

Extraction of Oil from Cocoa Shell Waste by Hydrodistillation using Microwave

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Abstract. Phytosterols are consumed in many pharmacological products. Cocoa shell is an interesting source as its oil extract has high phytosterol content and potential of valorization. This paper reports application of microwave to control rapid heating assisting hydrodistillation (MAE-HD) of cocoa shell waste (CSW) powder. The objectives were to optimize factors to maximize extraction yield and time. Water to CSW ratio, microwave power and extraction time were varied in One-Factor-At-a-Time (OFAT) manner from 2:1 to 10:1, from 180 to 280 W and from 30 to 150 min, respectively using optimum, predetermined factors. Selected range of the factors was further tested in central composite design. The extract was analyzed by using the Liebermann-Burchard method to measure phytosterol amount. From the response surface of CCD, oil extraction was optimal at 225W for 90 minutes with the water-CSW ratio of 7.94:1 with the yield of 2.46 mass% under significant model of surface functions.

INTRODUCTION

Phytosterols are known to have bad-cholesterol-lowering effect on human blood circulation system. They are normally found in human diets such as corn, soybean, wheat and rice [1]. Their main structure is similar to cholesterol, differing only in aliphatic side chain length and saturation [2]. More than 40 phytosterols have been identified and β -sitosterol is comprising about 50 per cent of dietary phytosterols [3]. They are employed as emulsifiers for cosmetic manufactures, which are steroidal intermediates and precursors for the production of hormone pharmaceuticals [4].

Phytosterols are also found in food wastes, including cocoa shells or hulls (CSW) [5]. Malaysia is a cocoa-producer from developing countries. Growing interest in the use of cocoa in food and beverages processing industries causes generation of abundant waste, particularly the CSW [6]. Valorization of this waste in phytosterols is deemed an interesting idea in order to achieve two objectives: minimum waste disposal and value for money [7]. The content of phytosterol in CSW is higher than in edible oil [8, 9]. An efficient extraction technique is therefore required to properly separate this valuable product from other hazardous ingredients. Hydro-distillation (HD) is the conventional extraction method that is still practicable. However, latest technology of extraction method is required to fulfill increasing demand to have lesser the extraction time and reduce the solvent consumption to obtain higher yield of product.

Microwave, supercritical fluid and pressurized liquid are among technologies that recently emerged to intensify the extraction process. A review on previous studies shows that vegetable wastes that were treated with microwave at appropriate temperature would enhance yield and particularly generate oxidatively stable oil of extract containing phytosterols and other phenolic compounds, which increases the oil's shelf life [10]. Microwave-assisted hydrodistillation (MAE-HD) technique applies microwave in rapidly heating mixture to a desired temperature by using electromagnetic wave. Microwave heating was used since 2020 and this alternative method of rising temperature is still studied to many nutrient resources [11]. For instance, studies conducted by Heri and Mahfud [12] in the extraction of Patchouli (*Pogostemon cablin*) from leaves revealed that maximum essential oil yield could be achieved within 2 h of operation with MAE-HD, while 6 h was at least required for the same purpose in the case of