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Experimental and artificial neural network application on the optimization of paint effluent (PE) coagulation using novel *Achatinoidea* shell extract (ASE)

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ABSTRACT

This study investigated the potentials of *Achatinoidea* shell extract (ASE) as a coagulant for the pretreatment of paint wastewater. ASE preparation was adapted from the modified method of Fernandez-Kim, with effective deacetylation of precursor by NaOH at 65 °C for 2 h. Bench scale jar test experiment was carried out using ASE for the removal of TDSP (total dissolved and suspended particles). The influence of operating parameters on the process efficiency was examined using both one factor at a time (OFAT) and central composite design (CCD) methods. Results indicated the process followed second order reaction with rate constant of 0.0001 (l/g.s) and period of 7.432 s. Optimum performance of 99.22% was recorded at pH 4, 4 g/l dosage and 45 °C. There was significant agreement between results obtained by OFAT and CCD, which was validated by experimental and artificial neural network (ANN) methods. The process efficiency showed that paint effluents (PE) could effectively be treated at the conditions of the experiment.

Nomenclature

AS	Acadenodia shell
ASF	Acatenodia shell flour
ASE	Acatenodia shell extract
ASEPE	Acatenodia shell extract in paint effluent coagulation
ANN	Artificial neural network
O.D.E	Optimized design efficiency
E.V.E	Experimental validated efficiency
ANNE	Artificial neural network efficiency
TDSP	Total dissolved and suspended particles
CCD	Central composite design
NT	Network training
NTTV	Networktraining, testing and validation

1. Introduction

Effluent management has been a major global concern. Discharge of untreated effluents into the environment has both short and long term impacts. Over the years different materials have been used to treat the effluents [1]. Effluent with high particles can come from chemical factories such as paint, textile, paper, mineral processing firms etc. In paint factories, considerable amount of waste waters which contain color and suspended particles are majorly generated through line wash off in between batches [2]. These wastewaters if discharged into the environment would have adverse effect if untreated.

Over the years, there has been increasing interest in the use of coag-flocculation, adsorption, reverse-osmosis etc. for treatment of effluents. Among these techniques, coag-flocculation emerges as one of the promising techniques for successful initial treatment of effluents containing suspended particles [3].

Coag-flocculation employs the use of coagulants. Inorganic coagulants such as alum, ferric chloride among others, have been in use. However, the desire for an eco-friendly, biodegradable and cheaply available alternative grew as a result of numerous limitations observed on the use of inorganic coagulants [3].

Many researchers have reported the presence of active coagulating content in some natural materials such *Moringa olefera*, periwinkle shell, snail shell, wheat flour, beans flour etc. [2,4,5].

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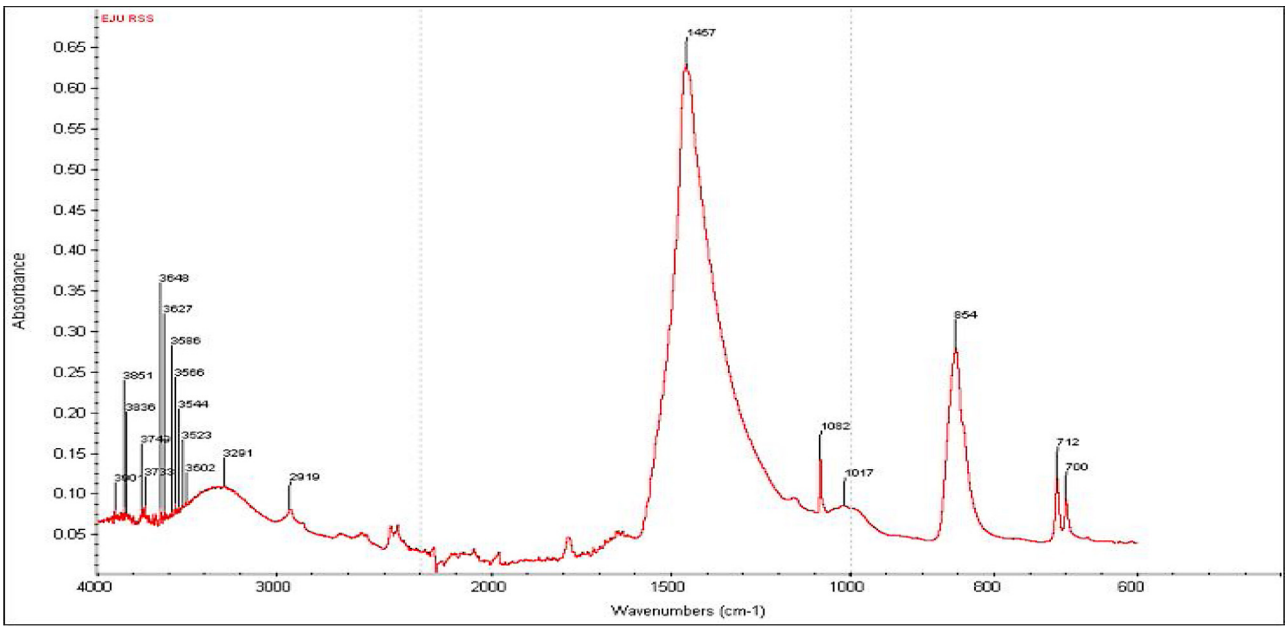
In this report, the study was extended to use of novel *Achatinoidea* shells to extract active coagulant (ASE).

Achatinoidea shells are considered as waste after processing the edible part. The brownish color shells contain calcium carbonate and organic matrixes which constitute of 6% proteins, called *conchiolin*. Both components can be extracted and used as coagulant for removal of turbidity from industrial effluents [4].

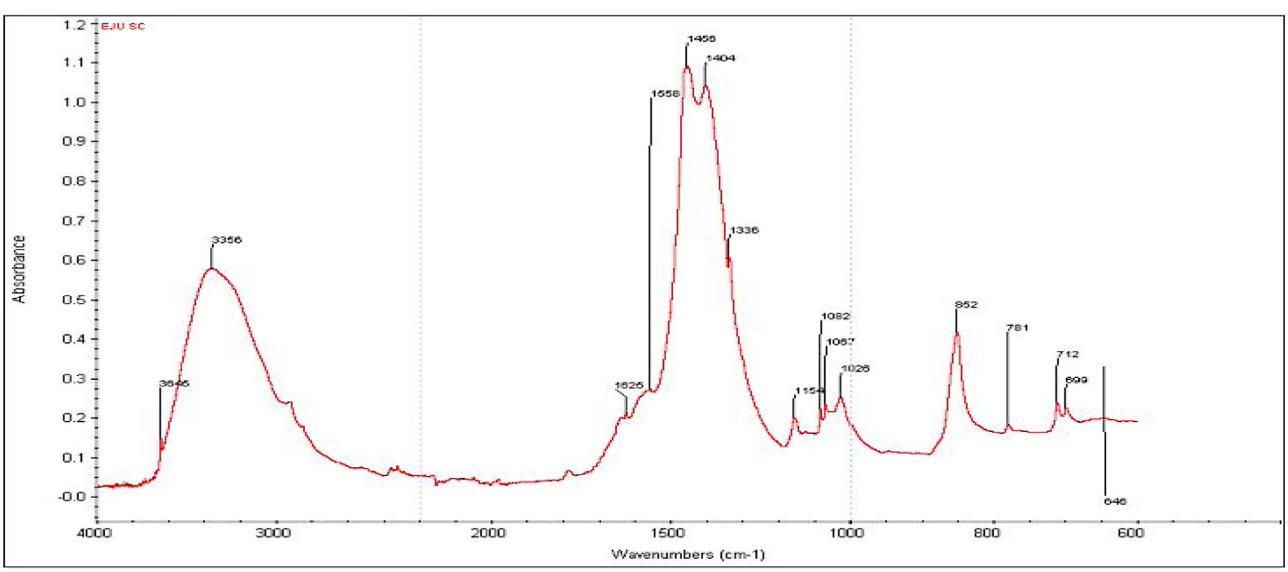
Using jar test, this study considered with respect to OFAT and CCD, the influences of selected variables on coagulation performance of ASE. While traditional OFAT studies the effect of one independent variable while keeping the rest constant, the CCD studies the effect of simultaneous multiple variations of independent variables [4–6]. CCD gives room to study the effects of independent variables interaction on the response variable while indicating the suspected polynomial curvatures in the process [7].

The polynomial equation thus developed, would often, be solved for optimization and subsequently validated and re-validated by traditional experimental and artificial neural network methods, respectively. One of the advantages of ANN is that, it generally provides network that train quite well, especially where relationships may be quite dynamic or non-linear. ANN is alternative to conventional analytical techniques, often limited by strict assumptions of variable independence, linearity, normality, etc. Given that ANN can capture many kinds of relationships, it allows for easy and quick modeling of phenomena that would have otherwise may be difficult or impossible to explain.

In this present investigation, the influences of pH, dosage, temperature and time on the coagulation of PE using novel ASE was investigated. Elaborate instrumental and physiochemical analyses were conducted to provide insight into structural, morphological, physiochemical and thermal characteristics of the investigated



(a)



(b)

Fig. 1. FTIR spectrum for: (a) ASF (b) ASE.