

COLOR AND HARDNESS COMPARISON BETWEEN PARBOILED AND NORMAL BLACK RICE

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ABSTRACT

Parboiling process had a potency to change the color and rice grain hardness of black rice. Although, this process could reduce the cooking time and improve the texture of black rice. The aim of this research was to compare the color difference and grain hardness from normal black rice and two different parboiled black rices. Cempo Ireng black rice variety as a sample was taken from local farmer in Ciampea, Bogor, West Java, Indonesia. There was normal (without parboiling process) black rice and two kind of parboiled black rice used in this research. First, parboiled black rice X (0% sodium citrate concentration, 5 minute steaming time, and 1 time freezing-thawing cycle), parboiled black rice Y (5% sodium citrate concentration, 15 minutes steaming time, and 4 times freezing-thawing cycles). One way Anova, Least Square Difference (LSD) and Independent sample t-test was used to determine the significant differences between mean values. There was significant difference on color parameter between normal and parboiled black rice grain. In cooked rice, there was significant difference on lightness parameter only. The grain of parboiled black rice X was harder than Y.

Keywords: black rice, color, grain, hardness, parboiled

INTRODUCTION

Color is an important parameter that represent the quality of food materials. The color of food could describe the functional components in it. By example, carotenoids had orange, red or yellow color and anthocyanin had purple, black color in food substances (Guine *et al.*, 2009). Some rice become special because of their anthocyanin content. For instance, red and black rice had high anthocyanin content that represent by their color.

The hydrothermal process that purposed at inducing milling, nutritional, and organoleptics improvements is called parboiling (Arendt and Zannini, 2013). This process consists of dehulling, soaking, steaming, drying, and milling (Buggenhout *et al.*, 2013). Some modification such as sodium citrate addition or freezing-thawing cycle could be added to obtain the specific purposes.

Parboiling process on black rice had purpose to reduce the cooking time and improve the texture quality (Widyasaputra *et al.*, 2019).

During parboiling, the use of heat had a potency to destruct the color. Black color in the bran layer of black rice is the expressions of anthocyanins pigments (Oikawa *et al.*, 2015). The anthocyanin content is located in the pericarp and incorporated with fiber, minerals and some amino acids (Kushwaha, 2016). Cyanidin-3-glucoside, cyanidin-3-rutinoside, and peonidin-3-glucoside were some anthocyanin could be found in the black rice pericarp (Loypimai *et al.*, 2015).

Black rice cooking increase the thermal degradation of cyanidin-3-glucoside (Hiemori, *et al.*, 2009). Also, the parboiling process could change the rice grain hardness. Parboiling process made rice become more resistant to breakage during milling (Mir *et al.*, 2013). Hardness become the important parameter for

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storage and transportation. Consumer prefer the whole milled grain rice rather than the breakage one.

The purpose of this research was to compare the color difference and grain hardness from normal black rice and two different parboiled black rice. This comparison result was used as maximum and minimum factor in process optimization of parboiled black rice.

MATERIALS AND METHODS

Materials

Cempo Ireng black rice variety as a sample was taken from local farmer in Ciampea, Bogor, West Java, Indonesia. The other materials such as sodium citrate and distilled water were taken from Setia Guna chemicals store, Bogor, West Java, Indonesia.

Parboiling Process of Black Rice

The process consisted of soaking, steaming under pressure, freezing, thawing, and drying. Soaking was prepared by using sodium citrate solution and distilled water at rice/water ratio of 1:2 (w/v) for 30 minute. Steaming was done by using Hirayama Hiclave HVE-50 (Hirayama Manufacturing Corp., Saitama, JP) in 1.1 bar pressure. One cycles of freezing was carried out with by using LG GR-M712YLA freezer (LG Corp., Seoul, KR) in -20 ± 2 °C for 22 hours and thawing was performed with LG GR-M712YLA refrigerator (LG Corp., Seoul, KR) in 4 ± 2 °C for 40 minute then left under running water in room temperature for 20 minute. Drying process was done by using Memmert UF-110 universal oven (Mettler GmbH, Schabach, DE).

Experimental Design

Two kind of black rice were analyzed. That were parboiled black rice X (0% sodium citrate concentration, 5 minute steaming time, and 1 time freezing-thawing cycle), parboiled black rice Y (5% sodium citrate concentration, 15 minutes steaming time, and 4 times freezing-thawing cycles). Independent sample t-test was used to determine the significant differences between mean values using the SPSS V.22 Statistical Software Program (SPSS Inc. Chicago, IL, USA). The normal black rice (without parboiling process) was also analyzed to be a reference. Anova one way analysis and Least Square Difference (LSD)

were used to determine the significant differences between normal black rice, parboiled black rice X and Y.

Total Color Difference for Rice Grain and Cooked Rice

Color measurement was conducted by using Chromameter CR300 Minolta (Konica Minolta Sensing Singapore Pte Ltd., Pandan Gardens, SG). Rice grain or cooked rice sample was placed on the transparent dish then measured with Chromameter. The measurement resulted L^* , a^* , and b^* . L^* value represent the lightness from dark to light (0-100). a^* value showed the red to green chromatic color, a^+ for red color and a^- for green color. b^* value showed blue to yellow chromatic color, b^+ for yellow color and b^- for blue color. The normal black rice color value was used as a reference. Total color difference was counted by using the equation:

$$\Delta E^*_{ab} = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

Rice Grain Hardness

The hardness of grain after parboiling without re-cooking was determined as the rice grain hardness. This analysis was performed by using Kiya Grain Hardness Tester Instrument (Kiya Seisakusho Co. Ltd., Kawagoe, JP). Ten grains of black rice sample were tested. The needle was set to 0. The grain was pressed by using tester spindle until it sounds "crack". The needle would show the hardness value in kg.

RESULTS AND DISCUSSION

Before compared two kind of parboiled black rice, the normal black rice was analyzed. The result of analysis was showed in Table 1. Cooking process lower the lightness (L^*) and blue-yellow chromatic color (b^*) value of black rice. But, the red-green chromatic color (a^*) of cooked black rice was higher than rice grain. The anthocyanin dissolution from rice to the water during cooking process made the cooked black rice had darker color than rice grain. Anthocyanin was the water soluble pigment that could be extracted during cooking process of colored rice (Handayani *et al.*, 2014). The water dispersed anthocyanin into the all surface of cooked rice.

The individual rice grain color difference between normal black rice,

parboiled black rice X, and Y could be found in Table 2. There was significant difference ($\alpha=0.05$) between normal black rice and parboiled black rice in Lightness (L^*), red-green chromatic color (a^*) and blue-yellow

chromatic color parameter (b^*). But, the difference between parboiled black rice X and Y in all (L^* , a^* , b^*) color parameter was not significant.

Table 1. Physical characteristic of cempo ireng black rice variety

Parameters	Values \pm Standard Deviation
Rice Grain Color**	
L^*	27.78 ± 0.13
a^*	3.89 ± 0.11
b^*	2.66 ± 0.01
Cooked Rice Color**	
L^*	18.10 ± 0.18
a^*	7.02 ± 0.16
b^*	1.85 ± 0.04
Rice Grain Hardness (kg)	5.60 ± 0.20

**Source: (Widyasaputra, Syamsir, and Budijanto 2019); L^* = Lightness; a^* = red-green chromatic color; b^* = blue-yellow chromatic color

Parboiling process could change the lightness of black rice became darker than before. This could happen because the soaking process in parboiling process helped water soluble component such as anthocyanin

pigment to leach out from the rice bran (Tang *et al.*, 2016). After leached out, the pigment was well dispersed into the surface area of black rice.

Table 2. Rice grain color (CIE L^* , a^* , b^*) comparison between normal black rice, parboiled black rice X and parboiled black rice Y

Parameters	Normal Black Rice**	Parboiled Black Rice X	Parboiled Black Rice Y
L^*	27.78 ± 0.13^a	19.70 ± 0.82^b	20.03 ± 0.75^b
a^*	3.89 ± 0.11^a	2.29 ± 0.59^b	1.48 ± 0.49^b
b^*	2.66 ± 0.01^a	0.65 ± 0.18^b	0.52 ± 0.21^b

^a the numbers in the same row with same letter did not have significant difference ($\alpha=0.05$); **Source: (Widyasaputra *et al.*, 2019); L^* = Lightness; a^* = red-green chromatic color; b^* = blue-yellow chromatic color

Table 3 showed the comparison of cooked rice color parameter between normal, parboiled X and Y black rice. The one way Anova test showed that there was significant difference ($\alpha=0.05$) between lightness value (L^*) of normal black rice and parboiled black rice. But it did not have significant difference in red-green chromatic color parameter (a^*) and blue-yellow chromatic color parameter (b^*) between normal and parboiled black rice. Also, there was no significant difference

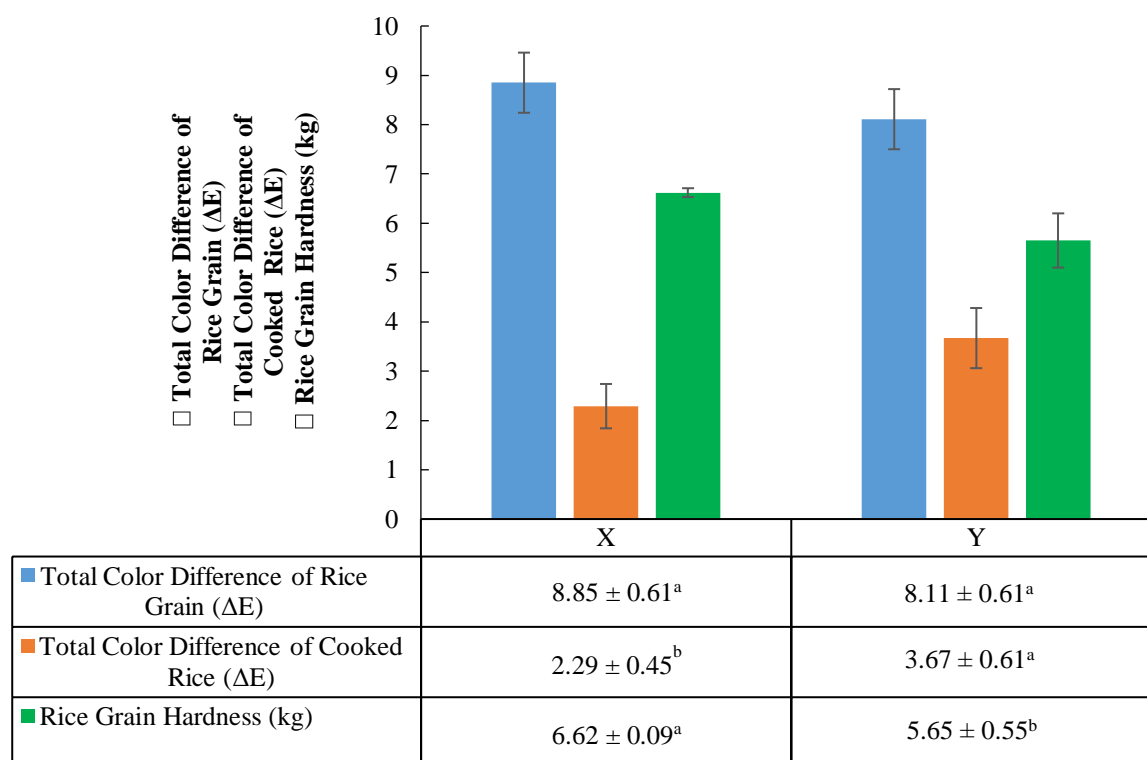
between parboiled black rice X and Y in all individual color parameter (CIE L^* , a^* , b^*).

The cooked rice of parboiled black rice tended to have brighter color than normal black rice. Cooked parboiled black rice had been passed two time cooking process. Firstly, when it was parboiled. Secondly, when it was re-cooked. It made higher anthocyanin lost than normal black rice. Anthocyanin pigment in colored rice dissolve to the water during cooking process (Handayani *et al.*, 2014).

Table 3. Cooked rice color (CIE L^* , a^* , b^*) comparison between normal black rice, parboiled black rice X and parboiled black rice Y

Parameters	Normal Black Rice**	Parboiled Black Rice X	Parboiled Black Rice Y
L^*	18.1 ± 0.18^b	20.27 ± 0.57^a	21.50 ± 0.77^a
a^*	7.02 ± 0.16^a	7.17 ± 0.73^a	6.10 ± 0.78^a
b^*	1.85 ± 0.04^a	1.95 ± 0.27^a	2.27 ± 0.70^a

^a the numbers in the same row with same letter did not have significant difference ($\alpha=0.05$)



^a the numbers in the same row with same letter did not have significant difference ($\alpha=0.05$)

Figure 1. Total Color Difference of Rice Grain, Cooked Rice (ΔE), and Rice Grain Hardness (kg) Comparison between Parboiled Black Rice X and Parboiled Black Rice Y

The independent sample t-test showed that there was significant difference ($\alpha=0.05$) between parboiled black rice X and Y on total color difference of cooked rice and rice grain hardness parameter. But, the total color difference of rice grain was not significant. After re-cooking, parboiled black rice Y had higher total color difference than X. Sodium citrate addition on parboiled black rice Y was higher than X. The addition of sodium citrate solution helped rice to resist the Anthocyanin. The anthocyanin degradation could be prevented by reducing the pH value with the addition of citric acid (Patras *et al.*, 2010).

Generally, parboiled black rice had higher grain hardness than unparboiled. This result was in line with parboiled white rice. Parboiling process could increase the rupture force of white rice (Taghinezhad *et al.*, 2015). Parboiled black rice Y had lower grain hardness than X. The sodium citrate addition in parboiled black rice Y was higher than X. This condition made rice had more porous structure (Husain *et al.*, 2007). Rice became more brittle and easily broken. Soaking in parboiling process also reduced the broken grain percentage (Ayamdoo *et al.*, 2013).

CONCLUSION

The difference of normal black rice and parboiled black rice lightness, red-green chromatic color and blue-yellow chromatic color was significant. There was significant difference between lightness value of normal black rice and parboiled black rice. Parboiled black rice X had significant difference with parboiled black rice Y on total color difference of cooked rice and rice grain hardness parameter. Although, the parboiled black rice color reduction X was bigger than Y, the difference was not significant. In cooked rice, parboiled black rice Y had bigger color reduction than X. The grain of parboiled black rice X was harder than Y. The total color difference of cooked rice and rice grain hardness result could be used as a maximum and minimum factor in process optimization.

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