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Evaluation of Chromium Fortified Parboiled Rice Coated with Herbal Extracts: Cooking Quality and Sensory Properties

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***Abstract*—**Parboiled rice was developed to produce rice, which has a low glycemic index for diabetics. However, diabetics also have a chromium (Cr) deficiency. Thus, it is important to fortify rice with Cr to increase the Cr content. Moreover, parboiled rice becomes rancid easily and has a musty odor, rendering the rice unfavorable. Natural herbs such as pandan leaves (*Pandanus amaryllifolius* Roxb.), bay leaves (*Syzygium polyanthum* [Wigh] Walp) and cinnamon bark powder (*Cinnamomon cassia*) are commonly added to food as aroma enhancers. Previous research has shown that these herbs could improve insulin sensitivity. The purpose of this study was to evaluate the effect of herbal extract coatings on the cooking quality and the preference level of chromium fortified - parboiled rice (CFPR). The rice grain variety used for this experiment was Ciherang and the fortificant was $CrCl_3$. The three herbal extracts used for coating the CFPR were cinnamon, pandan and bay leaf, with concentration variations of 3%, 6%, and 9% (w/w) for each of the extracts. The samples were analyzed for their alkali spreading value, cooking time, elongation, water uptake ratio, solid loss, colour and lightness; and their sensory properties were determined by means of an organoleptic test. The research showed that coating the CFPR with pandan and cinnamon extracts at a concentration of 3% each produced a preferred CFPR. When coated with those herbal extracts the CFPR had the following cooking quality properties: alkali spreading value 5 (intermediate gelatinization temperature), cooking time, 26-27 min, color value, 14.95-15.00, lightness, 42.30 – 44.06, elongation, 1.53 – 1.54, water uptake ratio , 4.05-4.06, and solid loss, 0.09/100 g – 0.13 g/100 g.

***Keywords*—**Bay leaves, chromium, cinnamon, pandan leaves, parboiled rice.

I. Introduction

THE prevalence and incidence of diabetes mellitus has increased drastically in new industrial and developing countries, including Indonesia. The prevalence of diabetes for all age-groups worldwide was estimated to be 2.8% in 2000 rising to 4.4% in 2030. The number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030. In that year, the number of diabetics in Indonesia has been predicted to reach 21.3 million, an increase of 150 % from 8.43 million people in 2000 [1]. Globally, at least one in 10 deaths among adults aged 35-64 years is attributable to diabetes, rising to a quarter of all deaths in some parts of the world [2]. The International Diabetes Federation (IDF) states that two individuals develop diabetes every 10 seconds and two individuals die of diabetes related conditions every 10 seconds worldwide [3]. One strategy that can be applied to manage diabetes is the consumption of foods that raise blood sugar slowly, but it can provide the satisfaction of satiety. The trick is to consume food products that have a low glycemic index (GI). For that, there must be a source of carbohydrates, especially rice which, as a staple food has a low GI, contains functional components that can lower blood sugar, and is preferred by consumers. The research showed that traditional parboiled rice has a GI of 46 and can significantly lower the blood sugar profile of type 2 diabetics compared with the consumption of non-parboiled rice (GI 55) [4]. These low GI values can be caused by high levels of resistant starch. Yet, parboiling rice is not enough because diabetics also lack of chromium [5]. This mineral deficiency can cause high blood sugar levels. Signs of Cr deficiency had a similar metabolic syndrome to high blood sugar, high triglycerides, low density lipoprotein and hypertension. Supplemental Cr has been shown to improve all these signs in human subjects [6].

In producing parboiled rice, the first step is a soaking process. This stage plays an important role in the hydration and pre-gelatinization processes, whereas the gelatinization process itself takes place during steaming. With the fortification of chromium in the parboiled rice processing, it is expected to be a functional food for diabetics. Iron fortification during parboiling of rice was reported by [7]-[9].

Naturally-occurring compounds that have been shown to improve insulin sensitivity and blood sugar control include Cr (Chromium) and polyphenols, which are found in cinnamon (*Cinnamomum cassia*) [5]. The polyphenols which were extracted from cinnamon bark powder, bay leaves, and pandan leaves can improve insulin sensitivity or blood sugar control in experiments in vitro, both animal and human [5], [10]–[13].

In previous research, [14] found that the lowest glycemic index of rice, i.e. 36.33, was obtained using a parboiling treatment with a modified grain soaking time treatment of 2.5 hours and a $CrCl_3$ concentration of 7.47 mg/L. Although that particular rice was included in the low glycemic index (<55) and was suitable for diabetes sufferers, sensoric test results showed that it scored low to medium on the 'likeable' scale. Therefore, in this research, modifications and improvements were carried out to meet the preferences of the panelists by producing rice fortified with a Cr coating treatment and herbal extracts (cinnamon, bay, and pandan leaves). The herbal extract coating enhanced the aroma and flavour to produce

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rice that consumers like. In addition, the research also evaluated the cooking quality of chromium-fortified parboiled rice with coated herbal extract.

II. Materials and Methods

A. Materials and Equipment

The main material used in this research was rice, of the type Ciherang (medium amylose) obtained from an agriculture shop in Sleman, Yogyakarta. Fortificant used was chromium ($CrCl_3$), and Cinnamon bark powder (*Cinnamomum cassia*), bay leaves (*Syzygium polyanthum* [Wigh] Walp) and pandan leaves (*Pandanus amaryllifolius* Roxb) were also used as natural herbs. Other chemical substances included gum arabic 30%, sorbitol and tween 80. The equipment used in this study was water bath, boiler, steamer pans, cooler (showcase), cabinet dryer, cooker, sensory testing set, spectrophotometer, and analytical tools. The study was conducted at the Laboratory of Agricultural Product Processing, Faculty of Agro-Industry, University of Mercu Buana Yogyakarta.

B. Production of Chromium Fortified–Parboiled Rice (CFPR)

Grain was washed 3 times, twice using water and once using aquadest at a ratio of 1: 1.5 i.e. 10 kilos of grain to 10 7.5 litres aquades/water. Sorting was also carried out in this research to separate the good quality grain (sinking) from the bad (floating). The grain used was the grain which sank when soaked. The grain was then soaked in 15 litres of aquades at a temperature of 65°C ±2°C for 2.5 hours. Fortification process was performed by adding chromium at a concentration of 7.47 mg/L. Grain was drained and then steamed for 25 min. After steaming, it was cooled at 0°C for 6 hours and dried using a cabinet dryer at 50°C till it reached a water concentration of 13 to 14 % (w/w). Next, the hulling process was done and CFPR produced.

C. CFPR Coating with Herbal Extracts of Cinnamon, Bay and Pandan Leaves

The extracts of cinnamon, bay and pandan leaves were prepared by using the method of [15] which is modified. Five hundred grams of the herbal materials were soaked in 1500 ml of hot water (88ºC) in the water bath for 6 hours. The next process was to filter with Whatman paper no 41, and the filtrate obtained was then caught in a dark bottle and kept in a refrigerator (4ºC). Then the filtrate was rotary vacuumed at 60°C until 225 ml of each herbal extract was obtained. The parboiled rice was then coated with varying concentrations (3, 6 and 9%) of the herbal extracts (cinnamon, bay and pandan leaves) using the method of Laohakunjit and Kerdchoechuen [16] modified. Coating dough was prepared consisting of gum arabic 30% with aquadest and added until it reached 100 ml, plus 2 drops of tween 80. Next, the dough was placed in the refrigerator for 12 hours, and then 30 g of sorbitol was added. Herbal extract concentrations used were 3% (15 ml per 500 g chromium fortified – parboiled rice), 6% and 9%. The coating was done by spraying 500 g CFPR with 50 g of the solution and dried at 50°C using the Fluid Bed Dryer till the concentration of water was 13%.

D. Alkali Spreading Value (ASV) Test

The analysis of alkali spreading value was done by putting 10 grains of rice in a petri dish and adding 15 ml KOH 1.7% solution then allowing it to stand for 23 hours at room temperature (32±2°C). The research result was evaluated using a scale of 2-7, i.e. with 2 as the high gelatinization temperature, 3-5 as the medium GT and 6-7 as the low GT [17]. Grains that were unaffected were given an ASV of 1, and grains that were dispersed and disappeared completely were given a score of 7.

E. Cooking Time

Rice to be analysed was taken in amounts of 10 grams for each sample then 70 ml of aquadest was added in a 100 ml glass beaker. The cooking process was done at 97-99°C. Monitoring was performed 20 min after cooking by taking random samples on a glass plate. The taking was done at 1 minute intervals till the rice was 90% cooked, and this time was used for the cooking time [18].

F. Lightness and Colour Value

A colour meter (CR-300, Minolta Co., Ltd., Tokyo, Japan) was used to measure the lightness and colour value of the parboiled rice fortified with chromium. L* shows lightness value, a* and b* each show the co-ordination of red/green and yellow/blue. Color value is counted thus: $B= \sqrt{(a^*)^2+ (b^*)^2}$.

G. Elongation

Elongation analysis was done by taking 2 grams of rice to be tested and cooking with 20 ml of water in a 100 ml glass beaker. The time used for elongation analysis was the cooking time from each sample. The elongation measurement was done by measuring the length before and after cooking in the following way:

$$\text{Elongation} = \frac{\text{length after cooking}}{\text{length before cooking}}$$

H. Water Uptake Ratio (WUR)

The analysis of the water uptake ratio was done by taking 2 grams of rice to be tested and cooking with 20 ml of water in a 100 ml glass beaker, the time for this analysis was result of the cooking time of each sample. The measurement was done by measuring the weight before and after cooking in the following way:

$$\text{Water up take ratio} = \frac{\text{weight after cooking}}{\text{weight before cooking}}$$

I. Solid Loss

Solid loss analysis was done by taking 2 grams of rice to be tested and cooking with 20 ml of water in a 100 ml glass beaker. The time for this analysis was the result of the cooking time of each sample. 5 ml of the cooking water was taken before drying in an oven at a temperature of 105°C for 1 hour, and then it was weighed until a constant weight was determined. The solid loss was counted in grams per 100

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grams of dry weight.

J. Level of Preference

The test of preference level used 20 half-trained panelists, who were asked to give a score for the quality of taste, aroma, colour and texture as well as the whole rice obtained, for both parboiled rice fortified with chromium and coated with herbal extracts, and non-parboiled rice. A scale of 1 to 7 was used where, 1 = extremely disliked, 2 = very disliked, 3 = disliked, 4 = between liked and disliked, 5 = liked, 6 = liked very much, 7 = extremely well liked.

K. Analysis Data

The trial design done was a factorial pattern complete random design with 2 factors i.e. various herbal extracts (bay, pandan and cinnamon) as the first factor and herbal extract concentrations (3%,6%, and 9%) as the second factor. Data was obtained by analysis of variance at the trust level of 95%. Any significant difference in each treatment was continued by Duncan Multiple Range Test.

III. Results and Discussions

A. Alkali Spreading Value

The result of monitoring the alkali spreading value of CFPR by adding herbal extract is shown in Table I. The results of various analyses show that the interaction between different kinds and concentrations of herbal extracts in producing parboiled rice fortified with chromium causes significantly different influences ($P<0.05$) on the alkali spreading value of parboiled rice fortified with chromium. Coating treatments with various kinds and concentrations of herbal extracts influence the alkali spreading value of CFPR.

TABLE I
Alkali Spreading Value of CFPR Coated with Various Kinds and Concentrations of Herbal Extracts

Kinds of extracts	Concentration (%)		
	3	6	9
Cinnamon powder	5^{c}	5^{c}	4^{b}
Pandan leaf	5^{c}	4^{b}	4^{b}
Bay leaf	4^{b}	4^{b}	3^{a}

The number followed by the notation of the same letter shows there is no significant difference in the level of 0.05 ($P<0.05$)

From Table I, it can be seen that the alkali spreading value ranged from 3 to 5. According to [17], the data indicated the rice to be at the medium / intermediate level of GT (Gelatinization Temperature) which means the CFPR can undergo gelatinization of starch at a temperature of 70–74°C. This is the temperature at which 90% of rice starch granules swell irreversibly in hot water with loss of crystalline structure and birefringence. Any significant difference in each treatment was continued by Duncan Multiple Range Test.

Results of earlier research have also shown that parboiled rice fortified with chromium without the addition of herbal extracts has medium temperature gelatinization, or an alkali spreading value of 5. Dipti et al. [19] reported the ASV of six fine grain rice varieties (Superfast, Basmati 4488, Khaszar, Basmati PNR, Badshabhog, and BRRI dhan 28) ranging from 3.0 to 3.9. GT was indexed by alkali spreading test. ASV corresponds to the following GT range low = < 70°C (ASV = 6-7), intermediate = 70 – 74°C (ASV = 3 – 5), and high = > 74°C (ASV = 2) [17]. A low ASV corresponds to a high GT, and conversely, a high ASV indicates a low GT.

The treatment of adding herbal extract at various concentrations influences the GT of parboiled rice fortified with chromium. The tendency found is toward the greater the concentration of herbal extract being used in coating, the lower the alkali spreading value. This is caused by the material in the extract coating the surface of the rice so it blocks the rice damaging process of the KOH.

B. Cooking Time

Monitoring results of the cooking time of CFPR with the addition of herbal extracts is shown in Table II. The cooking time is the time needed to cook the rice until 90% of the starch which does not show an opaque centre when the rice is pressed between 2 glass plates.

TABLE II
Cooking Time (in Min) of CFPR Coated with Various Concentrations and Kinds of Herbal Extracts

Kinds of extracts	Concentration (%)		
	3	6	9
Cinnamon powder	27^{d}	24^{a}	24^{a}
Pandan leaf	26^{c}	26^{c}	25^{b}
Bay leaf	25^{b}	25^{b}	25^{b}

The number followed by the notation of the same letter shows no difference in the significant level of 0.05.

Based on the statistical test in Table II, it was shown that cooking time with the addition of 6% and 9% cinnamon extract were not significantly different (24 min). Therefore, the addition of cinnamon extract at that concentration has a faster cooking time than rice with the addition of other extracts. While the addition of herbal extract concentration of bay leaf does not influence the length of cooking time, there is a tendency to show that greater addition of herbal extract concentrations shorten the cooking time. The monitoring result shows that particular cooking time becomes short enough compared to the cooking time of the rice without the parboiling treatment (28 min). This is due to the pre-gelatinization treatment during the parboiling process helping to speed up the gelatinization process in the cooking of the rice. This research differs greatly to the report by [20] who stated cooking times of 52 and 56 min in two local rice varieties from the same region where samples were collected. Meanwhile, it was reported by [21], that the cooking time was significantly decreased by increasing the soaking temperature from 40°C to 50°C and to 60°C ($p<0.05$), from 14.59 to 14.53 and to14.33 min, respectively.

C. Colour Value

Colour measurement was done by using a colour meter type CR-300. The colour test result of CFPR rice with herbal extract coating is shown in Table III. The results of various analyses show that the interaction between the kinds and

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concentrations of herbal extracts in making parboiled rice fortified with chromium causes a significantly different influence ($P<0.05$) on the colour value of parboiled rice fortified with chromium.

TABLE III
COLOUR VALUE OF CFPR COATED WITH VARIOUS KINDS AND CONCENTRATIONS OF HERBAL EXTRACT

Kinds of extracts	Concentration (%)		
	3	6	9
Cinnamon powder	15.00[a]	15.35[b]	16.23[c]
Pandan leaf	14.96[a]	15.99[c]	16.08[c]
Bay leaf	16.02[c]	17.45[d]	17.75[e]

The numbers followed by the notation of the same letters showed that there was no significant difference at the level of 0.05 ($P<0.05$).

Table III shows that there is a tendency for greater additions of herbal extract concentrations to lead to higher colour values of CFPR produced. The higher the colour value the darker the parboiled rice produced. Colour value test in parboiled rice by adding cinnamon extract ranged from 15.01 to 16.23. The colour of parboiled rice when cinnamon extract is added is influenced by flavonoids and chlorophyll. The water extract of pandan leaf contains tannin, alkaloids, flavonoids and polifenol [12], [22]. The highest colour value produced was in parboiled rice with a coating of bay leaf extract at a concentration of 9% i.e. 17.74.

The colour produced tended to be yellowish, and this yellow colour came from the flavonoid in bay leaf. Another influential factor is the herbal extract colour, the parboiled rice is known to have a yellowish colour because of the parboiling process [21], [23]. They reported that discoloration was mainly caused by Maillard type non-enzymatic browning and the processing conditions determined the intensity of colour during parboiling. The husk pigment also contributes by diffusing into endosperm during soaking.

D. Lightness

The values of L, which represent the degree of lightness of the samples (L = 100 denotes white; L = 0 denotes black). The analysis result of rice lightness from CFPR coated with various kinds and concentrations of herbal extracts is shown in Table IV. The statistical test result shows that there is significant difference with the addition of various kinds and concentrations of herbal extract.

TABLE IV
LIGHTNESS OF RICE FROM CFPR COATED WITH VARIOUS CONCENTRATIONS AND KINDS OF HERBAL EXTRACTS

Kinds of extracts	Concentration (%)		
	3	6	9
Cinnamon powder	42.30[d]	41.43[b]	39.80[a]
Bay leaf	44.13[f]	41.96[c]	41.36[b]
Pandan leaf	44.06[f]	43.93[f]	43.53[e]

The number followed by the notation of the same letters showed that there is no significant difference in the level of 0.05.

Table IV shows that the more the extracts added in CFPR, the less the brightness of the rice produced. This is caused by the higher content of herbal extract colour substance which lends a darker colour. The cinnamon is having essential oils, resinous compounds, cinnamic acid, cinnamaldehyde and cinnamate [24]. Essential oil such as eugenol is a liquid in oil form and with a yellowish colour. In bay leaf there are phenolic and polyphenol e.g. tannin and flavonoid compound [25], while in pandan leaf the substances with the colour function are chlorophyll, tannin and polyphenol [26]. Besides the influence of herbal extract colour substances, the brightness level of parboiled rice is also influenced by the parboiling process itself. Reported by Parnsakhorn and Noomhorn [27], the lightness or whiteness value decreased with increases in soaking time, soaking temperature and steaming time. Parboiling reduced the whiteness value of Chainat 1 from 43.63% to 37.57%, Supanburi1 from 40.88 to 36.30 and KDML 105 from 38.00 to 32.40%.

E. Elongation

The addition of various concentrations and kinds of herbal extract in CFPR can significantly influence elongation during the rice cooking process. It is shown in Table V that lengthening of CFPR coated with various kinds and concentrations of herbal extracts ranged from 1.53 to 1.87. The highest elongation was reached by the addition of 9% bay leaf extract (1.87). Elongation of rice can be influenced by the length (l) / breadth (b) ratio and the amylose contents. Grain elongation ratio of Ofada rice (*Oryza sativa* L.) ranged from 1.24–1.75 [28]. A positive correlation was also recorded for both amylose content and l/b ratio in relation to the elongation of rice [29].

TABLE V
ELONGATION OF PARBOILED RICE BY VARIOUS KINDS OF HERBAL EXTRACT COATINGS AT DIFFERENT CONCENTRATIONS

Kinds of extracts	Concentration (%)		
	3	6	9
Cinnamon powder	1.54[a]	1.67[b]	1.68[b]
Bay leaf	1.53[a]	1.68[b]	1.87[d]
Pandan leaf	1.53[a]	1.55[a]	1.71[c]

The number followed by the notation of the same letters showed that there is no significant difference in the level of 0.05.

F. Water Uptake Ratio

The extent of the amount of water absorbed by rice during cooking is considered an economic quality as it gives some estimate of the volume increase during cooking. If the bulk density is higher, correspondingly, water uptake ratio will also be higher. Water uptake ratio of CFPR coated by various kinds and concentrations of herbal extracts is shown in Table VI.

Based on the statistical test analysis results, it was shown that the concentration and kinds of herbal extract could influence the value of WUR of CFPR. WUR value ranged from 4.05-4.50. There was a tendency that the greater the amount of herbal extract added, the higher the WUR value was. The existence of compounds in herbal extracts which interact with starch from the CFPR can also increase the absorption of water. Water uptake ratio shows a positive influence on grain elongation (Tables V and VI). Meanwhile it was reported by [28], WUR of Ofada rice samples ranged from 1.74 – 2.11.

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TABLE VI
WATER UPTAKE RATIO (G/G) FROM CFPR COATED BY VARIOUS KINDS AND CONCENTRATIONS OF HERBAL EXTRACTS

Kinds of extracts	Concentration (%)		
	3	6	9
Cinnamon powder	4.05[a]	4.40[d]	4.44[e]
Pandan leaf	4.06[a]	4.11[b]	4.51[f]
Bay leaf	4.19[c]	4.37[d]	4.50[f]

The number followed by the notation of the same letters showed that there is no significant difference in the level of 0.05.

G.Solid Loss

Solids released by rice into the cooking water have also been considered a cooking quality attribute. Solids in cooking water may be correlated with the amylose content and may also be related to the stickiness of cooked rice. The analysis result of solid loss in rice from CFPR coated with various kinds and concentrations of herbal extracts is shown in Table VII which shows that significant differences in the amount of solid loss are caused by the addition of different concentrations and kinds of herbal extract in CFPR. It can be seen with the addition of herbal extract at 3%, the amount of solid loss ranged from 0.09 to 0.13% (dry weight) while with additions at 6% and 9% the amount of solid loss decreased from 0.05 to 0.07% (dry weight). The amount of solid loss decreased at the same time as the amount of herbal extract added. It also can be said that, the higher the concentration of extract added, the lower the solid loss in CFPR. Danbaba et al. [28] reported that solid loss ranged from 0.80% in Ofada 8 and 9 to 2.10% in Ofada 3 and on average 1.25%. The slightly higher solids recorded in Ofada cooking water than the checks may be attributed to the processing techniques of Ofada rice.

TABLE VII
SOLID LOSS FROM CFPR COATED BY VARIOUS CONCENTRATIONS AND KINDS OF HERBAL EXTRACTS

Kinds of extracts	Concentration (%)		
	3	6	9
Cinnamon powder	0.09[g]	0.07[f]	0.07[e]
Bay leaf	0.09[h]	0.06[b]	0.05[a]
Pandan leaf	0.13[i]	0.06[d]	0.06[c]

The number followed by the notation of the same letters showed that there is no significant difference in the level of 0.05.

H.Level of Preference

A preference test is a test done to determine panelists' preference levels of CFPR coated with various concentrations and kinds of herbal extracts. Parameters tested are: aroma, texture, colour, taste and whole scores. Preference test results can be seen in Table VIII.

The analysis result showed that in the aroma parameter, panelists preferred parboiled rice fortified with chromium with the addition of pandan extracts. From Table VIII it can be seen that panelists preferred rice from CFPR added with 3% to 9% pandan extract and 3% cinnamon extract. This is due to the pandan leaf extract is more fragrant than other extracts. The main compound responsible for the aroma in pandan leaf is 2-acetyl-1-pyrolin [26], [30]. While the addition of cinnamon extract at more than 3% gave, too strong aroma was less liked by the panelists.

Table VIII shows that the treatment of herbal extract addition to CFPR influenced the panelists' judgement of the attributes of rice texture of CFPR coated with 3% pandan extract and 3% cinnamon extract. The development of water volume and its absorption into rice during cooking time has a positive correlation with the concentration of rice amylose, whereas stickiness, softness, fluffiness and rice taste score has a negative correlation with the rice amylose concentration. When rice is cooked with high amylose concentration, the rice becomes dry and hard. CFPR has 18.9 to 22.30% amylose, which comes into the category of medium amylose concentration.

The statistical test result in Table VIII showed that panelists preferred CFPR coated with 3% cinnamon extract. The use of cinnamon extract at more than 3% and other herbal extracts produced a rather brownish colour and panelists did not like it.

Panelists preferred the taste of rice from CFPR coated with 3% and 6% pandan extract and 3% cinnamon extract. A coating of bay leaf was not liked because of the bitter taste caused by the saponin in the bay leaf.

Based on the panelists' judgement result of whole quality attributes (aroma, colour, texture and taste) was found the most preferred/well liked rice was from CFPR coated by 3% pandan and cinnamon extract which had a score of 5.15 to 5.20 and there was significant difference in control or in CFPR without herbal extract (5.35 = liked till liked very much).

TABLE VIII
SENSORIC TEST RESULT OF RICE FROM CFPR COATED WITH VARIOUS KINDS AND CONCENTRATIONS OF HERBAL EXTRACTS

Kinds of herbal	Concentration (%)	Parameter				
		Aroma	Texture	Colour	Taste	Overall
Cinnamon powder	3	4.95[ab]	4.70[abc]	5.45[a]	4.85[ab]	5.20[a]
Cinnamon powder	6	4.00[cd]	3.85[d]	4.25[b]	3.95[cd]	3.80[bc]
Cinnamon powder	9	3.90[cd]	3.80[d]	3.30[cd]	3.45[cd]	3.45[c]
Pandan leaf	3	4.75[abcd]	4.85[ab]	3.85[bc]	4.85[ab]	5.15[a]
Pandan leaf	6	5.05[a]	3.80[d]	4.30[b]	4.25[abc]	4.35[b]
Pandan leaf	9	4.60[abcd]	4.15[bcd]	3.85[bc]	3.45[cd]	3.75[bc]
Bay leaf	3	3.90[cd]	4.10[bcd]	3.25[cd]	4.10[bc]	4.05[bc]
Bay leaf	6	4.05[bcd]	4.40[bcd]	3.10[d]	3.85[cd]	3.70[bc]
Bay leaf	9	3.85[d]	4.00[cd]	2.60[d]	3.20[d]	3.55[bc]
*Control	0	4.80[abc]	5.35[a]	6.00[a]	5.05[a]	5.35[a]

The number followed by the notation of the same letters showed that there is no significant difference in the level of 0.05.
*Control is parboiled rice fortified with chromium without herbal extract (the addition of gum arabic, sorbitol, and tween 80).

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IV. Conclusions

The parboiled rice fortified with chromium and coated with herbal extracts preferred by panelists is rice coated with 3% pandan and cinnamon extract, which has a score of 5.15 to 5.20 (liked till like very much). That rice has cooking qualities such as: an alkali spreading value of 5 (intermediate gelatinization temperature), cooking time of 26-27 min, color value was 14.95-15.00, and lightness was 42.30 – 44.06, elongation of 1.53 – 1.54, water uptake ratio of 4.05-4.06 and solid loss of 0.09/100 g – 0.13 g/100 g.

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