caffeine-extraction

4/20/2024

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Cruising Review

Extraction of Caffeine from Robusta Coffee Husks Using Supercritical Carbon Dioxide

This webpage QR code

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PDF Version of the webpage (first pages)

Extraction of Caffeine from Robusta Coffee Husks Using Supercritical Carbon Dioxide

1. Caffeine is a widely consumed stimulant throughout the world. It is known to have both positive effects: counteracting tiredness and increased alertness; and negative effects: causing increased heartrate and blood pressure. As such, it is intentionally added to some products while being removed from others.
2. While coffee is not the only source of caffeine, it, quote – is the main source of caffeine in daily consumption given its generally higher caffeine content – unquote.
3. With an appreciable market for decaffeinated coffee, the extraction of caffeine from coffee is a natural choice for sourcing caffeine for other products.
4. Multiple methods of coffee decaffeination exist, but none are as advantageous as Supercritical Carbon Dioxide (SC-CO2) extraction.
5. The two primary competing methods involve highly toxic organic solvents, or a process known as Swiss water decaffeination, quote – which results in a less flavorful brew than other methods – unquote.
6. The most significant drawback to SC-CO2 extraction is CO2's non-polar characteristics which make it a poor solvent for polar materials.
7. In 2009, more than 8 million tons of raw coffee beans were processed. Quote – for every ton of clean coffee produced, 1 ton of husks – unquote, or more are also produced as waste.
8. Waste bean husks often end up as fuel in coffee mills used to heat and dry the coffee beans even though they still contain more than 1% caffeine.
9. The objective of this study was to determine if SC-CO2 could viably extract the remaining caffeine in coffee bean husks before final disposal.
10. Two different pretreatments were investigated in this study: ground vs. raw and differing levels of husk humidity.
11. In a secondary investigation, the authors took samples of pure caffeine and dissolved it into SC-CO2 to experimentally determine the solubility of caffeine in SC-CO2.
12. Solubility was found to increase as extraction pressure was increased. At pressures below 2,900 psi, an increase in temperature actually decreased the solubility; above 2,900 psi an increase in temperature was associated with increased solvency.
13. The influence of temperature on SC-CO2 solvency has to do with the fact that, quote – small increases in temperature result in drastic decreases in solvent density and consequently, on solvent capability – unquote. Above the 2,900 psi threshold, the increase in temperature has more of an effect on the solute vapor pressure than it does on the solvent density, improving the solubility of the system.
14. Experimental results concurred with the industry standard practice of wetting coffee beans prior to SC-CO2 decaffeination. Husk caffeine extraction benefited from humidly increase up to 32 percent.
15. Investigation of the impact of grinding the coffee husks prior to SC-CO2 extraction indicated that it was an unnecessary and even a hinderance to extraction efficiency. This was likely do to an increase tendency for fluid channeling inside of the extraction chamber.
16. Also, of interest was the finding that, quote – the color of the extract was influenced by the working temperature...samples obtained at higher temperatures showed a dark brown color instead of the yellowish-green seen in the samples obtained at lower temperatures – unquote.
17. The authors conclude that SC-CO2 is a viable method for extracting caffeine from the husks of coffee beans. Their results also indicated that grinding the husks was not beneficial but wetting the husks to a humidity of 32 percent was beneficial. Further economic analysis would need to be undertaken, but caffeine extraction from coffee husks may offer a profitable use for this otherwise waste material.

Publication: The Journal of Supercritical Fluids. Tello J, Viguera M, Calvo L. Extraction of caffeine from Robusta coffee (Coffea canephora var. Robusta) husks using supercritical carbon dioxide. 2011;59:53-60. doi:10.1016/j.supflu.2011.07.018.

Review by: SP

4/20/2024