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Some generalization on Fixed Point Theorems Related to Fuzzy Metric Spaces

Mahesh Kumar Verma, Manoj Kumar Jha, Vikas Kumar Mishra

Dept. of Mathematics, Govt GB College Hardibazar, Korba, India

Dept. of Mathematics, Rungta Engineering College, Raipur, India

Dept. of Mathematics, Rungta College of Engineering & Technology, Raipur, India

ABSTRACT: In the present paper some generalization on fixed point and common fixed point theorems in complete Fuzzy 4-metric spaces are established which are motivated by Gahler [13-15], Sharma, Sharma and Isekey [30],Sharma , S.[31], Shrivastava R., Singhal J.[36].

KEYWORDS: Fuzzy metric spaces, fuzzy 2- metric spaces, fuzzy 3- metric spaces, fuzzy 4- metric spaces fixed point, Common fixed point.

I. INTRODUCTION

In 1965, the concept of fuzzy sets was introduced by Zadeh [36]. After that many authors have expansively developed the theory of fuzzy sets and applications. Especially, Deng [8], Erceg [10], Kaleva and Seikhala [23], Karamosil and Michalek [25], have introduced the concept of fuzzy metric spaces in different ways. Recently, many authors [1,6,11,17,20,21,22,27,28,31,32] have also studied the fixed point theory in the fuzzy metric spaces and [2,3,4,5,19,26,33] have studied for fuzzy mappings which opened an avenue for further development of analysis in such spaces and such mappings. Consequently in due course of time some metric fixed point results were generalized to fuzzy metric spaces by various authors.

Gahler in a series of papers [13, 14, and 15] investigated 2-metric spaces. Sharma, Sharma and Iseki [30] studied for the first time contraction type mappings in 2-metic space. We [34, 35] have also worked on 2-Metric spaces and 2- Banach spaces for rational expressions.

We know that 2 and 3-metric space is a real valued function of a point triples on a set X, which abstract properties were suggested by the area function in Euclidean spaces. Now it is natural to expect 4-Metric space, which is suggested by the volume function.

II. SOME FIXED POINT THEOREMS IN FUZZY 2-METRIC SPACE

Definition (3 A): A binary operation *: [0, 1] x [0,1] x [0,1] → [0,1] is called a continuous t-norm if ([0,1],*) is an abelian topological monodies with unit 1 such that $a_1 * b_1 * c_1 \geq a_2 * b_2 * c_2$ whenever $a_1 \geq a_2$, $b_1 \geq b_2$, $c_1 \geq c_2$, for all a_1, a_2 , b_1, b_2,and c_1, c_2 are in [0,1].

Definition (3 B): The 3-tuple (X, M, *) is called a fuzzy 2-metric space if X is an arbitrary set, * is continuous t-norm and M is fuzzy set in $X^3 \times [0, \infty)$ satisfying the followings

$(FM' - 1): M(x, y, z, 0) = 0$
$(FM' - 2): M(x, y, z, t) = 1, \forall t > 0, \Leftrightarrow x = y$
$(FM' - 3): M(x, y, t) = M(x, z, y, t) = M(y, z, x, t)$, Summary about three variable
$(FM' - 4): M(x, y, z, t_1, t_2, t_3) \geq M(x, y, u, t_1) * M(x, u, z, t_2) * M(x, y, z, t_3)$
$(FM' - 5): M(x, y, z): [0,1) \rightarrow [0,1] is\ left\ continuous, \forall\ x, y, z, u\ \varepsilon\ X, t_1, t_2, t_3 > 0$

Principal
Govt G.B. College
Hardi Bazar,Korba (C.G.)

Govt G.B. Mahavidyalaya Hardibazar Distt. Korba (C.G.)

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Definition (3 C): Let (X, M, *) be a fuzzy 2-matric space. A sequence $\{x_n\}$ in fuzzy 2-metric space X is said to be convergent to a point $x \varepsilon X$,
$\lim_{n\to\infty} M(x_n, x, a, t) = 1, for\ all\ a \varepsilon X\ and\ t > 0$
A sequence $\{x_n\}$ in fuzzy 2-metric space X is called a Cauchy sequence, if
$\lim_{n\to\infty} M(x_{n+p}, x_n, a, t) = 1, for\ all\ a \varepsilon X\ and\ t, p > 0$
A fuzzy 2-matric space in which every Cauchy sequence is convergent is said to be complete.
Definition (3 D): A function M is continuous in fuzzy 2-metric space, iff whenever for all $a \varepsilon X$ and $t > 0$.
$x_n \to x, y_n \to y, then \lim_{n\to\infty} M(x_n, y_n, a, t) = M(x, y, a, t), \forall\ a \varepsilon X\ and\ t > 0$
Definition (3 E): Two mappings A and S on fuzzy 2-metric space X are weakly commuting iff $M(ASu, SAu, a, t) \geq M(Au, Su, a, t), \forall u, a\ \varepsilon\ X\ and\ t > 0$
Theorem 3.1. Let (X, M, *) be a complete fuzzy 2-metric space. Let f and g be weakly compatible self maps of X satisfying
$M(g_x, g_y, a, k_t) \geq M(f_x, f_y, a, t) where\ 0 < k < 1, a > 0$
$g(X) \subseteq f(X)$
If one of $g(X) or\ f(X)$ is complete then f and g have a unique common fixed point.
Proof. Let $x_0 \varepsilon X$. Since $g(X) \subseteq f(X)$. Choose $x_1 \varepsilon X$ such that $g(x_0) = f(x_1)$. In general, choose x_{n+1} such that $y_n = fx_{n+1} = gx_n$. Then by (3.1), we have

$$M(fx_n, fx_{n+1}, a, t) = M(gx_{n-1}, gx_n, a, t) \geq M\left(fx_{n-1}, fx_n, a, \frac{t}{k}\right)$$
$$= M\left(gx_{n-2}, gx_{n-1}, a, \frac{t}{k}\right) \geq \cdots \ldots. \geq M\left(fx_0, fx_0, a, \frac{t}{k^n}\right).$$

Therefore, for any p,

$$M(fx_n, fx_{n+p}, a, t) \geq M\left(fx_n, fx_{n+1}, a, \frac{t}{p}\right) \geq \cdots . \geq M\left(fx_{n+p-1}, fx_{n+p}, a, \frac{t}{p}\right) \geq M\left(fx_0, fx_1, a, \frac{t}{pk^n}\right) \geq \cdots ,$$
$$\geq M\left(fx_0, fx_1, a, \frac{t}{pk^{n+p-1}}\right)$$

As $n \to \infty$. $\{fx_n\} = \{y_n\}$ is a Cauchy sequence in fuzzy 2-metric space and so, by completeness of X, $\{y_n\} = \{fx_n\}$ is convergent. We call the limit z, then $\lim_{n\to\infty} fx_n = \lim_{n\to\infty} gx_n = z$. As f(X) is complete, so there exist a point p in X such that $f_p = z$. Now, from (3.1),
As $n \to \infty$. $M(gp, gx_n, a, kt) \geq M(fp, fx_n, a, t)$,
$M(gp, z, a, kt) \geq M(fp, z, a, t)$,
$M(gp, z, a, kt) \geq M(z, z, a, t)$,
$M(gp, z, a, kt) \geq 1$,
$M(gp, z, a, kt) = 1$,
$gp = z = fp$.
As f and g are weakly compatible. Therefore fgp=gfp i.e. fz=gz. Now, we show that z is fixed point of f and g. From (3.1),
As $n \to \infty$, $M(gz, gx_n, a, kt) \geq M(fz, fx_n, a, t)$,
$M(gz, z, a, kt) \geq M(fz, z, a, t)$,
$M(gz, z, a, kt) \geq M(gz, z, a, t)$,
$gz = z = fz$.
Hence z is a common fixed point of f and g. For uniqueness, let w be another fixed point of f and g. Then by (3.1),
$M(gz, gw, a, kt) \geq M(fz, fw, a, t), M(z, w, a, kt) \geq M(z, w, a, t)$ and z=w.
Therefore z is unique common fixed point of f and g.
Theorem 3.2. Let (X, M, *) be a fuzzy 2-metric space. Let f and g weakly compatible self maps of X satisfying condition (3.1) and (3.2). If one of g(X) or f(X) is complete then f and g have a unique common fixed point.
Proof. From the proof of above theorem. We conclude that $\{fx_n\} = \{y_n\}$ is a Cauchy sequence in X. Now suppose that f(X) is a complete subspace of X. Then the subsequence of $\{y_n\}$ must get a limit in f (X). Call it be a and f(v) = a. As $\{y_n\}$ is a Cauchy sequence containing a convergent subsequence, therefore the sequnce $\{y_n\}$ also converges implying thereby the convergence of subsequence of the convergent sequence. Now, from (3.1),

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As $n \to \infty$, $M(gv, gx_n, a, kt) \geq M(fv, fx_n, a, t)$,
$M(gv, u, a, kt) \geq M(fv, u, a, t)$,
$M(gv, u, a, kt) \geq M(u, u, a, t)$,
$M(gv, u, a, kt) \geq 1$,
$M(gv, u, a, kt) = 1$,
$gv = u = fv$.
Which shows that pair (f,g) has a point of coincidence. Since, f and g are weakly compatible, fgv = gfv, i.e. fu = gu.
Now, we show that u is a fixed point of f and g. From (3.1),
As $n \to \infty$, $M(gu, gx_n, a, kt) \geq M(fu, fx_n, a, t)$,
$M(gu, u, a, kt) \geq M(fu, u, a, t)$,
$M(gu, u, a, kt) \geq M(fu, u, a, t)$,
$gu = u = fu$.
Hence u is a fixed point of f and g. For uniqueness, let w be another fixed point of f and g. Then by (3.1),
$M(gz, gw, a, kt) \geq M(fz, fw, a, t)$, $M(z, w, a, kt) \geq M(z, w, a, t)$ and z=w.
Therefore z is unique common fixed point of f and g.

III. SOME FIXED POINT THEOREMS IN FUZZY 3-METRIC SPACES

Definition (4 A): A binary operation *: [0, 1] x [0,1] x [0,1] x [0,1] → [0,1] is called a continuous t-norm if ([0,1],*) is an abelian topological monodies with unit 1 such that $a_1 * b_1 * c_1 * d \geq a_2 * b_2 * c_2 * d_2$ whenever $a_1 \geq a_2$, $b_1 \geq b_2$, $c_1 \geq c_2$ and $d_1 \geq d_2$ for all a_1, a_2 , b_1, b_2, c_1, c_2 and d_1, d_2 are in [0,1].
Definition (4 B): The 3-tuple (X, M, *) is called a fuzzy 3-metric space if X is an arbitrary set, * is continuous t-norm and M is fuzzy set in $X^4 \times [0, \infty)$ satisfying the followings
$(FM'' - 1)$: $M(x, y, z, w, 0) = 0$
$(FM'' - 2)$: $M(x, y, z, w, t) = 1, \forall\, t > 0$
$(FM'' - 3)$: $M(x, y, z, w, t) = M(x, w, z, y, t) = M(z, w, x, y, t) = \cdots$ $(FM'' - 4)$: $M(x, y, z, w, t_1 + t_2 + t_3) \geq M(x, y, z, u, t_1) * M(x, y, u, w, t_2) * M(x, u, z, w, t_3) * M(x, y, z, w, t_4)$
$(FM'' - 5)$: $M(x, y, z, w)\colon [0,1) \to [0,1]$ $is\ left\ continuous, \forall\, x, y, z, u\ \varepsilon\ X, t_1, t_2, t_3, t_4 > 0$
Definition (4 C): Let (X, M, *) be a fuzzy 3-matric space. A sequence $\{x_n\}$ in fuzzy 3-metric space X is said to be convergent to a point $x \varepsilon X$,
$\lim_{n\to\infty} M(x_n, x, a, b, t) = 1, for\ all\ a, b\ \varepsilon\ X\ and\ t > 0$
A sequence $\{x_n\}$ in fuzzy 3-metric space X is called a Cauchy sequence, if
$\lim_{n\to\infty} M(x_{n+p}, x_n, a, b, t) = 1, for\ all\ a, b\ \varepsilon\ X\ and\ t, p > 0$
A fuzzy 3-matric space in which every Cauchy sequence is convergent is said to be complete.
Definition (4 D): A function M is continuous in fuzzy 3-metric space, iff whenever for all $a \varepsilon X$ and $t > 0$.
$x_n \to x, y_n \to y, then \lim_{n\to\infty} M(x_n, y_n, a, b, t) = M(x, y, a, t), \forall\, a, b\ \varepsilon\ X\ and\ t > 0$
Definition (4 E): Two mappings A and S on fuzzy 3-metric space X are weakly commuting iff $M(ASu, SAu, a, b, t) \geq M(Au, Su, a, t), \forall u, a, b\ \varepsilon\ X\ and\ t > 0$.
Theorem 4.1. Let (X, M, *) be a complete fuzzy 3-metric space. Let f and g be weakly compatible self maps of X satisfying
$M(g_x, g_y, a, b, k_t) \geq M(f_x, f_y, a, t) where\ 0 < k < 1, a, b > 0$
$g(X) \subseteq f(X)$
If one of $g(X) or\ f(X)$ is complete then f and g have a unique common fixed point.
Proof. Let $x_0 \varepsilon X$. Since $g(X) \subseteq f(X)$. Choose $x_1 \varepsilon X$ such that $g(x_0) = f(x_1)$. In general, choose x_{n+1} such that $y_n = fx_{n+1} = gx_n$. Then by (4.1), we have

$$M(fx_n, fx_{n+1}, a, b, t) = M(gx_{n-1}, gx_n, a, b, t) \geq M\left(fx_{n-1}, fx_n, a, b, \frac{t}{k}\right)$$
$$= M\left(gx_{n-2}, gx_{n-1}, a, b, \frac{t}{k}\right) \geq \cdots, \geq M\left(fx_0, fx_0, a, b, \frac{t}{k^n}\right)$$

Therefore, for any p,

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$$M(fx_n, fx_{n+p}, a, b, t) \geq M\left(fx_n, fx_{n+1}, a, b, \frac{t}{p}\right) \geq \cdots . \geq M\left(fx_{n+p-1}, fx_{n+p}, a, b, \frac{t}{p}\right) \geq M\left(fx_0, fx_1, a, b, \frac{t}{pk^n}\right) \geq \cdots .$$
$$\geq M\left(fx_0, fx_1, a, b, \frac{t}{pk^{n+p-1}}\right)$$

As $n \to \infty$, $\{fx_n\} = \{y_n\}$ is a Cauchy sequence in fuzzy 3-metric space and so, by completeness of X, $\{y_n\} = \{fx_n\}$ is convergent. We call the limit z, then $\lim_{n\to\infty} fx_n = \lim_{n\to\infty} gx_n = z$. As f(X) is complete, so there exist a point p in X such that $f_p = z$. Now, from (3.1),

As $n \to \infty$, $M(gp, gx_n, a, b, kt) \geq M(fp, fx_n, a, b, t)$,
$M(gp, z, a, b, kt) \geq M(fp, z, a, b, t)$,
$M(gp, z, a, b, kt) \geq M(z, z, a, b, t)$,
$M(gp, z, a, b, kt) \geq 1$,
$M(gp, z, a, b, kt) = 1$,
$gp = z = fp$.

As f and g are weakly compatible. Therefore fgp=gfp i.e. fz=gz. Now, we show that z is fixed point of f and g. From (4.1),

As $n \to \infty$, $M(gz, gx_n, a, b, kt) \geq M(fz, fx_n, a, b, t)$,
$M(gz, z, a, b, kt) \geq M(fz, z, a, b, t)$,
$M(gz, z, a, b, kt) \geq M(gz, z, a, b, t)$,
$gz = z = fz$.

Hence z is a common fixed point of f and g. For uniqueness, let w be another fixed point of f and g. Then by (3.1),
$M(gz, gw, a, b, kt) \geq M(fz, fw, a, b, t)$, $M(z, w, a, b, kt) \geq M(z, w, a, b, t)$ and z=w.
Therefore z is unique common fixed point of f and g.

Theorem 4.2. Let (X, M, *) be a fuzzy 3-metric space. Let f and g weakly compatible self maps of X satisfying condition (4.1) and (4.2). If one of g(X) or f(X) is complete then f and g have a unique common fixed point.

Proof From the proof of above theorem. We conclude that $\{fx_n\} = \{y_n\}$ is a Cauchy sequence in X. Now suppose that f(X) is a complete subspace of X. Then the subsequence of $\{y_n\}$ must get a limit in f (X). Call it be u and f(v) = u. As $\{y_n\}$ is a Cauchy sequence containing a convergent subsequence, therefore the sequence $\{y_n\}$ also converges implying thereby the convergence of subsequence of the convergent sequence. Now, from (4.1),

As $n \to \infty$, $M(gv, gx_n, a, b, kt) \geq M(fv, fx_n, a, b, t)$,
$M(gv, u, a, b, kt) \geq M(fv, u, a, b, t)$,
$M(gv, u, a, b, kt) \geq M(u, u, a, b, t)$,
$M(gv, u, a, b, kt) \geq 1$,
$M(gv, u, a, b, kt) = 1$,
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$gu = u = fu$.

Hence u is a fixed point of f and g. For uniqueness, let w be another fixed point of f and g. Then by (4.1),
$M(gz, gw, a, b, kt) \geq M(fz, fw, a, b, t)$, $M(z, w, a, b, kt) \geq M(z, w, a, b, t)$ and z=w.
Therefore z is unique common fixed point of f and g.

IV. SOME FIXED POINT THEOREMS IN FUZZY 4-METRIC SPACES

Definition (5 A): A binary operation $* : [0,1]^5 \to [0,1]$ is called a continuous t-norm if ([0,1],*) is an abelian topological monoid with unit 1 such that $a_1 * b_1 * c_1 * d_1 * e_1 \geq a_2 * b_2 * c_2 * d_2 * e_2$ whenever $a_1 \geq a_2, b_1 \geq b_2, c_1 \geq c_2, d_1 \geq d_2$ and $e_1 \geq e_2$ for all $a_1, a_2, b_1 b_2, c_1, c_2, d_1, d_2$ and e_1, e_2 are in [0,1]

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Definition (5 B): The 3-tuple $(X, M, *)$ is called a fuzzy 4-metric space if X is an arbitrary set, * is continuous t-norm monoid and M is a fuzzy set in $X^4 \times [0, \infty]$ satisfying the following conditions:

(1) $M(x, y, u, v, w, 0) = 0$
(2) $M(x, y, u, v, w, t) = 1 \forall t > 0$
(3) $M(x, y, u, v, w, t) = M(x, v, u, y, w, t) = M(u, y, x, v, w, t) = \cdots \dots \dots$
(4) $M(x, y, u, v, w, t_1 + t_2 + t_3 + t_4 + t_5) \geq M(x, y, u, v, w, t_1) + M(x, y, u, v, w, t_2) + M(x, y, u, v, w, t_3) + M(x, y, u, v, w, t_4) + M(x, y, u, v, w, t_5)$
(5) $M(x, y, u, v, w): [0,1] \to [0,1]$ is left continous, $\forall x, y, u, v, w \in X, t_1, t_2, t_3, t_4, t_5 > 0$

Definition (5 C): Let $(X, M, *)$ be a fuzzy 4 metric space:
(1) A sequence $\{x_n\}$ in fuzzy 4 metric space X is called convergent to appoint $x \in X$, if $\lim_{n\to\infty} M(x_n, x, a, b, c, t) = 1$, for all $a, b \in X$ and $t > 0$
(2) A sequence $\{x_n\}$ in fuzzy 4 metric space X is called Cauchy sequence, if $\lim_{n\to\infty} M(x_{n+p}, x, a, b, c, t) = 1$, for all $a, b \in X$ and $t, p > 0$
(3) A fuzzy 4 metric space in which every Cauchy sequence is convergent is said to be complete.

Definition (5 D): A function M is continuous in fuzzy 3-metric space if $x_n \to x, y_n \to y$, then $\lim_{n\to\infty} M(x_n, y_n, a, b, c, t) = M(x, y, a, b, c, t), \forall a, b \in X$ and $\ > 0$

Definition (5 E): Two mappings A and S on fuzzy 4-metric space X are weakly commuting iff,

$M(ASu, SAu, a, b, c, t) \geq M(Au, Su, a, b, c, t) \forall u, a, b, c \in X$ and $t > 0$

Theorem (5.1) Let $(X, M, *)$ be a complete fuzzy 4-metric space. Let f and g be weakly compatible self maps of X satisfying

(5.1) $M(gx, gy, a, b, c, kt) \geq M(fx, fy, a, b, c, t)$ where $0 < k < 1, a, b > 0$

(5.2) $g(X) \subseteq f(X)$

If one of $g(X)$ or $f(X)$ is complete then f and g have a unique common fixed point.

Proof. Let $x_0 \in X$. Since $g(X) \subseteq f(X)$. Choose $x_1 \in X$ such that $g(x_0) = f(x_1)$. In general, choose x_{n+1} such that $y_n = fx_{n+1} = gx_n$. Then, we have

$$M(fx_n, fx_{n+1}, a, b, c, t) = M(gx_{n-1}, gx_n, a, b, c, t) \geq M\left(fx_{n-1}, fx_n, a, b, c, \frac{t}{k}\right) = M\left(gx_{n-2}, gx_{n-1}, a, b, c, \frac{t}{k}\right)$$
$$\geq \cdots \dots \dots \geq M\left(fx_0, fx_1, a, b, c, \frac{t}{k^n}\right)$$

Therefore for any p,

$$M(fx_n, fx_{n+p}, a, b, c, t) \geq M\left(fx_n, fx_{n+1}, a, b, c, \frac{t}{p}\right) \dots \dots \geq M\left(fx_{n+p-1}, fx_{n+p}, a, b, c, \frac{t}{p}\right)$$
$$\geq M\left(fx_0, fx_1, a, b, c, \frac{t}{pk^n}\right) \geq \cdots \dots \geq M\left(fx_0, fx_1, a, b, c, \frac{t}{pk^{n+p-1}}\right)$$

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As $n \to \infty, M(gp, gx_n, a, b, c, kt) \geq M(fp, fx_n, a, b, c, t)$

$M(gp, z, a, b, c, kt) \geq M(fp, z, a, b, c, t)$

$M(gp, z, a, b, c, kt) \geq M(z, z, a, b, c, t)$

$M(gp, z, a, b, c, kt) \geq 1$

$M(gp, z, a, b, c, kt) = 1$

$g = z = fp.$

As f and g are weakly compatible. Therefore fgp=gfp i.e. fz=gz. Now, we show that z is fixed point of f and g.

As $n \to \infty$ $M(gz, gx_n, a, b, c, kt) \geq M(fz, fx_n, a, b, c, t)$

$M(gz, z, a, b, c, kt) \geq M(fz, z, a, b, c, t)$

$M(gz, z, a, b, c, kt) \geq M(gz, z, a, b, c, t)$

$gz = z = fz.$

Hence z is a common fixed point of f and g. For uniqueness, let q be another fixed point of f and g. Then

$M(gz, gq, a, b, c, kt) \geq M(fz, fq, a, b, c, t), M(z, q, a, b, c, kt) \geq M(z, q, a, b, c, t)$ and z=q.

Therefore z is unique common fixed point of f and g.

Theorem (5.2) Let $(X, M, *)$ be a fuzzy 4-metric space. Let f and g are weakly compatible self maps of X satisfying conditions (5.1) and (5.2).

Proof. From the proof of above theorem. We conclude that $\{fx_n\} = \{y_n\}$ is a Cauchy sequence in X. Now suppose that $f(X)$ is complete subspace of X. Then the subsequence of $\{y_n\}$ must get a limit in $f(X)$. Call it be r and f(s)=r. Then $\{y_n\}$ is a Cauchy sequence containing a subsequence, therefore the sequence also convergent implying thereby the convergence of the convergent sequence. Now, from (5.1),

As $n \to \infty, M(gs, gx_n, a, b, c, kt) \geq M(fs, fx_n, a, b, c, t),$

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$M(gs, r, a, b, c, kt) \geq M(fs, r, a, b, c, t),$

$M(gs, r, a, b, c, kt) \geq M(r, r, a, b, c, t),$

$M(gs, r, a, b, c, kt) \geq 1,$

$M(gs, r, a, b, c, kt) = 1,$

$gs = r = fs$

Which shows that pair (f,g) have a point of coincidence. Since, f and g are weakly compatible. $fgs = gfs, i.e. fr = gr$.

Now, we show that r is a fixed point of f and g. From (5.1).

$M(gr, gx_n, a, b, c, kt) \geq M(fr, fx_n, a, b, c, t),$

$M(gr, r, a, b, c, kt) \geq M(fr, u, a, b, c, t),$

$M(gr, gx_n, a, b, c, kt) \geq M(gr, fx_n, a, b, c, t),$

$gr = r = fr$

Hence r is a fixed point of f and g. For uniqueness, let d be be another fixed point of f and g. Then by (5.1).

$M(gr, gd, a, b, c, kt) \geq M(fr, fd, a, b, c, t),$

$M(r, d, a, b, c, kt) \geq M(r, d, a, b, c, t),$ and

$r = d.$

Therefore r is unique common fixed point of f and g.

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Some Fixed Point Theorems for Weakly Commuting Mappings Related to Fuzzy-3 Metric Spaces

Mahesh Kumar Verma, Vikas Kumar Mishra, Manoj Kumar Jha

***Abstract*— In the present paper some generalization on fixed point and common fixed point theorems in complete Fuzzy 3-metric spaces are established**

***Index Terms*— Fuzzy metric spaces, fuzzy 3- metric spaces, fixed point, Common fixed point.**

I. INTRODUCTION

Highlight a section that you want to designate with a certain style, The study of common fixed points of mappings in a fuzzy metric space satisfying certain contractive conditions has been at the center of vigorous research activity. In1965, the concept of fuzzy sets was introduced by Zadeh [36]. With the concept of fuzzy sets, the fuzzy metric space was introduced by O.Kramosil and J. Michalek [25] in 1975. Helpern [19] in 1981first proved a fixed point theorem for fuzzy mappings. Also M.Grabiec [17] in 1988 proved the contraction principle in the setting of the fuzzy metric spaces. Moreover, A. George and P. Veeramani [16] in1994 modified the notion of fuzzy metric spaces with the help of t-norm, by generalizing the concept of probabilistic metric space to fuzzy situation. Consequently in due course of time some metric fixed point results were generalized to fuzzy metric spaces by various authors. Gahler in a series of papers [13, 14, and 15] investigated 2-metric spaces. Sharma, Sharma and Iseki [30] studied for the first time contraction type mappings in 2-metic space. We know that that 2-metric space is a real valued function of a point triples on a set X, which abstract properties were suggested by the area function in Euclidean spaces. In the present paper we are proving a common fixed point theorem for **fuzzy3-metric** spaces for weakly commuting mappings which are compatible also.

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Mahesh kumar verma, Department of mathematics, Govt GB college Hardibazar, Korba, India
Vikas kumar Mishra, Department of mathematics, Rungta college of Engg. & Tech., Raipur, India
Manoj kumar jha, Department of mathematics, Rungta Engg. college, Raipur, India

2. SOME FIXED POINT THEOREMS IN FUZZY 3-METRIC SPACE

Definition (2 A): A binary operation *: [0, 1] x [0,1] x [0,1] x [0,1] → [0,1] is called a continuous t-norm if ([0,1],*) is an abelian topological monodies with unit 1 such that $a_1 * b_1 * c_1 * d \geq a_2 * b_2 * c_2 * d_2$ whenever $a_1 \geq a_2$, $b_1 \geq b_2$, $c_1 \geq c_2$ and $d_1 \geq d_2$ for all a_1, a_2, b_1, b_2, c_1, c_2 and d_1, d_2 are in [0,1].

Definition (2 B): The 3-tuple (X, M, *) is called a fuzzy 3-metric space if X is an arbitrary set, * is continuous t-norm and M is fuzzy set in $X^4 \times [0, \infty)$ satisfying the followings

$(FM'' - 1): M(x, y, z, w, 0) = 0$

$(FM'' - 2): M(x, y, z, w, t) = 1, \forall t > 0$

$(FM'' - 3): M(x, y, z, w, t) = M(x, w, z, y, t) = M(z, w, x, y, t) = \cdots$

$(FM'' - 4): M(x, y, z, w, t_1 + t_2 + t_3) \geq M(x, y, z, u, t_1) * M(x, y, u, w, t_2) * M(x, u, z, w, t_3) * M(x, y, z, w, t_4)$

$(FM'' - 5): M(x, y, z, w): [0,1) \rightarrow [0,1]$ *is left continuous*, $\forall\, x, y, z, u \,\varepsilon\, X, t_1, t_2, t_3, t_4 > 0$

Definition (2 C): Let (X, M, *) be a fuzzy 3-matric space. A sequence $\{x_n\}$ in fuzzy 3-metric space X is said to be convergent to a point $x \in X$,

$\lim_{n \to \infty} M(x_n, x, a, b, t) = 1, for\ all\ a, b \in X\ and\ t > 0$

A sequence $\{x_n\}$ in fuzzy 3-metric space X is called a Cauchy sequence, if

$\lim_{n \to \infty} M(x_{n+p}, x_n, a, b, t) = 1, for\ all\ a, b \in X\ and\ t, p > 0$

A fuzzy 3-matric space in which every Cauchy sequence is convergent is said to be complete.

Definition (2 D): A function M is continuous in fuzzy 3-metric space, iff whenever for all $a \varepsilon X$ and $t > 0$.

$x_n \rightarrow x, y_n \rightarrow y, then \lim_{n \to \infty} M(x_n, y_n, a, b, t) = M(x, y, a, t), \forall a, b \in X\ and\ t > 0$

I. DEFINITION (2 E): TWO MAPPINGS A AND S ON FUZZY 3-METRIC SPACE X ARE WEAKLY COMMUTING IFF

$M(ASu, SAu, a, b, t) \geq M(Au, Su, a, t), \forall u, a, b \in X\ and\ t > 0$

3. MAIN RESULT

Theorem 3.1 Let $(X, M, *)$ be a complete fuzzy 3-metric space and let F and T be continuous mappings of X in X. Let A be a self mapping of X satisfying {A,F} and {A,T} are weakly commuting and

(3.1a) $A(X) \subseteq F(X) \cap T(X)$

(3.1b)

$$M(Ax, Ay, a, b, t) \geq r\begin{bmatrix} Min\{M(Fx, Ty, a, b, t)\}, M(Fx, Ax, a, b, t), M(Fx, Ay, a, b, t), \\ M(Ty, Ay, a, b, t), M(Ax, Ty, a, b, t), M(Fy, Ay, a, b, t)\} \end{bmatrix}$$

For all $x, y \subset X$, where $r: [0,1] \rightarrow [0,1]$ is a continuous function such that $r(t) > t$ for each $0 \leq t \leq 1$ and $r(t) = 1$ for $t = 1; a, b \in X$. Then sequence $\{x_n\}$ and $\{y_n\}$ in X are such that

$x_n \rightarrow x, y_n \rightarrow y \Rightarrow M(x_n, y_n, a, b, t) \rightarrow M(x, y, a, b, t)$

where $t > 0$ (3.1c)

Then F,T and A have a unique common fixed point in X.

Proof: We define a sequence $\{x_n\}$ such that $Fx_{2n+1} = Ax_{2n}$ and $Tx_{2n+2} = Ax_{2n+1}, n = 1,2, \ldots$ We shall prove that $\{Ax_n\}$ is a Cauchy sequence for $n = 0,1,2, \ldots$

$G_n = M(Ax_n, Ax_{n+1}, t) < 1; n = 0,1,2,3, \ldots\ldots$

$G_{2n} = M(Ax_{2n+1}, Ax_{2n}, t)$

$$\geq r\begin{bmatrix} Min\{M(Fx_{2n+1}, Tx_{2n}, a,b,t)\}, M(Fx_{2n+1}, Ax_{2n+1}, a,b,t), M(Fx_{2n+1}, Ax_{2n}, a,b,t), \\ M(Tx_{2n}, Ax_{2n}, a,b,t), M(Ax_{2n+1}, Tx_{2n}\ a,b,t), M(Fx_{2n}, Ax_{2n}, a,b,t)\} \end{bmatrix}$$
$$= r\begin{bmatrix} Min\{M(Ax_{2n}, Ax_{2n-1}, a,b,t)\}, M(Ax_{2n}, Ax_{2n-1}, a,b,t), M(Ax_{2n}, Ax_{2n}, a,b,t), \\ M(Ax_{2n-1}, Ax_{2n}, a,b,t), M(Ax_{2n+1}, Ax_{2n-1}, a,b,t), M(Ax_{2n-1}, Ax_{2n}, a,b,t)\} \end{bmatrix}$$
$$\geq r\begin{bmatrix} Min\{M(Ax_{2n}, Ax_{2n-1}, a,b,t)\}, M(Ax_{2n}, Ax_{2n+1}, a,b,t), M(Ax_{2n}, Ax_{2n}, a,b,t), \\ M(Ax_{2n-1}, Ax_{2n}, a,b,t), M(Ax_{2n+1}, Ax_{2n}, a,b,t), M(Ax_{2n-1}, Ax_{2n}, a,b,t), M(Ax_{2n-1}, Ax_{2n}, a,b,t)\} \end{bmatrix}$$
$$= r[Min\{G_{2n-1}, G_{2n}, 1, G_{2n-1}, G_{2n}, G_{2n-1}, G_{2n-1}\}]$$

If $G_{2n-1} > G_{2n}$, then $G_{2n} > r[G_{2n-1}] > G_{2n-1}$

A contradiction, therefore $G_{2n-1} < G_{2n}$

Therefore $G_{2n} \geq r[G_{2n-1}] \geq G_{2n-1}$

Thus $\{G_{2n} : n \geq 0\}$ is increasing sequence of positive real numbers in [0,1] and therefore tends to a finite limit $L \leq 1$. It is clear that L=1 because if $L < 1$ then on taking limit $n \to \infty$ we get $L \geq r(L) > L$, a contradiction. Hence L=1

Now for any integer m,

$$M(Ax_n, Ax_{n+m}, a,b,t) \geq M\left(Ax_n, Ax_{n+1}, a,b,\frac{t}{m}\right) * \dots\dots\dots * M\left(Ax_{n+m-1}, Ax_{n+m}, a,b,\frac{t}{m}\right)$$
$$\geq M\left(Ax_n, Ax_{n+1}, a,b,\frac{t}{m}\right) * \dots\dots\dots * M\left(Ax_n, Ax_{n+1}, a,b,\frac{t}{m}\right)$$

$$limit\ n \to \infty M(Ax_n, Ax_{n+m}, a,b,t) \geq 1 * 1 * 1 * \dots\dots\dots * 1 = 1$$

Thus $\{Ax_n\}$ is a Cauchy sequence and by completeness of X, $\{Ax_n\}$ converges to $u \in X$. So subsequence $\{Fx_{2n+1}\}$ and $\{Tx_{2n}\}$ of $\{Ax_n\}$ are also converges to same point u.

Since A is R weakly commuting with F, so

$$M(AFx_{2n+1}, FAx_{2n+1}, a,b,t) \geq M\left(AFx_{2n+1}, FAx_{2n+1}, a,b,\frac{t}{R}\right)$$

On taking limit $n \to \infty$, $AFx_{2n+1} = FAx_{2n+1} = Fu$. Now we will prove $Fu = u$. First suppose that $Fu \neq u$ then there exist $t > 0$ such that $M(Fu,u,t) < 1$.

Now

$$M(AFx_{2n+1}, Fx_{2n}, a,b,t) \geq$$
$$r\left[Min\begin{Bmatrix} M(F^2x_{2n+1}, Tx_{2n}, a,b,t), M(F^2x_{2n+1}, AFx_{2n+1}, a,b,t), M(F^2x_{2n+1}, Ax_{2n}, a,b,t), \\ M(Tx_{2n}, Ax_{2n}, a,b,t), M(AFx_{2n+1}, Tx_{2n}, a,b,t), M(Fx_{2n}, Ax_{2n}, a,b,t) \end{Bmatrix}\right]$$

$$M(Fu,u,a,t) \geq r\left[Min\begin{Bmatrix} M(Fu,u,a,b,t), M(Fu,Fu,a,b,t), M(Fu,u,a,b,t), \\ M(u,u,a,b,t), M(Fu,u\ a,b,t), M(Fu\ u,a,b,t) \end{Bmatrix}\right]$$

$$M(Fu,u,a,b,t) \geq r[M(Fu,u,a,b,t)] >$$
$$M(Fu,u,a,b,t)$$

which is a contradiction.

Thus u is a fixed point of F. Similarly we can show that u is also fixed point of A. Now we claim that u is a fixed point of T. Suppose it is not so then for any t>0, $M(u,Tu,a,t) < 1$

$$M(Au, Tx_{2n}, a\ b,t)$$
$$\geq r\left[Min\begin{Bmatrix} M(Fu, T^2x_{2n}, a,b,t), M(Fu\ Au,a,b,t), M(Fu, ATx_{2n}, a,b,t), \\ M(T^2x_{2n}, ATx_{2n}, a,b,t), M(Au, T^2x_{2n}, a,b,t), M(FTx_{2n}, ATx_{2n}, a,b,t) \end{Bmatrix}\right]$$

$$M(u,Tu,a,b,t) \geq r\left[Min\begin{Bmatrix} M(u,Tu,a,b,t), M(u,u,a,b,t), M(u,Tu,a,b,t), \\ M(Tu,Tu,a,b,t), M(u,Tu,a,b,t), M(Tu,Tu,a,b,t) \end{Bmatrix}\right]$$

$$M(u,Tu,a,b,t) \geq r[Min\{M(u,Tu,a,b,t)\}]$$

Which is a contradiction so $M(Tu\ u,a,b,t) = 1$

Hence u is also a fixed point of T. That is u is a common fixed point of T, F and A.

Uniqueness: Suppose there is another fixed point $v \neq u$, then

$$M(Ax,Ay,a,b,t) \geq r\left[Min\begin{Bmatrix} M(Fx,Ty,a,b,t), M(Fx,Ax,a,b,t), M(Fx,Ay,a,b,t), \\ M(Ty,Ay,a,b,t), M(Ax,Ty,a,b,t), M(Fy,Ay,a,b,t) \end{Bmatrix}\right]$$

$$M(Au,Av,a,b,t) \geq r\left[Min\begin{Bmatrix} M(Fu,Tv,a,b,t), M(Fu,Au,a,b,t), M(Fu,Av,a,b,t), \\ M(Tv,Av,a,b,t), M(Au,Tv,a,b,t), M(Fv,Av,a,b,t) \end{Bmatrix}\right]$$

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$$M(u,v,a,b,t) \geq r\left[Min\begin{Bmatrix}M(u,v,a,b,t), M(u,u,a,b,t), M(u,v,a,b,t),\\ M(v,v,a,b,t), M(u,v,a,b,t), M(v,v,a,b,t)\end{Bmatrix}\right]$$

$$M(u,v,a,b,t) \geq r[Min\{M(u,v,a,b,t)\}]$$ which is a contradiction so u=v.

Hence A, F and T have unique common fixed point.

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Research Paper

Fluoride distribution in the underground water of Northern Chhatissgarh India

K.Venu Achari and S. Krishnamurthi
Department of Zoology, Government College, Sanawal, Balrampur-497220, India
Department of Chemistry, Government G. B. College, Korba-495446, India
Corresponding author, Email: kvenu99@rediffmail.com

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Abstract: An attempt has been made to analyze the public hand pump water from seven different locations of northernmost Chhattisgarh. The study indicated that, except at one sampling station viz. Trisuli, the fluoride levels v~s within the prescribed limit of WHO standards of drinking waters. Trisuli water showed marginal levels of fluoride contents (1.4 mg/L). The study revealed the heterogenous fluoride distribution in the underground water and the result of these analyses are concluded that proper de-fluoridation measures seems to be needed to protect the habitants of Trisuli area from problems of fluorosis.
Keywords: Hand pump water, fluoride, Trisuli, northern Chhattisgarh, de-fluoridation

INTRODUCTION

Study area is situated in Balrampur-Ramanujganj district of Chattisgarh and it has been explored for fluoride distribution in the underground water. These distributions have been conducted in various seasons of the years from March 2013 to February 2014.

Ramachadrapur block is a significant biodiversified territory of Chattisgarh located in the northernmost part of Chattisagrh, positioned at 26.05°N latitude and 74.02°E longitude. Temperature varies from 10° C to 45°C. People of this region have divergent way of life and civilization, enriched as it is with dense forests and a very diverse population comprising to a number of tribes. They prefer animal husbandry and small industries as additional income-generating activities and are keen to take these up. The individual of sanawal be desperate to commence apiculture, sericulture and lac culture. The Kanhar River is the principal river near the sanawal. Life here is governed by tribal customs, culture and traditions. In the rural areas of the region, people are dependent largely on agriculture and minor forest produce. Further groundwater is a major source of drinking water in urban and rural areas. Near about ninety percent of the rural population uses groundwater for household purposes. Nearly half the population of study area is illiterate, not at all aware of the water borne diseases affecting their health. Millions of people all over the world, including India is suffering with fluorosis due high concentration of fluoride in the drinking water. When the fluoride level cross the optimum concentration i.e., 1.5 mg/L, then it exhibit the toxic effects in the human body.

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The Indian districts such as Andhra Pradesh, Tamilnadu, Karnataka, Kerla, Rajasthan, Delhi, Bihar, Jharkand, Uttar Pradesh, Orrisa, Jammu Kashmir have been reported to contain high fluoride levels (Rammamohan, 1964; Rao, 1974; Rao *et. al.*, 1993; Susheela, 1993; WHO, 1994) rendering these areas of the contrary as either affected areas from fluorosis to various extends or to the risk of the same. Near about one lack people of Assam (Karbi Anglong district) affected by excessive fluoride levels in ground water in June 2000. The symptoms were anemia, stiff joints, painful and restricted movement, mottled teeth and kidney failure.

MATERIALS AND METHODS

Northern Chhattisgarh with its variety of ecosystems ranging from mountains supporting thick forests, coastal plains, we were selected seven sampling station at various locations in the study area with view to cover most of the segment of the block. These sampling stations were A_1 = Sanawal, A_2 = Pachawal, A_3 = Kameshwar Nagar, A_4 = Trisuli, A_5 = Jhara, A_6 = Idravatipur, A_7 = Dhauly. Water samples were collected from the public hand pumps situated at these sampling sites on monthly basis over a period of one calendar year. These samples were taken to laboratory ande subsequently analyses for their fluoride cor-ents. The analysis of fluoride contents were performed spectrophotometrically using ALPHA, AWWA and APCF (1985) Standard Method for Examination of Water and Wastewater. The de-colorization of SPANDS Zirconyl complex was found to follow a linear relationship with fluoride contents.

RESULTS AND DISCUSSION

The study reveals the heterogenous fluoride distribution in the underground water of the area and the results of these analyses are reported in table.

Table: Fluoride distribution in Northern Chhattisgarh

SN	Sampling Site	Fluoride Concentration (mg/L)											
		March	April	May	June	July	August	September	October	November	December	January	February
G_1	Sanawal	1.19	1.22	1.24	1.19	1.02	1.08	1.18	1.08	1.15	1.20	1.22	1.1
G_2	Pachawal	1.20	1.24	1.26	1.21	0.86	1.16	1.20	1.16	0.98	0.86	1.00	0.96
G_3	Trisuli	1.38	1.41	1.43	1.45	1.22	1.28	1.38	1.48	1.41	1.44	1.40	1.36

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G_4	Kameswar Nagar	1.22	1.26	1.32	1.24	0.99	1.43	1.30	1.34	1.31	1.24	1.28	1.20
G_5	Jhara	1.16	1.20	1.25	1.21	1.03	1.11	1.22	1.31	1.10	1.06	1.09	1.18
G_6	Indrawatipur	1.10	0.96	1.14	1.18	1.02	1.21	1.29	1.22	1.22	1.30	1.20	0.90
G_7	Dhauly	1.02	89	1.10	1.16	0.89	1.08	1.16	1.21	1.15	1.24	1.20	0.88

All the groups of sampling station the fluoride level was within permissible fluoride limits for drinking water as recommended by WHO (WHO,1970; National research, 1977; WHO guidelines, 1984). The frequency distribution of fluoride was different in the G_3-Trisuli group characterized by relatively higher concentration i.e., 1.48 mg/L. Group G_3-Trisuli exhibit nearly equal to maximum permissible limits (1.5 mg/L) recommended by WHO (WHO guidelines, 1984; 1994). The effect of fluoride in human body differs individually, but the common person is evidence for prevention of tooth decay, strengthening of skeleton in 0.8–1.2 mg/L fluoride concentration. When the concentration exceeds more than 1.5 mg/l, Fluorosis occurs in which pitting of tooth enamel and deposits in bones are common phenomenon. Above about 10 mg/L, show signs of Crippling skeletal fluorosis (Deshmukh and Malpe, 1996). Therefore, it is remarkable that proper de-fluoridation measures seem to be needed to protect the populations of Trisuli area from the problems of fluorosis.

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A COMMON FIXED POINT THEOREM ON FUZZY 3-METRIC SPACES

Mahesh Kumar Verma*, D.P. Sahu
*Ph.D. Scholar, Department of Mathematics, Dr. C.V. Raman University Bilaspur (C.G.)
Retired professor, Department of Mathematics, Govt. Science College (C.G.)

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ABSTRACT
In this paper, we prove a common fixed point theorem for four mappings on fuzzy 3-metric spaces. Our result is an extension of results of S. H. Cho [2] to fuzzy 2-metric spaces. Also, it is a generalization of a result of S. Sharma [11].

INTRODUCTION
The concept of fuzzy sets was introduced by L. A. Zadeh [13] in1965. To use this concept in topology and analysis, many authors have extensively developed the theory of fuzzy sets and applications. With the concept of fuzzy sets, the fuzzy metric space was introduced by I. Kramosil and J. Michalek [8] in 1975. M. Grabiec [5] proved the contraction principle in fuzzy metric spaces in 1988. Moreover, A. George and P. Veeramani [4] modified the notion of fuzzy metric spaces with the help of *t*-norms in 1994. GÄahler [3] investigated 2-metric spaces in a series of his papers. Sharma, Sharma and Iseki [12] investigated, for the first time, contraction type mappings in 2-metric spaces. Many authors have studied common fixed point theorems in fuzzy metric spaces. Some of interesting papers are Y. J. Cho [1], George and Veeramani [4], Grabiec [5], Kramosil and Michalek [8] and S. Sharma [11]. S. H. Cho [2] proved a common fixed point theorem for four mappings in fuzzy metric spaces and S. Sharma [11] proved a common fixed point theorem for three mappings in fuzzy 2-metric spaces. In this paper we prove a common fixed point theorem for four mappings in fuzzy 2-metric spaces. Our theorem is an extension of results of S. H. Cho [2] to fuzzy 3-metric spaces. And also, it is a generalization of result of and S. Sharma [11].

PRELIMINARIES
Now we begin with some definitions:
Definition (2 A): A binary operation *: [0, 1] x [0,1] x [0,1] x [0,1] → [0,1] is called a continuous t-norm if ([0,1],*) s an abelian topological monodies with unit 1 such that $a_1 * b_1 * c_1 * d \geq a_2 * b_2 * c_2 * d_2$ whenever $a_1 \geq a_2$, $b_1 \geq$ b_2, $c_1 \geq c_2$ and $d_1 \geq d_2$for all a_1, a_2 , b_1, b_2, c_1, c_2 and $d_1, d_2$are in [0,1].
Definition (2 B): The 3-tuple (X, M, *) is called a fuzzy 3-metric space if X is an arbitrary set, * is continuous t-norm and M is fuzzy set in $X^4 \times [0, \infty)$ satisfying the followings
$(FM'' - 1): M(x,y,z,w,0) = 0$
$(FM'' - 2): M(x,y,z,w,t) = 1, \forall t > 0$
$(FM'' - 3): M(x,y,z,w,t) = M(x,w,z,y,t) = M(z,w,x,y,t) = \cdots$ $(FM'' - 4): M(x,y,z,w,t_1 + t_2 + t_3) \geq$
$M(x,y,z,u,t_1) * M(x,y,u,w,t_2) * M(x,u,z,w,t_3) * M(x,y,z,w,t_4)$
Definition (2 C): Let (X, M, *) be a fuzzy 3-matric space. A sequence $\{x_n\}$ in fuzzy 3-metric space X is said to be convergent to a point $x \in X$,
$\lim_{n\to\infty} M(x_n, x, a, b, t) = 1, for\ all\ a, b \in X\ and\ t > 0$
A sequence $\{x_n\}$ in fuzzy 3-metric space X is called a Cauchy sequence, if
$\lim_{n\to\infty} M(x_{n+p}, x_n, a, b, t) = 1, for\ all\ a, b \in X\ and\ t, p > 0$
A fuzzy 3-matric space in which every Cauchy sequence is convergent is said to be complete.
Definition (2 D): A function M is continuous in fuzzy 3-metric space, iff whenever for all $a \varepsilon X$ and $t > 0$.
$x_n \to x, y_n \to y, then \lim_{n\to\infty} M(x_n, y_n, a, b, t) = M(x, y, a, t), \forall\ a, b \in X\ and\ t > 0$

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COMMON FIXED POINT THEOREM ON FUZZY 3-METRIC SPACES

Mahesh Kumar Verma*, D.P. Sahu
.D. Scholar, Department of Mathematics, Dr. C.V. Raman University Bilaspur (C.G.)
Retired professor, Department of Mathematics, Govt. Science College (C.G.)

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ARIES

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A): A binary operation *: [0, 1] x [0,1] x [0,1] x [0,1] → [0,1] is called a continuous t-norm if ([0,1],*) topological monodies with unit 1 such that $a_1 * b_1 * c_1 * d \geq a_2 * b_2 * c_2 * d_2$ whenever $a_1 \geq a_2$, $b_1 \geq$ nd $d_1 \geq d_2$ for all a_1, a_2 , b_1, b_2, c_1, c_2 and d_1, d_2 are in [0,1].

2 B): The 3-tuple (X, M, *) is called a fuzzy 3-metric space if X is an arbitrary set, * is continuous t-norm zy set in $X^4 \times [0,\infty)$ satisfying the followings

$M(x,y,z,w,0) = 0$

$M(x,y,z,w,t) = 1, \forall\, t > 0$

$M(x,y,z,w,t) = M(x,w,z,y,t) = M(z,w,x,y,t) = \cdots$ $(FM''-4)$: $M(x,y,z,w,t_1+t_2+t_3) \geq$

$t_1) * M(x,y,u,w,t_2) * M(x,u,z,w,t_3) * M(x,y,z,w,t_4)$

C): Let (X, M, *) be a fuzzy 3-matric space. A sequence $\{x_n\}$ in fuzzy 3-metric space X is said to be a point $x \in X$,

$,a,b,t) = 1, for\ all\ a,b \in X\ and\ t > 0$

$x_n\}$ in fuzzy 3-metric space X is called a Cauchy sequence, if

$,x_n,a,b,t) = 1, for\ all\ a,b \in X\ and\ t,p > 0$

atric space in which every Cauchy sequence is convergent is said to be complete.

D): A function M is continuous in fuzzy 3-metric space, iff whenever for all $a \in X$ and

$y, then \lim_{n\to\infty} M(x_n,y_n,a,b,t) = M(x,y,a,t), \forall\, a,b \in X\ and\ t > 0$

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ion (2 E): Two mappings A and S on fuzzy 3-metric space X are weakly commuting iff $M(ASu, SAu, a, b, t) \geq$ $Su, a, t), \forall u, a, b \in X$ and $t > 0$.

ion (2 F): Self mappings A and B of a fuzzy 3 metric space (X, M, Δ) is said to be compatible, if $ABx_n, BAx_n, a, t) = 1$ for all $a \in X$ and $t > 0$, whenever $\{x_n\}$ is a sequence in X such that $_1 = \lim_{n\to\infty} Bx_n = z$ for some $z \in X$.

RESULT

3.1. $M(x, y, z, w, .)$ is non-decreasing for all $x, y, z, w \in X$.

et $s, t > 0$ be any points such that $t > s$. Then $t = s + \frac{t-s}{2} + \frac{t-s}{2}$.

e have

$$, y, z, w, t) = M\left(x, y, z, w, s + \frac{t-s}{2} + \frac{t-s}{2}\right) \geq \Delta M(x, y, z, w, s), M\left(x, y, z, w, \frac{t-s}{2}\right), M(x, y, z, w, \frac{t-s}{2}) = M(x, y, z, w, s)$$

$$Thus, M(x, y, z, w, t) > M(x, y, z, w, s)$$

From now on, let (X, M, Δ)be a fuzzy 2 − metric space with the following condition : $y, z, w, t) = 1$ for all $x, y, z, w \in X$.

.2. *Let (X, M, Δ) be a fuzzy 3-metric space. If there exists $q \in (0,1)$ such that $M(x, y, z, w, qt + 0) \geq$ $w, t)$ for all $x, y, z, w \in X$.*
$x, w = y, w \neq z$ and $t > 0$ then $x = y = z$.

ce $M(x, y, z, w, t) \geq M(x, y, z, w, qt + 0) \geq M(x, y, z, w, t)$ for all $t > 0$, $M(x, y, z, w, .)$ is constant. $M(x, y, z, w, t) = 1$, for all $t > 0$.Hence, $x = y = z$.because $w \neq x, w = y, w \neq z$.

3. *Let (X, M, Δ)be a fuzzy 3-metric space, and let*
$x, \lim_{n\to\infty} y_n = y, \lim_{n\to\infty} u_n = u, \lim_{n\to\infty} v_n = v$,Then the followings are satisfied .
$M(x_n, y_n, a, b, t) \geq M(x, y, a, b, t)$ *for all* $a, b \in X$ *and* $t \geq 0$.
$a, b, t + 0) \geq \lim sup M(x_n, y_n, a, b, t)$ $a, b \in X$ *and* $t > 0$.

or all $a, b \in X$ and $t > 0$; we have

$$M(x_n, y_n, a, b, t) \geq \Delta(M(x_n, x, a, b, t), M(x_n, y_n, x, y, t); M(y_n, x, a, b, t))$$
$$\geq \Delta(M(x_n, x, a, b, t), M(x_n, x, y_n, a, t); M(y_n, y, a, b, t), M(x, y, a, b, t), M(y_n, x, y, t))$$

es

$x_n, y_n, a, b, t) \geq \Delta(1, 1, 1, M(x, y, a, b, t), 1) = M(x, y, a, b, t)$
$\in X$ and $t > 0$.
0 be given. For all $a, b \in X$ and $t > 0$, we have

$$M(x, y, a, b, t + 2\varepsilon) \geq \Delta\left(M\left(x, x_n, a, b, \frac{\varepsilon}{2}\right), M(x_n, y, a, b, t + \varepsilon), M\left(x, y, x_n, a, \frac{\varepsilon}{2}\right)\right)$$

$$\Delta\left(M\left(x_n, x, a, b, \frac{\varepsilon}{2}\right), M\left(x_n, x, y, a, \frac{\varepsilon}{2}\right), M(x_n, y_n, a, b, t), M\left(x_n, y, y_n, a, \frac{\varepsilon}{2}\right), M\left(y_n, y, a, b, \frac{\varepsilon}{2}\right)\right)$$

es $M(x, y, a, b, t + 2\varepsilon) \geq \lim sup M(x_n, y_n, a, b, t)$. Letting $\varepsilon \to 0$ in the above inequality, we have $t + 0) \geq \lim sup M(x_n, y_n, a, b, t)$.
all $a, b \in X$ and $t > 0$, in general the inequality
$) \geq \lim sup M(x_n, y_n, a, b, t)$,is not true, because $M(x, y, z, w, .)$ is left continuous (in general, not right

Let (X, M, Δ) be a fuzzy 3-metric space and let A and B be continuous self mappings of X and $[A, B]$ be et x_n be a sequence in X such that $Ax_n \to Az$and $Bx_n \to Bz$ Then $ABx_n \to Az$.

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Proof. Since A, B are continuous maps, $ABx_n \to Az$, $BAx_n \to Bz$ and so, $M\left(ABx_n, Az, a, b, \frac{t}{3}\right)$ and $M\left(BAx_n, Bz, a, b, \frac{t}{3}\right) \to 1$ for all $a, b \in X$ and $t > 0$. Since the pair $[A, B]$ is compatible, $\left(BAx_n, AB, a, b, \frac{t}{3}\right) \to 1$ for all $a, b \in X$ and $t > 0$. Thus, $M(ABx_n, Bz, a, t) \geq \Delta\left(M\left(ABx_n, Bz, BAx_n, a, \frac{t}{3}\right), M\left(ABx_n, BAx_n, a, b, \frac{t}{3}\right), M\left(BAx_n, Bz, a, b, \frac{t}{3}\right)\right)$
$\geq \Delta\left(M\left(BAx_n, Bz, ABx_n, a, \frac{t}{3}\right), M\left(BAx_n, ABx_n, a, b, \frac{t}{3}\right), M(BAx_n, Bz, a, b, \frac{t}{3})\right) \to 1$ $a, b \in X$ and $t > 0$. Hence, $ABx_n \to Bz$.

Theorem 3.5. *Let (X, M, Δ) be a complete fuzzy 2-metric space with continuous t-norm Δ of H-ype, and let S and T be continuous self mappings of X. Then S and T have a unique common fixed point in X if and only if there exist two self mappings A, B of X satisfying*

(1) $AX \subseteq TX, BX \subseteq SX$
(2) *the pair* $[A, S]$ *and* $[B, T]$ *are compatible,*
(3) *there exists* $q \in (0,1)$ *such that for every* $x, y, a, b \in X$ *and* $t > 0$.

$$M(Ax, By, a, b, qt)$$
$$\geq \{min M(Sx, Ty, a, b, t), M(Ax, Sx, a, b, t), M(By, Ty, a, b, t), M(Ax, Ty, a, b, t)\}. \quad (3.0)$$

Indeed, A, B, S and T have a unique common fixed point in X.

Proof. Suppose that S and T have a (unique) common fixed point, say $z \in X$. Define $A : X \to X$ by $Ax = z$ for all $x \in X$, and $B : X \to X$ by $Bx = z$ for all $x \in X$. Then one can see that (1)- (3) are satisieed. Conversely, assume that there exist two self mappings A, B of X satisfying conditions (1)- (3). From condition (1) we can construct two sequences $\{x_n\}$and $\{y_n\}$ of X such that $y_{2n-1} = Tx_{2n-1} = Ax_{2n-2}$ and $y_{2n} = Sx_{2n} = Bx_{2n-1}$ for $n = 1,2, \ldots\ldots$ Putting $x = x_{2n}$ *and* $y = x_{2n+1}$ in (3.0), we have that for all $a \in X$ *and* $t > 0$. In general, we obtain that for all $a \in X, t > 0$ and $n = 1,2, \ldots\ldots$

$M(y_n, y_{n+1}, a, b, qt), M(y_n, 1, y_n, a, b, t)$. Thus, for all $a \in X, t > 0$ and $n = 1,2, \ldots\ldots$

$$M(y_n, y_{n+1}, a, b, t) \geq M\left(y_0, y_1, a, b, \frac{q}{t^n}\right). \quad (3.1)$$

We now show that $\{y_n\}$ is a Cauchy sequence in X.

Let $\varepsilon \in (0,1)$ be given. Since the t-norm Δ is of H-type, there exists $\lambda \in (0,1)$such that for all $m, n \in N$ with $m > n$ $\Delta^{2^{m-n}}(1-\lambda) > (1-\epsilon)$. (3.2)

Since $\lim_{n\to\infty} M\left(y_0, y_1, a, b, \frac{q}{t^n}\right) = 1$, there exists $n_0 \in N$ such that for all $a, b \in X$ and $t > 0$ with $\lim_{n\to\infty} M\left(y_0, y_1, a, b, \frac{q}{t^n}\right) = 1$, for all n , n_0 From(3.1) we have that for all $a, b \in X$ and $t > 0$,

$$M(y_n, y_{n+1,} a, b, t) > 1 - \lambda, for\ all\ n\ , n_0.$$

Let $m > n \geq n_0$. Then for all $a, b \in X$ and $t > 0$ we have

$$M(y_m, y_n, a, b, t) \geq \Delta(M(y_{n+1}, y_n, a, b, 3^{-1}t), \Delta(M(y_{n+1}, y_n, y_m, a, 3^{-1}t), M(y_{n+1}, y_m, a, b, 3^{-1}t)))$$
$$\geq \Delta\left(\Delta^2((1-\lambda), M(y_{n+1}, y_m, a, b, 3^{-1}t))\right) \ldots\ldots\ldots\ldots\ldots\ldots (3:3)$$

Since $M(y_{n+1}, y_n, a, b, 3^{-2}t) \geq \Delta(M(y_{n+2}, y_{n+1}, a, b, 3^{-2}t), \Delta M(y_{n+2}, y_{n+1}, y_m, a, 3^{-2}t), M(y_{n+2}, y_m, a, b, 3^{-2}t))$, from (3.3) we get

$M(y_m, y_n, a, b, t) \geq \Delta\left(\Delta^{2^2}(1-\lambda), M(y_{n+2}, y_m, a, b, 3^{-2}t)\right)$.

Inductively, we obtain

$$M(y_m, y_n, a, b, t) \geq \Delta(\Delta^{2m-n}(1-\lambda), M(y_m, y_n, a, b, 3^{n-m}t)) = \Delta^{2m-n}(1-\lambda) \ldots\ldots\ldots (3.4)$$

From (3.2) and (3.4) we get for all $a, b \in X$ and $t > 0$ $M(y_m, y_n, a, b, t) > 1 - \varepsilon$ for $m > n \geq n_0$. Thus $\{y_n\}$ is a Cauchy sequence.

It follows from completeness of X that there exists $z \in X$ such that

$\lim_{n\to\infty} y_n = z$. Hence $\lim_{n\to\infty} y_{2n-1} = Tx_{2n-1} = Ax_{2n-2} = z$.

From Lemma 3.4, $ASx_{2n-1} = Sz$ *and* $BTx_{2n-1} = Tz \ldots\ldots\ldots\ldots\ldots (3.5)$

Meanwhile, for all $a \in X$ with $a \neq Sz$ and $a \neq Tz$, and $t > 0$

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$$\geq min\left\{\begin{matrix} M(ASx_{2n+1}, BTx_{2n+1}, a, b.qt) \\ M(SSSx_{2n+1}, TTSx_{2n+1}, a, b, t), M(ASSx_{2n+1}, SSSx_{2n+1}, a, b, t), M(BTx_{2n+1}, TTx_{2n+1}, a, b, t), \\ M(ASx_{2n+1}, TTx_{2n+1}, a, b, t) \end{matrix}\right\}.$$

Taking limit as $n \to \infty$, and using (3:5), and Lemma 3.5, we have for all $a \in X$ with $a \neq Sz$ and $a \neq Tz$, and $t > 0$

$$M(Sz, Tz, a, b, qt + 0)$$
$$\geq minM(Sz, Tz, a, b, t), M(Sz, Sz, a, b, t), M(Tz, Tz, a, b, t), M(Sz, Tz, a, b, t), M(Sz, Tz, a, b, t).$$

By Lemma 3.2, we have $Sz = Tz$ ……………………(3.6)

By Lemma 3.2, we have $Sz = Tz$ and $a \neq Tz$, and $t > 0$

From (3.0) we get for all $a \in X$ with $a \neq Sz$ and $a \neq Tz$, and $t > 0$

$$M(Az, BTx_{2n+1}, a, b, qt)$$
$$\geq min\{M(Sz, TTx_{2n+1}, a, t), M(Az, Sz, a, b, t), M(BTx_{2n+1}, TTx_{2n+1}, a, b, t), M(Az, TTxx_{2n+1}, a, b, t)\}$$

Taking limit as $n \to \infty$, and using (3:5),(3:6) and Lemma 3.3,

$$M(Az, Tz, a, b, qt + 0)$$
$$\geq min\{M(Sz, Tz, a, b, t), M(Az, Sz, a, b, t), M(Tz, Tz, a, b, t), M(Az, Tz, a, b, t)\}$$
$$\geq M(Az, Tz, a, b, t).$$

By Lemma 3.2, $Az = Tz$ ……………………….(3.7)

and for all $a \in X$ with $a \neq Sz$ and $a \neq Tz$, and $t > 0$

$$M(Az, BTx_{2n+1}, a, b, qt)$$
$$\geq min\{M(Sz, Tz, a, b, t), M(Az, Sz, a, b, t), M(Bz, Tz, a, b, t), M(Az, Tz, a, b, t)\}$$
$$\geq min\{M(Tz, Tz, a, b, t), M(Tz, Tz, a, b, t), M(Bz, Az, a, b, t), M(Tz, Tz, a, b, t)\}$$
$$\geq M(Az, Bz, a, b, t).$$

By Lemma 3.2, $Az = Bz$ ………………………………….(3.8)

It follows that $Az = Bz = Sz = Tz$.

For all $a \in X$ with $a \neq Bz$ and $a \neq z$, and $t > 0$

$$M(Ax_{2n}, Bz, a, b, qt)$$
$$\geq min\{M(Sx_{2n}, Tz, a, b, t), M(Ax_{2n}, Sx_{2n}, a, b, t), M(Bz, Tz, a, b, t), M(Ax_{2n}, Tz, a, b, t)\}$$

Taking limit as $n \to \infty$, and using (3.5), and Lemma 3.3, we have for all $a \in X$ with with $a \neq Bz$ and $a \neq z$, and $t > 0$

$$M(z, Bz, a, b, qt + 0)$$
$$\geq min\{M(z, Tz, a, b, t), M(z, z, a, b, t), M(Bz, Bz, a, b, t), M(z, Tz, a, b, t)\} \geq M(z, Tz, a, b, t) \geq M(z, Bz, a, b, t)$$

and hence $Bz = z$.

and so we have $M(z, Bz, a, b, qt) \geq M(z, Bz, a, b, t)$, and so z is a common fixed point of A, B, S and T

Thus $z = Az = Bz = Sz = Tz$, and so z is a common ¯xed point of A, B, S and T.

For uniqueness, let w be another common ¯xed point of A, B, S and T. and $a \neq w$, and $t > 0$

For uniqueness, let w be another common with $a \neq z$ and $a \neq w$, and $t > 0$

Then, for all $a \in X$ with with $a \neq z$ and $a \neq w$, and $t > 0$

$$M(z, w, a, b, qt) = M(Az, Bw, a, b, qt)$$
$$\geq min\{M(Sz, Tw, a, b, t), M(Az, Sz, a, b, t), M(Bw, Tw, a, b, t), M(Az, Tw, a, b, t)\}$$
$$min\{M(z, w, a, b, t), M(z, z, a, b, t), M(w, w, a, b, t), M(z, w, a, b, t)\}$$
$$\geq M(z, w, a, b, t).$$

which implies that $M(z, w, a, b, qt) \geq M(z, w, a, b, t)$ and hence $z = w$.

This complete the proof of Theorem.

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Common Fixed Points Theorem of Three Maps on a Metric Space

Mahesh Kr. Verma, Dr. D.P.Sahu
Dr. C.V. Raman University, Kota Bilaspur (C.G.), India

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ABSTRACT

The aim of the present paper is to generalize the above result for three maps and prove a theorem using asymptotic regularity.

1. INTRODUCTION

Let (X, d) be a metric space. A map T : X → x is said to be asymptotically regular at x ∈ X if $d(T_x^n, T_x^{n-1}) \to 0$ as $n \to \infty$.

In 1978, Chumki Panja and A.P. Baisnab proved the following:

Let (X, d) be a complete metric space and T be a self map on X satisfying $d(T_x, T_y) \leq \alpha[d(x, T_x) + d(y, T_y)] + \beta [d(x, y)]$ for x, y ∈ X ......(1.1)

Where $0 \leq \alpha, \beta < 1$

Then T has a unique fixed point in X if T is asymptotically regular at some point in X.

In 1987, H.N. Rao and K.P.N. Rao develop the results on common fixed point if two maps on a metric space.

2. MAIN THEOREMS

Theorem (2.1)

Let S, U and T be self maps on complete metric space (X, d) satisfying

$d(U_x, S_y) \leq \alpha[d(x, U_x) + d(y, S_y)] + \beta [d(x, S_y) + d(x, U_x)] + \gamma d(x, y)$......(2.1.1)

$d(T_x, U_y) \leq \alpha[d(x, T_x) + d(y, U_y)] + \beta [d(x, U_y) + d(x, T_x)] + \gamma d(x, y)$......(2.1.2)

and

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$d(T_x, S_y) \leq \alpha[d(x, T_x) + d(y, S_y)] + \beta [d(x, S_y) + d(x, T_x)] + \gamma\, d(x, y)$ .....(2.1.3)

for all $x, y \in X$ where α, β and γ are non-negative real numbers with $\alpha+\beta<1$ and $2\beta+1+\gamma < 1$ and .....(2.1.4)

(S, U) (U, T) and (S, T) is asymptotically regular at some point in X.

Thus S, U and T have a unique common (2) fixed point in X.

Proof:

Suppose that (U, S) is asymptotic regularity at $x \in X$

Then $d(X_n, X_{n+1}) \to 0$ as $n \to \infty$,

where $x_{2n+1} = Ux_{2n}$, $x_{2n+2} = Sx_{2n+1}$,

for $n = 0, 1, 2, 3$ .... with $x_0 = x$.

Now there exists a positive integer N if

$d(x_i, x_i +1) < 1$ for every $i \geq N$.

if (T, U) and (S, T) is asymptotic regularity at $x \in X$ then

$d(xn, xn+1) \to 0$ as $n \to \infty$ where

$x_{2n+1} = Tx_{2n}$, $x_{2n+2} = Ux_{2n+1}$

and $x_{2n+1} = Sx_{2n}$, $x_{2n+2} = Tx_{2n+1}$

Now we have to prove that first $\{x_n\}$ is bounded.

So, let $T_n = \text{Sup}\{d(x_i, x_j)\}$, $i \leq n$, $j \leq n$, i is odd, j is even, we have

$$d(x_i, x_j) = d(Sx_{i-1}, Ux_{j-1}) = d(Ux_{j-1}, Sx_{i-1})$$

$$\leq \alpha\, [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)] + \beta\, [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)]$$

$$+ \gamma\, d(x_{i-1}, x_{j-1})$$

if,

$$d(x_i, x_j) = d(Ux_{i-1}, Tx_{j-1}) = d(Tx_{j-1}, Ux_{i-1})$$

$$\leq \alpha\, [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)] + \beta\, [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)]$$

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$+ \gamma\, d(x_{i-1}, x_{j-1})$

$d(x_i, x_j) = d(Sx_{i-1}, Tx_{j-1}) = d(Tx_{i-1}, Sx_{i-1})$

$\leq \alpha\, [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)] + \beta\, [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)]$

$+ \gamma\, d(x_{i-1}, x_{j-1})$

if $i \leq N, j \leq N$ then $d(x_i, x_j) \leq t_n$

if $i > N, j \leq N$ or $i \leq N, j > N$ then

$d(x_i, x_j) \subseteq \alpha t_n + \alpha + (2\beta + \gamma)\, t_n$

if $i > N, j > N$ then

$d(xi, xj) \leq 2\alpha + (2\beta + \gamma)\, t_n$

Thus for $i \leq n$, $2 \leq j \leq n$, i odd, j even

$d(x_i, x_j) \leq t_n + 2\alpha + (2\beta + \gamma)\, t_n$

Also, $d(x_i, x_0) \leq d(x_i, x_2) + d(x_2, x_0) \leq A$

Where

$A = t_N + 2\alpha + (2\beta + \gamma)\, t_n + d(x_2, x_0)$

Thus $i \leq n, j \leq n, i + j$ is odd

we have

$d(x_i, x_j) \leq A$

For $i \leq n, j \leq n, i + j$ is even, we have

$d(x_i, x_j) \leq t_N$ if $i \leq n, j \leq n$ for $i > N$

$d(x_i, x_j) \leq d(x_i, x_{i-1}) + d(x_{i-1}, x_j) < 1 + A$

Similarly $d(x_{i-1}, x_j) < 1 + A$ if $j > N$

Hence $t_n \leq 1 + A$

$= 1 + t_N + 2\alpha + (2\beta + \gamma)\, t_n + d(x_2, x_0)$

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$$t \leq \frac{1+2\alpha+d(x_2, x_0)+t_N}{1-2\beta-\gamma}$$

Thus $\{x_n\}$ is bounded.

Secondly, we have to show that $\{x_n\}$ is Cauchy. For this let $E > 0$, F M

$d(x_i, x_{i+1}) < E$ for every $i \geq M$.

Let $n > M$ and $S_n = \text{Sup}\ \{d(x_i, x_j) \mid i \geq n, j \geq n\}$

Since $\{t_n\}$ is bounded, Sn is finite for each n and $Sn+1 \leq Sn$, $n = 1, 2, \ldots$

Hence, $S_n \to S \geq 0$. Suppose $S > 0$

For $i \geq n+1$, $j = n+1$, i odd, j even

$$d(x_i, x_j) = d(Sx_{i-1}, Ux_{j-1}) = d(Ux_{j-1}, Sx_{i-1})$$

$$\leq \alpha\ [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)] + \beta\ [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)]$$

$$+ \gamma\ d(x_{i-1}, x_{j-1}) \leq 2\alpha E + (2\beta + \gamma)S_n.$$

||y, $$d(x_i, x_j) = d(Ux_{i-1}, Tx_{j-1}) = d(Tx_{j-1}, Ux_{i-1})$$

$$\leq \alpha\ [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)] + \beta\ [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)]$$

$$+ \gamma\ d(x_{i-1}, x_{j-1}) \leq 2\beta E + (2\gamma + \alpha)\ U_n.$$

and $$d(x_i, x_j) = d(Sx_{i-1}, Tx_{j-1}) = d(Tx_{j-1}, Sx_{i-1})$$

$$\leq \alpha\ [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)] + \beta\ [d(x_{j-1}, x_j) + d(x_{i-1}, x_i)]$$

$$+ \gamma\ d(x_{i-1}, x_{j-1}) \leq 2\gamma E + (2\beta + \alpha)\ T_n.$$

For $i \leq n$, $j \leq n$, i odd, j odd

$$d(x_i, x_j) \leq d(x_i, x_j) + d(x_i, x_j) \leq E\ 2\alpha E + 2(\beta+\gamma)\ S_n$$

$$d(x_i, x_j) \leq d(x_i, x_{i+1}) + d(x_{i+1}, x_j) \leq E + 2\beta E + 2(\alpha+\gamma)\ U_n$$

and $$d(x_i, x_j) \leq d(x_i, x_{i+1}) + d(x_{i+1}, x_j) \leq E\ 2\gamma E + 2(\beta+\gamma)\ T_n$$

Here, let $n \to \infty$, we have

$$S \leq E + 2\alpha E + (2\beta+\gamma)\ S$$

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$U \leq E + 2\beta E + (2\gamma+\alpha)\, U$

$T \leq E + 2\gamma E + (2\alpha+\beta)\, T$

This is true for every $E > 0$

Hence $S \leq (2\beta+\gamma)\, S$ which is a contradiction $2\beta+\gamma < 1$. Thus $S = 0$.

By $U = 0$, $T = 0$, which implies that (4)

$\{x_n\}$ is Cauchy

Since, X is complete, a $z \in X$ s.t.

$x_n \rightarrow z$ as $x \rightarrow \infty$

$d(x_{2n}, S_z) = d(Ux_{2n-1}, S_z)$

$\leq \alpha\, [d(x_{2n-1}, x_{2n}) + d(z, S_z)] + \beta\, [d(x_{2n-1}, S_z) + d(z, x_{2n})]$

$+ \gamma\, d(x_{2n-1}, z)$

$d(x_{2n}, U_z) = d(Tx_{2n-1}, U_z)$

$\leq \alpha\, [d(x_{2n-1}, x_{2n}) + d(z, U_z)] + \beta\, [d(x_{2n-1}, U_z) + d(z, x_{2n})]$

$+ \gamma\, d(x_{2n-1}, z)$

and $d(x_{2n}, T_z) = d(Sx_{2n-1}, T_z)$

$\leq \alpha\, [d(x_{2n-1}, x_{2n}) + d(z, S_z)] + \beta\, [d(x_{2n-1}, T_z) + d(z, x_{2n})]$

$+ \gamma\, d(x_{2n-1}, z)$

Let $x \rightarrow \infty$, $d(z, S_z)$, $d(z, U_z)$ and $d(Z, T_z)$ s.t.

$d(z, S_z) \leq (\alpha+\beta)\, d(z, S_z)$

$d(z, U_z) \leq (\alpha+\beta)\, d(z, U_z)$

$d(z, T_z) \leq (\alpha+\beta)\, d(z, T_z)$

which implies $S_z = z$.

$Uz = z$ and $Tz = z$ by equation (2.1.1) we get

$U_z = z$, $T_z = z$ and $S_z = z$.

Thus z is a common fixed point of S, U and T.

Corollary : By above theorem if (3.1.4) is replaced by (3.1.1) SU = US and either S is non expansive, U is asymptotic regularity at some point in α or U is non expansive, S is asymptotic regularity at some point in X. Similarly in second their point

$$UT = TU \text{ and } ST = TS$$

Proof : Let U is non expansive and S is asymptotic regularity at $x \in X$. Define as

$$x_{2n+1} = Sx_{2n},\ x_{2n+2} = Ux_{2n+1} \text{ for } n = 0,1, \ldots\ldots \text{with } x_0 = x$$

then $$d(x_{2n}, x_{2n+1}) = d(U^n S^n x, U^n S^{n+1} x) \le d(S^n x, S^{n+1} x) \to 0$$

Also, $$d(x_{2n}, x_{2n+1}) \le \frac{\alpha+\beta+\gamma}{1-\alpha-\beta} \to d(x_{2n}, x_{2n+1}) \to 0$$

Similarly in other cases. Thus $d(x_n, x_{n+1}) \to 0$ as $n \to \infty$

Thus (S, U) (U,T) and (S, T) is asymptotically regular at x.

3. REMARK

By taking S = U, U = T and T = S and $\beta = 0$ in theorem (2.1), we get the result of Chumki Panja and Baisnab and Rao.

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Contraction type Mapping of Fixed Point Theorem in 3-Metric Space over Topological Semifield

Mahesh Kumar Verma and D. P. Sahu

Research Scholar,
Dr. C. V. Raman University,
Bilaspur, C.G., INDIA.

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ABSTRACT

The notation of 2-metric was investigated by Gahler[1]. Antonovskii[2] defined topological semi field in 1960. Sharma and Sharma[4] proved a fixed point theorem in 2-metric space over topological semifield. Ganguly[5] defined contraction type mapping as general 2-metric space in this note. We wish to further study fixed point theorem in 3-metric space over topological semifield. For this we shall require some definitions.

Keywords: Cauchy sequence, topological semi field, matric mapping, 2-matric space.

INTRODUCTION

Definition (1)

Let E be a semifield and K be the set of all its five elements. The set X is called a 3-metric space over the semifield E if there exists a metric mapping, $d : X \times X \times X \times X \rightarrow \overline{K}$ for each form of points x, y, z, w $\in$ X s.t. to each pair of points x, y, x $\neq$ z from X, $\exists$ W $\in$ X satisfying :

(I) $d(x, y, z, w) \neq 0$

(II) $d(x, y, z, w) = 0$ only when altered three of four elements are equal.

(III) $d(x, y, z) = d(x, y, w) = d(z, w, x = d(w, x, y)$

(IV) $d(x, y, z) \leq d(x, y, t_1) + d(x, t_1, z) + d(t_1, y, z)$

and $(y, z, w) \leq d(y, z, t_2) + d(y, t_2, z) + d(t_2, y, z)$

Remark:

A 3-metric space over topological semi field is called $d(x, y, z) \le M$, for all $x, y, z \in X$, and $d(y, z, w) \le M_2$ for $y, z, w \in X$.

If E = R, the field of real numbers, then we arrive at the definition of 3-matric space[1] Also, if X consists of two points, we get the definition of metric space over topological semi field.

Definition : (2)

A sequence $\{x_n\}$ in a 3-metric space over a topological semi field X is called a Cauchy sequence if

$\underset{m,n,p \to \infty}{Lim} d(x_m, x_n, x_p, y) \in U$ For all $y \in E$ is the neighborhood of the origin.

Definition: (3)

A sequence $\{x_n\}$ in a 3-metric space over topological semi field X is called a convergent sequence, if ∍ is an $x \in X$ S.t. Lim P $d(x_p, x, y) \in U$ for all $y \in X$.

Definition : (4)

A 3-metric space over a topological semi field X, in which every Cauchy Sequence converges is called a complete 3-metric space.

Theorem

(1) : Let X be a bounded complete 3-metric space over a topological semi field E, T_1, T_2 and T_3 be three mapping an X s.t.

$$d(T_1x, T_2y, T_3z, a) \le K \max\{d(x, y, z), a\},$$
$$\frac{1}{3}[d(x, T_1x, a) + d(y, T_2y, a) + d(z, T_3z, a)],$$
$$\frac{1}{3}[d(x, T_2y, a) + d(y, T_1x, a) + d(z, T_3x, a)],$$
$$\frac{1}{3}[d(x, T_3z, a) + d(z, T_1x, a) + d(y, T_2y, a)],$$
$$\frac{d(x, y, T_3z, a)[1 + d(x, T_1x, a) + d(y, T_1x, a) + d(z, T_1x, a)]}{3[1 + d(x, y, z, a)]}$$
$$\frac{d(y, T_1x, a)[1 + d(y, T_2y, a) + d(x, T_2y, a)]}{3[1 + d(x, y, z, a)]}$$

$$\frac{d(y,T_1x,a)[1+d(y,T_1x,a)+d(x,T_2y,a)]}{3[1+d(x,y,z,a)]}$$

For all x, y in X and some point $a \in X$. Where $K \in (0,1)$, then T_1, T_2 and T_3 have a *unique* common fixed point in X.

Proof:

Take an element $x_0 \in X$ and define $x_{2n+1} = T_1x_{2n}, x_{2n+2} = T_2x_{2n+1}, x_{2n+3} = T_3x_{2n+2}$, n=0, 1, 2....... Then by above theorem for $x = x_0$ and $y = x_1$, and $z = x_2$ after simplifications.

(2) $d(x_1,x_2,x_3,a) \le K \max\{d(x_0,x_1,x_2,a), \frac{1}{2}[d(x_0,x_1,x_2,a)+d(x_1,x_2,x_3,a)],$

$\frac{1}{2}[d(x_0,x_1,x_2,a)], \frac{1}{2}d(x_0,x_1,x_2,a), 0\}$

(3) $\max\left\{d(x_1,x_2,a)\frac{1}{2}[d(x_0,x_2,a)+d(x_2,x_3,a)],\right.$

$\left.\frac{1}{2}d(x_0,x_2,a)\right\} = d(x_0,x_2,a)$,

then

(4) $d(x_2,x_3,a) \le K\ d(x_0,x_2,a)$.

If in (3), the maximum of three numbers is

$\frac{1}{2}d(x_0,x_2,a)+d(x_2,x_3,a)$,

then $d(x_2,x_3,a) \le K\ \frac{1}{2}[d(x_0,x_2,a)+d(x_2,x_3,a)]$

which implies

(5) $d(x_2,x_3,a) \le \frac{K}{3-K}a(x_0,x_2,a) \le K(x_0,x_2,a)$, of maximum of three numbers in (3) is $\frac{1}{2}d(x_0,x_3,a)$,

then

$$d(x_2,x_3,a)K\frac{1}{2}d(x_0,x_3,a) \le K\frac{1}{2}[d(x_0,x_2,x_3,a)+d(x_0,x_2,a)+d(x_0,x_2,x_3,a)]$$

and from (2), we see that $d(x2,x_3,x_0) = 0$.

Thus

(6) $d(x_2,x_3,a) \le K\frac{1}{3}d(x_0,x_2,x_3,a) \le K\ d(x_0,x_2,a)$ From (4) - (6) we have

(7) $d(x_2, x_3, a) \le K\ d(x_0, x_2, a)$

Similarly by (1) and (2) we have

$$d(x_2,x_3,a) \le K \max\Big\{d(x_1,x_2,a), \frac{1}{2}[d(x_1,x_4,a), + d(x_2,x_3,a),$$

$$\frac{1}{2}d(x_2,x_4,a), 0, \frac{1}{2}d(x_3,x_4,a)\Big\}$$

Now by following the similar argument as above we have

(8) $d(x_2,x_3,a) \le K\ d(x_2,x_3,a) \le K^2\ d(x_1,x_2,a).$

In general repeating the argument n times, we get

(9) $d(x_{n+1},x_{n+2},a)\sum K^n\ d(x_1,x_2,a).$

Therefore by axioms (II) and (III) for $n < m$ we have

$$d(x_{n+1},x_{m+1},a) \le d(x_{n+1},x_{m+1},x_{m+2}) + d(x_{n+1},x_{m+2},a) + d(x_{n+2},x_{m+1},a)$$

$$\le d(x_{n+1},x_{n+2},x_{m+1}) + d(x_{n+1},x_{m+2},a) + d(x_{n+2},x_{m+1},a)$$

$$\le d(x_{n+1},x_{n+2},x_{m+1}) + d(x_{n+1},x_{m+2},a) + d(x_{n+2},x_{m+1},x_{n+3})$$

$$+ d(x_{n+2},x_{n+3},a) + d(x_{n+3},x_{m+1},a)$$

$$\le d(x_{n+1},x_{n+2},x_{m+1}) + d(x_{n+2},x_{m+2},x_{m+1})$$

$$+ d(x_{n+1},x_{n+2},a) + d(x_{n+2},x_{n+3},a) + d(x_{n+3},x_m)$$

$$\le ---d(x_{n+1},x_{n+2},x_m) + d(x_{n+2},x_{n+3},x_{m+1}) + ---+ d(x_{n+3},x_{m+2},x_{m+1})$$

$$d(x_{n+1},x_{n+2},a) + d(x_{n+2},x_{n+3},a) + -----+d(x_{m-2},x_{m+1},a)$$

By (9) the above inequality implies

$$d(x_{n+1},x_{m+1},a) \le \left[K^{n+1} + K^{n+2} + K ---+K^{m-3}\right]$$

$$+ d(x_1,x_2,x_{m+1}) + \left[K^{n+1} + K^{n+2} + ---+ K^{m-2}\right] d(x_1,x_2,a)$$

Since X is bonded, we have

$$d(x_{n+1},x_{m+1},a) \le 2\left[K^{n+1} + K^{n+2} + ---+ K^{n-2}\right]M$$

By hypothesis K < 1, then we have

$$\frac{Lim}{n+1,m+1} d(x_{n+1},x_{m+1},a) \in U$$

Hence $\{x_{n+1}\}$ is a Cauchy Sequence. Therefore $\{x_{n+1}\}$ has a limit u. We shall show that u is e fixed print of T_1, T_2, and T_3.

By axiom (III) we have

(10) $d(T_{1u},u,a)+d(T_{1u},u,x_{2n+2})+d(T_{1u},T_2x_{2n+1},a)+d(x_{2n+}{}'u'a)$

from (1)

(ii) $d(T_{1u},x_{2n+2},a)=d(T_1u,T_2x_{2n+1},a)$

$$\leq K\max\{d(u,x_{2n+1},a\},\frac{1}{2}[d(u,T_1u,a)+d(x_{2n+1},T_2x_{2n+1},a)]$$

$$\frac{1}{2}[d(u,T_{2n+1},a)+d(x_{2n+1},T_1u,a)],$$

$$\frac{d(u,T_2x_{2n+1},a)[(1+d(u,T_1u,a)+d(x_{2n+1},T_1u,a)]}{2[1+d(u,x_{2n+1},a)]}$$

$$\frac{d(x_{2n+1},T_1u,a)[(1+d(x_{2n+1},T_2x_{2n+1},a)+d(u,T_2x_{2n+1})]}{2[1+d(u,x_{2n+1},a)]}$$

$$\leq K\max\{d(u,x_{2n+1},a\},\frac{1}{2}[a(u,T_1u,a)+d(x_{2n+1},x_{2n+2},a)],$$

$$\frac{1}{2}[d(u,x_{2n+2},a)+d(x_{2n+1},T_1u,a)],$$

$$\frac{d(u,x_{2n+2},a)[(1+d(u,T_1u,a)+d(x_{2n+1},T_1u,a)]}{2[1+d(u,x_{2n+1},a)]}$$

$$\frac{d(x_{2n+1},T_1u,a)[(1+d(x_{2n+1},x_{2n+2},a)+d(u,x_{2n+2},a)]}{2[1+d(u,x_{2n+1},a)]}$$

Putting ...11 in ...10 and taking as $n\to\infty$ we get $(T_1u, u, a)\in U$, $a\in X$, Similarly,

(12) $d(T_2,u,x_{2n+3},a)=d(T_2u,T_3x_{2n+2},a)$

$$\leq K\max\{d(u,x_{2n+2},a\},\frac{1}{2}[d(u,T_2u,a)+d(x_{2n+2},T_3x_{2n+2},a)],$$

$$\frac{1}{2}[d(u,T_3x_{2n-2},a)+d(x_{2n+2},T_2u,a)],$$

$$\frac{d(u,T_3x_{2n+2},a)[(1+d(u,T_2u)+d(x_{2n+2},T_2u,a)]}{2[1+d(u,x_{2n+2},a)]}$$

$$\leq K\max\{d(u,x_{2n+2},a\},\frac{1}{2}[d(u,T_2u,a)+d(x_{2n+2},x_{2n+3},a)],$$

$$\frac{1}{2}[d(u,x_{2n+3},a)+d(x_{2n+2},T_2u,a)],$$

$$\frac{d(u, x_{2n+3}, a)[(1 + d(u, T_2u, a) + d(x_{2n+2}, T_2u, a)]}{2[1 + d(u, x_{2n+2}, a)]}$$

$$\frac{d(x_{2n+2}, T_2u, a)[(1 + d(x_{2n+2}, x_{2n+3}, a) + d(u, x_{2n+3}, a)]}{2[1 + d(u, x_{2n+2}, a)]}$$

Putting (12) in (ii) and taking as $n \to \infty$ we obtain

$d(T_2u, u, a) \in U$ for every $a \in X$

The above results implies that

$h = T_1u$ and $u = T_2u$

Similarly, if follows that $T_3u = u$, so that u is a fixed point of T_1, T_2 and T_3.

Now suppose x is another fixed point and T_1, T_2 and T_3

Then,

$d(u, v, w, a) = d(T_1u, T_2v, T_3w, a)$

So that by (1) we have

$d(u, v, w, a) = K \text{ Max } \{d(u, v, w, a), 0, d(u, v, w, a),$

$\frac{1}{2}[d(u, v, w, a), \frac{1}{2}(u, v, w, a)],$

which implies $u = v = w$

This completes the proof.

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Periodic Water Quality Monitiring of Surface Water in Korba District (C.G.) India

Madan Murari Vaishnav, Ramesh Janjala, Milan Hait, Pralhad Kanhaiyalal Rahangdale, and Shreni Dewangan

Abstract—**In this present attempt, surface water source of Korba district was studied for its know-how of its quality depletion over a period of time. During the analysis period, nine water sampling sites were selected, assigned from KDS-1-to KDS-9. Water samples were collected in pre-cleaned polyethylene and glass bottles of 1L capacity from March-2010 to May-2010 (pre-monsoon). The collected water samples were analyzed as per the standard methods. Results were compared with standard values prescribed by BIS (1991) and WHO (2008). Except fluoride (1.17) and Dissolved Oxygen (4.411mgL^{-1}), remaining all parameters were exceeded the desired limits. It was quite evident from the data that significant strong positive correlation was observed across Fe Vs TDS (r=+0.961), Fe Vs Hardness (r=0.961) Fe Vs phosphate (r=0.961) Fe Vs Al (r=0.961). On contrary, Do and TDS related negative high degree correlation (r=-0.792). Calculated WQI revealed that entire water sources were highly polluted by the undesirable chemical constituents; hence water sources of the present study area might not be useful for any purposes.**

Index Terms—**Physico-chemical parameter, monitoring, statistical value, surface water and water quality.**

I. Introduction

Clean water is basic and essential vital component for all healthy living organisms. Good quality of water is defined as absence of deleterious chemicals and microbes. In the universe, water is present as vapor (atmospheric moisture), liquid water (substance and ground water sources) and solid ice (in glacier) etc. Since ancient times, ground and rain water is being considered as fresh and safe water sources. Water also plays a significant role in science due to its universal solvent behavior. With the development of civilization, increasing industrialization and application of various fertilizers, pesticides, careless dumping and discharge of solids, liquids water sources the Earth planet is continuously getting polluted conducing various sources water unfit for use [1]. Heavy metals are one of the chief pollutants of water sources, which not only cause severe threat for human beings but also affect flora and fauna. The constituents of environment air, soil and food are also polluted by the heavy metallic elements that enter in water bodies through natural and artificial process. Although the trace amount of metallic elements are having biological importance, but theirs higher exposure [2] may create health problems like hypertension, iti-iti, cancer, kidney and liver disorder etc.

II. Materials and Methods

A. Study Area

Korba district is situated in the northern half of Chhattisgarh state and spread at the confluence of river Hasdeo and Ahiran. The geographical location is 22°01′ North latitude and 82°08′ to 83°09′ East longitude. Topographically, study area is plane as well hilly area with height of 304.8 meter above mean sea level. The geo-morphological status of the district is lower Gandwana group [3]. Soils are red yellow with rich deposits of ferric oxide and laterite hard soil, which richest source of Fe and Al. The investigation field received average rainfall 1506.7mm. The minimum temperature is 7°C in winter and higher temperature is 43°C in summer. Korba district is abundant with rich mineral reserves like bauxite, coal, etc. Coal based thermal power plant namely NTPC, BCPP, CSEB-east, OED-west; Lanco generated more than 21500 MW of electricity. Owing to high power generation, thermal pollution is very high there by conducing water bodies of the study field polluted by the intrusion of undesirable substances. Therefore the present study will highlight and throw some light by scientific approach of assessing the water bodies of the study area (Fig. 1). In this present discussion, pre-monsoon 2010 (March to May 2010) was chosen as base for ongoing discussion of the results.

B. Sampling and Preservations

Water samples were collected in March, April and May (considered as pre-monsoon henceforth for ongoing discussion) selected site during pre-monsoon season of 2010 in pre-cleaned polythene and glass bottles of 1 L capacity for physico-chemical analysis and metallic analysis respectively. Collected samples were preserved as per standard method at 10°C and by adding of 1 or 2 mL conc. HNO_3 to protect the precipitation and absorption of dissolved metallic ions.

C. Brief Analytical Methods

Physical parameters like Temp., pH, EC, turbidity, TDS,

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Madan Murari Vaishnav is with the Department of Chemistry, Govt. G.B.College, Hardibazar, Korba, India (e-mail: drmmvaishnav@yahoo.co.in).

Ramesh Janjala was with the Department of Chemistry, C.M.D. Post Graduate College, Bilaspur, India (e-mail: jandhyala.ramesh@gmail.com).

Milan Hait is with the Department of Chemistry, Dr. C.V. Raman University, Kargi Road, Kota, Bilaspur, C.G., India (e-mail: haitmilan@gmail.com).

Pralhad Kanhaiyalal Rahangdale is with the Department of Chemistry, Bhawabhuti Mahavidyalaya, Amgaon, Gondia, India (e-mail: pkrahangdale@yahoo.co.in).

Shreni Dewangan is with the Department Public Health Engineering, State Government of Chhattisgarh, Champa, Janjgir, Champa, India (e-mail: ashreni@rediffmail.com).

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analyzing at the sampling site by the portable kit (EI, model no.172). Collected samples were to laboratory for the analysis of total hardness and linity by titration method. Anion parameter chloride ured volumetrically by Argentometric method using chromate as indicator. Fluoride was measured by tive electrode. Sulphate was measured by Turbidity ethod, phosphate and nitrate were analyzed by otometric method. Demand parameters such as re detected by Iodometric titration method, COD was d by dichromate reflux method. Dissolved solids in TS and TDS were detected by gravimetric method. elements were analyzed as per standard methods APHA, 2005 [4], Trivedi and Goel, 1984 [5] and N. kam, 2002 [6].

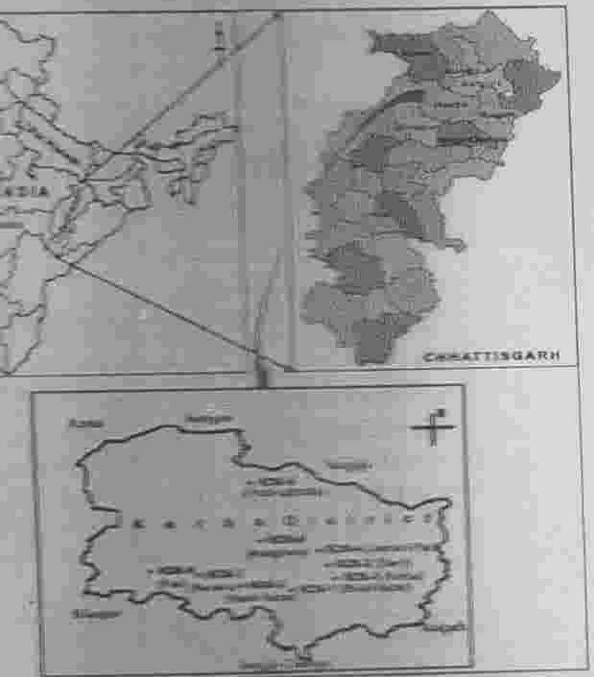

Fig. 1. Location of study area.

III. Results and Discussion

e obtained results of physico-chemical parameters and lic elements were interpreted by statistical means in of mean, range, SD, SE, and %CV as illustrated in e I and correlation matrix was established between us parameters and is shown in Table II.

pH of drinking water is an important index for mining the acidic or alkaline nature of water. When pH is v 4.0, creates acidic pollution resulting in destruction of of the vertebrates and microorganism [7]. During onsoon 2010, the average and range found to be and 6.14 to10.58 respectively. The range was quite nd the standard range of 6.5 to 8.5 as per BIS (1991) [8] WHO (2008) [9]. These results showed that the nature of r is varied from slightly acidic to strong base in nature.

ectrical Conductivity (EC): EC of water is depended on resence of dissolved ions and high ionizable solids. The dard value of EC for potable as well as agricultural water 0-2250 SCm^{-1} as per BIS (1991). If EC exceeds above Scm^{-1}; the germination of almost all crops would be ted and results in much reduced yields [10]. In study area, mean value for EC was found to be 1798.5 cm^{-1}, while it was found ranging from 626 to 2404 Scm^{-1}. The max EC was reported at the sampling site KDS-2 in the month of May 2010. Owing to high atmospheric temp reduced the water level and increase the conc. of dissolved ions and mixing of domestic sewage in that particular water source.

Turbidity: Turbidity of water is the presence of suspended and partial dissolved material in water sources. Its standard value prescribed 5–25 NTU as per standards of BIS (1991) [8] and WHO (2008) [9]. During the tenure of study period, its range was noted very wide from 38 NTU to 374 with 134.33 NTU as mean value. This obtained data was many folds greater than standard value. The value was found at the site no KDS-3 in the month of May to 2010 due to presence of high amount of suspended particles.

TDS: The fresh water had the value of TDS smaller than 1000 mg L^{-1} when it deviates from its standard value, water become blackish [11]. TDS is causing dissolved cation and anion species and bear a relationship with the electrical conductivity of water [12]. TDS was gravimetric analyzed, found the average value 1868.05 mg L^{-1} and ranging from 1651.6mg L^{-1} to 2124 mg L^{-1}. These statistical parameters showed, all water sources are highly polluted and for beyond from the acceptable ranges; 500 mg L^{-1} to 1500 mgL^{-1}as BIS (1991) [8] and WHO (2008) [9].The high value was found at the sampling water KDS-3 in the month of May 2010 causing the increasing the cons of dissolved inorganic ions.

Total alkalinity: Chemical sources of total alkalinity in water are CO_3^{--}, HCO_3^-, OH^-, $HSiO_3^-$, HPO_4^{--} and HS^- The large quantity of alkalinity imparts bitter taste of water [13]. The desirable value for alkalinity is 200 mg L^{-1} while the excessive permissible level is 600 mgL^{-1}as per water monitoring agency BIS (1991) and WHO (2008). During the study period, mean value was calculated to be 549.31 $mgL^{-1}$and it's ranging values varied from 466 mg L^{-1} to 711 mg L^{-1}. The high concentration was detected at the sampling spot KDS-3 in the month of March 2010 owing to the increased the concentration of chemical species that comes from various industrial sources.

Total Hardness: Water become hard when the cation and anion species of Ca^{++},Mg^{++} Sr^{++},Ba^{++},Fe^{++},Mn^{++},CO_3^{--},SO_4^{--}, Cl^- ions are present. Extreme hard water produces krolithiasis, encephaly, parental mutatility cancer and cardiovascular disease [14]. In our study field, mean value obtained to be 671.66 mgL^{-1} which was categorized as extreme hard water as per Sawyer and Mc-Worthy. The ranging value was reported from 498 mgL^{-1} to 818.1 mgL^{-1}. The max. concentration was reported at the sampling site KDS-2 in the month of April 2010, owing to discharge of liquid wastes with high conc of alkali and alkaline earth metals.

Fluoride: Fluoride is one of the minor constituents in natural waters but play vital in assessing the suitability of water for various purposes [15]. The slandered value prescribed for fluoride is 1.00 mgL^{-1} to 1.50 mg^{-1}as per BIS (1991) and WHO (2008). During the study period, Fluoride range was obtained from 0.39 mgL^{-1} to 1.60 mgL^{-1} with erythematic mean 1.17 mgL^{-1}.This average value was within the standard value. The max. concentration was found at the sampling site just above the marginal max. allowable limit of 1.50 mgL^{-1}.

TABLE I: STATISTICAL PARAMETER OF WATER QUALITY OF PRE-MONSOON (MARCH-MAY)' 2010

Parameters	MEAN	S.D	S.E	%CV	MAX	MIN	RANGE	WHO Rec.2008
Temperature	25.31	2.865	0.106	0.1132	KDS-9, May	KDS-5, Mar	32.31-21.22	21-28
PH	8.027	1.233	0.046	0.1536	KDS-5, Mar	KDS-2, Mar	10.98-6.14	6.5-8.5
Conductivity	1798.5	536.45	19.869	0.2982	KDS-2, May	KDS-8, Mar	2404-626	1000
Turbidity	134.33	91.06	3.37	0.677	KDS-3, May	KDS-7, May	374-38	5 NTU
TS	2189	137.727	5.101	0.0629	KDS-4, May	KDS-6, Mar	2390-1881.5	***
TDS	1868.05	124.88	4.625	0.0669	KDS-3, May	KDS-1, Mar	2124-1651.6	1000
TSS	321.71	116.846	4.328	0.3632	KDS-8, May	KDS-9, Mar	550.1-127.67	***
Alkalinity	549.51	66.75	2.472	0.1215	KDS-3, Mar	KDS-2, Mar	711-466	***
Total Hardness	671.66	84.57	3,132,	0.1259	KDS-2, Apr	KDS-8, Mar	818.1-498	500
Chloride	841.77	224.75	8.324	0.267	KDS-5, Apr	KDS-4,Mar	1281-63.11	200-1000
Fluoride	1.17	0.338	0.013	0.2888	KDS-2, May	KDS-7, Apr	1.60-0.39	1.5
Sulphate	289.26	69.95	2.591	0.2418	KDS-3, May	KDS-7, Mar	4111-171.61	250
D.O	4.411	1.065	0.039	0.2414	KDS-7, Mar	KDS-3, May	5.97-3.01	5
BOD	24.04	7.32	0.271	0.3044	KDS-4, May	KDS-8, Mar	41.04-8.11	5
COD	58.05	43.06	1.595	0.7417	KDS-9, May	KDS-8, Apr	179.2-8.55	10
Nitrate	60.82	27.16	1.006	0.4465	KDS-5, Mar	KDS-2, May	114.5-31.51	45
Phosphate	0.274	0.188	0.007	0.6861	KDS-1, May	KDS-7, May	0.539-0.013	0.01-0.05
Al	0.532	0.794	0.029	1.4924	KDS-3, May	KDS-8, Apr	2.56-0.06	0.03
Iron	0.8166	1.415	0,052	1.7327	KDS-3, May	KDS-5, May	4.91-0.02	0.3

TABLE II: CORRELATION MATRIX OF PRE-MONSOON (MARCH-MAY)' 2010

	Temp.	PH	Cond	TDS	TSS	Turb.	TS	Alk.	T.H	Cl–	F–	SO42-	D.O	COD	BOD	NO3–	PO43–	Al	Fe
Temp.	1.000																		
PH	-0.126	1.000																	
Cond.	-0.380	-0.200	1.000																
TDS	0.446	-0.239	0.053	1.000															
TSS	-0.306	-0.003	-0.163	-0.783	1.000														
Turb.	0.371	0.004	0.323	-0.404	-0.404	1.000													
TS	0.336	-0.389	-0.118	0.592	-0.013	0.592	1.000												
Alk.	0.441	0.343	0.134	-0.262	-0.493	0.859	0.737	1.000											
T.H	-0.555	-0.436	0.711	-0.260	-0.349	-0.097	-0.187	-0.260	1.000										
Cl–	-0.059	0.709	0.392	-0.093	-0.285	0.454	-0.327	0.630	-0.093	1.000									
F–	0.335	-0.314	0.330	0.243	-0.224	0.436	0.210	0.210	0.243	243.00	1.000								
SO42-	0.300	0.210	0.588	0.698	-0.429	0.725	-0.010	0.728	0.698	0.787	0.698	1.000							
D.O	-0.071	-0.033	-0.666	-0.792	0.311	-0.699	-0.322	-0.398	-0.792	-0.512	-0.776	-0.792	1.000						
COD	0.392	-0.011	-0.227	-0.018	-0.752	-0.030	-0.107	0.101	-0.018	-0.015	0.219	0.149	-0.018	1.000					
BOD	0.333	-0.564	0.574	0.232	-0.508	0.637	0.446	0.388	0.232	-0.038	0.541	0.497	-0.585	0.232	1.000				
NO3–	0.111	0.765	0.160	-0.100	-0.402	0.447	-0.250	0.681	-0.100	0.950	0.152	0.706	-0.393	0.179	-0.100	1.000			
PO43–	0.191	0.575	0.140	0.641	0.053	0.396	-0.167	0.450	0.641	0.730	0.417	0.693	-0.542	-0.096	-0.107	0.641	1.000		
Al	0.312	-0.121	0.256	0.370	-0.295	0.911	0.518	0.818	0.370	0.299	0.302	0.583	-0.513	0.168	0.382	0.250	0.370	1.000	
Fe	0.368	-0.01	0.031	0.961	-0.33	0.868	0.525	0.837	0.961	0.250	0.073	0.448	-0.35	-0.101	0.488	0.263	0.961	0.961	1.000

Chloride: The chief sources of chloride in water are agricultural fertilizer, industrial and domestic sewages beside chloride rich rocks [16]. As per the analytical study, the mean value was obtained to be 841.77 mgL^{-1} and min. value was reported to be 63.11 mg L^{-1} to max value of 1281mgL¯1. The high value was found at sampling site KDS-5 (April-2010) due to discharging of domestic and municipal wastes into the water sources.

Sulphate: Sulphate ion may be sourced by industrial and anthropogenic addition in the form of sulphate fertilizers. High concentration may cause laxative effect on human system [17]. In study field, the mean value was found to be 289.26 mgL^{-1} crossed the desirable limit 200 mgL^{-1}while it's range spread from 171.61 mgL^{-1} to 411 mg L^{-1} as max values. The high values was slightly above the excessive permissible level: 400 mgL^{-1}(BIS) that was found at sampling location KDS-3 during May (2010) due to intrusion of residue of agricultural fertilizer through surface runoffs.

Nitrate: The high concentration of nitrate in drinking water is toxic, causes blue baby disease, methamoglobinemia in children and gastric carcinomas [18]. In investigation field, the min conc. of nitrate ion was analyzed as 31.51 mgL^{-1} and max conc. was found to be 114.5 mgL^{-1} found at sampling site KDS-5 during March (2010). The average value was calculated to be 60.82 mgL^{-1}, which was above the threshold value of 45 and 50 mgL^{-1} as set by BIS (1991) [8] and WHO (2008) [9].

Phosphate: Phosphate is main constituents of fertilizers and different kinds of rocks. In the study field the mean value 0.274 mgL^{-1} was observed beside its range value of 0.013 mg

L^{-1} to 0.539 mg L^{-1}. The high concentration of phosphate was reported at the sampling site KDS-1during the month of May-2010.

Dissolved Oxygen (DO): Plays a vital role for aquatic bio-system. The standard value of DO for survival of aquatic life is 5mgL^{-1} as per WHO (2008) standard [9]. In study field the dissolved oxygen was calculated as average value 4.411 mgL^{-1} which is slightly lower than required value. The ranging value found from 3.01mg$L^{-1}$to 5.97mgL^{-1}. The high value was found at the sampling location KDS-7 during March-2010 indicating that water sources were deficient of dissolved oxygen and unfit for aquatic life.

BOD: Biological oxygen demand of water is depended on the presence of aquatic wastes and toxic materials. During, the mean value was found to be 24.04 mgL^{-1} which is six fold higher than the WHO (2008) limit. The minimum conc. found to be 8.11 mg L^{-1} and max concentration was analyzed as 41.04 mg L^{-1} at the sampling site KDS-4 in the month of May 2010, which could be attributed to the disposal of organic waste in that water sources.

COD: In study area, mean value of 58.05 mgL^{-1} was found which is five times greater than the standard value 10 mgL^{-1}as per WHO (2008) [9] where as it was found ranging from 8.55 mgL^{-1} to 179.2 mgL^{-1}. The max value was seen at the sampling point KDS-9 in the month of May 2010, which could be attributed to the mixing of municipal wastes in water source.

Metallic Elements: We have selected four elements namely aluminum, iron, mercury, and zinc that are environmentally significant for assignment. During the monitoring period, the average value for Al and Fe were calculated to be 0.532 and 0.8166 mgL^{-1} respectively. The rang found to be between 0.06 mg$L^{-1}$and 2.56 mgL^{-1} for Al while 0.02 mgL^{-1} to 4.91 mgL^{-1} for iron respectively .The high conc. of Al and Fe were observed at the sampling site KDS-3 in the month of May 2010 owing to lithological erosion.

Correlation Analysis: To observe the correlation between different physicochemical quality, which shown in correlation matrix form, Total 190 relations were established, in which 108 were positive relations while remaining were categorized as negative relations. The higher positive significant value was found Fe Vs hardness, Fe Vs phosphate Fe Vs TDS respectively. This was self-explanatory that the iron compound was greatly influence the total hardness and total dissolved solids orderly. Aluminum compounds were also observed to a great extent of positive value of 0.913 and 0.818 with turbidity and total alkalinity. Nitrate was also found to be positive correlated with chloride $r = 0.950$. Al and Fe were established positive relation with total alkalinity with r value of $r = 0.818$ and 0.837 respectively. It means that the high concentration of Aluminum and iron compounds were main cause of total alkalinity. Metallic elements are naturally correlated together by the positive significance such as iron and aluminum with r value of 0.961 indicating that the source of both metallic elements in water bodies was same. High relative correlation was also found between DO and TDS ($r =$ -0. 792). DO also formed negative relation with hardness, fluoride and sulphate with r value -0. 792, -0.776, and -0.792 orderly. It showed that the F^-, SO_4^{--} and hardness components found decreased dissolved oxygen in water, making it unfit for aquatic environments.

% CV: Percentage of correlation variances were calculated for all selected water quality parameters. It was obtained from 66.85 for TDS to 173.2 for Fe. This calculation suggested that the value of TDS was changed among all selected sources. While Fe concentration observed high variance among other WQP's, indicated the iron concentration are high changes place to place.

IV. Conclusion

On the basis of above observation and its subsequent results & discussion, it was very conspicuous that the maximum concentrations of physico-chemical parameters were crossed the maximum permissible level. One of selected metallic elements Fe and Al were reported far above the desired value. Furthermore it can also be concluded that water sources of the present study area got polluted at high degree of unacceptability with the std. values.

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Madan Murari Vaishnav was born in Bilaspur district of Chhattisgarh State, India on January 30, 1964. He had secondary school education from Frastepur, Bilaspur, India. Then he proceeded to Guru Ghasidas University, Bilaspur where he obtained his BSc. 2nd division in 1985, the MSc. (organic chemistry) in 1987 and the Ph.D. in phytochemistry in 1 992. He is associate professor and HOD, Department of Chemistry, Govt. G.B.College, Hardibazar, Korba, C.G. India. His area of specialization is phytochemistry and water pollution. He has more than 22 years teaching and research experience. He is a member of Journal of Indian Chemical Society. He has published six books in state level publication and 41 research paper in national and international Journal.

Ramesh Janjala was born April 5, 1981 in the Coastal Andhra Pradesh state of India, and had a schooling and graduation in the same place. He completed his M.Sc. with organic chemistry in the year 2005 and the Ph.D in environmental chemistry from Guru Ghasidas University, Bilaspur, C.G. India in 2014. He has published 6 papers in international journal.

Milan Hait was born on July 2, 1987 in Purba Medinipur, West Bengal. He obtained his M.Sc. in chemistry in 2006 from the Guru Ghasidas University, Bilaspur, C.G. India; the M.Phil and the PhD (contd.) from Dr. C.V. Raman University, Kota, Bilaspur, C.G. India. He joined as an assistant professor of the University in 2011. He has published 17 papers in international journal.

Pralhad Kanhaiyalal Rahangdale was born in Maharashtra State, India on October 24, 1962. He obtained the Ph.D. in organic chemistry in August, 1996 from RTM Nagpur University, Nagpur. He is associate professor & HOD, Department of Chemistry, Bhawabhuti Mahavidyalaya, Amgaon-441902, India. His area of specialization is organic chemistry, polymer chemistry, synthetic and ion exchange chemistry, photo chemistry & activated carbon chemistry. He has more than 25 years teaching and 24 years research experience. He has published 32 research papers in national and international Journal.

Shreni Dewangan was born in Korba district of Chhattisgarh State, India on April 20, 1980. She had secondary school education from Korba, Chhattisgarh, India. Then she proceeded to Government P. G. College, affiliated to Guru Ghasidas University, Bilaspur where she obtained her BSc. 1st division in 2001, the MSc. (organic chemistry) in 2004 and the Ph.D. in chemistry in 2013. Presently, she is working as a chemist in Public Health Engineering Department, Division of State Government of Chhattisgarh, posted at Champa, District Janjgir – Champa, C.G., India. Her area of specialization is drinking water quality and water pollution. She is an associate member in International Congress of Environmental Research. She had published 11 research paper in National and International Journals.

Principal
Govt. G.B.College
Hardi Bazar, Korba (C.G.)

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POSTMONSOON EVALUATION OF SURFACE WATER WITH REFERENCE OF STATISTICAL PARAMETERS OF KORBA DISTRICT, CHHATTISGARH, INDIA

M.M. VAISHNAV[a1], R. JANJAYALA[b], S. KRISHNAMURTHY[c] AND D. SINHA[d]

[ac]Department of Chemistry, Govt. G.B. College, H'Bazar, Korba ,C.G., India
[b]Department of Chemistry, C.M.D. Post Graduate College, Bilaspur ,C.G., India
[d]Department of Chemistry, Govt. N.P.G. College, Raipur ,C.G.,India

ABSTRACT

Postmonsoon (Oct'09 to Dec'09) assessment was done for different surface water sources in Korba district (C.G.) India. Twenty seven water samples were collected in pre-cleaned polythene and glass bottles separately, then subjected for physicochemical and selected metallic element analysis as per prescribed method (APHA 2005). The obtained results were compared with the standard value stipulated by BIS (1991) and WHO (2008) of standard drinking water. The mean value for TDS (1737.77 mg/L), TS (1848.458 mg/L), Turbidity (123.74 NTU), Total Alkalinity (497.185 mg/L), T. Hardness (598.548 mg/L), Chloride (599.302 mg/L), Sulphate (252.967 mg/L), COD (38.619 mg/L) and Iron (0.572 mg/L) were reported from the above maximum desirable limit while fluoride (0.887 mg/L), DO (5.206 mg/L), Nitrate (37.37 mg/L), Phosphate (0.105 mg/L), Al (0.04 mg/L), Hg (0.04 mg/L) were found under the acceptable value. Strong correlations were established between Total Alkalinity and pH (0.811), Fluoride and EC (0.936), Fluoride and TSS (-0.946), Nitrate and Turbidity (0.863). WQI showing from 235.93 (KDS – 6) to 3631.27 (KDS – 3) indicating water quality of the study area was tremendously deteriorated during the monitoring period.

KEYWORDS: Water Quality, Correlation Coefficient, WQI, Korba, Heavy Metals

Air, Water, Soil and foods are fundamental necessities for flora, fauna and human beings. The chief constituent of air is oxygen, which is inhaled by the living organism, plants intake carbon dioxide to synthesis of material through photosynthetic activity. Water is active as the universal solvent, by which various nutrients are entered in the living system. From the last few decades owing to various anthropogenic sources and natural weathering phenomenon the air, water, soil and food materials are continuous contamination by undesirable matters.

Trace metals could be heavy, when the density is greater than 5 mg/cm^3. Heavy metals acting as the activator or inhibitor for the enzymatic catalysis process(Hollond, 1998 and Reily, 1980). For keeping good health and human system, the required as well as intake quantity of mineral should be balanced. The imbalance may create serous health problems (WHO and Tripathi et.al., 1997). In trace amount the heavy metals are beneficial like Zn is an essential nutrient for many metabolic functions(Zodl, 2003, Crawford, 1972) which takes part in more than hundred enzymatic process. The deficiency of Zn causes diabetes. Cd occurring in earth's crust, it is entered in plants, animals and human body through food chain. It is chief pollutant metal and extremely toxic to living organism (Kaneta, 1986 and Oskarsson, 2004) induce material hypertension and affects the kidney and also Itai–Itai disease which is more common in Japanese people (Fangmin, 2006). Chromium (VI) form causes the various health hazards like skin rashes, upset stomach, respiratory problems, weakened immune system, Kidney, Liver damaged and lung cancer (Daisy, 1976 and Ducros, 1992). Fe is acting as the catalyst for fat oxidation, high concentration is causing of cerate haemochromatosis.

STUDY AREA

Korba town and its district area is important in India as well as World map for industrial, natural resources and environmental significant point of view. Our study field is located at 22°20' North latitude and 82°42' East Longitude, with a height of 304.8 meter above mean sea level. The total area of district is 7,14,544 hectare in which near about 2 lakh population are residing as per census 2011. The study field is received rain from south west monsoon from mid June till the end of September. The average rainfall in the whole district in 1506.7 mm, with average temp 36°C. The district is richest source of bituminous type coal (Tripathi, 2003), therefore coal based thermal power plants are setup by NTPC, CSEB Korba (East) and West, BALCO captive power plant etc. 3650 MW of electricity is generated, so that Korba district is known as ENERGY HUB. Owing to huge haphazardly mining and industrial activity, the different part of ecosystem is not free from unwanted materials. So we have taken major and extensive study of different aquatic system in

[1]Corresponding author

the Korba district. In this paper we have discuss only the post monsoon assessment of physicochemical characteristics with some selected metallic elements of different surface water. The analytical results were interpreted by the statistical quality like Mean, SD, SE, %CV, r and SWQI.

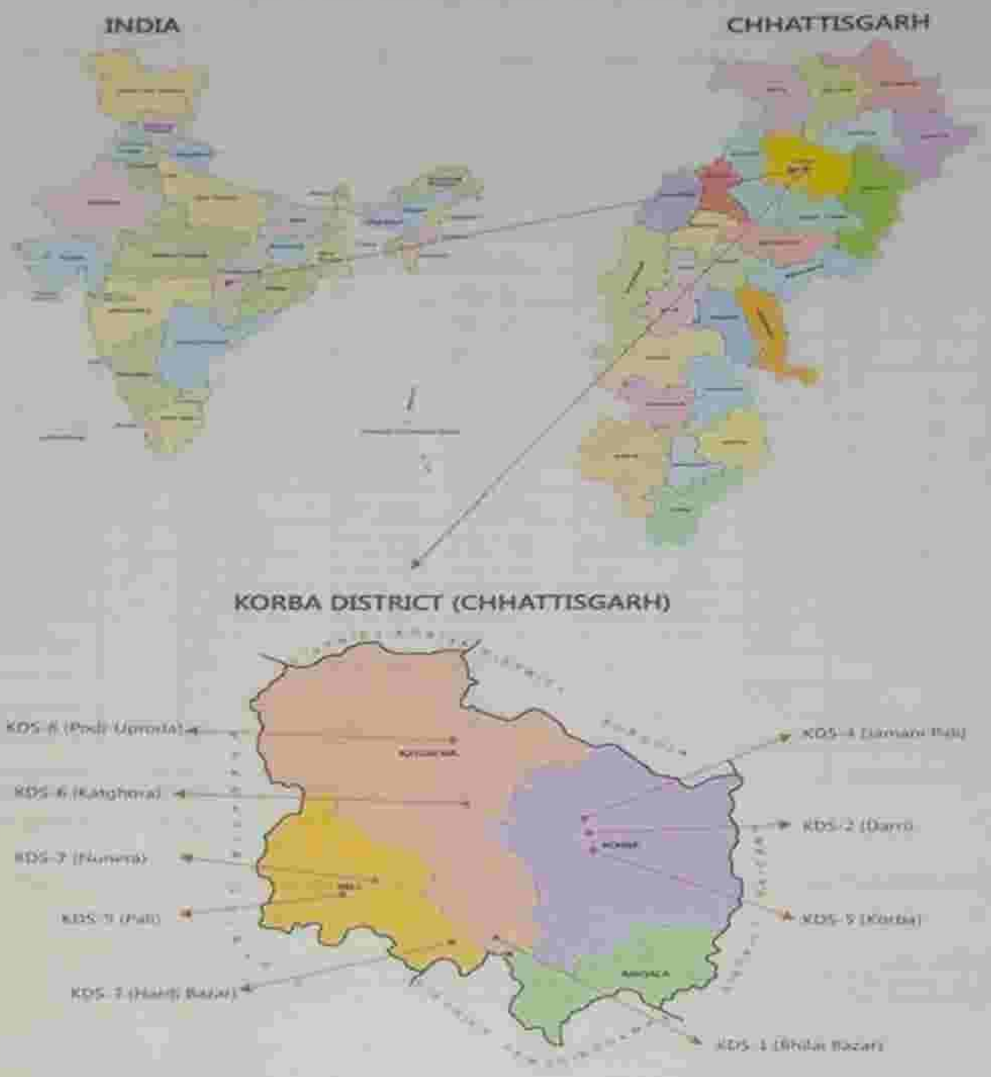

Figure 1: Map of Study Area (Korba Distrct)

MATERIALS AND METHODS

Water samples were collected from different selected site (Shown in Fig. 1) in precleaned polyethene and glass bottles of 1L capacity separately. The samples were preserved by the appropriate reagents and experiment was carried out by the standard method given in APHA (2005), Trivedi and Goel (1984) and Manivaksam (2002).

RESULTS AND DISCUSSION

The experimental results in the form of mean, ranges, min., max., SD, SE, %CV are given in Table-I. The correlations between water quality parameter are presented in matrix form in Table–II.

The pH of the waste water mainly depends on the source and chemical composition of wastes. The lower level of pH > 7 is due to the release of organic acid(Meenambal, 2003) while the high level of pH is cause the dissolved ions like HCO_3^- and CO_3^{2-}. pH contribute the positive impact on the water quality index. In postmonsoon period of 2009 the mean value was found 7.431 with ranging covered from 6.44 (KDS–2, Nov'2009) to 8.52 (KDS–1, Oct'2009) indicated the nature of water is from slightly acidic to alkaline and marginal beyond the fixed ranges of pH 6.50 to 8.50 pH units as per different water monitoring agency; BIS(1991) and WHO(2008). pH is negatively correlated with the temp (-0.016). Percentage of CV was calculated 0.077.

Table I: Post Monsoon Report (Oct. to Dec. 2009)

S.No	PARAMETERS	No of Samples	Range	Min	Max	Mean	Std.Dev	%CV	Std Error	Drinking Water Std (WHO)
1	Temp	27	20.1-26.4	KDS-8,Dec	KDS-4,Oct	22.748	2.061	0.091	0.076	
2	pH	27	6.44-8.52	KDS-2,Nov	KDS1,Oct	7.431	0.574	0.077	0.021	6.5 to 8.5
3	E.C	27	543-2036	KDS-8,Dec	KDS-6,Oct	1559.22	498.9	0.32	18.478	1400*
4	T.D.S	27	1509.9-1968.3	KDS-1,Dec	KDS-3,Nov	1737.77	125.89	0.072	4.663	50
5	T.S.S	27	37.717-243.412	KDS-7,Oct	KDS-8,Oct	110.684	54.93	0.496	2.035	
6	Turbidity	27	19-541	KDS-7,Dec	KDS-3,Oct	123.74	120.401	0.973	4.459	5
7	Total Solids	27	1603.39-2098.32	KDS-1,Dec	KDS-3,Oct	1848.458	111.347	0.06	4.124	
8	T.Aci	27	83-190	KDS-7,Oct	KDS-1,Oct	120.963	21.709	0.179	0.804	
9	T.Alk	27	398-678	KDS-2,Nov	KDS-3,Dec	497.185	70.279	0.141	2.603	200
10	Hardness	27	474.6-741.3	KDS-8,Dec	KDS-2,Oct	598.548	78.024	0.13	2.89	300
11	Chlorides	27	413.01-831.31	KDS-9,Dec	KDS-6,Oct	599.302	131.355	0.219	4.865	250
12	Fluorides	27	0.32-1.21	KDS-8,Nov	KDS-2,Dec	0.887	0.283	0.319	0.01	0.6-1.2
13	Sulphates	27	39.31-371.58	KDS-6,Nov	KDS-5,Oct	252.967	89.728	0.355	3.323	200
14	D.O	27	3.98-6.11	KDS-3,Nov	KDS-2,Nov	5.206	0.603	0.116	0.022	5.0*
15	C.O.D	27	6.13-151.12	KDS-7,Dec	KDS-9,Oct	38.619	40.602	1.051	1.504	
16	B.O.D	27	3.41-18.31	KDS-5,Dec	KDS-8,Nov	9.267	4.569	0.493	0.169	
17	Nitrogen Nitrate	27	17.18-84.41	KDS-2,Dec	KDS-5,Oct	37.37	18.335	0.491	0.679	45
18	Phosphate	27	0.011-0.71	KDS-7,Dec	KDS-1,Oct	0.105	0.153	1.464	0.006	
19	Al	27	0.04-0.04	KDS-2,Dec	KDS-2,Dec	0.04				0.03
20	Fe	27	0.07-1.53	KDS-5,Oct	KDS-8,Nov	0.572	0.419	0.732	0.016	0.3
21	Hg	27	0.04-0.04	KDS-2,Dec	KDS-2,Dec	0.04				No Relaxation
22	Zn	27								5

Range of concentration are in mg/L, except for pH,Temp, temp measured in deg C

* WHO specification for drinking water

Table II: Correlation Matrix for various Physico-Chemical Analysis Parameter of Water Post-Monsoon (Oct. to Dec. 2009)

	S.No.	1 Temp	2 pH	3 E.C	4 T.D.S	5 T.S.S	6 Turbidity	7 Total Solids	8 T.Aci	9 T.Alk	10 Hardness	11 Chlorides	12 Fluorides	13 Sulphates	14 D.O	15 C.O.D	16 B.O.D	17 Nitrogen Nitrate	18 Phosphate	19 Al	20 Fe	21 Hg	22 Zn
1	Temp	1.000																					
2	pH	0.195	1.000																				
3	E.C	0.394	-0.000	1.000																			
4	T.D.S	0.271	-0.151	0.396	1.000																		
5	T.S.S	0.061	-0.031	-0.646	-0.035	1.000																	
6	Turbidity	0.231	-0.376	0.175	0.730	-0.952	1.000																
7	Total Solids	0.352	-0.130	0.129	0.900	-0.035	0.800	1.000															
8	T.Aci	-0.614	0.170	0.119	-0.290	-0.146	-0.090	-0.388	1.000														
9	T.Alk	0.011	0.649	0.192	0.496	-0.039	0.702	0.544	-0.066	1.000													
10	Hardness	0.211	-0.538	0.501	0.429	-0.393	0.079	0.291	-0.080	-0.103	1.000												
11	Chlorides	0.131	0.474	0.679	0.238	-0.234	0.306	0.153	0.004	0.535	0.142	1.000											
12	Fluorides	-0.049	-0.153	0.792	0.315	-0.605	0.067	0.056	0.333	0.156	0.514	0.417	1.000										
13	Sulphates	0.339	0.237	0.436	0.458	-0.466	0.356	0.353	0.165	0.378	0.271	0.256	0.542	1.000									
14	D.O	-0.071	-0.552	-0.226	0.092	-0.665	-0.396	-0.136	-0.177	-0.497	0.439	-0.510	-0.074	0.075	1.000								
15	C.O.D	0.122	0.122	-0.289	0.251	-0.906	0.238	0.290	-0.025	0.374	0.222	-0.229	-0.172	0.319	0.220	1.000							
16	B.O.D	0.632	0.167	0.006	0.143	0.008	0.055	0.166	0.096	-0.046	0.208	0.000	-0.195	0.171	0.121	0.200	1.000						
17	Nitrogen Nitrate	0.420	0.492	0.248	0.545	0.023	0.753	0.628	-0.160	0.877	0.090	0.492	0.070	-0.442	-0.362	0.244	0.121	1.000					
18	Phosphate	0.012	0.364	-0.073	-0.351	-0.143	-0.221	-0.467	0.813	-0.097	-0.364	-0.179	0.136	0.187	-0.106	0.013	-0.012	-0.133	1.000				
19	Al	*	*	*	*	*	*	*	*	*	*	-0.038	*	*	*	*	*	*	*	1.000			
20	Fe	0.934	-0.397	-0.539	-0.653	0.646	*	0.259	1.000	0.325	-0.321	-0.036	-0.604	0.273	-0.137	0.139	0.119	0.232	-0.134	*	1.000		
21	Hg	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1.000	
22	Zn	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1.000

* Indicates that it has no correlation due to below detection limit in the samples (No [illegible] detected)

Govt. G.B. Mahavidyalaya Hardibazar Distt. Korba (C.G.)

Principal
Govt. G.B.College
Hardi Bazar,Korba (C.G.)

Table III: SWQI (Post Monsoon 2009)

S. No.	Sample Code	WQI
1	KDS - 1	1409
2	KDS - 2	1235.31
3	KDS - 3	3631.27
4	KDS - 4	459.12
5	KDS - 5	805.7
6	KDS - 6	235.93
7	KDS - 7	567.29
8	KDS - 8	715.27
9	KDS - 9	1235.8

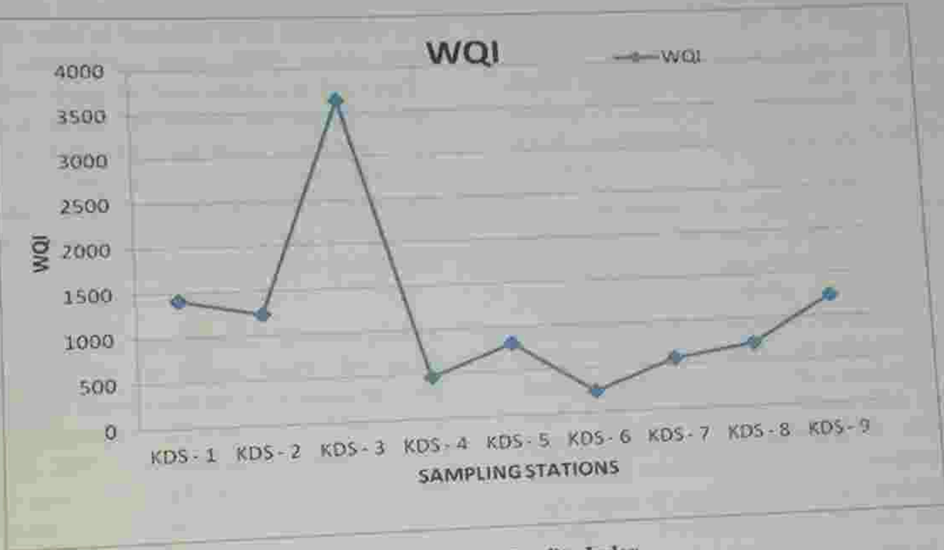

Figure 2: Water Quality Index

Electrical Conductivity is measured the concentration of inorganic and organic salts in aqueous medium. High electrical conductivity reduces the osmotic activity of plants and interferes with adsorption of water and nutrients from the soil (Joshi, 2011). In the investigation of the post monsoon period of 2009 the mean and ranging values were obtained 1559.22 µS cm^{-1}, 543 to 2036 µS cm^{-1} at the sampling points KDS–8 (Dec. 2009) and KDS–6 (Oct. 2009) respectively. EC showed positive and negative correlation with temp. (0.117) and pH (– 0.074). The %CV was also reported 0.32, which is also too much narrow.

Turbidity is detected the magnitude of suspended particles as clay, silt and less dissolved organic wastes. In research field the two statistical values; mean was found 123.74 NTU, while ranging values were fluctuated from 19 NTU (KDS–7, Dec' 2009) to 541 NTU (KDS–3, Oct 2009). These data are many fold greater than prescribed range 0–5 NTU. The water sources are highly polluted by the suspended particles. Turbidity established low degree correlation with temp. (0.570), pH(0.395) and EC (0.327). The % CV was reported too much less as 0.973.

The total dissolved solids in water is represented by the weight of residue left, when a water sample has been evaporated upto dryness(Tatawat, 2007). The average data was calculated as 1737.77 mg/L and min. concentration was obtained at the site KDS-1 (Dec. 2009); 1509.9 mg/L and max. concentration was found at the sampling spot KDS–3 (Nov. 2009); 1968.3 mg/L. These low and high concentration was far away from the acceptable limit 500–1500 mg/L as per WHO (2008) guideline. TDS showed high positive significant correlation with temp (+ 0.714). The %CV was found 0.072 for TDS, which is very low and indicating the variation ranges is narrow.

The chemical constituents of Total alkalinity is CO_3^{-2}, HCO_3^{-1}, OH^-, BO_3^{-3}, HPO_4^{-1} , HS^-, NH_3. In study period the mean value was obtained 497.185 mg/L which is higher than desirable value; 200 mg/L, but less than excessive permissible limit; 600 mg/L as per BIS (1991) and WHO (2008). The low concentration 398 mg/L was observed at the position of KDS–2 (Nov, 2009); 678 mg/L. Total alkalinity is correlated with pH (0.811) and turbidity (0.749) respectively. The % CV was computed 0.141 as less value.

Total hardness was calculated as arithmetic mean value 598.548 mg/L which is crossed the desirable limit. The sampling site KDS 8 (Dec. 2009) showed low value of hardness; 474.6 mg/L while the water of site KDS–2 (Oct. 2009) contain high concentration of total hardness component; 741.3 mg/L. The ranging values are beyond the standard value prescribed by BIS (1991) and WHO (2008)300 – 600 mg/L. The hardness formed inverse relation with TSS with r value of – 0.655, indicating the compounds responsible for hardness is not imparting in TSS. The variation of concentration of total hardness is measured in terms of %CV which is very low; 0.13.

The fluoride concentration in water plays a significant role for the human health, the excess concentration of fluoride ions cause the dental fluorosis, while less concentration are creating the dental carries (Parashuram, 2007). In investigation period the mean value was seen 0.887 mg/L which is lower than the required value and ranging data was varied from 0.32 mg/L at KDS–8 (Nov. 2009) to 1.21 mg/L at KDS–2 (Dec. 2009). The mathematical values are indicating that the water sources are not affected by fluoride compounds. In one hand fluoride forms high significant of positive correlation with EC (+ 0.936) indication of fluoride compounds play key role in value of EC but other hand fluoride forms negative correlations with TSS (– 0.946). The %CV for fluoride is 0.379 intimated narrow changes in concentration of fluoride compounds among selected water samples.

In nature chloride ion occur in conjunction with sodium concentration (Jameel, 2003). The acceptable range of chloride ion concentration in water prescribed by BIS (1991) and WHO (2008); 250 mg/L to 1000 mg/L. In our study mean values was computed 599.302 mg/L and ranges were recorded from 413.01 mg/L at KDS–9 (Dec 2009) to 831.31 mg/L at KDS–6 (Oct. 2009). These data are showed that the water sources are received chloride ions greater than desirable value, however less than upper limit. Chloride established positive significant of correlation with EC (r = + 0.570 and Total Alkalinity (r = + 0.603). The %CV was found 0.219 showed little changes in conc. of chloride ion form location to location.

The source of nitrate in water systems is anthropogenic ways like domestic sewage, excess using of fertilizers, agriculture, human and animal excreta and decomposition of organic compounds. High concentration of nitrate (>45 mg/L) is causing of health hazard such as gastric cancer, oral cancer, methemoglobninemia in infants. In the present study the 37.37 mg/L is obtained as mean value within desirable limit. The low concentration was recorded at KDS–2 (Dec. 2009) 17.18 mg/L and high conc. was observed at the site of KDS–5 (Oct. 2009); 84.41 mg/L, this may be attributed the inputs from waste and agricultural runoffs. Nitrate ion established positive correlation with turbidity (+ 0.863), TS (+ 0.666) and Total alkalinity (+0.881) respectively. The % CV was found 0.491 as less value.

Phosphate is occurring in nature as orthophosphate. Its chief sources are phosphate containing fertilizers and pesticides through comes in water bodies (Joseph, 2010). The analysis of post monsoon 2009 the mean value was found 0.105 while ranging values was changes from 0.011 mg/L as min. at location site KDS–7 (Dec. 2009) to max. conc. of 0.710 mg/L at the sampling site no KDS–1 (Oct. 2009). The high concentration be attributed to discharge of agricultural wastes in water bodies. Phosphate formed a high degree of positive significant correlation with T. Acidity (+0.859). The % CV was found 1.464, indicating little changes in concentration of phosphate among various selected spots.

The highest concentration of sulphate was found at point KDS–5 (Oct. 2009); 371.58 mg/L within excessive permissible limit and lowest value was reported at sampling point KDS–6 (Nov – 2009); 39.31 mg/L. The average value was added as 252.967 mg/L which is a lightly higher than the desirable limit; 200 mg/L stipulated by BIS (1991) and WHO (2008) standard. Sulphate showed positive significant of correlation with different degree among SO_4^{-2} vs Temp. (0.561), SO_4^{-2} vs EC (0.671), SO_4^{-2} vs TDS (0.715), SO_4^{-2} vs T. Hardness (0.715), SO_4^{-2} vs Fluoride (0.715). The %CV was found 0.335.

The dissolved form of oxygen is depended upon the temp, photosynthetic activity, oxygen demanding substances and reducing matter (Parashuram, 2007). Owing to population load the concentration of dissolved oxygen decline the posses thorough on the aquatic ecosystem. In the present investigation the mean value was found 5.206 mg/L within the desirable level. The min. conc. was detected at the KDS–3 (Nov. 2009); 3.98 mg/L. The low conc. may be attributed to the presence of domestic and agricultural wastes. The high concentration was reported at the sampling site no. KDS–2 (Nov. 2009). Dissolved oxygen showed mild degree negative correlation with pH (r = – 0.718). Like other parameters, the %CV was also showed the narrow value 0.176.

Chemical oxygen demand is the amount of oxygen required for oxidation of organic compounds with strong oxidising agents. In the present analysis the ranging values vary from 6.13 mg/L (KDS–7, Dec. 2009) to 151.12 mg/L (KDS–9, Oct. 2009) with 38.619 mg/L as mean value. These statistical data showed that the average and max. value are crossed the max. admissible value; 10 mg/L as set by BIS (1991)[17] and WHO (2008)[18]. COD outlined positive significant correlation with Temp.(+ 0.595) and sulphate (+ 0.501). 1.051 values was calculated as % CV for COD. The magnitude of BOD is depended upon the presence of biodegradable organic material, temp. and density of plankton. In the present study the average value was found 9.267 mg/L and ranging data were changes as 3.41 mg/L as min. value at KDS–5 (Dec. 2009) to 18.31 mg/L at KDS–8 (Nov. 2009). The BOD formed positive significant correlation with temperature (r = + 0.542) and DO (0.544). The %CV was also low for BOD; 0.493.

We have selected four metallic elements namely aluminium, iron, mercury and zinc. In the study period the mean value for iron was detected as 0.572 mg/L and ranging data varied form 0.07 mg/L at the sampling site KDS–5 (Oct. 2009) to 1.53 mg/L from site KDS–8 (Nov. 2009), which is crossed the upper limit for drinking water. Al and Hg were found in same concentration 0.04 mg/L a mean value. Aluminium established positive significant correlation with high degree for Turbidity (r = 0.870), Total Solid (r = 0.755) and Total Alkalinity (r – 0.712) orderly. Iron form high degree correlation with TSS (r = + 0.751). The %CV was calculated only for iron 0. 732, this show very low concentration changes from one sampling site to another sampling site.

WQI

Water quality index is defined as a rating which reflects the composite influences of different water quality parameters on the overall quality of water. In study field and post monsoon period of 2009 water quality index was computed on the basis of selected physic chemical parameters. The results were obtained from 235.93 as min. on sampling spot KDS–6 to 3631.27 as max. in the sampling site KDS–3. These ranges are far further away from the standard value of WQI; 0–25 excellent, 26–50 Good, 51–75 poor, 75–100 very poor and above 100 unsuitable. All water sources are highly polluted by the intrusion of various kinds of pollutants.

CONCLUSION

From the above experimental values the physicochemical properties except pH, Fluorides, DO, Nitrates, Phosphates, Aluminium, Mercury and Zinc were reported beyond the desirable value. TS positively related with TDS indicating total dissolved solid as part of total solids. Strong correlation was found between F vs EC as positively and F vs TSS as negatively, showed fluoride compounds are imparting in electrical conductivity while these class of compounds are not contributing in TSS. Like sulphate was also established negative significant correlation with TSS but with Total Hardness positively correlation means the hardness is caused by sulphatic compounds. SWQI's were ranges from 235.93 (KDS–6) to 3631.27 (KDS–3) indicating the surface water sources of the study field is highly polluted and not applicable for domestic, industrial and agricultural purpose. Prior using of different purpose, the water of different sources and purification.

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Periodic Water Quality Monitoring of Ground Water Sources in Jashpur District, Chhattisgarh, India

D. Sinha[1], S.K. Jain[2], A.K. Mishra[3], K.K. Dubey[4] and M.M. Vaishnav[5]*

1. Department of Chemistry, Govt. N. P.G. College of Science, Raipur, Chhattisgarh, INDIA
2. Department of Chemistry, Govt. R.B.S. NES P.G. College, Jashpur, Chhattisgarh, INDIA
3. Examination Controller, C.G. P.S.C., Raipur, Chhattisgarh, INDIA
4. Department of Physics, Govt. G.B. College, H'bazar, Korba, Chhattisgarh, INDIA
5. Department of Chemistry, Govt. G.B. College, H'bazar, Korba, Chhattisgarh, INDIA

Email: drmmvaishnav@yahoo.co.in

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ABSTRACT

The extensively study of ground water sources of entire Jashpur district has been taken in perspective of physico-chemical qualities of water. In our study, we have given the more emphasized the detection of fluoride and iron concentration in ground water sources. The analysis was done in the period of March, 2015 to February, 2016. At the period of investigation, ten sampling spots were selected and samples were collected in sterilized bottles. The collected samples were subjected for analysis technique by the standard methods. The experimental result were compared with the standard values stipulated by the monitoring agency BIS (2012) and WHO (2011). Some parameters such as Turbidity (125NTU, JD-5), Fluoride (5.90 mg L^{-1}, JD-8), Calcium (27.2 mg L^{-1}, JD-5), Magnesium (178 mg L^{-1}, JD-6), TH (436 mg L^{-1}, JD-6), DO (2.89 mg L^{-1}, JD- 2), COD (14 mg L^{-1}, JD-3), Iron (47.3 mg L^{-1}, JD-3), have been found beyond the standard values. In statistical parameters, the % CV was obtained upto 65.82 for iron. The correlation was established from +Ve to -Ve between selected qualities. The +Ve correlation was ranging from +0.022 (0.072) between pH vs K to +0.983 (17.33) between SAR vs Na. In negative correlation, the ranges were seen -0.03(-0.11) between K vs TDS to -0.89 (-6.26) between SAR vs DO. WQI was calculated from 926.5088 (JD-8) to 2896.6531 (JD-5), indicated water sources became contaminated by the undesirable chemical constituents study field.

Key words: Ground Water, Physico-chemical, WQI, % CV, Correlation coefficient.

INTRODUCTION

In developing countries viz. India, 90% population [1] including urban and rural areas are depends on Ground Water (GW) sources for different purposes, such as drinking, domestic irrigation, agricultural, industrial etc., Since last few decades, owing to population growth, socio-economic development, modernization in technology and climate change, the surface water became scarcity, hence the demand of GW sources has been increased [2]. The ground water quality is depended upon the hydrogeochemical composition, which are basic reason in variation of water qualities of GW sources.

Now the GW sources are gradually contaminated by the mixing of undesirable materials through naturally and anthropogenic means. In most of the industrial sector, the untreated effluents are continue discharging into nearly open pits, through seepage, the ground water sources are continue receiving pollutants. Metallic elements [3] are playing major role for creating GW pollution. The desirable amounts of the metallic ions are supported for the maintained the human health, but the higher concentration is acting as toxicants. In urban areas, large volumes of domestic cum septic wastes are storages in small areas, which are causing of pathogenic pollution of water sources. Feical pollution [4] in drinking water is causing reason of water born diseases such as Jaundice, Hepatitis, Dysentery, Diarrhoea etc. Hence due to these facts, the analytical measurements of GW quality is necessary for determine the suitability of different main kind goal with the time to time.

The Jashpur district is situated in the north-eastern corner of Chhattisgarh state, with geographical location 22°17' to 23°15' north latitude and 83°30' to 84°24' east latitude. The study field is covered geomorphologically by granitodes and small part with Deccan traps and Lamelas, Ultisols and Alfisole are main type of soils. The Jashpur district is spread over 6701 km^2 in which 8, 52, 043 peoples are residing as per report of 2011 census [5]. Average rainfall recorded from 1250 mm to 1600 mm during the study tenure. The area has highly undulating topographically. The occupation of the people is agricultural activity. The main crops growing paddy in 82% agricultural area. The silent sources of water is GW's, which is apply in the field of domestic, drinking, irrigation and small industrial sector. So far, the GW sources are unexplored, therefore, we have taken for the systematic analysis of physico-chemical quality of under surface water with over emphasized fluoride and iron ions.

MATERIALS AND METHODS

After selection of the ten water sampling spots, it was decided to collect water samples from tube-wells, bore-wells and open wells during the period of March, 2015 to February, 2016 in pre-cleaned plastics containers of 1 L capacity. The collected samples were preserved properly by the keeping in refrigerator at 4°C and adding of concentration nitric acid (Merck). The parameters Temperature, pH, EC, Turbidity, TDS, DO were measured on sampling spots by electronic analyzer (EI Model-172), TS, TH, TA, Ca, Mg, Cl, BOD, COD in laboratory by the volumetric and gravimetric method [6-10]. Sodium and Potassium were detected by the flame photometer, ferrous and fluoride ions were fixed by the ICP-AES and Ion selective electrode technique in instrumental section of BITS Ranchi, Jharkhand.

RESULT AND DISCUSSION

The experimental results of the study period, March, 2015 to February, 2016 has been depicted in the forms of statistical parameters such as Mean, SD, SE, %CV in Table 1. The obtained results are discussed in the following sub-headings:

pH: Ninety observation were note down from ten collected samples, during the period of study from 5.62 to 7.48 at the sampling site JD-4 in the month of November, 2015 and JD-8 in the month of December, 2015 respectively. 62 (68.88%) samples showed beyond the standard ranges < 6.50 to 8.50, while 28 (31.11%) samples under permissible ranges. The results showed the nature of water are slightly acidic to slightly alkaline in nature. These observed ranges of pH, 5.62 to 7.48 were also recorded in same sources by the H. Ayedun [13] and C. Dushiyanthan [14] in southern India and south-western Nigeria in 2011 respectively. pH showed high degree positive correlation with Mg (0.884, 5.998), COD (0.855, 5.227), K (0.850, 5.123). The % CV was note down 6.692.

EC: For measurement of EC of water samples, ninety readings were taken out. The minimum value was find out as 129.3 μscm^{-1} at the site JD-3 in the month of November, 2015 and maximum value was detected 727 μscm^{-1} at the site JD-6 in the month of June 2015 respectively. The observed ranges were under the acceptable ranging 400-2000 μscm^{-1} as per WHO (2011) [12]. 81(90%) readings covered below the desirable level, while 9 (10%) readings were under acceptable ranges. Thus the water of the study field was free from ionic pollutants. The maximum concentration was also analyzed earlier by the H. Ayedun [13] in 2011 in GW of south-eastern Nigeria. The EC was established high degree positive correlations with the TS (0.865, 5.470) and COD (0.800, 4.230). The % CV was found out 42.732, it measures large variation in the value of EC among the selected spots.

Table I. Statistical Analysis (March, 2015 to February, 2016).

Parameters	Mean	S.D.	Std. Error	Coff. of Var.
Tem	26.290	3.232	0.295	12.292
pH	6.340	0.424	0.039	6.692
EC	266.339	113.812	10.390	42.732
Turbidity	39.481	30.382	2.774	76.953
TS	313.167	91.247	8.330	29.137
TDS	171.331	69.256	6.322	40.423
TSS	141.836	57.693	5.267	40.676
TA	169.400	50.536	4.613	29.832
TH	154.133	68.827	6.283	44.654
Ca^{+2}	100.783	44.231	4.038	43.887
Mg^{+2}	53.350	26.613	2.429	49.884
Cl^{-}	56.159	9.9.1.7	0.905	17.658
DO	5.259	1.159	0.106	22.049
BOD	5.561	1.234	0.113	22.196
COD	9.313	1.521	0.139	16.337
Na^{+}	119.121	27.518	2.512	23.101
K^{+}	5.240	1.366	0.125	26.067
SAR	4.363	1.115	0.102	25.547
PS	61.704	9.992	0.912	16.193
RSC	-0.288	0.890	0.081	-309.174
HCO_3^{-2}	169.400	50.536	4.613	29.832
F^{-1}	0.726	1.473	0.134	202.568
Fe^{+2}	21.493	15.007	1.370	69.821

Turbidity: Out of 90 observations 77 readings (85.55%) above the excessive permissible level, while 4 readings (4.44%) were below the desirable limit and 7 (7.77%) observations were recorded under the acceptable ranges from the standard value stipulated by the BIS (5-8, 2012) [11] and WHO (2011, 5-10) [12]. A.P. Dwivedi [15] was also detected near about the same value (2.00 NTU) of their minimum concentration in GWS of Vindhyan plateau in 2013. Turbidity was showed high degree positive correlation with temperature (0.918, 7.725), TH (0.618, 6.056), Ca (0.818, 4.512), Mg (0.923, 7.618), Na (0.836, 4.830), SAR (0.801, 4.236), COD (0.852, 5.165). The %CV for turbidity was calculated out 76.953, which showed, very high differences between two spots in the reading of turbidity.

TS: Total solid measured the dissolved as well suspended ions in water. The minimum concentration 200 mgL^{-1} was detected at the sampling point JD-3 in the month of July, 2015, while the maximum concentration; 720 mg L^{-1} was determined at the site JD-6 in the month of April, 2015. In ninety collected samples, 84 (93.33%) showed below the desirable limit. Only 5 (5.55%) samples are accepting ranges. None of the sample contain showed above the permissible limit as per BIS (2012) [11] and WHO (2012) [12]. TS established high degree positive correlation with EC (0.865, 5.470), TSS (0.800, 4.222) and BOD (0.791, 4.100). The % CV was recorded 29.137.

TDS: The dissolved ions are reflux by the TDS. During the study period, the ranges were spread from minimum 80 mg L^{-1} JD-3 August, 2015 to maximum 426.30 mg L^{-1} at JD-3 June, 2015. These values were under the desirable limit. None of the samples showed above the excessive permissible limit as per BIS (2012) [11], 500-2000 mg L^{-1} and WHO (2012) [12] 500-1500 mg L^{-1}. The minimum and maximum concentration was also finding out by the A.O. Jayeola and A.C. Ogunyele [16] in 2014. TDS showed low degree positive correlation with pH (0.594, 2.337), EC (0.548, 2.075). The % CV was calculated 40.423, which is also large variation in concentration of TDS from sampling spot to spot.

Total Alkalinity: At the period of investigation, ninety readings were observed with minimum concentration 112 mg L^{-1} at the sampling site JD-10 in the month of December, 2015, whereas, the maximum concentration was seen at the sampling point JD-6 in the month of July, 2015 with the 274 mg L^{-1}. None of the values were found above the excessive permissible limit; 300-600 mg L^{-1} as per BIS (2012) [11] 200-600 mg L^{-1} and according to WHO (2011) [12]. Only 17 (18.88%) readings were calculated under the acceptable ranges and 73 values (81.11%) were observed below the desirable limit. TA showed positive correlation with Na (0.810, 4.520) BOD (0.782, 3.967). The % CV was calculated 29.832.

TH: The standard values for TH is 300-600 mg L^{-1} as per BIS (2011) [11] whereas, as per WHO (2012) [12] 100-500 mg L^{-1}. Out of ninety observations, the minimum concentration was fond at the sampling site JD-2, 78 mg L^{-1} in the month of November, 2015, while the maximum concentration was found at JD-6; 436 mg L^{-1} in the month of May, 2015. Only 7 (7.77%) readings were recorded in between acceptable ranges, and then remaining values 83 (93.33%) were below the desirable limit. These results indicated, the total hardness didn't great imparting in the contamination of GW sources. This minimum concentration 78 mg L^{-1} was also detected previously by the A.O. Jayeola [16] in 2014 in GW sources of Ikare-Akoko areas of south-western Nigeria, while the maximum concentration was also earlier reported near about this concentration by the A.K. Pandey *et al.*, [17] in 2014 in GWS of Digod tehsil of Kota district in Rajasthan, India. TH showed positive correlation with turbidity (0.886, 6.056), Ca (0.981, 16.06), Mg (0.791, 12.96) DO (0.851, 5.1114) Na (0.868, 6.122) SAR (0.815, 4.449). The % CV of total hardness was note down 44.65, which is indicated in among all sampling spots, the total hardness concentration is sufficient differences.

Calcium: Seven readings (7.77%) were shown the above excessive limit and sixty two (68.88%) readings were under acceptable ranges as per BIS (2012) [11] 75 mg L^{-1} to 200 mg L^{-1} and remaining twenty one reading (23.33%) were below the desirable limit in out of ninety observations. The minimum concentration was note down as 272 mg L^{-1} at the sampling points JD-54 in the month of May, 2015. The calcium compounds are also contributed in total hardness. Thus minimum concentration was earlier reported as 56 mg L^{-1}, which was very close to recent reported value by the C. Dushiyanthan *et al.*, [14] in 2011. Calcium interrelated with the other parameter by the high degree positive correlation such as turbidity (0.818, 4.512), TH (0.981, 16.06), BOD (0.851, 5.134), COD (0.888, 6.122), SAR (0.815, 4.449). The % CV was also calculated 43.887, which measure vast changing in the concentration of Ca in from sample to sample.

Magnesium: Magnesium ions play a key role in total hardness. At the period of study, the minimum value was found as 24 mg L^{-1} at the sampling site JD-1 in the month of November, 2015 while, the highest value was observed as 178 mg L^{-1} in the month of May, 2017 at JD-6. Only seven (7.77%) observations were recorded above the excessive permissible level as per BIS (2012) [11] standards, five (5.55%) readings were below the acceptable ranges. This minimum concentration was also seen as 25 mg L^{-1} by the Rajkumari Surywanshi [18] in 2014 in and around the Pune areas. The positive correlation was formulated with BOD (0.897, 6.443), COD (0.779, 3.940), Na (0.945, 9.152), SAR (0.898, 6.477), HCO_3 (0.717, 3.940). The %CV was calculated 49.884, indicated wide variation in dissolved amount of magnesium compounds in among the selected spots.

Fluoride: Thirty observations were analysed in the study period. The ranges were formulated from 0.04 mg L^{-1} to 5.90 mg L^{-1}. The minimum and maximum concentration was detected at the site JD-5 and JD-8 in the month of November, 2015 and September, 2015 respectively. Three (10%) observations were findings above the excessive level and four (4.44%) observations were under acceptable ranges while thirteen samples (47.33%) showed below the desirable ranges. The standard values for drinking water is 1 to 1.2 mg L^{-1} BIS (2012) [11] 1 to 1.5 mg L^{-1} (WHO, 2011) [12]. K.M. Reddy and J.R. Prasad [19] was also assessed this minimum concentration; 0.04 mg L^{-1} in 2003 in Wazirabad areas of Nalgonda district, while the V. Sunitha *et al.*, [20] was also reported earlier the maximum concentration 5.51 mg L^{-1}, which was very close to recently reported concentration in GW sources. Fluoride was didn't established any positive correlation with other parameters of water. The % CV was calculated 202.968, which in indicated the vast differences in concentration of fluoride ion in selected water samples.

Table 2. WQI (Mar. 2015 to February 2016).

Sampling Spot	Σqiwi	ΣWi	WQI= Σqiwi/ΣWi
JD-1	45651.93800	23.65338586	1930.038188
JD-2	51064.77402	23.65338586	2158.877985
JD-3	51932.33101	23.65338586	2195.555905
JD-4	64368.52153	23.65338586	2721.323784
JD-5	68515.65535	23.65338586	2896.653179
JD-6	43379.10487	23.65338586	1833.949064
JD-7	66566.63998	23.65338586	2814.254178
JD-8	21915.07109	23.65338586	926.5088396
JD-9	42937.71238	23.65338586	1815.288205
JD-10	31915.36018	23.65338586	1349.293516

Chloride: Chloride is dissolved in water as negative anion. At the period of testing all the ninety (100%) readings were obtained below the desirable limit, when it is compared with the standard value as per BIS (2012) [11] and WHO (2011) [12]; 200-1000 mg L^{-1}. The minimum concentration of chloride ion was seen as 35.60 mg L^{-1} at the sampling site JD-8 in the month of May, 2015, while the maximum concentration was found 92.60 mg L^{-1} on the sampling site JD-5 in the month of May, 2015. These minimum and maximum concentrations were very close to the previously seen as 34 mg L^{-1} and 91.1 mg L^{-1} by the P.G. Sabu [21] in 2014. Chloride formed positive correlation with Na (0.655, 2.746) and SAR (0.638, 2.663). The % CV was calculated as value 17.658.

DO: In out of ninety readings, the minimum dissolved oxygen was detected as 2.89 mg L^{-1} at the site JD-2 in the month of January, 2015. However, 6.99 mg L^{-1} was seen as maximum value at the site JD-3 in the month of December, 2015. As per WHO (2011) [12] the standard ranges for DO as 5-6 mg L^{-1} and BIS (2011) [11] suggested the acceptable value should be 5 mg L^{-1}. 18 observations (20%) were crossed the upper limit, 22 readings (24.44%) were estimated under acceptable ranges. 23 readings (25.55%) were below the acceptable ranges, thus the one fifth water samples are suffering from less dissolved oxygen owing to oxygen reducing chemicals. Near about same values were also reported by the earlier scientist K.V. Sastri *et al.,* [22]. DO showed high degree negative correlation with SAR (-0.89, -6.26) PS (-0.91, -6.94), Na (-0.78, -3.94. The % CV was calculated 22.049 among obtained observations of all selected spots.

BOD: The minimum concentration was estimated on 3.38 mg L^{-1} at site JD-10 in the month of November, 2015, but the maximum concentration was assessed as 8.51 mg L^{-1} at the site JD-3 in the month of May, 2015. The WHO (2011) [12] and BIS (2012) [11] has proposed 5 mg L^{-1} as the upper limit for drinking water. 64 values (71.11%) crossed the upper limit, while the remaining 26 (28.88) were below the standard limit, it means the maximum collected water samples are affected by the BOD constituents. P.C. Mishra *et al.,* [23] was also observed very close of this value; 3.40 mg L^{-1} in GWS of the steel city Orissa in the year of 2005. BOD positive correlated with turbidity (0.769, 3.809), TS (0.791, 4.100), TA (0.782, 3.967), Ca (0.778, 3.916), Mg (0.897, 6.443). Negative correlation was also established with DO (-0.78, -3.94). The % CV was found out 22.196.

COD: The standard value of COD is stipulated by BIS (2012) [11] and WHO (2011) [12] 10 mg L^{-1} for drinking water. In ninety observations, the minimum value was note-down at the location spot JD-4 as 7.02 mg L^{-1} in the month of September, 2015 and maximum concentration was seen at the site JD-3, 14.10 mg L^{-1} in the month of May, 2015. 21 observations (22.33%) were above the limit of standard value, whereas 64 readings (76.66%) were below the upper limit. These ranges were already reported by the farmers author A.P. Dwevedi [15] in the years of 2013 in GWS of Rewa district. The

COD has established positive correlation with temperature (0.892, 6.250) EC (0.800, 4.230), Turbidity (0.852, 5.165), TS (0.720, 3.282). TH (0.796, 4.169), Ca (0.777, 3.903), Mg (0.779, 3.940). The % of CV was estimated 16.337, which is not sufficiently high concentration changes among selected GW sources.

Sodium: Sodium is an alkaline metal, which is dissolved in GWS through seepage or weathering of underground rocks. In our study period, the low concentration of sodium ion was detected 71.2 mg L^{-1} at the location of JD-8 in the month of September, 2015, whereas the 156.20 mg L^{-1} was found as the maximum concentration at the site JD-3 in the month of September, 2015. BIS (2012) [11] and WHO (2011) [12] as per the threshold value for drinking water is 200 mg L^{-1}. The all recorded values were below the upper limit, as indicating, water sources are didn't sufficiently contaminated by the sodium. This maximum value was also reported previously by the L. Elango *et al.*, [24] in the year of 2006 of Chengalpet region. The sodium positively correlated with the Temperature (0.735, 3.428), TH (0.888, 6.122). Ca (0.804, 4.290), Mg (0.945, 9.152), BOD (0.921, 7.471) with DO negatively correlated (-0.85, -5.13). The % CV was calculated 27.101.

Potassium: The standard value of K for drinking water is 10 mg L^{-1} as per BIS (2012) [11] and 25 mg L^{-1} WHO (2011) [12]. In the study time, ninety observations were taken out. The minimum and maximum values were looked as 2.89 mg L^{-1} and 9.66 mg L^{-1} at the site JD-1 and JD-8 in the month of March, 2015 and November, 2015 respectively. All the values were seen under the limit value. This maximum concentration was also detected in 2015 in GWS in Kanyo city of Turky as 9.00 mg L^{-1} by the M.T. Nalbantcilar and D. Pinarkara [25]. Potassium correlated positively with DO (0.637, 2.619). The % CV was calculated as 26.067, which is sufficiently as high as indication, the concentration of potassium in vastly changes from location to location.

Iron: Thirty observations were taken in the period of study in which the minimum concentration was recorded as 0.10 mg L^{-1} at the sampling site JD-8 in the month of November, 2015 and the maximum concentration was observed as the 47.73 mg L^{-1} at the sampling site JD-3 in the month of November, 2015. Only three values (10%) were below the upper limit remaining observation (90%) were crossed the upper limit; 1.0 mg L^{-1} as per BIS (2012)[11] and WHO (2011) [12]. This minimum concentration was already detected earlier by the P.B. Vyas [26] in Gandhi Nagar township in 2011. The % CV was estimated as 69.827%. Which is indicated the iron concentration are high degree fluctuated from spot to spot.

SAR: This parameter was calculated for ninety water samples which ranges were found from 1.80 mg L^{-1} at the sampling site JD-8 in the month of Dec. 2015, while the maximum concentration was seen as 7.20 mg L^{-1} at the sampling site JD-2 in the month of May, 2015. All the observations were under the acceptable ranges as per BIS (2012) [11]. The maximum value was also finding out by the G.K. Sethi [2]. SAR established high degree positive correlation with Temperature (0.801, 4.236), TA (0.824, 4.611), TH (0.815, 4.449), Mg (0.898, 6.477), DO (0.872, 5.655), Na (0.835, 4.812), with DO found negative correlation (-0.39, -6.26). The % CV was calculated 25.847.

PS: Percentage of sodium was calculated in 90 observations in which 72 samples (80%) were above the threshold limit, while the remaining concentration was under the acceptable limit 20-60. The minimum data was detected as 33.99 mg L^{-1} at the location site JD-9 in the month of December, 2015. However the maximum value was measured as 76.79 mg L^{-1} at the site JD-2 in the month of May, 2015. Earlier scientist G.K. Sethi [2] was also measured the PS around our noted value as 34.17 mg L^{-1}. The %CV was computed as 16.193.

RSC: In the study tenure, the RSC was computed as minimum -0.03 mg L^{-1} at the sampling site JD-2 in the month of April, 2015, while the maximum value was found as 0.65 mg L^{-1} at the site JD-3 in the month of December, 2015. The ranges of RSC were below the acceptable values; 1.25 to 2.5.

G.K. Sethi and his co-worker were also found out earlier [2] as -0.05 in 2010, which was very vicinity to our reported value.

Bi-carbonate: Bicarbonate is also one of the pollutants, which is measured in the ranging value as 96 mg L^{-1} at the site JD-1 in the month of November, 2015, while the maximum concentration was reported as 302 mg L^{-1} at the site JD-8 in the month of December, 2015. This maximum concentration was also detected earlier by the Abhaym Yarde *et al.*, [27] in 2014 of Nagpur district (M.S.). The bicarbonate established high degree positive correlation with BOD (0.782, 3.967), Na (0.819, 4.520), SAR (0.824, 4.611), PS (0.740, 3.480). The % CV was calculated 29.832.

CONCLUSIONS

The scientifically assessment has been taken of GWS of Jashpur district (C.G.) India. At the tenure of the analytical monitoring, the twenty one parameters were observed for ten water samples up to continue 12 months, which, were collected from the ten different spots. Every spots are located at the equal distance. The results for turbidity (125 NTU) at the JD-5, TH (476 mg L^{-1}) at JD-6, fluoride (5.90 mg L^{-1}) at the JD-8, DO (2.89 mg L^{-1}) at JD-2, Iron (47.73 mg L^{-1}) at JD-3, Bicarbonate (302 mg L^{-1}) at JD-8 were obtained at the alarming level, which makes the GWS unfit for any human development purposes. The chemical impurities come in GWs through weathering of under surface rock. So we have suggested to people of the study areas, prior purification is must before all type's application of ground water sources.

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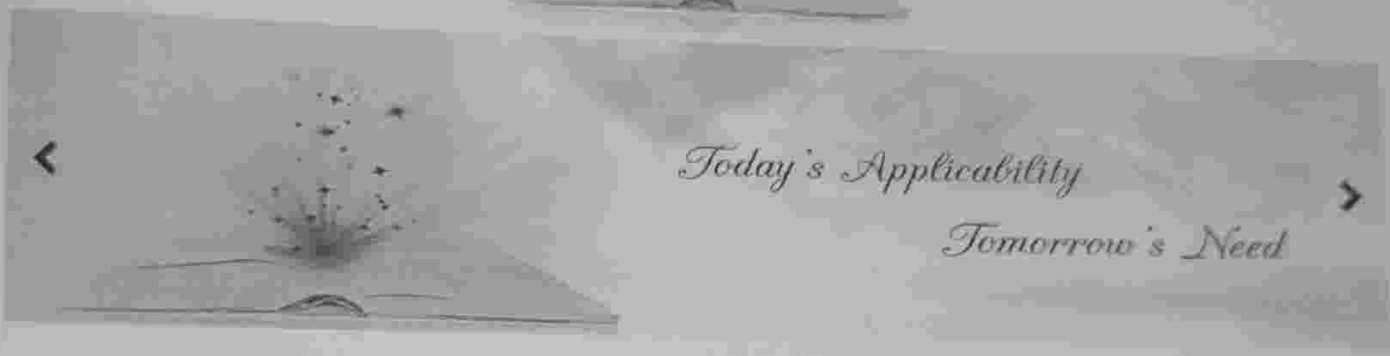

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TREATMENT OF WATER BODIES FROM THE EFFLUENT OF SIRGITTI INDUSTRIAL AREA BILASPUR USING BIOADSORBENTS

Milan Hait[1*], Jitendra Chandran[1], Amit Kumar Chaturwedi[1], M. M. Vaishnav[2]

[1]Dept. of Chemistry, Dr. C.V. Raman University, Kargi Road, Kota, Bilaspur, C.G.-495113, India.
[2]Dept. of Chemistry, Govt. G. B. College, Hardibazar, Korba, C.G.-495446, India.

ABSTRACT

Analytical explorations of some selected physicochemical parameter with metallic elements have been made on the surface water bodies of Sirgitti industrial region, Bilaspur (Chhattisgarh). Water samples were collected from two distinct chosen points in April'2019 of Pre-monsoon season, had been investigated for physicochemical and heavy metal like Fe, Zn, Mn and Al by means of standard process as per IS guidelines. More than 70% of these parameters were beyond the allowable limit of BIS: 10500 and WHO standard of drinking water. The higher values of these parameters are of great concern to public health. Treatment of water pollutants has been completed by making ready bio-adsorbents from local plant source. Adsorption Potential of different adsorbents has been examined and compared for the removal of various pollutants. The changes in pH, colour, COD, TS, TDS, TSS, TA, TH, Chloride, Fluoride, Sulphate, Nitrate, Phosphate, Ca, Mg, Na, K and heavy metals e.g., Cu, Zn, Fe, Al etc. were found.

KEYWORDS: Industrial effluent, physico-chemical parameter, water quality, public health and bio-adsorbent.

INTRODUCTION

Water is the best valuable thing for the survival of existence. Pure ingesting water assets are diminishing because of deforestation, mining and industrialization. Approximately seventy one percentage of the earth surface is enclosed with water, especially in the form of oceans. The real fresh water is to be had for human consumption is around 1% of the full earth water Ground and surface water used by man are of various characteristics. Ground water includes dissolved minerals from the soil layers via which it passes[1-3]. Owing to natural weathering and anthropogenic activities a majority of these parts of universe has been degraded the water excellent. Moreover, substantial part of this limited quantity of water is contaminated by sewage, commercial wastes and large number of synthetic chemicals. Thus, the excellent in addition to the quantity of clean water supply is of crucial importance for the welfare of mankind[4-7].

Study area:

Bilaspur city is the district head zone of Bilaspur district, is the second one largest city of Chhattisgarh state. It is located on the banks of river Arpa. Bilaspur district is located between 21°47′ to 23°08′ North latitudes and 81°14′ to 83°15′ East latitudes, with a height of 262 meters from the sea level. The average rain fall in this area is 1220 mm. Many agencies large small have their manufacturing or manufacturing devices are situated in an around Bilaspur. Due to huge industrialization of Bilaspur city and its surrounding air, water and soil are uninterruptedly polluted, so it is essential to explore the quantity of pollutant present within the water of this area[8-9].

The most important causes for the deterioration of water excellent in water bodies are mixing of pollutants due to release of untreated or partially treated waste water from these industries, municipal sewage and domestic effluents, so it is essential to examine the quantity of pollutant present inside the water of this area. In this present paper we have assessed the evaluation of water quality in April'2019 of pre-monsoon season in reference of physicochemical parameters and explored treatment procedures of polluted water by locally based bio-adsorbents.

MATERIAL AND METHOD

In order to ascertain the water chemistry, two surface water samples have been accumulated in a high quality polyethylene jerry canes having two liter capability (one for physical, chemical analysis, metal analysis and another for treatment with bio-adsorbents) formerly soaked with 8M HNO_3 and clean with detergent accompanied by washing with double distilled water in the month of April'2019 of pre monsoon season. The surface water samples were accumulated *Sirgitti Stock Dam* (SS_1) and Bannakdih (SS_2) nearby the Bilaspur, Tifra industrial area, are shown in *Fig.1*. The collected water sample was preserved in ice cooled chamber and kept in dark room[10-11]. Analysis was executed through the standard protocol[10-20] within a quick period of time to obtain more consistent and perfect results. *In situ* measurements like Temperature, pH, EC, Turbidity, TDS etc.were measured via Water analyzer kit and colour was measured by visual comparison techniques. TS and TSS were measured gravimetrically. Cl^-, TH, TA were measured by titrimetrically, Dissolved oxygen was measured by DO meter, COD by digestion and BOD in an incubator. The anions (F^-, NO_3^-, PO_4^{3-} and SO_4^{2-}) were analyzed by spectrophotometrically. The major cations were measured by flame photometer. Trace elements namely Fe, Zn, Mn, Al were analyzed by Atomic Absorption Spectroscopy. The values of physico-chemical parameters of surface waters are given in Table 1.

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Bio adsorbents were prepared in the laboratory with the help of fresh dried wood of *Cassia fistula* and *Annona squamosa* by means of activating in muffle furnace at a moderate temperature. The Polluted water samples are fed into the bio-adsorbents by column operation techniques[21-25]. Physico-chemical analysis of the treated effluents were completed after running off through the column to compare with the untreated effluents by water quality monitoring authorities like WHO (2011) and BIS (2012) which are tabulated in Table 1 & 2.

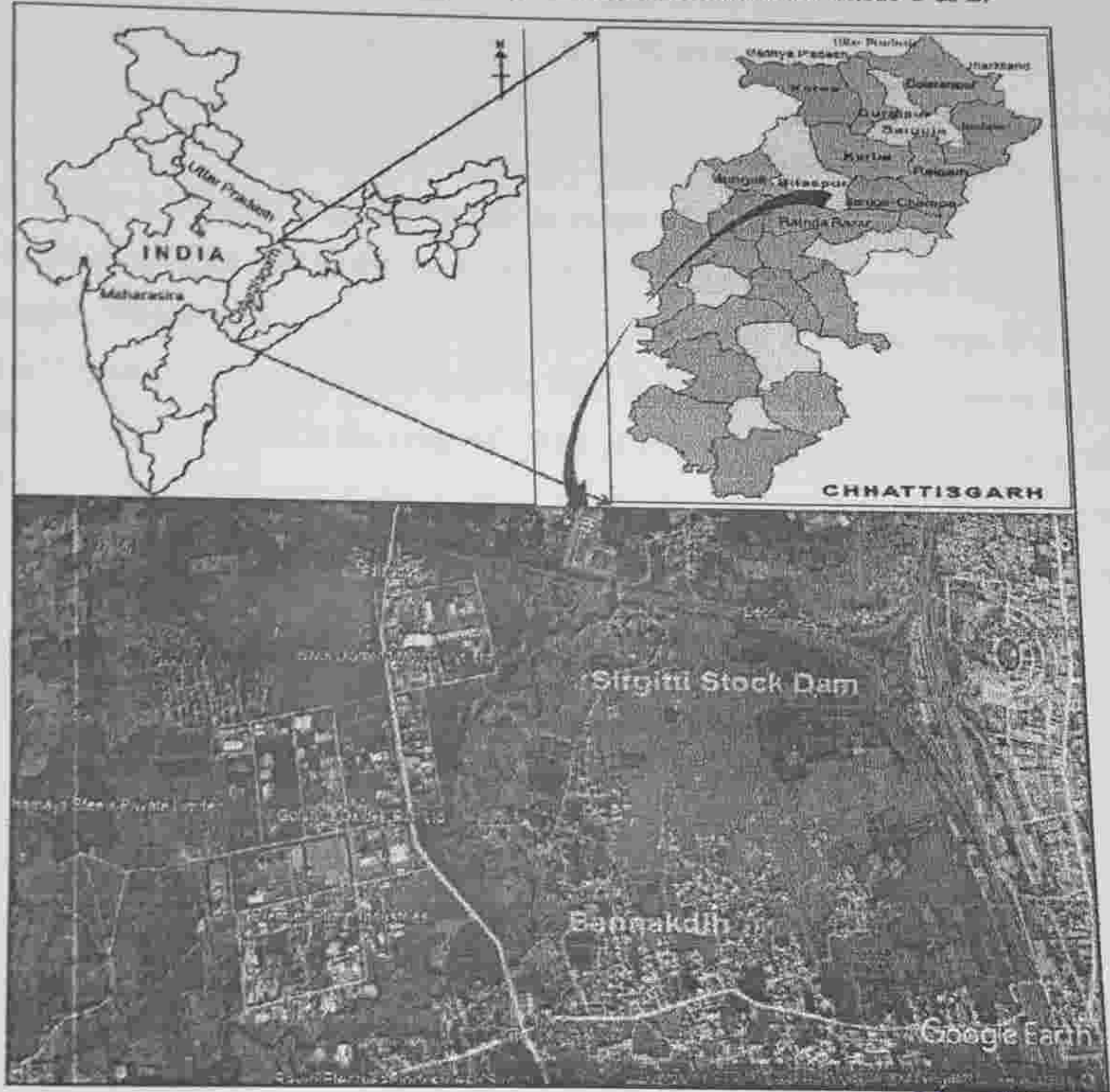

Fig. 1: Location of study area

RESULT AND DISCUSSION

The consequences of physico-chemical parameters which include Colour, Temperature, pH, EC, Turbidity, Total Solid (TS), Total Dissolve Solid (TDS), Total Suspended Solid (TSS), Total alkalinity (TA), Total Hardness (TH), Chloride, Fluoride, Sulphate, Nitrate, Phosphate, Dissolved oxygen (DO), Biochemical Oxygen demand (BOD), Chemical Oxygen Demand (COD), Sodium, Potassium, Calcium, Magnesium, Iron, Manganese, Zinc, Aluminum and WQI for different surface water samples collected in month of April' 2019 from two sites around

Sirgitti industrial area, Bilaspur (C.G.). The analytical details of untreated and treated effluents with different water quality standards e.g., BIS (2012) and WHO (2011) are given in the Table-1 and 2 respectively.

The experimental results of the samples were as: pH were in the range of 7.51 to 7 .80, Colour were in the range of 10 to 11 Hazen, EC were in the range of 1232 to 1345 µs/cm, Turbidity were in the range of 24 to 28 NTU, TS were in the range of 890.23 to 912.22 mg/L, TDS were in the range of 750.24 to 804.76 ppm, TSS were in the range of 107.46 to 140.03 mg/L, Total Alkalinity were in the range of 440 to 485 mg/L, Total hardness were in the range of 396 to 492 ppm, Chloride were in the range of 581.42 to 656.24 mg/L, Fluoride were in the range of 1.04 to 1.13 mg/L, Sulphate were in the range of 571 to 620 ppm, DO were in the range of 3.8 to 4.6 ppm, BOD were in the range of 4.54 to 4.83 ppm, COD were in the range of 31.22 to 34.6 ppm, Nitrate were in the range of 51.07 to 52.82 ppm, Phosphate were in the range of 0.08 to 0.12 ppm, Sodium were in the range of 272.4 to 276 ppm, Potassium were in the range of 26 to 28 ppm, Calcium were in the range of 251.7 to 258.62 ppm. Magnesium were in the range of 34.8 to 36.2 ppm. Iron were in the range of 3.2 to 3.42 ppm. Manganese were in the range of 0.14 to 0.16 ppm. Zinc were in the range of 0.24 to 0.51 ppm. Aluminum were in the range of 0.62 to 1.10 ppm and WQI were in the range of 121.6 to 122.

Table 1: Physico-chemical constituents and WQI analysis of different water samples

Parameters/ Sampling Spot	SS_1	SS_2	Indian Drinking water Std. IS 10500: 2012	WHO Rec. 2011
Colour	10	11	5 Hazen	15 TCU
Temperature	30.4	30.5	-	27-28
pH	7.80	7.51	6.5-8.5	6.5-8.5
Conductivity	1232	1345	750-2250	400-2000
Turbidity	24	28	5-8 NTU	5 NTU
TS	890.23	912.22	520-2050	500-1500
TDS	750.24	804.76	500-2000	500-1500
TSS	140.03	107.46	20-50	-
Alkalinity	440	485	300-600	200-600
Total Hardness	492	396	300-600	100-500
Chloride	656.24	581.42	200-1000	200-1000
Fluoride	1.04	1.13	1-1.2	1-1.5
Sulphate	571	620	200-400	200-600
D.O	3.8	4.6	5	5-6
BOD	4.54	4.83	5	5
COD	31.22	34.6	10	10
Nitrate	51.07	52.82	45	50
Phosphate	0.08	0.12	0.1	0.1
Sodium	272.4	276	75-200	200
Potassium	26	28	10	25
Calcium	258.62	251.7	75-200	25-200
Magnesium	34.8	36.2	30	30
Iron	3.2	3.42	0.3-1.0	0.3-1.0
Manganese	0.16	0.14	0.1 - 0.3	0.5
Zinc	0.51	0.24	5	3
Aluminium	1.10	0.62	0.03 - 0.2	0.2
WQI	121.6	122	50-75	-

* All parameters in mg/L except Colour (Hazen), Conductivity (µ mhos/cm), Turbidity (NTU) pH and WQI

SS_1– Sirgitti Stock Dam and SS_2– Bannakdih.

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Table 2: Average value of physicochemical characterization of treated and untreated effluents with bio-adsorbents

Parameters	Untreated effluents	Treated effluents with bio-adsorbents			
		Cassia fistula	Adsorption Capacity (%)	*Annona squamosa*	Adsorption Capacity (%)
Colour	10.50±0.71	3.02	71.24	3.4	67.62
Temperature	30.45±0.07	29.3	-	29.4	-
PH	7.66±0.21	7.04	-	7.15	-
Conductivity	1,288.50±79.90	462.8	64.08	512.6	60.22
Turbidity	26.00±2.83	4	84.62	5.2	80.00
TS	901.23±15.55	216.44	75.98	264.4	70.66
TDS	777.50±38.55	188.64	75.74	235.2	69.75
TSS	123.75±23.03	27.8	77.54	28.2	77.21
Alkalinity	462.50±31.82	156.5	66.16	172.4	62.72
Total Hardness	444.00±67.88	90.2	79.68	104.3	76.51
Chloride	618.83±52.91	147.5	76.16	148.6	75.99
Fluoride	1.09±0.06	0.33	69.72	0.4	63.30
Sulphate	595.50±34.65	121.6	79.58	202	66.08
D.O	4.20±0.57	8.98	53.23	8.82	52.38
BOD	4.69±0.21	9.24	49.24	8.84	46.95
COD	32.91±2.39	8.2	75.08	9.14	72.23
Nitrate	51.95±1.24	14.6	71.90	20.22	61.08
Phosphate	0.10±0.03	0.04	60.00	0.05	50.00
Sodium	274.20±2.55	73.76	73.10	79.68	70.94
Potassium	27.00±1.41	8.4	68.89	8.8	67.41
Calcium	255.16±4.89	66.4	73.98	80.46	68.47
Magnesium	35.50±0.99	12	66.20	14.1	60.28
Iron	3.31±0.16	0.43	87.01	0.82	75.23
Manganese	0.15±0.01	0.02	86.67	0.04	73.33
Zinc	0.38±0.19	0.1	73.68	0.18	52.63
Aluminium	0.86±0.34	0.01	98.84	0.3	65.12
WQI	121.80±0.28	43.2	-	50.78	-

* All parameters in mg/L except Colour (Hazen), Conductivity (µ mhos/cm), Turbidity (NTU) pH and WQI

Investigation of Industrial effluents (surface water) gave following parameters: Colour, 11 Hazen; Turbidity, 28 NTU; TSS, 140.3 mg/L; Sulphate, 620 mg/L; DO, 3.8 mg/L; BOD, 4.83 mg/L; COD, 34.6 mg/L; Nitrate, 52.82 mg/L; Phosphate, 0.12 mg/L; Na, 276 mg/L; K, 28 mg/L; Ca, 258.62 mg/L; Mg, 36.2 mg/L; Fe, 3.42 mg/L; Al, 1.10 mg/L and WQI, 122 which is higher than the tolerable limit of BIS (2012) and WHO (2011). DO and BOD level implies an excessive amount of water pollutant existing in the sampling spot which is incompatible for aquatic life or any other purposes. All the investigating points exposed more than maximum WQI (>100); 76-100 WQI values (very poor water quality); intimation of intrusion of pollutants through house hold garbage and industrial effluent which is terrific concern of health.

Considerably more reduction in all physicochemical parameters was noticed when the effluent was treated with activated charcoal form biological sources i.e., bio-adsorbents (Table 2). Relatively more efficiency of bio-adsorbent was because of its organophillic nature. It has matrix of micro-pore, which yields quite more active surface area and thus making it appropriate for adsorption[26-28]. However, specific mechanisms leading initial fast rate for the pollutant removal due to surface adsorption monitored by intra-particle diffusion, which seems to be the rate governing steps in this experiment. Besides, phenomenon of adsorption can be connected to several mechanisms e.g., electrostatic pulling and repulsion, chemical interaction and ion exchange etc.[29-30].

CONCLUSION

The present study has been accomplished to assess the pollutants load on surface water around the Sirgitti industrial area and its treatment techniques by locally based bio-adsorbents. The water qualities had been marginally higher than the standard values of drinking water, higher values than the standards means very poor water quality; indication of intrusion of pollutants by house hold garbage and industrial effluent. On the idea of the above study, it is observed that the bio-adsorbent from *Cassia fistula* act as more effective bio-adsorbent for the removal of harmful water pollutants from industrial effluent than the *Annona squamosa*.

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Milan Hait
Assistant Professor
Department of Chemistry, Dr. C.V. Raman University, Kargi Road, Kota, Bilaspur, Chhattisgarh, India

Sagar Kumar Behera
M.Phil Scholar,
Department of Chemistry, Dr. C.V. Raman University, Kargi Road, Kota, Bilaspur, Chhattisgarh, India

Amit Kumar Chaturwedi
Ph. D Scholar,
Department of Chemistry, Dr. C.V. Raman University, Kargi Road, Kota, Bilaspur, Chhattisgarh, India

M. M. Vaishnav
Assistant Professor
Department of Chemistry, Govt. G. B. College, Hardibazar, Korba, Chhattisgarh, India.

Correspondence
Assistant Professor
Milan Hait
Department of Chemistry, Dr. C.V. Raman University, Kargi Road, Kota, Bilaspur, Chhattisgarh, India

Exploration of phytochemical potential on flower of *Butea monosperma*

Milan Hait, Sagar Kumar Behera, Amit Kumar Chaturwedi and M. M. Vaishnav

Abstract

Phytochemical exploration is an important step in the finding of bioactive composite present in medicinal flora. The *Butea monosperma* flower extracts and its solvent fractionates was subjected to preliminary phytochemical screening using standard phytochemical tests. The aim of the present study was to investigate the presence of phytochemicals. Soxhlet apparatus was used for the organic solvent extraction. These investigations revealed the presence of flavonoids, tannins, saponins, carbohydrates, terpenoids, alkaloids, proteins, quinones, phenols and glycosides in the flower of the plant extracts. The presence of various bioactive compounds confirms the application of *B. Monosperma* for various ailments by traditional practitioners. However, isolation of individual phytochemical constituents may proceed to find a novel drug.

Keywords: *Butea monosperma*, extraction techniques, phytochemical screening

Introduction

Medicinal floras are an origin of immense economic importance in anywhere within the earth. Nature has bestowed on us a highly rich botanical wealth and a big number of numerous forms of plants grown in a various part of the country [1]. Plants are the origin of massive quantity of medicine and used as medication on account that from the ancient. Phytochemicals are natural substances and could be acquired in both primary and secondary metabolic pathway. They are naturally synthesized in all portion of plant frame; bark, stem, root, flower, fruits, seeds, leaves, and many others [2]. The quantity and grade of photochemical observed in plant parts can also moreover fluctuate from one component to some other [3]. The most vital bioactive elements of plant are steroids, flavonoids, alkaloids, tannins, terpenoids, glycosides, and so forth. Antibiotics or antibacterial substances like saponins, glycosides, flavonoids, and alkaloids and so on, are observed to be disbursed in plants [4-6].

Butea monosperma (Lam.) Taub. (Bastard Teak, Flame of the Forest; Synonyms: *Butea frondosa* Roxb; *Butea frondosa* Willd; *Butea monosperma* (Lam.) Kuntze and *Butea braamania* DC.) Belongs to a family of fabaceae native to tropical southeastern Asia and a popularly ornamental tree grown around the world. It is a deciduous tree growing to 12–15 m tall, with a crooked trunk diameter of up to 20-40 cm in mature tree. The leaves are pinnate, with an 8-16 cm petiole and three leaflets, each leaflets 10-20 cm long. The flowers are 2.5 cm long, bright orange in color, and produced in racemes up to 15 cm long, these are appearing in spring. The fruit is a pod; about 15-20 cm long and 4-5 cm broad, ripening brown [7-11]. The plant is used in distinct parts of the world for the remedy of several illnesses like stomatitis, sores and skin troubles, constipation, ringworm, insomnia, dysentery, muscular pains, liver disorders, ulcer, tumor, fever, gonorrhea, diabetic, inflammation, fungal infection, piles, urinary disorder, asthma, leucorrhoea and is the source of a various form of chemical constituents including fatty acids, amino acids, terpenoids, phenolics, flavonoids, alkaloids, steroids, glycosides, tannins and many others [12-14]. In the prevailing have a look at, numerous solvent extracts of flower of *Butea monosperma* have been qualitatively screened for phytochemicals using standards methods.

Materials and Methods

Collection of plant materials

The flower of *Butea monosperma* was collected from Bilaspur area, C.G. in the month of March' 2019. The plant materials were taxonomically identified and authenticated by Botanical Survey of India (BSI), Central Regional Centre, Allahabad (U.P.).

Processing of Plant Materials

The plant Materials were cleaned and shade dried until all the water molecules evaporated and the dried plant materials (petals of flower) were taken and grinded into coarse powder. The powdered samples were kept in a fresh glassware vessel until needed for analysis with suitable marking.

Preparation of plant extracts

Solvent extraction

Crude plant extract was made ready by means of Soxhlet extraction techniques. About 20 gm of powdered plant material was equally packed into a thimble and extracted with 250 ml of various solvents one by one. Solvents used were petroleum ether, chloroform, ethyl acetate, acetone methanol, ethanol and water as per increasing polarity. The process of extraction continues for 24 hours or till the solvent in siphon tube of an extractor emerge as colorless. After that the extract was taken in a beaker and kept on hot plate and heated at 30-40°C till all the solvent got evaporated. Dried extract was kept in refrigerator at 4°C for their future use in phytochemical evaluation.

Qualitative phytochemical analysis

The extract was tested for the presence of bioactive compounds by using following standard methods [15-19].

Phytochemical Screening

Test for Alkaloids (Wagner's reagent)

A fraction of extract was treated with 3-5 drops of Wagner's reagent (1.27 g of iodine and 2 g of potassium iodide in 100 ml of water) and observed for the formation of reddish brown precipitate (or colouration).

Test for Carbohydrates (Molisch's test)

Few drops of Molisch's reagent were added to 2 ml portion of the various extracts. This was followed by addition of 2 ml of conc. H_2SO_4 down the side of the test tube. The mixture was then allowed to stand for two-three minutes. Formation of a red or dull violet colour at the interphase of the two layers was a positive test.

Test for Cardiac glycosides (Keller Kelliani's test)

5 ml of each extract was treated with 2 ml of glacial acetic acid in a test tube and a drop of ferric chloride solution was added to it. This was carefully underlayed with 1 ml concentrated sulphuric acid. A brown ring at the interface indicated the presence of deoxysugar characteristic of cardenolides. A violet ring may appear below the ring while in the acetic acid layer, a greenish ring may form.

Test for Flavonoids (Shinoda test)

To the extract, a few magnesium turnings and a few drops of concentrated hydrochloric acid were added and boiled for five minutes. Red coloration identifies the presence of flavonoids.

Test for Phenols (Ferric chloride test)

A fraction of the extracts was treated with aqueous 5% ferric chloride and observed for formation of deep blue or black colour.

Test for Phlobatannins (Precipitate test)

Deposition of a red precipitate when 2 ml of extract was boiled with 1 ml of 1% aqueous hydrochloric acid was taken as evidence for the presence of phlobatannins.

Test for Amino acids and Proteins (1% Ninhydrin solution in acetone).

2 ml of filtrate was treated with 2-5 drops of Ninhydrin solution placed in a boiling water bath for 1-2 minutes and observed for the formation of purple colour.

Test for Saponins (Foam test)

To 2 ml of extract was added 6ml of water in a test tube. The mixture was shaken vigorously and observed for the formation of persistent foam that confirms the presence of saponins.

Test for Sterols (Liebermann-Burchard test)

1 ml of extract was treated with drops of chloroform, acetic anhydride and conc. H_2SO_4 and observed for the formation of dark pink or red colour.

Test for Tannins (Braymer's test)

2 ml of extract was treated with 10% alcoholic ferric chloride solution and observed for formation of blue or greenish colour solution.

Test for Terpenoids (Salkowki's test)

1 ml of chloroform was added to 2 ml of each extract followed by a few drops of concentrated sulphuric acid. A reddish brown precipitate produced immediately indicated the presence of terpenoids.

Test for Quinones

A small amount of extract was treated with concentrated HCl and observed for the formation of yellow precipitate (or colouration).

Test for Oxalate

To 3 ml portion of extracts were added a few drops of ethanoic acid glacial. A greenish black colouration indicates presence of oxalates.

Results and Discussion

Results obtained for qualitative screening of phytochemicals in the flower of *B. monosperma* are delivered in Table 1. Of the thirteen phytochemicals screened for, ten were found present in various solvent extracts. They are cardiac glycosides, flavonoids, phenols, carbohydrates, saponins, tannins, alkaloids and terpenoids. Remarkably, flavonoids, phenols, quinones and terpenoids have been present within the flower of these plants. This shows that the plant part offer a much broader array of phytochemicals.

In these screening procedure alkaloids, tannins, saponins, flavonoids and terpenoids, glycosides, phenols exhibits distinct kinds of outcomes in various solvents. From the flower, water extract revealed the existence of carbohydrate, proteins, tannins, alkaloids and quinones. However, 70% ethanol and acetone had cardiac glycosides, carbohydrates, flavonoids, phenols, quinones and terpenoids. The methanol extract had the presence of alkaloids, cardiac glycosides, carbohydrate, flavonoids, phenol, tannins, proteins and terpenoids.

The medicinal value of flowers lies in some chemical substances that have a certain physiological activity on the human. Different phytochemicals had been established to have a extensive variety of activities, which may also help in protection against persistent sicknesses. Alkaloids defend against prolonged ailments. Saponins protect in opposition to hypercholesterolemia and antibiotic things. Steroids and triterpenoids show the analgesic for central nervous system actions [20].

Table 1: Result of phytochemical evaluation of flower of *Butea monosperma.*

S.N.	Phytochemicals/ Solvent Extracts	PE	CH	EA	AC	EtOH	MeOH	Water
1	Alkaloids	-	+	-	-	+	+	+
2	Cardiac Glycosides	-	+	-	+	+	+	-
3	Carbohydrates	+	+	+	+	+	+	+
4	Flavonoids	-	+	-	+	+	+	-
5	Phenols	-	+	-	+	+	+	-
6	Phlobatannins	-	-	-	-	-	-	-
7	Proteins	-	+	-	-	+	+	-
8	Saponins	+	+	-	-	-	+	+
9	Sterols	-	-	-	-	-	-	-
10	Tannins	-	-	-	+	+	+	+
11	Terpenoids	-	+	+	+	+	+	-
12	Quinones	+	+	+	+	+	+	+
13	Oxalates	-	-	-	-	-	-	-

+ = present; - = absent; PE = Pet. Ether; CH = Choloform; EA = Ethyl acetate; AC = Acetone; EtOH = Ethyl alc; MeOH = Methyl alc.

The result specifies that *Butea monosperma* flower hold assurance as source of therapeutically significant phytochemicals. Flavonoids generally present in areal components like flowers play a few metabolic roles and regulate improvement in living organism. They are also comprise in defensive action in animals and are used as remedy particularly the flavonol glycosides. Tannins are recognized to inhibit pathogenic fungi. The flavonoids and phenolic compounds in plant have been stated to exert a couple of organic consequences together with antioxidant, free radical scavenging abilities, anti-inflammatory, anti-carcinogenic and so on [21].

Conclusion

Phytochemicals detected in flower extracts of *Butea monosperma* specifies their ability as a source of ideas which could deliver novel drugs. Thus the plant studied may be used as an effective origin of latest valuable remedies. The phytochemical characterization of the extracts, the isolation of accountable bioactive components and their biological activity are important for future investigations. Further studies are therefore recommended to verify their antitumor, anticancer and antiulcer, antipyretic, antidiabetic, anti-inflamatory activities etc.

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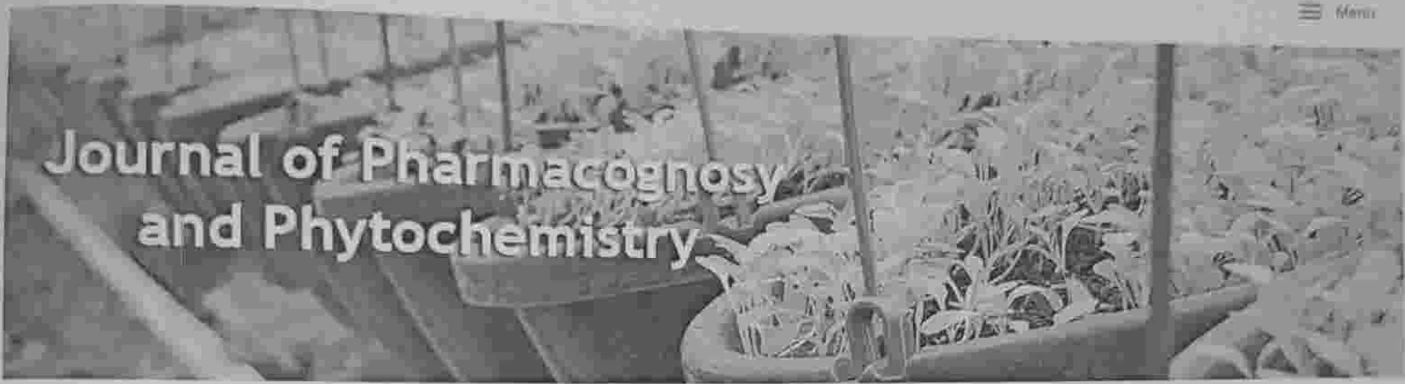

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"I try to give to the poor people for love what the rich could get for money. No, I wouldn't touch a leper for a thousand pounds; yet I willingly cure him for the love of God."

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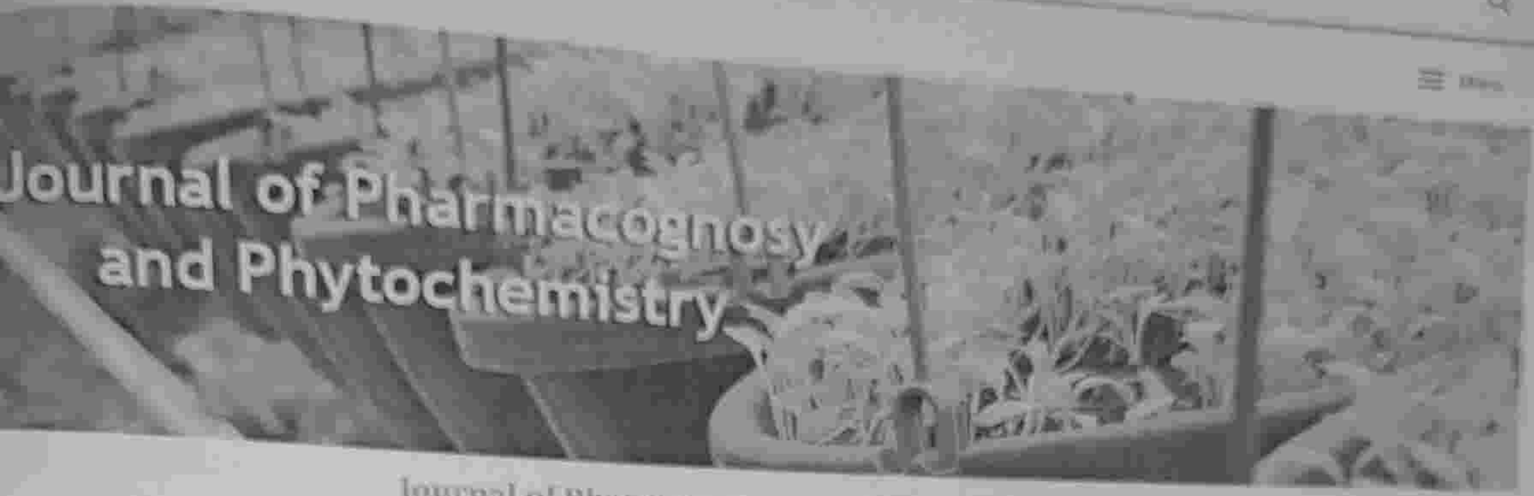

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Milan Hait
Assistant Professor
Department of Chemistry, Dr. C.V. Raman University, Kargi Road, Kota, Bilaspur, Chhattisgarh, India

Arvind Kumar Bhardwaj
M. Phil Scholar,
Department of Chemistry, Dr. C.V. Raman University, Kargi Road, Kota, Bilaspur, Chhattisgarh, India

Nand Kumar Kashyap
Ph. D Scholar,
Department of Chemistry, Dr. C.V. Raman University, Kargi Road, Kota, Bilaspur, Chhattisgarh, India

M. M. Vaishnav
Assistant Professor
Department of Chemistry, Govt. G. B. College, Hardibazar, Korba; Chhattisgarh, India

Correspondence
Milan Hait
Assistant Professor
Department of Chemistry, Dr. C.V. Raman University, Kargi Road, Kota, Bilaspur, Chhattisgarh, India

Physicochemical and phytochemical evaluation on non-areal part of *Curcuma caesia*

Milan Hait, Arvind Kumar Bhardwaj, Nand Kumar Kashyap and M. M. Vaishnav

Abstract
Curcuma caesia rhizome extracts and its solvent fractionates were subjected to physicochemical and preliminary phytochemical screening using standard tests. The present study deals with phytochemical explorations of non-aerial part (rhizome) of *Curcuma caesia* comprising determination of loss on drying, ash values and extractive values. The qualitative chemical investigations exposed the existence of different phytoconstituents like flavanoids, terpenoids, saponins, phenolic compounds, steroids, alkaloids, quinones, proteins, carbohydrates, tannins and glycosides in the rhizome of the plant extracts. The occurrence of many bioactive constituents affirms the utilization of *C. caesia* for several disorders by traditional practitioners. The study disclosed specific individualities for the particular crude drug which will be suitable in recognition and control to adulterate of the raw drug.

Keywords: *Curcuma caesia*, physicochemical analysis, extraction techniques, phytochemical screening

Introduction

Nature has the huge reservoirs of therapeutically active constituents. Since the primitive age, plants have functioned as the enormous origin of raw ingredients for customary as well as modern remedy [1, 2]. Many countries still rely mainly on medicinal herbs for the curing of several contagious infections due to their low cost and slighter side effects. Orthodox tropical medicinal floras could help as a good source of novel consistent, ecofriendly and sustainable medicines for the remedial of many ailments [3, 4]. The therapeutic value of plants is mainly due to the occurrence of some phytochemicals. They are essentially plant metabolites, are produced in all part of plant organism by itself and have some specific functional operation on animals [5, 6].

Curcuma caesia Roxb. (Black Turmeric, Syn. *Curcuma kuchoor* Royle) belongs to the family Zingiberaceae. Vernacular name: English- Black zedoary; Hindi- Kali Haldi, Nar Kachura, Krishna Kedar; Sanskrit- Rajani, Nishaa, Nishi, Raatri; Bengali- Kala haldi; Assamese- Kala haladhi; Telugu- Nalla Pasupu, Manupasupu; Marathi- Kala-haldi; Manipuri- Yaingang Amuba or yaimu; Mizo-Aihang, Ailaihang. It is a rhizomatous herbs which is found throughout India and other parts of tropical climate around the world. *Curcuma caesia* is an herbaceous perennial with erect to semi-erect plant stature. It is a rhizomatous aromatic herb with a leafy bunch and 30-60 cm long. Leaves are large, long, petiolate, oblong-lanceolate shaped with an acuminate leaf apex, tapering at both ends, glabrous and green on both sides. Corolla is long tubular, pale yellow lip-3 lobe semi- elliptic. *Curcuma caesia* has a lateral or central inflorescence on a long erect peduncle, covered with 5–6 sheaths, and hidden by the sheathing bases of the leaves. Inflorescence is a spike, about 15 cm long or altogether about 30 cm high on basal peduncle. Flowers are pale yellow, reddish at the outer border and shorter than their bracts. Petiole and sheath are about as long as the blade. Spikes appear before the leaves. Flowers appear in June and July, while fruits mature in September and October [7-12].

The rhizome is tuberous with camphoraceous sweet odor, about 2–6 cm in diameter, the shape and size is often variable. It is sessile, laterally flattened, and covered with adventitious roots, root scars, and warts; moreover, it shows longitudinal circular wrinkles on the surface giving the look of nodal and internodal zones to the rhizome. The surface (cork) of rhizome is dark brown, bluish black, or buff in color; it shows circular arrangements of remnants of scaly leaves, which gives a false impression of growth rings. The branching is more or less sympodial. It has many pharmacological activities like *in-vitro* anti-diabetic, antioxidant, antimicrobial, analgesic, anti-cancer, antiulcer, antiemetics, antiviral, antitumor, anti-inflammatory, anti-tubercular, anti-asthmatic, anti-hyperglyceridemic, astringent, anti-diarrhoetic and antipyretic effects [7-14]. In the present paper, the physicochemical parameters and preliminary phytochemical potential of different solvent extracts of non-aerial part (rhizome) of *Curcuma caesia* were executed for identification of the drug in dry form and control the adulterants.

Materials and Methods

Collection of plant materials

The rhizome of *curcuma caesia* was collected from Indra Gandhi Krishi Viswavidyalaya area, Raipur (C.G.) in the month of February' 2019. The plant materials were taxonomically identified and authenticated by Principal Scientist, Centre of Excellence on Medicinal and Aromatic Plants, Indra Gandhi Krishi Viswavidyalaya, Raipur (C.G.).

Processing of plant materials

The plant Materials were cleaned, washed with fresh water and shade dried until all the water molecules evaporated, cut into pieces, and the shed dried plant materials (rhizome) was taken and grinded into coarse powder. The powdered samples were stored in a clean and air tight glass container with proper labeling for analysis.

Preliminary physicochemical characteristics

Air dried rhizomatous materials were used for quantitative determination of proximate analysis e.g., loss on drying, total ash, acid insoluble ash, alcohol soluble extractive values. These physicochemical studies were done according to standard procedure of Indian Pharmacopoeia and WHO guidelines [15-18].

Preparation of plant extracts

Solvent extraction

Crude plant extract was prepared by Soxhlet extraction method. About 50 gm of powdered plant material was uniformly packed into a thimble and extracted with 250 ml of different solvents separately. Solvents used were petroleum ether, chloroform, ethyl acetate, acetone methanol, ethanol and water as per solvent polarity. The process of extraction continues for 24 hours or till the solvent in siphon tube of an extractor become colorless. After that the extract was taken in a beaker and kept on water bath and heated at 30-40°C till all the solvent got evaporated. Dried extract was kept in refrigerator at 4°C for their future use in phytochemical analysis.

Qualitative phytochemical analysis

The extracts were tested for the presence of bioactive components by using following standard methods [19-22].

Phytochemical Screening:

Test for Alkaloids (Wagner's test)

A fraction of extract was treated with 3-5 drops of Wagner's reagent (1.27 g of iodine and 2 g of potassium iodide in 100 ml of water) and observed for the formation of reddish brown precipitate (or colouration).

Test for Carbohydrates (Molisch's test)

Few drops of Molisch's reagent were added to 2 ml portion of the various extracts. This was followed by addition of 2 ml of conc. H_2SO_4 down the side of the test tube. The mixture was then allowed to stand for two-three minutes. Formation of a red or dull violet colour at the interphase of the two layers was a positive test.

Test for cardiac glycosides (Keller Kelliani's test)

5 ml of each extract was treated with 2 ml of glacial acetic acid in a test tube and a drop of ferric chloride solution was added to it. This was carefully underlayed with 1 ml concentrated sulphuric acid. A brown ring at the interface indicated the presence of deoxysugar characteristic of cardenolides. A violet ring may appear below the ring while in the acetic acid layer, a greenish ring may form.

Test for flavonoids (Shinoda test)

To the extract, a few magnesium turnings and a few drops of concentrated hydrochloric acid were added and boiled for five minutes. Red coloration identifies the presence of flavonoids.

Test for phenols (Ferric chloride test)

A fraction of the extracts was treated with aqueous 5% ferric chloride and observed for formation of deep blue or black colour.

Test for phlobatannins (Precipitate test)

Deposition of a red precipitate when 2 ml of extract was boiled with 1 ml of 1% aqueous hydrochloric acid.

Test for amino acids and proteins (1% Ninhydrin solution in acetone).

2 ml of filtrate was treated with 2-5 drops of ninhydrin solution placed in a boiling water bath for 1-2 minutes and observed for the formation of purple colour.

Test for saponins (Foam test)

To 2 ml of extract was added 6ml of water in a test tube. The mixture was shaken vigorously and observed for the formation of persistent foam that confirms the presence of saponins.

Test for sterols (Liebermann-Burchard test)

1 ml of extract was treated with drops of chloroform, acetic anhydride and conc. H_2SO_4 and observed for the formation of dark pink or red colour.

Test for tannins (Braymer's test)

2 ml of extract was treated with 10% alcoholic ferric chloride solution and observed for formation of blue or greenish colour solution.

Test for terpenoids (Salkowski's test)

1 ml of chloroform was added to 2 ml of each extract followed by a few drops of concentrated sulphuric acid. A reddish brown precipitate produced immediately indicated the presence of terpenoids.

Test for Quinones

A small amount of extract was treated with concentrated HCl and observed for the formation of yellow precipitate (or colouration).

Test for oxalate

To 3 ml portion of extracts were added a few drops of ethanoic acid glacial. A greenish black colouration indicates presence of oxalates.

Results and Discussion

Results obtained for quantitative determination of proximate analysis and qualitative phytochemical screening of *C. caesia* rhizome is exhibited in Table 1 & 2. Total thirteen phytochemicals were screened in which eleven were found present in different solvent extracts. They are cardiac glycosides, flavonoids, phenols, carbohydrates, saponins, tannins, alkaloids, sterols, quinones, proteins and terpenoids. Remarkably, carbohydrate, flavonoids, phenols, saponins, tannin, alkaloids, quinones, amino acids and terpenoids were present in the rhizome of these plants. This indicates that the rhizomes have large possibilities of phytochemicals.

Physiochemical parameters of the *Curcuma Caesia* Roxb rhizome are shown in Table 1. Different extracts of the powdered rhizome were prepared for the study of extractive values. Percentage of extractive values was calculated with reference to the air dried drug. The results are shown in Table 1. Deterioration time of the plant material depends upon the amount of water present in plant material. If the water content is high, the plant material can be easily deteriorated due to fungus. The loss on drying at 105°C in rhizome was found to be 10.02 %. Total Ash value of plant material indicated the amount of minerals and earthy materials attached to the plant material. Analytical results showed total Ash value content was 9.00 %. The negligible amount of acid insoluble siliceous matter present in the plant was 4.49 %. The alcohol soluble extractive values indicated the presence of polar constituents like phenols, alkaloids, steroids, glycosides, flavonoids etc.

In these screening process alkaloids, tannins, saponins, flavonoids and terpenoids, glycosides and phenols shows different types of results in different solvents. From the rhizome, water extract showed the presence of carbohydrate, alkaloids, saponins and tannins. However, ethanol and acetone had the presence cardiac glycosides, carbohydrates, flavonoids, phenols, saponins, proteins, alkaloids and terpenoids. The methanol extract had the presence of cardiac glycosides, carbohydrate, alkaloids, flavonoids, phenol, tannins, saponins, phenols, sterols, quinones, proteins and terpenoids.

Different phytochemicals have been found to possess a wide range of activities, which may help in protection against diseases. Alkaloids protect against chronic diseases. Saponins protect against hypercholesterolemia and antibiotic properties. Steroids and triterpenoids show the analgesic for central nervous system activities [23].

Table 1: Physicochemical analysis of rhizome of *Curcuma caesia*

S.N.	Parameters	Results (% w/w)
1	Total Ash	9.00
2	Acid insoluble Ash	4.49
3	Water insoluble Ash	2.56
4	Water soluble extractive value	13.53
5	Alcohol soluble extractive value	6.08
6	Loss on Drying	10.02

Table 2: Result of phytochemical evaluation of rhizome of *Curcuma caesia*

S.N.	Phytochemicals/ Solvent Extracts	Pet. Ether	Chloroform	Ethyl acetate	Acetone	Ethanol	Methanol	Water
1	Alkaloids	-	-	+	+	+	+	+
2	Cardiac Glycosides	-	+	+	+	+	+	-
3	Carbohydrates	-	+	+	+	+	+	+
4	Flavonoids	-	+	+	+	+	+	-
5	Phenols	-	+	-	+	+	+	+
6	Phlobatannins	-	-	-	-	-	-	-
7	Proteins	+	+	-	+	+	+	-
8	Saponins	+	+	-	+	+	+	+
9	Sterols	+	+	+	-	-	+	+
10	Tannins	-	-	-	-	-	+	+
11	Terpenoids	+	+	-	+	+	+	-
12	Quinones	+	+	-	+	-	+	-
13	Oxalates	-	-	-	-	-	-	-

+ = present; - = absent.

The result indicates that *Curcuma caesia* rhizome carry potentials as source of pharmaceutically significant phytochemicals. Flavonoids present in non-areal parts like rhizomes play some metabolic role and control development in living system. Tannins are known to inhibit pathogenic fungi. The flavonoids and phenolic compounds in plant have been reported to exert multiple biological effects including antioxidant, free radical scavenging abilities, anti-inflammatory, anti-carcinogenic, astringent, anti-diabetic, anti-tubercular, antipyretic effects etc. [24, 25].

Conclusion

Proximate analysis is beneficial for checking reality and clarity of sample and also these values are significant for qualitative standards. The screening of a crude drug is essential for biochemical alteration in the drug, degradation due to handling, storage and substitution and contamination. Preliminary Phytochemical screening is a part of chemical exploration. The qualitative chemical test is useful in exposure of contamination. Phytochemicals found in rhizome extracts of *Curcuma caesia* indicates their prospect as a resource herbal remedy. The results from the ash value, acid insoluble ash and water soluble ash values implied that the rhizome holds noticeable amount of inorganic salts. The phytochemical characterization of the extracts, the isolation of important bioactive composites and their biological activity are inevitable for future studies. Standardization of bioactive extracts procured from the medicinal plant will be conceded on the basis of the phytochemical components exist in that plant, which is a vital step in recognizing novel and potent sources of medically and industrially significant constituents.

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A SURVEY OF FLUORIDE DISTRIBUTION IN THE UNDERGROUND WATER OF CENTRAL INDIA

K Venu Achari[1] and S Krishnamurthy[2]

[1]Deparment of Zoology, Government Madan Lal Shukla College Seepat Bilaspur - 495555 India
[2]Deparment of Chemistry, Government G B College, Hardi Bazar, Korba - 495446 India

Abstract: India is among 23 nations around the globe where health problems occur due to excess ingestion of fluoride (> 1.5 mg/L) in drinking water. An exploratory qualitative survey was conducted of the community regarding fluoride and related health problems in central India. The study indicated that, except at two sampling station viz. Chhattisgarh, the fluoride levels in drinking water is within the prescribed limit of WHO standards. It is significant to state that the study area exhibit marginal levels of fluoride contents (1.4 mg/L). The study revealed the heterogeneous fluoride distribution in the underground water and the result of these analyses are concluded that proper defluoridation measures seems to be needed to protect the habitants of central India from the problems of fluorosis.

Keywords: Hand pump water, fluoride, de-fluoridation

INTRODUCTION

Study area is situated in the centre of Chhattisgarh and it has been explored for fluoride distribution in the underground water (Achari and Krishnamurthy, 2015). These distributions have been conducted in various seasons of the years from July 2018 to December 2018 within the significant biodiversified territory of Chattisgarh located in the centre part of Chattisagrh, positioned at 21.47°N latitude and 81.14°E longitude. Temperature varies from 20° C to 48°C. People of this region have divergent way of life and civilization, enriched as it is with south eastern central railway zone, high court, national thermal power of corporation and very diverse population comprising to a number of tribes. The individual of Chhattisgarh be desperate to commence agriculture, sericulture and horticulture. Life here is governed by urban customs, culture and traditions. In the rural areas of the region, people are dependent largely on agriculture and minor forest produce. Further groundwater is a major source of drinking water in urban and rural areas. Near about ninety percent of the rural population uses groundwater for household purposes. Nearly one third of the population of study area is illiterate, not at all aware of the water borne diseases affecting their health. Millions of people all over the world, including Indian are suffering with fluorosis due high concentration of fluoride in the drinking water (Achari and Krishnamurthy, 2015; Chuah *et al* 2016; Junyong *et al* 2016; Mohammadi *et al* 2017). When the fluoride level cross the optimum concentration i.e., 1.5 mg/L, then it exhibit the toxic effects in the human body. Long-term exposure to high level of fluoride can caused several adverse effects on human health including dental and skeletal fluorosis (Mohammadi *et al* 2017).

The Indian districts such as Andhra Pradesh, Tamilnadu, Karnataka, Kerla, Rajasthan, Delhi, Bihar, Jharkand, Uttar Pradesh, Orrisa, Jammu Kashmir have been reported to contain high fluoride levels (Rammamohan, 1964; Rao, 1974; Susheela, 1993; WHO, 1994) rendering these areas of the contrary as either affected areas from fluorosis to various extends or to the risk of the same (Achari and Krishnamurthy, 2015). Near about one lack people of Assam (Karbi Anglong district) affected by excessive fluoride levels in ground water in June 2000. The symptoms were anemia, stiff joints, painful and restricted movement, mottled teeth and kidney failure. Moreover fluoride in the water, other factors contribute to the endemic fluoride problem such as nutritional deficiencies, high ambient temperature, high water alkalinity, low calcium and vitamin C intake. Moreover, there has also been large increase in the use of fluoride-containing sachets of *pan masala, gutka* (containing tobacco), and mouth washes and mouth rinses in Chhattisgarh.

MATERIALS AND METHODS

Central India exhibit variety of ecosystems ranging from mountains supporting thick forests, coastal plains, we were selected seven sampling station at various locations in the study area with view to cover most of the segment of the Chhattisgarh. These sampling stations were *A1 = Bilaspur, A2 = Seepat, A3 = Belha, A4 = Gourella, A5 = Marwahi, A6 = Takatpur, A7 = Lormi*. Water samples were collected from the public hand pumps situated at these sampling sites on monthly basis over a period of half calendar year. These samples were taken to laboratory and subsequently analyses for their fluoride contents. The analysis of fluoride contents were performed spectro-photometrically using ALPHA, AWWA and APCF (1985) Standard Method for Examination of Water and Wastewater. The de-colorization of SPANDS Zitconyl complex was found to follow a linear relationship with fluoride contents.

RESULTS AND DISCUSSION

The study reveals the heterogenous fluoride distribution in the underground water of the area and the results of these analyses are reported (Table 1). All the groups of sampling station the fluoride level was within permissible fluoride limits for drinking water as recommended by WHO (WHO,1970; National research, 1977; WHO guidelines, 1984). The frequency distribution of fluoride was different in the A3 - Belha and A4 -Gourella groups characterized by relatively higher concentration (Table 1). These groups exhibit nearly equal to maximum permissible limits (1.5 mg/L) recommended by WHO (WHO guidelines, 1984). The effect of fluoride in human body differs individually, but the common person is evidence for prevention of tooth decay, strengthening of skeleton in 0.8–1.2 mg/L fluoride concentration (Achari and Krishnamurthy, 2015; Mohammadi *et al* 2017). Similarly Mohammadi and his colleque (2017) worked on river and well water by SPANDS method and suggested for the de-fluoridation from the immediate effects. Further when the concentration exceeds more than 1.5 mg/l, Fluorosis occurs in which pitting of tooth enamel and deposits in bones are common phenomenon (Achari and Krishnamurthy, 2015; Chuah *et al* 2016; Junyong *et al* 2016). Subsequently when about 10 mg/L, fluoride in the drinking water confirm the signs of Crippling skeletal fluorosis (Deshmukh and Malpe, 1996). Therefore, it is remarkable that proper de-fluoridation measures seem to be needed to protect the populations of Belha and Gourella area from the problems of fluorosis. The removal of fluoride from drinking water is common now, Junyong *et al* (2016) used Freundlich model based on ultralong hydroxyapatite nanowires which is a thermodynamic parameters suggest that the adsorption of fluoride in a spontaneous endothermic phenomenon. The maximum of adsorption capacity of this model is 40.65 mg/g at pH 7.0 when the fluoride concentration is 200 mg/L. Similarly other models are also available for the removal of fluoride from drinking water (Zheng *et al* 2016).

Table 1 : Fluoride distribution in Bilaspur District

SN	Sample	Concentration of Fluoride (mg/L)					
		July	Aug	Sept	Oct	Nov	Dec
A1	Bilaspur	0.20	0.23	0.34	0.40	0.44	0.38
A2	Seepat	0.22	0.25	0.24	0.35	0.34	0.38
A3	Belha	**0.18**	**1.02**	**1.25**	**1.20**	**1.22**	**1.10**
A4	Gourella	**1.38**	**1.39**	**1.39**	**1.40**	**1.40**	**1.36**
A5	Marwahi	0.43	0.46	0.34	0.41	0.47	0.39
A6	Takatpur	0.21	0.24	0.29	0.38	0.39	0.36
A7	Lormi	0.29	0.34	0.44	0.31	0.36	0.40

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FLUORIDE DISTRIBUTION IN THE UNDERGROUND WATERS OF KORBA INDUSTRIAL TOWNSHIP

S. Krishnamurthy[1], K. Venu Achari[2]

[1]Deparment of Chemistry, Government G B College, Hardi Bazar, Korba - 495446 India
[2]Deparment of Zoology, Government Madan Lal Shukla College Seepat Bilaspur - 495555 India

Abstract: **An exploratory qualitative survey was conducted of the community regarding fluoride and related health problems in Korba industrial township (22°-23°5' N latitude and 82°5'-83°E longitude) of eastern Chhattisgarh. The study indicated that, except at one sampling station viz. Kusmunda, the fluoride level v ~s within the prescribed limit of WHO standards for drinking waters, Kusmunda water showed marginal levels of fluoride contents(1.4mg/L). The study revealed the heterogeneous fluoride distribution in the underground water and the result of these analyses are concluded that proper defluoridation measures seems to be desirable to protect the habitants of Chattisgarh from the problems of fluorosis.**

Keywords: **fluoride distribution, underground water, health problems, drinking waters.**

1. INTRODUCTION

Study area is positioned in the eastern part of Chhattisgarh and it has been explored for fluoride distribution in the underground water (Achari and Krishnamurthy, 2015; Achari and Krishnamurthy, 2019). These distributions have been conducted in various seasons of the years from March 2018 to February 2019 within the significant biodiversified territory of Chattisgarh located in the eastern part of Chattisagrh, positioned at 22°-23°5' N latitude and 82°5'-83°E longitude. Temperature varies from 28° C to 46°C. People of this region have divergent way of life and civilization, enriched as it is with Bharat Aluminium Company Limited, National thermal power of corporation and very diverse population comprising to a number of tribes. The individual of Korba district be desperate to commence agriculture, sericulture and horticulture. Life here is governed by urban customs, culture and traditions. In the rural areas of the region, people are dependent largely on agriculture and minor forest produce. Further groundwater is a major source of drinking water in urban and rural areas. Near about ninety percent of the rural population uses groundwater for household purposes. Nearly one third of the population of study area is illiterate, not at all aware of the water borne diseases affecting their health. Several people all over the world are suffering with fluorosis due high concentration of fluoride in the drinking water (Achari and Krishnamurthy, 2015; Achari and Krishnamurthy, 2019; Chuah *et al* 2016; Junyong *et al* 2016; Mohammadi *et al* 2017). When the fluoride level cross the optimum concentration i.e., 1.5 mg/L, then it exhibit the toxic effects in the human body. Long-term exposure to high level of fluoride can caused several adverse effects on human health including dental and skeletal fluorosis (Mohammadi *et al* 2017).

The Indian districts such as Bihar, Jharkand, Uttar Pradesh, Odissa, Delhi,Andhra Pradesh, Tamilnadu, Karnataka, Kerla, Rajasthan, and Jammu Kashmir have been reported to contain high fluoride levels (Rammamohan, 1964; Rao, 1974; Susheela, 1993; WHO, 1994) rendering these areas of the contrary as either affected areas from fluorosis to various extends or to the risk of the same (Achari and Krishnamurthy, 2015; Achari and Krishnamurthy, 2019). Moreover fluoride in the water, other factors contribute to the endemic fluoride problem such as nutritional deficiencies, high ambient temperature, high water alkalinity, low calcium and vitamin C intake. Moreover, there has also been large increase in the use of fluoride-containing sachets of *pan masala, gutka* (containing tobacco), and mouth washes and mouth rinses in Chhattisgarh.

2. MATERIAL AND METHODS

Korba district exhibit variety of ecosystems ranging from mountains supporting thick forests, coastal plains, we were selected seven sampling station at various locations in the study area with view to cover most of the segment of the Chhattisgarh. Seven sampling stations were selected at various locations in the area study with a view to cover most of the urban segments. These sampling stations were S^1 = Korba Railway stations S^2 = Korba old bus station; S^3= Kusmunda; S^4= Balco city; S^5= Balco outer, S^6 = Gevara and S^7 = Deepka. Water samples were collected from the public hand pumps situated at these sampling sites on monthly basis over a period of one calendar year. These sample were taken to laboratory and subsequently analysed for their fluoride contents. The analysis of fluoride contents were performed spectro photometrically using SPADNS method. The decolorisation of SPADNS Zitconyl complex was found to follow a linear relationship with fluoride contents.

3. RESULT AND DISCUSSION

An exploratory qualitative survey reveals the different fluoride distribution in the underground water of the study area and the results of these analyses are descriped (Table 1). All the groups of sampling station the fluoride level was within permissible fluoride limits for drinking water as recommended by WHO (WHO,1970; National research, 1977; WHO guidelines, 1984). The frequency distribution of fluoride was different in the S^3 Kusmunda characterized by relatively higher concentration (Table 1). These groups exhibit nearly equal to maximum permissible limits (1.5 mg/L) recommended by WHO (WHO guidelines, 1984). The effect of fluoride in human body differs individually, but the common person is evidence for prevention of tooth decay, strengthening of skeleton in 0.8–1.2 mg/L fluoride concentration (Achari and Krishnamurthy, 2015; Achari and Krishnamurthy, 2019; Mohammadi *et al* 2017). Similarly Mohammadi and his colleque (2017) worked on river and well water by SPANDS method and suggested for the de-fluoridation from the immediate effects. Further when the concentration exceeds more than 1.5 mg/l, Fluorosis occurs in which pitting of tooth enamel and deposits in bones are common phenomenon (Achari and Krishnamurthy, 2015; Chuah *et al* 2016; Junyong *et al* 2016). Subsequently when about 10 mg/L, fluoride in the drinking water confirm the signs of Crippling skeletal fluorosis (Deshmukh and Malpe, 1996). Therefore, it is remarkable that proper de-fluoridation measures seem to be needed to protect the populations of Belha and Gourella area from the problems of fluorosis. The removal of fluoride from drinking water is common now, Junyong *et al* (2016) used Freundlich model based on ultralong hydroxyapatite nanowires which is a thermodynamic parameters suggest that the adsorption of fluoride in a spontaneous endothermic phenomenon. The maximum of adsorption capacity of this model is 40.65 mg/g at pH 7.0 when the fluoride concentration is 200 mg/L. Similarly other models are also available for the removal of fluoride from drinking water (Zheng *et al* 2016).

TABLE 1: FLUORIDE DISTRIBUTION IN KORBA INDUSTRIAL TOWNSHIP

		FLOURIDE CONCENTRATIONS (mg/L)											
S.No	SAMPLING	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19
1	S^1 Korba RLY Station	1.09	1.22	1.24	1.19	1.02.	1.08	1.18	1.08	1.15	1.2	1.22	1.1
2	S^2 Korba OLD Bus Station	1.2	1.24	1.26	1.21	0.86	1.16	1.2	1.16	0.98	0.86	1	0.96
3	S^3 Kusmunda	1.38	1.41	1.43	1.45	1.22	1.28	1.38	1.48	1.41	1.44	1.4	1.36
4	S^4 BALCO City	1.22	1.26	1328	1.24	0.99	1.15	1.2	1.24	1.31	1.24	1.28	1.2
5	S^5 BALCO Outer	1.16	120	1.25	1.21	1.03	1.17	1.22	1.21	1.1	1.06	1.09	1.18
6	S^6 Gevra	1.1	0.96	1.14	1.18	1.02	1.21	1.29	1.22	1.22	1.3	1.2	0.9
7	S^7 Deepka	1.02	0.89	1.1	1.16	0.89	1.08	1.16	1.21	1.15	1.24	1.2	0.88

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International Journal of Life Sciences Research (IJLSR) is one of the leading Journals in the field of Life Sciences. It is referred journal having high citation. This Journal invites articles of original scientific research work, Informative reviews, Comparative studies, and brief communications. Articles which are most preferred for publications are precise, accurate, adequate, complete, and newness should be there by which editorial board members feel interesting. All articles are given equal importance every time during whole submission to decision of manuscript is done. All submitted scientific research Work are fast screened by Editorial Board or others concerned members to make the publication process of manuscripts rapid. After getting acceptance from reviewer manuscript published on same day.

Publication frequency:

Journals issues finalises every Quarter. Current status of the manuscript can be tracked just by filling number allotted to manuscript at the time of submission of paper easily on website. Generally review process takes 5 to 10 days but this can be extended more.

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Principal
Govt. G.B. College
Hardi Bazar, Korba (C.G.)

Important Topic Covered

Some of the important topics are Affective Neuroscience, Anatomy, Animal Sciences, Apiculture, Aquaculture, Astrobiology, Behavioural Biology, Biochemistry, Biocomputers, Biocontrol, Biodiversity and Conservation, Biodynamics, Biogeography, Bioinformatics, Biological engineering, Biology, Biomaterials, Biomechanics, Biomedical science, Biomedicine, Biomonitoring, Biopharmaceutics, Biophysics, Biopolymers, Biotechnology, Botany, Cell biology, Cognitive neuroscience, Computational neuroscience, Conservation biology, Cryobiologym, Developmental biology, Ecology, Embryology, Environmental Impact Assessment, Environmental science, Ethnobiology, Ethology, Evolutionary biology, Evolutionary genetics, Fisheries, Food and Nutrition And Genomics, Food science, Genetics, Genomics, Gerontology, Health sciences, histoenzymology, Immunogenetics, Immunology, Immunotherapy, Limnology, Marine biology, Medical devices, Medical Sciences, Microbiology, Molecular biology, Neuroethology, Neuroscience, Novel Drug Delivery, Oncology, Optometry, Paleontology, Parasitology, Pathology, Pest Management, Pharmaceutical Analysis, Pharmaceutics, Pharmacogenomics, Pharmacognosy, [illegible]ology, Physiology, Population dynamics, Proteomics, Psychology, Radiobiology, Sericulture, [illegible]ogy, Soil biology, Sports science, Structural biology, Systematics, Systems biology, Taxonomy, [illegible]culture, Toxicology, Veterinary Sciences, Wild Life, Zoology, etc.

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Principal
Govt. G.B.College
Hardi Bazar, Korba (C.G.)

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