Characteristics Characteristic Of Chemical Rice Analog Based On Arrowroot Starch (*Maranta arundinacea*) With The Addition Of Kelor Leaf (*Moringa oleifera*) and Broccoli Pulp

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Abstract. This research studied the effect of different sources and percentage of chlorophyll on the quality of analog rice. This study uses Nested design with first factor as the nest is the source of chlorophyll and second as a nested factor is concentration of chlorophyll (5%, 7.5% and 10%). The analysis tested was moisture content, ash, protein, lipid, fiber, carbohydrate, total calories, antioxidant activity, and total chlorophyll. After cooking, the rice conducted the sensory test (appearance, flavor, aroma, texture), antioxidant activity and total chlorophyll. The results showed that the addition of chlorophyll sources and the percentage of chlorophyll affect moisture, ash, protein, fat, carbohydrate, fiber, total calories, antioxidant activity, total chlorophyll, and the appearance of analog rice as well as no effect on the flavor, texture, and aroma of analog rice. This research resulted that the lowest moisture of 8.22% derived from the treatment of 5% kelor leaf, the highest carbohydrate of 90.58% from the treatment of 5% broccoli pulp, the highest antioxidant activity in rice of 22.118% from treatment 10% broccoli pupl as well as the highest chlorophyll in rice of 10%, 2.72 mg/L from the treatment of kelor leaf.

Key word : arrowroot tuber, antioxidant, chlorophyll, diversification, fortification

INTRODUCTION

Rice demand in Indonesia to meet food needs is increasing. At 2017, Indonesia is still importing rice as much as 305,274.6 tons from several countries (BPS, 2019). Diversification of food is carried out as a food security effort by utilizing local food resources. One of the local food resources is arrowroot tuber. Arrowroot can be used as a diversified material because of the abundant amount of it reach 17 tons/ha or about 1.7-3.4 tons of starch per ha (Djafar et al., 2010), however the utilization of arrowroot in Indonesia is still low. In addition, the content of carbohydrate in arrowroot starch is high about 91.59% (Damat and Kurniawati, 2006).

Analog rice is one of the efforts of food diversification. In addition to requiring materials with high carbohydrate, analog rice also needs other ingredients such as *Gracillaria sp.* as a hydrocolloidal. The functional properties of analog rice is performed fortification with Kelor leaves and broccoli which are rich in antioxidants (caratenoid, phenolic, flavonoid) and minerals. Moreover it

also contain chlorophyll that able to improve the more attractive color of the analog rice. This research aimed to make the analog rice from arrowroot starch with the addition of kelor leaves and broccoli that has functional properties.

RESEARCH METHODS
Materials
The materials used in this research were arrowroot starch obtained from the Magetan, East Java, Indonesia with white color, smelling typical tuber arrowroot, fresh dark green Kelor leaves and dark green broccoli from market Malang, East Java, Indonesia.

Equipment
The tools used were juicer, extruder, cabinet dryer, analytical scale GR-200, Spektophotometer Shimadzu UV-1800.

Brocolli and Kelor leaves preparation
Broccoli and Kelor leaves were sorted to remove undesirable part. Then the material was cleaned and washed with water flow to remove dirt and drained dirt. Then put into the juicer to be mashed up.

Rice Analog production
The arrowroot starch was weighted then mixed with the brocolli and Kelor leaves pulp, and followed by steaming for 30 minutes. Then extrusion process was carried out using an extruder machine. After granules analog rice formed, the next step was dried using a cabinet dryer for ± 10 hours. Then, sifting was done to separate the grains of rice.

Research Parameter
Analysis carried out on Kelor leaf and broccoli pulp includes antioxidant activities and total chlorophyll. Analysis carried out on analog rice include moisture, ash, carbohydrate, protein, fat, crude fiber, total chlorophyll, color intensity, and antioxidant activity while analysis of rice after cooking included organoleptic, antioxidant activities and total chlorophyll.

Research Method and Data Analysis
This research uses the draft of a nest pattern with a factor of 1 as the nest is the source type of extract and factor II as a nested factor ie the percentage of extracts. Factor I consists of two levels (the leaves of kelor and broccoli) and the II factor consists of 3 levels (5%; 7.5%; 10%). Data analyzed by Analysis of variance (ANOVA) to know influence of treatment. Furthermore, if the effect is then continued with the Honestly Significant Difference (HSD) test with α = 5%.

RESULTS AND DISCUSSION
Raw Material Characteristic

Table 1 shows that the content of starch in arrowroot starch is high. According to Valencia (2014) starch content in arrowroot starch starch amounted to 98.10%. The starch content of a tuber is influenced by the type or clones, the optimum harvest age, and the weather conditions at the time of harvest. If the tube harvested in the rainy season relatively produce low yield due to the high water content (Ginting and Noerwijati, 2008). Starch content consists of amylose and amylopectin which amounted to 24.64% and 73.46% respectively.

Table 1. Results of raw materials analysis

Components	Garut starch	Kelor leaves	Broccoli
Moisture content	15.05*	77.31	89.45
Starch content (% bb) * *	9.10	-	-
Fibre (%) * *	0.12		
Amyc levels (% bb) * *	24.64	-	-
Amiopektin levels (% bb) * *	73.46	-	-
Antioxidant activity (%)	-	47.24	69.97
Total Chlorophyll (mg/l)	-	12.68	6.21

Sources: **Valencia et al (2014)
            *Faridah, dkk (2014)

Kelor leaves and brocolli have antioxidant activity of 47.24% and 69.97% respectively, that perhaps derived from chlorophyll about 12.68%. and 6.21% respectively. It can contribute functional properties into analog rice.

Analog Rice Nutrition and Calories
Moisture content of rice analog

Table 2 shows the moisture of analog rice with the addition of broccoli pulp is higher than the addition of the Kelor leaf pulp. Based on the results of raw material, kelor leave contain of 77.31% of moisture and broccoli amounted 89.45%. The higher the percentage of pulp added the higher the water content of the analog rice produced. Moisture of analog rice ranged from 8-10%. These results have fulfilled the Indonesian National Standard (SNI) 6128:2008 of Rice that rice should contain moisture less than 14%.

Ash of analog rice

Table 2 shows that the ash of the analog rice with the addition of broccoli pulp is higher compared to the addition of Kelor leaf pulp, because the content of ash and mineral in broccoli is higher than the Kelor. The higher pulp percentage, the higher the ash of analog rice. The amount of ash on a food depends on the amount of mineral content used (Fatkhurahman et al., 2012).

Table 2. Analog Rice Nutrition and Calories

Chlorophyll sources	(%)	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fibre (%)	Carb (%)	Callories (kal)
Kelor Leaf Pulp	5	8.224 d	0.473 e	0.159 cd	1.381 c	23.151 f	89.488 b	371.017 b
	7.5	8.712 cd	0.662 d	0.243 b	2.354 b	24.282 e	88.036 c	374.303 a
	10	9.724 ab	0.947 b	0.294 a	3.335 a	25.282 d	85.583 d	373.527 a
Broccoli Pulp	5	8.480 d	0.861 c	0.132 d	0.541 e	33.137 c	90.583 a	367.729 c
	7.5	9.313 bc	0.986 b	0.136 d	0.761 de	34.299 b	89.014 b	363.451 d
	10	10.152 a	1.089 a	0.179 c	1.079 cd	35.263 a	87.672 d	361.115 e

The average value participated by the same letter notation does not differ according to the HSD test α = 5%

Protein of analog rice

The protein of the analog rice with the addition of Kelor leaf pulp is higher than the addition of broccoli pulp, because Kelor leaves contain a variety of amino acids. The content of amino acid in the Kelor leaves such as Argine, Leusin, Lysin, Pheynilalanine (Aminah et al., 2014). The higher of the percentage of pulp added, the higher protein got. According to Krisnadi (2015), the protein content of the Kelor leaves is 6.7% while 2.82% in broccoli (USDA, 2016).

Fat of analog rice

The analog rice with the addition of the Kelor leaf pulp contains highest fat. The addition of Kelor and broccoli increased the fat of analog rice. According to Salimi et al (2019), the highest fatty acids found in kelor leaf is oleic acid of 38.08% while the Broccoli contains Omoga-3 as much as 8% (Dawn, 2008).

Fibre of analog rice

The analog rice with the addition of broccoli porridge has a higher fibre. As the percentage of pulp increased, the fiber of analog rice also increased, because the vegetables contain high fiber. According to Krisnadi (2015) fiber content of Kelor leaves is 0.9 g, while in the broccoli amounted to 1.5 g (USDA, 2016).

Carbohydrate of analog rice

The analog rice with the addition of broccoli pulp have a higher carbohydrate. The carbohydrates of the analog rice decreased as the increase of the Kelor leaf and Brocolli pulp percentage. According to Fatkhurahman et al (2012), the carbohydrate levels calculated by the difference are influenced by other nutritional components i.e. water, ash, fats and proteins.

Total calories of analog rice

The total calories of the analog rice decreases as the percentage of the Kelor leaf and Broccoli increase. Total calorie of the analog rice is influenced by other nutritional content such as carbohydrates, proteins and fats. The higher the three components, the higher the energy produced. Total calories of rice analog in this research is higher than the rice that commonly consumed around 360 kcal (Larasati, 2013).

Antioxidant activity

Table 3 shows the antioxidant activity of analog rice with the addition of Kelor leaf pulp is almost equal to Brocolli addtion. According to Table 1, antioxidant activity of Kelor leaves is 47.24%, while Broccoli amounted to 69.97%. The antioxidant activity of analog rice increases as the percentage of Kelor or Brocolli pulp increases.

Table 3. Average activity of antioxidant analog rice and cooked-analog rice

Chlorophyll sources	Percentage (%)	Rice (%)	Cooked rice (%)	Decline (%)
Kelor Leaf Porridge	5	19.749 c	17.440 c	2.3
	7.5	21.386 b	18.987 b	2.4
	10	22.083 a	20.464 a	1.6
Broccoli Porridge	5	18.983 d	17.581 c	1.4
	7.5	21.351 b	19.093 b	2.2
	10	22.118 a	20.394 a	1.7

The average value participated by the same letter notation does not differ according to the HSD test $\alpha = 5\%$

Antioxidant activity of analog rice decrease when compared to the initial percentage of kelor and broccoli leaves. This is due to the heating when analog rice processing such as steaming or pregelatinization, destruction, and drying.

Total Chlorophyll

Table 4 shows that the total chlorophyll of analog rice with the addition of the Kelor leaf pulp has twice as high as the rice with the addition of broccoli pulp. This is influenced by the total chlorophyll of the Kelor leaves that higher than broccoli (Table 1).

The total chlorophyll decreased after cooking, ranged from 1 to 1.5%. It is influenced by several factors such as pH, light, heat and oxygen that can affect the chlorophyll stability. Heating can denaturate protein so the chlorophyll becomes unshield (Oktaviani, 2014).

Table 4. Average activity of Chlorophyll analog rice and cooked-analog rice

Chlorophyll sources	Percentage (%)	Rice (%)	Cooked rice (%)	Decline (%)
Kelor Leaf Porridge	5	2.047 c	1.583 b	0.46
	7.5	2.535 b	1.758 a	0.77
	10	2.723 a	1.854 a	0.88
Broccoli Porridge	5	1.260 e	1.229 c	0.03
	7.5	1.320 de	1.263 c	0.06
	10	1.387 d	1.295 c	0.09

The average value participated by the same letter notation does not differ according to the HSD test $\alpha = 5\%$

Sensory of Cooked-Rice Analog
Appearance

Table 5 shows that the panelist is more like cooked analog rice with the addition of the Kelor leaf pulp than analog rice with broccoli, because the color of the cooked analog rice with the addition of the leaf pulp is more interest. According to Krisnadi (2012), Kelor leaves contain chlorophyll with high concentrations. Kelor leaves contain chlorophyll at 6.890 mg/kg of dry material.

Table 5. The average appearance score of rice analog

Chlorophyll sources	(%)	Appearance	Taste	Flavor	Texture
Kelor Leaf Pulp	5	3.6 ab	3.1	2.7	3.1
	7.5	3.2 ab	2.7	2.9	3.4
	10	3.6 a	2.5	2.8	3.0
Broccoli Pulp	5	2.6 b	2.7	3.0	2.7
	7.5	2.5 b	2.9	3.2	3.2
	10	2.7 b	2.7	2.7	2.9

The average value participated by the same letter notation does not differ according to the HSD test $\alpha = 5\%$

Score Description :
Appearance:
1=very uninteresting,2 = not interesting,3= quite interesting, 4= draw, 5 =very interesting
Taste :
1 = Very bad, 2 = not tasty, 3 = quite tasty, 4 = tasty, 5 = very good
Flavor:
1 = very unscented cooked rice, 2 = no flavorful cooked rice, 3 = moderately scented cooked rice, 4 = flavoured cooked rice, 5 = very flavorful cooked rice
Texture :
1=very unfluffy 2=not fluffy, 3=moderately fluffy, 4=fluffy, 5= very fluffy

Taste

The differences of chlorophyll source and percentages did not affect the taste, but the higher the percentage of pulp, the taste score decrease, especially in the addition of kelor leaf treatment. The more addition of Kelor leaves, the

bitter taste of cooked analog rice. This is influenced by the amino acid of the Kelor leaves which serves as one of the aroma and flavor. In addition, Kelor leaves have a distinctive flavor because the content of tannins (Rosyida, 2016). Cooked analog rice with broccoli addition also has bitter taste because it contains glucosinolate compounds.

Flavor

The lower flavor score of the cooked analog rice show the similarity to ordinary cooked rice. The analog rice produced by arrowroot starch that have a distinctive flavor thus it will affect the flavor. The flavor of Kelor leaf pulp also influenced the panelist. Kelor has compound that causes the unacceptable smell. According to Hasniar et al (2016) Kelor leaves have an essential and enzyme lipoxygenase that causes an unacceptable smell.

Texture

The texture score of cooked analog rice indicated that the analog rice is quite fluffy. The texture tends to chewy. This is due to the high of amylopectin in arrowroot starch as raw material that amounted to 73.46% (Faridah, et al, 2014).

Kelor leaf pulp addition produces cooked analog rice with a more fluffy texture and chewy than the addition of broccoli. It is not in accordance with Dewi et al. (2016), that tannins causes dry. Kelor leaves have tannins that can bind and precipitate proteins. This inconformity can be influenced by untrained panelists who have varying levels of sensitivity.

CONCLUSION

The differences chlorohyll source and its percentage affected the chemical content of analog rice. The addition of Kelor and broccoli also influenced the antioxidant activity and total chlorophyll. The increase of antioxidant activity and total chlorophyll reaches 3.13% and 0.68%, respectively. The addition of kelor and broccoli affects the appearance of cooked analog rice but has no effect on the flavor, texture, and aroma.

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