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Research Article

Leveraging of Agricultural Tailings and Industrial Wastes Together in Black Ink Preparation

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Abstract: The textile industries in their production processes and biological laboratories in their research works throw quite a few quantities of various types of dyes and stains to the river's water and sewerage. The problem is going to get worse if these wastewater from textile factories and biological laboratories poses without any treatment. This paper deals with examine the treating ability of polluted water with nine kinds of textile dyes and biological stainswhich were Congo red, direct black, direct brown, Indigo Carmine, haematoxylin, eosin, brilliant green, crystal violent and methylene blue using potato peels as low cost material with two methods, the first one is enzymatically method via extraction of polyphenol oxidase (PPO) enzyme from fresh potato peels and treating water polluted of high dyes concentrations with loaded PPO on zeolite prepared from rice husk and the other method is physically method through using potato peels residue from enzyme extraction process treating water polluted of low dyes concentrations by adsorption technique. The results show high ability of two methods (enzymatically and physically) to remove dyes from polluted water for both high and low concentrations. After that the benefit of the potato peel residue wasted from adsorption process of dyes from SSAS has been done in preparing of black ink. Thus, the treatment of dyes polluted water was achieved with all concentrations, in addition to prepare useful material which was black ink from obsolete and less valuable remnants moreover getting rid of potato peels polluted environment by beneficial, economical and eco-friendly method and achieving access to zero residues level (ZRL) of contaminations.
Keywords: Black Ink, Agricultural Tailings, Industrial Wastes, Eco-friendly, Economical, Potato peels.

INTRODUCTION

The environment includes the earth planet as one board of its concepts; thus it represents the place in which human is live, benefit of all its living and non-living elements and invests its natural resources which the Great Creator has put them since thousands of years for human life, welfare and prosperity. Until now and despite his relentless pursuit, his continuing research and his continuous work for many decades ago in the space invasion, planetary exploration and discovery of new galaxies cosmic; the human has not been able to find any place adequate for life, convenient for existence, eligible for habitation in this vast and huge cosmos other than the blue planet.

Actually, the environment (i.e. this planet) is facing various problems, convulsed by multiple challenges and surrounded by devastating risks as a result of disasters forms caused by nature sometimes due to fires, floods, hurricanes, droughts, earthquakes, desertification, tsunamis and others disasters and the pollution caused by humans to environment due to their agricultural, industrial, commercial, scientific, research and practical activities and means of transportation used by them to satisfy their requirements in all different walks of life at other times. Humans are represents the main source of contamination of basic environmental elements in general and water especially, since they found on the surface of earth however, the pollution was little some extent due to the limited evolution and the simplicity needs of humans. But the pollution in the recent decades has begun to take new forms, many dimensions, increasing its risks and aggravated its damages not only the environment, but even the humans themselves.

The environment has becomes suffer from thermal pollution represented by global warming, radioactive pollution represented by remnants of nuclear reactors and disasters of nuclear weapons, electronic pollution represented from one side by older electronic sets and its accessories such as computers, TVs, radios, calculators, cameras, telephones, batteries, monitors, wires, etc. and by electromagnetic fields produced around electronic sets, starting from the electric bell and ending with the satellites which have a negative impact on the nerve cells of the human brain, biological pollution represented by microbiological organisms

(like bacteria, viruses, etc.) and new diseases that have emerged, such as Human Immunodeficiency Virus (HIV) infection or acquired immunodeficiency syndrome commonly known as AIDS, Bovine Spongiform Encephalopathy (BSE), commonly known as mad cow disease, Severe acute respiratory syndrome commonly known as SARS, pandemic Influenza (such as avian influenza and swine influenza) and coronavirus (MERS-CoV) and chemical pollution with heavy metals, pesticides, organic substances, poisons and dyestuffs.

The pollution due to dyes resulting from the textile industry, the health laboratories and biological experiments considered as one of the most important types of pollution in general and, in particular, chemical pollution which leads to contamination of water with toxic and hazardous organic compounds and change the water color thus obscures the sun's rays from reaching to the aquatic organisms in addition to distort the aesthetic side of rivers, ponds and contaminated water bodies. For this, the humans should not stand idly by and leave the situations exacerbated and problems get complicated but they must find solutions to solve these problems in a balanced manner to meet their multiple needs and persistent requirements at the same time uses the methods and processes that prevent or reduce the pollution of the environment in various types. One of these solutions through applied of it can be achieved ex-goals together is made the pollutants one of resources that contribute to improve the human conditions by the maximum leveraging possible of agricultural and industrial wastes that poses to the environment in large quantities in production of fuel or generation of electricity or extraction of useful substances or conversion to industrial materials with low cost or preparation the necessary supplies for human life.

This research tries to translate the above aforementioned speak into practical reality via studying the possibility of exploitation from potato peels, which is considered as one of the agricultural waste produced as a waste of food plants, homes, restaurants and others in large quantities through extraction of polyphenol oxidase (PPO) enzymes from its which works to remove nine types of dyes which were Congo red, direct black, direct brown, Indigo Carmine, haematoxylin, eosin, brilliant green, crystal violent and methylene blue that contaminated water and utilization of the remainder potato peels from extraction process in preparing black ink from natural substances and agricultural wastes at almost very simple cost and accessible to the zero residues level (ZRL) of pollutants. In this, accomplish three tasks simultaneously: the first task is getting rid of the dyes remnants contaminated aqueous solutions through the PPO enzyme extracted from the potato peel, the second task is preparing of useful substances which is ink cheaply and the third task is disposal of potato peel waste that polluting the environment using economical useful and eco-friendly manner.

EXPRIMENTAL WORK

Materials

Potato peels (adsorbent media)

Potato peels, mature potato with brown peel, was collected from local market in Baghdad. The potato peels was washed three times with excess double distilled water to remove dust, impurities and other fine dirt particles that may be attached to it.

Preparation of Crude Poly Phenol Oxidase (PPO) Enzyme Extract from Potato Peels

100 g of fresh potato peels was cut into small pieces (nearly 0.5-1 cm) and homogenized by using (200 ml) of pre-chilled (4°C) containing 0.1M sodium phosphate buffer extraction buffer (pH 6.5), Poly vinyl pyrolidone (PVP) and Triton X-100 using blender for 1 minute at maximum speed. The slurry was centrifuged at 9000 rpm at 4°C for 15 minutes. The supernatant obtained was filtered under vacuum from a Buncher funnel containing Whatman® No. 1 filter paper and the filtrate was collected in a conical flask. Then, 100ml of the filtrate was pipette drop by drop into (200ml) of cold acetone (–20°C) for the formation of the precipitates. The crude PPO precipitates separated by centrifugation at 10,000 rpm at 4°C for 15 minutes. The resultant light brown colored acetone precipitates was dried overnight at room temperature. The acetone powder that obtained was stored at (–20°C). The enzyme extraction from acetone powder was conducted by mixing 0.1g acetone powder, 15 ml of pre-chilled 0.1M sodium phosphate buffer, pH 6.5 and stirring for 1 hour at 4°C with a magnetic stirrer. The temperature was maintained by covering the beaker with aluminum foil and was enclosed with ice surrounding the beaker. The obtained crude extract was filtered through cheese cloth and the filtrate was centrifuged at 10,000 rpm for 30 min. The supernatant was discarded and used as crude PPO [1, 2].

Enzyme Assay

The assay solution was prepared by mixing 1 ml of 20 mM substrate (L-DOPA), 1 ml 0.2M sodium phosphate buffer, 0.9 ml H_2O and 0.1 ml of enzyme solution. Enzyme activity was measured spectrophotometrically at 475 nm against a blank containing no enzyme. One unit of enzyme activity is defined as the amount of enzyme that transforms 1 µmole of substrate Levodopa (L-DOPA) (L-3, 4-dihydroxyphenyl-alanine) per minute under assay conditions [1].

Preparation of Zeolite from Rice Husk as a Carrier for PPO

Rice husk (which was a raw material for zeolite type Y catalyst synthesis) firstly treated with 10% phosphoric acid (H_3PO_4) for 24 hours. Then they were

well washed with double distilled water, filtered, dried in air, and calcined at 750°C for 6 hours. 12 g of calcined rice husk were then subjected for dissolution in sodium hydroxide NaOH (4 M) followed by refluxing at 90°C for 12 hours. After that concentrated hydrochloric acid (HCl (37%)) was added to the aforementioned base dissolved rice husk for complete precipitation. Rice husks were filtered, washed with excess distilled water to be freeing from chloride ions and finally dried in an oven at 120°C for 6 hours. Zeolite type Y was synthesized using prepared rice husk above as a silica source in the following method. A 500 ml Teflon beaker containing a magnetic stirrer was washed with deionized water. Sodium hydroxide of 1.6616g was added slowly to deionized water and stir until clear and homogenous solution appeared for about 5 minutes. The aqueous solution of sodium hydroxide was ready for the preparation of seed gel. The gel was prepared according to the following molar chemical composition: 10.67 Na_2O: Al_2O_3: 10 SiO_2: 180 H_2O. Two milliliters aqueous solution of sodium hydroxide was added to 0.7515g sodium aluminate oxide until a homogenous mixture was formed; 1.5361g of prepared rice husk above was added separately to 5.5 ml sodium hydroxide aqueous until mixed homogenously. Both of the preparations were heated under vigorous stirring to obtain a homogenous mixture. The sample was aged for 24 hours at room temperature in the Teflon bottle. The aluminate and silicate solutions were mixed together in the polypropylene beaker, subsequently stirred for 2 hours with the purpose of making it completely homogenized.

This combined solution was used as the feed stock gel. The synthesized zeolite type Y which was in sodium (Na^+) powder form. In order to make a promoted HY-zeolite catalyst ready for test in any process, hydrogen zeolite (HY-zeolite) form must be prepared. The HY-zeolite was prepared by exchanging Na^+ ions in the sodium form zeolite type Y with ammonium chloride solution NH4Cl. In order to obtain ideal degree of ion exchange the technique of multi-steps (three times repeating) was used. Thus, the first step, 2N of ammonium chloride solution (26.75 g of NH_4Cl in 250 ml of distilled water) contacted with 90 g of prepared NaY-zeolite with stirring for 2 hours. In the second step, the procedure in the first step was repeated under the same conditions but on about 60 g of zeolite, which was taken from the total zeolite amount produced in the first step. Finally, in the third step, the procedure under the same conditions was repeated again but on about 30 g of zeolite, which was taken from the total zeolite amount produced in the second step. The exchanged ammonia zeolite were filtered off, washed with deionized water to be free of chloride ions dried overnight at 120°C and then calcined initially at 150°C for two hours. The temperature was increased 75°C per hour until it reached 550°C and it was held constant for 5 hours at this temperature. During calcination, ammonia and water were liberated and HY-zeolite was formed [3].

PPO Immobilization in zeolite type Y

25 g of prepared HY-zeolite powder (prepared in section 2.2.2 above) was used for the immobilization of PPO in HY-zeolite. Immobilization solution of PPO was achieved by adding 10 mg of NaY-Zeolite carrier to 10 ml 0.05 M sodium phosphate buffer (pH 7.0) and mixing with 40 mg of crude PPO enzyme prepared. Mixture was left over night on shaker at 600 rpm at 4°C. Biocatalyst (enzyme and support) was taken out from solution, centrifuge at 10,000 rpm and washed six times in 20 ml 0.05 M sodium phosphate buffer to remove free PPO enzyme. The removed biocatalyst was finally stored in 0°C [4].

Stock solutions

In order to avoid interference with other elements in wastewater, the experiments in this study were carried out using simulated synthetic aqueous solution (SSAS) of different dyes concentrations. 1000 mg/l stock solution of dyes was prepared by dissolving known weight of five types of dyes which were Congo red, direct black, direct brown, Indigo Carmine, haematoxylin, eosin, brilliant green, crystal violent and methylene blue in one liter of double distilled water, all solutions using in the experiments were prepared by diluting the stock solution with double distilled water to the desired concentrations for the experimental work of this investigation. The dyes concentrations were measured using spectrophotometer thermo – genesys 10 UV, USA.

Application of immobilized PPO (biocatalyst)

Adsorption unit was used to study the potential of immobilized PPO (biocatalyst) to remove different types of dyes from SSAS. The operating conditions used in this study were temperature, pH, flow rates of SSAS of dye (each type alone), initial feed concentration and height of biocatalyst bed are constant at 25°C, 7, 5 ml/min and 50 cm respectively, and initial feed concentrations of SSAS of different dyes which are varied between (50-100) mg/l. Outlet samples after treatment in each experiment were collected every 10 minutes from the bottom of packed column and the remaining dye concentration in SSAS was detected spectrophotometrically.

Adsorption unit

Fixed bed column of continuous mode experiments were conducted in order to test nine types of dyes (Congo red, direct black, direct brown, Indigo Carmine, haematoxylin, eosin, brilliant green, crystal violent and methylene blue) removal by treated SSAS of above dyes each one alone at desire concentration with the various bed heights of the adsorbent media (potato peels residue remaining from extraction of PPO enzyme) using different flow rates of SSAS of nine

types of dyes at various pH. The pH value was adjusted using 0.1 N NaOH and 0.1 N HCl solutions. The sorption unit consists of two glass container of SSAS of dyes one for inlet and another for outlet each of (1 liter) capacity. Glass column has 2.54 cm ID and 60 cm height. The sorption column packed with adsorbent media to a height of (10, 20, 30, 40 and 50 cm) supported from the top by plastic beads (0.5 cm). Before starting the runs, the packed bed sorption column was rinsed by double distilled water down flow through the column.

The potato peels residue is packed in the column to the desired depth, and fed to it as slurry by mixing the media potato peels residue with distilled water in order to avoid the formation of air bubbles inside the adsorption media. After the fixed bed was accommodation and putting the required amount of adsorbent media, the adsorption process started by allowing the dyes SSAS of required concentration and pH down flow through the sorption column from inlet container by gravity at a precise flow rate in experiment which is adjusted by the valve. To determination the best operational conditions, the experiments were carried out at a temperature between (20–45°C), various pH values which are (1–8) and initial feed concentrations of SSAS of different dyes which are between (1–50) mg/l and at different flow rates which are between (5–100) ml/min for dyes initial feed concentration. Outlet samples after treatment in each experiment were collected every 10 minutes from the bottom of packed column and the unadsorbed concentration of dyes in SSAS was analyzed by spectrophotometer.

Preparation of Black Ink

The wastes residue of potato peel from used in sorption unit to remove dyes were collected and washed carefully with dropped double distilled water and prepare for the second step which was preparation of black ink. 100 g of potato peels residue were added to 250 ml of distilled water. The slurry was mixed with 13 g of okra waste, 2 ml of distilled water, and 4.5 g of lamp black. All above ingredients were mixed with blender carefully until obtain a thick paste. 5 ml of phenol, methanol and rose water were added to above paste to dilute it so that it flows easily as a fluid and bottled. Thus, the black ink was prepared.

RESULTS AND DISCUSSION

The ability of potato peels to remove nine types of dyes from SSAS in fixed bed column of continuous mode at various parameters which are pH's of SSAS of dyes (*pH*), height bed of adsorbent media EP (*l*), flow rates of SSAS (*F*), SSAS temperature (T_{feed}) and time of treatment (*t*) was investigated. The experiments were achieved by varying all above parameters for different initial concentrations (C_o) of SSAS of dyes. Thus, the results obtained are explained below.

Effect of Application of Immobilized PPO (Biocatalyst)

The results show the ability of prepared biocatalyst to remove (Congo red, direct black, direct brown, Indigo Carmine, haematoxylin, eosin, brilliant green, crystal violent and methylene blue) dyes from SSAS in different concentrations with removal efficiency reach to more than 99 % for initial concentration of 50 mg/l as for nine types of dyes as shown in Fig. 1. Polyphenol oxidases (PPO) can act on a broad range of substrates such as substituted polyphenols, aromatic amines, benzenethiols, and a series of other easily oxidizable compounds.

Thus, they can catalyze the decolorization and decontamination of organic pollutants. In view of the potential of the enzymes in treating the phenolic compounds, several microbial and plant oxidoreductases have been employed for the treatment of dyes, but none of them has been exploited at large scale due to low enzymatic activity in biological materials and high cost of enzyme purification. In order to improve polyphenol oxidases activity and stability, enzyme immobilization technology has been applied. According to its properties, zeolite supporter was applied to immobilize PPO enzyme. This technology is an effective means to make enzymes reusable and to improve its stability, which is considered as a promising method for the effective decolorization of dye effluents [5].

Initial Concentration Effect on Dyes Removal Using Adsorption Unit

The results showed that using adsorbent material, the percent removal of dyes was decreased when the initial concentration (C_o) of SSAS of dyes was increased at constant other variables as shown in Fig. 2. This can be explained by the fact that the initial concentration of dyes had a restricted effect on dyes removal capacity; simultaneously the adsorbent media had a limited number of active sites, which would have become saturated at a certain concentration. This was lead to the increase in the number of dyes molecules competing for the available functions groups on the surface of adsorbent material. Since the solution of lower concentration has a small amount of dyes than the solution of higher concentration of it, so the percent removal was decreased with increasing initial concentration of dyes. For adsorbent media, higher percent removal were (95.75, 97.15, 96.25, 95.00, 95.75, 94.50, 95.50, 96.75 and 94.85) % for Congo red, direct black, direct brown, Indigo Carmine, haematoxylin, eosin, brilliant green, crystal violent and methylene blue respectively at initial concentration of dyes 1 mg/l, so adsorbent material was found to be efficient to dyes removal from SSAS and wastewater.

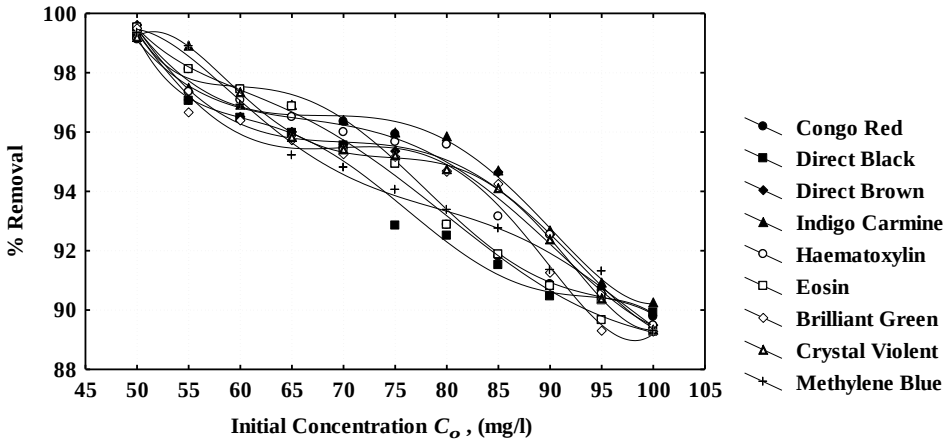

Fig. 1: Effect of initial concentration ($C_\circ$) on the percent removal of different types of dyes using PPO enzyme @ T=25°C, pH=7, and5 ml/min

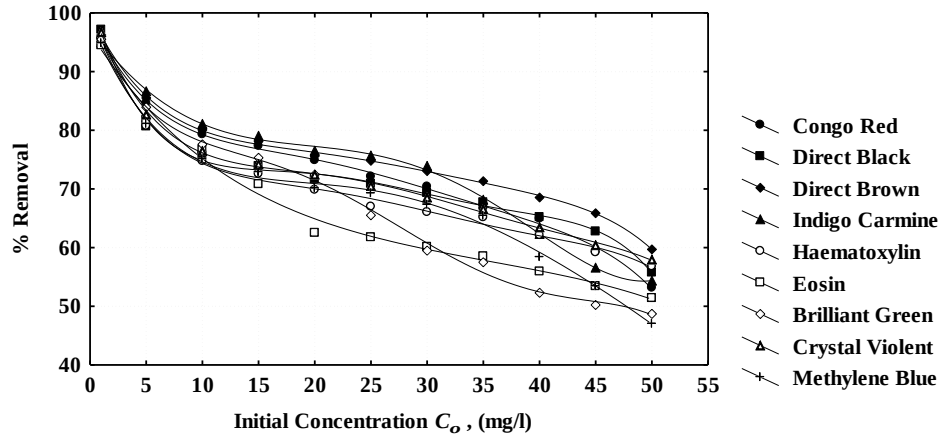

Fig. 2: Effect of initial concentration ($C_\circ$) on the percent removal of dyes @ T_f =45°C, l = 50cm, pH=1 or 8, t=60 min., and F=5 ml/min

pH Effect on Dyes Removal Using Adsorption Unit

The results showed that using adsorbent material, the percent removal of Congo red, direct black, direct brown, Indigo Carmine, haematoxylin, and eosin were decreased when the pH of SSAS was increased at constant other variables, while the percent removal of brilliant green, crystal violent and methylene blue were increased when the pH of SSAS was increased at constant other variables as shown in Figure 3. It is well recognized that the pH of the aqueous solution is an important parameter in affecting adsorption of dyes. High adsorption of Congo red, direct black, direct brown, Indigo Carmine, haematoxylin, and eosin at low pH can be explained in both terms; the species of these dyes and the adsorbent surface. For this case, at low pH, i.e. acidic conditions, the surface of the adsorbent becomes highly protonated and favour adsorb of above group of the dyes in the anionic form. With increasing the pH of SSAS, the degree of protonation of the potato peels residue surface reduces gradually and hence adsorption is decreased. Furthermore, as pH increases there is competition between hydroxide ion (OH^-) and species of dyes the formers being the dominant species at higher pH values. The net positive surface potential of sorbent media decreases, resulting in a reduction the electrostatic attraction between the sorbent (Congo red, direct black, direct brown, Indigo Carmine, haematoxylin, and eosin) species and the sorbate (potato peels residue) surface, with a consequent reduced sorption capacity which ultimately leads to decrease in percentage adsorption of Congo red, direct black, direct brown, Indigo Carmine, haematoxylin, and eosin dyes. In the other hand, the adsorption of brilliant green, crystal violent and methylene blue can be explained by ion-exchange mechanism of sorption in which the important role is played by functional groups that have cation exchange properties.

For this case at lower pH values, dyes removal was inhibited, possibly as a result of the competition between hydrogen and dyes molecules on the sorption sites, with an apparent preponderance of hydrogen ions, which restricts the approach of metal cations as in

consequence of the repulsive force. As the pH increased, the ligand functional groups in adsorbent media would be exposed, increasing the negative charge density on the adsorbent material surface, increasing the attraction of dyes molecules with positive charge and allowing the sorption onto adsorbent material surface [6, 7].

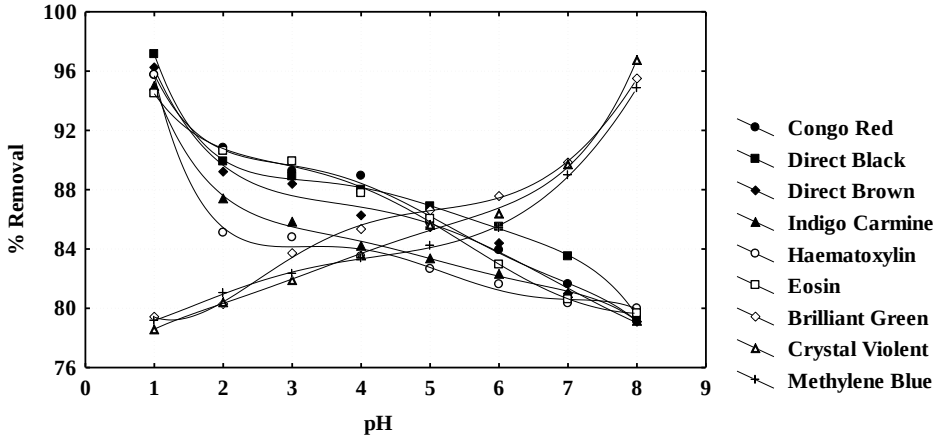

Fig. 3: Effect of *pH* on the percent removal of dyes @ $C_\circ$ = 1 mg/l, T_f =45°C, *l* = 50cm, *t*=60 min, and *F*=5 ml/min

Bed Height Effect on Dyes Removal Using Adsorption Unit

The results elucidated that when the adsorbent media bed height was increased, the percent removal of dyes was increased too at constant other variables as shown in Fig. 4. The increased of bed height (*l*) meaning increased in the amount of adsorbent media, thus increasing the surface area of adsorbent material, hence increased the number of active sites in the adsorbent material surface i.e. increased the availability of binding sites for adsorption and consequently increase dyes removal capacity on potato peels. This lead to increase the ability of adsorbent media to adsorb greater amount of dyes from SSAS at different initial concentrations and ultimately the percent removal of dyes increased.

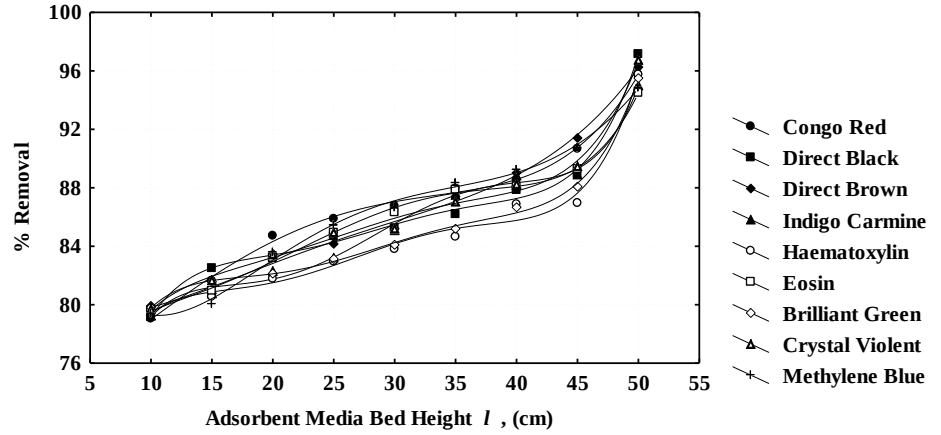

Fig. 4: Effect of adsorbent media bed height (*l*) on the percent removal of dyes @ $C_\circ$ = 1 mg/l, *pH*=1 or 8, T_f =45°C, *t*=60 min, and *F*=5 ml/min

Flow Rate Effect on Dyes Removal Using Adsorption Unit

The results illustrated that when the flow rate of SSAS of dyes was increased, the percent removal of dyes was decreased at constant other variables as shown in Fig. 5. This may be due to the fact that when the flow of SSAS of dyes increasing, the velocity of solution in the column packed with the adsorbent media was increasing too, so the solution spend shorter time than that spend in the column while at low flow rate, the SSAS of dyes resides in the column for a longer time, and therefore undergoes more treatment with the adsorbent media, thus the adsorbent media uptake low amount of dyes from SSAS of dyes for high flow rate, therefore the percent removal of dyes was decreased when the flow rate was increased.

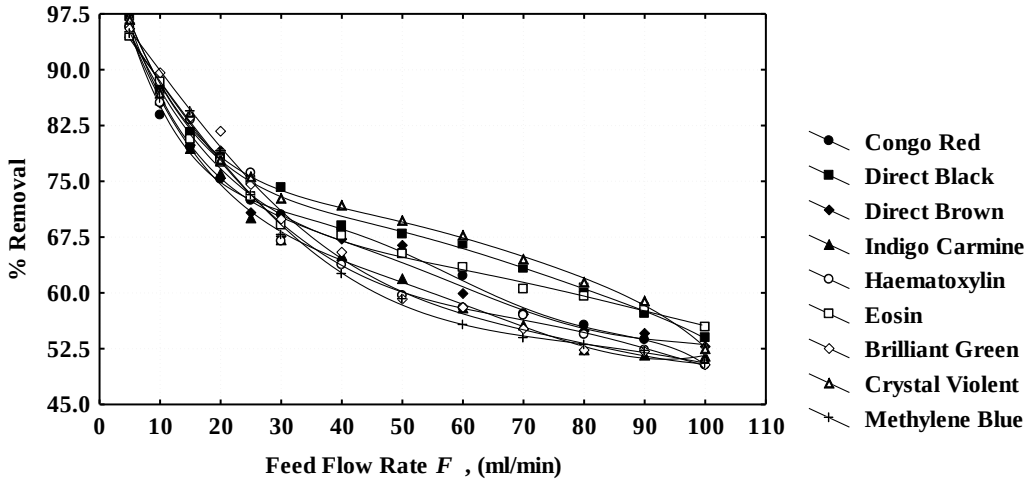

Fig. 5: Effect of aqueous solution flow rate (*F*) on the percent removal of dyes @ $C_\circ$ = 1 mg/l, *pH*=1 or 8, T_f =45°C, *l* = 50cm, and *t*=60 min

Effect of Feed Temperature

The results demonstrated that when the temperature of feed which was SSAS of dyes was increased, the percent removal of dyes was increased too at constant other variables as shown in Fig. 6. The effect of temperature is fairly common and increasing the mobility of the acidic ion. Furthermore, increasing temperatures may produce a swelling effect within the internal structure of the adsorbent media enabling dyes ions to penetrate further. It was indicated that dyes adsorption capacity increased with increasing feed temperature from 20 to 45°C. This effect may be due to the fact that at higher temperature an increase in active sites occurs due to bond rupture.

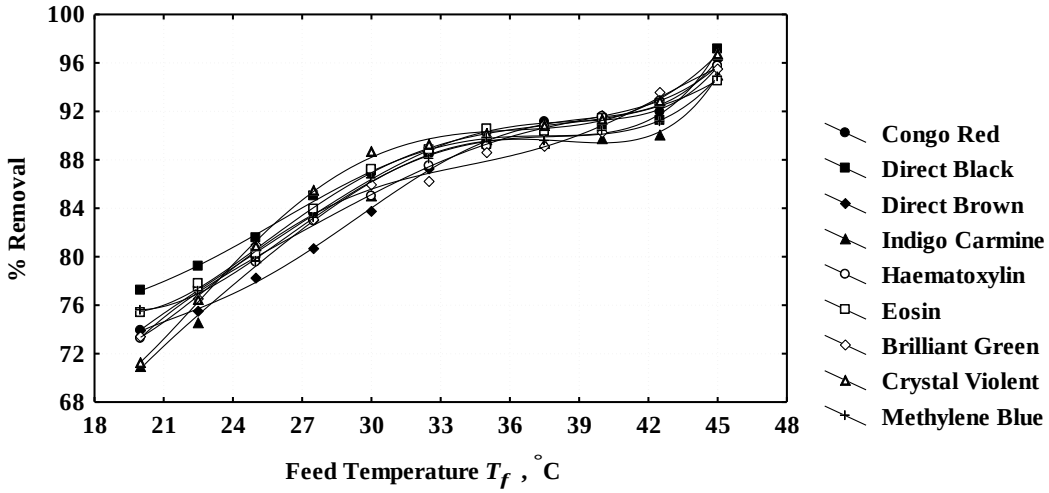

Fig. 6: Effect of feed temperature (T_f) on the percent removal of dyes @ $C_\circ$ = 1 mg/l, *pH*=1 or 8, *l* = 50cm, *t*=60 min, and *F*=5 ml/min

Treatment Time Effect on Dyes Removal Using Adsorption Unit

The results demonstrated that when the treatment time of SSAS of dyes increased the percent removal of dyes increased at constant other variables as shown in Fig. 7. This may be due to the fact that when the time of treatment of SSAS of dyes increasing and the velocity of SSAS in the column packed with the adsorbent material was remaining constant, the solution spend longer time than that spend it when the time of treatment decreased, so the adsorbent material uptake more amount of dyes from SSAS, therefore the percent removal of dyes from SSAS was increased.

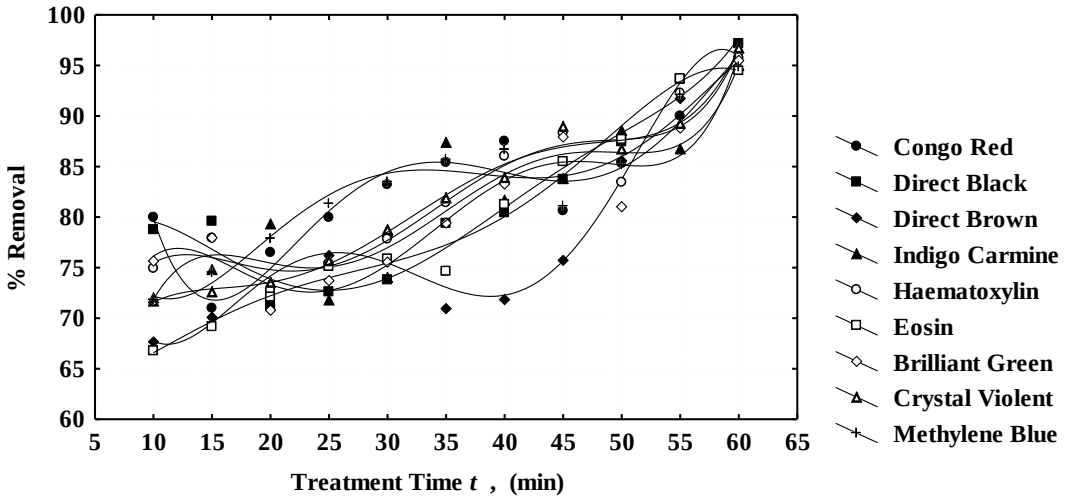

Fig. 7: Effect of treatment time (*t*) on the percent removal of dyes @ $C_\circ$ = 1 mg/l, T_f =45°C, *pH*=1 or 8, *l* = 50cm, and *F*=5 ml/min

Black Ink Preparation

Utilization from these potato peels waste residue can be accomplished by using them in ink preparation process as follows: potato peels waste which was remaining after using it in removal of dyes by adsorption method were utilized from them as a raw material for black ink preparation with other materials. Black ink prepared show good performance when writing with like other traditional black ink.Ink was first, used by the Egyptians around 4000 years ago. Ink is a liquid or paste that contains pigments and / or dyes and is used to color a surface to produce an image, text, or design. Ink is used for drawing and / or writing with a pen, brush, or quill. Thicker inks, in paste form, are used extensively in letterpress and lithographic printing. Ink is an essential item for students, teachers, authors and others. Ink formulas vary, but commonly involve four components which were colorants, vehicles (binders), additives, and carrier substances.

All these ingredients of black ink were replaced with other cheaper substances trying to prepare black ink homemade, cheap and economically using potato peels residue. Potato peels residue has ability to prepare ink with water only but the ink is invisible and diffuse on the paper. Therefore, the exploitation of potato peels residue in adsorbed dyes helps to make a type of black ink can visible to reader. The black lump has a role of give the black color required for ink and disperses any color effects can appear from any dyes adsorbed by potato peels. Also, Arabic gum has result in a sticky solution and replaced in this preparation process with slurry of okra waste and water. The gum make the ink turns bright, the color of ink does not fade with time and the flow of ink is maintained smooth. In addition, alcohol makes ink quick drying and the ink does not diffuse on papers after writing. The principal constituents of ink are organic in nature.

The breakdown of these materials spoils the ink and this causes deposition of constituents in fountain pen of in the ink pot. Incorporation of Phenolic acid to the black ink preparation checks this problem. The organic decay of ink gives it sometimes, foul smell. To avoid this, scented materials are incorporated in the preparation of black ink process.

CONCLUSIONS

The following conclusions can be drawn:

- There is ability to remove high concentrations of dyes (between 50-100 mg/l) by extract PPO enzyme from potato peel and loaded it on the prepared biocatalyst (zeolite type Y). The removal efficiency reaches to more than 99% for all nine types of dyes used.
- Waste potato peels remaining from PPO extraction showed a good ability to remove dyes too for low and middling concentrations (between 1-50 mg/l) from SSAS using fixed bed adsorption unit. Higher percent removal was (95.75, 97.15, 96.25, 95.00, 95.75, 94.50, 95.50, 96.75 and 94.85) % for Congo red, direct black, direct brown, Indigo Carmine, haematoxylin, eosin, brilliant green, crystal violent and methylene blue respectively at initial concentration of 1 mg/l, so waste potato peels residue was found to be efficient to remove dyes from SSAS and wastewater by adsorption method.
- The percentage removal of dyes was increased with decreeing flow rate of SSAS, initial concentration, and pH of Congo red, direct black, direct brown, Indigo Carmine, haematoxylin and eosin dyes while the percentage removal was decreased with increasing of the height of adsorbent material (potato peels), treatment time and pH of

brilliant green, crystal violent and methylene blue dyes.

- It can be utilized from the residual samples of potato peels that adsorb dyes from SSAS as a raw material for preparing a type of black ink in economic way.

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