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Microwave Assisted Thermal Process of Castor Oil for The Production of Specialty Chemical

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EXTENDED ABSTRACT

The utilization of vegetable oils is currently in the highlight of the chemical industry, as they are one of the most important renewable resources due to their universal availability, inherent biodegradability, low price, and eco-friendly. Castor oil from castor plant (*Ricinus Communis*) which is the non-edible oil crop is chosen in this study due to the high annual seed production and yield, and since it can be grown on marginal land and in semi-arid climate [1]. Castor oil derivatives are variously used in the production of paints, varnishes, coatings, lubricants and grease, hydraulic fluids, soaps, printing inks, and as a raw material in the manufacturing of various chemicals [2]. The chemistry of castor oil is centered on its high percentage of 12-hydroxy-9-octadecenoic acid (ricinoleic acid) and the three types of functionality existing in the molecule. These are the carboxyl group which can provide a wide range of esterifications; the single point of unsaturation which can be altered by hydrogenation or epoxidation or vulcanization; and the hydroxyl group which can be acetylated or alkoxyated, may be removed by dehydration to increase the unsaturation of the compound to give a semi-drying oil. The hydroxyl position is so reactive the molecule can be split at that point by high-temperature pyrolysis and by caustic fusion to yield useful products of shorter chain length. The double bonds, on the other way, makes the oil suitable for many chemical reactions and modification (refer Table 1). This study focuses on the Castor oil, covering the preparation, properties and major application possibilities of chemical derivatives of castor oil are highlighted. Our discussion focuses on the applications and the possibilities of castor oil and its derivatives for the synthesis of renewable monomers and polymers. The aim of this investigation was to produce specialty chemicals from castor oil by the microwave assisted thermal conversion over Zeolite catalyst. The microwave and its experimental equipment were set up as in Figure 1 below. Temperatures of 200°C and 650 W microwave power were used for the microwave heating. Addition of 3, 5 and 10% (w/w) Zeolite catalysts into the samples was also studied. The products obtained from the experiment were analysed by FTIR and GCMS. The targeted product of the thermal process of the castor oil is to obtain high-value added organic products which is potentially to be used for specialty chemicals.

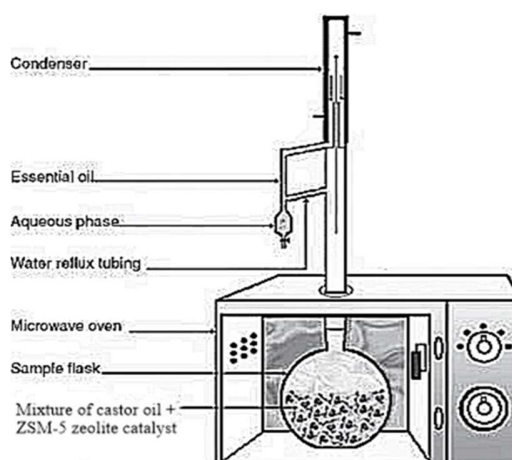


Fig. 1 : Experiment set up for the microwave assisted thermal process [3].

Table 1 : Different types of reactions of Castor oil [4]

	Nature of reaction	Added reactants	Type of products
Ester linkage	Hydrolysis	Acid, enzyme, or Twitchell reagent catalyst.	Fatty acids, glycerol.
	Esterification	Monohydric alcohols.	Esters
	Alcoholysis	Glycerol, glycols, pentaerythritol, and other compounds.	Mono- and diglycerides, monoglycols, etc.
	Saponification	Alkalies, alkalies plus metallic salts.	Soluble soaps, insoluble soaps
	Reduction Amidation	Na reduction Alkyl amines, alkanolamines, and other compounds.	Alcohols Amine salts, amides
Double bond	Oxidation,	Heat, oxygen, crosslink agent	Polymerized oils
	polymerization	Hydrogen (moderate pressure)	Hydroxystearates
	Hydrogenation	Hydrogen peroxide	Epoxidized oils
	Epoxidation	Cl ₂ , Br ₂ , I ₂	Halogenated oils
	Halogenation	S, maleic acid	Polymerized oils, factice
	Addition reactions	H ₂ SO ₄	Sulphonated oils
	Sulphonation		
Hydroxyl group	Dehydration, hydrolysis, distillation	Catalyst (plus heat)	Dehydrated castor oil, octadecadienoic acid
	Caustic fusion	NaOH	Sebacic acid, capryl alcohol
	Pyrolysis	High heat	Undecylenic acid, heptaldehyde
	Halogenation	PCl ₅ , POCl ₃	Halogenated castor oils
	Alkoxylation	Ethylene and/or propylene oxide	Alkoxyated castor oils
	Esterification	Acetic-, phosphoric-, maleic-, phthalic anhydrides	Alkyl and alkylaryl esters, phosphate esters
	Urethane reactions	Isocyanates	Urethane polymers
	Sulphation	H ₂ SO ₄	Sulphated castor oil (Turkey red oil)

Keywords: Castor Oil; Thermal Process; Microwave; Specialty chemical, Catalyst.

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