

Multi-objective Optimization, Process Scale-up Techno-Economics and Uncertainty analysis of Microwave-Assisted Extraction of Phenolic-Rich Extract from *Allium sativum*

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Abstract

Allium sativum extract is one of the medicinal and aromatic products used in pharmaceutical and food industries. The scientific literature bibliography regarding process scale-up simulation and techno-economics of phenolic extract from *Allium sativum* microwave-assisted extraction is seldom reported. This study presented optimization and techno-economic evaluation of phenolics recovery from *allium sativum* microwave-assisted extraction. Box-benken design extraction experiment was conducted at irradiation power (520 – 1040 W), extraction time (2- 10 minutes) and solid-liquid ratio (0.4 – 1 g/100 ml). The extraction conditions that optimized experimental extractable yield and Total Phenolic Content (TPC) were evaluated in Box-benken desirability of Response Surface Methodology. Bioactive finger printing of the extract was analyzed using HPLC. Aspen Batch Process Developer was used for the process techno-economic analysis. Profitability uncertainty was analyzed using Monte-Carlo Simulation (MCS). Optimal extractable yield (28.62 %) and TPC (76.8 mgGAE/g dry extract) were obtained at irradiation time 7.62 mins, microwave power 826.67 Watt with solid-liquid ratio 0.55g/100ml. The HPLC fingerprint revealed Bentulinic acid, galic acid, chlorogenic acid, ellagic acid and ferulic acid. Cost of Manufacturing (COM) for 5L, 50L and 500L extractors gave US\$ 1480, US\$ 220 and US\$ 56 respectively. Techno-economic results of 500L extraction capacity with 900 kg/year design gave batch size (0.25 kg), production rate (2 kg/min), cycle time (125 mins), discounted NPV (38133 US\$), ROI (34%), IRR (37%) and PBT (2.94yrs). MCS results show 85.58 % and 83.53certainties of achieving base case ROI PBT. Therefore, the study shows that MAE of garlic powder is economically feasible.

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