



The catalytic production of biofuels (biodiesel and bioethanol) using sonochemical, microwave, and mechanical methods

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1 Introduction

A Web of Science search using key words “Biofuels, Biodiesel, and Bioethanol” yields search results of “10,806, 4796, and 1540,” respectively, for the year 2018 alone. This indicates the intensity of research activity in the field of biofuels and more specifically biodiesel and bioethanol. Non-traditional methods of activation, for instance, ultrasound and microwave irradiation, are being employed for the acceleration of key chemical reactions like lipid or oil extraction from biomass, transesterification of triglycerides (lipids), waste cooking oil, and free fatty acids, leading to biodiesel production,^{1–102} and vital reactions like the biomass pretreatment,^{103–129} biomass hydrolysis,^{130–139} and fermentation of sugars,^{140–146} leading to the accelerated and high yield bioethanol production. However, the potential of nontraditional methods of activation, especially ultrasound and microwave irradiation, for biofuel production is not utilized to its fullest as evident from the relatively smaller number of publications dealing with these subjects (Fig. 1). The use of unconventional methods of activation is nearly two orders of magnitude lower than the traditional catalytic methods for bioethanol production and an order of magnitude lower for biodiesel production. This prompts a review on the role and potential of microwave and sonochemical irradiation on the conversion of biomass to biofuels, the challenges involved in the design of large-scale processes based on such non-traditional methods of activation, and the opportunities and rewards awaiting in this field of research and development.