Research Article

Effect of Herbal Fumes on Water pH in Traditionally Used Metal and Clay Containers

Ekta chandel[1]*, Ajit Singh Saini[2]

[1]Visiting scientist,Yagyavalkya Center for Yagya Research, Dev Sanskriti Vishwavidyalaya, Haridwar, India
[2]Research Assistant,Yagyavalkya Center for Yagya Research, Dev Sanskriti Vishwavidyalaya, Haridwar, India
*Corresponding author: Author Ekta chandel. Email: ektachandel8@gmail.com
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Abstract. Effect of traditional metal pots made up of copper and brass along with clay pot are used for water storage in India in routine use as well as in rituals and Yagya. During Yagya herbal fumes are exposed to water stored in copper and clay pot. To understand the utility of the copper and clay container during Yagya, in the present study, the pH of water in copper, brass, clay and glass containers were recorded in the presence and absence of herbal fumes exposure. The study used only mango wood fumes in one set of experiments and in other set of experiment herbal mixture plus mango wood fumes in Gayatri Yagya was used. The herbal fumes plus mango wood fumes and mango wood fumes both significantly made water pH alkaline in nature. Specifically, herbal fumes during Gayatri Yagya caused significant increase in water pH in copper (mean difference 0.42; n=3; p=0.0032) and clay pot (mean difference 0.46; n=3; p=0.0013) compared to control. Interestingly, poring of water in brass pot (7.44 + 0.06; n=6; p<0.0001), clay pot (7.24$\pm$0.02; n=6; p=0.0013) and copper pot (7.26$\pm$0.06<0.0001) significantly increased water pH instantly it was added compared to control glass pot (7.13$\pm$0.04; n=6). Alkaline water utility has been well documented for human health and this study supports the scientific reasons behind traditional knowledge of Indian culture about storing drinking water in brass and copper vessels in daily routine as well during rituals.

Keywords. Water pH, Alkaline Water, Herbal Fumes, Herbal Mixtures, Gayatri Yagya, Brass, Copper, Clay, Glass Containers

Introduction

Traditionally, in India different metal containers such as copper, brass, etc. are used for water storage. During traditional rituals like Yagya these water pots of copper, clay are specifically used and kept for specific purpose.

The *Ayurvedic* system of Indian medicine has great antiquity, dating back to about 5000 years B.C. Its Materia Medica state the use of different metals, and contain resources in the form of drugs derived from metals, herbs, animal, and other mineral sources, (1), the use of which have been advocated in overall improvement of health and various different pathological manifestations. *Pittala* (brass) is an important metal also known as *MisraLoha*, it is an alloy of *Copper* and *Zinc*, known since the period of ancient times of *Samhita Kala*. Rishi *Charak*a used this metal (brass) to prepare medicine *Vastinetra*. According to the descriptions available in *Rasa RatnaSamuchaya*, there are two varieties of brass which are *Ritika* and *Kakatundi* (2).

Tamra (Copper) is a metal known to Indian civilization since ancient times and use of it for storing drinking water in India is a common practice. Rishi *Charaka* uses the term *Arka* in a few places in his literature in which *Chakrapani* clarifies as synonymous with copper (3). According to the descriptions of *Rasa* available in *Vagbhata*, there are two forms of copper (*Tamra)* which are *Nepaliya* and *Mlechha*, only the former being acceptable for therapeutic use and for storing of water (4). Copper is also known for its high antimicrobial activity amd hence storing water copper vessel helps to make water free from pathogenic bacteria and making it safe for drinking and cooking purpose.

The objective of this study is to evaluate the influence of traditionally used metal water pots and clay pot on stored water pH and also to evaluate influence of herbal fumes of mango wood and *hawan samgri* (herbal mix) used in the *Gayatri* Yagya on the pH of water.

Material and method

Study site and sampling

The study site was Yagyavalkya Center for Yagya Research, Dev Sanskriti University Haridwar, Uttarakhand India. Specifically, the room was of 12.5 feet X 12.5 feet with fire pit (Yagya *kund*) made in the center. The water sample used for this study was ground tap water of the campus. The water is collected in glass beaker and poured to subjected metal pots, which are made up of brass, copper, and to clay pot, glass pot, and also passed through glass impinge of air sampler (APM 433, Envirotech Instruments Pvt. Ltd, New Delhi, India).

Experimental procedure

The experiment was performed in closed Yagya Room (Figure 1A) in triplets to evaluate the effect of herbal fumes on the pH of water stored in different containers. There were two types of herbal fumes were used i.e. herbal fumes made up of pure mango wood and fumes of mango wood plus *Hawan samgri* (common herbal mixture, Shantikunj Herbal Pharmacy, Haridwar, India), which are typically used in Yagya. The water containers were kept in presence of fumes for 10 minutes but in case of air sampler, herbal fumes were passed through impinger (air sampler) for the same duration of time. The metal pots with nearly same amount of volume and surface area were kept open next to the Yagya *Kund* (Figure 1B). The air sampler was kept inside the room next to Yagya *Kund* (Figure 1C).

Figure 1. Yagya room, where experiments have been performed (A), Water container placed during experiment (B), and air sampler containing water in glass impinger (C).

Herbal fumes of Mango Wood

To evaluate the effect of mango wood fumes in the change of water pH following procedure has been followed. Fumes of mango wood were produced using 200 gm dry mango wood 45 gm hydrogenated vegetable oil (Cargill Pvt Limited, Gujarat, India). The mango wood was burned in Yagya *kund* using 45 gm of vanaspati ghee inside the Yagya room. The different metals, clay, glass containers along with the air sampler were kept in Yagya room and fumes were allowed to generate, and react with the water sampler for 10 minutes. After 10 minutes the windows of the room has been opened and fumes were allowed to departed from room. The change in pH of water in different containers and air sampler were immediately recorded along with the control. The control, used in all the experiments, was water in glass beaker kept in other room for the same duration of time without exposure to the herbal fumes.

Herbal fumes of Mango Wood plus hawan Samagri

Same procedure was used as that of generating fumes of Mango wood as described above except Mantra rituals described in *Gayatri* Yagya were used (5). Herbal fumes of *Gayatri* Yagya were produced using 200 gm mango wood 45 gm vanaspati ghee and 40 gm *hawan samagri*. The total duration of herbal fumes exposure were kept same. Total 24 *ahutis* (offerings) were performed. The change in pH of water contained in different containers along with air sampler has been immediately recorded using pH meter along with the control.

Results

The evaluation of effects of mango wood herbal fumes on pH of water

The pH of water kept in different metal container along with the control had been recorded after 10 minutes of exposure to mango wood fumes in the closed Yagya room (Figure 1, Table 1). There was no significant change in the control pot before and after the exposure of fumes. Similarly Brass pot also showed no change in the pH of water in 10 minutes of exposure. However, the change in the pH of water in glass pot (0.41), copper pot (0.37), earthen pot (0.26), and air sampler impinge (0.45) showed significant difference after 10 minutes of exposure.

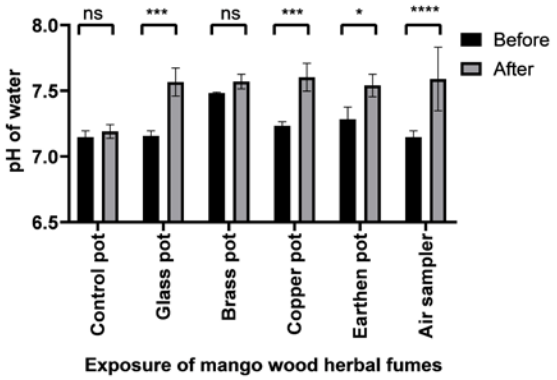

Figure 1. Change in the pH of water in different container after exposure to mango wood fumes. The difference of pH shown along with statistical significant (Ordinary one-way ANOVA, Sidak's multiple comparisons test; ns=not significant; *p<0.05, **p<0.01, ***p<0.001, ****p<0.0001)

The evaluation of effects of herbal mixture (hawan samagri) and mango wood herbal fumes on pH of water

During Yagya the herbal mixtures is used along with mango wood. Only mango wood fumes showed the change in the pH of water in all types of container after 10 minutes of exposure (Figure 1, Table 1). Then same experiment was performed using *hawan samagri*. The pH of water kept in different metal container along with the control had been recorded after 10 minutes of exposure to *hawan samagri* and mango wood fumes in the closed Yagya room (Figure 2, Table 2) during *Gayatri* Yagya keeping exposure of fumes for the same duration to that of only mango wood fume experiment. Control remained unchanged before and after the exposure of fumes. However, the glass pot (0.46), copper pot (0.49), brass pot (0.42), earthen pot (0.30), glass impinge (0.49) significant increase in pH of the water after 10 minutes of exposure.

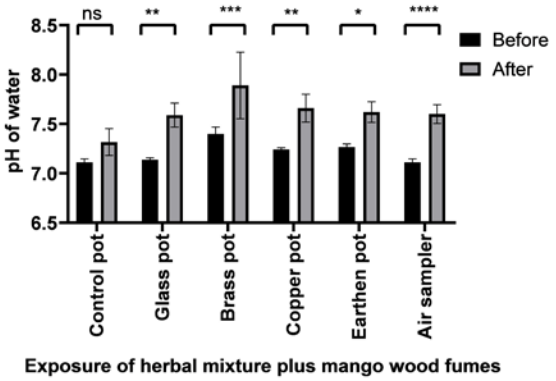

Figure 2. Change in the pH of water in different container after exposure to herbal mixture and mango wood fumes. The difference of pH shown along with statistical significant (Ordinary one-way ANOVA, Sidak's multiple comparisons test; ns=not significant; *p<0.05, **p<0.01, ***p<0.001, ****p<0.0001)

The evaluation of effects of container on pH of water after pouring into it

In addition, the study observed a very interesting pattern i.e. when water was added to the containers; it changed the pH of the water within 10 minutes. The study looked at the effect of type of container on pH of water once water is poured into containers. The pH of tap water taken in glass container before pouring into glass, brass, copper, clay containers and glass impinge. Within 10 minutes pH was recorded. Surprisingly the pH of Brass (7.44 $\pm$ 0.06; n=6; p<0.0001), copper (7.24 $\pm$ 0.02; n=6; p=0.0013) and clay (7.26 $\pm$ 0.06; n=6; p<0.0001) increased significantly while pH of water in both glass container was unchanged) (7.15 $\pm$ 0.03; n=6; p=ns) (Figure 3) compared to control (7.13 $\pm$ 0.04; n=6) (Ordinary one-way ANOVA Dunnett's multiple comparisons test). Thus, results were indicating the metals (brass and copper) and clay pot increases the pH of water stored in them, supporting the traditional utility of these metals for storing water for specific purposes.

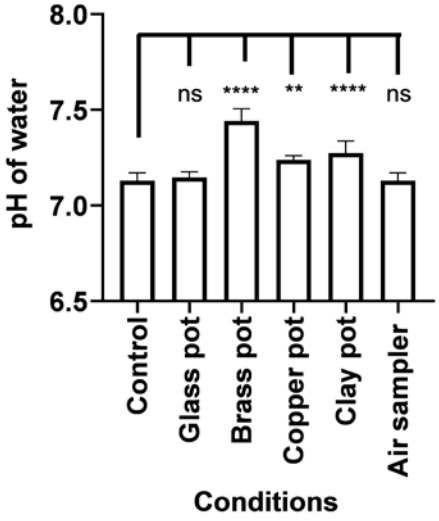

Figure 3. Change in the pH of water in different container after poring tap water into them. The statistical significant change compared to control is shown (Ordinary one-way ANOVA, Sidak's multiple comparisons test; ns=not significant; *p<0.05, **p<0.01, ***p<0.001, ****p<0.0001).

Water container	Change in pH								Difference in pH change	P value
	Before				After					
	I	II	III	Mean ±SD	I	II	III	Mean ±SD		
Control pot	7.11	7.13	7.20	7.15 ± 0.05	7.16	7.16	7.25	7.19 ± 0.05	0.05	0.9948 (ns)
Glass pot	7.13	7.14	7.20	7.16 ± 0.04	7.51	7.69	7.50	7.57 ± 0.11	0.41	0.0001 (***)
Brass pot	7.48	7.49	7.48	7.48 ± 0.01	7.51	7.62	7.58	7.57 ± 0.06	0.09	0.8589 (ns)
Copper pot	7.20	7.24	7.26	7.23 ± 0.03	7.49	7.70	7.62	7.60 ± 0.11	0.37	0.0005 (***)
clay pot	7.23	7.39	7.23	7.28 ± 0.09	7.45	7.62	7.55	7.54 ± 0.09	0.26	0.0187 (*)
Air sampler	7.11	7.13	7.20	7.15 ± 0.05	7.45	7.87	7.45	7.59 ± 0.24	0.45	<0.0001 (****)

Table 1. Effect of mango wood fumes on pH of water stored in different metals, clay and glass containers. The difference of pH shown along with statistical significant (Ordinary one-way ANOVA, Sidak's multiple comparisons test; ns=not significant; *p<0.05, **p<0.01, ***p<0.001, ****p<0.0001)

Water container	Change in pH								Difference in pH change	P value
	Before				After					
	I	II	III	Mean ±SD	I	II	III	Mean ±SD		
Control pot	7.10	7.15	7.09	7.11 ± 0.03	7.30	7.19	7.46	7.32 ± 0.14	0.20	0.3233 (ns)
Glass pot	7.13	7.16	7.12	7.14 ± 0.02	7.67	7.65	7.45	7.59 ± 0.12	0.46	0.0013 (**)
Brass pot	7.40	7.47	7.33	7.40 ± 0.07	8.20	7.94	7.53	7.89 ± 0.34	0.49	0.0005 (***)
Copper pot	7.23	7.24	7.26	7.24 ± 0.02	7.81	7.64	7.53	7.66 ± 0.14	0.42	0.0032 (**)
clay pot	7.30	7.26	7.24	7.27 ± 0.03	7.67	7.69	7.50	7.62 ± 0.10	0.30	0.0145 (*)
Air sampler	7.10	7.15	7.09	7.11 ± 0.03	7.70	7.59	7.51	7.60 ± 0.10	0.49	0.0006 (***)

Table 2. Effect of herbal mixture *(hawan samagri*) plus mango wood fumes during Gayatri Yagya on pH of water stored in different metals, clay and glass containers. The difference of pH shown along with statistical significant (Ordinary one-way ANOVA, Sidak's multiple comparisons test; ns=not significant; *p<0.05, **p<0.01, ***p<0.001, ****p<0.0001)

Discussion

The change in pH of water stored in brass, copper containers along with clay and glass containers when subjected to exposure of herbal fumes were investigated. The results showed that exposure of herbal fumes of mango wood alone or with herbal mixture increased pH of water (Figure 1-3, Table 1-2) and trended pH towards the alkaline scale of pH meter. In this investigation 4 different types of containers used were glass, brass, copper and earthen pot, along with air sampler (made up of glass but fumes were bubbled at 1 Cubic Feet per Meter (CFM) for 10 minutes). The control was the container made of glass and was not subjected to any kind of fumes. In this study, we used the water from the same source but when we subjected it to different storage containers, instant change (within 10 minutes) in pH was recorded before exposure to any kind of herbal fumes. This observation revealed that the metal brass and copper used in practice of storing drinking water and used in holy practice of Indian culture (as in Yagya *kalash* - pot used during Yagya) holds great impact on health.

When herbal fumes of mango wood fumes was investigated, results indicated the change in pH was highest recorded in air sampler with the difference of pH 0.45 from the original pH (pH before the exposure of mango wood fumes of

mango wood) followed by glass, copper, earthen pot and brass with pH 0.41, pH 0.37, pH 0.26, pH 0.09 respectively (Table 1-2). Air sampler passed air with force in the water, which may explained its higher value. There was a difference in the volume besides keeping the surface area of different container the same. Hence, it would be ideal to test the change in the pH of water with exact same volume and surface area of pot.

When water stored in different container subjected to the exposure of *Gayatri* Yagya fumes (*hawan samagri* plus mango wood fumes plus chanting of mantras) the highest change was recorded in brass metal and air sampler with the difference of pH 0.49 in both followed by glass, copper and earthen pot which are pH 0.46, pH 0.42 pH 0.36 respectively, compared to only mango wood fumes. By observing and analyzing the data we found that the difference in change of pH was reported higher in herbal fumes exposure of *Gayatri* mantra by difference of pH 0.12, 0.03, 0.32, 0.06, 0.08 and 0.01 in control, glass, brass, copper, earthen pot and air sampler than from exposure of herbal fumes of mango wood. In this experiment, if Mantra resonance had played any role, was could not be ruled out with limited set of experiment. Though scope of the study could not differentiate the effect between 'herbal fumes of herbal mixture plus mango wood in *Gayatri* Yagya' and 'the herbal fumes of mango wood' on the water pH as there were not enough number of repetitions needed for statistical power. However, the pH of water seemed had higher value when Gayatri Yagya is performed demanding further experiments.

The results showed herbal fumes caused alkaline pH of water. Alkaline water, also referred to as alkaline ionized water, is commercially available and is mainly proposed to bring positive changes in the organism consuming it. It is also known for providing electrolyte supplementation during intensive perspiration. Early studies performed on animal models reported that alkaline water supplementation may exert positive effects on body weight improvement and development in off spring (6,7). Water produced by the process of electrolysis generated by minerals, such as magnesium and calcium, which is characterized by high pH (alkaline), supersaturated hydrogen, and a negative redox potential. This hydrogen-rich functional water is known for disease prevention and has been introduced as a therapeutic strategy for health promotion in humans (8).

There are several studies that confirmed that mineral water has a significant impact on electrolytic (acid-base) balance, which determines anaerobic exercise capacity of muscles (9). The acid-base equilibrium balance within the body is strictly maintained by the interaction of three complementary mechanisms which are the blood and tissue buffering systems such as bicarbonate, and the diffusion of gases such as oxygen and carbon dioxide from the blood to the lungs via respiration, and the excretion of hydrogen ions from the blood to the urine by the kidneys (10).

Our results indicated that traditional ritual like Yagya caused water pH towards alkaline (Figure 1-2, Table 1-2). In studies performed by several scientists around the globe states that the Alkaline and electrolyzed water is antioxidant in nature and exerts a suppressive effect on free radical levels in living organisms there by resulting in disease prevention (11). Along with that various biological effects, such as antidiabetic effects (8), DNA protecting effects (12), and growth-stimulation activities (7), were documented. An investigation conducted by Konig et al. (13) reported that the drinking water rich in minerals enhance the urine pH which is from pH 5.94 to pH 6.57. A study conducted by Heil (14) described the positive effects of highly alkalized water on the improvement of acid base balance and state of hydration in mammals.

The water made alkaline through *vedic* practice of Yagya have great benefit on health as this water is made alkaline naturally without adding any additives. This way drinking alkaline water will improve the overall health of the person consuming it by improving their acid base balance, state of hydration, improving the pH of

blood and promoting the antioxidant activity. In our study we found during Yagya pH of water is made alkaline suggesting that drinking Yagya water will help improve health of individual.

Water stored in copper pots is antibacterial in nature; copper kills the diarrheal bacteria (15). Sudha et al. studied the antibacterial effect of water stored in copper pot against important diarrhoea causing bacteria, such as *Vibrio cholerae* O1, *Shigella flexneri*, *Salmonella enterica Typhi*, Enterotoxigenic *Escherichia coli*, Enteropathogenic *E. coli*, and *Salmonella Paratyphi* and reported the water becomes antibacterial in nature and provide positive results against all these bacteria. They also investigated the change in pH in water stored in copper pot and described that the pH changed from 7.83 to 7.93 in 16 hours, but in our study we found that introduction of mango wood for 10 minutes can increase the pH from pH 7.23 to pH 7.60 in copper pot and with the herbal fumes of *Gayatri* Yagya the pH increase from pH 7.24 to pH 7.66 in copper pot. This suggests the utility of copper pot in Yagya and other Indian Vedic rituals.

Conclusion

Herbal fumes generated in various Indian traditional rituals play important role in making water alkaline. Besides copper, brass, clay itself contribute for making water pH alkaline. Water stored in brass, copper, and earthen pot becomes alkaline instantly as we pour the water in that and this alkalinity has been increased on exposure to herbal fumes. This investigation signifies the role Yagya water used in Indian culture and practices and its scientific authenticity in day today life.

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