Extraction of resin from cashew nut sludge an Agro-industrial wastes

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In this work, the extraction of resin from the cashew nut sludge (agro-industrial waste) was done using three different solvents namely methanol, propanol and diethyl ether. Among the three solvents propanol shows the better results for extraction of resin and it was further confirmed with FTIR, TGA-DTA and DSC. The FT-IR (Fourier Transform Infra Red Spectroscopic analysis was used to explore the structural changes of the extracted resin using propanol. The maximum peak obtained using propanol as a solvent for the extraction of resin was 14-16 min intensity. All the experimental study throughout the present study indicated that the obtained resin has wide application on waste water treatment. In future, it can be used as a cheap substitute instead of commercial resin for a better environment.

Key words: Cashew nut sludge, Extraction, FTIR, TGA-DTA and DSC

Introduction

The major amount of wastes is generated every year from the industrial processing of agricultural raw materials, which are used as animal feed or burned as an alternative for elimination. However, such wastes usually have a composition rich in sugars, minerals and proteins, and therefore, they should not be considered “wastes” but raw materials for other industrial processes. Agro-industrial wastes can be used as solid support, carbon and nutrient source in SSF processes for the production of a variety of value-added compounds. India is the largest producer and processor of cashew in the world. The resin produced by most plants is a viscous liquid, composed mainly of volatile fluid terpenes, with lesser components of dissolved non-volatile solids which make resin thick and sticky. Proprietary design features of the extraction vessel ensure efficient contacting, minimal solids entrainment in the extract stream, and simple and effective removal of de-oiled solids from the extraction vessel. The processing sequence depends on sludge characteristics, solvent availability, recycling considerations and treatment requirements. In this present article an attempt was made to develop a extracted resin using cashew nut sludge with different solvents like Methanol, Propanol, and Diethyl ether. The extracted resin was characterized using FTIR, TGA-DTA and DSC to study the thermal and morphological characteristics.

Materials and Methods

All the reagents and chemicals used were of analytical grade. Cashew nut sludge (CNS) was obtained from the cashew nut industry in Panruti (muthandikuppam) Tamil Nadu, INDIA. They were grounded, sieved, and stored at 4°C to minimize the degradation of its compounds. Defatting of CNS was carried out using propanol at 50°C for 12 h followed by n-hexane at 69°C for another 12 h in a soxhlet extractor. The two solvents n-Hexane and propanol used for defatting CNS were of HPLC grade. CNS (15 g) was soaked in water at 30°C of 1:5 (w/w) for 2 h. The mixture was blended for 5 min and screened using a 50-mesh sieve. The residue was re-blended with 50 ml of 70% ethanol for 5 min, passed through a 60-mesh sieve and the residue was re-blended with 50 ml of 0.1 M NaOH for another 5 min and screened using a 50-mesh sieve. The residue restrained at the filter paper was dried using a freeze drier. All purification and analysis experiments were done at least in duplicates. During drying all the blended materials were used completely and there is nothing was commited as waste material. Thermal analysis was performed using DSC-6 Perkin Elmer at heating rate of 10°C/min under nitrogen whilst TGA – DTA was performed using TGA-(Model Hi. Res. 2950 TGA

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unit interfaced with Thermal Analyst 2100 control unit) in nitrogen atmosphere. FTIR spectrum was obtained using ABB BOMEN MB-3000, with a spectrometer in the range of 4000–400 cm\(^{-1}\).

**Pretreatment of Sludge**

The components of cashew nut sludge were more accessible while pretreatment was carried out. About 5g of finely ground raw materials was mixed with 20ml of alkali (0.1N) solution and was soaked for a period of 12 hrs. The residue was washed with water till a neutral pH was obtained. The raw materials were filtered using muslin cloth and it was dried at 60°C over night.

**Results and Discussion**

**FTIR**

Fourier transform infrared (FTIR) spectroscopy is a measurement technique that allows one to record infrared spectra. Infrared light is guided through an interferometer and then through the sample. A moving mirror inside the apparatus alters the distribution of infrared light that passes through the interferometer. It was confirmed that the extraction of resin using propanol was found to be the best when compared to resin extraction using methanol as a solvent. Since the presence of resin was confirmed with the peak (912) present in the FTIR analysis. There is no peak observed when methanol and diethyl ether was used as solvents. The FTIR spectra of the extracted resin showed the presence of the relevant functional groups. Alkynes bend (C–H bending) was observed at 675-1000 cm\(^{-1}\). The presence of hydroxyl group (O–H stretch) was characterized by the absorption peak at 3600-3700 cm\(^{-1}\). The ester group (C–O stretch) was identified at 1000-1260 cm\(^{-1}\). The presence of aromatic amines (C–N stretch) was confirmed at 3300-3500 cm\(^{-1}\). The peaks corresponding to the presence of alkenes (–C=C– stretch) were found at 1400-1600 cm\(^{-1}\). The alkane (C–H stretch) group was identified at 2850-2960 cm\(^{-1}\). The presence of alkenes was characterized by the absorption peak at 3010-3080 cm\(^{-1}\). These peaks confirmed that the presence of cationic resin functional groups in the extraction of resin using propanol. Single-cycle extraction with propane provides excellent bulk oil removal, but is somewhat less effective than the multi-cycle process for removal of heavy organics like poly nuclear aromatics (PNAs)\(^1\).

**Thermo Gravimetric Analysis (TGA)**

Thermo gravimetric Analysis is a technique in which the mass of a substance is monitored as a function of temperature or time as the sample specimen is subjected to a controlled temperature program in a controlled atmosphere. The percent weight loss and thermal degradation characteristics of the prepared samples were evaluated by Thermo gravimetric analyzer (TGA) of TA Instrument (Model Hi. Res. 2950 TGA unit interfaced with Thermal Analyst 2100 control unit). About 5–10mg of sample was taken in a platinum sample pan and nitrogen was purged at 60 ml/min during the dynamic runs. Most TGA experiments use an inert sample purge gas. This is done so the sample only reacts to temperature during decomposition. It can be seen from the TG curve that the sample has a little of mass loss before 100°C; this may be caused by evaporation of residual water in the resin. It is clear from the TGA-DTA curve of the material that at ≤ 180°C is only 2 % weight loss was observed which is due to removal of...
the external water molecules present. Weight loss in the regime of 180-350°C accounts for the removal of interstitial water molecules caused by the condensation of –OH groups. After 350°C, due to the resin chain breaking, the resin mass loss rapidly the sample mass loss is about 56.5% at 906°C. The results show that the extractive resin has a good thermal stability.

Differential Scanning Calorimetric (DSC) Analysis
Cure temperatures of the prepared samples were observed by taking very little quantity of samples of Differential Scanning Calorimeter (DSC). This was placed in sample cell of the instrument. The starting temperature, programmed rate and final temperature were taken at heating rate of 10 °C/min. Dynamic scans were obtained which were used for assuming the cure temperature. The cure temperature initiation was observed at 48°C. The onset Temperature of curing (Tonset), the exothermic peak temperature or the temperature of maximum cure (Tp) and the final temperature or the temperature at the end of the cure (Tstop) for the samples were determined from DSC scans as 98.5 °C, 354.7°C and 474.4°C. Where ΔH was found to be -2.13mJ/mg. From the above results it was confirmed that the extracted resin is cationic type of resin.

Conclusion
From the above results, it was concluded that the analysis shows that propanol is the best solvent for the extraction of resin from cashew nut sludge. Other solvents like methanol and diethyl ether does not show better peaks. The FTIR spectra were further confirmed as the resin which was extracted from cashew nut sludge waste. The TGA and DSC analysis indicated the type of resin and it was found in the cationic category of resin. Thus it shows the waste from the cashew industry can be regenerated and reused for detoxification of effluents. In this future work the type of the resin and its molecular formula with necessary composition will be found out.

References