Accelerated Solvent Extraction of Pistachio Oil Using a Modified Supercritical Fluid Extractor

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An accelerated solvent extraction (ASE) method for the extraction of pistachio oil was developed using a modified supercritical fluid extractor. Two different solvents of n-hexane and ethanol were used instead of SC-CO_2 to extract pistachio oil. The effect of parameters such as temperature of (50-80) ^{o}C, pressure of (10-200) bar, the percent of glass beads mixed with the sample before loading into the extraction cell, and volume of solvent (15-35) mL on the extraction yield were investigated. With increasing temperature from 50 to 80 ^{o}C the yield is increased, but increase in pressure had no significant effect on the extraction yield. The glass bead (~10%) mixed with the grinded pistachio to disperse the matrix has increased the extraction yield. The extraction yield is increased with volume of both solvents. For 4-5 g of grinded pistachio kernel, 30 mL of n-hexane were used at a temperature of 60 ^{o}C and a pressure of 50 bar to extract approximately 100% of the oil content of the sample compared to the Soxhlet extraction which takes 5 h to complete and consumes 100 ml of n-hexane.

INTRODUCTION

Pistachio nut oil is a highly unsaturated emollient providing superior moisturization and a high level of nourishing essential fatty acids in a dry non-greasy, rapidly absorbed, very low odor form. It contains about 51-54% oleic acid and 31-35% linoleic acid.

Supercritical fluid extraction (SFE) has been used for extraction from different samples such as hazelnut and pistachio oil at high pressures of 300-450 bar. Even addition of modifiers such as ethanol at 5-10% was not lead to much lower pressure of pistachio oil extraction [1-2]. Maximum pistachio oil recovery of 66.14% was obtained at 345 bar and 60°C in the presence of 10 wt% ethanol [2].

Accelerated solvent extraction (ASE) as an efficient, rapid, selective, and reliable extraction process, has been applied to quantitative extraction of different samples such as environmental organic compounds in soils, lipids, and analysis of food, and biological samples [3-6]. The possibility of varying extraction variables such as temperature, pressure, and volume of solvent is a promising characteristic of newly available automated ASE [Schafer 98].

In this work, we have tried to develop a method for the extraction of pistachio oil using ASE at lower pressures and extraction time in comparison with SFE.

MATERIALS AND METHODS

Ethanol and n-hexane was supplied by Merck Co. The pistachio kernel was grinded, passed through mesh of 16, and dried at 70 ^{o}C to constant weight. It was kept in refrigerator till used in sealed bag.

The main components of SFE apparatus that had been introduced in detail elsewhere [7], modified using a switching valve to be able to pump solvent and supercritical carbon dioxide (SC-CO_2) separately into the extraction vessel. Two different solvents of n-hexane and ethanol were used to extract pistachio oil. The extraction system was designed so that we could send SC-CO_2 through the sample to remove solvent residue and separate the extraction solvent in the collection vessel after finishing the ASE.

The grinded pistachio kernel (4-5 g) was loaded into the 10 mL stainless steel cell. The extraction program consisted of 5 min static extraction followed by dynamic extraction at the set pressure and temperature. The extraction yield was calculated as the weight of extracted oil relative to the dry weight of the sample loaded into the extraction cell. A conventional Soxhlet extraction (SE) was used as a reference method.

The effect of parameters such as temperature of (50-80) ^{o}C, pressure of (10-200) bar, volume of solvent (15-35) mL and the percent of glass beads mixed with the sample before loading into the extraction cell on the extraction yield were investigated. With increasing temperature from 50 to 80 ^{o}C the yield is increased, but increase in pressure had no significant effect on the extraction yield as shown in Figs 1-2. The glass beads (~10%) mixed with the grinded pistachio to disperse the matrix has increased the extraction yield for 3-4%. The extraction yield is increased with volume of both solvents as shown in Fig. 3. For 4-5 g of grinded pistachio kernel, 30 mL of n-hexane were used at a temperature of 60 ^{o}C and a pressure of 50 bar to extract approximately 100% of the oil content of the sample within 30 min compared to the SE which takes 5 h to complete and consumes 100 mL of n-hexane. The extraction yield was about one third, when ethanol was used as the extraction solvent.

CONCLUSION

An ASE method was developed to extract almost 100% pistachio oil content using 30 mL of n-hexane within 30 min at temperature of 60^{o}C and pressure of 50 bar. Solvent recovery by SFE after finishing ASE was performed to remove the solvent from the pistachio residue and the extracted oil. Ethanol is not a good extraction solvent for extracting pistachio oil using ASE method.

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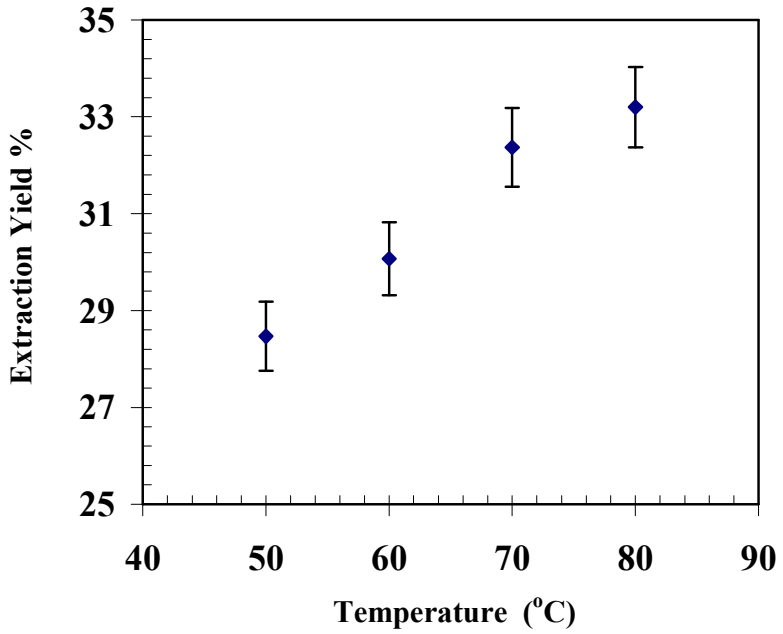

Fig. 1. Extraction yield versus temperature at pressure of 50 bar and flow rate of 1 mL/min.

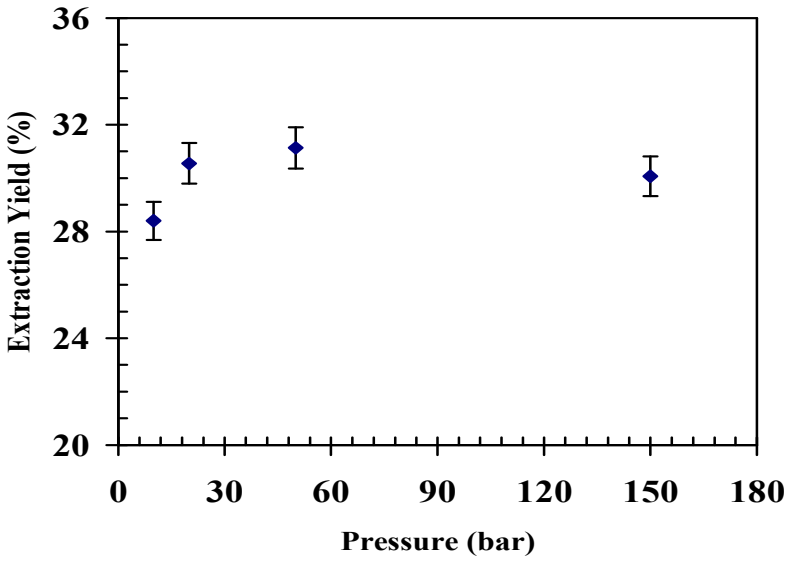

Fig. 2. Extraction yield versus pressure of extraction at temperature of 60 ^{o}C and flow rate of 1 mL/min.

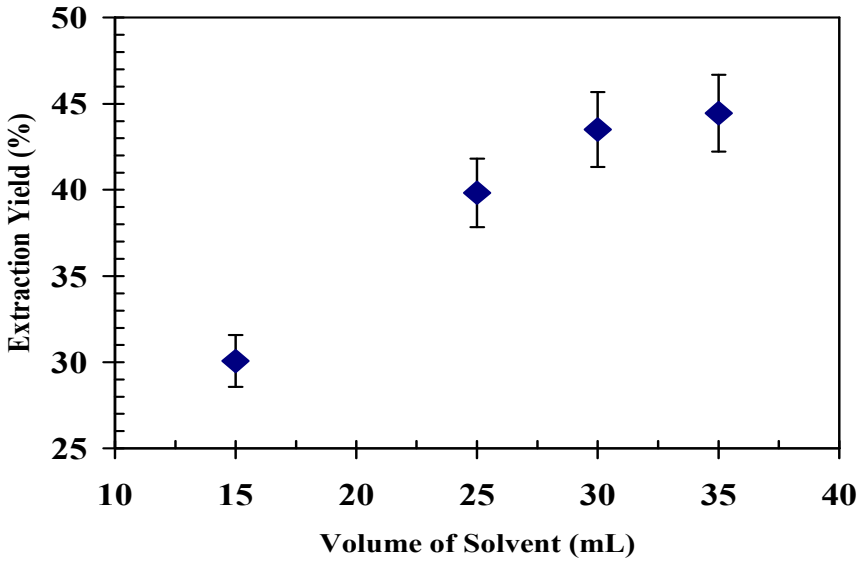

Fig. 3. Extraction yield versus volume of solvent consumed in extraction at 50 bar and 60 ^{o}C and flow rate of 1 mL/min.