ACS FOOD SCIENCE & TECHNOLOGY

pubs.acs.org/acsfoodscitech

Article

Environment-Friendly Approach to Isolate Ascorbic Acid from Plants and Micro-identified Using Fourier Transform Infrared Spectroscopy

Muhammad Abdurrahman Munir,* Jamia Azdina Jamal,* and Ahlam Inayatullah

Cite This: *ACS Food Sci. Technol.* 2024, 4, 501−506

Read Online

ACCESS | Metrics & More | Article Recommendations

ABSTRACT: Vitamin C [ascorbic acid (AA)] is an imperative antioxidant that humans require. Fruits and vegetables commonly contain AA. The application of titrimetric or chromatographic methods is generally performed to analyze AA; nevertheless, these approaches have several disadvantages such as being very costly for chromatographic methods and exhibiting food color interference upon using titration techniques. This study cruises the application of microwave treatment on AA compounds of plant samples and identified the AA level using Fourier transform infrared (FTIR) spectroscopy. The purposes of this study were to establish a validated method for the microwave-assisted isolation (MAI) of AA from plant samples. Validation studies such as linearity, selectivity, sensitivity, detection, and quantitation limits were evaluated using a standard AA solution. These methods were also applied for AA quantitation in oranges, guava, and spinach. The methods were selective and sensitive when applied to the standard solution. The FTIR spectroscopy approach was more sensitive, with lower values for detection limit (13.76 nmol·L^{-1}) and quantitation limit (41.69 nmol·L^{-1}), and more accurate with an error of less than 1%. The imperative AA groups are also identified, such as the hydroxyl groups found at 3297 nm^{-1}. In contrast, the aromatic group of AA can be obtained at 2084 cm^{-1}, although the absorption intensity is weak. The 1635 cm^{-1} atom is related to the carbonyl group (−C═O). The validated method was applied to investigate the AA level in plant samples, and all of them showed identical peaks with the standard, showing that the MAI has isolated the AA completely.

KEYWORDS: *ascorbic acid, foods, microwave isolation, spectrophotometry, validation*

INTRODUCTION

Vitamin C [ascorbic acid (AA)] is a crucial component required for the human diet that can be found easily in fruits and vegetables. AA plays a significant role in several body functions, such as involvement in redox reactions and helping in the reactions of crucial enzymes. Several studies reported that consuming 10 mg·day^{-1} for adults can forestall scurvy. Furthermore, an intake of AA of more than 10 mg·day^{-1} is needed to replenish the body's supplies and optimize functionality.[1] AA is involved in collagen, carnitine, and norepinephrine production in gene transcription and histone production.[2] It has also been associated with several pharmacological applications, such as relieving the common cold[3] and showing an inverse relationship with cardiovascular mortality.[4] Moreover, the application of AA has been studied during chemotherapy, which can escalate the survival rate and life span in humans who have ovarian cancer.[5] Lastly, AA is also imperative for neuronal repair and can be used to treat Alzheimer's disease.[6]

Generally, most animals and plants can produce AA by themselves. However, humans are the opposite owing to a hereditary mutation in the enzyme gluconolactone oxidase, which catalyzes the final step in AA production.[7] Furthermore, the situation causes AA to be required to be consumed from foods such as vegetables and fruits, acting as primary sources.[8] Consequently, to consume AA reasonably, it is crucial to establish fast, sensitive, selective, reliable, and efficient approaches for the isolation and quantitation of AA in different matrices.[9]

Recently, a study of AA has attracted many researchers. The number of reports related to AA has increased significantly, showing that this issue is becoming more and more famous. The general isolation methods include ultrasonic-assisted extraction, liquid−liquid extraction, solid-phase extraction, microwave-assisted isolation (MAI), and so on,[10] while the analytical approaches such as electrophoresis, titration, chromatography, and spectrophotometry are commonly applied.[11−13] The oxidation−reduction titration technique has become a famous technique applied to verify the AA presence in samples where the AA compound converts to dehydroascorbic acid due to the oxidation process. In contrast, adding indophenol will degrade the color of the solution during the titration process. Furthermore, the outcome of the titration can be obtained when an excess of the unreduced dye provides a rose-pink color in an acid solution.[14] A number of approaches have been performed to detect AA levels, including spectrofluorimetry, UV spectroscopy, and electrophoresis.

Received: November 6, 2023
Revised: January 4, 2024
Accepted: January 4, 2024
Published: January 22, 2024