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## Nutrient improvement of *Bruguiera gymnorrhiza* peel fruit through fermentation using commercial tempeh (Indonesian fermented soybean) mold

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# Nutrient improvement of *Bruguiera gymnorrhiza* peel fruit through fermentation using commercial tempeh (Indonesian fermented soybean) mold

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**Abstract.** The whole *Bruguiera gymnorrhiza* fruit contains about  $80 \pm 1.75$  % edible fruit and  $20 \pm 1.75$  % peel, in which the peel contains about 94,400 ppm tannin. This research aims to study the nutritional improvement of *Bruguiera gymnorrhiza* peel flour through fermentation using commercial tempeh (Indonesian fermented soybean). The blanched fruit was peeled out, and then the peel was chopped and inoculated thoroughly with the dry matter of tempeh culture at a concentration of 0.2 % (w/w), 0.4 % (w/w) and 0.6 % (w/w). The fermentation was carried out in a glass jar for 72 hours at the ambient temperature. This research showed that fermentation can reduce the tanin concentration and increase the carbohydrates and protein. The lowest tanin concentration was obtained using a mold concentration of 0.6 % (w/w) ( $39,600 \pm 0.01$  ppm), which was much lower than the unfermented fresh peel ( $94,400 \pm 0.01$  ppm). Fermentation using mold at 0.6 % (w/w) also produced flour with the highest carbohydrate and protein content compared to the unfermented fresh peel and other lower mold concentrations used. Hence, the higher the mold concentration, the more nutritional value and the less anti-nutritional *Bruguiera gymnorrhiza* flour can be obtained.

## 1. Introduction

*Bruguiera gymnorrhiza* is a mangrove plant that is widely cultivated in some coastal areas in Indonesia, which protects the land from the risk of sea waves as well as maintaining other living organism sustainability. The whole *Bruguiera gymnorrhiza* fruit contains about  $80 \pm 1.75$  % edible fruit and  $20 \pm 1.75$  % peel. The peeled fruit is processed by people in the surrounding coastal area into flour, which can be formulated into food ingredients such as cake, cookies and bread. *Bruguiera gymnorrhiza* peel



can be abundant, since the flour is massively produced. Meanwhile, *Bruguiera gymnorrhiza* peel has not yet been utilized.

The preliminary study on the chemical characteristics of *Bruguiera gymnorrhiza* peel demonstrated that *Bruguiera gymnorrhiza* peel contains about 94,400 ppm tannin. Tannin is a natural antioxidant substance derived from various plants, but it can be toxic for humans or animals in excess concentrations. Aside from tannin, HCN is also an anti-nutritional substance found in *Bruguiera gymnorrhiza* fruit [1].

Massive *Bruguiera gymnorrhiza* flour production will produce peel abundantly, so the utilization of peel is highly possible to be carried out on a massive scale as well. So far, people use ash suspension to reduce the content of HCN and tannin in the fruit, instead of repeatedly water rinsing, because ash absorbs those substances [1]. Unfortunately, ash is produced through burning wood or leaves, whereas these are not highly recommended to be massively exploited, due to environmental sustainability issues.

Solid state fermentation using *Rhizopus* sp. proved able to reduce the content of HCN and tannin in the *Bruguiera gymnorrhiza* peel, which is catalyzed by the cyanogenic glucosidases secreted by *Rhizopus* sp. during fermentation [2, 3]. It also secretes lipase, amylase and protease, which modify the physicochemical of growth medium [4]. However, although the use of pure *Rhizopus* sp. was successfully proven able to improve the medium, it is not really practical as the price is not that affordable.

Tempeh is a soybean product produced through fermentation inoculated using *Rhizopus* sp. Nowadays, people have discovered a commercial mixed culture containing *Rhizopus* sp., which is easily found and not expensive. The mixed culture contains yeast, mold and microfloras (*Lactobacillus* sp.) which modify the physicochemical properties of the tempeh [5]. Therefore, this promotes the use of the tempeh mixed culture. Therefore, this work aims to study the effect of inoculum (commercial tempeh mold) on the content of the HCN, tannin and other macronutrients of *Bruguiera gymnorrhiza* peel flour.

This research is expected to be able to provide pivotal information to improve the quality of *Bruguiera gymnorrhiza* peel flour, which is simply implemented by people for feed purposes. Aside from that, this is a reference for the government to assist them in conserving the mangrove ecosystem for maintaining or even improving environmental sustainability.

## 2. Material and method

### 2.1. *Bruguiera gymnorrhiza* peel preparation

The *Bruguiera gymnorrhiza* fruit was obtained from the mangrove conservation site in Wonorejo, Surabaya, East Java, Indonesia. The fruit was heated in hot water at the temperature of 90 °C for 4 - 5 minutes and then the fruit was peeled and copped using a copper food processor.

### 2.2. Production of fermented *Bruguiera gymnorrhiza* peel flour

Solid state fermentation was carried out using cooked *Bruguiera gymnorrhiza* peel as the medium. The mold was inoculated throughout the copped fruit peel at a concentration of 0.2 % (w/w), 0.4 % (w/w) and 0.6 % (w/w), and then incubated at an ambient temperature for 3 days. After 3 days, the fermented peel was sun-dried until fully dry and the dry peel was milled and then passed through a 100 mesh cut-off membrane.

## 3. Results and discussion

Solid-state fermentation often brings about an improved quality in the substrate and enhances the nutritional quality of the food. The results have been summarized in Table 1, and they tend to support the previous studies. This is because the chemical quality of the fermented *Bruguiera gymnorrhiza* peel was richer than that of the unfermented peel. Several interrelated biochemical processes are believed to have led to the improved quality of the peel [2, 3, 6]. The complex processes characterizing fungal growth and peel degradation may have resulted in the depletion of the sugars, particularly the monosaccharides. This may have led to the biosynthesis of new ones.

**Table 1.** Proximate properties of the fermented *Bruguiera gymnorrhiza* peel flour

Parameter	Unfermented	Inoculum concentration (%)		
		0.2	0.4	0.6
Moisture (%)	12.56	12.88	13.00	10.97
Carbohydrate (%)	70.78	72.60	72.70	73.11
Ash (%)	4.44	3.43	3.41	3.93
Crude protein (%)	5.32	5.50	5.59	6.45
Fat (%)	6.9	5.60	5.31	5.54
BETN (%)	NA	64.93	65.35	64.88
ME (Kcal/kg)	NA	2993.03	2989.38	3054.34
HCN (ppm)	ND	ND	ND	ND
Tannin (ppm)	54500	57900	40100	39600
Yield (% w/w)	NA	39.90	41.00	42.00

ND : not detected

NA : not analyzed

The changes in the tannin content of the peel were a good indicator of fermentation. Based on these results, the extent of detoxification appeared to be related to fungal growth in the fresh peel. Thus, the major benefit of fermentation was the drastic reduction in the concentration of the toxic components. The final tannin level of the fermented peel was lower than the official level recommended for *Bruguiera gymnorrhiza* products. HCN was not found in both fermented and unfermented peel flour, because the content of HCN in the peel was too low and the analysis could not detect it. This phenomenon is caused by the environmental condition of the *Bruguiera gymnorrhiza* that was cultivated.

A few species of fungi are known to produce enzymes that hydrolyse cyanogenic glucosides [2, 3]. They are important in the detoxification process. Therefore, it is possible that the *Rhizopus* sp. used in this study had a high potential to produce cyanogenic glucosidases and other enzymes important in the modification of the texture and digestibility of the *Bruguiera gymnorrhiza* peel. The results could be important in the development of food stuffs from the *Bruguiera gymnorrhiza* peel.

#### 4. Conclusion

This research showed that fermentation reduced the tanin concentration and increased the carbohydrate and protein. The lowest tanin concentration was obtained using a mold concentration of 0.6 % (w/w) ( $39,600 \pm 0.01$  ppm), which was much lower than in the unfermented fresh peel ( $94,400 \pm 0.01$  ppm). Fermentation using mold at 0.6 % (w/w) also produced flour with the highest carbohydrate and protein content compared to the unfermented fresh peel and other lower mold concentrations used. Hence, the higher the mold concentration, the more nutritional value and less anti-nutritional *Bruguiera gymnorrhiza* flour was obtained.

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