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"Comparative Bacteriological Contamination Assessment of Drinking water (Pipe water supply/hand pump) by three different methods in Lucknow, Uttar Pradesh"

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Abstract-Water borne diseases like cholera, typhoid, diarrhoea, and jaundice are caused by consumption of microbial contamination in water. For assessment and monitoring of drinking water quality, a group of bacteria commonly referred as fecal Coliforms is normally taken as indicator. Most predominantly used method for assessment of bacteriological quality of water in Public Health Laboratories is MPN method which measures bacterial presence as MPN/100 ml of sample. Another method very predominantly used for field determination of Bacterial contamination is testing by H_2S Vials, however this is just an indicative test and has high probability of false negative and false positive results. The significance of bacteriological testing in ensuring the quality of drinking water, warrants for comparative analysis of different methods available for it. In this context tests were carried out to assess the efficacy of BioMed devices (InTray™ Colorex ™ ECC) based on Membrane Filtration Technique method through which both E.coli and total coliform can be identified separately by distinctive color characterization and then counting them in calculative form as colony forming unit i.e. CFU/100 ml of sample in a single experiment. A comparative assessment of drinking water of different sources carried out in monsoon and post monsoon have been done to observe the variation in the result by different method of estimation like H_2S vials, BioMed devices (InTray™ Colorex ™ ECC) and Traditional Membrane Filtration technique indicates that InTray™ Colorex ™ ECC applications are economical, less time consuming. It is also easier to use than ampoules and petri dishes, which improves work flow and reduces sample exposure and contamination.

Keywords: Coliforms, H_2S vials, MPN and. Colorex ™ ECC

INTRODUCTION:

Water sustains all life on earth. Water quality plays a very important role for all living beings whether humans or animals. The adequacy for different uses of water depends on its quality. The protection of public and environmental health requires safe water for drinking that is it must be free from any pathogenic bacteria **(Gupta *et al.*, 2014).** It is necessary that the quality of drinking water should be checked at regular time intervals, because due to use of contaminated drinking water, human population suffers from varied of water borne diseases **(Basavaraja *et al.*, 2011).** In developing countries, large portion of the population, suffers from health problems associated with either lack of drinking water or due to the presence of microbiological contamination in the water **(Van Leeuwen, 2009).** Continuous microbiological monitoring of drinking water is essential to ensure compliance with quality standards and to protect public health. Total (TC) and fecal coliforms (FC) have traditionally been regarded as indicators of microbial contamination of waters **(Clark *et al.*, 1991; Rompre *et al.*, 2002).** Recent reviews, however, have shown *E.coli* to be the best indicator for the assessment of fecal contamination **(Clark *et al.*, 1991; Edberg *et al.*, 2000)** and the possible presence of enteric pathogens **(Geissler *et al.*, 2000; US EPA, 2002).** Coliforms are mostly present in large numbers among the intestinal flora of humans and other warm-blooded animals **(Pal, 2014).** Many micro-organisms may be present in drinking water that may deteriorate its quality and make it unsuitable for human consumption. So, the concept of microbiological testing of water was introduced in the 19th century so as to assess the quality of water used for human consumption. Many indicator organisms like the coliform group of bacteria are used as an indicator for determining the contamination of water by faecal matter or by other sources. The microbial analysis of water determines its potability and sanitary quality. But the inability to access laboratories and good field

test kits is a major obstacle towards the quality assurance in the provision of drinking water which is microbiologically safe to many communities and people all over the world. **(Gupta *et al.*, 2014)**
According to WHO, faecal indicator are defined as a group of organisms that indicate the presence of faecal contamination, hence they only indicate whether pathogens may be present **(WHO2008)**. *E.coli* is the best coliform indicator of fecal contamination from human and animal wastes. E.coli's presence is more representative of faecal pollution because it is present in higher numbers in faecal material and generally not elsewhere in the environment **(Hurst *et al*., 2002).**
High levels of fecal-indicator bacteria can be indicated by presence of pathogenic microorganisms present in water body. Higher the level of indicator bacteria is directly propositional to faecal contamination and greater the risk of water-borne diseases **(Pipes, 1981).** Cryptosporidiosis, typhoid fever, Cholera, dysentery, hepatitis are some of the common waterborne diseases that spread through contaminated water. Human faecal material is generally caused greater risk to human health because it contains human enteric pathogens **(Scott *et al.*, 2003).** Contaminated water can cause eye, ear, nose, and throat infections also. Faecal coli and Faecal streptococci are most widely used indicator bacteria **(Kistemann *et al.*, 2002; Pathak and Gopal, 2001; Harwood *et al.*, 2001).**
The most commonly used method is the hydrogen sulphide or H2S test, which detects hydrogen sulphide-producing bacteria, which are considered to be associated with faecal contamination. **(Gupta *et al.*, 2014)** Coliform group has been extensively used as an indicator of drinking water quality and historically led to the public health protection concept. Multiple tube fermentation technique has been currently used for assessment of the microbial quality of drinking water. Presence of coliforms is determined by performing the coliform tests which include several methods. Most probable number (MPN) test is a specific test to determine the presence of coliforms in a given sample. The coliforms are detected on the basis of their characteristic capability of fermenting lactose with the production of gas (**Talat *et al.*, 2015).** BioMed devices (InTray™ Colorex ™ ECC) test serves as a microbiology sample collection, transport and culture device allowing for simultaneous growth, observation and chromogenic differentiation of Escherichia coli and other coliforms.

In present study H_2S vials, MPN method and BioMed devices (InTray™ Colorex ™ ECC) had been used for identifying the presence of coliform bacteria in Drinking water (Pipe water supply/hand pump).

MATERIALS AND METHOD

Collection of water samples:
All the samples were collected on in during monsoon season (July, 2016) and post monsoon season in November month in scattered part of Lucknow District. As water borne disease are more common in monsoon season. Total 86 samples were collected in which 35 were during monsoon season and 51 after post monsoon season.

Samples were collected where the possibility of hand pump sources having maximum contamination. Some sample were also collected which were based on complainant requested regarding the quality of drinking water coming out through. All Samples were collected in sterile sample collection bottles and labeled with respective sample number. The samples were stored at 4℃ until use and analyzed.

1. Procedure in H_2S Vials

Concept:
A simple bacteriological test vial indicates the presence/ absence of pathogens in water samples. This is simple field test kit to indicate the presence of bacterial colonies in water. The principle of test is similar to that of Presumptive Coliform Test. It does not attempt to find pathogens but only shows the indicator for the presence of pathogens. The test kit can be used for any water irrespective of its source, including chlorinated water.

Advantage:
The advantage of the method is its simplicity, low cost and ability to be performed in the absence of a typical microbiology laboratory or field laboratory, test tubes or other containers holding the test material and can be used in the field by minimally trained personnel.

Observation:
Color becomes black of sampled water which indicated presence of bacterial contamination

2. Procedure in MPN Method

This method is also called as multiple tube fermentation technique. This technique was used to detect the total coliforms.

***Sterilization*:** Media, Apparatus (Test tube, pipette, Durham tubes, dispenser used were sterilized in Autoclave.

***Inoculation*:** Inoculate a series of Mac Conkey broth tubes with appropriate measured quantities of water to be tested. (20 ml x 5, 11 ml x 5, 10.1 ml x 5). Inoculate all the tubes at 37ºC for 24-48 hrs.

Procedures : Examine each tube at the end of 24±2 hr for gas production/ Color Change (Red become yellow) and if no gas has been formed in Durham Tube or, re-incubated up to 48 hr. Recorded the presence or absence of the gas at each examination of the tube regardless of the amount. The absence of gas formation at the end or no color change of 48±3 hr in any amount in inner fermentation tube constitutes a negative test.

3. Procedure in Biomed

Procedure were followed as per availed document InTray™ Colorex™ ECC (*Escherichia coli* and Coliforms). This enables simultaneous detection, chromogenic differentiation, and enumeration of *E. coli* and other coliforms in water samples. Water contamination due to fecal coliform consists mainly of *E. coli.*

Colorex ECC Tray were used for chromogenic differentiation, and enumeration of *E. coli* and other coliforms in drinking water samples collected from Supply and Hand pump at Three and one place respectively.

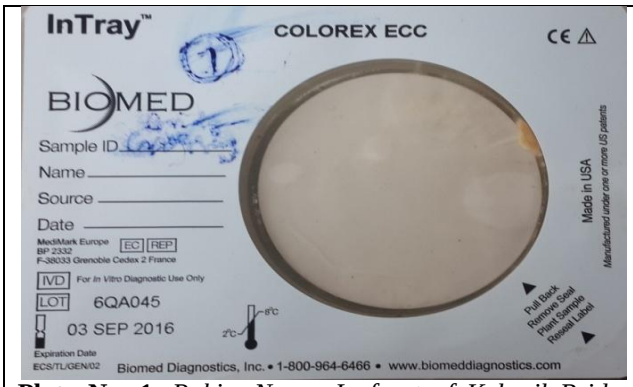

Plate No. 1. *Rahim Nagar In front of Kukrail Bridge (Sarvoday Nagar Tiraha)*
Presence of other bacteria due to Colorless or Inhibited Bacteria

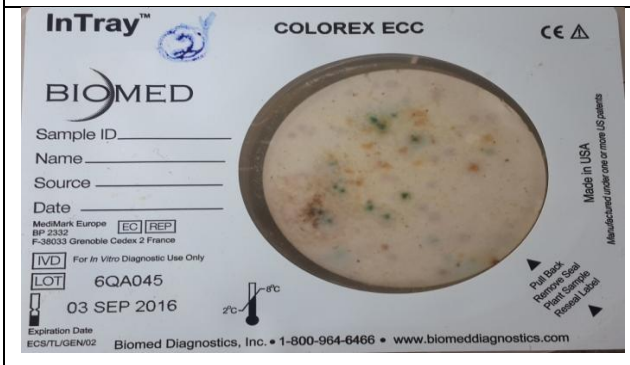

Plate No. 2 . *Rahim Nagar Behind RLB School With E Coli and Other Coliform and Other Bacteria and Other*

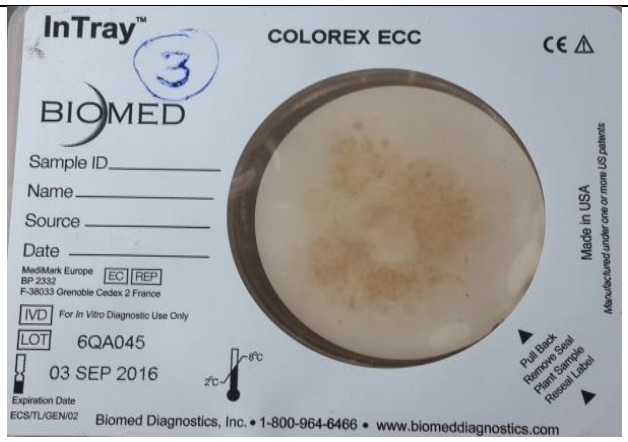

Plate No. 3 . *Rahim Nagar-Sarvoday Nagar Near Bolan Shah Majar E Coli Presence with*

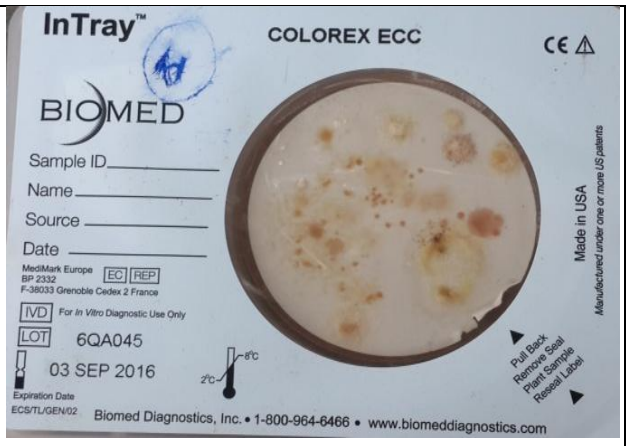

Plate No. 4 *Rahim Nagar- S.R.Tiwari's Residence, with E . Coli and Other Bacteria*

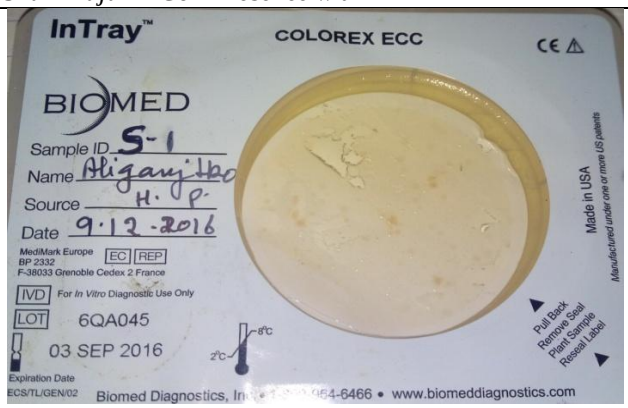

Plate No. 5 . *Central School Aliganj*
Presence of other bacteria due to Colorless or Inhibited Bacteria

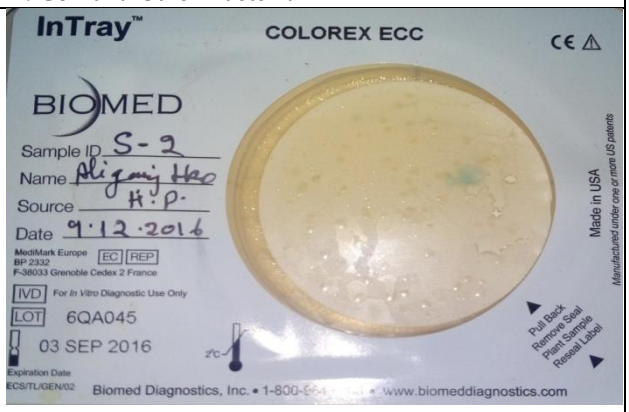

Plate No. 6 . *Ram Bank Churaha With Other Coliform and Other Bacteria and Other*

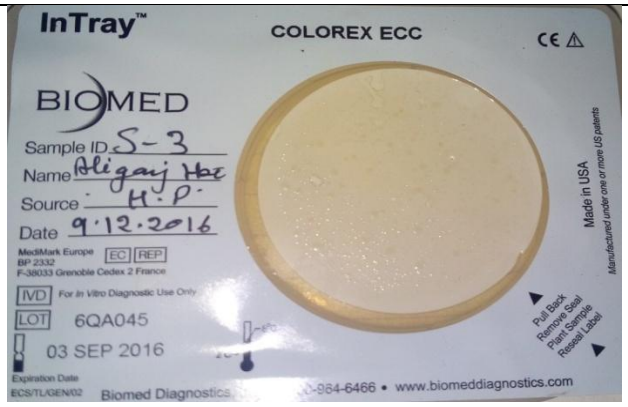

Plate No. 7 . *Sitapur Road Lucknow in Park*

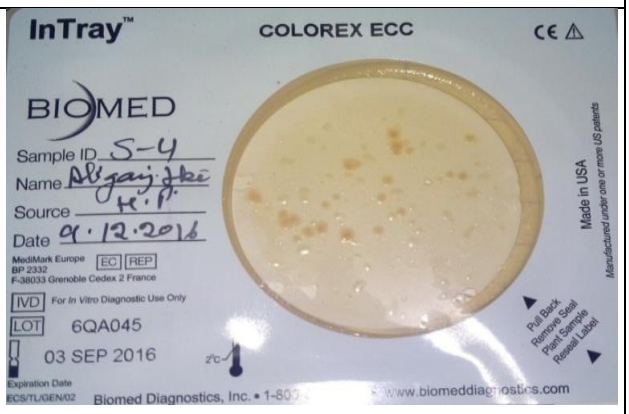

Plate No. 8 *Behta Sabauli Primary School Other Bacteria*

Figure 1: Growth of Bacterial Colonies at Specified Location

RESULTS AND DISCUSSION:

Analysis of collected drinking water (supply/hand pump) samples by three different methods H_2S Vials, MPN, and BioMed devices (InTray™ Colorex ™ ECC) Technique.

Table 1: Bacteriological testing results during Monsoon season

	Type of Source	Sample code	Location		Date of Sampling	Results with H_2S Vial (Qualitative)					Results with MacConkey Agar	
						After 24 hr	After 48 hr	No. of E-Coli CFU/100 ml		Other form of Bacteria	Total Coliform (MPN/100 ml)	
			District	Area				After 24 hr	After 48 hr		After 24 hr	After 48 hr
1	H.P	Ballia - 1	Ballia	Surah Tal	22.06.2016	- ve	+ ve	- ve	4	+ ve	- ve	17
2	H.P	Ballia - 2	Ballia	Surah Tal	22.06.2016	- ve	- ve	- ve	- ve	- ve	- ve	- ve
3	H.P	Ballia - 3	Ballia	Surah Tal	22.06.2016	- ve	+ ve	- ve	8	+ ve	170	220
4	H.P	Ballia - 4	Ballia	Surah Tal	22.06.2016	- ve	- ve	- ve	- ve	- ve	- ve	0
5	H.P	Ballia - 5	Ballia	Surah Tal	22.06.2016	- ve	+ ve	- ve	8	+ ve	140	900
6	Supply	S-1	Lucknow	Sarvodai Nagar	14.07.2016	- ve	+ ve	- ve	2	+ ve	14	240
7	Supply	S-2	Lucknow	Sarvodai Nagar	14.07.2016	+ ve	+ ve	16	16	+ ve	17	>1600
8	H.P	S-3	Lucknow	Sarvodai Nagar	14.07.2016	- ve	- ve	0	0	+ ve	8	23
9	Supply	S-4	Lucknow	Sarvodai Nagar	14.07.2016	- ve	+ ve	2	2	+ ve	0	4
10	H.P	1-P	Lucknow	Aishbagh	20.08.2016	- ve	+ ve	- ve	2	+ ve	0	4
11	H.P	2-P	Lucknow	Aishbagh	20.08.2016	- ve	+ ve	- ve	1	+ ve	0	11
12	H.P	3-P	Lucknow	Aishbagh	20.08.2016	- ve	+ ve	- ve	0	+ ve	0	11
13	H.P	4-P	Lucknow	Aishbagh	20.08.2016	- ve	+ ve	- ve	4	+ ve	0	14
14	H.P	5-P	Lucknow	Aishbagh	20.08.2016	- ve	+ ve	- ve		+ ve	0	14
15	H.P	6-P	Lucknow	Aishbagh	20.08.2016	- ve	+ ve	2	2	+ ve	0	30
16	Supply	T-7	Lucknow	Rahim Nagar	24.08.2016	+ ve	+ ve	16	20	+ ve	9	130
17	H.P	7-S	Lucknow	Aliganj	24.08.2016	- ve	- ve	- ve	- ve	- ve	0	0
18	H.P	8-S	Lucknow	Aliganj	24.08.2016	- ve	+ ve	- ve	- ve	+ ve	0	13
19	H.P	9-S	Lucknow	Aliganj	24.08.2016	- ve	+ ve	- ve	- ve	+ ve	4	8
20	H.P	10-S	Lucknow	Aliganj	24.08.2016	- ve	+ ve	- ve	- ve	+ ve	8	11

21	H.P	V-1	Lucknow	Near Prag Dairy	03.09.2016	- ve	+ ve	- ve	- ve	+ ve	0	130
22	Supply	Tr-1	Lucknow	Rahim Nagar	03.09.2016	+ ve	+ ve	- ve		+ ve	Not done	Not done
23	H.P	R-A	Lucknow	Sultanpur road Khurdehi bazar	06.09.2016	- ve	+ ve	22	- ve	+ ve	9	350
24	H.P	M-1	Lucknow	Jopling Road	06.09.2016	- ve	+ ve	- ve	- ve	+ ve	23	23
25	H.P	V-1	Lucknow	Jopling Road	06.09.2016	- ve	+ ve	- ve	20	+ ve	21	50
26	Supply	Tr-1	Lucknow	Rahim Nagar	06.09.2016	- ve	+ ve	16	- ve	+ ve	9	130
27	H.P	R-B	Lucknow	Sultanpur Road, Khurdehi bazar	09.09.2016	- ve	+ ve	- ve	- ve	+ ve	0	6
28	H.P	R-1	Lucknow	Sultanpur Road, Khurdehi bazar	09.09.2016	- ve	+ ve	- ve	8	+ ve	12	34
29	H.P	R-2	Lucknow	Sultanpur Road, Khurdehi bazar	09.09.2016	- ve	+ ve	8	3	+ ve	17	900
30	H.P	R-3	Lucknow	Sultanpur Road, Khurdehi bazar	09.09.2016	- ve	+ ve	3	2	+ ve	220	500
31	H.P	R-4	Lucknow	Sultanpur Road, Khurdehi bazar	09.09.2016	- ve	+ ve	2	6	+ ve	14	>1600
32	H.P	R-5	Lucknow	Sultanpur Road, Khurdehi bazar	09.09.2016	- ve	+ ve	6	- ve	+ ve	9	350
33	H.P	R-6	Lucknow	Sultanpur Road, Khurdehi bazar	12.09.2016	- ve	+ ve	- ve		+ ve	2	6
34	H.P	Mo-1	Lucknow	Madiyanv, Sitapur Road	20.09.2016	- ve	- ve	∞	∞	+ ve	>1600	>1600
35	H.P	V-2	Lucknow	Parag Dairy, Jopling Road	20.09.2016	+ ve	+ ve	∞	∞	+ ve	33	33

Table: 2 Bacteriological testing results Post monsoon Season

Sr. No.	Type of Source	Sample code	Location		Date of Sampling	Results with H_2S Vial (Qualitative)					Results with MacConkey Agar	
						After 24 hr	After 48 hr	No. of E-Coli CFU/100 ml		Other form of Bacteria	Total Coliform (MPN/100 ml)	
			District	Area				After 24 hr	After 48 hr		After 24 hr	After 48 hr
Post Monsoon												
1	S.P	1-P	Lucknow	Aishbagh	26.11.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
2	H.P	2-P	Lucknow	Aishbagh	26.11.2016	- ve	- ve	- ve	- ve	+ ve	- ve	13
3	H.P	3-P	Lucknow	Aishbagh	26.11.2016	- ve	- ve	- ve	- ve	Not clear	- ve	- ve
4	H.P	4-P	Lucknow	Aishbagh	26.11.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
5	H.P	5-P	Lucknow	Aishbagh	26.11.2016	- ve	- ve	10	16	+ ve	- ve	- ve
6	S.P	6-P	Lucknow	Aishbagh	26.11.2016	- ve	+ ve	∞	∞	+ ve	- ve	50
7	S.P	P-7	Lucknow	Aishbagh	26.11.2016	- ve	- ve	2	2	+ ve	- ve	- ve
8	H.P	P-8	Lucknow	Aishbagh	26.11.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
9	H.P	T-10	Lucknow	Rahim nagar	27.11.2016	- ve	+ ve	- ve	- ve	+ ve	- ve	- ve
10	T.S	Tr-1	Lucknow	Rahim nagar	27.11.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
11	T.S	Tr-1	Lucknow	Rahim nagar	27.11.2016	- ve	+ ve	2	2	+ ve	- ve	13
12	T.S	T-7	Lucknow	Rahim nagar	27.11.2016	+ ve	+ ve	12	12	+ ve	- ve	80
13	H.P	T-13	Lucknow	Rahim nagar	27.11.2016	+ ve	+ ve	- ve	- ve	+ ve	- ve	70
14	H.P	R-A-1	Lucknow	Sultanpur Road	03.12.2016	- ve	- ve	- ve	2	+ ve	- ve	- ve
15	H.P	R-B-1	Lucknow	Sultanpur Road	03.12.2016	- ve	- ve	- ve	1	+ ve	- ve	- ve
16	H.P	R-1-1	Lucknow	Sultanpur Road	03.12.2016	- ve	+ ve	- ve	15	+ ve	4	7
17	H.P	R-2-2	Lucknow	Sultanpur Road	03.12.2016	- ve	+ ve	- ve	- ve	+ ve	170	170
18	H.P	R-3-3	Lucknow	Sultanpur Road	03.12.2016	+ ve	+ ve	1	∞	+ ve	70	70
19	H.P	R-4-4	Lucknow	Sultanpur Road	03.12.2016	- ve	- ve	5	24	+ ve	2	2

20	H.P	R-5-5	Lucknow	Sultanpur Road	03.12.2016	- ve	- ve	12	∞	+ ve	4	4
21	H.P	R-6-6	Lucknow	Sultanpur Road	03.12.2016	- ve	- ve	7	∞	+ ve	4	4
22	H.P	R-7	Lucknow	Sultanpur Road	03.12.2016	- ve	- ve	3	3	+ ve	- ve	- ve
23	H.P	R-8	Lucknow	Sultanpur Road	03.12.2016	- ve	- ve	2	3	+ ve	- ve	2
24	H.P	R-9	Lucknow	Sultanpur Road	03.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
25	H.P	R-10	Lucknow	Sultanpur Road	03.12.2016	+ ve	+ ve	3	6	+ ve	4	9
26	H.P	V1-1	Lucknow	Jopling Road	05.12.2016	- ve	+ ve	1	1	+ ve	2	4
27	H.P	V1-2	Lucknow	Jopling Road	05.12.2016	- ve	+ ve	2	∞	+ ve	2	4
28	H.P	V1-3	Lucknow	Jopling Road	05.12.2016	- ve	- ve	∞	∞	+ ve	- ve	- ve
29	H.P	M-1-1	Lucknow	Jopling Road	05.12.2016	- ve	- ve	∞	∞	+ ve	- ve	2
30	H.P	M_0-1-1	Lucknow	Madiyaon	08.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
31	H.P	S-1	Lucknow	Aliganj	09.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
32	H.P	S-2	Lucknow	Aliganj	09.12.2016	- ve	- ve	- ve	1	+ ve	- ve	- ve
33	H.P	S-3	Lucknow	Aliganj	09.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
34	H.P	S-4	Lucknow	Aliganj	09.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
35	H.P	S-5	Lucknow	Bakshi ka talab	15.12.2016	- ve	- ve	∞	- ve	+ ve	- ve	- ve
36	H.P	S-6	Lucknow	Bakshi ka talab	15.12.2016	- ve	- ve	5	5	+ ve	- ve	- ve
37	H.P	S-7	Lucknow	Bakshi ka talab	15.12.2016	- ve	+ ve	4	4	+ ve	2	2
38	H.P	S-8	Lucknow	Bakshi ka talab	15.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
39	H.P	S-9	Lucknow	Bakshi ka talab	15.12.2016	- ve	+ ve	12	12	+ ve	2	2
40	H.P	S-10	Lucknow	Bakshi ka talab	15.12.2016	- ve	- ve	5	5	+ ve	2	2
41	H.P	S-11	Lucknow	Bakshi ka talab	15.12.2016	- ve	- ve	∞	∞	+ ve	13	17
42	H.P	S-12	Lucknow	Bakshi ka talab	15.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
43	H.P	S-13	Lucknow	Bakshi ka talab	15.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
44	H.P	S-14	Lucknow	Bakshi ka talab	15.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
45	H.P	S-15	Lucknow	Bakshi ka talab	15.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
46	H.P	S-16	Lucknow	Bakshi ka talab	15.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
47	S.W	T1	Lucknow	Rahim nagar	21.12.2016	- ve	- ve	- ve	3	+ ve	- ve	- ve

48	S.W	T2	Lucknow	Rahim nagar	21.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve
49	H.P	T3	Lucknow	Rahim nagar	21.12.2016	- ve	+ ve	- ve	2	+ ve	11	80
50	S.W	T4	Lucknow	Rahim nagar	21.12.2016	- ve	- ve	- ve	2	+ ve	- ve	4
51	S.W	T5	Lucknow	Rahim nagar	21.12.2016	- ve	- ve	- ve	- ve	+ ve	- ve	- ve

Table 3: Result of Testing during Monsoon and Post Monsoon Period

MONSOON							POST MONSOON			
S. No.	**Methods**	**Duration**	**Response**	**In No**	**Remarks**		**Response**	**in No**	**Remarks**	
1	**H2S Vials**	**After 24 hr**	Negative	47			Negative	31		
			Positive	4			Positive	4		
		After 48 hr	Negative	37			Negative	5		
			Positive	14			Positive	30		
2	**Biomed**	**After 24 hr**	Negative	28	∞	5	Negative	22	2 in infinity	
			Positive	17			Positive	10		
		After 48 hr	Negative	22			Negative	12	2 in infinity	
			Positive	20	∞	8	Positive	18	2 blank	
		Other form of Bacteria	Negative		not clear	1				
			Positive	49						
3	**MPN Method**	**After 24 hr**	Negative	37			Negative	2	2	Not Done
			Positive	14			Positive	31		
		After 48 hr	Negative	29			Negative	1	1	Not Done
			Positive	22			Positive	33		

A) Monsoon Period July, 2016

In first 24 hrs analysis it was observed that 4, 14, 31 (11.43, 40.00, 88.57 %) sources were found contaminated out of 35 Samples through H_2S vials Biomed and MPN Method respectively. It indicates that BioMed strips in short time indicate presence of Bacterial contamination in drinking water sources. While on observing after 24-48 results H_2S vials and MPN methods were able to indicate presence of bacterial contamination while not so case with the BioMed Strips, which was restricted least about 58.82 %.

Positive After 24 Hrs Monsoon				
Method	**Duration**	**Samples**	**Total Samples**	**%**
H_2S	24 Hrs Positive	4.00	35.00	11.43
BioMed	24 Hrs Positive	14.00	35.00	40.00
MPN	24 Hrs Positive	31.00	35.00	88.57
Positive After 48 Hrs Monsoon				
H_2S	48 Hrs Positive	30.00	35.00	85.71
BioMed	48 Hrs Positive	20.00	34.00	58.82
MPN	48 Hrs Positive	33.00	34.00	97.06

B) Post Monsoon in Nov & Dec 2016

In first 24 hrs analysis it was observed that 4, 17, 14 (7.84, 33.33, 27.45 %) sources were found contaminated out of 51 Samples through H_2S vials Biomed and MPN Method respectively. It indicates that BioMed strips in short time indicate presence of Bacterial contamination in drinking water sources.

After 24-48 hrs preservation/ processing further through H_2S vials Biomed and MPN rise of 19.61, 5.88 and 15.69 % enhancement was observed in positive samples.

Positive After 24 Hrs Monsoon				
Method	**Duration**	**Samples**	**Total Samples**	**%**
H_2S	24 Hrs Positive	4.00	51.00	7.84
BioMed	24 Hrs Positive	17.00	51.00	33.33
MPN	24 Hrs Positive	14.00	51.00	27.45
Positive After 48 Hrs Monsoon				
H_2S	48 Hrs Positive	14.00	51.00	27.45
BioMed	48 Hrs Positive	20.00	51.00	39.22
MPN	48 Hrs Positive	22.00	51.00	43.14

Comparative Analysis: Comparison between three Processes

	H_2S Vials	**MPN (FMT)**	**ECC TRAY**
Type of System	Closed	Open	Closed
Sample Preparation Time	Less	More	Less
Experiment Duration	24 Hrs	24-48	16-20 Hrs
Accessories Requirement	No	McConkey Broth, Multiple Fermentation Tube, Durham Tube	Chromo-genic Media In built within tray.
Cost			
Possible Species Differentiation	No	No	Yes
Requirement of Slide Preparation for Speciation	Not	Yes	No
Speciation of Bacteria	Not Possible	Not Possible	Within 17-18 Hrs
Colony Growth Identification	Not Possible	Not Possible	Yes
Auto Staining	No	NO	YES

CONCLUSION

It is revealed from the study that a strict monitoring of the microbiological parameters needs to be done in order to ascertain the potability of drinking water not only at the time of installation of the hand-pumps but also during their use.

On the basis of this study, following conclusions may be drawn:

1. Detection of coliforms and *E.coli* in water sample itself is an indication of faecal contamination of water from original source.
2. The H_2S test can be used in the field or in village level without any skilled personnel. Hence the test can be recommended for detection of faecal contamination in drinking water in the field where laboratory facilities are limited.
3. Conventional MPN method of coliform detection have limitations, such as long durations of incubation, antagonistic organism interference, lack of specificity and poor detection of slow growing.
4. BioMed device (InTrayTM Colorex TM ECC) is an acceptable method to measure the presence and quantity of coliform and E. coli bacteria in water samples. BioMed device (InTrayTM Colorex TM ECC) is a reasonable alternative to membrane filtration. in this study, BioMed device (InTrayTM Colorex TM ECC) provided an easy and accurate assessment of water quality. Because the BioMed method is easy to use, it could be an alternative to membrane filtration.

SIGNIFICANCE AND IMPACT OF THE STUDY

The BioMed device (InTrayTM Colorex TM ECC) is a very suitable quality control tool for evaluating the efficiency of methods for bacterial enumeration in water samples. In conclusion, the BioMed device (InTrayTM

Colorex TM ECC) is superior to the current H_2S Vials and MPN method for routine monitoring of drinking water. It is easy to perform and gives more rapid and more realistic estimate of total coliforms and *E.coli* than H_2S Vials and MPN.

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