



RESEARCH ARTICLE

Effectiveness of hydrothermal pretreatment to rice bran before extraction on physico-chemical qualities of rice bran oil

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ABSTRACT

Rice bran oil has great benefits over other edible oils due to its unique antioxidant, oryzanol. There are many techniques employed for the extraction of rice bran oil. This research examined the impact of hydrothermal pretreatment ($^{\circ}\text{C}/\text{min}$) before screw press extraction on physico-chemical quality attributes of rice bran oil such as peroxide value ($\text{meq O}_2/\text{Kg oil}$), acid value ($\text{mg KOH}/\text{g oil}$), free fatty acid (% oleic acid), tocopherol ($\mu\text{g}/\text{g}$), FRAP ferric reducing antioxidant power ($\text{mg FeSO}_4/\text{g}$), DPPH radical scavenging activity (%), γ -oryzanol content (mg/g) and oil extraction yield (%). Our results revealed that rice bran should be heated at 120°C for 8 min before screw press extraction to obtain the best physico-chemical and antioxidant qualities of rice bran oil. By this investigation, the economic value of rice bran would be improved significantly as a valuable input for food and pharmaceutical industry, instead of mono utilization as by-product for feed. Consumers would have better chance to improve their health via a green phytochemical food.

Introduction

Agriculture produce animal and plant as raw materials essential for human consumption and other industries (1). Consumers' attitudes and behaviours in the technology-driven sharing economy provided empirical evidence on motivations for participating in collaborative consumption (2). Rice bran is normally considered as a waste from the rice processing factories. Rice bran oil (RBO) is usually received from the outer layer of the brown rice. RBO has a bright colour, translucent appearance, distinct aroma as well as neutral taste. It is a good source of unsaturated fatty acids and free of trans fats. RBO revealed various benefits compared to other edible oils owing to numerous functional elements like tocopherols, γ -oryzanol and tocotrienols, which are accounted for its oxidative capacity and therapeutic advantages (3-4). The β -sitosterol, campesterol, stigmasterol, squalene and γ -oryzanol were identified as phytosterols in RBO (5). The availability of γ -oryzanol and γ -tocotrienol in RBO decides a preventive mechanism of α -tocopherol in deep-frying (6). The polyunsaturated fatty acids in this oil contributes to higher hyperlipidaemic activities over other edible oils

including linoleic acid and thus decreases the cardiovascular risk (7). RBO alleviates the menopausal ailments, enhances the cognitive ability and prevents allergic reactions (8).

The extraction of vegetable oil is commonly done by the application of mechanical force or by solvent extraction. The continuous prototype outperforms the original batch system to interfere the pressure shock waves. Pilot apparatus can not compete with the commercial scale (9). The application of pressure shock waves, together with the mechanical press, may accelerate oil yields, minimize pressing energy requirements while obtaining the similar oil yield, low oil residue in the seed cake, limited volatile substance, less pollution, and more biogas formation (10). In press utilization, pretreatments are very necessary to alter the cellular texture supporting the oil escape and to enhance the extraction recovery (11-12). In a study it was found that hot pressing affected the concentration of unsaturated fatty acids (13). Objective of our study was to examine the influence of hydrothermal pretreatment (110/12, 115/10, 120/8, 125/6, 130/4 $^{\circ}\text{C}/\text{min}$) before screw press extraction on physico-chemical quality attributes such as peroxide

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value, acid value, free fatty acid, tocopherol, ferric reducing antioxidant power, radical scavenging activity, γ -oryzanol content and oil extraction yield of rice bran oil. It's urgent to examine the hydrothermal pretreatment so that the best physico-chemical and antioxidant qualities of rice bran oil would be achieved and human health would be improved via utilization of valuable substances in rice bran oil.

Materials and Methods

Rice bran was collected from rice milling factories in Soc Trang province, Vietnam. After collecting, it was stored at ambient temperature for experiments. All chemical substances were of analytical grade.

Researching method

Rice bran was treated by dehydration in an air-blast drying machine (power supply: 220V 50Hz; dimension: 54*36*35 cm; origin: Jiangsu, China) at 40 °C to a moisture content around 7.0%. The hydrothermal treatment was conducted at 110/12, 115/10, 120/8, 125/6, 130/4 (°C/min). The pre-treated samples were screw-pressed under a volume of 2.5 kg/hr. The pressed oil was subjected to clarification by centrifugation at 3000 rpm for 5 min. The collected press oil was stored in dark glass bottle and ready for physico-chemical analysis.

Physico-chemical analysis

Yield of extraction = rice bran oil (gm) x 100/ primary weight of rice bran (gm). γ -oryzanol content (mg/g extract) of rice bran oil samples were determined by reversed-phase HPLC (14). DPPH (mg/mL) radical scavenging activity was analyzed by DPPH assay (15). FRAP (mg FeSO₄/gm) procedure was conducted following the standard protocol (16). Tocopherol (μ g/gm oil), free fatty acid or FFA (% Oleic acid), acid value or AV (mg KOH/gm oil), peroxide value or PV (meq O₂/Kg oil) of rice bran oil samples were evaluated by the analyzing standard method (17).

Statistical analysis

All experiments were set in 3 replications. The presented data were shown as mean \pm standard deviation. Statistical analysis was accounted by the Statgraphics (version 16.2.04, 64-bit).

Results and Discussion

The yield of rice bran oil in different hydrothermal pretreatments (110/12, 115/10, 120/8, 125/6, 130/4 °C/min) are shown in Fig. 1. The highest rice bran oil yield (7.30 \pm 0.02 %) was obtained by heating rice bran at 120 °C for 8 min before screw extraction. There was no significant difference in 120/8, 125/6 and 130/4 (°C/min) as hydrothermal pretreatment for rice bran. It's obviously noticed that primary thermal treatment of rice bran prior to screw extraction strongly increased extraction yield. Temperature softened the cells and made the oil current in the sample released freely during screw-press. It was proved that thermal treatment at 60 °C for rice bran prior to screw-press accelerated the recovery from 4.8 to 8.3 % w/w (18). In comparison with results

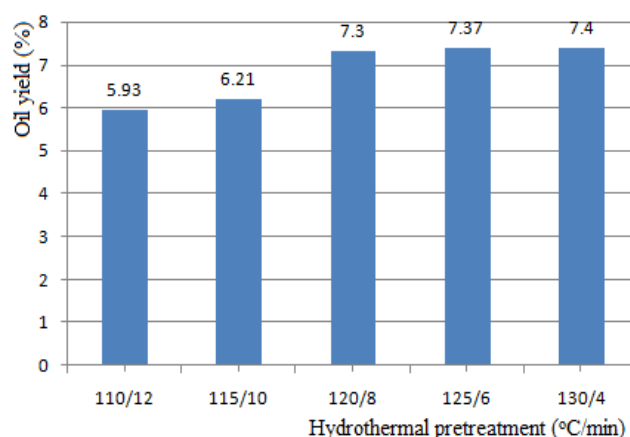


Fig.1. Effect of hydrothermal pretreatment (°C/min) to rice bran oil yield (%).

presented by Khongsak and Maythawinee, we successfully achieved a high rice bran oil yield. Hydrothermal pretreatments were demonstrated to enhance antioxidant capacities of rice bran oil (Fig. 2 and 3). There was significant difference of DPPH (mg/mL) and FRAP (mg FeSO₄/gm) values among hydrothermal pretreatments. The highest DPPH (mg/

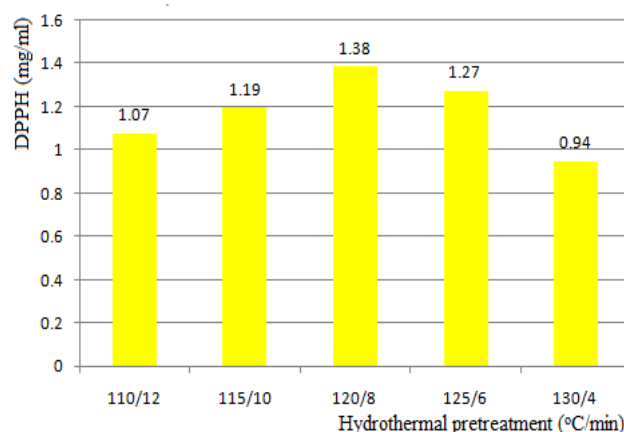


Fig.2. Effect of hydrothermal pretreatment (°C/min) to DPPH (mg/mL) in rice bran oil.

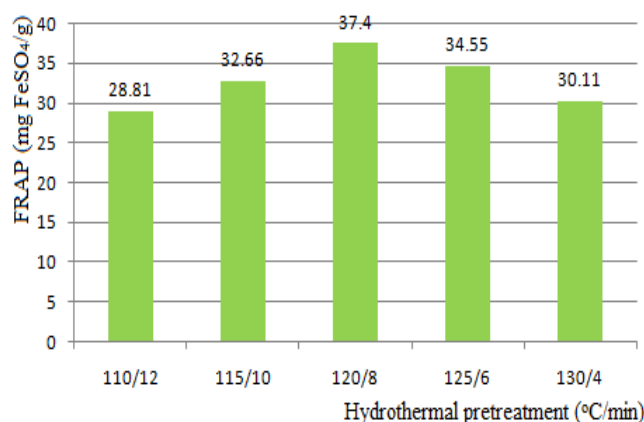


Fig.3. Effect of hydrothermal pretreatment (°C/min) to FRAP (mg FeSO₄/gm) in rice bran oil.

mL) and FRAP (mg FeSO₄/gm) in rice bran oil were obtained at 1.38 \pm 0.01 mg/mL and 37.4 \pm 0.03 mg FeSO₄/

gm respectively by heating rice bran at 120 °C for 8 min before screw extraction. The γ -oryzanol contents (mg/gm) and tocopherol ($\mu\text{g/gm}$) values of rice bran oil by hydrothermal pretreatments were shown (Fig. 4 and 5). There was significant difference among hydrothermal pretreatments. It was obviously noticed that the highest γ -oryzanol (mg/gm) and

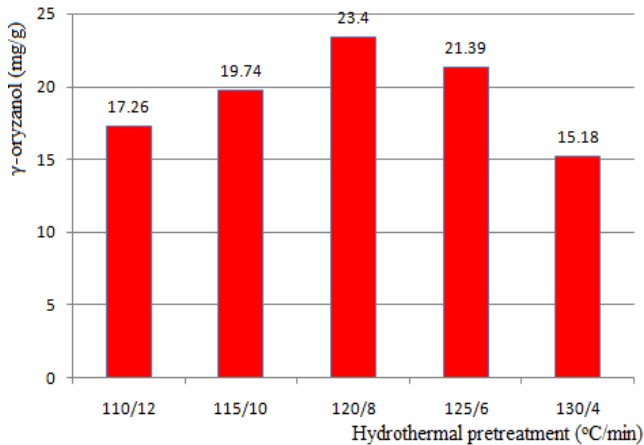


Fig.4. Effect of hydrothermal pretreatment (°C/min) to γ -oryzanol (mg/gm) in rice bran oil.

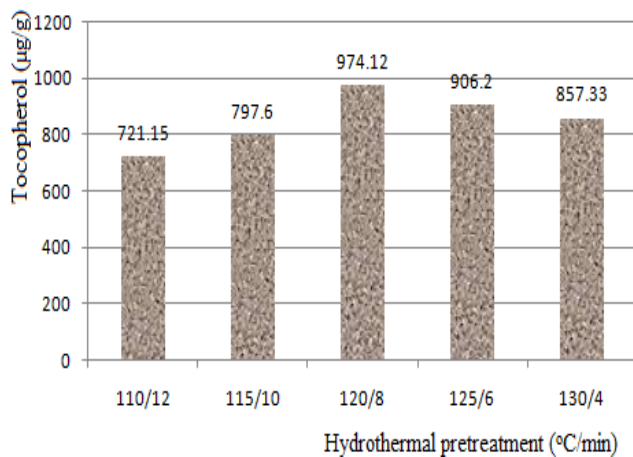


Fig.5. Effect of hydrothermal pretreatment (°C/min) to tocopherol ($\mu\text{g/gm}$) in rice bran oil.

tocopherol ($\mu\text{g/gm}$) in rice bran oil were achieved at 23.4 ± 0.03 mg/gm 974.12 ± 0.01 $\mu\text{g/gm}$ respectively by heating rice bran at 120 °C for 8 min before screw extraction. Gamma-oryzanol, a mixture of triterpene alcohols and plant sterols, was the main composition of rice bran oil (7). Oryzanol was a popular antioxidant help lowering serum and plasma cholesterol, platelet aggregation and cholesterol absorption. It was utilized to cure hyperlipidemia and menopause disorders (19). The free fatty acid and acid value of edible oil was an indicator of hydrolytic rancidity. The lower the values of both FFA and AV the better the quality of the oil and more stable was the oil against hydrolytic rancidity (20). The free fatty acid and acid values of rice bran oil under hydrothermal pretreatments were presented (Fig. 6 and 7). There was minor significant difference among hydrothermal pretreatments. It's obviously noticed that the lowest free fatty acid (% oleic acid) and acid value (mg KOH/gm oil) in rice bran oil were presented at 0.85 ± 0.00 % and 1.65 ± 0.02 mg KOH/g oil

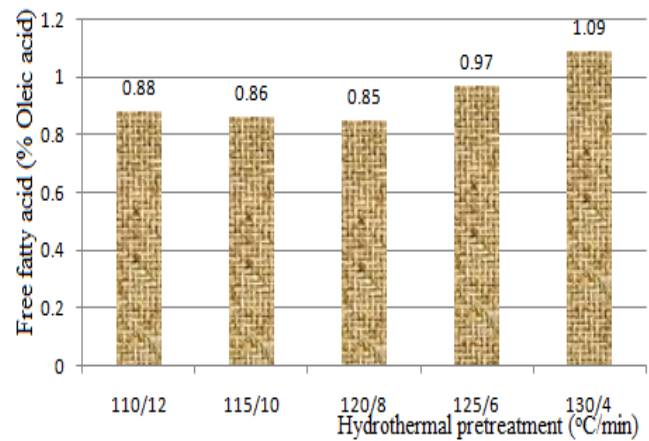


Fig.6. Effect of hydrothermal pretreatment (°C/min) to free fatty acid (% Oleic acid) in rice bran oil.

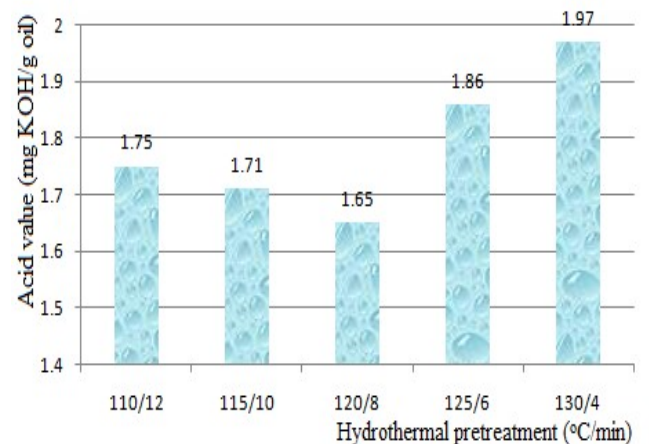


Fig.7. Effect of hydrothermal pretreatment (°C/min) to acid value (mg KOH/gm oil) in rice bran oil.

respectively by heating rice bran at 120 °C for 8 min before screw extraction. Peroxide value (PV) is an important quality indicator of oxidative stability of edible oil (21). The peroxide value (meq O_2 / Kg oil) values of rice bran oil by hydrothermal pretreatments were shown in (Fig. 8). There was significant difference among hydrothermal pretreatments. It's obviously noticed that the lowest

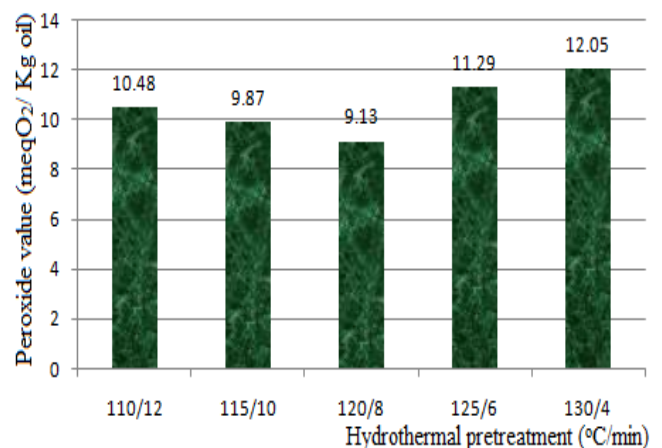


Fig.8. Effect of hydrothermal pretreatment (°C/min) to peroxide value (meq O_2 / Kg oil) in rice bran oil.

peroxide value (9.13 ± 0.02 meq O_2 / Kg oil) in rice bran oil was obtained by heating rice bran at 120 °C for 8 min before screw extraction. It was proved that temperature in the extraction process strongly affected the value of rice bran oil (22). The influence of hydrothermal-microwave pretreatment in various variables on canola oil expression was examined (23). They proved that seeds pretreated by hydrothermal- microwave at 130 °C for 2.98 mins obtained maximum canola oil recovery and the highest amount of canolol and the total tocopherol retention. Gasification improved the broken effects of the edges of the pressure waves, inducing to higher lignocellulose decomposition. Cell walls decomposition enhanced oil extraction yield and supported the upcoming anaerobic fermentation of the press cake residue (24). Shockwave pretreatment greatly accelerated the next enzymatic hydrolysis, which finally released the vacuoles rich in oil (25). Disruptive technologies will enable digitization of the processing industry (26). Agriculture development should be build on scientific foundation. Artificial intelligence would be absolutely appreciated as a beneficial strategy for business analyses and forecasting (27).

Conclusion

Rice bran was utilized to get rice bran oil. Rice bran oil contained high level of physiologically functional constituents. The phytochemical constituents of the rice bran oil were highly associated with its health advantages. Rice bran oil was gaining popularity due to its excellent cooking property to extend longevity and well-balanced fatty acid constituent. In this research, we successfully demonstrated the impact of hydrothermal pretreatment before screw press extraction to physico-chemical quality attributes of rice bran oil. Yield of rice bran oil extracted by screw compression accelerated by thermal treatment of rice bran before the mechanical extraction. This treatment at 120 °C for 8 min also improved the oil quality with higher contents of γ -oryzanol and tocopherol, improved antioxidant capacity, while lowering the levels of free fatty acid, acid value and peroxide value.

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Authors' contributions

Minh Phuoc Nguyen arranged the experiments and also wrote the manuscript.

Conflict of interests

The authors confirmed that this study was conducted without any conflict of interest.

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