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Effectiveness Of The Mustard Seed Powder And Cake For The Coagulation Of Synthetic Municipal Waste Water.

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ABSTRACT

This study was aimed to determine the effectiveness of mustard powder and mustard cake prepared from naturally available mustard seeds to use as coagulants for treating synthetic municipal waste water using coagulation-flocculation process. The experiment was conducted by varying coagulant dosage and pH which were the selected parameters for the treatment process. The tests were carried out using conventional jar test apparatus. The dosages were changed from 10 to 100 mg for 300 ml of waste water and the pH was varied from 2.5 to 10.5. The optimum dosage of mustard powder was found to be 30 mg for 300 ml with the maximum reduction in COD and turbidity of 31% and 21% respectively, whereas for mustard cake COD and turbidity reduction was 23% and 25% at an optimum dosage was of 25 mg for 300 ml. The optimum pH value with mustard powder and mustard cake was found to be 8 and 6.5. In case of mustard powder and mustard cake maximum reduction in COD were found to be 37% and 32% and maximum reduction in turbidity was found to be 27% and 31% respectively.

Keywords: Mustard powder, Mustard cake, Turbidity, Chemical Oxygen Demand (COD)

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INTRODUCTION

Municipal wastewater is a combination of different types of waste waters originating from the sanitary system of commercial housing, industrial facilities and institutions, in addition to any surface water and storm water that may be present. Raw water contains high levels of organic material, numerous pathogenic microorganisms, heavy metals as well as nutrients and toxic compounds. It must be carried away from its source of generation and should be treated properly before its final disposal because they cause environmental and health hazards. The ultimate goal of wastewater management is to safeguard the environment with public health and socio-economic concerns [1]. In major cities treated municipal waste water is used as additional source for various uses such as agricultural irrigation, landscaping, industrial activities (cooling and process needs), groundwater recharge and recreational purposes. Due to stringent rules and persistent dependency of the treated waste water researchers and scientists are coming up with new technologies to treat the municipal waste water in an efficient and effective manner [2]. Generally, the organic matter present in the waste water constitutes about 65 – 90% of colloidal or particulate matter, which can be minimised by chemical pre-treatment of raw wastewater Therefore, chemically enhanced process, can be employed to improve the efficiency of the primary treatment process and to reduce the cost of the secondary treatment stage [3]. Amongst the available methods of water and wastewater treatment, coagulation and flocculation is a low cost, simple, reliable, and low energy consuming process that is commonly practiced since it does not require any exclusive or complex machinery also less energy consumed for the operation, once an effective coagulant is obtained [4].The purpose of the process is to remove turbidity, colour, microorganisms, inorganic ions and natural organic matter through induced aggregation of both micro and macro particulates into larger-sized ones, followed by sedimentation [5].This process is sensitive to factors such as type and nature of turbidity producing substances, turbidity levels, type of coagulant and its dose, the rate of change of velocity, and pH of water [6].Inorganic coagulants such as aluminum sulfate, ferric chloride and calcium carbonate and synthetic organic polymers (polyaluminium chloride (PACl) polyethylene imine) are used in this stage of treatment. Aluminium sulphate (alum) is commonly used in the waste water treatment [7]. But there are some drawbacks associated with the usage of these coagulants such as these are inefficient in cold waters, production of large volumes of sludge and alter pH of the treated water [8]. Moreover, some studies have reported that prolonged usage of aluminum sulfate (alum) and polyaluminium chloride treated water induce may induce Alzhemier's disease in human beings and toxicity to aquatic life [9]. To solve the problems associated with the usage of aluminium and iron-based coagulants has moved research interests towards natural organic coagulants which can be produced or extracted from microorganisms, animal or plant tissues [10]. Generally, natural coagulants cause minimal health risk to living organisms, highly biodegradable, eco-friendly cost effective as compared to inorganic coagulants [11]. In addition, they produce less sludge volumes that amounts to only 20 - 30% that of alum treated equivalent [12] and do not vary the pH of the water [13]. Plant based natural coagulants may be obtained from seeds, leaves, fruits, roots and barks. However, the most common plant part used is the seed of plants [14]. Plant based coagulants which are used as natural coagulants are the Drum stick (Moringa oleifera) [15], Nirmali seeds (Strychnos potatorum) [16], Common bean (Phaseolus vulgaris) [7], Tamarind seeds (Tamarindus indica) [17], Jatropha curcas [5], Ocimum basilicum [8] chest nut and acorn [13] and others were found to be efficient in water and waste water treatment. Mustard or rape seeds are extensively grown in India, Canada, USA and some other European countries. The production in India is about 5.7 million metric tons every year [18].The mustard plant belongs to the Cruciferae (Brassicaceae) family. Mustard is often a mixture of seeds from two or more species of Brassicaceae, Sinapis alba L. (white or 'yellow mustard), Brassica nigra (black mustard) and Brassica juncea L. (Brown or oriental mustard) [19]. Mustard seeds contain 30–35% oil and 34–39% protein and 19% hull. After extracting the oil from the seed, about 60% of residue is left as cake which is available to the livestock industry [18]. The seed and press cake (waste after oil extraction) are considered to contain an active coagulant agent which can be used in water and waste water treatment. Recently [20] found the crude extract derived from various seeds of mustard and cake has the ability to coagulate the synthetic clay solution and turbid water from a pond and reported the coagulation activity of turbid pond was higher (60%) than moringa seed extract (50%). The objective of the present study was to investigate the potential use of mustard powder and mustard cake as coagulants in treatment of synthetic municipal waste water. In addition, the effects of various operating conditions, such as coagulant dosage and pH on turbidity and chemical oxygen demand (COD) removals using mustard powder and mustard cake were studied.

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MATERIALS AND METHODS

Preparation of mustard seed and cake powder

The mustard seeds were purchased from the local market of rajam and they were washed to remove the dust adhered to it. Then the seeds are sun dried and grounded to fine powder using ordinary food processor. The mustard cake was obtained from an oil factory Visakhapatnam and it was blended to fine powder.

Preparation of Synthetic Municipal Wastewater

Synthetic municipal wastewater was prepared to represent actual municipal wastewater. The synthetic municipal wastewater was prepared according to the following composition composed of non-fat dry milk (2000 mg/l), sodium acetate (600 mg/ l), yeast extract (40 mg/l), ammonium chloride (191 mg/l), potassium dihydrogen phosphate (44 mg/l), sodium hydrogen carbonate (1000 mg/l), sucrose (2000 mg/l), urea (500 mg/l), soluble starch (1000 mg/l), sodium chloride (1000 mg/l) [21, 22].

Coagulation test

The digital flocculator (jar test apparatus) (Model / Cat No: 2303 C) was utilised in all the coagulation flocculation experiment. A sample waste water of 300 ml was filled in to the beakers of 500 ml capacity leaving one as a blank (without the addition of any coagulant) and they are placed in the slots of the jar tester which was equipped with an illuminator. Various dosages of mustard powder were added to each beaker and the content was stirred for 4 min at 140 rpm. Then the mixing speed was reduced to 40 rpm for another 30 min. All the suspensions were then left for 60 min of sedimentation. The above mentioned procedure is repeated using the mustard cake. Finally, the clarified sample was collected from the top of the beaker using a pipette for physicochemical measurements, so that the effect of coagulant dose on coagulation could be studied. Then the samples are measured for the residual turbidity and COD for representing an initial concentration.

Optimization of coagulant dose and pH

To get the optimum result, the dosage of mustard powder and mustard cake fixed was in between 10 to 100 mg for 300 ml. The maximum removal efficiency was determined by using the mentioned dosage of mustard powder and cake. pH was changed from 2.5 - 10.5 using 1N NaOH or HCl to attain the optimum result.

Analytical methods

The COD was determined by closed reflux titrimetric method IS 3025 (part 58): 2006. The COD reduction was calculated as follows [8]

$$\%\, x_{COD,Reduction} = \frac{x_i - x_o}{x_i} \times 100$$

Where, x_i and x_o were initial and final COD concentrations.

Turbidity was measured using a turbidimeter according to IS 3025 (part10): 1984 and it was expressed in Nephelometric Turbidity Units (NTU). The turbidity reduction was calculated as follows [23].

$$\%\, Turbidity\ reduction\,(T) = \frac{T_i - T_o}{T_i} \times 100$$

Where, T_i and T_o were initial and final turbidities of sample.

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RESULTS AND DISCUSSIONS

Wastewater Characteristics

An initial experiment was carried out to determine the characteristics of the prepared synthetic municipal waste water. After completion of the jar test the sludge was settled at the bottom of the beaker and the analysis were carried out on the clarified sample to investigate the effectiveness of the mustard powder and its cake as a coagulant.

Table 1: Characteristics of the Synthetic Municipal Wastewater.

S. No	Parameter	Value	
		Prepared sample	After jar test
1.	pH	7.65	7.65
2.	Turbidity (NTU)	1060	400
3.	COD (mg/l)	1600	750

Coagulation and Flocculation by varying the Dosage

The optimum dosage of the coagulants is determined by varying the dosage from 10 mg to 100 mg for 300 ml at the original pH of the municipal waste water 7.65.

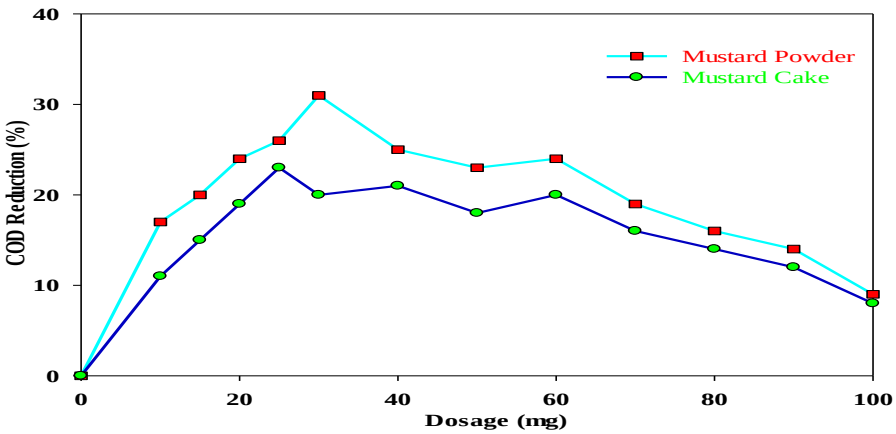

Fig. 1. COD reduction by varying the coagulant dosage with constant pH

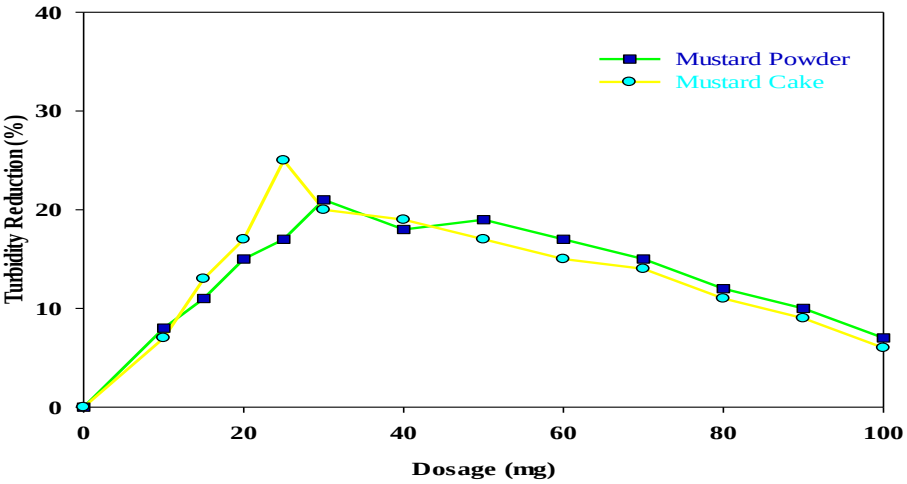

Fig. 2.Turbidity reduction by varying the coagulant dosage with constant pH

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Figs. 1 and 2 represent the percentage removal of COD and turbidity at various dosages of mustard powder and mustard cake. The COD removal was increased from 17 - 31% for mustard powder and 11 - 23% for mustard cake for the change in the dosage from 10 to 30 mg and 10 to 25 mg respectively. Thereafter decrease in the COD removal was observed from 31 - 9% and 23 - 8% for the mustard powder and mustard cake for the increase in the dosage from 30 to 100 mg and 25 to 100 mg respectively. The turbidity removal was increased from 8 - 21 % and 7 - 25 % for the mustard powder and mustard cake for the change in the dosage from 10 to 30 mg and 10 to 25 mg respectively. Further increase in the dosage of 30 to 100 mg and 25 to 100 mg for mustard powder and cake there was a decrease in the turbidity removal from 21 - 7 % and 25 - 6% respectively.

Coagulation and Flocculation by varying the pH

The pH of the sample was varied from 2.5 to 10.5 at the constant dosage of coagulants as 30 mg for 300ml for mustard powder and for mustard cake it is 25 mg for 300 ml.

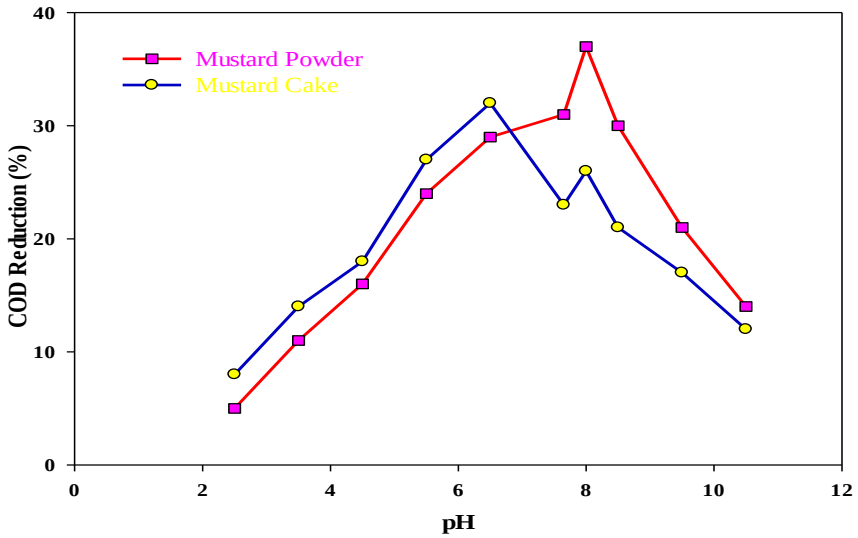

Fig. 3.COD reduction by varying the pH with constant coagulant dosage

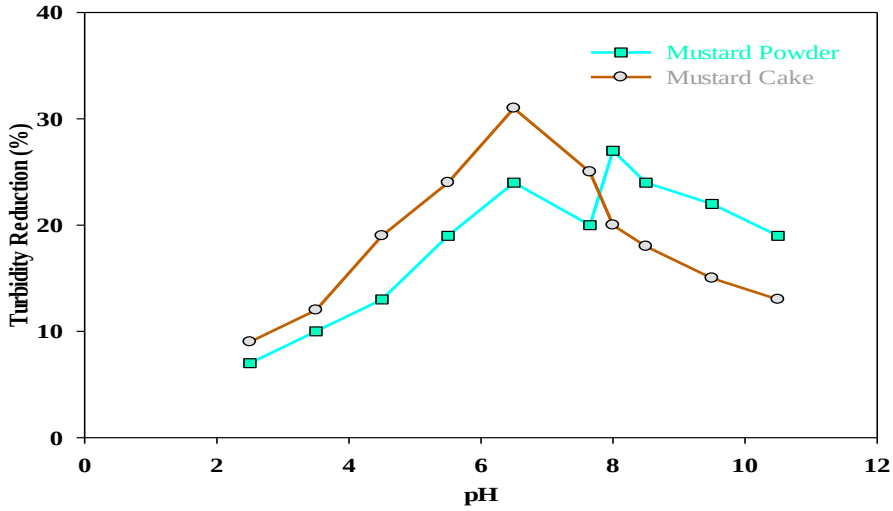

Fig. 4.Turbidity reduction by varying the pH with constant coagulant dosage

Figs. 3 and 4 represent the effect of pH on COD and turbidity removal when the dosages of coagulants are kept constant. It was observed that COD and turbidity removal were changing with the change in the pH of the waste water. The COD removal for mustard powder was 5%, 29%, 31%, 37% and 14% while for mustard

cake it was 8%, 32%, 23%, 26% and 12% at a pH values of 2.5, 6.5, 7.65, 8 and10.5 respectively. At a pH values of 2.5, 6.5, 7.65, 8, 10.5 for mustard powder the turbidity removal was 7%, 24%, 20%, 27% and 19% and for the mustard cake it was 9%, 31%, 25%, 20% and 13% respectively.

CONCLUSIONS

From the experimental work conducted on treating the synthetic municipal waste water using the natural coagulants by varying the coagulant dosage and pH the following conclusions are drawn.

- The optimum dosage for the mustard powder and mustard cake is 30 mg and 25 mg for 300 ml of waste water with COD and turbidity reduction of 31%, 21% and 23%, 25% respectively.
- Further by changing the initial pH, the COD and turbidity removal was increased at an optimum pH 8 for mustard powder and 6.5 for mustard cake with an efficiency of 37%, 27% and 32% and 31% respectively.

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