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Effects of Cooking on Anthocyanin Concentration and Bioactive Antioxidant Capacity in Glutinous and Non-Glutinous Purple Rice

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Abstract: Purple rice is a source of bioactive antioxidants for rice consumers. Loss of the major antioxidant compounds after a range of cooking processes was evaluated by measuring the changes in anthocyanin concentration (ATC) and antioxidant capacity (DPPH activity) of four non-glutinous and four glutinous genotypes. However, soaking in water prior to cooking generally decreased more ATC and antioxidant capacity in non-glutinous than in glutinous genotypes. Wet cooking (WC) and soaking before wet cooking (S-WC) led to lose almost all the ATC and antioxidant capacity with only slight variation between genotypes. In the glutinous genotype Pieisu, which had the highest raw rice ATC, ATC remained the highest when cooked by the WC method. By contrast, almost no ATC remained after WC and S-WC in the low ATC genotypes such as Kum Doi Saket. Overall, the loss of ATC was greater in non-glutinous than in glutinous genotypes for both WC and S-WC methods, but the reverse occurred for antioxidant capacity. WC using electric rice cooker retained higher ATC than the pressure cooking. Thus, for genotypes with high ATC and antioxidant capacity, the selection of cooking method is critical for retaining and stabilizing rice quality.

Key words: purple rice; rice cooking; anthocyanin; antioxidant capacity; wet cooking

Purple rice with pigmented grain has long been a unique and traditional food for desserts and for some medical purposes in many cultures (Rerkasem, 2015). Currently, its benefits have been widely acknowledged, and pigmented rice is being used as commercial food products as well as in dietary supplements, cosmetics and pharmaceuticals, especially among Asian countries as well as in the USA and Europe, leading to an increase in the demand for its value as a natural health food (Chaudhary, 2003; Appa Rao et al, 2006; Sukhonthara, 2009). Dietary antioxidants can protect against free radicals that may promote the aging process and disease progression (Sies, 1997). Furthermore, anthocyanins, polyphenols and other compounds in colored rice may have other beneficial effects for human (Chatthongpisut et al, 2015) and animal health (Xia et al, 2006; Suwannakul et al, 2015). Thus, purple rice has gained attention from food manufacturers in forms such as malt, flour, bread, ice cream and wine (Minh, 2014). However, the concentration of antioxidants and bioactivities varies with rice genotype, although the genotypes have similar bran color (Surarit et al, 2015).

In general, rice is cooked before its consumption using methods such as rapid-boiling, pressure-cooking and steaming depending on the consumer's preference and expectation of sensory quality (aroma, taste and texture). Each method can include pre-cooking processes such as rinsing to remove chemical residues

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and soaking to shorten the cooking time, but this differs between countries (Son et al, 2013). In Thailand, the cooking methods differ between non-glutinous and glutinous rice: wet cooking with an electric rice-cooker is commonly used for non-glutinous rice, while soaking before steaming is the traditional method for glutinous rice. However, both wet cooking and steaming methods can be applied both for non-glutinous and glutinous rice depending on consumer's preference e.g., steaming for non-glutinous rice helps to remain firmness and chewiness texture, while wet cooking has less the result. On the other hand, pressurized rice cookers are now widely used as an easy and rapid method. The cooking method may differentially affect the levels of antioxidants and other compounds in pigmented rice (Zaupa et al, 2016). For example, the decline response in anthocyanin concentration (ATC) and antioxidant capacity of black rice differ between two home-cooked products (rice porridge and cooked rice) (Tang et al, 2016).

Compounds with antioxidant properties differ in their chemistry, with anthocyanins being water soluble and temperature labile, while phenolic acids occur in both soluble and insoluble forms with different properties from anthocyanins (Goufo and Trindade, 2014). Notably, the anthocyanin in pigmented rice decreases by about 80% after cooking with an electric rice cooker whereas phenolic compounds fall by 54% (Bhawamai et al, 2016). In comparison of the cooking methods, the risotto cooking retains more anthocyanin and other phenolic compounds than the boiling as most water is absorbed by the specific grain type with high porosity in the former method (Zaupa et al, 2015). So far, the effect of cooking process on the comparative antioxidant compounds in non-glutinous and glutinous rice genotypes has not been studied. Such knowledge would provide useful information for rice consumers in order to stabilize the antioxidant capacity during the cooking process. Therefore, this study was undertaken to evaluate the effect of cooking methods and soaking time on ATC and antioxidant capacity among non-glutinous and glutinous purple rice genotypes.

MATERIALS AND METHODS

Rice samples

Eight pigmented rice genotypes with purple pericarp color were used: Four were non-glutinous rice genotypes [Hom Nil (HN), Rice Berry (RBR), CMU168 and CMU107], and four were glutinous rice genotypes [Kum Doi Saket (KDK), CMU125, Kum Hom CMU (KHCMU) and Pieisu (PES)]. All genotypes were collected at maturity under the same growing condition at the research field of Agronomy Division, Department of Plant and Soil Sciences, Faculty of Agriculture, Chiang Mai University, Thailand in the wet season 2015. The paddy rice samples were sun-dried to reach 11%–12% moisture content before de-husked with a husker (Model P-1 from Ngek Seng Huat Co. Ltd., Thailand) to produce brown rice (the form of rice grain where palea and lemma are removed, but embryo and bran layers are still intact). Samples of the brown rice were analyzed for initial ATC and antioxidant capacity in the detail below. The amylose content was analyzed by iodine reaction (Juliano, 1971), and it ranged from 14% to 17% for non-glutinous rice genotypes and from 2% to 6% for glutinous ones, while total fat content in brown rice was also analyzed (Xu and Godber, 1999) within the range of 15–20 mg/kg among the eight genotypes. Grains were kept in zip-lock plastic bags and stored at -25 ºC before analysis.

Experimental design

The factorial randomized complete block design with two treatment factors was arranged in the experiment 1. The treatment factors were set as rice genotypes and the cooking method. The eight genotypes included were in the above detail, and the cooking method consisted of one process [soaking (SR)] and two cooking methods, [wet cooking (WC) and combination of soaking and wet soaking (soaking before wet cooking, S-WC)]. Each treatment was carried out in triplicate. A completely randomized design was used in the experiment 2. The samples were cooked by using either an electric rice cooker (ERC) or a pressure rice cooker (PRC) in eight treatments with varying of soaking and cooking times. The treatment was also carried out in triplicate.

Experiment 1: Effects of cooking process on ATC and antioxidant capacity of non-glutinous and glutinous rice genotypes

Brown rice samples (100 g) of each genotype were soaked in water with the ratio of 1:2 at room temperature for 12 h based on the saturation point testing (Tang et al, 2016), which is also a traditional way to reduce cooking time and maintain the softness