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The effect of rice bran oil coating in the Portuguese "Carolino" rice

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Abstract

This study aims to nutritionally enrich Portuguese "Carolino" white rice *(Oryza sativa japonica)* by incorporating rice bran oil (RBO) on grain surface. Three levels of RBO coating were used: 0% (control), 0.3% and 0.6% (w/w). Antioxidant capacity (DPPH and ABTS), vitamin E (α, δ and γ-tocopherols), and Total fat % were determined. Also, acid value (AV) and peroxide value (PV) were measured on day one and after 183 days of storage to assess samples stability. Samples with 0.6% RBO presented significantly ($p<0.05$) higher concentrations of α-tocopherol (39.52±12.57 μg/g) and were the only sample where δ-tocopherol was quantifiable (14.05±1.85 μg/g). DPPH increased with the RBO addition, but no significant differences were found by ABTS analysis. PV and AV increased over time, with 0.6% RBO samples presenting the highest values ($p<0.05$). Adding 0.6% of RBO to Carolino rice increased the tocopherols concentrations and antioxidant capacity, adding value to white rice.

Keywords: Carolino rice, Rice bran Oil, Vitamin E.

1. Introduction

Rice (*Oryza sativa*) is one of the most important foods in the world, supplying as much as half of the daily calories of the world population [1]. In many parts of the world, but especially in the East, South and South-East Asia, it is a staple food and the second-most consumed cereal grain [2]. Rice bran (RB) is a by-product obtained from the outer layer of the rice kernel during milling to produce white rice. It is removed in commercial rice mills using a battery of polishers, and different fractions of rice bran are produced [3]. Rice bran also includes nutritional components and bioactive compounds, such as cellulose, hemicellulose, pectin, arabinoxylan, lignin, β-glucan, polyphenols, γ-oryzanol, β-sitosterol, vitamin B9, vitamin E, micronutrients and essential amino acids. Rice bran oil (RBO) can be obtained by extracting the lipidic phase from the rice bran. This natural oil is rich in essential vitamin E complex, tocotrienols, and gamma-oryzanol [4].

RBO contains about 0.1–0.14% vitamin E components and 0.9–2.9% oryzanol; the concentrations can vary substantially according to the origin of the rice bran [5]. This study aims to nutritionally enrich rice with a product from its own matrix, rice bran oil.

1. Materials and methods

2.1. Coating method

Portuguese "Carolino" white rice (Portuguese industrial mill) and the rice oil (Alfa One Rice Bran Oil, London, UK) were used. Three levels of RBO concentration were used: 0% (control), 0.3% and 0.6% (w/w). The coating process was done by placing the rice and the oil in a plastic container and shaking it manually. The enriched samples were dried in a vacuum oven (40°C, 60 min.), vacuum-packed and stored at room temperature in the absence of light.

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2.2. Antioxidant capacity, Vitamin E quantification, Acid Value, Peroxide Value, and total fat determination.

Antioxidant capacity was performed using two different methods: DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method, based on Brand-Williams, (1995) [6], and ABTS (2,2´-Azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) scavenging method was based on Porter, 2012 [7]. Sample preparation for both analyses was based on the extraction method described by Shao, 2011 [8]. Vitamin E quantification (α-tocopherol, δ-tocopherol and γ-tocopherol) was performed using a method adapted from Bele, 2013 [9]. A ThermoScientific UltiMate 3000 HPLC system was used, equipped with a Hypersil ODS C18 column (particle diameter 5 µ and 250x4.6 mm) operated at 40° C. Isocratic acetonitrile: methanol (50:50 v/v) eluent was used, with a flow rate of 1.5 ml/min. The analytes were detected with a fluorescence detector (excitation at 290 nm and emission at 325 nm) in a total run time of 8 minutes. Retention times were 4.8, 5.3 and 5.8 minutes for (α-tocopherol, δ-tocopherol, and γ-tocopherol. Quantitation calculations were performed using the external calibration method, using standards of α, δ and γ-tocopherol, with linearity of 0.9976, 0.9992 and 0.9977, respectively. Detection limits were also calculated for each component: 0.36 ppm for α-tocopherol, 0.30 ppm for δ-tocopherol and 0.68 ppm γ-tocopherol. Acid Value determination was performed according to the Portuguese Standard NP 2967:1991 [10]. Peroxide values were obtained according to Standard ISO 3960:2017 [11]. For fat content determination, the reference method used was AOAC 945.38-F [12].

2.3. Statistical analysis

Statistical analysis was performed using TIBCO® Statistica®, v.14.0.0, TIBCO Software Inc, Palo Alto, CA, USA. Differences were considered significant at the significance level of 0.05 (p<0.05).

3. Results and discussion

Antioxidant capacity

Antioxidant activity values (DPPH and ABTS) were determined for each coated rice sample and white rice (as a control sample). Results (Table 1) showed that the enrichment of Carolino rice with 0.6% of RBO increased the antioxidant capacity when compared to control (p<0.05). However, by the ABTS method, no statistically significant differences were found between samples.

Table 1. Antioxidant activity determined by DPPH and ABTS methods (expressed in µmol eq trolox/g).

	DPPH	ABTS
Control	0.32±0.00^{b}	0.66±0.03
RBO 0.3%	0.35±0.05^{ab}	0.75±0.07
RBO 0.6%	0.40±0.02^{a}	0.79±0.05

Different superscripts within rows indicate significant differences (p<0.05).

Vitamin E quantification

Vitamin E is composed of, α, δ, and γ-tocopherols. The values obtained in the quantification of these compounds of coated rice and the control sample are expressed in Table 2. The sample coated with 0.6% of RBO contained the higher values of tocopherols: α-tocopherol concentration was about 4 times higher than other samples; also, it was the only sample with a quantifiable concentration of δ-tocopherol. γ-tocopherol was not detected in any of the samples. Thus, these findings allow to conclude that rice bran oil is the main contributor of vitamin E in samples. Values of tocopherols obtained by Kong, 2010 [13], carried out on whole black rice from two different *Oryza sativa* cultivars, showed the amount of α-tocopherol varied between 14.1 and 11.9 (µg/g), values of γ-tocopherol were between 1.28 and 1.51 (µg/g), and δ-tocopherol was not detected.

Table 2. Tocopherols determination (concentrations are expressed in µg per gram of sample).

	Compounds (µg/g)		
	α-tocopherol	δ-tocopherol	γ-tocopherol
Control	11,50±4,22^{b}	<LoD	<LoD
RBO 0,3%	8,70±0,08^{b}	<LoD	<LoD
RBO 0,6%	39,52±12,57^{a}	14,05±1,85	<LoD

Different superscripts within rows indicate significant differences (p<0.05).

Table 3. Peroxide Value, Acid Value, and Fat percentage

	Peroxide value (milieq./kg)		Acid value (mg H_2SO_4/g)		Fat (%)
Sampling time (days)	**1**	**183**	**1**	**183**	
Control	0.00 ± 0.00^a	0.00 ± 0.00^c	8.63 ± 0.02^b	21.49 ± 0.09^c	1.13 ± 0.06^c
RBO 0,3%	0.00 ± 0.00^a	28.70 ± 0.46^b	10.13 ± 0.02^a	32.07 ± 2.72^b	2.44 ± 0.07^b
RBO 0,6%	0.00 ± 0.00^a	35.75 ± 0.49^a	10.14 ± 0.06^a	39.01 ± 0.06^a	3.48 ± 0.20^a

Different superscripts within rows indicate significant differences ($p<0.05$).

4. Conclusions

Rice enrichment with rice bran oil led to higher tocopherols concentration and higher antioxidant capacity. With the obtained results in this experiment, it can be concluded that the addition of oil to Carolino rice is beneficial since it adds nutritional value to the white rice when used in a proportion of 0.6% (w/w) and stored for six months under vacuum conditions and protected from light. However, further studies are needed to support this conclusion, namely performing sensory analysis of the samples at the end of the shelf-life, in order to assess if the consumers can detect the measured rancidity.

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Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

References

1. Abbas, A.; Murtaza, S.; Aslam, F.; Khawar, A.; Rafique, S.; Naheed, S., Effect of Processing on Nutritional Value of Rice (Oryza sativa), *Journal of the Medical Sciences* **2011**, *6*, 68-73.
2. Patil, S.B.; Khan, M.K., Germinated brown rice as a value added rice product: A review, *Journal of Food Science and Technology-Mysore* **2011**, *48*, 661-667, doi:10.1007/s13197-011-0232-4.
3. Lavanya, M.N.; Saikiran, K.C.S.; Venkatachalapathy, N., Stabilization of rice bran milling fractions using microwave heating and its effect on storage, *Journal of Food Science and Technology-Mysore* **2019**, *56*, 889-895, doi:10.1007/s13197-018-3550-y.
4. Vorarat, S.; Managit, C.; Iamthanakul, L.; Soparat, W.; Kamkaen, N, Examination of Antioxidant Activity and Development of Rice Bran Oil and Gamma-Oryzanol Microemusion, *Journal Health Research* **2010**, *24*, 67-72.
5. Zigoneanu, I.G.; Wilhams, L.; Xu, Z.; Sabliov, C.M., Determination of antioxidant components in rice bran oil extracted by microwave-assisted method, *Bioresource Technology* **2008**, *99*, 4910-4918, doi:10.1016/j.biortech.2007.09.067.
6. Brand-Williams, W.; Cuvelier, M.E.; Berset, C., Use of a free-radical method to evaluate antioxidant activity, *Food Science and Technology-Lebensmittel-Wissenschaft & Technologie* **1995**, *28*, 25-30.
7. Porter, Y, Antioxidant properties of green broccoli and purple-sprouting broccoli under different cooking conditions, *Bioscience Horizons: The International Journal of Student Research* **2012**, *5*, doi:10.1093/biohorizons/hzs004.
8. Shao, Y.F.; Zhang, G.; Bao, J.S, Total phenolic content and antioxidant capacity of rice grains with extremely small size, *African Journal of Agricultural Research* **2011**, *6*, 2289-2293.
9. Bele, C.; Matea, C.T.; Raducu, C.; Miresan, V.; Negrea, O., Tocopherol Content in Vegetable Oils Using a Rapid HPLC Fluorescence Detection Method, *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* **2013**, *41*, 93-96.
10. Portuguese Standard NP 2967:1991, Cereals, cereal flours, semolina and pasta. Determination of Acid Value, Instituto Português da Qualidade, 1991.
11. Standard ISO 3960:2017, Animal and vegetable fats and oils — Determination of peroxide value — Iodometric (visual) endpoint determination, International Organization for Standardization, 2017.
12. AOAC 945.38F, Degermed maize (corn) meal and maize (corn) grits: Fat determination. AOAC 945.38F; 920.39C, AOAC International, 1995.
13. Kong, S.; Lee, J, Antioxidants in milling fractions of black rice cultivars, *Food Chemistry* **2010**, *120*, 278-281, doi:10.1016/j.foodchem.2009.09.089.