Recycling and Upcycling of agricultural waste in dye industry

Article *in* International Journal of Chemical Research · February 2019

1 author:

Sushila Hooda
Footwear Design & Development Institute
21 PUBLICATIONS **7** CITATIONS

International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 882-884

Received: 05-01-2019
Accepted: 10-02-2019

Sushila
Department of Textile & Apparel Designing, I.C. College of Home Science, CCS HAU, Hisar, Haryana, India

Nisha Arya
Department of Textile & Apparel Designing, I.C. College of Home Science, CCS HAU, Hisar, Haryana, India

Correspondence
Sushila
Department of Textile & Apparel Designing, I.C. College of Home Science, CCS HAU, Hisar, Haryana, India

Recycling and Upcycling of agricultural waste in dye industry

Sushila and Nisha Arya

Abstract
In the present scenario of the rapidly growing world, the wastes are also increasing day by day in large quantity which strongly influences the health of ecosystems and ultimately the human community. Therefore, every agro-industrial sectors have pressing demand toward the safe utilization of agro-materials through recycling of wastes. Agricultural waste materials have little or no economic value and often pose a disposal problem. The utilization of agricultural waste is of great significance. A dye is a colored substance that has an affinity to the substrate to which it is being applied. The dye is generally applied in an aqueous solution, and may require a mordant to improve the fastness of the dye on the fiber. The removal of color from dye-bearing effluents is a major problem due to the difficulty in treating such wastewaters by conventional treatment methods. Agro-industrial wastes can be a good option to meet the demands of the present generation without compromising the future generations, so there is a gravid need for more attention into the depth of agro-industrial waste utilization and recycling methodologies. The present study focused the several most abundant agricultural waste materials are used for eco-friendly dyes and removal of synthetic dyes from dye bath.

Keywords: Agricultural waste, fermentation, organic waste, recycling, value-added products

Introduction
Waste production is a complex issue confronting local, national, and international governments. Upcycling as the reuse of discarded items in order to create a product of higher value than the original (2011). The word “Upcycle” and its antonym downcycling derive their meaning from variations of recycling which is commonly associated with reducing our waste and reusing everything we discard. Upcycling can be done using either pre-consumer or post-consumer waste or a combination of the two. Pre-consumer waste is produced while items are being manufactured and post-consumer waste results from the finished product reaching the end of its useful life for the consumer (such as a T-shirt that doesn’t fit anymore). Upcycled, ecofashion offers creativity and individuality because consumers won't see someone else wearing the same outfit. An eco designer, according to Lee & Sevier (2008) [11], must face increased challenges of sourcing, designing with “green” issues in mind, and inventing new techniques that add value (Lee & Sevier, 2008) [11]. There are other recycling options including insulation, automobile soundproofing and furniture stuffing (Bristwistle & Moore, 2007) [1].
Dyes are widely used in industries such as textiles, rubber, plastics, printing, leather, cosmetics, etc., to color their products. As a result, they generate a considerable amount of colored wastewater. Color is a visible pollutant and the presence of even minute amounts of coloring substance makes it undesirable due to its appearance. The removal of color from dye-bearing effluents is a major problem due to the difficulty in treating such wastewaters by conventional treatment methods. The most commonly used methods for color removal are biological oxidation and chemical precipitation. The discharge of dyes in the environment is a matter of concern for both toxicological and esthetical reasons. Agricultural waste materials have little or no economic value and often pose a disposal problem. The utilization of agricultural waste is of great significance. A number of agricultural waste materials like garlic peel, hazelnut shell, pineapple stem, jack fruit peel, oil palm trunk fiber, rice bran and wheat bran, broad bean peel, ground nut shell, sawdust and papaya seeds are being investigated for the removal of different dyes from aqueous solutions at different operating conditions. So this study main focused on use of agricultural waste in garment dyeing and removal of dye from garment.

Use of agricultural waste for removal of dyes by low-cost sorbents

Various agricultural waste are used for removal of dyes by low-cost sorbents like peel of vegetables and fruits, sawdust of different plants.

Garlic (Allium sativum L.)

Garlic (Allium sativum L.) is widely used as a condiment and for medicinal and pharmaceutical preparations. In the past, garlic has been utilized as a remedy during the various epidemics such as typhus, dysentery, cholera, influenza, and whenever an epidemic has emerged, garlic has been the first preventive and curative remedy. Garlic are credited to the presence of the sulphur-containing compound, Allicin, found in fresh, crushed garlic, garlic peel due to which it has anti-bacterial and anti-fungal properties (Fig. 1).

Hameed and Ahmad (2009) [6] investigated that Garlic peel used as a low-cost adsorbent for the removal of Methylene blue from aqueous solution. Equilibrium isotherms were determined and analyzed using the Langmuir, Freundlich and Temkin isotherms. They observed that the adsorption capacity was higher due to the presence of polar functional group.

Ma, *et al*. (2014) [2]. stated that a new biosorbent prepared by using garlic peel as the raw material was investigated for the removal of Methylene blue (MB) from aqueous solution. Results showed that adsorption of MB on garlic peel gel was highly pH-dependent, and equilibrium was attained in 10 min. The adsorption capacity is 440 mg MB per gram of garlic peel gel. The column adsorption results show that MB can be completely removed from aqueous solution, and 1.0 M HCl is effective to elute the adsorbed MB off the column and condense the initial MB solution to more than 40 times. The prepared garlic gel exhibits as a potential low-cost and effective adsorbent for dyes removal from waste water.

Fig 1: Garlic peel

Jackfruit (Artocarpus heterophyllus Lam.)

All parts of the tree are used either as food or as medicine. The unripe fruits can be eaten as vegetable whereas ripe fruits are a good source of vitamins and minerals. Jack is essentially carbohydrate rich in fibres.

Jackfruit waste is superior to green grass which can use as sub stitute for fodder grass. The jackfruit contains different compounds especially phenolic compounds, flavonoids, stilbenoids, arylbenzofurons, carotenoids, Volatile acid sterols and tannins which varies depending on the variety. Jackfruit peel is one among the under-utilized waste materials (Fig. 2).

Hameed (2008) [5] investigated the Jack fruit peel used as adsorbents for removal of Methylene blue. The effect of different system variables like adsorbent dose, initial dye concentration, contact time and pH were evaluated and found that as the amount of adsorbent increased, the percentage of dye removal increased accordingly. Low concentrations of Methylene blue favored high adsorption percentages and the optimum pH value for dye adsorption was found to be 4.0. The sorption capacity of Methylene blue on jack fruit peel was found to be 285.713 mg g^{-1}.

Jayarajan *et al*. (2011) [12]. conducted a study of agricultural wastes of jackfruit peel nano-porous adsorbent for removal of rhodamine dye. The adsorption equilibrium data were analyzed by using various adsorption isotherm models and the results have showed that adsorption behavior of the dye could be described reasonably well by langmuir and freundlich models. The monolayer adsorption capacity was determined to be 4.361 to 1.98 mg g^{-1} and concluded based on these results that Jackfruit peel nano-porous adsorbent was an attractive candidate for removing Rd dye from the wastewater.

Fig 2: Jackfruit peel

Broad bean peel

Binomially, fava pods belong to the *Fabaceae* family, in the genus: *Vicia.* Scientific name: Vicia faba.Commonly used as vegetables, they are one of the popular bean varieties that can be grown easily in the home gardens. Broad beans peel are rich in phytonutrients such as isoflavone and plant sterols (Fig. 3).

Hameed and El-Khaiary (2008b) [5] used Broad bean peel an agricultural waste chopped, sieved, washed and oven dried at 60 °C for 48 h for removal of cationic dye (Methylene blue) and adsorption capacity of 192.7 mg g^{-1} was found. It was noted that adsorption of dye decreases with an increase in the initial Methylene blue concentration. The adsorption of dyes was reported to follow Langmuir adsorption model and pseudo-first-order kinetic model.

Fig 3: Broad bean peel

Sawdust

Sawdust or wood dust is a by-product or waste product of woodworking operations such as sawing, milling, planing, routing, drilling and sanding. It is composed of fine particles of wood. Sawdust is the main component of particle board.

Wood dust is a form of particulate matter, or particulates. Rose wood sawdust a low-cost adsorbent for the removal of Malachite green from aqueous solution (Fig. 4). Raw agricultural solid wastes and waste materials from forest industries such as sawdust have been used as adsorbents. Sawdust has proven to be a promising effective material for the removal of dyes from wastewater (Garg *et al*. 2003) [4] Mahogany sawdust and rice husk as adsorbents for the removal of (acidic dye) Acid yellow 36. The adsorbents were activated by means of steam. The kinetics of the process was found to be dependent on contact time, adsorbent dose and pH (Malik, 2003) [13]. Rattan sawdust as adsorbent for the removal of Malachite green from aqueous solution. The adsorbent was studied without any physical or chemical treatment. The equilibrium data fit with the Langmuir isotherm with a monolayer capacity of 62.71 mg g^{-1}. The authors found that for a short time period the rate of adsorption is controlled by film diffusion. However, at longer adsorption times, pore diffusion controls the rate of adsorption (Hameed *et al*. 2007) [7].

Fig 4: Rose wood sawdust

Use of agricultural waste in garment dyeing

A dye is a colored substance that has an affinity to the substrate to which it is being applied. Textiles may be dyed as raw fibre (dyed in the fleece or dyed in the wool), as spun yarn (dyed in the hank or yarn-dyed), or after weaving (piece-dyed). Dyes are usually soluble in water whereas pigments are insoluble. Some dyes can be rendered insoluble with the addition of salt to produce a lake pigment. The majority of natural dyes are derived from plant sources: roots, berries, bark, leaves, and wood, fungi, and lichens. Most dyes are synthetic i.e. using petrochemicals. Pigments from leaves, fruits, seeds and roots are used as dye stuff for textiles. Natural dyes are ecofriendly and user friendly. Agricultural waste materials have little or no economic value and often pose a disposal problem. The utilization of agricultural waste is of great significance. Agricultural waste including peanut shells, nuts pericarps, guayacan trees, carob tree liquids, romerillo, ash tree, yerba mate, onion, mistol, colliguay and palo pinche. The natural dye extracted from the different plant sources i.e. *Aloe vera, Azadirachta indica, Bixa orellana, Curcuma longa, Punica granatum, Quercusinf ectoria*, and Thymus Vulgaris extracts can be successfully applied to the fabrics to obtain a wide range of colour shadings along with the application of the mordant as a fixative agent. These dyes are environmental friendly and harmless when compared to the synthetic dyes. Rose flowers, orange peel and lemon peel extract used for dyeing of wool yarn and an industrial process designed for using herbal pulps as natural dyes. Uddin (2015) [15] evaluated the performance of dyes extracted from mango leaves in silk dyeing. Results concluded that the color values were found to be influenced by the addition of mordants, consequently different fashion hues were obtained from the same dye extract using different mordents.

Conclusion and Future Outlook

Utilization of wastes not only eliminates the disposal problems but also solves the pollution-associated problems. Global perception about agro-industrial waste is changing rapidly in response to the need for environmental sustainability and conservation. In the present era, wastes from agro-industrial residues have been utilized in a number of ways, for instance, in the production of various value-added products.

References

1. Birtwistle G, Moore CM. Fashion clothing – where does it all end up? International Journal of Retail & Distribution Management. 2007; 35(3):210-216.
2. Ma CY, Li Z, Zhao WH. Garlic Peel as Adsorbent for the Removal of Methylene Blue from Aqueous Solution, 2014.
3. https://www.researchgate.net/publication/280929241_Garlic_Peel_as_Adsorbent_for_the_Removal_of_Methylene_Blue_from_Aqueous_Solution.
4. Garg VK, Gupta R, Yadav RB, Kumar R. Dye removal from aqueous solutions by adsorption on treated sawdust. Bioresour Technol. 2003, 89:121-124.
5. Hameed BH. Removal of cationic dye from aqueous solution using Jack fruit peel as non-conventional low cost adsorbents. J Hazard Mater. 2008, 39:338-343.
6. Hameed BH, Ahmad AA. Batch adsorption of Methylene blue from aqueous solution by garlic peel, an agricultural waste biomass. J Hazard Mater. 2009, 164:870-875.
7. Hameed BH, Ahmad AL, Latiff KNA. Adsorption of basic dye Methylene blue onto activated carbon prepared from rattan sawdust. Dyes Pigment. 2007; 75:143-149.
8. Hameed BH, El-Khaiary MI. Sorption kinetics and isotherm studies of a cationic dye using agricultural waste: broad bean peels. J Hazard Mater. 2008, 154:639-648.
9. https://link.springer.com/article/10.1007/s13201-013-0117-y
10. https://www.treehugger.com/style/natural-dyes-for-textiles-made-from-agricultural-waste-in-argentina.html
11. Lee M, Sevier L. The A-Z of Eco Fashion. Ecologist. 2008. Retrieved from http://www.theecologist.org/green_green_living/clothing/269326/the_a_z_of_eco_fashion.html
12. Jayarajan M**,** Arunachalam R, Annadurai G. Agricultural wastes of jackfruit peel nano-porous adsorbent for removal of rhodamine dye. 2011. https://scialert.net/fulltextmobile/?doi=ajaps.
13. Malik PK. Use of activated carbons prepared from sawdust and rice-husk for adsorption of acidic dyes: a case study of acid yellow 36. Dyes Pigment. 2003, 56:243-250.
14. Malik R, Ramteke DS, Wate SR. Adsorption of Malachite green on groundnut shell waste based powdered activated carbon. Waste Manag. 2007; 27:1129-1138.
15. Uddin MG. Extraction of eco-friendly natural dyes from mango leaves and their application on silk fabric. Text Cloth Sustain. 2015; 1:7. https://doi.org/10.1186/s40689-015-0007-9.