)	

Health Benefits of caraway seeds

In addition to their utility as remedial items in the traditional medicines, caraway seeds have their own food value, and indeed, have many health benefiting nutrients, minerals, vitamins and antioxidants. Caraway seeds are a rich source of dietary fiber. 100 g seeds provide 38 g of fiber, 100% of daily recommended intake of fiber. The soluble as well as insoluble dietary fiber increase the bulk of the food and help prevent constipation by speeding up its movement through the gut. Also, dietary fiber binds to the toxins in the food and helps protect the colon mucosa from cancers. Further, dietary fibers bind to bile salts (produced from cholesterol) and decrease their re-absorption in the colon, and thus help in reducing serum LDL cholesterol levels. Caraway contains health benefiting essential oils. These compounds indeed work as powerful antioxidants by removing harmful free radicals from the body and thus protect from cancers, infection, aging and degenerative neurological diseases. Copper present in caraway required for the production of red blood cells. [5-8] Iron required for red blood cell formation. Zinc is a co-factor in many enzymes that regulate growth and development, digestion and nucleic acid synthesis. Potassium is an important component of cell and body fluids that helps regulate heart rate and blood pressure. Manganese used by the body as a co-factor for the powerful antioxidant enzyme, superoxide dismutase. The caraway seeds indeed are the

Table 1: Main constituents of Caraway seeds and their nutrition value.

Principle	**Nutrient Value**	**Percentage of RDA**
Energy	333 Kcal	17%
Carbohydrates	49.90 g	38%
Protein	19.77 g	35%
Total Fat	14.59 g	48%
Cholesterol	0 mg	0%
Dietary Fiber	38 g	100%
Vitamins		
Folates	10 µg	2.5%
Niacin	3.606 mg	23%
Pyridoxine	0.360 mg	28%
Riboflavin	0.379 mg	29%
Thiamin	0.383 mg	32%
Vitamin A	363 IU	12%
Vitamin C	21 mg	35%
Vitamin E	2.5 mg	17%
Electrolytes		
Sodium	17 mg	1%
Potassium	1351 mg	29%
Minerals		
Calcium	689 mg	69%
Copper	0.910 mg	101%
Iron	16.23 mg	203%
Magnesium	258 mg	64.5%
Manganese	1.300 mg	56.5%
Phosphorus	568 mg	81%
Zinc	5.5 mg	50%
Phyto-nutrients		
Carotene-ß	189 µg	–
Crypto-xanthin-ß	58 µg	–
Lutein-zeaxanthin	205 µg	–

storehouse for many vital vitamins. Vitamin-A, vitamin-E, vitamin-C as well as many B-complex vitamins like thiamin, pyridoxine, riboflavin, and niacin particularly concentrated in the seeds. Caraway water often used as a remedy for flatulence and indigestion in traditional medicines, especially used to relieve colicy pain. It also used in pharmaceuticals as a flavoring agent in mouthwash and gargle preparations. Caraway extraction is used as a rubefacient (to soothe muscle sores), clear the cold, as a remedy for bronchitis and IBS (irritable bowel syndrome) in many traditional medicines. [7-10]

Culinary uses

Caraway is a unique spice long used in cooking and herbal medicine. Caraway seeds feature warm, sweet, and slightly peppery aroma when squeezed between index and thumb fingers. They used extensively in European and Mediterranean cooking. To keep their fragrance and flavor intact; caraway seeds roasted gently under low flame and ground just before using them in a recipe. Caraway seed employed widely as a savory spice. It principally added in cooking as a condiment and flavoring base. It features in savory dishes, including cabbage soups, sauerkraut, and salads. Caraway gives a pleasant aroma to bread, cakes, biscuits, and cheese. In France, the seeds offered in a saucer to sprinkle over Munster cheese before eating. Cheddar cheese with caraway seeds is a popular spice mixed, hard cheese in UK. The addition of caraway seeds give this cheddar cheese a savory flavor. Also, along with other spicy items, they are being used to season sausage and other meat preparations. In Central Europe (Poland), caraway-seasoned sausages (Kielbasa Kminkowa) are a favorite dish. Caraway seeds have a strong anise-like taste, making them popular in savory dishes, such as sauerkraut and harissa. In modern times, caraway seeds are most often used in baking recipes, from rye bread to pastry toppings and cakes. Its slightly bitter, earthy flavor is reminiscent of licorice, coriander, anise, and fennel. It can be used whole or ground in both sweet and savory dishes, such as breads, pastries, curries, and stews. It's sometimes infused into spirits and liqueurs as well. A tea made from the seeds is a pleasant stomachic and carminative, it has been used to treat flatulent colic. [6-10]

CONCLUSION

Studies have shown that caraway oil has antibacterial and larvicidal properties. Caraway has a long history of use as a household remedy especially in the treatment of digestive complaints where its antispasmodic action soothes the digestive tract and its carminative action relieves bloating caused by wind and improves the appetite. It is often added to laxative medicines to prevent griping. The seed is antiseptic, aromatic, anaesthetic, anodyne, antianxiety, diuretic, mildly expectorant, fungicidal, muscle relaxant, soporific, tonic, emmenagogue, expectorant, galactogogue and stimulant. It is used to treat failing vision and loss of appetite. Caraway boasts a wide variety of essential nutrients, several of which are lacking in Western diets. These include Fe, Zn, Ca and fibre.

REFERENCES

1. **Begum J , Bhuiyan MNI , Chowdhury JU , Hoque MN, Anwar MN**. Antimicrobial Activity of Essential Oil from Seeds of Carum carvi and Its Composition. *(2008) Banglad J Microbiol* 25(2): 85-89.
2. **Putievsky E, Ravid U, Dudai N & Katzir I.** 1994. A new cultivar of caraway (*Carum carvi* L.) and its essential oil. *J Herbs Spices Med Plants* 2(2): 81-84.
3. **Toxopeus H & ouwmeester HJ.** 1993. Improvement of carawayessential oil and carvone production in The Netherlands. *Ind Crops Prod* **1**: 295-301.
4. **Halva S, Hirvi T, Makinen S & Honkanen E.**1986.Yield and glucosinolates of mustard seeds and volatile oils of caraway seeds and coriander fruit. II Yield and volatile oils of caraway seeds (*Carumcarvi*). *J Agric Sci Finland* **58**:163-167.
5. **Iacobellis NS, Cantore PL, Capasso F & Senatore F.** 2005. Antibacterialactivity of Cuminum cyminum L. andCarum carviL. essential oils. *J Agric Food Chem*. **53**(1): 57-61.
6. **Foster S & Duke JA.** 1990. A Field Guide to Medicinal Plants: Easternand Central North America. Houghton Mifflin Co, Boston.
7. **Coffey T.** 1993.The History and Folklore of North American Wild Flowers. Facts on File, New York.13.Tsarong TJ. 1994.
8. **Tewari M Mathela CS**. 2003. Compositions of the essential oilsfrom seeds of Carum carviLinn. andCarum bulbocastanum Koch. *Indian Perfumer* . **47**: 347-349.
9. **Arganosa GC, Sosulski FW & Slinkard AE.** 1998. Seed yields and essential oils of annual and biennial caraway (Carum carvi L.) grown in Western Canada. *J Herbs Spices Med Plants* .**6**(1): 9-17.
10. **Wichtmann EM, Biskup SE** (1987) Composition of the essential oils from caraway herb and root. *Flav Fragr* J **2** (2): 83-89.

SAVE THE ENVIRONMENT (STE) was founded and registered on 19th November 1990. In 1992 with the collaboration of WWF (India), the organization started working to combat arsenic poisoning problem of water in the arsenic prone areas of West Bengal. Since then STE has been involved in various projects related to combat arsenic problem in India.

Our Vision

To protect present and future generations from various environmental hazards.

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