Rice Phytonutrients: Do Realistic Intakes of Rice and Rice Bran Oil Promote Health?

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Brown rice provides traditional nutrients, notably B-vitamins, and also several classes of non-essential bioactive compounds (phytonutrients). These include the γ-oryzanols, phytosterols, phenolic compounds and tocotrienols. This presentation addresses whether realistic intakes of brown rice or rice bran oil (RBO) can provide effective levels of bioactive compounds; that is, amounts that have been identified as having the potential to promote human health.

Rice phytonutrients purportedly facilitate mechanisms that protect against adverse conditions and diseases including oxidative damage, inflammation, carcinogenesis, and diabetes. However, the best evidence for protection of human health centers on lipid lowering, a risk factor for cardiovascular disease. For example, RBO is similar to canola, corn and olive oils in lowering blood lipids even though RBO has the least favorable fatty acid profile (Lichtenstein et al, 1994). Similarly, components of RBO other than fatty acids are responsible for decreasing LDL-cholesterol (Most et al, 2005).

Research on bioactive compounds focuses on identifying the amounts present in foods of interest, determining the bioavailability of the compounds or their metabolites to target tissues, and evaluating the efficacy of the compounds in promoting health. At least one of these key pieces of information is limiting for evaluating health potentials of key phytochemicals from rice products.

γ -Oryzanols

The most notable property of the γ-oryzanols is their ability to lower plasma cholesterol. Human studies, although sparse, have successfully used 300 mg of γ-oryzanol/d to lower LDL-cholesterol (Cicero and Gaddi, 2001). γ-Oryzanol, which is reported to be poorly absorbed, is a mixture of compounds. The 4-desmethylsterol ferulates are more effective than the 4,4'-dimethylsterol ferulates in lowering cholesterol (Berger et al, 2005). Rice bran is a rich source of γ-oryzanol (Bergman and Xu, 2003), but most of the γ-oryzanol in RBO is lost during the refining process (Van Hoed et al, 2006). Assuming the γ-oryzanol content of RBO is 3000 mg/kg, one could expect to receive 300 mg of γ-oryzanol by consuming ~6.7 tablespoons of RBO. Although it is possible to consume this amount of RBO, it would provide about 900 calories. Based on γ-oryzanol values for uncooked brown rice (260 to 630 mg/kg; Miller and Engel, 2006), ~7 to 17 cups of cooked brown rice would provide 300 mg of γ-oryzanol. Research is needed to identify the relative bioactivities of various forms of γ-oryzanol, the amounts of γ-oryzanols in RBO, as eaten, and the amounts required to produce desired biological outcomes.

Phytosterols

Although sterols are a component of γ-oryzanol, most of the sterols in RBO are free phytosterols. These compounds act in the GI tract to inhibit absorption of cholesterol.

Normolipemic subjects who consumed margarine containing 2.1 g/d of plant sterols from RBO for 3 wk reduced their LDL-cholesterol by 9% (Vissers et al. 2000). Intake of ~2 g of phytosterol per day produces maximum effectiveness for lipid lowering, but in a single meal, phytosterols in intact foods are bioactive at doses as low as 150 mg (Ostlund, 2004). The 4-4'-dimethylsterols, which predominate in RBO, are less effective than 4-desmethylsterols. Assuming that a low level, 150 mg, of phytosterols is efficacious and that RBO contains approximately 1000 to 2000 mg of efficacious phytosterols (Lichtenstein et al, 1994; Van Hoed et al, 2006), then 0.5 to 1 tablespoon of RBO should provide effective amounts. However, the amount of RBO that would provide 2 g phytosterols /d is far greater (~7 to 14 tablespoons). By rough estimate, ~5 to 6 cups of cooked brown rice provides 150 mg of phytosterol. Dose-response studies using human subjects and focusing on low levels of phytosterol intake have not been conducted.

Phenolic compounds

Rice bran contains an array of phenolic compounds (Hudson et al, 2000). These compounds are purported antioxidant, anti-inflammatory and anti-cancer agents, and thus may protect against a number of chronic diseases. Ferulic and *p*-coumaric acids are present in cereal cell walls, and the food matrix appears to limit absorption of these compounds (Adam et al, 2002). Phenolic compounds are found at low levels in human plasma but at high levels in the lower intestine where they may protect against reactive oxygen, nitrogen and chlorine species, lipid peroxides and other problematic compounds. It appears that phenolic compounds are released by bacterial esterases in the large intestine and, in rather small amounts, by mammalian esterases in the small intestine (Andreasen et al, 2001; Halliwell et al, 2005). Data are insufficient to assess the ability of rice phenolic acids to alter biomarkers of human health.

Tocotrienols

Rice bran is a rich source of tocotrienols (Bergman and Xu, 2003), which are unsaturated forms of tocopherols. Tocotrienols possess excellent antioxidant activity in vitro and are thought to be superior to tocopherols in suppressing reactive oxygen species. Additionally, tocotrienols reduce HMG-CoA reductase, thus limiting cholesterol synthesis. Tocotrienols are bioavailable; plasma tocotrienol concentrations increased 16 fold after subjects consumed 50 mg of rice bran /d for 4 wks (Qureshi et al, 2001). However, clinical studies have not generally shown improvement in lipid profiles of hypercholesterolemic subjects supplemented with 160 to 200 mg tocotrienols per day (Mensink et al, 1999; Mustad et al, 2002).

Summary

An attempt was made to calculate the amount of brown rice or RBO one must consume to provide concentrations of bioactive compounds that are efficacious for protecting human health. Literature values were used as benchmarks for amounts expected to be efficacious and for concentrations of bioactive compounds in rice bran or RBO. The literature search was not exhaustive; it is likely that better values (especially for bioactive components of rice products) exist, and that better estimates can thus be made. These data pertain only to improving blood lipid profiles because currently, the best evidence that rice phytonutrients protect human health centers on their ability to lower blood lipids.

Hopefully data will soon become available for applying such calculations to biomarkers of glucoregulatory control and control of oxidation and inflammation.

For each of the bioactive compounds reviewed, key values for the calculations were missing or were considered “soft data.” Publications vary widely in values reported for amounts of bioactive compounds in rice, rice bran and RBO, and processing steps typically lead to loss of phytonutrients. Chemical structure determines biological properties, and within each class of phytonutrient, little is known about the relative bioactivity of compounds. Additionally, few well-controlled studies of human subjects have evaluated the bioavailability or efficacy of rice bran or rice bran components.

There are problems with the approach used here – that of calculating the amount of a rice product needed to provide an efficacious amount of phytonutrient. Humans eat mixed diets and seldom depend on a single food source to provide any given nutrient or phytonutrient. Bioactive compounds from rice may react synergistically with each other or with other dietary compounds, a concept not captured in these calculations.

With the new-found ability to stabilize rice bran, the potential to use rice products as a dietary means to prevent chronic diseases holds promise. The research community has opportunities to identify the type and amount of rice phytonutrients that will promote human health, to optimize these compounds in rice and rice products, as eaten, and to provide foods that are both rich in bioactive compounds and desirable to consumers.

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