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Extraction of Capsaicin from Black and White Pepper

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Abstract: Capsaicin has general impressive health benefits such as anticancer, stimulates digestion and enables weight loss. The aim of this study is to extract capsaicin from black pepper and white pepper by using polar (Ethanol) and nonpolar (Acetone) solvents and to maximize the percentage yield of capsaicin. The effect of temperature and solid to solvent ratio on percentage yield is investigated for extraction of capsaicin from black pepper and white pepper. The percentage yield of capsaicin is higher for acetone than ethanol for both black and white pepper at the temperature and solid to solvent ratio of 50ºC and 1:10, respectively. Also, the percentage yield of capsaicin is higher for ethanol than acetone for both black and white pepper at the temperature and solid to solvent ratio of 70ºC and 1:10, respectively. Hence, black and white pepper could be the potential substrates for the extraction of capsaicin.

Keywords: Capsaicin, black and white pepper, temperature, solid to solvent ratio, acetone, ethanol

1. Introduction

Capsaicinoids' therapeutic applications have sparked new ideas for their utilization. Capsicums have a long history of therapeutic use, dating back to the Mayas, who used them to cure asthma, coughs, and sore throats. Chile pepper is historically linked to Christopher Columbus' journey; he is credited with introducing chili to Europe, and then to Africa and Asia [1,2]. *(E)-N-[(4-hydroxy-3-methoxyphenyl) methyl] -8-methylnon-6-enamide*, or *-8-methylnon-6-enamide* Capsaicin is the most common cap-saicinoid found in chili peppers, followed by dihydrocapsaicin *N-[(4-hydroxy-3-methoxyphenyl) methyl]* and dihydrocapsaicin *N-[(4-hydroxy-3-methoxyphenyl) methyl]*. Both *8-methylnonan-amide* and *8-methylnonan-amide* account for 90% of the total pungency of pepper fruits. In comparison to minor capsaicinoids, these two chemicals are more strong in terms of intense taste and hypersensitive nerves*: nordihydrocapsaicin (E)-N-[(4-hydroxy-3-methoxy-phenyl) methyl] -7-methyloctanamide, homo dihydro capsaicin, and homo capsaicin(E)-N- [(4-hydroxy-3-methoxy phenyl) methyl] homo capsaicin(E)-N- [(4-hydroxy-3-methoxy phenyl) methyl] homo capsaicin(E)-N- [(4-hydroxy-3-methoxy phenyl -9-methyldec-6-enamide* [1,2]. Capsaicin is well-known for being absorbed through the skin. Capsaicin topical creams are used to treat pain in the peripheral nervous system in disorders including rheumatoid arthritis, diabetic neuropathy (0.075 percent cream 3-4 times daily for eight weeks), osteoarthritis (0.025 percent cream four times daily), muscle pain, shingles, and more [3,4]. Capsaicin works by binding to the transient receptor potential vanilloid 1 (TRPV1), also known as the vanilloid receptor, which is found mostly in sensory neurons. This receptor is a ligand-operated, non-selective cationic channel found largely in nociceptive neurons' short fibers [5]. Capsaicin works by binding to TRPV1, also known as the vanilloid receptor, which is mostly expressed in sensory neurons. This receptor is a non-selective, ligand-operated cationic channel found mostly in nociceptive neurons' small fibers [5]. When capsaicin binds to TRPV1, it causes an increase in intracellular calcium, which causes neuropeptides such substance P and calcium gene-related peptide to be released (CGRP). Capsaicin binds to sensory neurons, causing pain, inflammation, and a localized heat sensation [6].

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Capsaicinoids are made by combining an aromatic moiety with an unsaturated acyl chain in a condensation process (C9-C11 branched fatty acid). Capsaicin is acilyted degraded phenilpropane from a biogenetic standpoint, with the aromatic ring and acyl radicals produced by specific metabolic processes found only in the placenta of hot pepper fruit. So far, 17 isomers have been identified in the literature, with changes primarily in their acyl-group. The length of the alkyl chain (C8-C13), the way it ends, and the presence or absence of a -3 or -4 carbon atom could all be factors. Capsaicin is the major ingredient in this category.

Capsaicin, together with dihydrocapsaicin, is the most important component for pepper pungency, accounting for 69-72 percent of the capsaicinoids concentration. Because capsaicin and dihydrocapsaicin concentration can be modified by various factors such as the fruit's developmental stage and environmental growing conditions, the degree of pungency varies by Capsicum species and cultivars. The Scoville test, which was first devised in 1912 by Wilbur Scoville and was an organoleptic test, was the first test developed to quantify pungency. However, spectroscopic and chromatographic procedures, which are more trustworthy and accurate, have essentially supplanted this test nowadays. Pepper pungency is measured in Scoville heat units [7,8]. In 1997, the variety of applications, Supercritical Fluid Technology makes use of the unique physico-chemical features of solvents. Chemical engineers, chemists, food scientists, materials scientists, agronomists, and researchers in biotechnology and environmental control use supercritical fluid (SF) technology, which has become an interdisciplinary field. The relevance of SF applications has shifted in the last 10 years, from commodity chemicals and synthetic fuels to more complicated, highly specialized, and valuable molecules. Significant efforts have also been made to get a better understanding of the phase behavior and transport features of SFs at a fundamental level. Although key fundamental principles had already been established for more than 80 years, development of the technology of separating compounds using SFs began in the early 1960s. The critical point of every pure component is defined as a specific temperature and pressure. The material exists solely as a gas above this temperature and pressure. It can exist as both a liquid and a vapor below the critical point. The critical point for water is 375°C and 3226 psia pressure. Because SFs have the density and diffusivity of a liquid and the viscosity of a gas, they are an appealing solvent for extraction techniques. Changing the temperature and pressure (or density) of the fluid can easily change the solvating strength and transport capabilities of an SF. SFs can diffuse and penetrate fast into the sample matrix from which the product of interest is to be isolated, depending on the conditions and the application of interest [9]. A simple solid phase micro extraction–gas chromatography–mass spectrometry method for analyzing capsaicin and dihydrocapsaicin in peppers and pepper sauces has been devised. To avoid fiber breakage, a unique technology for direct extraction solid phase micro extraction was developed. The gas chromatography–mass spectrometry analysis was carried out without derivatization. The fiber selection, extraction temperature, extraction time, and pH were all tweaked to perfection. For both capsaicinoids, the technique was linear in the range 0.109–1.323 g/mL for capsaicin and 0.107–1.713 g/mL for dihydrocapsaicin, with correlation coefficients up to r = 0.9970. The method's precision was less than ten percent. The approach was used to examine 11 different pepper varietals as well as four different pepper sauces. The pepper and pepper sauce samples (4.3–717.3 and 1.0–134.8 g/g, respectively) contained a wide range of capsaicin (55.0–25 459 g/g) and dihydrocapsaicin (93–1 130 g/g) [10]. This research aims to extract capsaicin for different solid to solvent ratios, effect of temperature, and mixing on the extraction of capsaicin from black and white pepper.

2. Materials and Experimental Procedure

2.1 Materials

Black pepper is collected from the pepper plant's unripe, still-green drupes. To clean and prepare the drupes for drying, they are briefly boiled in hot water. The pepper fruit's darker-colored skin has been removed, leaving only the seed of the pepper plant. The pepper's cell walls are ruptured by the heat, which speeds up the operation of browning enzymes during drying. The pepper around the seed shrinks and darkens into a thin, wrinkled black covering when the drupes dry in the sun or by machine for many days. White Pepper spirit and oil can be produced from the berries after the peppercorns have been dried. Many medical and cosmetic items contain pepper spirit. Pepper oil is also utilized as an ayurvedic massage oil, as well as in a variety of aesthetic and herbal therapies. The darker-colored skin of the pepper fruit has been removed, leaving only the seed of the pepper plant. This is commonly performed through retting, which involves soaking completely ripe red pepper berries in water for about a week, during which time the flesh softens and decomposes. The remaining fruit is then rubbed away, and the bare seed is dried. Alternative ways for detaching the outer covering of the pepper from the seed have been employed in the past, including mechanical, chemical, and biological procedures [11].

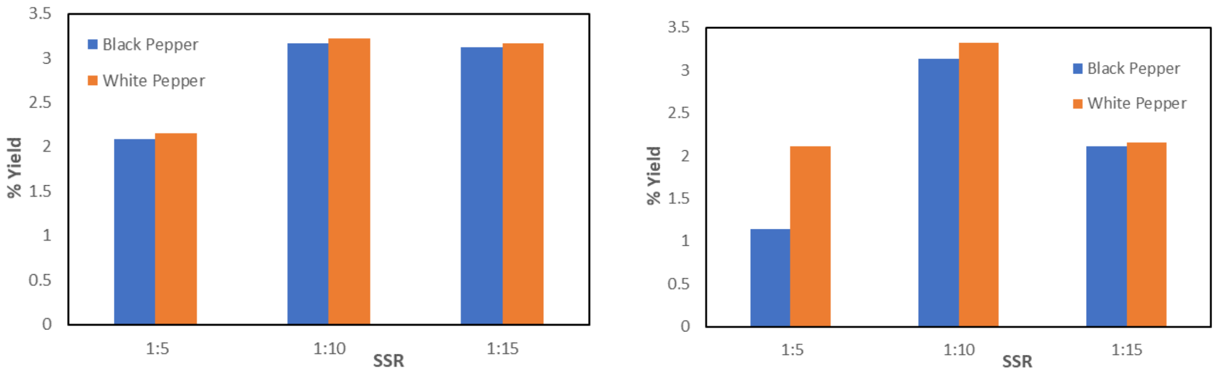
2.2 Experimental Procedure

Black and white pepper are washed with distilled water. Weigh 1g of black and white pepper powder and put in the conical flask. 5, 10 and 15 ml of solvents (Acetone and Ethanol) were added with 1 g of white pepper (1:5, 1:10, 1:15) with Solid Solvent Ratio (SSR). The samples with different SSR were kept n water bath at 60ºC and 70ºC for Ethanol and 50ºC and 55ºC for Acetone in 2 hours. After 2 hours, the sample was filtered to separate the solids from solvents, and load the sample on the hot plate, hence all solvents will be vaporized, then add 20ml of water to the samples, Filter the samples to separate the water from solid, Heat filter paper in oven at 60 ºC and the yield of capsaicin extracted from the pepper can be measured [11].

3. Results and Discussion

3.1 Effect of Temperature on SSR (Acetone) on Capsaicin Yield

The % yield of capsaicin was calculated for different solid to solvent (acetone) ratios of 1:5, 1:10 and 1:15 at the temperature of 50ºC and 55ºC for the time period of 2 hours was measured for black and white pepper. It was observed that the highest % yield was obtained for black and white pepper for the SSR of 1:10 [8]. Though increase in temperature increases the capsaicin yield. The % yield of capsaicin in white pepper was comparatively better than when compared to black pepper at 50ºC and 55ºC as shown in Fig. 1.

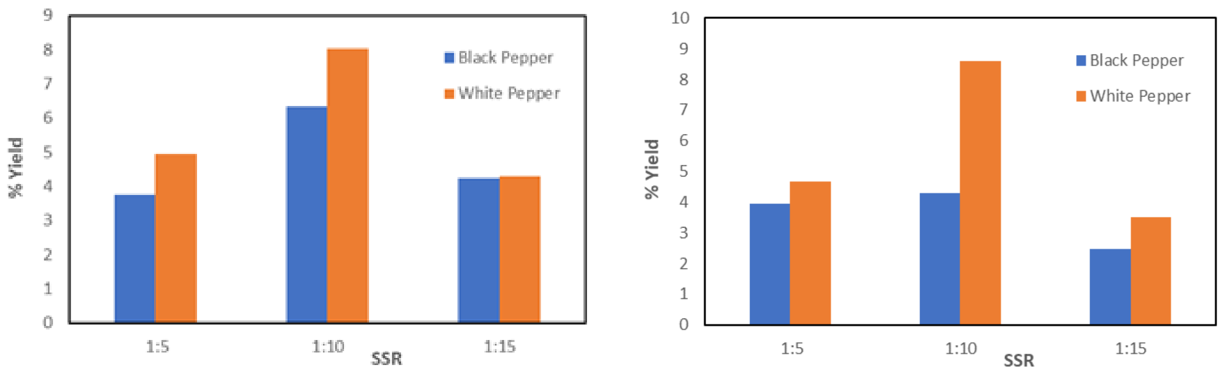


(a) (b)

Fig. 1 - Effect of temperature on % yield of black and white pepper with SSR (acetone) of 1:10; (a) 50ºC; (b) 55ºC

3.2 Effect of Temperature on SSR (Ethanol) on Capsaicin Yield

The % yield of capsaicin was calculated for different solid to solvent (ethanol) ratios of 1:5, 1:10 and 1:15 at the temperature of 60ºC and 70ºC for the time period of 2 hours was measured for black and white pepper. It was observed that the highest % yield was obtained for black and white pepper for the SSR of 1:10. Though increase in temperature increases the capsaicin yield [8]. The % yield of capsaicin in white pepper was comparatively better than when compared to black pepper at 60ºC and 70ºC as shown in Fig. 2.

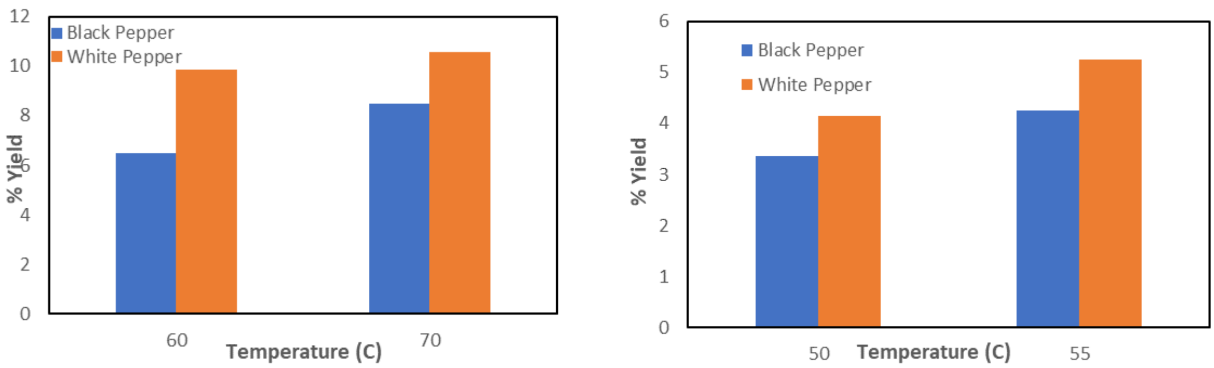


(a) (b)

Fig. 2 - Effect of temperature on % yield of black and white pepper with SSR (ethanol) of 1:10; (a) 60ºC; (b) 70ºC

3.3 Effect of Mixing on SSR (Acetone and Ethanol) on Capsaicin Yield

The effect of mixing on the % yield of capsaicin was calculated for solid to solvent (acetone and ethanol) ratio of 1:10 for the temperature of 50ºC and 55ºC for the time period of one hour was measured for black and white pepper and for ethanol at the temperature of 60ºC and 70ºC. It was observed that the highest % yield was obtained for black and white pepper for the SSR of 1:10. The yield of capsaicin was increased due to mixing of solution and the time period for the extraction of capsaicin decreases due to proper mixing [11]. The % yield of capsaicin in white pepper was comparatively better than when compared to black pepper at 60ºC and 70ºC as shown in Fig. 3.



(a) (b)

Fig. 3 - Effect of mixing on % yield of black and white pepper of 1:10 with SSR; (a) acetone; (b) ethanol

4. Conclusion

Capsaicin was successfully extracted from black and white pepper using solvents such as acetone and ethanol. Capsaicin was primarily extracted by using the solvents acetone and ethanol phases with various SSR, temperature and mixing on percentage yield. They were easily retrieved once the solvent was removed to allow for further extraction. It's a good approach for extracting and separating natural active compounds in plants that have distinct polarity.

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