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RESEARCH ARTICLE

A SCIENTIFIC STUDY ON EARTHENWARE POTTERY WASTE AND ITS POTENTIAL USE

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ABSTRACT

The pottery industry is one of the major industries which generate employment for the people in rural and urban areas. There are thousands of pottery units scattered all over India and the yearly production of pottery products from one unit is slated to be around ₹ 85 crores. However, during the course of production and transportation, a huge amount of pottery items get damaged or broken. It imparts negative effects on the environment as the baked clay products are non-biodegradable. Thus, an attempt has been made to characterize the various Physico-chemical properties and micro/macro nutrient levels in earthenware pottery waste (EPW). So that it could be used as wealth from waste for soil quality improvement. The bulk density of EPW is in the range of 51.20 to 60.63%, pH 7.5 to 9, electrical conductivity 212.70 to 239.90 µs/ppm. From the analysis, it was found that the level of micro and macro nutrients is low to medium except for iron content which is in the medium range in EPW collected from different districts. EPW contains most of the micro and macro nutrients and has significant bulk density. Thus, it may be assumed that EPW will help to improve the soil quality by enhancing the nutrients.

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INTRODUCTION

India, being a very ancient land of inventors, had the knowledge of pottery craft since the early dawn of human civilization. It is said that a millennium ago Indian potters had been making clay dolls and infusing life into them. The clay craft existed in India at least 10,000 years ago. The latest excavations of Mohenjo-Daro and Harappa which date back to 3,000 B.C. give more than one sample of pottery as evidence to show that at that time fine pottery art was in existence [Mirmira, 2004]. Pottery is made by forming a clay body into object of desired shape and heating them to high temperature (600-1600^{0}C) that leads to permanent changes including increasing the strength and rigidity of the object [Hyder, 2013]. Clay based pottery can be divided into three main groups: earthenware, stoneware and porcelain depending on firing temperature [Tite, 2008]. Pottery industry is one of the major industries which generate employment to the people in rural and urban areas [Akilandeeswari, 2016]. There are thousands of pottery units scattered all over India and yearly production of pottery products from one unit is slated to be around ₹ 85 crore.

However, during the course of production and transportation a huge amount of pottery items get damage or broken. Products get damaged specially during the process of firing.If the heat is not maintained as needed the products gets damage [Shrestha, 2018]. It is observed that, 10–30% product get damage [Juan *et al.*, 2018]. This damage or waste product of baked clay imparts negative effects on environment as the baked clay products are non- bio-degradable. Because of non-biodegradable nature of baked clay made material it gets accumulated on earth and create solid waste. To minimize this solid waste generation the most environmentally, economically efficient method is the reuse of waste product [Raut *et al.*, 2018]. Literature survey revealed that although a lot of work has been done on reuse of earthenware pottery for construction purpose [Silva *et al.*, 2010], but no attempt has yet been made to reuse earthenware pottery waste for planting purpose. Toward this objective an effort was taken to use earthenware pottery waste in agriculture. Thus, this study mainly focused on analysis of various constituent in EPW which are required for good agricultural practices.

MATERIALS AND METHODS

Sample collection: Earthenware Pottery Waste (EPW) Samples were collected from six different sites as shown in table 1, stored in a sampling bag and labeled to avoid contamination.

Table 1. Profile of samples collected from various locations

Sr. No.	Sample	District	State	Country
1	S_1	Wardha	Maharashtra	India
2	S_2	Chandrapur	Maharashtra	India
3	S_3	Nagpur	Maharashtra	India
4	S_4	Yevatmal	Maharashtra	India
5	S_5	Chhindwara	Madhya Pradesh	India
6	S_6	Gondia	Maharashtra	India

Reagents: Reagent used were of analytical grade obtained from M/S Merck specialties private Limited.

Sample preparation: The dried EPW sample was turned into small pieces using laboratory mortar and pestle and pulverized to powder. The resultant sample sieved through 90µm mesh sieve to get homogeneous sample for analysis.

Analysis of physico-chemical properties: Physico-chemical properties like Bulk Density, Water Holding Capacity, pH, and electrical conductivity were determined as per standard protocols in Indian pharmacopeia (2010) [Indian Pharmacopoeia, 2010].

Determination of macro and micronutrient: Quantification of macro and micro nutrient in EPW samples were done on Atomic Absorption Spectroscopy (Perkin–Elmer AAnalyst 200 model) and Flame Photometry (Systronics) using standard protocol in Indian pharmacopeia (2010) [Indian Pharmacopoeia, 2010;&Maurya, 2018].

RESULTS AND DISCUSSION

From table 2, it was found that the bulk density of EPW sample is in range of 0.79 to 1.18 g/cm^{3}and powder EPW texture is similar to soil. The water holding capacity of EPW sample was found between 51.20 to 60.63% and its pH was found to be 7.5 to 9.0 which are alkaline in nature. The physico-chemical property varies with sample collection location. The Electrical conductivity of EPW sample was found to be 212.70 to 239.90 µs/ppm. Table: 3 and figure: 1 shows the profile of micronutrients as Cu 0.010 to 0.040%, Pb 0.003 to 0.007%, Mn 0.020 to 0.100%, Ni 0.003 to 0.010%, Fe 0.220 to 0.245%, Co 0.001 to 0.005%, Cr 0.044 to 0.100%.

The concentration of Fe was found to be higher than other element due to iron rich clay which is prevalent in central India (Stucki, J. W. 2013). Table: 3 and figure: 2 shows the profile of macronutrients as Mg 0.010 to 0.050%, Ca 0.040 to 0.080%, and K 0.060 to 0.100%.These elements play a very crucial role in plant growth.

DISCUSSION

From this study it was observed that EPW contains most of the micro and macro nutrients which is in low to medium range.Thus, it may be assumed that, it will help to increase the nutrients in soil [Shukla et al., 2008].The physico-chemical parameter like bulk density, electrical conductivity of EPW powder showed similarity with agriculture soil parameters.The bulk density is an indicator of soil porosity, soil compaction which helps better plant growth [Chaudhari et al., 2013]. The bulk density of EPW was found between 0.79 to 1.18 g/cm3, which means EPW will help to enhance the soil porosity.

Thus, will be helpful for easy seed germination, adequate aeration to root; enhancing percentage survival of seedlings and ensuing better plant growth rate. Similarly, Water holding capacity of EPW was found to be less than standard range that of soil. Hence it is assumed that EPW can be used for those plants which are affected by root rot disease, occurs due to water logging.

The pH of EPW was found to be alkaline pH 7.5 to 9, thus it may help to reduce soil acidification. The soil electrical conductivity (EC) is an indirect indicator of the quantity of salts available for plant uptake and salinity levels [Rysan, 2008]. The EC of EPW sample was found to be in optimal range thus, EPW can be used as nutrient source for growing plants.

Table 2. Profile of Physico-Chemical parameter in EPW

Sample No.	S_1	S_2	S_3	S_4	S_5	S_6
Color	Brick Red	Brick Red	Brick Red	Brick Red	Brick Red	Brick Red
Texture	powder	powder	powder	powder	powder	powder
Bulk Density(g/cm^3)	1.18	1.08	1.14	1.13	0.79	0.98
Water Holding Capacity(%)	51.20	54.77	51.86	52.89	60.63	53.89
pH	7.50	7.80	7.70	9.00	8.50	7.70
Electrical Conductivity(µs/ppm)	220.60	212.70	239.90	233.40	230.00	228.50

Table 3 Profile of minerals percentage in EPW

Minerals	Sample	S_1	S_2	S_3	S_4	S_5	S_6
Micronutrient (%)	Cu	0.010	0.030	0.030	0.020	0.040	0.010
	Pb	0.004	0.007	0.006	0.005	0.010	0.003
	Mn	0.100	0.100	0.100	0.070	0.090	0.020
	Ni	0.010	0.009	0.010	0.007	0.010	0.003
	Fe	0.245	0.245	0.244	0.244	0.245	0.220
	Co	0.005	0.004	0.005	0.004	0.004	0.001
	Cr	0.096	0.089	0.095	0.082	0.100	0.044
Macronutrient (%)	Mg	0.050	0.020	0.020	0.010	0.010	0.030
	Ca	0.050	0.060	0.080	0.500	0.060	0.040
	K	0.100	0.060	0.070	0.020	0.060	0.090

Cu- Copper, Pb- Lead, Mn- Manganese, Ni- Nickel, Fe- Iron, Co- Cobalt, Cr- Chromium, Ca- Calcium, K- Potassium, Mg- Magnesium

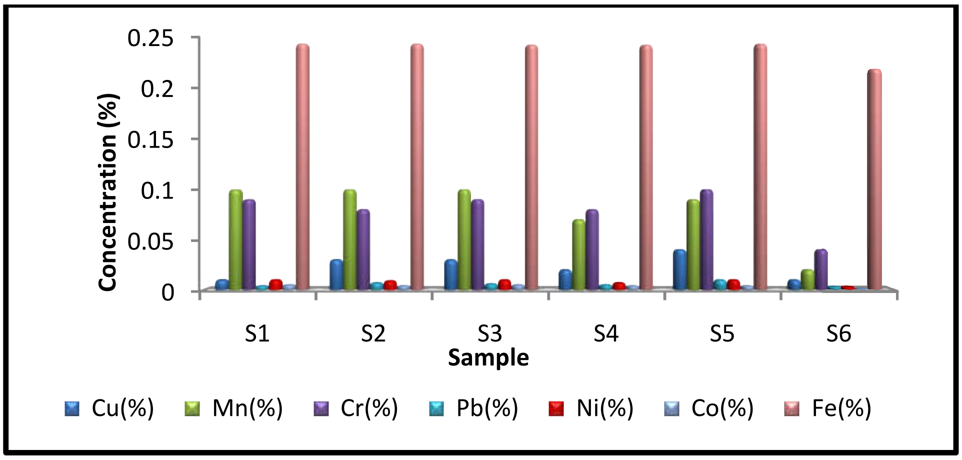

Figure 1. Profile of Micronutrient (%) in EPW

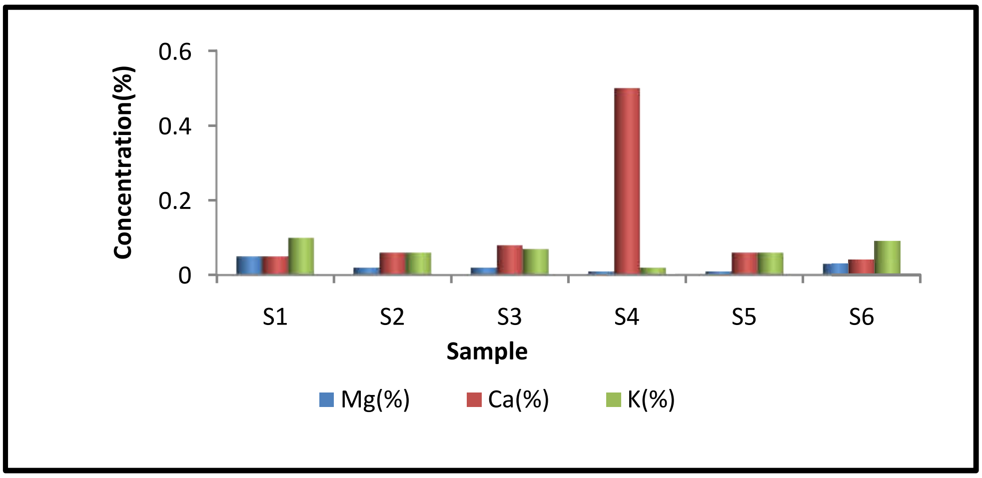

Figure2. Profile of Macronutrient (%) in EPW

CONCLUSION

EPW waste product from pottery industry and has no application except using it in construction industry. Further, there are no alternatives present/potential applications for it in sight. Therefore, to allow it unutilized will be a hazardous not only for its generating industry, but also for environment. In fact, it can create major environmental and health hazardous as it is non-biodegradable. Through this study, an attempt has been made to develop its meaningful use by converting it into powder comparable to soil. The protocol is designed simple, easy to operate, economical and eco-friendly thus converting waste to wealth. The low water holding capacity of EPW decrease water logging to some extent thus preventing plant from root rot disease and the high porosity will be useful for sustained release of nutrient to plants for their sustained development and productivity. EPW is no substitute to chemical fertilizer but it may be cost effective for sustaining soil texture and nutrient. Thus, present attempt of conversion of waste into wealth provides us an opportunity to meet objectives to use EPW. This study can further be extended to determine the use of earthenware pottery waste for growing ornamental plants. Many literatures clearly show that clay is used as adsorbents in water purification process [Firmansyah, 2018] thus; application of earthenware pottery waste as an adsorbent to remove to heavy metal from the contaminated water can be studied.

Last of all, the EPW is rich in minerals with high porosity, study discloses analogous property as of soil.Thus, postulation, if it is mixed with soil in standardized ratio it may support to improve soil quality and will be bonus to pottery industry and ecosystem.

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