Effects of Different Extraction Methods on the Chemical Properties of Cranberry Seed Oils

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Introduction

Cranberry seed oil extracted from cranberry seeds, the by-products of cranberry juice processing is a rich source of essential fatty acids, phyto-sterols, and antioxidants. Extraction techniques have significant effect on these natural phytochemicals present in the seed. Many new efficient methods have been suggested as an alternative to the conventional method of oil extraction, however the most commonly used and studied methods are the cold press method and accelerated solvent extraction method.

Objective

To evaluate the yields and the functional properties of cranberry seed oils extracted using different extraction methods, cold pressing (CP) and accelerated solvent extraction (ASE) methods.

Material and Methods

Oil Extraction: Cranberry seeds (approx. 99.9% pure seed) were obtained from local cranberry seed oil processors (Simply Incredible Foods Inc. Port Edwards, WI).

- ***Cold pressing (CP) method:*** using cold press extractor with small scale 'Komet' expeller (IBG Monforts and Reiners, German) in a pilot scale (temperatures 40-60°C). Cold-filtered using muslin cloth (20 micron size).
- ***Accelerated solvent extraction (ASE) method:*** using solvent extractor (ASE 200, Dionex Corporation, Sunnyvale, CA). The operating conditions of ASE were oven temperature: 105°C, pressure: 1500 psi., oven heat up time: 5 min, static time: 10 min, flush volume: 100%, purge time: 60 s, solvent: hexane, and static cycles: 3 times. Solvent was removed under fume hood.




Sample Analysis: The oils, **CP1** (using July harvested seed), **CP2** (using September harvested seed), **ASE** and **COM** (commercial cranberry seed oil), were analyzed for…

1. **Extraction yield**: Croteau and Fogerson method (Bhagdeo, 2004).
   Actual yield of oil = oil obtained (g)*100/seed taken (g)
2. **Fatty acid profile and Phytosterol content**: using gas chromatography (GC-FID). Wax column (Supelco; 30 m × 0.25 mm; 0.25 μm) for fatty acids & Equity-5 column (bonded 5% diphenyl and 95% dimethylsiloxane phase, Supelco., 30 m × 0.25 mm; 0.25 μm) for phytosterols (Du and Ahn 2002).
3. **Antioxidant properties**:
   a. **Total phenolic content (TPC):** Folin-Ciocalteu's colourimetric method (Yu & Zhou, 2004).
   b. **1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity:** using UV/Visible spectrophotometer (Varian, Santa Clara, CA) at 517 nm (Parry et al., 2005).
4. **Peroxide Value (PV):** Titration Method (AOAC Official Method)

Data Analysis: Randomized complete block using a mixed effects model. Statistical Package for Social Science (SPSS) statistical software using the Tukeys' HSD (honest significant difference) tests at $P < 0.05$ using triplicate sample.

Results

- Cranberry seed oil had good omega-6:omega-3 fatty acid ratio (1.2:1) and polyunsaturated (PUFA): saturated (SFA) fatty acid ratio (9.5:1).
- ASE method achieved higher yields of oil (89.2%) and phytosterols such as stigmasterol (34.2 ppm) and β-sitosterol (1001.6 ppm) than the CP method (79.0% oil yield from CP1 and 78.8% from CP2; 14.4 ppm stigmasterol from CP1 and 18.7 ppm from CP2; and 660.2 ppm β-sitosterol from CP1 and 642.9 ppm from CP2).
- However, oils from ASE method had higher lipid oxidation level (10.9 meq/kg), lower alpha-tocopherol content (84.7 ppm) and lower antioxidant activities (1.23 mg GAE/g) than that with the CP method.

Table 1. Fatty acid composition of cranberry seed oils by different extraction methods and harvesting time.

Parameter	COM	CP1	CP2	ASE
Palmitic acid (16:0)	6.13^{ab}	6.20^{ab}	6.00^{b}	6.43^{a}
Stearic acid (18:0)	1.03^{a}	1.33^{a}	1.73^{a}	1.13^{a}
Oleic acid (18:1)	19.67^{c}	20.13^{c}	22.03^{b}	23.13^{a}
Linoleic acid (18:2, n-6)	38.37^{ab}	38.57^{ab}	37.93^{b}	38.93^{a}
Linolenic acid (18:3, n-3)	34.80^{a}	33.77^{b}	32.37^{c}	30.40^{d}
Saturated (SFA)	**7.16^{d}**	**7.53^{c}**	**7.73^{a}**	**7.56^{b}**
Polyunsaturated (PUFA)	**73.17^{a}**	**72.34^{b}**	**70.30^{c}**	**69.33^{d}**
Monounsaturated (MUFA)	19.67^{d}	20.13^{c}	22.03^{b}	23.13^{a}

Data were expressed as mean (n = 3). Different letters within each row represent significance difference (P < 0.05). The results are expressed in percentage. CP1: July harvested seed, cold pressed cranberry seed oil, CP2: September harvested seed, cold pressed cranberry seed oil, ASE: July harvested seed, accelerated solvent extracted cranberry seed oil. COM: Commercially available cold press cranberry seed oil (Botanical Oil Innovation)

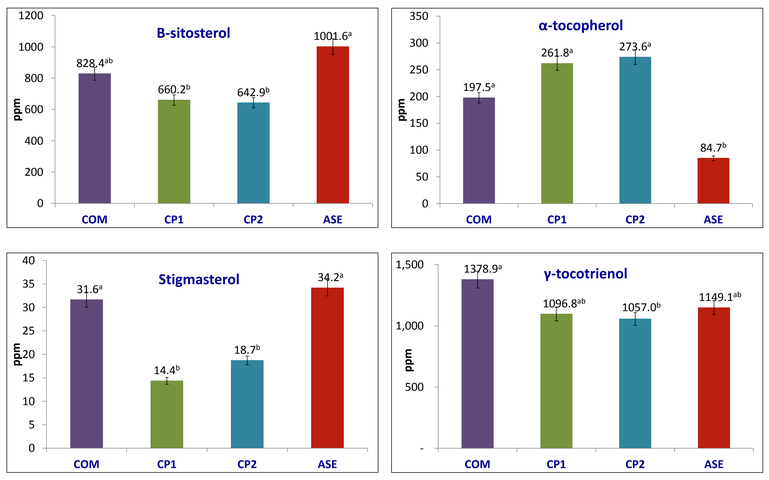
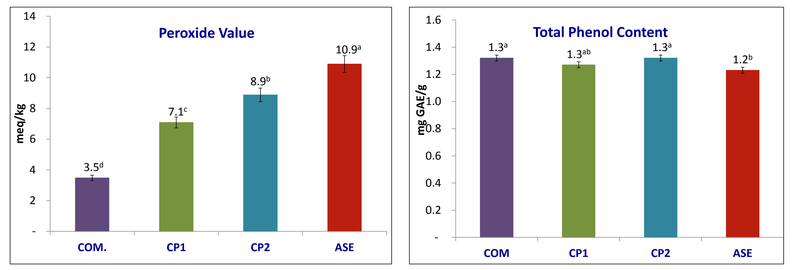


Figure 1. Phytosterol profiles of cranberry seed oils by different extraction methods and harvesting time. (Unit: ppm or mg/kg oil)



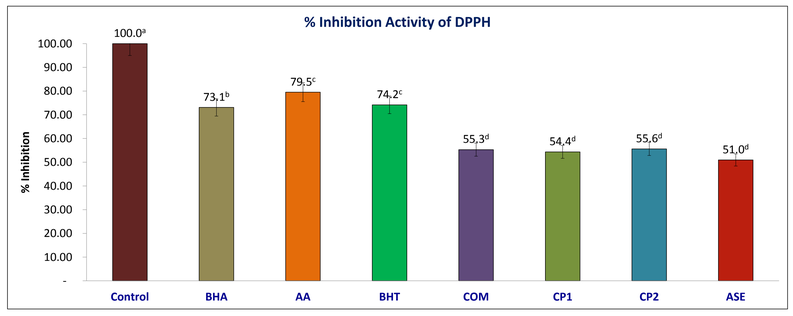


Figure 2. Antioxidant properties and lipid oxidation of cranberry seed oils by different extraction methods and harvesting time.

Conclusions

- Although ASE method achieved high yield of oil production and amounts of phytosterols, it was low antioxidant activities and high lipid oxidation due to additional solvent (hexane)-removing step during oil processing, which can exposure the oil to the air and then accelerate lipid oxidation.
- This additional step was not acceptable especially to cranberry seed oil because of high PUFA and MUFA contents of oils, which can be highly susceptible to oxidation.
- CP method is excellent for the extraction of oils with high PUFA contents such as cranberry seed oil.
- However, extraction temperature of CP, refining processing to remove impurities from the crude oil, and the protection of oils from light using ambient bottle during storage were important factors for the quality of cold-pressed cranberry seed oils.
- Fatty acid content may depend on different growing, processing and storage conditions.

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