High Recovery of Biologically Active Compounds from Red Ginseng Marc using Subcritical Water

R. Cao[a], A.A. Myint[a,b], J. Kim[a,b,c*]

[a]*School of Mechanical Engineering, Sungkyunkwan University, Suwon, 16419, Republic of Korea*

[b]*School of Chemical Engineering, Sungkyunkwan University, Suwon, 16419, Republic of Korea*

[c]*Sungkyunkwan Advanced Institute of Nano Technology, Sungkyunkwan University, Suwon, 16419, Republic of Korea*

[*]*Corresponding authors: jaehoonkim@skku.edu (Jaehoon Kim), mashweaye@skku.edu (Aye Aye Myint)*

1. Introduction

Red ginseng marc (RGM), a byproduct obtained during manufacturing various ginseng products, which is typically discarded as waste, contains numerous residual bioactive compounds. To date, several studies have been conducted to recover various valuable components from RGM using traditional extraction methods[1,2]. However, the traditional methods have been unsatisfactory owing to high energy consumption, long extraction times, and low extraction yields of bioactive compounds. To overcome these drawbacks, subcritical water extraction (SWE), a highly efficient and environment friendly technique, was used in this study. The primary goals of this study were to identify the efficiency of the SWE method for the extraction of biologically active compounds from RGM powder and to gain insight into the extraction mechanism. SWE was performed in the temperature range of 140–200 °C for an extraction time in the range of 15–90 min. The extraction yields, total carbohydrates contents (TCCs), total phenolic contents (TPCs), and browning intensities of the extracts, and the types and contents of ginsenosides in the extracts obtained under various extraction conditions were analyzed. Moreover, the extraction yields, chemical species, and antioxidant activities of the subH_2O extracts were compared with those of the extracts obtained using the conventional Soxhlet method with water and 80% ethanol.

2. Materials and Methods

For a typical experiment, 1.0 g of RGM powder and 20 mL of DI water were loaded into the reactor with stirring. The reactor was purged with N_2 gas, followed by pressurization with N_2 gas to an experimentally desired pressure of 10 MPa. Upon the reactor was heated to reach the target temperatures, extraction was performed for the predetermined time. After extraction, cooled reaction mixture was filtered using a vacuum pump. For comparison, conventional Soxhlet extractions were performed using DI water and 80 vol% ethanol for 8 h. Subsequently freeze-drying was used to collect the dried extract powders.

Characteristics including extraction yields, TCCs, TPCs, browning intensities, and antioxidant activities of the RGM extracts were analyzed. In addition, the molecular weight and chemical compositions including sugars, organic acids, degradation compounds and ginsenosides of the extracts and raw RGM were quantitatively evaluated. The relationships between the TPCs, TCCs, browning intensities, and ginsenoside contents and the antioxidant capacities of the extracts were investigated statistically.

3. Results and discussion

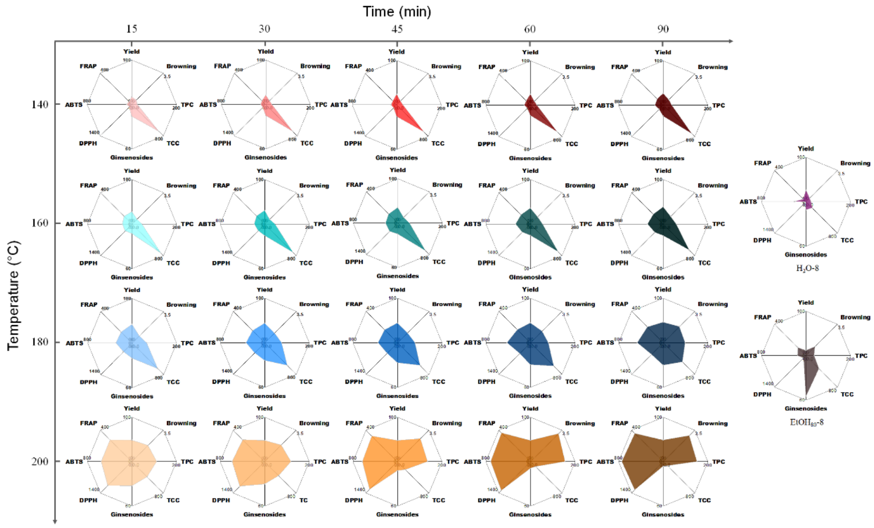

Fig. 1. Radar graphs of the extraction yields, browning (UV360), total phenolic contents (TPCs), total carbohydrate contents (TCCs), and ginsenoside contents in the subcritical water and Soxhlet extracts. The antioxidant activities of the extracts measured using the DPPH, ABTS, and FRAP methods are also illustrated.

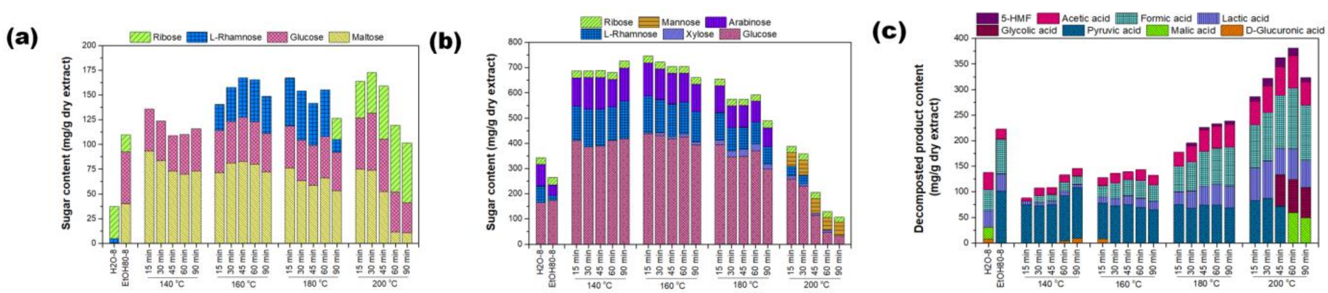

Fig. 2. Contents of sugars of the red ginseng marc (RGM) extracts (a) before and (b) after acid hydrolysis. (c) Contents of organic acids and 5-HMF of the RGM extracts. The chemical compositions were determined using high-performance liquid chromatography.

4. Conclusions

In summary, we demonstrated that SWE is a promising method for recovering highly bioactive compounds from RGM. The extraction efficiencies and antioxidant activities of the extracts significantly depended on the SWE temperature and time. The optimal temperature and time for the SWE of RGM were 200 °C and 15 min, respectively, and the corresponding bioactive compound recoveries and antioxidant activities were the highest at the short extraction time. The strong antioxidant activities of the subH_2O extracts were attributed to their high TPCs and abundant Maillard reaction products. Therefore, the high yields and strong antioxidant activities of the subH_2O extracts render SWE a promising alternative to the conventional Soxhlet extraction. Moreover, we believe that subH_2O extracts can be used in various sectors, including the functional food and cosmeceutical and pharmaceutical industries. The environmentally benignity, nontoxicity, and ability to extract high antioxidant active species associated with SWE make it highly promising for recovering value-added compounds from RGM.

References

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