Correlation of hydro-thermal processing with rutin content in tartary buckwheat flour

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ABSTRACT

Tartary buckwheat flour was subjected to several hydro-thermal processing including steaming, autoclaving, and boiling. The contents of rutin in the resulting buckwheat samples were analyzed by HPLC and the correlations between rutin content and hydro-thermal treatments were investigated. When raw buckwheat flour was mixed with distilled water, there was a dramatic reduction of rutin content while a high amount of quercetin was detected. Even, mixing with water for 1 h gave rise to a decrease in rutin content up to 88.6% while the content of quercetin increased up to 98.3%. It would be probably because water addition made rutin susceptible to the attack of rutin-degrading enzymes in buckwheat flour. However, after buckwheat flour was hydro-thermally treated with steaming, autoclaving, and boiling, the loss of rutin in buckwheat flour by water addition was dramatically reduced and quercetin was hardly detected. Specially, it appeared that steaming and boiling were effective in preventing rutin loss in buckwheat flour. Even though the beneficial health effects of rutin in buckwheat have been widely recognized, the effects of food processing parameters on rutin loss have been disregarded. Thus, this study can aid in maximizing the beneficial health effects derived from rutin even when incorporated into food formulations, providing more potentials for developing various buckwheat-based functional foods.

Keywords: buckwheat; hydro-thermal processing; rutin; quercetin

INTRODUCTION

Recently, buckwheat (*Fagopyrum spp*) that belongs to the family Polygonaceae has been receiving great attentions as an alternative crop due to its nutritional superiority to cereals. Moreover, it is widely recognized that buckwheat has beneficial health effects derived from its phenolic compounds. Especially, rutin that is the primary phenolic compound of buckwheat, is shown to reduce the risk of arteriosclerosis [1] and high blood pressure [2], antagonize the increase of capillary fragility associated with hemorrhagic disease [3], prevent diabetes [4] and cardiovascular disease [5], and show antioxidant activity [6; 7]. Out of 20 species of buckwheat, tartary buckwheat (F. *tataricum*) is known to contain a high amount of rutin, even several times higher than common buckwheat [8].

It is however interesting to note that the reduction of rutin content is generally observed when buckwheat seeds are ground into flour. Also, water addition to buckwheat flour can cause rutin to be easily degraded into quercetin with bitter taste by rutin-degrading enzymes (RDEs) [9]. Therefore, the reduced amount of rutin as well as bitter taste may play a negative role in consumer preferences, consequently discouraging the food industry to develop a variety of buckwheat-based foods. Thus, the goals of this study were to apply several hydro-thermal processing (steaming, autoclaving, and boiling) into buckwheat flour and to establish the experimental procedures to minimize the rutin loss during buckwheat processing.

MATERIALS & METHODS

Materials

Tartary buckwheat *(F. tataricum)* was purchased from Bongpyeong Memil Farm (Bongpyeong, Gangwondo, Korea) and ground by using a laboratory blender (DA338-G, Dae Sung Artlon Co., Ltd. Seoul, Korea). Rutin and quercetin standards were purchased from Sigma Aldrich (St Louis, Mo, U.S.A.) and other chemicals were of analytical grade.

Hydro-thermal treatments of buckwheat flour

Buckwheat flour (40 g) was subjected to three different hydro-thermal treatments – steaming, autoclaving, and boiling. For steaming, buckwheat flour was placed on a plate in a steam cooker with a lid, steamed over

boiling water for 10 min, and then aerated overnight at 25℃. In case of autoclaving, buckwheat flour was placed into an autoclave (HA-240MII, Hirayama Manufacturing Co., Tokyo, Japan) and autoclaved for 10 min at 120℃, followed by aeration at 25℃ overnight. Also, buckwheat flour was immersed in boiling water for 10 min and the boiled sample was freeze-dried.

Analysis of rutin and quercetin contents in buckwheat flour

Raw and hydro-thermally treated buckwheat (6 g) samples were mixed with distilled water (4 ml) for 0, 2, 5, 10, 30, 60 min and freeze-dried. Then, the contents of rutin and quercetin in the buckwheat samples were analyzed [10] as a function of mixing times with distilled water. Buckwheat flour (1 g) was treated with 20 ml of methanol at 80℃, followed by cooling overnight at 4℃. After the extracts were filtered through Whatman filter paper (No. 41) and 0.45 ㎛ filter paper, the amounts of rutin and quercetin were quantitatively measured by using Agilent 1200 series HPLC (Santa Clara, CA, U.S.A.) with a UV detector and Capcell Pak C18 column (UG120 S-5, Shiseido Co., Ltd., Tokyo, JAPAN). The mobile phase for HPLC consisted of methanol/ acetic acid (95: 5, v/v) (solvent A) and water (solvent B). A linear gradient of the solvent A was applied from 10% to 60% for 40 min, followed by an increase to 100% in 5 min. The flow rate was 0.5 ml/min, the column temperature was set at 30℃, and the components were detected at 350 nm.

RESULTS & DISCUSSION

The contents of rutin and quercetin in steamed buckwheat flour were measured and compared with those of raw buckwheat flour. As shown in Fig.1, 46.06 mg/g of rutin was contained in raw buckwheat flour while the rutin content dramatically decreased when the buckwheat flour was mixed with distilled water. Even, after mixing with distilled water for 60 min, only 5.24 mg/g of the rutin remained, showing a 88.6% decrease in the rutin content. On the other hand, the quercetin content significantly increased from 0.52 mg/g to 31.2 mg/g. Therefore, it seemed that mixing with water caused rutin-degrading enzymes in buckwheat flour to easily be accessible to rutin, which consequently was degraded into quercetin These results are in a good agreement with those reported by Suzuki *et al* [8]. However, as also can be seen in Fig. 1, the rutin loss by the addition of water was not observed in the steamed buckwheat flour and also quercetin was hardly detected.

The contents of rutin and quercetin in autoclaved buckwheat flour are presented in Fig. 2. The autoclaved buckwheat samples contained 45.27 mg/g of rutin and 0.7 mg/g of quercetin which were similar to those of the control before mixing with water. It thus seemed that autoclaving caused rutin in buckwheat flour to remain constant even though mixed with water.

Fig.3 shows the amounts of rutin and quercetin in boiled buckwheat flour. Boiling treatment also resulted in the similar pattern of rutin content in buckwheat flour to the steaming and autoclaving treatments. However, the content of quercetin in boiled buckwheat flour (2.48 mg/g) was 3 to 4 fold higher than that of two other hydro-thermally treated samples, which was however not varied over mixing times. The results indicate that the rutin-degrading enzyme became deactivated by hydro-thermal treatments, consequently preventing the rutin loss in buckwheat flour by the addition of water.

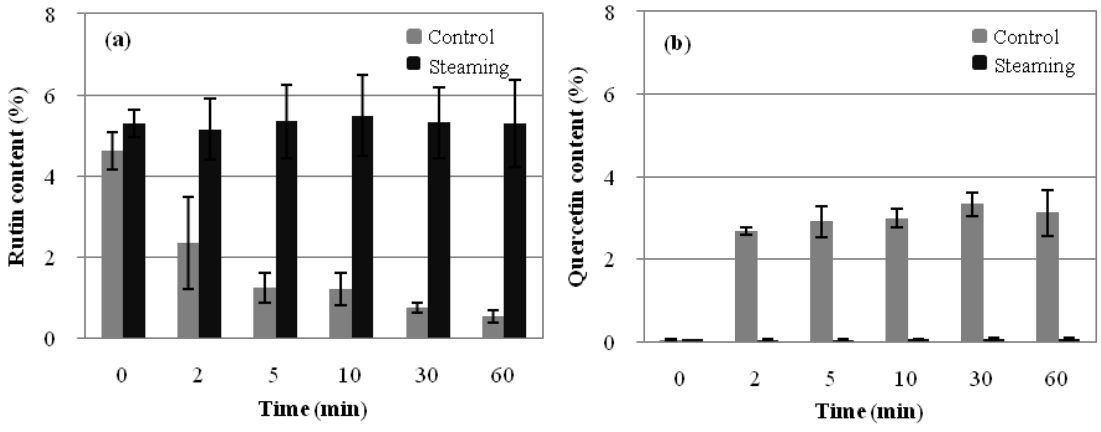

Figure 1. Effect of mixing time with water on the rutin (a) and quercetin (b) contents of raw and steamed buckwheat flours

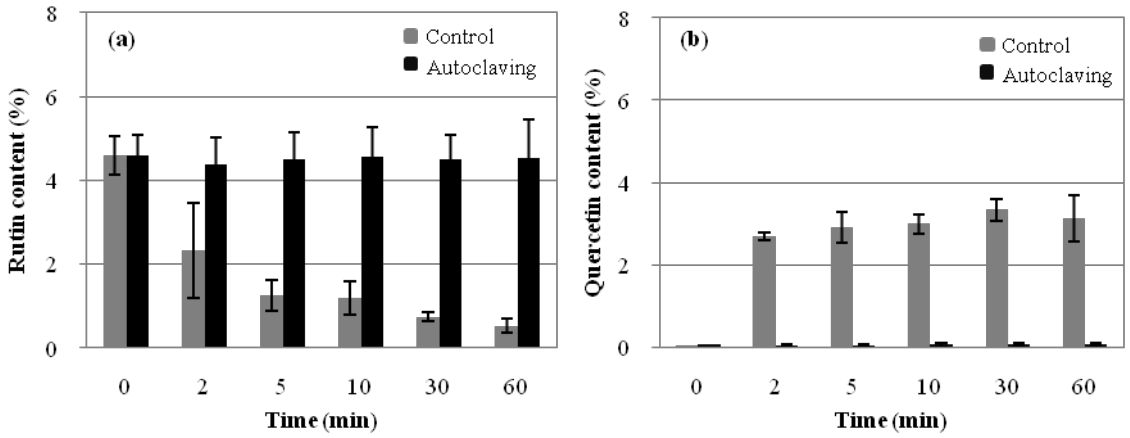

Figure 2. Effect of mixing time with water on the rutin (a) and quercetin (b) contents of raw and autoclaved buckwheat flours

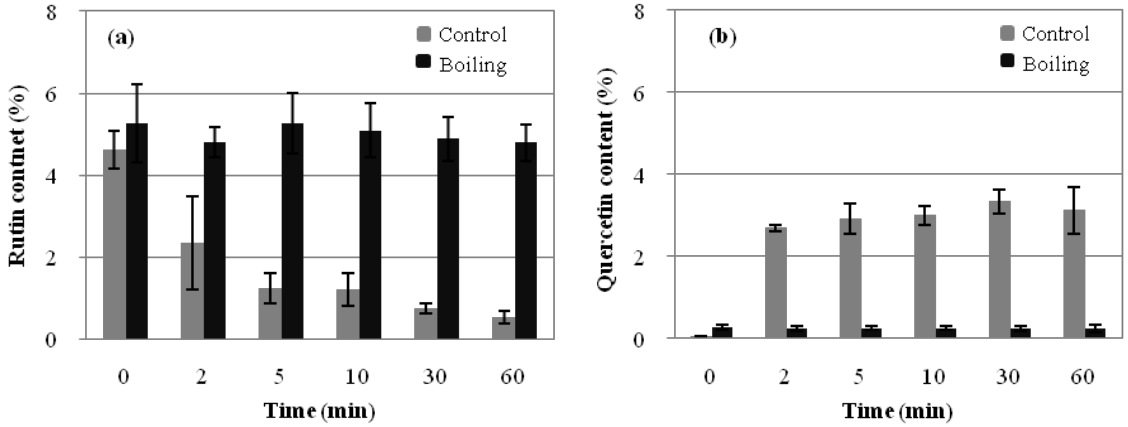

Figure 3. Effect of mixing time with water on the rutin (a) and quercetin (b) contents of raw and boiled buckwheat flours

CONCLUSION

In this study, tartary buckwheat flour was subjected to three different hydro-thermal processing (steaming, autoclaving, and boiling) in order to prevent rutin loss by rutin-degrading enzymes. The addition of water to raw buckwheat flour led to a dramatic decrease in rutin content and increase in quercetin content probably since it made rutin susceptible to the attack of rutin-degrading enzymes. However, the rutin contents in buckwheat flour after hydro-thermal treatments such as steaming, autoclaving and boiling were not changed by water addition, which also did not produce quercetin. Therefore, the use of hydro-thermally treated buckwheat flour can provide more health benefits derived from a high amount of rutin, probably encouraging the food industry to develop various buckwheat-based food products.

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