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Natural Product Research

Formerly Natural Product Letters

ISSN: 1478-6419 (Print) 1478-6427 (Online) Journal homepage: https://www.tandfonline.com/loi/gnpl20

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To cite this article: Mariangela Rondanelli, Alessandra Miccono, Gabriella Peroni, Mara Nichetti, Vittoria Infantino, Daniele Spadaccini, Tariq A. Alalwan, Milena Anna Faliva & Simone Perna (2019): Rice germ macro- and micronutrients: a new opportunity for the nutraceutics, Natural Product Research, DOI: 10.1080/14786419.2019.1660329

To link to this article: https://doi.org/10.1080/14786419.2019.1660329

NATURAL PRODUCT RESEARCH
https://doi.org/10.1080/14786419.2019.1660329

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Rice germ macro- and micronutrients: a new opportunity for the nutraceutics

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ABSTRACT

The aim of this study is to characterise the rice germ from the nutritional point of view. The latest laboratory methods for evaluation of macronutrients and micronutrients have been used. Rice germ has a high protein content (18 g per 100 g of edible product) with considerable amounts of essential amino acids (mainly lysine, histidine and valine), fatty acids (mainly monounsaturated and polyunsaturated fatty acids), and fibre (7 g per 100 g). Regarding water-soluble vitamins, rice germ has high amounts of thiamine (B1) and vitamin B6, while vitamin E is the main fat-soluble vitamin present. Iron (77% of RDA) and magnesium (108% of RDA) are the two main minerals found in rice germ. Given its great nutritional value, it will be of interest in future studies to explore ways for rice germ to be incorporated into dietary supplements aimed at increasing nutrition intake for a specific population.

ARTICLE HISTORY
Received 5 March 2019
Accepted 13 August 2019

KEYWORDS
Rice germ; nutraceutic; micronutrients; macronutrients

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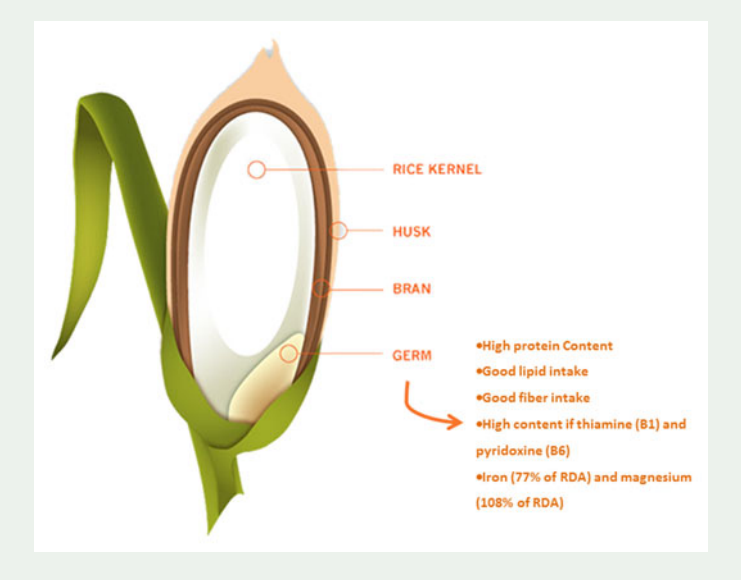
Supplemental data for this article can be accessed online at https://doi.org/10.1080/14786419.2019.1660329.



1. Introduction

Rice is one of the most important food resources of humanity with more than half of the world's population consuming it as a staple diet. Italy is the leading European country for rice (*Oryza sativa* L.) production with an average per capita consumption of >5 kg/year, making it the largest consumer in the European community (Ricepedia 2019).

Not only is rice a healthy and nutritious food, but it also a natural dietary product due to its nutritional value.

The process of white rice milling brings about marked changes in its nutritional value and its sensory characteristics. Milling involves the removal of the outer layer (husk), in addition to, the underlying bran layers and germ from the rice kernel. This results in considerable loss of vital nutrients such as minerals, vitamins, lipids, protein and fibre. In most cases, waste products obtained from rice processing are used as animal feed due to its high nutritional content (Hanmoungjai et al. 2002). In recent years, research has been focussing on utilising the by-products of rice processing in the pharmaceutical and nutraceutical industries, considering their potential nutritional and therapeutic values (Perretti et al. 2003).

The rice germ, which contains the embryo from which new life will spring, is of particular interest from a nutritional point of view due to its phytochemical characteristics and antioxidative properties as previously demonstrated (Rohrer and Siebenmorgen 2004). Although studies on the nutritional value of the germ first began in the late 1950s, however, no further studies were carried out since then.

For all the reasons mentioned above, the aim of this study was to assess the quantity of macronutrients and micronutrients in the rice germ, using the latest methods for evaluation of nutrients.

2. Results and discussion

Considering specific characteristics of the germ obtained from the whitening of Carnaroli rice, nutritional issues emerge that positively characterise this product. First, as shown in Table S2, the protein content is high (18 g per 100 g of edible product), with good amounts of lipids (not present in white rice because of the removal of the fatty acid-rich germ during the milling process), as well as fibre (7 g per100 g of germ). With regards to the amino acid composition, it is interesting to note the presence of high amounts of essential amino acids, namely histidine, lysine and valine (Table S3). These results are in line with a previous finding reporting the protein, lipid, carbohydrate and fibre contents of germ from four indica rice cultivars (Moongngarm et al. 2012). As for the fatty acid profile, the rice germ mainly consists of monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) instead of saturated fatty acids. In particular, it provides a considerable amount of essential fatty acids including linoleic and linolenic acids (Table S4). However, unsaturated fatty acids have a tendency to oxidise and become rancid during storage. For this reason, the germ is removed from the rice kernel during milling, which increases the merchantability and preservation of the product.

The results, as shown in Tables S5 and S6, indicate that rice germ has good amounts of micronutrients, including vitamins and minerals. The major water-soluble vitamins are thiamine (B1) and vitamin B6 and the main fat-soluble vitamin is vitamin E, which is a potent antioxidant. Although the content of these vitamins basically meets the RDA requirements, they are completely lost when the rice is polished. In comparison with wheat germ, rice germ has twice the amount of thiamine and vitamin E (Table S6). With regards to mineral content, rice germ is particularly rich in iron and magnesium, with a low content of sodium, as shown in Table S5. The intake of 100 g of rice germ provides 77. 5, 108 and 4% of the RDA for iron, magnesium and sodium, respectively. On the other hand, wheat germ contains greater levels of iron compared to rice germ (Table S6). However, the lower sodium content and higher magnesium content of rice germ compared to wheat germ may be beneficial for the prevention and treatment of hypertension and renal diseases. Finally, it is worth mentioning that the level of linoleic acid in rice germ exceeds that of wheat germ, and vice versa for the level of linolenic acid.

The strength of our study lies in the fact that it is the first to comprehensively characterize the macronutrient (proteins, lipids, carbohydrates and fibre) and micronutrient contents (vitamins B1, B6, and E, cadmium, magnesium, iron, and sodium) of rice germ from the Italian rice cultivar Carnaroli. Despite these interesting results, the main limitation is the difficulty in comparing our results with previously published studies because there are only two studies (Perretti et al. 2003; Moongngarm et al. 2012) that have investigated the nutritional value of rice germ.

Nonetheless, the results of this study indicate that rice germ will have potential for use as a nutraceutical food, because of its high nutritional and antioxidant value. It is surprising to note, however, that few studies are investigating the nutritional composition of rice gem in different rice varieties. Therefore, new studies should be performed to evaluate the nutritional composition of rice germ, in particular the different rice cultivars with particular reference to fertilisers and pesticides used, and to assess its

efficacy as a dietary supplement for use by specific population groups, such as amateur and professional athletes, elderly people and children.

3. Experimental

The nutritional characterisation of the rice germ was carried out by the Chelab srl laboratory (Treviso, Italy) using the methods listed in Table S1. The germ samples used in the present study were recovered from the rice grains of the Carnaroli variety (cultivated with a controlled protocol based on low use of fertilisers and pesticides with specific whitening techniques) supplied by the Acquerello company from Livorno Ferraris in the Province of Vercelli in Italy.

The nutritional values obtained were compared to the medium requirements of the recommended dietary allowance (RDA) for the general population. Finally, a comparison of macronutrients and micronutrients was made with a similar product, the germ of another cereal, specifically wheat.

4. Conclusions

To our knowledge, this is the first study in the literature that considers the analysis of macronutrients (proteins, including the amino acid content, lipids and the fatty acid profile, carbohydrates and fibre) and micronutrients (thiamine, vitamins B6 and E, cadmium, magnesium, iron, and sodium) present in the germ of an Italian rice cultivar Carnaroli. Only two studies to date (Perretti et al. 2003; Moongngarm et al., 2012) have attempted to explore the nutritional value of rice gem and neither one included all the nutrients analysed in this study, not to mention the fact that they were carried out on different rice cultivars.

The results of our study show that rice germ provides macronutrients including protein with high amounts of essential amino acids (mainly lysine, histidine and valine), healthy fatty acids (MUFAs and PUFAs, including linoleic and linolenic essential fatty acids), fibre, and micronutrients like thiamine, vitamins B6 and E, iron, and magnesium.

Disclosure statement

No potential conflict of interest was reported by the authors.

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