# STUDY ON THE UPTAKE OF ZINC(II) AND LEAD(II) BY DRY TARO (PEIN) *COLOCASIA ESCULENTA* L.

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## Abstract

This researchis concerned with the study on the uptake of Pb(II) and Zn(II) metal cations by the dry taro (biomass) using batchwise system. The plant sample was collected from thePyay University Campus. The similar shape, size, weight and height of taro plant were selected and washed with tap water, distilled water and dried in air. The dried sample was made to powder by using grinder and sieved with 0.9-1 mm mesh. The determinations of the initial amounts of Pb(II) and Zn(II) metal cations in taro plant, soil and water from sample site were carried out. It was observed that the initial amounts of Zn(II) ion in plant, soil and water from sample site was greater than those of Pb(II) ion. In experiment I, 8.5 g of the dried powder sample was packed in a cotton bag and immersed in each of experimental buckets containing 3L of different metal cations with different concentrations separately to determine the uptake ofPb(II) and Zn(II) metal cations on daily up to 7 days.Moreover in experiment II, the amount of uptake of Pb(II) and Zn(II) metal cations were examined eight times at the interval of 15 min up to 120 min by adding (8.5 g) each of sample in 150 mL of solutions containing different concentrations of metal cations.The optimum contact time at 45 min for Pb(II) and 60 min for Zn(II).It could be seen clearly that the uptake capacity for Pb(II) was greater than Zn(II) in both experiments I and II. The effect of temperature on the uptake of Pb(II) and Zn(II) by the dry taro (biomass) was studied at the range between 20ºC and 70ºC based on 50, 25 and 10 ppm.The optimum temperature was at 40 °C.  It was found that, the percent uptake of Pb(II) was higher than Zn(II) for the concentrations of 50, 25 and 10 ppm. The percent uptake of Zn(II) was investigated by the acidified biomass of drytaro at the interval of 15 min up to 120 minfor 50 ppm of Zn(II) solution. It was found that the optimum uptake of Zn(II) ion was reached at 60 min. The acidified biomass of dry taro was greater in uptake of Zn(II) ion than the non-acidified biomass of dry taro.

**Keywords**: dry taro, acidified dry taro, batchwise system, uptake of Pb(II) and Zn(II)

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## Introduction

Taro plant is an aquatic plant and commonly seen in ponds, lakes, ditches and quiet streams. *Colocasiaesculenta* L.(Figure 1) is a tropical plant grown primarily for its edible corms, the root vegetables most commonly known as taro. It is believed to be one of the earliest cultivated plants. There are two major cultivars of taro. They are green stem (taro) and red stem (taro).Cooking of the taro will reduce the crystal chemicals to a safe level and improve the taste and texture of the plant. Taro is popular in many dishes worldwide. It is commonly prepared in stews and stir fries. Due to the crystal compounds it is considered a "last-resort" food in many regions and is only consumed if there is a food shortage (Hambali, 1979). A taro is basically a potato which has a thick, hairy skin. It is often called albi. It is used in making taro or albi plaster. Like potatoes, taro tubers can be baked, fried, steamed, boiled or mashed.

Most taro cultivars taste acrid and can cause swelling of lips, mouth and throat if they are eaten raw. The acridity of taro is thought to be concentrated in the outer layers of the corm and may be largely removed by peeling off a thick layer followed by prolonged boiling. This acridity is learned to be caused by calcium oxalate presents as fine needle-like crystals or raphides, which can penetrate soft skin. Thereafter an irritant presents on the raphides, probably a protease can cause discomfort in the tissue.Taro contains substantial quantities of oxalate (Wang, 1983), as do the majority of higher plants.

The two common toxic effect of oxalate poisonings are

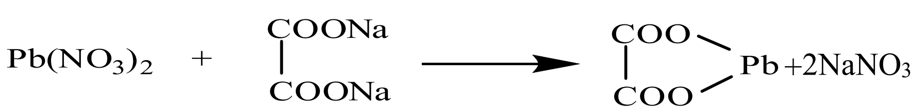
(1) acute poisoning, resulting in hypocalcaemia after ingestion of high levels of soluble oxalates and

(2) (more commonly) chronic poisoning in which calcium oxalate crystals are deposited in the kidneys, resulting in renal disorder.

**Figure 1** Photograph of Taro Plants (*Colocasiaesculenta* L.)

The oxalates are widely distributed in the plants in readily water soluble forms, such as potassium, ammonium and sodium oxalate and as insoluble needle like calcium oxalate crystal. Cooking can affect the soluble oxalate but not the insoluble oxalate content of the food. Boiling can reduce the soluble oxalate content of a food if the cooking water is discarded, while soaking, germination and fermentation will also reduce the content of soluble oxalates. Baking a food will reduce an effective concentration of oxalates in the food due to the loss of water from the baked food (Iwuoha and Kalu, 1995).

Sodium oxalate which presents in the plant can react with lead(II) nitrate by the metathesis reaction.




Lead(II) oxalate is sparingly soluble in water. Its solubility is increased in the presence of excess oxalate anions, due to the formation of $Pb(C_2O_4)_2^{2-}$ complex ion (Grases*et al*., 1993). But zinc oxalate is insoluble in water and converts to the oxide when heated.

## Materials And Methods

### Collection and preparation oftarosamples

All the tarosamples (green stem) used were of the long stem type, the botanical name being “*Colocasiaesculenta*L.”.

Taro plants (green stem) were collected from a proliferated taro pond with dimensions roughly about 10 x15 feet and 2.5feet in depth. It was located beside the Chemistry Department inPyay UniversityCampus. The samples of all taro plants (green stem) have the nearly same condition of size, shape, height and weight. The selected sample (green stem) was washed thoroughly with tap water, distilled water and dried in air.

### Determination of the amount of Zn(II) and Pb(II) in taro plant, soil and water sample

The taro plants, water and soil were collected from a proliferated taro pond with dimensions roughly about 10 x15 feet and 2.5feet in depth. It was located beside the ChemistryDepartment. Theconcentrations of Zn(II) and Pb(II) in Taro plant, soil and water sample were determined by AAS.

### Preparation of dry taro plants for biosorbent

The biosorbent used in this study was the dry taro plants (*Colocasiaesculenta*L.). The collected samples weredried in air for about three weeks and then dried in an oven at 70°C. After being completely dried, the biomass was cut into pieces and ground by grinder. After this, the biomass was sieved to get particle size between 0.9-1 mm for use as biosorbent.

### Uptake of Pb(II) and Zn(II) metal cations from model solution by the normal condition of dry taro (biomass) (batchwise of days and minutes)

#### (a) Preparation of model solutions

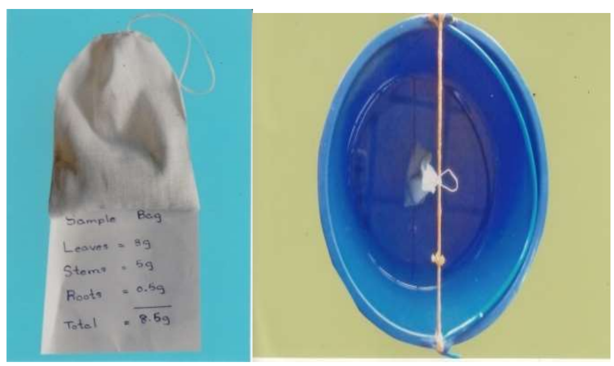
Model solutionsof Pb(II) and Zn(II) ions in 50,25 and 10 ppm concentrations were prepared by dissolving lead(II) nitrate and zinc nitrate in distilled water respectively. The fresh solutions were used for each study.

### (b) Effect of contact time (day) on the uptake of Pb(II) ion and Zn(II) ion by the normal condition of drytaro (biomass) based on 50, 25 and 10 ppm(Experiment I)

Each of the prepared solution(Pb(II) ion, Zn(II) ion)was poured into the experimental bucket. 8.5 g of drytaro (biomass) were packed in the bag (diameter7 cm, height 11 cm) and then this bag was hanged by nylon thread as shown in Figure 2.

The prepared sample-bag was immersed in experimental bucket containing( 3L±0.03 L) of the known metal cation solution. Whenever necessary the solution level was adjusted with the distilled water every morning.

Choosing the time frame of 1, 2, 3, days, an aliquot (40 mL) portion of Pb(II) solution was pipetted out by means of 20 mL glass syringe. Uptake of metal cations in thisprocedure was determined by AAS. The data of experimental work are shown in Tables 2, 3and 4 and Figures4, 5 and6.




(a) (b)

**Figure 2** Uptake of Pb(II) by the normal condition of dry taro (biomass) based on 50 ppm (a) sample bag (b) model bucket

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**(c)Effect of contact time (minute) on the uptake of Pb(II) ionand Zn(II) ion by thenormalcondition of dry taro (biomass) based on 50, 25 and 10 ppm(Experiment II)**

Each standard lead(II) nitrate solution and zinc nitrate solution of 50, 25 and 10 ppm concentrationswas prepared. Accurately weighed sample (8.5 g) was added into a conical flask (250 mL) containing 150 mL of lead(II) nitrate solution at pH 5. The flask was placed in an orbital shaker bath at room temperature. The mixture of solution and biosorbent was agitated in 100 rpm. The amount of uptake was examined at the interval of 15, 30, 45, 60, 75, 90, 105 and 120 min. After this time, the sample solutions were separated by filtration.Aliquot (40 mL) of Pb(II) andZn(II) solutionswere pipetted out by means of 20 mL glass syringe. Uptake of metal cations in this procedure was determined by AAS. The resulting data are shown in Tables 5, 6 and7 and Figures 7, 8 and 9.

**(d)Effect of temperature on the uptake ofPb(II) andZn(II) Ions by the normal condition of dry taro (biomass) based on 50, 25 and 10 ppm**

Standard lead(II) nitrate andzinc nitrate solutionswere prepared. Accurately weighed sample (8.5 g) was added into a conical flask (250 mL) containing 150 mL of lead(II) nitrate solution at pH 5. The solution was shaken by a hot-plate magnetic stirrer. The mixture of solution and biosorbent was agitated at 100 rpm for 15 min at different temperatures of20°C, 30°C, 40°C, 50°C, 60°C and 70 °C by using thermometer.Then, the sample solutions were separated by filtration. The residual contents of lead(II) ion and zinc ion in the solution were determined by AAS. The resulting data are shown in Tables8, 9 and10 and Figures10,11 and 12.

**Uptake of Zn(II) ion from model solution by the acidified condition of dry taro (biomass) based on 50 ppm (batchwise of minute)**

**(a)Preparation of acidified biosorbent**

The biomass was subsequently loaded with $H^+$ in a solution of 0.1 M HCl (biomass concentration of 50 $gL^{-1}$) for 30 min under slow stirring for protonation, which eliminates interference of biosorption by other cations such as $Na^+$, $K^+$, $Mg^{2+}$ and $Ca^{2+}$. Later the biomass was washed with deionized water (1000 mL) up to four times to remove excess hydrogen ions for neutralization(pH 7). Then, the biosorbent was again dried at 70°C for 24 h until a stable weight was observed.

**(b)Effect of contact time (minute) on the uptake of Zn(II) Ion by the acidified condition of dry taro (biomass) based on 50 ppm**

Standard zinc nitrate solution of 50 ppm was prepared.Accurately weighed acidified sample (8.5 g) was added into a conical flask (250 mL) containing 150 mL of zinc nitrate solution at pH 5. The flask was placed in an orbital shaker bath at room temperature. The mixture of solution and biosorbent was agitated at 100 rpm. The amount of uptake was examined at the interval of 15, 30, 45, 60, 75, 90, 105 and 120 min.After this time, the sample solutions were separated by filtration. The residual content of Zn(II) ion in the solution was determined by AAS. The resulting data are shown in Tables 11 and 12 and Figures 13 and14.

## Results And Discussion

**Assay of metal contents in taro plant, water and soil sample**

Table 1 and Figure 3 show the original contents of Zn(II) and Pb(II) ions in taro plant, water and soil sediment. The amount of Zn(II) ion was higher than Pb(II) ion in taro plant, water and soil sample (Figure 3).

**Table 1** The contents of Zn(II) and Pb(II) ions in taro plant, water and soil samples

| Sample | Zn(II) ion (ppm) | Pb(II) ion (ppm) |
|---|---|---|
| Plant | 0.57 | 0.08 |
| Water | 0.57 | 0.43 |
| Soil | 3.84 | 0.69 |

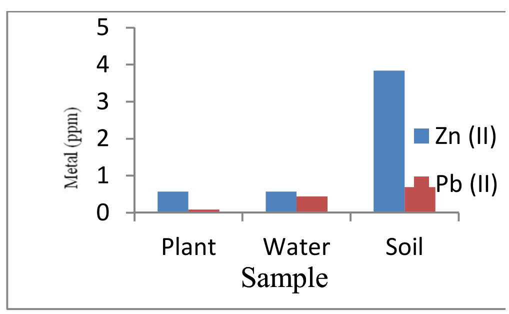



Figure 3 The contents of Zn(II) and Pb(II) ions in taro plant, water and soil sample

**Effect of contact time (day) on the uptake of Pb(II) and Zn(II) ions by the normal condition of dry taro (biomass) based on 50, 25 and 10 ppm (Experiment I)**

Tables 2, 3 and4 and Figures5,6 and7 show the uptake of metal cationsPb(II) and Zn(II) ions by the normal condition of drytaro (biomass).The uptake of the Pb(II) ion was found to be higherthan Zn(II) in the metal ion concentrationsof 50 ppm , 25 ppm and10 ppm.This is because sodium oxalate present in the of taro can react with lead(II)nitrate.Lead(II) oxalate is sparingly soluble in water. Its solubility increases in the presence of excess oxalate anions, due to the formation of $Pb(C_2O_4)_2^{2-}$ complex ion. But zinc oxalate is highly insoluble in water and converts to the oxide when heated.

The nature of uptake for each metal ion is quite different. The differential uptake of the drytaro (biomass) towards Pb(II) ion in first day was higher compared to Zn(II) ion at 50 ppm (i.e., the percent uptake of Pb(II) ion was 99.98%). It was observed that with the increases in concentration of heavy metal cations, the percent uptake increases and when the contact time increases percent uptake also increases.The uptake activity of the drytaro (biomass) towards Zn(II) ion was similar as Pb(II) ion. The increased differential still continued to uptake to the 6$^{th}$ days (i.e., optimum percent uptake of Zn(II) ion was 98.08% based on 50 ppm).

Table 2 Effect of Contact Time (Day)on the Uptake of Pb(II) and Zn(II) ionsby the Normal Condition of dryTaro(Biomass) Based on 50 ppm (Batchwise)

| Day | Percent uptake (%) | |
|---|---|---|
| | Pb(II) | Zn(II) |
| $D_1$ | 99.98 | 97.78 |
| $D_2$ | 99.98 | 97.89 |
| $D_3$ | 99.98 | 97.91 |
| $D_4$ | 99.98 | 97.96 |
| $D_5$ | 99.98 | 97.99 |
| $D_6$ | 99.98 | 98.08 |
| $D_7$ | 99.98 | 98.08 |

Each metal ion concentration = 50ppm
Weight of sample = 8.5g
pH = 5

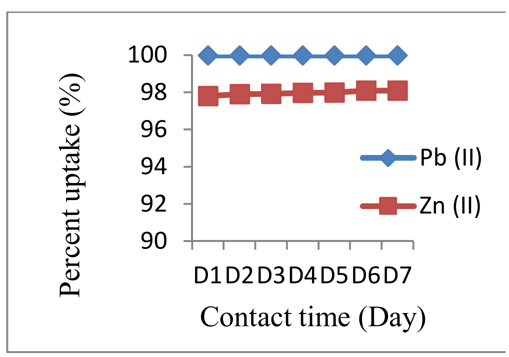
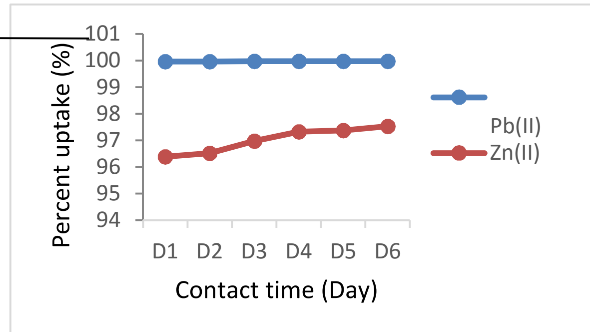



Figure 4 Uptake of metal cations by the normal condition of dry taro (Biomass) based on 50 ppm (Batchwise)

Table 3 Effect of Contact Time (Day) on the Uptake of Pb(II) and Zn(II) ions by the Normal condition of dry Taro (Biomass) Based on 25ppm (Batchwise)

| Day | Percent uptake(%) | |
|---|---|---|
| | Pb(II) | Zn(II) |
| $D_1$ | 99.96 | 96.39 |
| $D_2$ | 99.96 | 96.52 |
| $D_3$ | 99.97 | 96.97 |
| $D_4$ | 99.97 | 97.32 |
| $D_5$ | 99.97 | 97.37 |
| $D_6$ | 99.97 | 97.52 |
| $D_7$ | 99.97 | 97.52 |




Each metal ion concentration = 25ppm
Weight of sample = 8.5g
pH = 5

Jptake of metal cations by the normal condition of dry taro (Biomass) based on 25 ppm

**Table 4** Effect of Contact Time (Day) on the Uptake of Pb(II) and Zn(II) ions by theNormal Condition of dry Taro (Biomass)Based on 10 ppm (Batchwise)

| Day | Percent uptake(%) | |
|---|---|---|
| | Pb(II) | Zn(II) |
| $D_1$ | 99.68 | 93.46 |
| $D_2$ | 99.72 | 93.79 |
| $D_3$ | 99.75 | 93.80 |
| $D_4$ | 99.79 | 94.75 |
| $D_5$ | 99.79 | 94.81 |
| $D_6$ | 99.79 | 95.81 |
| $D_7$ | 99.79 | 95.81 |

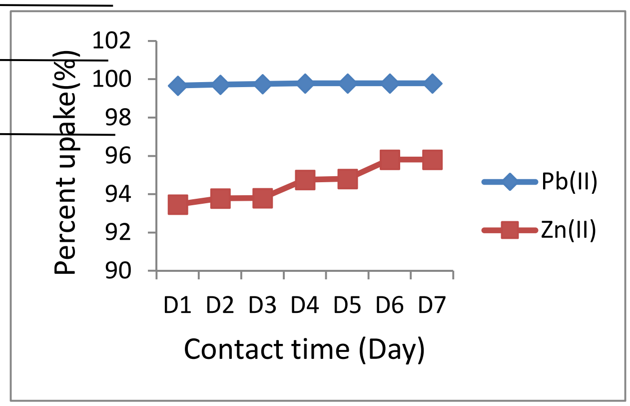



**Figure 6** Uptake of metal cations by the normal condition of dry taro (Biomass) based on 10 ppm (Batchwise)

**Effect of contact time (minute) on the uptake of Pb(II) and Zn(II) ions by the normal condition of dry taro (biomass) based on 50, 25 and 10 ppm(Experiment II)**

Time dependency studies offered data about the change in metal removal related to time. In this study, the minimum time necessary for biomass to be in contact with the metal ion solutions was elucidated.The percent uptake of Pb(II) and Zn(II) ions with respect to contact time for 50, 25, and 10 ppm onto each dry biomass (8.5 g of powdered sample) at pH 5 werestudied by varying the contact time from 15 to 120 minutes. The results were presented in Tables, 5,6 and7 and Figures7,8 and 9.Tables and Figures show the uptake of Pb(II) ion by the drytaro (biomass) using initial concentration ranging from 50 to 10 ppm.The uptake of Pb(II) ion reached at 45 min (i.e., optimum percent uptake of Pb(II) ion was 99.98% based on 50 ppm).After the maximum contact time, it could be seen that the uptake of Pb(II) ion was decreased with increasing time and the stationary state was reached at 75 min attaining adsorption of 99.94%.The uptake activity ofbiomass towards Zn(II) ion was similar as Pb(II) ion. It was observed that the percent uptake of Zn(II) ionincreased with increasing time. The optimum percent uptake for Zn(II) ion was 97.96% at 60 min and the stationary state reached at 105 min attaining adsorption of 97.85% based on 50 ppm. This is because the higher biosorption at the initial contact time could be related to the driving force of heavy metal ions into the surfaces of drytaro (biomass) and the abundance of active sites on the adsorbent. The slow uptake capacity with the subsequent time may be due to the diffusion of heavy metal ions into the surface of thedrytaro (biomass) and fewer remaining binding sites.

**Table 5** Effect of Contact Time (Minute) on the Uptake of Pb(II) and Zn(II)Ion by the Normal Condition of dry Taro (Biomass) Based on 50 ppm (Batchwise)

| Minute (min) | Percent uptake (%) | |
|---|---|---|
| | Pb (II) | Zn (II) |
| 15 | 99.94 | 97.76 |
| 30 | 99.94 | 97.77 |
| 45 | 99.98 | 97.79 |
| 60 | 99.96 | 97.96 |
| 75 | 99.94 | 97.90 |
| 90 | 99.94 | 97.87 |
| 105 | 99.94 | 97.85 |
| 120 | 99.94 | 97.85 |

Each metal ion concentration = 50 ppm
Weight of sample = 8.5 g
pH = 5

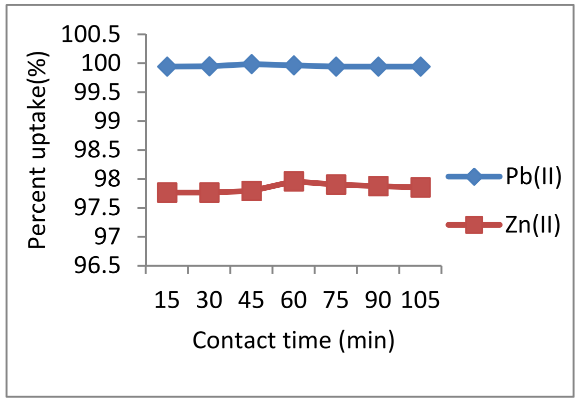



**Figure 7** Uptake of metal cations by the normal condition of dry taro (Biomass) based on 50 ppm (Batchwise)

**Table 6** Effect of Contact Time (Minute) on the Uptake of Pb(II) and Zn(II) ions by the Normal Condition of dry Taro (Biomass) Based on 25 ppm (Batchwise)

| Minute (min) | Percent uptake (%) | |
|---|---|---|
| | Pb(II) | Zn(II) |
| 15 | 99.92 | 95.78 |
| 30 | 99.92 | 95.80 |
| 45 | 99.98 | 95.94 |
| 60 | 99.97 | 96.26 |
| 75 | 99.96 | 95.91 |
| 90 | 99.96 | 95.79 |
| 105 | 99.96 | 95.76 |
| 120 | 99.94 | 95.76 |

Each metal ion concentration = 25 ppm
Weight of sample= 8.5 g, pH= 5

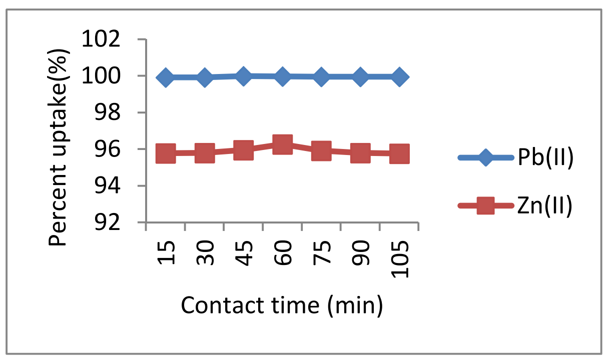



**Figure 8** Uptake of metal cations by the normal condition of dry taro (Biomass) based on 25 ppm (Batchwise)

**Table 7** Effect of Contact Time (Minute) on the Uptake of Pb(II) and Zn(II) ions by the Normal Condition of dry Taro (Biomass) Based on 10 ppm (Batchwise)

| Minute (min) | Percent uptake (%) Pb (II) | Zn (II) |
|---|---|---|
| 15 | 99.91 | 89.74 |
| 30 | 99.97 | 89.81 |
| 45 | 100.00 | 89.82 |
| 60 | 99.96 | 89.90 |
| 75 | 99.96 | 89.81 |
| 90 | 99.96 | 89.73 |
| 105 | 99.96 | 88.92 |
| 120 | 99.96 | 88.92 |

Each metal ion concentration= 10 ppm
Weight of sample = 8.5 g
pH = 5

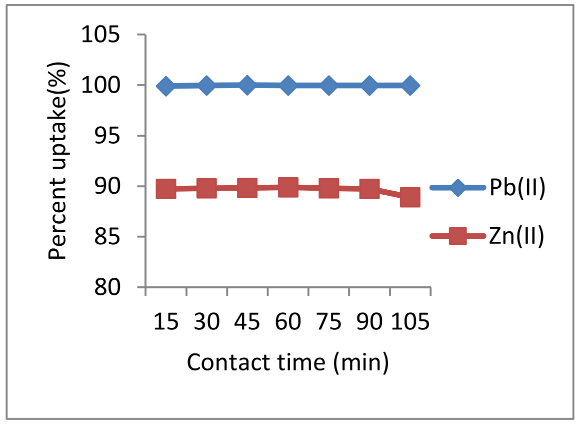



**Figure 9** Uptake of metal cations by the normal condition of dry taro (Biomass) based on 10 ppm (Batchwise)

**Effect of temperature on the uptake of Pb(II) and Zn(II) ions by the normal condition of dry taro (biomass) based on 50, 25 and 10 ppm**

Results presented in Tables 8, 9, 10 and Figures 10,11,12 indicate the percent uptake for selected heavy metals by the drytaro (biomass) at different temperaturesof 20°C to 70°C, based on 50, 25 and 10 ppm.

From Tables and Figures, it was clear that the percent uptake of Pb(II) was higher than Zn(II) where each metal cations concentration used were 50 ppm, 25 ppm and10 ppm. The maximum uptake of 99.84% for Pb(II) and 97.93% for Zn(II) at 40°C based on 50 ppm were observed. There was a decrease in the uptake capacity after 40°C. The temperature profile indicates that as the temperature is increased the uptake capacity increased to a maximum value and then decreased. This is because the biosorbent loses its properties at high temperature due to denaturation. So, the temperature increases above 40˚C the uptake capacity decreases.

**Table 8** Effect of Temperature on the Uptake of Pb(II) and Zn(II) ions by the Normal Condition of dry Taro (Biomass) Based on 50 ppm (Batchwise)

| Temperature (°C) | Percent uptake (%) | |
|---|---|---|
| | Pb (II) | Zn (II) |
| 20 | 99.82 | 97.65 |
| 30 | 99.83 | 97.82 |
| 40 | 99.84 | 97.94 |
| 50 | 99.84 | 97.76 |
| 60 | 99.84 | 97.71 |
| 70 | 99.84 | 97.71 |

Each metal ion concentration= 50 ppm,
Weight of sample = 8.5 g
Contact time = 15 min,
pH = 5

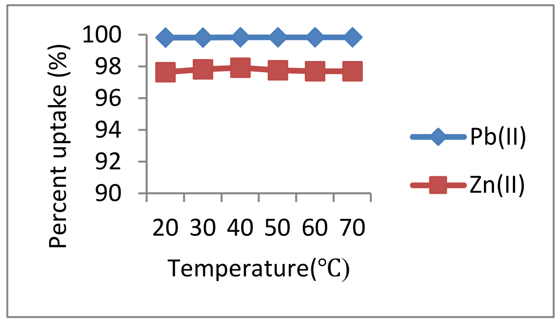



**Figure 10** Uptake of metal cations by the normal condition of dry taro (Biomass) based on 50 ppm (Batchwise)

**Table 9** Effect of Temperature on the Uptake ofPb(II) and Zn(II) ions by the NormalCondition of dry Taro (Biomass) Based on 25 ppm (Batchwise)

| Temperature (°C) | Percent uptake (%) | |
|---|---|---|
| | Pb (II) | Zn (II) |
| 20 | 99.72 | 95.68 |
| 30 | 99.72 | 95.72 |
| 40 | 99.78 | 95.80 |
| 50 | 99.73 | 95.74 |
| 60 | 99.73 | 95.72 |
| 70 | 99.73 | 95.72 |

Each metal ion concentration = 25 ppm
Weight of sample = 8.5 g
Contact time = 15 min, pH = 5

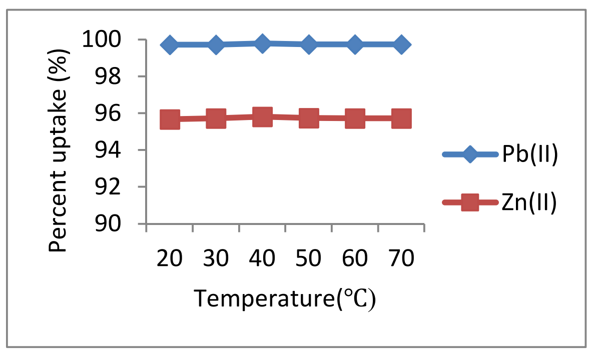



**Figure 11** Uptake of metal cations by the normal condition of dry taro (Biomass) based on 25 ppm (Batchwise)

**Table 10** Effect of Temperature on the Uptake of Pb(II) and Zn(II) ions by the Normal Condition of dry Taro (Biomass) Based on 10 ppm

| Temperature (°C) | Percent uptake (%) Pb (II) | Zn (II) |
|---|---|---|
| 20 | 99.61 | 89.62 |
| 30 | 99.62 | 89.70 |
| 40 | 99.69 | 89.76 |
| 50 | 99.67 | 89.74 |
| 60 | 99.67 | 89.73 |
| 70 | 99.67 | 89.73 |

Each metal ion concentration = 10 ppm
Weight of sample = 8.5 g
Contact time = 15 min, pH = 5

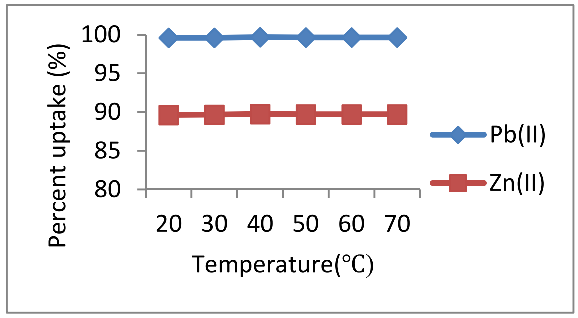



**Figure 12** Uptake of metal cations by the normal condition of dry taro (Biomass) based on 10 ppm (Batchwise)

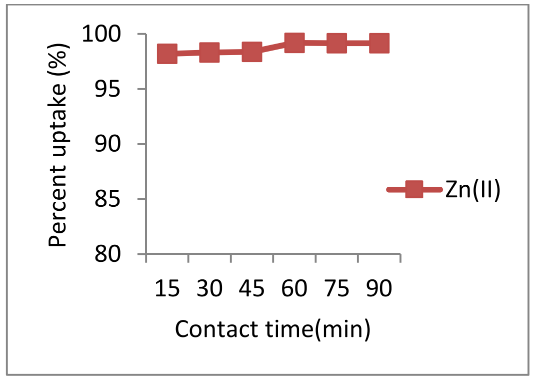
**Effect of contact time (minute) on the uptake of Zn(II) ions by the acidified condition of dry taro (biomass) based on 50 ppm**

The effect of contact time on the uptake of Zn(II) ion by the acidified condition of dry taro (biomass) based on 50 ppm were shown in Table 11 and Figure 13. According to the results, the time dependent behavior of adsorption was examined by varying the contact time between biosorbate and biosorbent in the range of 15-120 min. The uptake of Zn(II) ion increased with increasing contact time due to enough large surface area available of the adsorbent. The maximumpercent uptake was 99.18% at 60 min for Zn(II) based on 50 ppm. After the maximum contact time, it could be seen that the uptake of Zn(II) ion decreased with increasing time and the stationary state was reached at 105 min attaining adsorption of 99.15% based on 50 ppm.

Table 11 Effect of Contact Time (Minute) on the Uptake of Zn(II) ions by the Acidified Condition of dry Taro (Biomass) Based on 50 ppm (Batchwise)

| Contact Time (min) | Zn(II) concentration (ppm) | |
|---|---|---|
| | Final | Percent uptake (%) |
| 15 | 0.91 | 98.19 |
| 30 | 0.85 | 98.31 |
| 45 | 0.81 | 98.38 |
| 60 | 0.41 | 99.18 |
| 75 | 0.42 | 99.16 |
| 90 | 0.42 | 99.16 |
| 105 | 0.42 | 99.15 |
| 120 | 0.42 | 99.15 |

Each metal ion concentration = 25 ppm
Weight of sample = 8.5 g
pH = 3, Temperature = 15 °C




Uptake of metal cation by the acidified condition of non-living taro (Biomass) based on 50 ppm (Batchwise)

**Comparative Study on the uptake of Zn(II) ion by the normal condition and acidified condition of dry taro (biomass) (batchwise) based on 50 ppm and contact time (minute)**

Efficiency of drybiosorbent of normal biomass and acidified biomass were tested for the uptake of Zn(II) ion by varying the contact time from 15 to 120 min. Comparison of the results are presented in Table 12 and Figure 14. It was found that the uptake of Zn(II) ion by the acidified condition of drytaro (biomass) was more than that by the normal condition of dry taro (biomass). The maximum percent uptake of Zn(II) ion was 99.18% at 60 min for acidified biomass and 97.95% at 60 min for normal biomass respectively.

As the measurement of final pH represented the simultaneous release of $H^+$ with the uptake of heavy metal ions, because final pH of solution (pH = 3) were less than initial pH of solution (pH = 5), therefore ion exchange confirmed to be one of the biosorption mechanisms.

**Table 12** Comparison Study on the Uptake of Zn(II) ion by the Normal Condition and Acidified Condition of dry Taro (Biomass)(Batchwise) Based on 50 ppm and Contact Time (Minute)
Initial pH = 5, Final pH = 3

| Contact Time (min) | Zn(II) concentration (ppm) | |
|---|---|---|
| | Normal Condition of drytaro (Biomass) | Acidified Condition of drytaro (Biomass) |
| 15 | 0.91 | 98.19 |
| 30 | 0.85 | 98.31 |
| 45 | 0.81 | 98.38 |
| 60 | 0.41 | 99.18 |
| 75 | 0.42 | 99.16 |
| 90 | 0.42 | 99.16 |
| 105 | 0.42 | 99.15 |

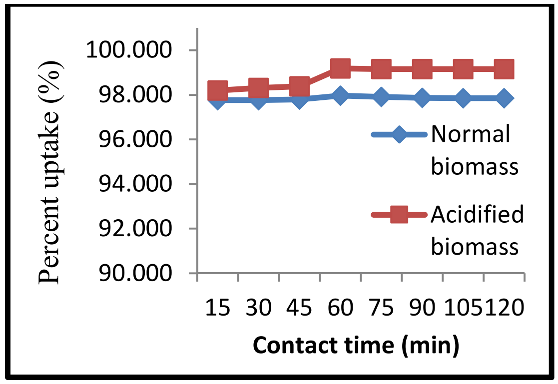



**Figure 14** Uptake of metal cation Zn(II) ion by the normal condition and acidified condition of dry taro (Biomass) based on 50 ppm (Batchwise)

## Conclusion

The initial amount of Zn(II) ion in plant, water and soil was higher than Pb(II) ion. From the uptake study (Batchwise system) of Pb(II) and Zn(II) ions based on 50, 25 and 10 ppm, both daily and minute by the drytaro (biomass), the uptake capacity of Pb(II) ion was greater than Zn(II) ion. It was observed that with the increases in concentration of heavy metal cations, the percent uptake increases and as the contact time increases, percent uptake increases.The effect of temperature on the uptake of Pb(II) and Zn(II) ions by the drytaro (biomass) was studied at the range between 20ºC and 70ºC based on 50, 25 and 10 ppm. It was found that the percent uptake of Pb(II) ion was higher than Zn(II) ionfor all metal cation concentrations used (50 ppm, 25 ppm and 10 ppm). The maximum uptake of 99.84% for Pb(II) ion and 97.93% for Zn(II) ion at 40ºC based on 50 ppm were observed. There was a decrease in the uptake capacity after 40ºC. The temperature profile indicates that as the temperature increases the uptake capacity increases to a maximum value and then decreases due to denaturation.

From the comparative study on the uptake of Zn(II) ion by the normal condition and acidified condition of drytaro (biomass) (Batchwise system) based on 50 ppm and contact time (min), the uptake capacity for Zn(II) ion by the acidified condition of the drytaro (biomass) was greater than the normal condition of drytaro (biomass). The maximum percent uptake of Zn(II) ion was 99.18% at 60 min for acidified biomass and 97.95% at 60 min for normal biomass.Based on the results obtained, it can be concluded that the dried biomass of taro has high uptake capacity towards the Pb(II) and Zn(II) metal cations. Hence this property can be effectively utilized for the removal of the heavy metals from the various industrial waste-water since it is of low-cost, save time,abundant and a locally available adsorbent.

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