Physico-Chemical and Optical Examination of Water Stored in Copper Vessels

Naidu Dhanpal Jayram, K. Viswanathan, Vinothkumar A, Mugeshkumar S, Vanitha V

Abstract*:Storage of water in copper vessels is traditionally followed in past and many reports have been published about the antibacterial growth in copper vessel. It is essential to determine the water purity for drinking purposes in daily life through low cost approach. In the present work an attempt has been made to investigate the effect of storage of different drinking water in copper vessel for two week. The corresponding values of pH and TDS meter for different waters were recorded and analyzed. The optical properties such as UV-Vis and Raman studies along with physio-chemical parameters like pH and TDS were analyzed for 3weeks against different water sources kept in copper vessel. The Raman spectra provide information for different water sources. Similarly the UV-Vis spectroscopy provide the peak variation for different waters, however the effect of days and copper concentration analysis are in investigation. The Results obtained in this study reveals that water stored in copper vessel reduces the TDS level of bore water Tirunelveli and maintains its pH at 8.0 after 2 weeks. The bore water in Krishnan kovil (virudhunagar district) shows no variation in TDS after 1 week, but in 2nd week there is sudden decrease in TDS from 1050 to 944ppm and pH level decreases to 8.3 showing alkaline nature. Throughout the experiment we have noticed that the colour of copper vessel changes in case of bore water. For variation in studies we have also studied the pH and TDS of Drinking water at Kalasalingam Academy of Research and Education. There is no change in colour of copper vessel and TDS and pH remains same up to one week, but in second week TDS increases to 100ppm while the pH remain constant at 7.4. These studies will help future researcher for designing of copper vessels and will help them to analyze the Physio-chemical studies of water. Moreover the chemical mechanism and reaction between copper vessel and leaching out of copper into water data base will be generated in future based on UV and Raman studies.

Keywords ***:copper vessels, pH, TDS, Bore water, Drinking water.***

I. INTRODUCTION

The continued rapid growth in human population demands for water resources in large quantity. Worldwide, more than one million deaths occur due to water-borne diarrheal diseases [1-2].Human health suffers due to contamination of drinking water. An approximation of more than800 million people is not accessed to pure water source. In India, there the water supply through municipality from pipe linesare need to cleaned in rural and urban areas, resulting in a need to store water for drinking, food preparation and bathing purposes [3,4]. Drinking water at time of storage has to be checked properly and it's proper handling to be maintained for infected or bacteria free water. Traditionally, vessels made up of copper and its alloys and earthenware pots have been used in India for storing drinking water. Still the scientific community hasn't found much uses for copper but the ancient people has used for copper for many eating and drinking. According to ayurveda, less amount of copper can cause gastric problems and other diseases. WHO has recommended few limits for the intake of copper. WHO limits of 2000 ppb (WHO, 2008) and BIS limits of 1500 ppb (BIS, 2009). Guideline value permits consumption of 2- 3 litres of water per day, use of a nutritional supplement. So drinking water in copper vessels for longer time won't effect on our health. Moreover the present study confirms that the copper doesn't leach out from the vessels

Many articles has reported that 50-70% bacteria like, *Escherichia coli*, *Staphylococcus aureu* fungi such as *Candida albicans*, viruses such as influenza viruses will be killed when kept in copper vessels for 16 to 20 hours[5-7]. The present study proposed to resolve the effect of different water storage in copper vessel for a 2 week. The corresponding values of pH and TDS meter for different waters were recorded and analyzed. As this work is in initial stage the UV-Vis and Raman studies will be extended for further investigation. Also the leaching of copper from vessel to water is to be determined.

II. EXPERIMENTAL PROCEDURE

A. Copper vessel

Copper glasses were purchased through local shop and pH and TDS meter were purchased online. For the study, 3 drinking sample were collected among which 2 were bore water from different districts of Tamil nadu and remaining one was regular drinking water of our university.

B. Observation Table

Tds and pH

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***** Correspondence Author

Naidu Dhanpal Jayram *, Department of Physics , Kalasalingam Academy of Research and Education, Krishnankoil-626 126, Tamil Nadu, India Email : dhanpal@klu.ac.in

K. Viswanathan, Department of Physics, Kalasalingam Academy of Research and Education, Krishnankoil-626 126, Tamil Nadu, India Email : kvnooty@gmail.com

Vinothkumar A, Department of Physics, Kalasalingam Academy of Research and Education, Krishnankoil-626 126,Tamil Nadu, India Email : asvinothkumar0512@gmail.com

Mugeshkumar S, Department of Physics, Kalasalingam Academy of Research and Education, Krishnankoil-626 126,Tamil Nadu, India Email : mugeshkumar1912@gmail.com

Vanitha.V, Department of Physics, Kalasalingam Academy of Research and Education, Krishnankoil-626 126, Tamil Nadu, India Email : vanithakutty98@gmail.com

Table 1. TDS and pH readings

Storage of water in Days	TDS and pH reading					
	Bore well Krishnan kovil		*Bore well 2 Tirunelveli*		*Drinking water Kalasalingam University*	
Day	pH	TDS	pH	TDS	pH	TDS
1st	8.4	1160	7.7	894	7.5	30
2nd	8.2	1420	8.2	900	8.0	31
3rd	8.4	1220	8.1	820	7.4	40
4th	8.0	1150	8.0	796	7.0	35
5th	7.9	1040	8.0	740	7.0	36
6th	8.1	1040	8.0	721	7.0	40
7th	8.1	1040	8.0	722	7.0	42
8th	8.3	1040	8.0	720	7.1	48
9th	8.3	1050	8.0	717	7.3	52
10th	8.5	1050	8.1	715	7.8	54
11th	8.5	1100	8.1	714	7.5	56
12th	8.1	1090	8.0	712	7.5	64
13th	8.4	1050	7.8	696	7.4	73
14th	8.2	996	8.0	689	7.4	86
15th	8.3	944	8.0	680	7.4	100

III. RESULTS AND DISCUSSIONS

Water with pH value more than 9 or less than 4.5 become unsuitable for most life forms and also for other uses. The desirable pH range for drinking water is 6.5-8.0 pH. In our experiments stored water ranges in between 7.0 to 8.4 as shown in figure 3.1. High pH is observed for bore well water Krishnankovil, while the pH for drinking water in our university shows low pH value of 7.0- 7.4. Copper has greater efficiency towards the pH water level and sometimes it makes water more alkaline when its pH is low. But in our experiment the drinking water available in university doesn't showed any variation in pH but the pH of bore water krishnankovil drastically decreases from 8.5 to 8.0, similarly for bore water Tirunelveli also, pH decreases initially but later it maintains at pH 8.0. This can be due to ability of absorption of minerals through copper vessels [8-12]

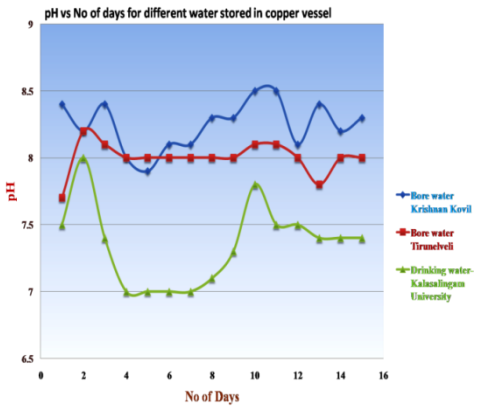

Fig. 1. Different water pH levels against the no of days in copper vessel

C. TDS

TDS is an important indicator of overall water quality. TDS helps in understanding the level of turbidity and hardness of water It is a measure of inorganic and organic materials dissolved in water. High TDS concentration may cause a bad odour or taste to drinking water, as well as cause scaling of pipes and corrosion. Waters can be classified based on the concentrations of TDS [**13-15**] as given below.

Up to 450mg/L-Desirable for drinking
Up to980mg/L-Permissible for drinking
Up to2000mg/L- Useful for irrigation
Up to3000mg/L-Not useful for drinking and irrigation**.**

In the present work the initial TDS of bore water tirunelveli was 894 ppm and keeping in copper for more than 2 weeks, it drastically changes to 680 ppm, while Bore well water Krishnan kovil is found to be 1050 ppm at initial days and remains constant even after one week. However at the end of 2nd week it also drastically decreases to 9Similarly in case of university drinking water the TDS shows constant reading value of 944 ppm. The solvents in water could be absorbed by the copper vessels and the alkalinity of water changes to 8.0.

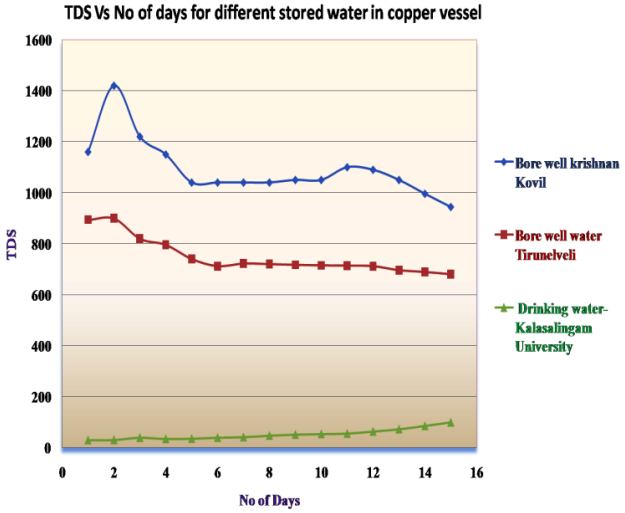

Fig. 2.Total dissolved salts in copper vessel for different waters

IV. COLOR CHANGE IN COPPER

The ability of absorption of minerals through copper vessels can be absorbed in our experiment as shown in figure 3. Copper has greater efficiency towards the pH water level and sometimes it makes water more alkaline when its pH is low. In our experiment the drinking water available in university doesn't showed any variation in pH and color of the copper vessel doesn't change from as purchased to till 16th day of experiment. In the case of Bore water- Tirunelveli the color of the vessels changes to pale blue after 16th day and this could we can also absorb in TDS reading. As discussed in the above figure 3.2, we have noticed down the drastic change in TDS from 900 to 689 ppm. While in the case of Bore water-Krishnan kovil the ppm level was above 1050, but after 15th day we found it decreases drastically and reached 944ppm

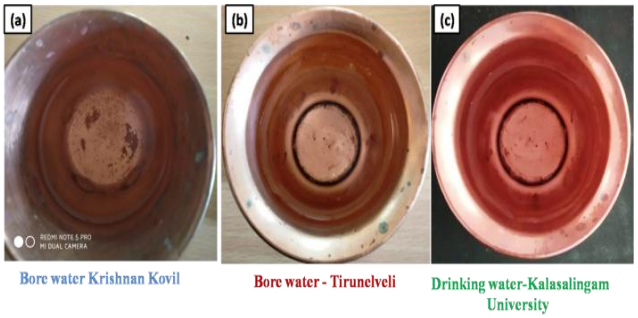

Fig. 3.Colour change of copper vessels

A. Uv visible Analysis

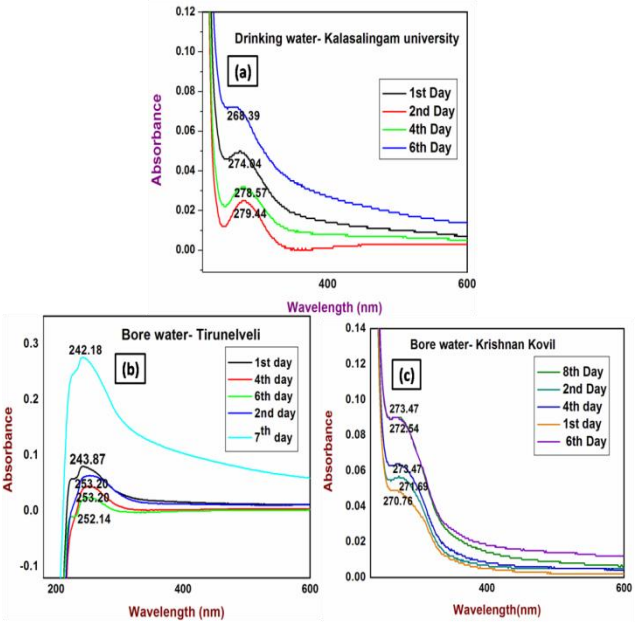

Fig. 4. UV-vis analysis of (a) Drinking water (b) Bore water Tirunelveli (c) Bore water Krishnan Kovil

UV visible

UV-vis analysis has been carried out to discuss the optical properties of bore water Tirunelveli, krishnankovil and kalsalingam university drinking water stored in copper vessel. Stored drinking water was subjected to UV-Visible spectroscopy analysis for consecutive even day's analysis. The reduction of Cu (II) to CuO particles was confirmed by the copper oxide peak at which correspond to absorption peaks at 279.44 and 268.39 nm respectively which are shown in **Fig.4.**

Similarly in case of Bore well water tirunelveli the peak shifted from 242.17 to 254.14. CuO particles exhibit Plasmon resonances, which are mostly sharp and well separated from inter band transitions. The red shift and the broadening of the band for drinking water Kalasalingam show larger particles. This is due to the dipole-dipole interaction among Copper particles coated on vessels and also electromagnetic coupling which enhances the polarizability of the electron cloud, resulting in red shift **[16-18]**. The absorbance spectra of bore water at 270 nm represent the specific peak corresponding to Cu-O-Cu bond which confirms the presence of copper particles.

B. Raman Analysis

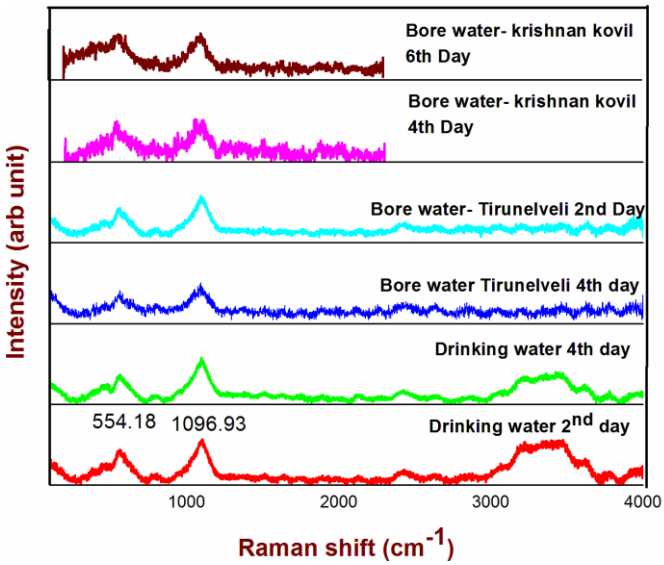

Fig.5. Raman spectral analysis of drinking water, Bore water Tirunelveli and Bore water Krishnan Kovil on consecutive even days.

One of the powerful techniques for characterizing the chemical composition of water is Raman spectroscopy. This technique is particularly well-suited for measurements of liquid samples because water is a weak Raman scattered. However, limited by the lower Raman cross-section and strong fluorescence background, complex, large size and sophisticated instruments are usually required; so many commercial Raman spectrometers are limited to laboratory use. To be used for on-line water monitoring, the Raman spectrometer should be compact, easy to use, fast, and most importantly, the limit of detection (LOD) should meet a certain level, such as the maximum contamination level (MCL). Metallic nanostructures especially Au, Ag, Pt and Ru possess a property of localized surface plasmon resonance (LSPR) which can greatly enhances the Raman scattering cross-section of the molecules which are adsorbed or present nearer to a metallic nanostructure. The research in SERS has attracted increasing interest because of the recent demonstration of single molecule detection **[19, 20]**. In the present work we have made an attempt to find out the water peaks after consecutive even days so that we could able to find out copper peaks at 8^{th} day. we could not able to find such a different peak even after dropping water on Ag Substrate (SERS) to ensure copper peaks as shown**fig 5**. The normal Raman and SERS spectra remains same in all the samples and further studies to be done to find out the difference in bore water and drinking water. The peak at 554cm^{-1} and 1096cm^{-1} may be due to the silica or glass slide however the literature survey suggests peaks at more than 3000cm^{-1} can be due to impurities in water.

V. CONCLUSION

The obtained TDS and pH are suitable for drinking purposes and well matches with WHO reports. Drinking water kept in copper vessel for 15days shows a good change in bore well water Tirunelveli, as the TDS and pH decreases continuously. In the case of bore well water Krishnan kovil, TDS remains constant up to 12 days and shows sudden decrease value of 944 ppm after 2 weeks.

The university drinking water from the beginning of analysis maintained pH value of 7.4 and TDS of 35ppm and doesn't show any variation throughout the week. In second week the TDS drastically increases and it reached 100 ppm. Overall results concluded that copper can be used effectively for drinking storage purpose up to 3 weeks and maintains pH and TDS without any bacterial growth. The colour change in copper vessel for bore water shows the leaching of hard minerals into copper after 2 weeks and could be the main reason of decrease in TDS. Uv-Vis and Raman studies are in investigation. Copper vessels can be used for drinking purposes as conventional resources especially in rural areas when the facilities for purifier not available. We have finally concluded that no copper has been leached out into water from copper vessel.

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AUTHORS PROFILE

Dr Naidu Dhanpal Jayram is working as assistant professor department of physics kalasalingam Academy of Research and Education. His Research interests are thin films and nanomaterials. His specific area of research is development of substrates for Surface Enhanced Raman Spectroscopy. He has obtained his doctorate degree from Bharathiar University, Coimbatore, Tamilnadu. He is recipient of National Postdoctoral fellowship and completed Postdoc from Indian institute of science, Bangalore. He is published 12 papers in international and national journals.

K. Viswanathan has completed M.Sc. and Ph.D. from University of Kerala Trivandrum in 1984 and worked in the High Energy Cosmic Ray group of TIFR for 22 years. Worked as Professor and HoD of Physics in Karpagam University for 10 years.Joined Kalasalingam University in August 2016 as Senior Professor. His fields of interest are molecular spectroscopy and Astroparticle physics at high energies

Vinoth Kumar has completed his under graduation from department of Physics, Kalasalingam Academy of research and education. He is currently as sales executive in Bajaj finserv.

Mugeshkumar S has completed his under graduation from department of Physics, Kalasalingam Academy of research and education. He is currently working in share market forex trading.

Vanitha V has completed his under graduation from department of Physics, Kalasalingam Academy of research and education. Currently she is pursing B.Ed., Special Education from kalasalingam Academy of Researcch and Education.