Abstract

Castor is a plant found in arid regions of India, China, Brazil, etc. India is the largest producer and exporter of castor seed. The various products obtained from castor seed like oil, lubricants, deoiled cake, etc. With the growing need for sustainability and adaptation for green and ecological processes for extraction, production, and isolation of bioactive components from plants can be used for industrial expansion. This study includes the characterization and valorization of waste generated during this process. The research is based on the biorefinery concept of Castor seed bioactive compounds. India is a major producer of castor seed, but this agricultural source is underutilized.

This study includes the characterization and valorization of castor seed for oil, protein, and carbohydrates. The study includes the development of a green process to produce pharmaceutical and cosmeceutical grade oil, an emulsifier for industrial and cosmeceutical applications in the form of MG (Mono Glyceride) Ricinoleate. The castor protein consists of ricin as a toxic substance that remains underutilized as waste or fertilizer. Therefore, the thesis includes the isolation of protein by Sub Critical Water (SCW) Treatment Process and detoxification by high-pressure treatment. Carbohydrate fraction of the seed and cake after extraction is used in conversion to bioethanol.

In the current scenario, castor seed is subjected to mechanical extraction by using conventional mechanical extraction followed by solvent extraction to isolate the oil, and waste generated in form of deoiled cake in solvent extraction industries are generally underutilized and therefore brought to use as biofertilizer. Castor oil which is extracted using solvent or mechanical extraction is used for lubricant purposes.

In the present study, the castor seed is utilized for the extraction of oil in non-conventional and greener processes like Sub-Critical Water Treatment, Aqueous Extraction, and Enzyme Assisted Aqueous Extraction methods. Current practices of using hazardous solvents for the extraction of oil fuels pollute the environment and are toxic in nature. The utilization of water as a universal solvent for the extraction of oil with the maximum possible yield aims at a greener process for industry. The Oil extracted deoiled cake contains huge amount of protein (approximately 20-40 %) which can become a very good source of income for farmers of our rural India. Soluble sugars in form of cellulose & hemicellulose are underutilized which are present in castor deoiled cake. The carbohydrates are intact in the

cellular walls of castor seed and after protein extraction they are present in the cake. The biorefinery concept to the castor seed and deoiled cake is applied to recover the bioethanol for utilization as biofuel in production of biodiesel.

The current process for extraction of oil involving the usage of solvent hexane is replaced by water and water + enzyme combination in accordance with the green process. The extracted oil using water as a solvent with 2.5:1:0.25 ratio (water: seed: enzyme) showed more than 91% recovery as compared to solvent extraction (hexane) by industrial acceptable process. Sub Critical Water Treatment proved to be better method in oil yield with more than 95 % recovery compared to that of solvent extraction of oil. The oil along with the byproduct of biodiesel, glycerol is used for producing high quality and high source of income product MG. Different co-solvent ratio for best optimal condition for highest yield of MG (59-62%) were carried out to extract a product of high value from waste.

The characterization of deoiled cake showed results as high in protein concentration (85% ±5) and also high in lignocellulosic biomass concentration (cellulose + hemicellulose = 32.4% ±2). Thus use of cake for the isolation of protein with different method and production of bioethanol for various industrial uses by fermentation process was carried out in laboratory scale. Sub critical water treatment as a green process for separation and isolation of protein from cake using water with 90% purity concentration and breaking of cellulosic wall for maximum utilization of soluble sugars to obtain highest yield of bioethanol (more than 85%) was carried out with different alteration in pressure, temperature, water: cake ratio, run time.