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Comparison of solvent and microwave extracts of cranberry press cake on the inhibition of lipid oxidation in mechanically separated turkey

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Abstract

Cranberry press cake, an under utilized by-product of the cranberry processing industry is a potential source of food antioxidants. The objective of this research were (1) to prepare extracts from cranberry press cake using solvent extraction (SE) and microwave assisted solvent extraction (MASE), and (2) to test the ability of these extracts to inhibit lipid oxidation in mechanically separated turkey (MST). Water, ethanol and acetone were used as extraction solvents. Heating press cake prior to extraction with 70% ethanol increased antioxidant efficacy compared to extracting unheated press cake. Water extracts were least effective in inhibiting lipid oxidation. The most effective extracts were obtained by SE with 100% acetone or MASE with 100% ethanol. A poor correlation of 0.69 was obtained between the total phenols in the extracts and their ability to inhibit thiobarbituric acid reactive substances (TBARS) formation in MST. The correlation coefficient between the amount of quercetin in the extracts and the number of days of TBARS inhibition in MST was 0.87. This indicates that although quercetin may be good inhibitor of lipid oxidation, polyphenols other than quercetin are likely have a role in the inhibition of TBARS in MST. For a similar yield of the extracts, MASE extract using 100% ethanol was a better inhibitor than 100% ethanol SE extract of lipid oxidation in MST. In terms of choice of solvent, based on their flammability and toxicity, MASE with 100% ethanol would be a more likely a choice over SE with 100% acetone, for inhibiting oxidation in MST.

Keywords: Cranberry press cake; Solvent extraction; Microwave assisted extraction; Antioxidative behavior; Mechanically separated turkey

1. Introduction

Lipid oxidation is a major cause of quality deterioration in muscle foods (Ladikos & Lougovois, 1990). Oxidation could be retarded by an exogenous addition of antioxidants to the foods systems (Dziezak, 1986). Due to safety and toxicity concerns related to the use of synthetic antioxidants (Madhavi & Salunkhe, 1996) in foods, natural antioxidants are being increasingly used in the meat industry. Cranberry press cake, an under utilized byproduct of cranberry industry contains several phenolic compounds, which could be used as a potential food antioxidants (Zheng & Shetty, 2000). Cranberry press cake is a mixture of cranberry skin and seeds and is obtained after pressing/removing the juice from cranberries.

Several extraction techniques and solvents are used for obtaining antioxidant extracts from plant origins. Extraction techniques include solvent extraction (SE) (Chen, Shi, & Ho, 1992), microwave assisted solvent

Abbreviations: SE, solvent extraction; MASE, microwave assisted solvent extraction; MST, mechanically separated Turkey; TBARS, thiobarbituric acid reactive substances.

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extraction (MASE) (Kaufmann & Christen, 2002), soxhlet extraction (Bicchi, Binello, & Rubiolo, 2000) and supercritical fluid extraction (Bicchi et al., 2000). Among these, MASE is a relatively new method used for the extraction of natural products (Ganzler, Salgo, & Valko, 1986). Pan, Niu, and Liu (2003) had earlier shown that MASE was more effective than conventional extraction methods in the extraction of tea polyphenols and tea caffeine. Hong et al. (Hong, Yaylayan, Raghavan, Pare, & Belanger, 2001) used MASE to optimize the extraction of phenolic compounds from grape seeds.

Due to the low economic value of cranberry press cake (Zheng & Shetty, 2000), a preparation of food grade antioxidant extract from cranberry press cake would increase the economic value of cranberries. As MASE has been shown to be effective for the preparation of antioxidant extracts from grape seeds and tea leaves (Hong et al., 2001; Pan et al., 2003), we explored the possibility of preparing antioxidant extracts from cranberry press cake using MASE. The press cake extracts were tested for their ability to inhibit lipid oxidation in mechanically separated turkey (MST). MST was chosen due to its growing popularity as a food product as well as due to its susceptibility to lipid oxidation (Dawson & Gartner, 1983; Mielnik, Aaby, Rolfsen, Ellekjaer, & Nilsson, 2002; Wilson, Pearson, & Shorland, 1976). In order to determine whether MASE is an efficient method for preparing press cake extracts, we compared the yields and potency of press cake extracts prepared using MASE with that prepared using SE.

2. Materials and methods

2.1. Materials

Cranberry press cake was packaged with frozen gel packs in an insulated packaging material and was shipped by Ocean Spray Cranberries, Inc. from Tomah, WI by overnight delivery. Upon arrival, the cranberry press cake was immediately repackaged in "zipper" seal polyethylene bags with around 300 g in each bag and stored at −20 °C until use. Mechanically separated turkey (MST) prepared from freshly processed turkeys was shipped from Newberry, SC to the Kraft–Oscar Mayer (Madison, WI) by refrigerated trucking. The MST was then immediately vacuum packaged and stored at −80 °C until use. MARSXpress (model no: 907500), used for microwave assisted solvent extraction (MASE) was loaned by CEM Corporation (Matthews, NC). Distilled water was collected using Milli-Q plus (Millipore, Billerica, MA). Zipper seal polyethylene bags (10 × 15 cm) and Fisher Isotemp magnetic stirrer were purchased from Fisher Scientific Co. (Pittsburg, PA). Vacuum pouch 3 mil standard barrier (17.5 × 20 cm) was purchased from Koch Supplies (Chicago, IL). Chemicals and solvents were purchased from Sigma Chemical Co. (St. Louis, MO). All reagents were of ACS grade.

2.2. Extraction of cranberry press cake

2.2.1. Effect of heat on cranberry press cake

The effect of heating cranberry press cake on (i) the total phenolic content and (ii) the ability of the extract to inhibit lipid oxidation in MST, was studied. Cranberry press cake was heated for 4 h at 100 °C and cooled at room temperature. The heated and unheated press cakes were extracted using ethanol:water (7:3). Fifty grams of the cranberry press cake was blended with 500 mL of ethanol:water (7:3) solvent in a Waring commercial blender for 1 min. The mixture was then stirred for 2 h using a Fisher Isotemp magnetic stirrer and filtered using a Whatman filter paper no. 4 (Whatman Inc., Florham Park, NJ). The filtrate was evaporated using a Buchi rotavapor under vacuum at 30–35 °C until the volume of the filtrate has concentrated to less than 50 mL. The evaporated filtrate was frozen at −80 °C, freeze-dried and stored at −80 °C.

2.2.2. Microwave and solvent extraction of cranberry press cake

Cranberry press cake was dried in an oven at 100 °C for 1 h. The dried press cake was powdered using a Hamilton Beach grinder (model 80354, Proctor Silex Inc., Washington, NC) at fine grind setting. The powdered cranberry press cake was used for the preparation of antioxidant extracts using SE and MASE. The solvents used for extraction were, ethanol, acetone, water, ethanol:water (1:1) and acetone:water (1:1).

Twenty one grams of the powdered cranberry press cake was blended with 105 mL of the solvent in a Waring commercial blender model 51BL32 (Waring Commercial, Torrington, CT) for 1 min. The mixture was stirred for 2 h using a Fisher Isotemp magnetic stirrer and then centrifuged at 8000*g* for 15 min at 4 °C using a Sorvall RC-5C Plus centrifuge (Kendro Laboratory Products, Asheville, NC). The supernatant was used for the preparation of the antioxidant extracts.

When organic solvents were used for extraction, clear supernatants were obtained. The supernatant was evaporated using a Buchi rotavapor, model R200 (BÜCHI Labortechnik AG, Switzerland) under vacuum at 30–35 °C until the volume of the supernatant has been concentrated to less than 50 mL (which is equal to the amount of water used for preparing 50% ethanol or 50% acetone). When 100% ethanol or 100% acetone was used as the extraction solvent, the supernatant was mixed with 50 mL water and evaporated in a rotavapor under vacuum at 30–35 °C, until the volume has been concentrated to less than 50 mL. The evaporated supernatant was frozen at −80 °C. The frozen mixture was freeze-dried using a freeze drier, model 52647 (Labconco Corp., Kansas City, MO) and used for antioxidant studies.

When water was used for extraction, a turbid supernatant was obtained. As the turbid supernatant could not be freeze dried, turbidity causing compounds were precipi-