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Herbs and copper effect on physical properties of water

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ABSTRACT

The present experiment is to study the effect of Tulasi, kusha, and copper on the Physical properties of water. In the study, commonly growing Tulasi (basil), and dry kusha, and the commercially available copper wire were used. Tulasi, kusha, and copper with a weight of 100 mg, 250 mg, and 500 mg were used. Materials were immersed in the glasses with 100 ml water and conductivity, turbidity, and pH of the water was measured at the time duration of immediate, two hours, four hours, six hours, and 24 hr. The Experiment conducted for five trials with three replications each and a total of 15 numbers. Kruskal-Wallis test was applied to assess changes between groups in all variables. Tulasi and copper decrease conductivity and turbidity of water irrespective of their weight while there was an exponential significant increase of these properties of water by kusha with the direct relation of its weight during all the duration of time. Tulasi, kusha, and copper decrease the pH of water for all the duration of time, and this decreasing trend is more by increasing their weight. Tulasi and copper decrease conductivity and turbidity of water while kusha increases these properties. All these materials decrease the pH of water during all the duration of time and this decreasing trend is more by increasing their weight.

Keywords**:** *Tulasi, Kusha, Copper, Conductivity, Turbidity, pH*

1. INTRODUCTION

Water is the most important factor for all living beings; therefore, it is necessary to protect its quality. Many people in developing countries don't have access to good quality water. Thus, proper water quality mechanism and sense of awareness must be created among people. General water quality parameters are temperature, conductivity, turbidity, pH and dissolved oxygen (DO). These parameters are routinely measured in order to maintain the quality of water [1]. The Conductivity is the ability of a solution to carry electric current. Total dissolved substances (TDS) also known as turbidity stands for total dissolved solids and denote the total concentration of dissolved substances in the water. Generally, conductivity and TDS share a linear relationship in natural water. The more the number of salts dissolved in the water, the higher is the conductivity. If water is pure without salts or minerals, then such highly pure water has low electrical conductivity [2]. Children may be associated with higher risk of fracture, certain neurodegenerative diseases, preterm birth and low weight at birth by the intake of soft water, i.e. water low in calcium. The concentrations of TDS which are mixed in water can be good if the body needs them. But if they exceed their limit, they may end up causing serious harm also. pH stands for potential of hydrogen. pH is defined as the number of hydrogen ions available in a solution. It helps to determine the acidity or alkalinity of water-soluble substances. The pH value ranges from 1 to 14 where 1 is the most acidic, 14 is most alkalinity and 7 being the neutral value. Generally higher the pH, the higher the level of corrosion in the water. In this way, pH can indirectly influence the health by increased ingestion of metals from plumbing and pipes or inadequate disinfection. Contaminated water is a potential health hazard but pure water devoid of natural minerals is also another extreme, which affects health adversely [3]. Reverse osmosis is said to remove healthy minerals like calcium and magnesium apart from harmful ones like lead [4]. It is estimated that 18% of the world's population have no access to clean drinking water. Water along with sanitation determines health in developing countries and also is an important indicator of development [5]. Some of the water-borne diseases are ringworm, cholera, dengue, diarrhea, malaria, lead poisoning, malnutrition, and typhoid [6]. Villagers in India had suffered arsenic skin lesions due to arsenic above 50 µg/lt in groundwater samples. The arsenic was detected over the limit in hair, nails, and urine [7]. Therefore, providing clean drinking water is imperative for any country for the holistic development of its people. Ayurveda mentions various methods to identify impure water and suggests the use of herbs (like tulasi - Ocimum tenuiflorum (synonym Ocimum sanctum), commonly known as holy basil) and metals like copper to improve the quality of drinking water. Nature has bestowed us with medicinal plants of great economic value. Most of the chemical disinfectants generate harmful by-products. Therefore, we must find traditional methods for water purification. A few leaves of tulasi dropped in drinking water or foodstuff can purify it by killing the germs in it. The seeds of tulasi destroyed the mosquitocidal larvae present in the water within 1 hr. The larvae, after coming into contact with the seeds, became firmly attached to it and died due to drowning [8]. Tulasi's antimicrobial activity against a range of human and animal pathogens suggests that it

can be used as a hand sanitizer, mouthwash, and water purifier as well as in animal rearing, wound healing, herbal raw materials and the preservation of foodstuffs [9]. Tulasi leaves sprinkled over cooked food prevents bacterial growth during the eclipses [10]. In addition to this, water-soluble flavonoids like orientin and vicenin present in tulasi provided significant protection against radiation-induced sickness and death [11]. Copper to have restraining effects on various micro-organisms including Legionella pneumophila as compared to stainless steel and plastic [12]. Tamra bhasma decreases in serum cholesterol and serum triglyceride levels [13]. During the solar and lunar eclipse, darbha grass is dropped in food items to prevent contamination. Though there is a wide belief that darbha grass is capable of absorbing light radiations and acoustic vibrations, however, the scientific reason for selecting this grass over several other grass varieties have not been explored till date [14]. Plant extracts and essential oils have been used in food preservation, alternative medicine and other therapies because of their antimicrobial compounds. Therefore, it is necessary to investigate those traditional plants to improve the quality of healthcare systems [15]. This present research was a small humble step in that direction. This study is aimed at finding the effects of various quantities of tulasi, kusha (Desmostachya bipinnata) and copper on the three parameters of water namely, conductivity, turbidity and pH. Thus, ancient knowledge can indeed provide solutions to modern day problems.

2. MATERIAL AND METHODS

In the present research tulasi of green color, kusha dry grass and copper wire with three different weights, 100 mg, 250 mg and 500 mg were used. Tulasi leaves and dry kusha grass were new for each replication and trial, while the copper wire was reused. The experiment conducted for each weight of materials with five trials and each trail contains three replications with total sample size 15. In a glass cup, 100 ml fresh drinking water was filled, the intervention materials were dropped in the water and the glass cups were closed with coasters. Conductivity, turbidity, and pH were measured by using instruments HM digital aquapro EC, HM digital aquapro TDS meter and Hanna pH meter (HI98107) respectively during the duration of immediate, two hours, four hours, six hours and 24 hr. Kruskal-Wallis test was applied to assess changes between groups in all variables. Statistical change with a p-value < 0.05 was considered a significant change.

3. RESULTS AND DISCUSSION

Table 1 shows the effect of an intervention on the conductivity of water. All treatment water samples tulasi, kusha and copper and even control water samples increased their conductivity by increasing the duration of time. Tulasi and copper decreased the conductivity of water while kusha increased significantly the conductivity of water with respect to control sample. The weight of tulasi and copper does not have any direct influence in reducing the conductivity of water but the weight of kusha have direct influence in increasing the conductivity of water. But for 250 mg and 500 mg samples, the capacity of tulasi samples to decrease the conductivity of water were not taken place at 24 hr duration. While comparing tulasi samples copper samples have the capacity to decreases conductivity of water was more during all the duration of time. From the above result can be obtained following empirical equations of the conductivity for 100 mg intervention material with six hours duration and100 ml water.

$$Tc = 0.92Cc \quad \text{.....(1)}$$

$$Kc = 1.31Cc \quad \text{.....(2)}$$

$$COc = 0.88Cc \quad \text{.....(3)}$$

Where, Tc – Conductivity of tulasi water, Kc - Conductivity of kusha water, COc – Conductivity of copper water and Cc – Conductivity of control water

Table 1: Effect on conductivity of water

Statistical tests		**Weight material 100 mg**					**Weight material 250 mg**				
		Time (hr)					**Time (hr)**				
		IMMD*	**2**	**4**	**6**	**24**	**IMMD**	**2**	**4**	**6**	**24**
Mean	Tulasi	75.87	76.67	78.40	80.40	82.00	76.47	77.80	78.60	79.47	85.73
	Kusha	77.20	98.87	108.40	113.00	117.53	79.87	141.13	160.13	173.00	188.67
	Copper	74.93	75.47	76.07	76.27	77.07	75.93	76.13	77.07	77.20	77.67
	Control	77.33	77.93	78.27	79.80	82.00	77.33	77.93	78.27	79.80	82.00
SD	Tulasi	11.55	11.45	12.06	12.89	13.47	8.50	8.65	8.35	7.99	9.00
	Kusha	10.41	16.59	16.73	15.23	15.52	8.94	16.49	15.51	16.24	17.65
	Copper	11.06	10.58	11.25	10.44	10.66	9.07	9.30	9.66	9.13	9.67
	Control	9.55	9.59	9.18	10.13	12.74	9.55	9.59	9.18	10.13	12.74
p	C†vsT‡	1	1	1	1	0.68	1	1	1	1	0.425
	C vs K•	1	<0.01	<0.001	<0.001	<0.001	1	<0.001	<0.001	<0.001	<0.001
	CvsCO‖	1	1	1	1	0.65	1	1	1	1	0.425
	T vc K	1	<0.01	<0.001	<0.001	<0.001	0.95	<0.001	<0.001	<0.001	<0.001
	TvsCO	1	1	1	0.47	0.44	1	1	1	0.78	<0.05
	KvsCO	1	<0.01	<0.001	<0.001	<0.001	0.87	<0.001	<0.001	<0.001	<0.001
Statistical tests		**Weight of material 500 mg**									
		Time (hr)									
		IMMD	**2**	**4**	**6**	**24**					

Mean	Tulasi	77.33	80.33	82.27	83.60	145.67
	Kusha	91.47	205.53	243.27	265.53	297.47
	Copper	76.47	76.60	76.93	77.33	79.00
	Control	77.33	77.93	78.27	79.80	82.00
SD	Tulasi	8.73	7.42	7.82	6.46	39.39
	Kusha	12.77	19.28	19.21	17.80	12.84
	Copper	9.26	9.08	9.32	8.85	9.94
	Control	9.55	9.59	9.18	10.13	12.74
p	C vs T	1	0.74	0.49	0.74	<0.001
	C vs K	<0.05	<0.001	<0.001	<0.001	<0.001
	C vs CO	1	0.74	0.75	0.74	0.59
	T vc K	<0.05	<0.001	<0.001	<0.001	<0.001
	T vs CO	1	0.23	0.14	0.14	<0.001
	K vs CO	<005	<0.001	<0.001	<0.001	<0.001

*Immediate, †Control, ‡ Tulasi, • Kusha ‖Copper

Legend: 1. Tulasi and copper decreases conductivity of water with respect to control sample at all duration of time but not of significant.

2. Kusha increases conductivity of water with respect to Tulasi, copper and control samples at all duration of time with exponential significant.

As the result given in Table 2, all treatment and control samples increased their turbidity as the duration of time increased. Tulasi and copper decreased turbidity of water while kusha increased significantly the turbidity with respect to control sample. The weight of tulasi and copper did not have any direct influence in decreasing the turbidity of water while the weight of kusha has direct influence in increasing the turbidity of water. But for the 250 mg and 500 mg tulasi samples did not reduce the turbidity of water with respect to control sample at 24 hr duration. The capacity of copper to decrease turbidity of the water is more than the capacity of tulasi. Can be derived following empirical equations of the turbidity for 100 mg intervention material with six hours duration and 100 ml water.

$$Tt = 0.95Ct \quad \text{.....(4)}$$

$$Kt = 1.36Ct \quad \text{.....(5)}$$

$$COt = 0.90Ct \quad \text{.....(6)}$$

Where, Tt – Turbidity of tulasi water, Kt - Turbidity of kusha water, COt – Turbidity of copper water and Ct – Turbidity of control water

Table 2: Effect on turbidity (ppm) of water

Statistical tests		**Weight material 100 mg**					**Weight material 250 mg**				
		Time (hr)					**Time (hr)**				
		IMMD*	**2**	**4**	**6**	**24**	**IMMD[1]**	**2**	**4**	**6**	**24**
Mean	Tulasi	36.40	36.47	37.60	37.93	39.20	36.67	37.07	37.60	37.87	41.07
	Kusha	37.07	48.20	52.20	54.13	55.87	40.80	66.73	78.47	82.80	91.13
	Copper	35.80	35.73	36.20	36.53	36.80	36.20	36.27	36.60	36.73	37.53
	Control	37.20	36.93	37.87	38.60	39.00	37.20	36.93	37.87	38.60	39.00
SD	Tulasi	5.73	5.83	5.93	5.79	6.38	4.48	4.48	4.44	4.19	4.15
	Kusha	4.73	7.82	7.89	7.85	7.65	4.92	8.19	7.76	6.93	8.04
	Copper	5.45	5.39	5.33	5.24	5.54	4.80	4.76	4.79	4.71	4.73
	Control	4.65	4.51	4.79	5.75	6.12	4.65	4.51	4.79	5.75	6.12
p	C† vs T‡	1	1	1	1	0.67	1	1	0.98	1	0.50
	C vs K•	1	<0.001	<0.001	<0.001	<0.001	0.33	<0.001	<0.001	<0.001	<0.001
	C vs CO‖	1	1	1	1	0.67	1	1	0.88	1	0.52
	T vc K	1	<0.01	<0.001	<0.001	<0.001	0.22	<0.001	<0.001	<0.001	<0.001
	T vs CO	1	1	1	0.88	0.40	1	1	0.88	0.91	0.11
	K vs CO	1	<0.001	<0.001	<0.001	<0.001	0.15	<0.001	<0.001	<0.001	<0.001

Statistical tests		**Weight of material 500 mg**				
		Time (hr)				
		IMMD[1]	**2**	**4**	**6**	**24**
Mean	Tulasi	36.87	37.87	38.73	40.13	69.40
	Kusha	45.47	98.87	115.40	126.60	143.00
	Copper	36.13	36.60	36.87	37.13	37.87
	Control	37.20	36.93	37.87	38.60	39.00
SD	Tulasi	4.37	4.31	3.75	3.91	17.73
	Kusha	8.95	9.71	10.24	9.88	7.53

	Copper	4.56	4.56	4.70	4.81	5.08
	Control	4.65	4.51	4.79	5.75	6.12
p	C vs T	1	0.67	0.93	0.76	<0.001
	C vs K	<0.05	<0.001	<0.001	<0.001	<0.001
	C vs CO	1	0.93	0.93	0.77	0.59
	T vc K	<0.05	<0.001	<0.001	<0.001	<0.001
	T vs CO	1	0.67	0.31	0.10	<0.001
	K vs CO	<0.05	<0.001	<0.001	<0.001	<0.001

*Immediate, †Control, ‡ Tulasi, • Kusha, ‖Copper

Legend: 1. Tulasi and copper decreases turbidity of water with respect to control sample at all duration of time but not of significant.

2. Kusha increases turbidity of water with respect to Tulasi, copper and control samples at all duration of time with exponential significant.

As per the result mention in Table 3 all the treatment and control samples increase their pH of the water as the duration increased. Tulasi, kusha and copper samples decreased their pH of water with respect to control samples. As the weight of the treatment increased the decrease of pH of the water was more this indicated that there is a direct influence of the weight of all the treatments in decreasing the pH of the water and at the weight of 500 mg tulasi decreased significantly the pH of water with respect to control sample. From the above result can arrived following equations of the pH for 100 mg intervention material with six hours duration and 100 ml water.

$$Tp = 0.94Cp \quad \text{.....(7)}$$

$$Kp = 0.96Cp \quad \text{.....(8)}$$

$$COp = 0.97Cp \quad \text{.....(9)}$$

Where, Tp – pH of tulasi water, Kp - pH of kusha water, COp – pH of copper water and Cp – pH of control water

Table 3: Effect on pH of water

Statistical tests		**Weight material 100 mg**					**Weight material 250 mg**				
		Time (hr)					**Time (hr)**				
		IMMD*	**2**	**4**	**6**	**24**	**IMMD[1]**	**2**	**4**	**6**	**24**
Mean	Tulasi	7.11	7.27	7.15	7.31	7.54	7.08	7.28	7.03	6.85	7.46
	Kusha	7.04	7.22	7.27	7.46	7.39	7.01	7.49	7.65	7.27	6.97
	Copper	7.04	7.45	7.49	7.55	7.83	7.07	7.55	7.73	7.35	7.81
	Control	7.13	7.37	7.55	7.74	7.91	7.13	7.37	7.55	7.74	7.91
SD	Tulasi	0.52	0.34	0.39	0.71	0.85	0.67	0.18	0.45	0.69	0.73
	Kusha	0.63	0.43	0.48	0.92	0.64	0.65	0.32	0.35	0.68	0.60
	Copper	0.65	0.57	0.71	0.98	0.74	0.61	0.25	0.37	0.74	0.68
	Control	0.47	0.23	0.43	0.52	0.98	0.47	0.23	0.43	0.52	0.98
p	C† vs T‡	1	1	0.07	1	0.98	1	0.579	<0.05	<0.01	0.37
	C vs K•	1	0.50	0.26	1	0.55	1	0.651	1	0.197	0.05
	C vs CO‖	1	1	1	1	0.98	1	0.271	1	0.517	0.42
	T vc K	1	1	1	1	0.98	1	0.354	<0.01	0.199	0.37
	T vs CO	1	1	1	1	0.98	1	0.034	<0.01	0.197	0.37
	K vs CO	1	0.95	1	1	0.55	1	0.651	0.7258	0.517	0.05

Statistical tests		**Weight of material 500 mg**				
		Time (hr)				
		IMMD[1]	**2**	**4**	**6**	**24**
Mean	Tulasi	6.81	7.00	6.62	6.67	7.13
	Kusha	6.87	7.24	7.25	7.45	6.27
	Copper	7.02	7.32	7.37	7.64	7.63
	Control	7.13	7.37	7.55	7.74	7.91
SD	Tulasi	0.38	0.24	0.65	0.63	0.85
	Kusha	0.41	0.31	0.40	0.36	1.09
	Copper	0.43	0.33	0.44	0.42	0.78
	Control	0.47	0.23	0.43	0.52	0.98
p	C vs T	0.42	<0.01	<0.01	<0.001	0.1052
	C vs K	0.52	0.6314	0.1607	0.3064	<0.01
	C vs CO	1	0.9823	0.4795	0.4306	0.2527
	T vc K	1	0.3100	<0.05	<0.001	0.1322
	T vs CO	1	0.0634	<0.05	<0.001	0.2015
	K vs CO	1	0.9823	0.5048	0.4132	<0.05

*Immediate, †Control, ‡ Tulasi, • Kusha, ‖Copper

Legend: Tulasi, Kusha and copper decreases pH of water with respect to control sample at all duration of time but not of significant.

Tulasi decreased conductivity, turbidity and pH of water with respect to control and its weight had direct influence in quantity of reducing the pH of water, this may be due to chemical composition of tulasi or the Indian holy basil contains many biologically active compounds, nutrients and antibacterial agents in the form of essential oils [6] and earlier studies also show that tulasi extract removed E.coli bacteria in the water [16; 17], dosage of tulasi showed best antimicrobial activity in both tap and river water [18].

The analysis of results showed that irrespective of weight, kusha increases the conductivity and turbidity of water and decreases the pH of water at all the duration of time. This may be due to kusha contains Phytochemical constituents [19] and earlier studies also demonstrated that darbha could be used as a natural food preservative (disinfectant) and helps to protect against toxic radiation and negative energies of all types [20].

The results demonstrated that for all the type of weight of copper material conductivity, turbidity and pH of water decreased at all the duration of time. This may be due to the copper is a ductile metal with high electrical conductivity and conducts heat and energy much better & efficiently [21] and earlier studies like Ayurveda recommends storing of water overnight in copper pot as one of the methods of water purification [22], ushapana (drinking water in morning) with the water kept in the copper vessel overnight [23], tamra with characteristic metallic sheen, soft, bright reddish in color, having high tensile strength, heavy, and devoid of impurities are identified as best used for medicinal purposes [24]. Earlier scientific studies also indicated that bacteria had lost culturability in the water stored in the copper and copper holds promise as an instrument in microbial purification of drinking water [25], antimicrobial properties of cast copper alloys with regard to E. coli O157, and have great potential to aid in safety of food from infection [26], paper embedded with silver and/or copper nano particles serve as effective point-of-use water purifiers [27], and significant reduction of the bacteria was found in the copper pots [28], tamra bhasma has shown a significant decrease in serum cholestrol and serum triglyceride levels [13].

4. CONCLUSION

The present study indicates that tulasi and copper decrease conductivity and turbidity of water while kusha increases these properties. The weight of tulasi and copper did not have any influence on their decreasing capacity of conductivity and turbidity but the weight of kusha had a direct influence on the quantity of increase in these properties. Tulasi, kusha, and copper decreasing the pH of water at all the duration of time and as their weight increase their capability to decrease pH of water also increases.

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