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Application of Domestic Waste (Black Tea Residue) as Water Purifier

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ABSTRACT

Water purification is the process of removing undesirable chemicals, biological contaminants, suspended solids, and gases from water. The goal of this investigation is to make water fit for specific purposes. Pesticides are among the major organic compounds encountered in wastewater effluents of the pesticide industry and domestic activities. Pesticides are essential for modern agriculture, but their extensive use may be a cause of serious water pollution. These pesticides pollute soil, water, and air for a long period they show the harmful effect on humans and the environment. When these pesticides are sprayed on crops, some part of these chemicals stays in the area where it is sprayed, but most of the part gets transported to various environmental compartments (WHO 1996) like soil, plant, and water. By using Imidacloprid remove the pesticides from water.

INTRODUCTION-

Most water is purified and disinfected for human consumption (drinking water), but water purification may also be carried out for a variety of purposes, including medical, pharmacological, chemical, and industrial applications

Types of Drinking Water Contaminants

Physical contaminants primarily impact the physical appearance or other physical properties of water. Examples of physical contaminants are sediment or organic material suspended in the water of lakes, rivers, and streams from soil erosion.

Chemical contaminants are elements or compounds. These contaminants may be naturally occurring or man-made. Examples of chemical contaminants include nitrogen, bleach, salts, pesticides, herbicides, metals, toxins produced by bacteria, and human or animal drugs.

Biological contaminants are organisms present in water. They are also referred to as microbes or microbiological contaminants. Examples of biological or microbial contaminants include bacteria, viruses, protozoans, and parasites.

Radiological contaminants are chemical elements with an unbalanced number of protons and neutrons resulting in unstable atoms that can emit ionizing radiation. Examples of radiological contaminants include cesium, plutonium, and uranium.

Different methods of treatment

Chlorination

Chlorination is a well-known applied method for water treatment. It not only deactivates microbes but also reduces some pesticide concentration by its oxidation. Concentrations of either pure chlorine or chlorine compounds are added to water supplies[53]. For its treatment, free chlorine is either in the form of pure chlorine gas (Cl2) dissolved in water, hypochlorous acid (HOCl), or the hypochlorite ion (OCl^-) which is formed because hypochlorous acid is a weak acid that dissociates based on pH[54].

UV-Photolysis

Treatment of waters and wastewaters with UV is another method used to degrade pesticides up to acceptable limits. UV-light is a form of electromagnetic radiation in the wavelength

range of 100 to 400 nanometers. There are four classes: UV-A (400 and 315 nm), UV-B (315 to 280 nm) UC-C (280 to 200 nm), and vacuum UV (200 to 100 nm). When used for water treatment, low-pressure mercury lamps (LP-UV) generate UV at a wavelength of 253.7 nm and medium pressure lamps (MP-UV) generate UV and visible light in the 200-800 nm range

Fenton oxidation

For oxidation and degradation of pesticides, the Fenton oxidation process can also use. In this process, iron salt is used as a catalyst with H_2O_2at low pH. In this process, a high amount of reductive hydroxyl radical gets formed, which oxidizes the pesticides present in the solution.

Ozonation

Ozonation is an accepted water treatment technique used in the eighteenth century. It is a powerful oxidation technique in which the $O_3$is forced through water, which will oxidize the pesticides present in it.

Reverse osmosis

Reverse osmosis is a water purification technology that uses a semipermeable membrane to remove impurities from water. In reverse osmosis, applied pressure is used to overcome osmotic pressure. Reverse osmosis can remove many types of molecules and ions from solutions, including pesticides, and is used in both industrial processes and the production of drinkable water. This membrane should not allow large molecules or ions through the pores (holes) but should allow smaller components of the solution (such as the solvent) to pass freely.

Adsorption

Mostly, adsorption is a mass transfer process in which a substance is transferred from the liquid phase to the surface of a solid and bounded by physical or chemical interactions. The performances of adsorption processes are dependent on solid-liquid equilibriums as well as mass transfer rates.

MATERIALS AND METHODS

Materials

Imidacloprid was purchased from the market, and nitric acid and methanol were supplied from a lab. Imidacloprid is a chronic-tinylnitroguanidine insecticide. Its IUPAC name is 1-

[(6-chloropyridin-3-yl)–n-nitro4,5-dihydroimidazol-2-amine. Imidacloprid is a systemic insecticide that acts as an insect neurotoxin and belongs to a class of chemicals called the neonicotinoids which act on the central nervous system of insects.

Nitric acid and methanol were used for the preparation of watermelon adsorbent and it acts as a natural adsorbent at low cost.

Methodology

Sample Collection- Black tea leaves (Camellia sinensis L.) were purchased from the local market with the brand name red label.

Watermelon peels (*Citrullus lanatus*) were purchased from the local market.

Preparation of adsorbent black tea waste

Camellia sinensis leaves were boiled with demineralized water. The residue of leaves was collected after boiling. The procedure was repeated again and again till the color of the extract disappear completely. The residue was dried in a hot air oven at 105°C for 24 hours [20]. The dried adsorbent was filled in an airtight container and stored for further studies.

Preparation of adsorbent watermelon peels

Watermelon peels, a by-product of watermelon washed thoroughly with water and then with deionized water to remove foreign impurities and were allowed to dry under sunlight for 5 days. The material was rewashed thoroughly with deionized water to remove the fine particles and dried in an electrical oven at 110°C. The material was then chemically treated with 0.1 M nitric acid for 1 h, followed by soaking in methanol for 1 h to remove inorganic and organic matter from the surface of the adsorbent. The chemically-treated WMP were subjected to thermal treatment in a closed muffle furnace to increase the surface area. The chemically and thermally treated watermelon peels (TWMP) were stored in vacuum desiccators to be used as adsorbents for further analysis. [21]

Analytical method development

Analytical method of Imidacloprid developed by UV spectroscopy. In this method, the dilution of 4, 8, 12, 16, and 20µg/mL was prepared in distilled water and the absorbance was taken at 270nm. These dilutions are considered a standard solution.

The sample solution was prepared by taking the same amount of pesticide solution and adsorbent 200mg, then diluting it to make a dilution of 4, 8, 12, 16, and 20µg/mL absorbance of each dilution was taken in 270nm with different time interval then graph plotted between concentration v/s absorbance to calculate R square value and equation. Now the amount of adsorption of pesticide by natural adsorbent was calculated by the formula.

Standard calibration curve of pesticide

The wavelength of maximum absorbency (λmax) was recorded for Imidacloprid dissolved in aqueous media and found 270 nm (Figure (7)). This value was utilized for the estimation of the quantity of pesticide adsorbed. Solutions of different concentrations were prepared by serial dilution. Absorbance values of these solutions were measured at 270 nm and plotted against concentration values.

Adsorption studies

Experiments were carried out to determine the adsorption capacity of the adsorbent. In this study, a stock solution of known concentration of Imidacloprid (100 µg/mL) was prepared in distilled water with 200mg of adsorbent. Test solutions were prepared by diluting the stock solution to concentrations (20µg/mL). The samples were shaken at room temperature (28 ◦C). Then Samples were taken at different time interval 2min, 4min, 6min, 8min, and 10min and the concentration of pesticides were analyzed by using a UV–VIS Spectrophotometer (Shimadzu Model: UV 1700) at 270 nm[22].

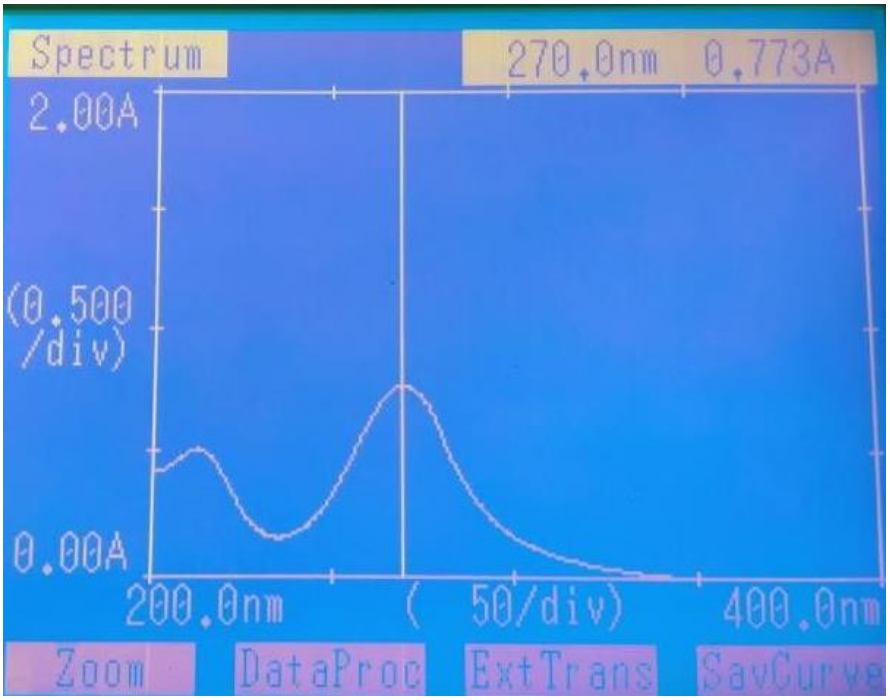
RESULTS AND DISCUSSION

Spectroscopic Condition

A standard sample of Imidacloprid of 10µg/ml was prepared in water and scanned between 200 – 800nm by UV- VIS spectrophotometer.

Table No. 1 Parameter and its values

Parameter	**Value**
Instrument	Shimadzu Model: UV 1700
Cuvette path length	1cm
Wavelength	270nm
Solvent	Water



2 Standard calibration of Imidacloprid

In a typical studies stock solution of known concentration of Imidacloprid (100 µg/ml) was prepared in distilled water. Then serial dilutions of different concentrations (4, 8, 12, 16, and 20µg/ml) of pesticide solution were taken in flasks. The concentration of pesticides was measured at their respective absorption maxima by using a UV–VIS Spectrophotometer (Shimadzu Model: UV 1700) at 270 nm.

Table No. 2 Data of calibration

Sr. No.	Concentration	Absorbance			Average
		Replicate 1	Replicate 2	Replicate 3	
1	3 µg/ml	0.347	0.365	0.335	0.349
2	6µg/ml	0.684	0.645	0.676	0.668
3	9µg/ml	1.056	1.022	1.065	1.047
4	12µg/ml	1.362	1.353	1.345	1.353
5	15µg/ml	1.612	1.621	1.644	1.625

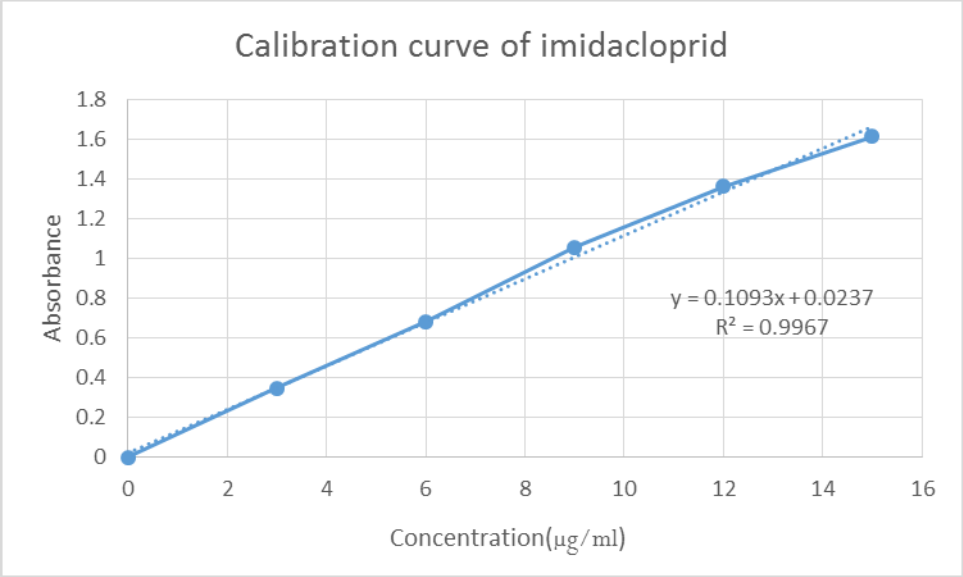


Table No. 3 Linearity studies of Imidacloprid at 270 nm in water

Conc.	Day 1			Day 2			Standard Deviation	% Relative STD
	Rep-1	Rep- 2	Rep-3	Rep-1	Rep-2	Rep-3		
3 µg/ml	0.347	0.365	0.335	0.342	0.354	0.355	0.010614	0.176908
6 µg/ml	0.684	0.645	0.676	0.644	0.645	0.645	0.018382	0.306368
9µg/ml	1.056	1.022	1.065	1.060	1.052	1.061	0.015667	0.261123
12 µg/ml	1.362	1.353	1.345	1.351	1.353	1.350	0.005574	0.092896
15 µg/ml	1.612	1.621	1.644	1.621	1.622	1.624	0.01064	0.202924
Mean of relative standard deviation								0.202924

Table No. 4 Accuracy studies of Imidacloprid at 270 nm in water

Conc.	Abs	The absorbance of spiked samples			Average	Recovery	% Recovery
		Rep-1	Rep-2	Rep-3			
3 µg/ml	0.347	0.692	0.691	0.687	0.691	0.344	99.13
6 µg/ml	0.684	1.029	1.005	1.029	1.021	0.674	98.53
9µg/ml	1.056	1.379	1.383	1.388	1.383	1.036	98.10
12 µg/ml	1.362	1.699	1.678	1.695	1.690	1.343	98.60
15 µg/ml	1.612	1.955	1.953	1.958	1.955	1.608	99.77

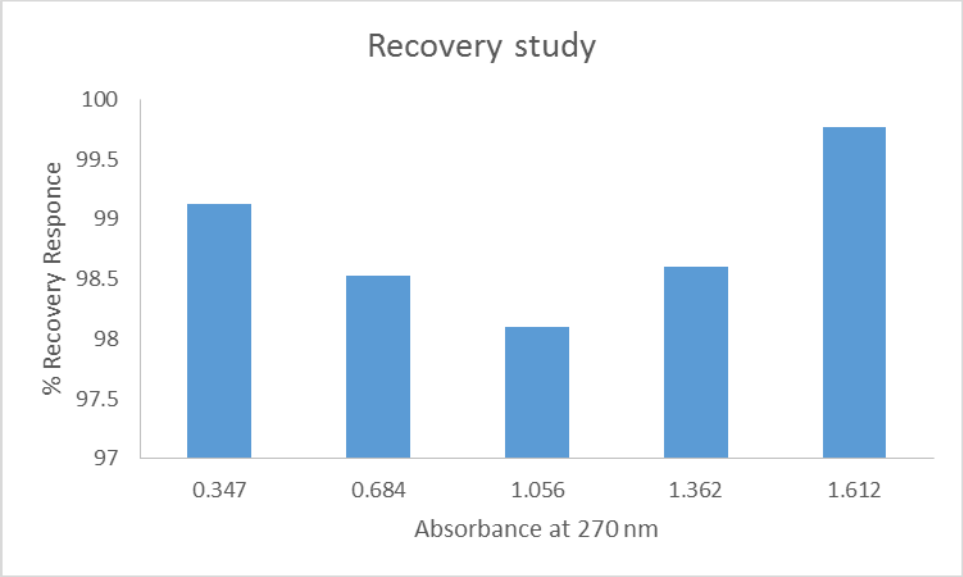


Figure No. 3 Recovery study for accuracy

Effect of contact time

It is essential to evaluate the effect of contact time required to determine adsorption for adsorption experiments. Therefore the effect of contact time on adsorption of Imidacloprid was also investigated. The table represents the uptake of pesticides as a function of contact time.

To determine the time for maximum uptake of the pesticide understudy, the adsorption of pesticide on adsorbents at fixed concentration was studied as a function of contact time. The effects of initial concentration with the effect of time (2- 10min) on adsorption of pesticide are shown in Table. Adsorption of pesticide onto adsorbents at an initial concentration (20µg/ml) with a fixed adsorbent dose (200mg) was carried out at room temperature (28°C) and at the same time blank solution (water+200mg) was prepared and studied with different time intervals. Then flasks were withdrawn at predetermined time intervals for 10 min. and analyzed.

Table No. 5 Effect of contact time on the removal of Imidacloprid

Time, t (min)	Pesticide solution (Pesticide solution+200mg)	Blank solution (Water+200mg)	% Removal
	Conc. (15µg/ml)		
2min	0.774	0.013	22.6%
4min	0.600	0.021	39.95%
6min	0.518	0.038	48.15%
8min	0.374	0.051	62.55%
10min	0.115	0.068	88.45%

RESULT

In this study, a successful attempt was made to develop a UV method for the analysis of IMD. The method was also validated with some parameters like accuracy by recovery study, linearity, and precision (inter & intraday).

The natural adsorbent was prepared by the residue of black tea and observed the adsorption performance of natural adsorbent concerning time.

It was observed that the black tea adsorbent was found significantly capable to remove the pesticide IMD (88.45%) from the water in 10min.

Based on the experimental results of this investigation, the following conclusions can be withdrawn.

- Black tea waste can be used as an adsorbent for the removal of the Imidacloprid pesticide solution.
- The percentage removal of pesticides was dependent on the contact time of the solution.

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