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Reduction of Anti-nutritional Compounds and Free Fatty Acids of Barley, Oats and Rice Bran Treated by Microwaves

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Abstract

At present, cereal bran is offered in our country without any processing to remove anti-nutritional compounds which can have adverse effects on consumers health. In this study, the effects of different conditions (power and time) of microwave treatment on the moisture content, anti-nutritional compounds (phytic acid and oxalic acid) and shelf life of barley, oat, and rice bran were evaluated. The samples were treated with microwave power of 2, 4, 6, 8 and 10 kW for 15, 30, 60, 90 and 120 s. The most optimum treatment to reduce moisture for barley, oat, and Iranian rice bran was 8 kW for 120 s. During the treatment at 8 and 10 kW microwave power for 120 s, around 50% loss in phytate and oxalate content was observed. There was no statistically significant difference between the results obtained for 8 and 10 kW radiation power. Therefore, treatment at 8 kW for 120 s to reduce phytate and oxalate in brans was identified as the optimal treatment. During the 28-day storage period under accelerated conditions, no statistically significant difference was observed between the moisture content and the percentage of free fatty acids in the treated samples with power of 8 and 10 kW. The results of the present study showed that treatment with 8 kW microwave power for 120 s for barley and rice brans and 10 kW for oat bran significantly reduced the amount of moisture, anti-nutritional factors of phytic acid and oxalic acid in all three bran samples and also reduced the amount of moisture, reduced lipase activity and production of free fatty acid during the 28-day accelerated storage period.

Keywords: Bran, Cereal, Microwave, Stability, Storage

Introduction

Today, it is scientifically demonstrated that cereal grains such as wheat, rice, barley, and oat, particularly their germ and bran, are rich sources of bioactive compounds, functional components, micronutrients, and dietary fibers that help improving well-being and health, reducing the risk of cardiovascular diseases and cancers, prevent inflammation, aging, obesity, and diabetes (Reynolds *et al.*, 2019; Xu *et al.*, 2019). At present, cereal bran is offered in our country without any processing to remove anti-nutritional compounds which can have adverse effects on consumers health (Bagdi *et al.*, 2016). The objective of this study was to evaluate the effects of different conditions (power and time) of microwave treatment on the moisture content, anti-nutritional compounds (phytic acid and oxalic acid) and shelf life of barley, oat, and rice bran.

Materials and methods

Barley, oats, and rice grains were cleaned, brushed, and milled using a laboratory mill to obtain white flour, fine bran particles and coarse bran particles. Then, these three components were separated into coarse bran particles, fine bran particles and white flour using a set of sieves with different meshes. Coarse bran particles were used for microwave treatment and experiments. The samples were treated with microwave power of 2, 4, 6, 8 and 10 kW for 15, 30, 60, 90 and 120 seconds (Liu *et al.*, 2021; Patil *et al.*, 2016).

Results and discussion

Treatments of 8 and 10 kW for 120 s reduce the moisture content of bran samples to 2-3%, which is lower than the moisture required for microbial growth and enzymatic activity. The most optimum treatment to reduce moisture for barley, oat, and Iranian rice bran was 8 kW for 120 s. Microwave heat treatment significantly reduced the phytic acid content of all three bran samples (P<0.05). Phytic acid in oat bran at 10 kW for 120 s was reduced by about 50%. The highest reduction in phytic acid was observed in the samples after 240 s of treatment at 10 kW, which decreased from 901.5 to 324 mg/100 g and indicated a reduction of about 64% in the amount of phytic acid. There was no significant difference between the amount of phytic acid in the sample of oat bran (about 62% reduction compared to the initial amount of phytic acid) upon the treatment with microwave power of 8 and 10 kW at 180 and 240 s (P<0.05). Considering that the treatment at 10 kW for 120 s reduced the phytic acid content more than 50%, so it can be introduced as the optimal treatment to reduce the amount of phytic acid in oat bran. In barley bran samples, the highest loss in phytic acid occurred during the treatment at 10 kW after 240 s (P<0.05), which reduced by 27.3%. Significant decrease in phytic acid content of rice bran samples at 8 and 10 kW was observed during 120, 180 and 240 s of irradiation (P<0.05). There was no statistically significant difference between the results obtained for 8 and 10 kW radiation power (P<0.05). Therefore, treatment at 8 kW for 120 s to reduce phytate in rice bran was identified as the optimal treatment. Our results are in accordance with the data reported by Patil *et al.* (2016) and Rose *et al.* (2008).

The content of oxalic acid in oat bran decreased about 56% during the 10 kW treatment for 120 s, and the continuation of the treatment at the same power for 240 s reduced the oxalic acid content by 70%. However, it should be noted that there was no statistically significant difference between the results of treatments of 8 kW for 240 s, 10 kW for 120 s, 10 kW for 180 s and 10 kW for 240 s (P<0.05). Therefore, the treatment at 10 kW for 120 s can be introduced as the optimal treatment to reduce the amount of oxalic acid in oat bran. In barley bran samples, the greatest decrease in oxalic acid content occurred during the treatment at 10 kW after 240 s, which was reduced by 32%. There was a significant decrease in the oxalic acid content of rice bran samples at 8 and 10 kW during 120, 180 and 240 s of exposure to microwaves (P<0.05). There was no statistically significant difference between the obtained data for 8 and 10 kW radiation power (P<0.05). Therefore, the treatment at 8 kW for 120 s to reduce oxalate in rice bran is introduced as the optimal treatment. The same results were announced by Liu *et al.* (2021).

During the treatment at 8 and 10 kW microwave power for 120 s, around 50% loss in phytate and oxalate content was observed. There was no statistically significant difference between the results obtained for 8 and 10 kW radiation power. Totally, the treatment at 8 kW for 120 s to reduce phytate and oxalate in brans was identified as the optimal treatment. During the 28-day storage period under accelerated conditions, no statistically significant difference was observed between the moisture content and the percentage of free fatty acids in the treated samples with power of 8 and 10 kW. The data are in agreement with the reports of Liu *et al.* (2021) and Onipe *et al.* (2021).

Conclusions

The results of the present study showed that treatment with 8 kW microwave power for 120 seconds for barley and rice brans and 10 kW for oat bran significantly reduced the amount of moisture, anti-nutritional factors of phytic acid and oxalic acid in all three bran samples and also reduced the amount of moisture, reduced lipase activity and production of free fatty acid during the 28-day accelerated storage period.

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