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# Adsorption on Toxic Metal Pb(II), Cd(II), Hg(II) and Cu(II) Ions on Agricultural Byproducts

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Agricultural byproducts like orange, banana, pomegranate, apple, chickoo, sweetlime were used in their natural state on which the study of adsorption of toxic metal ions Pb(II), Cd(II), Hg(II) and Cu(II) at 27°C has been made. The values of Freundlich constants (n and k) are estimated from the study. It can be seen that adsorption increases with the increase in concentration of metal ions.

**Key Words: Adsorption, Toxic metal ions, Agricultural byproducts.**

## INTRODUCTION

The presence of toxic metal ions in industrial waste has attracted worldwide attention. Several methods such as chemical precipitation, ion exchange, ultra-filtration, electrochemical treatment etc. are suggested for the removal of these metal ions. Few workers have suggested methods for adsorption of these ions by using inexpensive agricultural byproducts[1,2], tree barks[3–6], peanut skin[7,8] and agricultural waste material[9–11].

In the present work, an attempt has been made to study the adsorption of toxic metal ions, such as Pb(II), Cd(II), Hg(II) and Cu(II) on agricultural byproducts like orange skin, banana husk, pomegranate husk, apple skin, chickoo skin and sweetlime husk at 27°C.

Sondawale[12] has studied the adsorption of Pb(II), Cd(II), Hg(II) and Cu(II) on agricultural byproducts, such as orange, potato, chickoo, guava and banana husk. Adsorption of Cd and Pb from aqueous solution by spent grain has been studied by Low *et al.*[13] and Carolyn *et al.*[14] have studied the adsorption of aqueous heavy metals on to carbonaceous substrates.

## EXPERIMENTAL

Orange skin, banana husk, pomegranate husk, chickoo skin, apple skin were collected and exposed to sunlight for one week. Subsequently they were ground, further exposed to sunlight for 24 h and were preserved in plastic bottles with airtight corks.

The solutions at different concentrations (0.01, 0.008, 0.006, 0.004 and 0.002 M) of Pb(II), Cd(II), Hg(II) and Cu(II) were prepared in different conical flasks. 1.0 g of each of the adsorbents was weighed and placed in each conical flask. The flasks were corked and placed overnight. The solutions were filtered. pH of the filtrate were measured and the filtrates were preserved in airtight glass bottles. The changes in adsorption of metal ions before and after adsorption were measured the spectrophotometrically. The data obtained of percentage adsorption along with concentration are presented in Tables 1–6.

TABLE-1
ADSORPTION OF METAL IONS ON APPLE SKIN

| Conc. | Cu(II) | | Pb(II) | | Cd(II) | | Hg(II) | |
|---|---|---|---|---|---|---|---|---|
| | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - a_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ |
| 0.010 M | 0.993 | 0.885 | 1.077 | 0.957 | 0.903 | 0.786 | 0.989 | 0.863 |
| 0.008 M | 0.914 | 0.824 | 0.960 | 0.850 | 0.775 | 0.668 | 0.950 | 0.830 |
| 0.006 M | 0.851 | 0.778 | 0.887 | 0.794 | 0.660 | 0.560 | 0.900 | 0.788 |
| 0.004 M | 0.752 | 0.696 | 0.820 | 0.736 | 0.586 | 0.490 | 0.827 | 0.723 |
| 0.002 M | 0.643 | 0.604 | 0.735 | 0.658 | 0.515 | 0.433 | 0.753 | 0.657 |

TABLE-2
ADSORPTION OF METAL IONS ON BANANA HUSK

| Conc. | Cu(II) | | Pb(II) | | Cd(II) | | Hg(II) | |
|---|---|---|---|---|---|---|---|---|
| | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ |
| 0.010 M | 0.855 | 0.670 | 1.005 | 0.897 | 1.105 | 0.978 | 0.970 | 0.848 |
| 0.008 M | 0.779 | 0.622 | 0.903 | 0.813 | 0.817 | 0.700 | 0.840 | 0.731 |
| 0.006 M | 0.710 | 0.560 | 0.850 | 0.774 | 0.762 | 0.652 | 0.746 | 0.646 |
| 0.004 M | 0.680 | 0.538 | 0.735 | 0.670 | 0.684 | 0.585 | 0.650 | 0.560 |
| 0.002 M | 0.621 | 0.486 | 0.690 | 0.641 | 0.582 | 0.493 | 0.510 | 0.430 |

TABLE-3
ADSORPTION OF METAL IONS ON CHICKOO SKIN

| Conc. | Cu(II) | | Pb(II) | | Cd(II) | | Hg(II) | |
|---|---|---|---|---|---|---|---|---|
| | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ |
| 0.010 M | 0.648 | 0.557 | 0.957 | 0.672 | 0.485 | 0.360 | 0.876 | 0.761 |
| 0.008 M | 0.585 | 0.505 | 0.788 | 0.513 | 0.435 | 0.315 | 0.747 | 0.642 |
| 0.006 M | 0.530 | 0.461 | 0.706 | 0.441 | 0.382 | 0.271 | 0.635 | 0.540 |
| 0.004 M | 0.470 | 0.412 | 0.612 | 0.358 | 0.345 | 0.242 | 0.532 | 0.446 |
| 0.002 M | 0.410 | 0.362 | 0.556 | 0.308 | 0.293 | 0.198 | 0.420 | 0.344 |

TABLE-4
ADSORPTION OF METAL IONS ON ORANGE SKIN

| Conc. | Cu(II) | | Pb(II) | | Cd(II) | | Hg(II) | |
|---|---|---|---|---|---|---|---|---|
| | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ |
| 0.010 M | 0.956 | 0.836 | 0.875 | 0.647 | 0.937 | 0.827 | 0.958 | 0.853 |
| 0.008 M | 0.900 | 0.794 | 0.826 | 0.602 | 0.912 | 0.817 | 0.852 | 0.737 |
| 0.006 M | 0.840 | 0.748 | 0.786 | 0.565 | 0.884 | 0.804 | 0.810 | 0.705 |
| 0.004 M | 0.810 | 0.732 | 0.706 | 0.488 | 0.857 | 0.797 | 0.770 | 0.680 |
| 0.002 M | 0.735 | 0.672 | 0.667 | 0.452 | 0.830 | 0.780 | 0.710 | 0.628 |

TABLES-5
ADSORPTION OF METAL IONS ON POMEGRANATE HUSK

| Conc. | Cu(II) | | Pb(II) | | Cd(II) | | Hg(II) | |
|---|---|---|---|---|---|---|---|---|
| | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ |
| 0.010 M | 0.984 | 0.813 | 0.915 | 0.740 | 0.997 | 0.852 | 0.989 | 0.863 |
| 0.008 M | 0.910 | 0.755 | 0.840 | 0.670 | 0.908 | 0.783 | 0.950 | 0.830 |
| 0.006 M | 0.828 | 0.685 | 0.789 | 0.626 | 0.890 | 0.774 | 0.900 | 0.788 |
| 0.004 M | 0.735 | 0.607 | 0.705 | 0.547 | 0.840 | 0.742 | 0.827 | 0.723 |
| 0.002 M | 0.735 | 0.594 | 0.688 | 0.517 | 0.795 | 0.710 | 0.753 | 0.657 |

TABLE-6
ADSORPTION OF METAL IONS ON SWEETLIME HUSK

| Conc. | Cu(II) | | Pb(II) | | Cd(II) | | Hg(II) | |
|---|---|---|---|---|---|---|---|---|
| | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ | A after adsorption | ΔA $A_{after} - A_{before}$ |
| 0.010 M | 0.909 | 0.770 | 1.005 | 0.797 | 0.960 | 0.820 | 1.088 | 0.950 |
| 0.008 M | 0.875 | 0.749 | 0.910 | 0.716 | 0.945 | 0.823 | 0.961 | 0.835 |
| 0.006 M | 0.821 | 0.708 | 0.835 | 0.654 | 0.903 | 0.749 | 0.813 | 0.700 |
| 0.004 M | 0.790 | 0.692 | 0.776 | 0.610 | 0.878 | 0.788 | 0.755 | 0.655 |
| 0.002 M | 0.730 | 0.645 | 0.698 | 0.544 | 0.812 | 0.738 | 0.679 | 0.590 |

## RESULTS AND DISCUSSION

It could be seen from Table 1–6 that adsorption increases with respect to increase in concentration of metal ions; the order of adsorption between metal ions and agricultural byproducts are shown as under

(1) Apple skin: Cu(II) < Pb(II) > Cd(II) < Hg(II)
(2) Banana husk: Cu(II) < Pb(II) > Cd(II) > Hg(II)
(3) Chickoo skin: Cu(II) < Pb(II) > Cd(II) < Hg(II)
(4) Orange skin: Cu(II) < Pb(II) > Cd(II) < Hg(II)
(5) Pomegranate husk: Cu(II) > Pb(II) < Cd(II) > Hg(II)
(6) Sweet lime skin: Cu(II) > Pb(II) < Cd(II) > Hg(II)

The formation curves were constructed between log c *vs.* log O.D. and log c *vs.* log $\Delta A$; a straight line curves are formed for all for the systems for every toxic metal, which hold good the Langmuir adsorption isotherm. The values of Freundlich constants (n and k) are also estimated from graphs which are found to be n < 1 and k > 1. These values are shown in Table-7.

TABLE-7
VALUES OF k AND n FOR DIFFERENT ADSORPTION SYSTEMS

| Agricultural byproduct | Metal ions | $\lambda_{max}$ | k values | n values |
|---|---|---|---|---|
| Apple | Cu(II) | 350 nm | 5.212 | 0.480 |
| | Pb(II) | 360 nm | 6.309 | 0.200 |
| | Cd(II) | 365 nm | 7.762 | 0.220 |
| | Hg(II) | 360 nm | 6.309 | 0.275 |
| Banana | Cu(II) | 355 nm | 5.821 | 0.176 |
| | Pb(II) | 350 nm | 7.070 | 0.714 |
| | Cd(II) | 350 nm | 7.498 | 0.428 |
| | Hg(II) | 350 nm | 7.498 | 0.428 |
| Chickoo | Cu(II) | 370 nm | 7.585 | 0.443 |
| | Pb(II) | 350 nm | 7.498 | 0.250 |
| | Cd(II) | 350 nm | 7.498 | 0.250 |
| | Hg(II) | 350 nm | 7.498 | 0.250 |
| Orange | Cu(II) | 370 nm | 7.585 | 0.443 |
| | Pb(II) | 360 nm | 3.981 | 0.133 |
| | Cd(II) | 350 nm | 7.943 | 0.464 |
| | Hg(II) | 365 nm | 3.349 | 0.300 |
| Pomegranate | Cu(II) | 375 nm | 5.432 | 0.312 |
| | Pb(II) | 345 nm | 5.011 | 0.100 |
| | Cd(II) | 355 nm | 6.165 | 0.433 |
| | Hg(II) | 370 nm | 7.244 | 0.300 |
| Sweetlime | Cu(II) | 350 nm | 3.695 | 0.150 |
| | Pb(II) | 355 nm | 3.758 | 0.160 |
| | Cd(II) | 360 nm | 6.531 | 0.106 |
| | Hg(II) | 355 nm | 6.760 | 0.470 |

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