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Comparative Sorption Studies for Amaranth Dye Removal from Water in Cost-Effective Way Using Guava Leaves and Potato Peels

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In this work, guava leaves and potato peels were used as adsorbents for removal of synthetic dye, *i.e.* Amaranth. Biosorbents were characterized by FT-IR and Boehm titration. The removal of dyes was confirmed by UV-visible spectroscopy. Isothermal modeling was done and maximum adsorption capacity q_m for potato peels and guava leaves, respectively was found to be 1.709 and 1.028 mg g^{-1}, while ΔG° values were -1.265 and 2.461 KJ/mol which indicates that adsorption process was exothermic and spontaneous with potato peels and *vice versa* is true for guava leaves. Similarly, pH, moisture content and elemental analysis of the adsorbents was also carried out. Results showed that potato peels were more effective for removal of Amaranth dye than guava leaves.

Keywords: Amaranth, Guava leaves, Potato peels, Adsorption.

INTRODUCTION

Rapidly increasing urbanization and industrialization has changed the face of globe which is one of the major contributing factors of water pollution. A large number of industrial effluents are directly poured into water bodies which contaminate them. More than 700,000 metric tons of synthetic dyes are produced worldwide which are used for various purposes[1]. Water pollution is one of the major causes of nuisance all over the world which needs attention at all levels because it has been suggested that it is one of the foremost cause of worldwide deaths and diseases and it accounts for the 62 million deaths which contributes for approximately 40 % of total number of deaths annually[2].

Various types of dyes include natural or synthetic dyes, vat dyes, solvent dyes, nitro and sulfur dyes, *etc*. These are extensively used in chemical laboratories for analytical purposes and in many biomedical laboratories as biological stain. Synthetic dyes are also used in various branches of the textile industry, leather tanneries, in food industry, in agricultural research, in hair colourings, ink dyes, photographic dyes, indicators and in detergents as well. The multifarious molecular structure of dyes makes them stable and non-biodegradable[3].

The present study is concerned with the removal of a food dye Amaranth from water. Its colour varies from reddish-brown, dark red to purple. Its structural formula is given in Fig. 1. It is used as textile dye for wool and silk, as food dye in sweets and beverages and in photography. It was used as a food colour, but now it is banned due to its carcinogenic nature. It is also used in various drugs and cosmetics.Its long term intake can cause tumors, allergy, respiratory tract infections and birth flaws in the human beings[4-7]. It is a water soluble dye, so its removal is not so easy. Various methods like biosorption, photo-catalytic degradation as well as advanced oxidation were used for its removal from water. Various biosorbents involving bottom ash, de-oiled mustard, mesos-porous carbon, rice husk, pomegranate peels and cellulose carbon encapsulated ZnO, nanoparticles such as magnetic Fe_3O_4/C, polystyrene, magnetic Fe_2O_3 nanoparticles, peanut hull were found to be effective for its removal from water on batch scale[8-18].

Several methods such as coagulation, biological degradation, ion exchange, membrane filtration, photo-catalysis and photo-oxidation were developed but no one has been found satisfactory. Biosorption is one of the suitable processes for amputation of pollutants. The major factors consist of charge and molecular structure of adsorbate and adsorbent, surface functional groups of adsorbent, steric effect and electrostatic force of attraction, *etc*[19-21].

The present study was conducted to check the feasibility of potato (*Solanum tuberosum*) peels(PP) and guava (*Psidium guajava*) leaves (GL) for removal of Amaranth dye from water. *Psidium guajava* belongs to family Myrtaceae. It is grown most commonly in tropical and temperate areas. The chemical composition of leaves has shown that a variety of compounds are present in a fixed ratio. Its seeds and leaves are used to cure a number of diseases in humans[22,23]. Potato belongs to

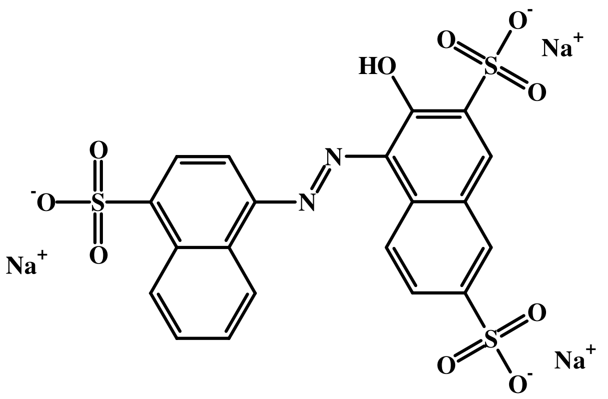

Fig. 1. Structure of Amaranth dye

family solanaceae which is being consumed as vegetable because of its high starch content. Potato peels can be easily obtained from chips making shops and cafe, bars etc and are used for removal of a variety of heavy metals and dyes[24,25].

The main purpose of this study was to check the biosorption of Amaranth dye using chemically treated potato peels and guava leaves by optimizing various conditions such as adsorbent dosage, pH, time and temperature. Moreover, surface functional groups were characterized and structural changes were examined by taking FT-IR spectra of adsorbents before and after chemical treatment and adsorption of dye.

EXPERIMENTAL

Amaranth dye (λ_{max} = 520 nm; molecular formula = $C_{20}H_{11}N_2O_{10}S_3Na_3$; IUPAC name: Trisodium 2-hydroxy-1-(4-sulphonato-1-naphthylazo) naphthalene-3,6-disulphonate; molecular weight = 604.6 g/mol; synonyms: Food Red 9, Acid Red 27 or Azorubin S) was purchased from Acros Organics. NaOH (Merck), HCl (Merck 11.6 M), $NaHCO_3$, Na_2CO_3, phenolphthalein and methyl orange were purchased from Friends Chemical Laboratory, Ltd. Distilled water was used for the preparation and dilution of solutions where ever required. Electric Balance (HX-T), Electric grinder (Moullinex), pH meter (GLP-21 Crison), Electric shaker digital timer and Spectrophotometer-721 model (UV-Vis Double Beam UVD-3500 Labomed) were used.

Preparation of adsorbents: Potato peels were collected from waste baskets of home institute cafe and from household domestic waste, whereas guava leaves were collected from home garden and trees grown at University of the Punjab, New campus, Lahore, Pakistan. Both the adsorbents were washed and dried in sunlight for one week followed by oven drying at 70 °C for 2 h. They were grinded into fine powder of 50 mesh size and stored in plastic jars. These were the sample of the untreated biosorbents.

Chemical modification of adsorbent: Biosorbent were chemically treated with acetone by dipping 100 g of dried leaves and peels powder into 400 mL of acetone solution for 24 h. After filtration, it was dried again in oven at 60 °C for 2 h.

Characterization of biosorbents

FT-IR analysis: FT-IR spectrophotometer (IR Prestige-21 SHIMADZU, DRS-8000) was employed for characterizing active sites of biosorbents for binding with dye molecules and ions.

Boehm titration: It was used for calculation of oxygen containing functional groups.1 g of the adsorbents were immersed in 15 mL solution of 0.1 M $NaHCO_3$, 0.05 M Na_2CO_3 and 0.1 MNaOH for characterizing acidic groups and 0.1 M HCl for basic groups, respectively at room temperature for 1 day. The first three filtrates were back titrated with HCl (0.1 M) and last one with NaOH (0.1 M).

Optimizing operational conditions: Biosorption experiments were carried out at room temperature. Various parameters were checked by varying adsorbent dose (0.1-1 g), pH (1-9), time (10-60) and temperature (10-80 °C). Volume (V) of dye solution was kept constant (25 mL) and initial concentration (C_o) of dye was also constant (25 ppm). The percentage removal was calculated by using eqn. 1:

$$\text{Removal of dye}\,(\%) = \frac{C_o - C_e}{C_o} \times 100 \qquad (1)$$

where, C_o and C_e are the concentration of dye before and after adsorption. Average values were used for further calculations. Isothermal modeling

Isotherms were studied by taking six solutions of varying concentration from 5-30 ppm. The optimized conditions of adsorbent dose, pH, time and temperature were taken for studying adsorption isotherm. Then solutions were filtered off and filtrates were analyzed for calculation of equilibrium dye concentration.The equilibrium expression for Langmuir isotherm is given in eqn. 2 as follows,

$$1/q = (1/bq_mC_e + 1/q_m) \qquad (2)$$

where

q = Dye adsorbed per unit weight of sorbent (mg g^{-1})
q_m = Top most adsorbing capacity (mg g^{-1})
b = Langmuir constant (L g^{-1})

Graph of 1/q *versus* $1/C_e$ gives Langmuir constants, from which 'b; is used further for calculating separation factor 'R_L' by eqn. 3. It is a dimensionless constant and indicates the feasibility of biosorption process. Its value ranges between 0-1[26].

$$R_L = 1/1 + bC_o \qquad (3)$$

Freundlich model is represented by eqn. 4:

$$\log q = 1/n \log C_e + \log K_F \qquad (4)$$

where, K_F = adsorption capacity ($mg^{1-(1/n)}$ $L^{1/n}$ g^{-1}) and 1/n = adsorption intensity, respectively.

Temkin isothermal model is given by eqn. 5.

$$q = B_T\ln C_e + B_T \ln K_T \qquad (5)$$

where 'B_T' gives heat of adsorption and 'K_T' is the equilibrium binding constant (L mg^{-1}). The thermodynamic parameter ΔG° was calculated taking Langmuir isotherm model into consideration by using eqn. 6 as follows:

$$\Delta G^\circ = -RT\ln K \qquad (6)$$

RESULTS AND DISCUSSION

Surface characterization of adsorbents: Amaranth is an anionic dye, so interaction between negative functional groups of dye and positive functional groups of adsorbent may developed. The surface functional groups of the adsorbents were characterized by FT-IR and absorption peaks were recorded and given in Tables 1 and 2. The spectra of untreated and acetone treated guava leaves before adsorption of dyes

TABLE-1
CHARACTERISTIC FT-IR ABSORPTION FREQUENCIES OF FUNCTIONAL GROUPS OF GUAVA LEAVES

Wave number (cm^{-1})	Untreated guava leaves	Acetone treated guava leaves	Acetone treated guava leaves after dye adsorption
$\nu_{(N\text{-}H\ str)}$	3309.85(w)	3321.42(w)	3309.85(w)
$\nu_{(O\text{-}H\ str)}$	2924.09(s)	2922.16(s)	2922.16(s)
Silane ν(Si-H)	-	2357.01	2366.66
$\nu_{(C=O\ str)}$	1728.22(s)	1730.15(s)	1730.15(s)
$\nu_{(N\text{-}H\ def)}$	1618.28(m)	1625.99(m)	1625.99(m)
$\nu_{(N\text{-}H\ def)}$	1527.62(s)	1527.62(s)	1527.62(s)
$\nu_{(C=C,\ str)}$	1444.68(m)	1440.83(m)	1438.90(m)
$\nu_{(C\text{-}N\ str)}$	1321.24(s)	1319.31(s)	1319.31(s)
$\nu_{(C\text{-}O\ str)}$	1236.37(s)	1240.23(s)	1240.23(s)
$\nu_{(C\text{-}O\ str)}$	-	1155.36(s)	1155.36(s)
$\nu_{(C\text{-}O\ str)}$	1010.70(s)	1004.91(s)	1001.06(s)

TABLE-2
CHARACTERISTIC FT-IR ADSORPTION FREQUENCIES OF FUNCTIONAL GROUPS OF POTATO PEELS

Wave number (cm^{-1})	Untreated potato peels	Acetone treated potato peels	Acetone treated potato peels after dye adsorption
$\nu_{(N\text{-}H\ str)}$	3300.20(w)	3304.06(m)	3170.97(m)
$\nu_{(O\text{-}H)}$	2924.09(w)	2926.01(w)	2927.94(w)
Alkyne $_{(str)}$	2146.77(m)	-	-
Silane$_{(Si\text{-}H\ str)}$	-	-	2360.87(s)
$\nu_{(C=C)}$	-	2056.12(w)	2056.12(w)
$\nu_{(N\text{-}H\ def)}$	1639.49(m)	1625.99(m)	1647.21(m)
$\nu_{(N\text{-}H\ def)}$	1537.27(s)	1527.62(s)	1521.84(s)
$\nu_{(C\text{-}O\ str)}$	1244.09(s)	1242.16(s)	1242.16(s)
$\nu_{(C\text{-}O\ str)}$	1149.57(s)	1151.50(s)	1151.50(s)
$\nu_{(C\text{-}O\ str)}$	1078.21(s)	-	-
$\nu_{(C\text{-}O\ str)}$	1001.06(s)	-	-

show peaks at 3309.85, 1618.28, 1527.62, 3321.42, 1625.99 cm^{-1} due to stretching vibrations of -NH group while the bands at 2924.09 and 2922.16 cm^{-1} could be due to stretching of -OH group. The bands at 1728.22 in untreated guava leaves and 1730.15 cm^{-1} in treated Guava Leaves were showing the stretching of C=O of ester. While bands observed at 1236.37, 1010.70 cm^{-1} in untreated guava leaves and 1240.23, 1155.36 and 1004.91 cm^{-1} in acetone treated guava leaves showed stretching frequency of C-O which could be of ester. The spectra are shown in Figs. 2 and 3.

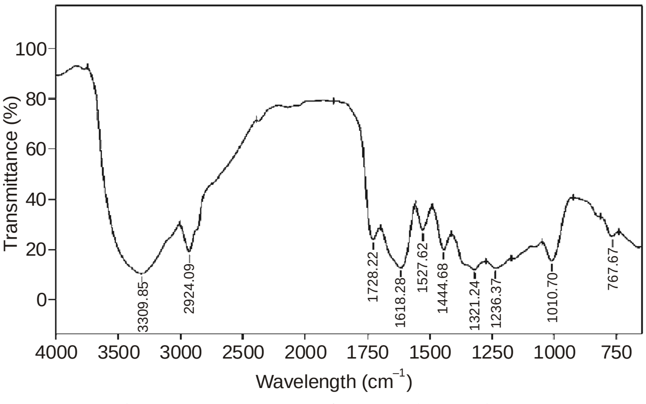

Fig. 2. FT-IR spectrum of untreated guava leaves

FT-IR spectrum was also obtained after adsorption of dye which was graduallly in different forms and shown in Fig. 4.

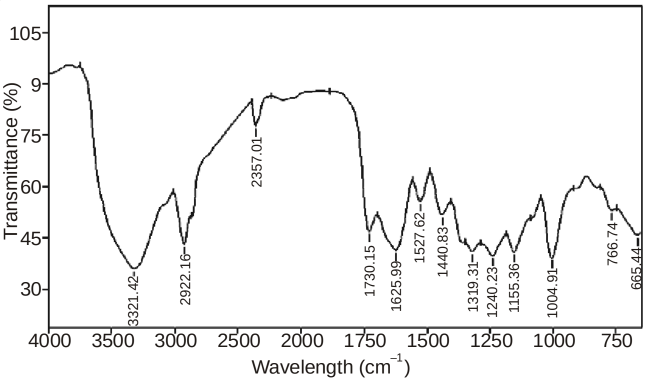

Fig. 3. FT-IR spectrum of acetone treated guava leaves

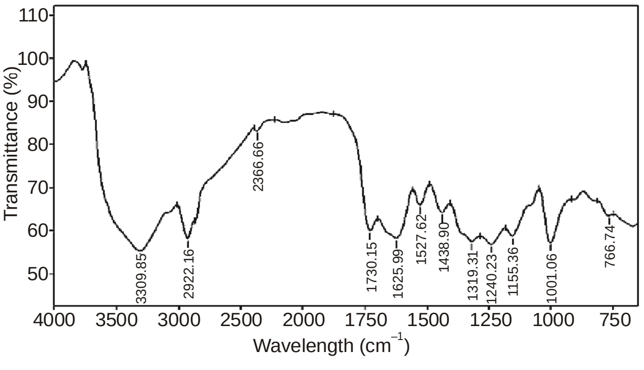

Fig. 4. FT-IR spectrum of acetone treated guava leaves after adsorption of Amaranth dye

The bands at 3321.42, 1625.99 showed stretching vibrations which could be of NH group in acetone treated guava leaves before adsorption of dye while bands at 3331.07, 1633.71 and 1529.55 cm^{-1} after adsorption of dye. While bands at 2922.16 cm^{-1} could be due to stretching of OH group, bands at 1240.23, 1155.36 and 1004.91 cm^{-1} in treated Guava leaves showed stretching frequency of C-O which could be of ester. The bands at 1728.22 and 1730.15 cm^{-1} in acetone treated guava leaves were showing the stretching of C=O of ester. Spectra obtained for acetone treated guava leaves after adsorption of Amaranth dye showed bands. 1240.23, 1155.36 and 1001.06 cm^{-1} elucidated the stretching of C-O of ester. Moreover, a band of silane (Si-H) was observed at 2357.01 and 2366.66 cm^{-1} in acetone treated guava leaves before and after adsorption of Amaranth, respectively.

FT-IR spectrum of untreated potato peels was given in Fig. 5, which showed bands at 3300.20, 1639.49, 1537.27 cm^{-1}. They were shifted to high wave number at 3304.06 in acetone treated Potato Peels as shown in Fig. 6 and to lower wave number at 1637.56 and 1531.48 cm^{-1} stretching due to N-H group. Bands at 2924.09 showed stretching due to O-H in untreated potato peels which was shifted to high wave number at 2926.01 in treated potato peels. Bands at 1244.09 and 1149.57 cm^{-1} showed stretching due to C-O group in untreated potato peels which was shifted to lower wave number at 1242.16 and higher wave number at 1151.50 cm^{-1} in acetone treated potato peels. Bands at 3311.78, 1639.49, 1529.55 cm^{-1} were observed due stretching of N-H group in acetone treated potato peels before adsorption of Amaranth which were shifted to lower wave number at 3170.97 and 1521.84 cm^{-1} and higher wave number at 1647.21 cm^{-1} in acetone treated potato peels after adsorption of Amaranth as shown in Fig. 7. Bands at 2924.09 in acetone treated potato peels before adsorption of Amaranth was obtained due to stretching of O-H which was shifted to higher wave number at 2927.94 cm^{-1} after Amaranth adsorption. Similarly, bands at 1242.16, 1149.57 and 1002.98 cm^{-1} were due to stretching of C-O group which were shifted to higher wave number at 1151.50. Another band at 2054.19 in acetone treated potato peels was observed due to arene which was shifted to higher wave number at 2056.12 in acetone treated potato peels after adsorption of Amaranth respectively. Band at 2360.87 was observed due to silane in acetone treated potato peels after adsorption Amaranth which was absent in untreated potato peels after adsorption of Amaranth.

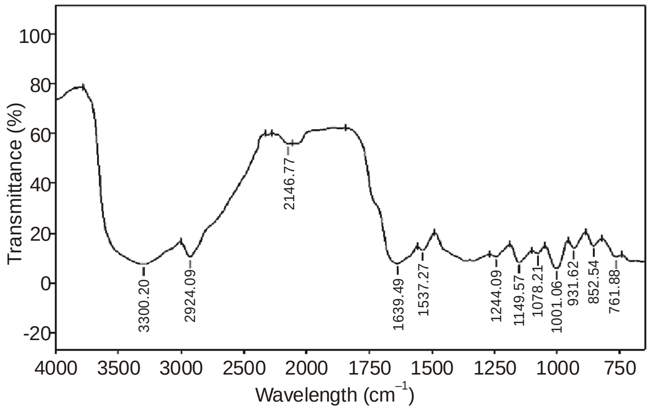

Fig. 5. FT-IR spectrum of untreated potato peels

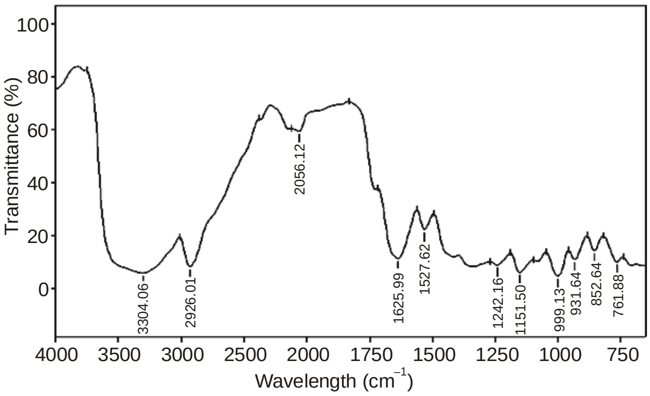

Fig. 6. FT-IR spectrum of acetone treated potato peels

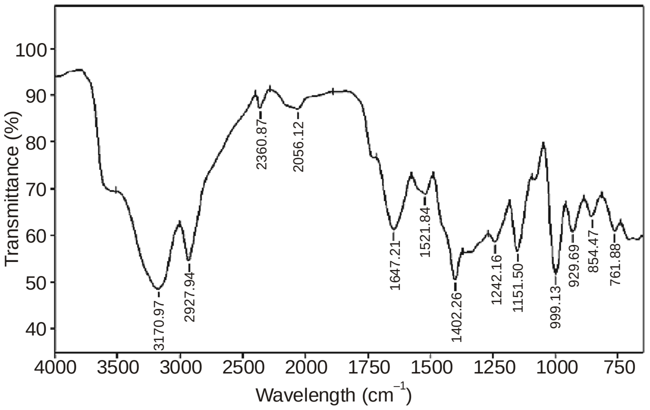

Fig. 7. FT-IR spectrum of acetone treated potato peels after adsorption of Amaranth dye

Effect of adsorbent dose: The comparative study of adsorption of Amaranth on potato peels and guava leaves was studied by varying adsorbent dose while all other parameters of the dye were kept constant and results shown in Fig. 8. The highest percentage removal was at 0.4 g of guava leaves and 0.2 g of potato peels. It is being observed that if the adsorbent dose is increased while keeping concentration of dye constant then adsorption is decreased due to less number of ions of dye per unit mass of the adsorbent. This is due to the fact after equilibrium is being established; all available sites are occupied by the dye molecules at the adsorbent surface[27].

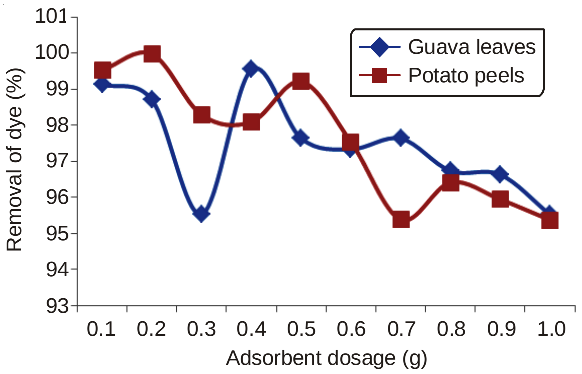

Fig. 8. Comparative study of adsorbent dosage effect on percentage removal of Amaranth dye by acetone modified guava leaves and potato peels

Effect of pH: Adsorption varies with the change in pH of medium. Generally, for anionic dyes the percentage removal of dye will increase in acidic pH, the positively charged species start dominating and surface tends to acquire a positive charge[28]. It is seen from Fig. 9 that the dye uptake was higher at lower pH and as the pH of the dye solution increased, dye uptake decreased considerably from 94.72 to 59.16 % for potato peels while maximum adsorption was observed at 94.72 % for guava leaves.

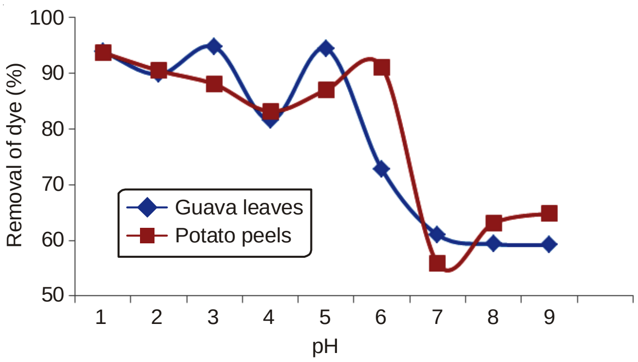

Fig. 9. Comparative study of solution pH effect on percentage removal of Amaranth dyeby acetone modified guava leaves and potato peels

Effect of time: Percentage removal of Amaranth initially increased with increasing time, which then started decreasing and then became stable. The optimum value was obtained after 20 min for guava leaves and 30 min for potato peels (Fig. 10). This is due to the attainment of equilibrium between adsorbate and adsorbent as the maximum active sites of adsorbent were occupied in optimum time.

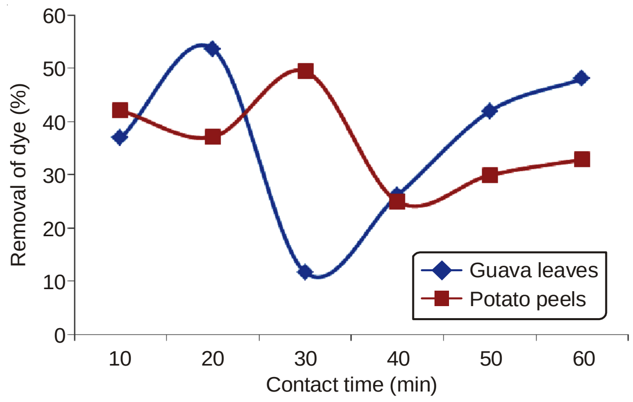

Fig. 10. Comparative studyof contact time effecton percentage removal of Amaranth dyeby acetone modified guava leaves and potato peels

Effect of temperature: Temperature is also another important parameter in the adsorption processes. If the adsorption capacity increases with increasing temperature then the process is endothermic. Fig. 11 shows the sorption of Amaranth on potato peels and guava leaves which started increasing at 30 °C for potato peels and at 40 °C for guava leaves and then became constant.

Isotherm modeling for adsorption of amaranth: Adsorption isotherm is a graphical representation which shows the relationship between the amount adsorbed by the adsorbent and the amount of adsorbate remaining in the solution at equilibrium[29]. Langmuir, Freundlich and Temkin isotherms were tested for the present experimental work.

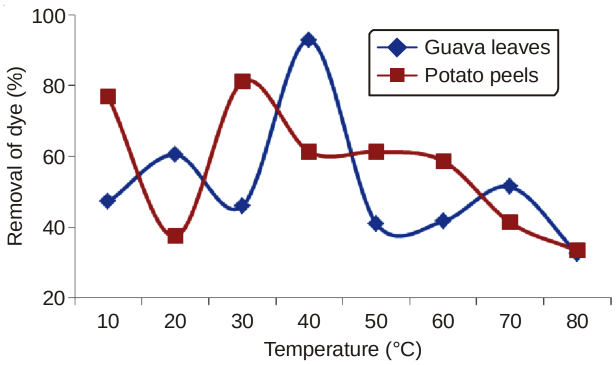

Fig. 11. Comparative study of effect of temperature on removal of Amaranth dyeby acetone modified guava leaves and potato peels

Langmuir isotherm: The Langmuir sorption isotherm describes the multilayer adsorption on a homogeneous surface without chemical interaction[30]. It was studied to check the feasibility of physio-sorption on guava leaves and potato peels. The corresponding adsorption parameters are given in Table-3. 'q_m' was 1.709 and 1.028 mg g^{-1} for potato peels and guava leaves, respectively.

The adsorption equilibrium constant (b) shows the attraction of dye molecules with the active sites of adsorbent which decreases while temperature is increased. Thus its value was 0.6 and 2.7 L g^{-1} for potato peels and guava leaves respectively. They were used to calculate separation factor 'R_L' values, *i.e.* 0.0625 and 0.0146 for potato peels and guava leaves, respectively showing that this process is favorable. The value of R^2 is close to one which indicates that Langmuir isotherm is best fitted to describe the adsorption of Amaranth dye onto potato peels and guava leaves. The thermodynamic parameter ΔG° was calculated by using Langmuir isotherm whose value came out to be -1.265 and 2.461 KJ/mol for potato peels and guava leaves, which indicates that adsorption process was exothermic and spontaneous with potato peels and *vice versa* is true for guava leaves.

Freundlich isotherm: This model is a brief description of mono layer adsorption on heterogeneous surfaces and it is more suitably applicable when the concentration of dye increases[31]. The equilibrium relationship describes the behaviour of many adsorption systems on the heterogeneous surface. The isothermal parameters are given in Table-4. The value of K_F (adsorption capacity) was 0.87 and 1.18 and 1/n (adsorption intensity) was found to be 0.18 and 0.042 for potato peels and guava leaves, respectively. The value of 1/n varies from 1 to 8 which indicates significant adsorption of dye onto heterogeneous surfaces. The value of R^2 is 0.932 and 0.911 which indicates that molecules can significantly adsorb onto heterogeneous

TABLE-3
ADSORPTION ISOTHERMAL PARAMETERS OF LANGMUIR MODEL FOR REMOVAL OF AMARANTH DYE BY ACETONE MODIFIED GUAVA LEAVES AND POTATO PEELS

Adsorbent	Slope	Intercept	R^2	b (L g^{-1})	q_m (mg g^{-1})	ΔG^o (KJ/mol)
Potato Peels	1.667	0.573	0.974	0.6	1.709	-1.265
Guava Leaves	0.408	0.974	0.971	2.7	1.028	2.461

TABLE-4
ADSORPTION ISOTHERMAL PARAMETERS OF FREUNDLICH MODEL FOR REMOVAL OF AMARANTH DYE BY ACETONE MODIFIED GUAVA LEAVES AND POTATO PEELS

Adsorbent	Slope	Intercept	R^2	K_F	1/n
Potato Peels	0.189	-0.076	0.932	0.87	0.18
Guava Leaves	0.042	0.075	0.911	1.18	0.042

TABLE-5
ADSORPTION ISOTHERMAL PARAMETERS OF TEMKIN MODEL FOR REMOVAL OF AMARANTH DYE BY ACETONE MODIFIED GUAVA LEAVES AND POTATO PEELS

Adsorbent	Slope	Intercept	R^2	B_T (KJ/mol)	K_T (L mg^{-1})
Potato Peels	0.191	0.988	0.968	2.5	1.279
Guava Leaves	0.038	0.939	0.943	9.9	1.068

surface of both the adsorbents forming a multilayer through chemical bond.

Temkin isotherm: Temkin and Pyzhev observed that the heat of adsorption of all molecules decreases linearly[32]. The isotherm constants obtained for various isotherm models are shown in Table-5. The heat of adsorption 'BT' was found to be 2.5 and 9.9 KJ/mol and 'K_T' was 1.279 and 1.068 L mg^{-1} for potato peels and guava leaves, respectively. The value of regression coefficient (R^2) is 0.968 and 0.943 for potato peels and guava leaves respectively showing physio-sorptive removal of dye is dominant over chemisorption.

Surface characterization by Boehm titration: The Boehm titration was used for calculation of oxygen containing functional groups. Carboxylic groups were thus calculated by direct titration with $NaHCO_3$. The difference between the groups titrated with Na_2CO_3 and those titrated with $NaHCO_3$ were supposed to be lactones and that titrated with NaOH and Na_2CO_3 were assumed to be phenol. Basic sites were examined by titration with HCl. The number and type of acidic sites were calculated as NaOH neutralizes carboxylic, lactonic and phenolic groups, Na_2CO_3 neutralizes carboxylic and lactonic groups and $NaHCO_3$ neutralizes only carboxylic groups. The results are recorded in Table-6.

TABLE-6
ADSORBENTS SURFACE CHARACTERIZATION BY BOEHM TITRATION METHOD

Functional group	Potato peels	Guava laves
Carboxylic (μmol)	1.225×10^{-3}	1.37×10
Phenolic (μmol)	1.345×10^{-3}	1.45×10
Lactonic (μmol)	0.93×10^{-3}	1.23×10
Basic group (μmol)	1.34×10^{-3}	1.345×10

Determination of moisture content: The percentage moisture content was computed by eqn. 7 after drying 1 g sample at 105 °C for 4 h.

$$\text{Moisture (\%)} = \frac{\text{Original weight (g)} - \text{Final weight (g)}}{\text{Original weight (g)}} \times 100 \quad (7)$$

It was found to be 9 % for potato peels and 6 % for guava leaves.

Determination of pH: The pH of untreated guava leaves and potato peels was 1.5 and 3.67, respectively while for acetone treated guava leaves and potato peels it was found to be 1.35 and 2.85, respectively. It indicates that acidic functional group concentration increased due to removal of colouring material after acetone treatment of adsorbents.

Elemental analysis: Concentration of various essential, non-essential and toxic metals was determined by taking absorbance on AAS. The results thus obtained are recorded in Table-7. It was found that Ca^{2+} is present in higher concentration in both guava leaves and potato peels while concentration of toxic metals Cr^{6+} and Ni^{2+} was zero in guava leaves.

TABLE-7
ELEMENTAL ANALYSIS OF GUAVA LEAVES AND POTATO PEELS

Metal ins	Potato peels (%)	Guava leaves (%)
Na^+	0.96	0.54
K^+	0.01	0.11
Ca^{2+}	1.14	0.98
Mg^{2+}	0.17	0.04
Ni^{2+}	1.28	0
Cu^{2+}	0.09	0.01
Cr^{6+}	0.16	0

Conclusion

In the present research work, low cost adsorbents were used for the removal of Amaranth using potato peels and guava leaves as biosorbents. UV-visible spectrophotometery was used as analytical technique. Biosorbents were modified by using mixture of water and acetone in 4:1 ratio. Later on characterization of these biosorbents was carried out by FT-IR and functional groups were calculated by Boehm titration.

Moreover, isothermal modeling was studied by using Langmuir, Freundlich and Temkin isotherms. Various parameters for adsorption of Amaranth dye onto were such as: 'q_m' came out to be 1.709, 1.028 mg/g; 'K_F' 0.87, 1.18; 'B_T' 2.5, 9.9; K_T' 1.279, 1.068 L mg^{-1} and $\Delta G°$-1.265 and 2.461KJ/mol were found for potato peels and guava leaves, respectively. Thus, Langmuir isotherm was found to be well suited for effective removal of Amaranth dye by potato peels.

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