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# Effects of Polishing on Proximate Composition, Physico-Chemical Characteristics, Mineral Composition and Antioxidant Properties of Pigmented Rice

Chagam Koteswara REDDY[1, 2], Lalmuan KIMI[1], Sundaramoorthy HARIPRIYA[1], Nayoung KANG[2]

([1]*Department of Food Science and Technology, Pondicherry University, Puducherry 605014, India;* [2]*School of Life Sciences and Biotechnology, Korea University, Seoul 136701, Republic of Korea*)

**Abstract:** The effects of polishing on proximate compositions, physico-chemical characteristics, mineral compositions and antioxidant properties of the rice flours obtained from three different pigmented rice varieties (Chak-hao Angangba, Chak-hao Amubi and Chak-hao Poireiton) were investigated. The rice varieties were significantly ($P$ < 0.05) different in the contents of the test characteristics. Lipids, ash, minerals, phytochemicals (phenolic acids and flavonoids) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) activity of rice flours were decreased after polishing (9% degree of milling), while amylose content and lightness were increased. X-ray diffraction pattern of rice flours exhibited A-type crystalline pattern with reflections at 15.1º, 17.1º, 18.2º and 23.0º. Pasting properties and transition temperatures were decreased after polishing treatment. Polishing resulted in changes in the crystallinity, enthalpy and morphology of rice flours.

**Key words:** amylose; antioxidant property; crystallinity; gelatinization; mineral; pigmented rice; polishing; pasting property; bran

Rice is the primary cereal of regular diet and one of the highest cultivated food crops in the world. It is the main staple food for half of the world's population, predominantly in developing countries (Monks et al, 2013). As a result of the high consumption and main source of carbohydrates, minerals, vitamins and bioactive components, rice represents an appropriate vehicle for nutrient delivery to these populations (Sompong et al, 2011; Nile et al, 2016). In a nutritional point of view, rice flour is a chief ingredient in numerous traditional foods, which is possibly due to the absence of gluten, low amount of calcium and allergenic proteins (Gujral and Rosell, 2004). There are numerous factors which are known to affect the nutritional value of rice such as rice genotype, agronomic and cultivation condition, storage and processing (Singh et al, 2000; Falade and Christopher, 2015).

Rice is consumed as the whole kernel of the white rice which is obtained after milling of the rough rice. The principle of rice milling is the removal of the husk (husking) followed by the rice bran (polishing), which gives us the edible portion (endosperm) of rice grain (Savitha and Singh, 2011). Usually, rice polishing is carried out by the industries to improve the physical and sensory properties of the rice grain and the storage stability (Monks et al, 2013; Paiva et al, 2016). Further, removal of the germ and bran layers of the rice caryopsis is done by polishing process. Rice bran layer is rich in minerals, vitamins, fat and dietary fibers (Roy et al, 2008; Paiva et al, 2014), while proteins and fats are concentrated in the germ of the rice caryopsis (Itani et al, 2002). Typically, a high degree of milling enriches the sensorial and physical quality of rice, while most of the nutritional components

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**Corresponding author:** Sundaramoorthy HARIPRIYA (shprieya@gmail.com)



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of rice are removed during the polishing process (Itani et al, 2002; Paiva et al, 2016).

Recently, pigmented rice varieties have received great attention owing to their high content of polyphenols, minerals, vitamins and numerous biological activities. In general, rice bran contains numerous nutrients, including fiber, minerals and vitamins (Patil and Khan, 2011), as well as health-promoting bioactive phyto-chemicals such as phenolics, flavonoids, γ-oryzanol, tocopherols, ferulic acid, phytic acid and tocotrienols (Friedman, 2013). Phenolic compounds are secondary metabolites in plants, and can scavenge free radicals and further decrease the oxidative stress and protect the biological macromolecules from potential damage (Okarter et al, 2010; Ti et al, 2014). The anti-oxidant properties of phenolic compounds are responsible for prevention of chronic diseases such as obesity, diabetes, atherosclerosis, cancer and cardiovascular diseases (Kong and Lee, 2010; Okarter et al, 2010).

Due to increase in the awareness on nutrition and health, research has taken a turn to improve the functional food products with bioactive components. Pigmented rice with augmented bioactive components such as phenolic, tocopherol and flavonoid compounds shows a key role in the improvement of functional foods. Numerous studies are being conducted to examine the effect of polishing on nutritional, physico-chemical and functional properties of pigmented and non-pigmented rice varieties (Singh et al, 2005; Sompong et al, 2011; Min et al, 2014; Zhang et al, 2015; Paiva et al, 2016). However, few studies have been carried out on the nutrient compositions, quality characteristics, and antioxidant properties of the pigmented rice cultivated in North-east India (Saikia et al, 2012; Reddy et al, 2016). Moreover, the impacts of polishing on the crystallinity, chemical composition, mineral content, phytochemicals, physico-chemical and antioxidant characteristics of the traditional pigmented rice varieties cultivated in North-east India are still unclear till now. Therefore, the objective of this study was to investigate the effects of polishing on proximate composition, morphology, mineral content, phytochemical content (phenolic and flavonoids), antioxidants and physico-chemical characteristics of three pigmented rice varieties cultivated in North-east India.

## MATERIALS AND METHODS

### Materials

Three different pigmented rice varieties, Chak-hao Angangba (CAng, brown rice), Chak-hao Poireiton (CP, purple rice) and Chak-hao Amubi (CA, black rice), were obtained from the Rice Research Centre, Central Agricultural University, Manipur Province, India. All the rice samples were from the recent harvest of December, 2015. All the paddy materials were dried, cleaned, further packed in screw-capped plastic containers and stored at 4 ºC. Folin-Ciocalteu reagent, catechol, quercetin, and 2,2-diphenyl-1-picrylhydrazyl (DPPH) were purchased from HiMedia Co., Ltd. (Mumbai, India). All chemicals were of analytical grade unless specially mentioned.

### Processing of rice

Rice grains were dehusked with a Rice Husker (THU-34A, Satake Engineering Co., Japan) to produce raw pigmented rice (RPR), which was further polished using the Rice Mill (TM05, Satake Manufacturing Co., Japan) to remove the bran with 9% degree of milling (DOM), resulting in the formation of the white rice or polished rice (PPR). Then, both RPR and PPR grains were milled to flour using a laboratory mill (A11B, IKA Inc, India). All the flour samples were sieved through 100 µm sieve-size and stored in airtight plastic containers.

### Determination of proximate composition

The proximate composition of rice flours was determined using the standard AOAC methods (AOAC, 1990). Moisture content was done by the gravimetric method in a hot air oven at 105 ºC until constant weight, and the quantity of ash was analyzed using a muffle furnace at 550 ºC. Crude protein content was measured by a standard Kjeldahl method using 5.95 as the conversion factor. Flour lipids were analysed by the solvent extraction procedure. The content of total carbohydrates was determined by difference from the analysis of moisture, ash, protein and lipids. Amylose content was assessed using the standard method described by Sowbhagya and Bhattacharya (1979).

### Measurement of colour characteristics

Colour measurement of rice flours was performed using a Hunter Lab Colorimeter (D-25, Hunter Lab Associates Inc., Ruston, USA). The instrument was calibrated using the Hunter Lab colour standards, and lightness to darkness ($L*$), redness to greenness ($a*$) and blueness to yellowness ($b*$) values of the rice flours were measured.