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Indonesia Local Beans and Its Benefit as Functional Food

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Abstract

Indonesia has a diversity of local bean resources that are spread throughout the region. Local beans were found in Indonesia include cowpea (*Vigna unguiculata*), kerandang (*Canavalia virosa*), sword beans (*Canavalia ensiformis*), koro (*Canavalia gladiata*), gude (*Cajanus cajan*), faba (*Vabia faba*), komak (*Dolichos lablab*), etc. Some research results have revealed the potential of local beans as a source of good nutrition for the body healthy. This local bean has a high protein content about 22.9% to 37.4% so that it functions as a source of protein. In Indonesia, local beans are used as raw material for the processing of tempeh, tofu, and non-dairy milk. Local beans and its products contain good nutritional value and contain isoflavones which have functional benefit as antioxidants.

Keywords: Local Beans; Resources Diversity; Functional Benefit; Protein Source; Isoflavones

Introduction

Indonesia has the potential of local bean resources that are spread throughout the region. Local beans have the potential as a source of nutrition, especially protein. Some research results have revealed the potential of local beans as a source of good nutrition for the body healthy. Local beans contain protein, fat, dietary fiber, minerals and phenolic compounds that have health benefits [1-3].

Local bean plants have advantages, can grow on sandy land and nutrient-poor fields with high productivity (0.7 to 5.0 tons/ha) [4]. The exploration of the potential and utilization of local beans in Indonesia has been supported by various studies on processing technologies. The development of local bean processing technology is intended as a substitute for even soybean substitutes to produce soybean-equivalent products, improving product quality both physical and nutritional quality, improving the image and taste of the product. The objective of this manuscript is to provide information about types, nutrition content, processing, and benefit as functional food of Indonesian local beans.

Type of Indonesia Local Beans

Various types of local beans can be found throughout the region of Indonesia. In this text, we will focus discuss four types of local beans in Indonesia, namely *koro*, mung bean, *kerandang*, and cowpea. Koro beans have many types (23 types), but those that are widely used as food are koro benguk (*Mucuna pruriens*), *koro pedang* (*Canavalia ensiformis*), koro glinding (*Phaseolus lunatus*) [5], as presented in Figure 1.

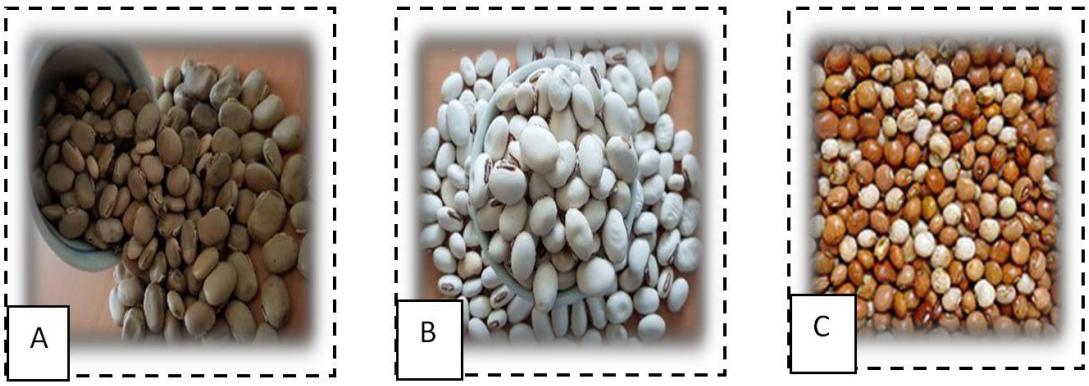

Figure 1: The types of koro beans, **(a)** *koro benguk* **(b)** *koro pedang dan* **(c)** *koro glinding*

*Main contributors

The other local beans is mung beans (*Vigna radiata*), Figure 2. Mung beans can be found throughout Indonesia. This bean was third ranked after soybeans and peanuts in peanut development in Indonesia. The various varieties of mung beans have been produced by the Indonesian Agency for Agricultural Research and Development, Ministry of Agriculture, including Vima 1, Vima 2, Vima 3, Vima 4 and Vima 5 [6].

(a) **(b)**

Figure 2: (a) Mung bean plant **(b)** Mung beans

Kerandang (*Canavalia virosa*) and cowpea (*Vigna unguiculata*) are the other local beans that can be found in Indonesia. Kerandang plant can be found in the sand beach area of the island of Java. *Canavalia virosa* which found in coastal sand in Kulon Progo Regency and Bantul Regency, Yogyakarta Special Region, is call as Kerandang. Kerandang plants that grow wild along the sand beach of Yogyakarta have productivity of 909 to 1000 kg/ha. Kerandang produce pods measuring between 10-15cm, containing 4-8 seeds that are brown color, with a seed length of 14.3 mm and a width of 9.8 mm [7,8] as presented in Figure 3.

(a) **(b)** **(c)**

Figure 3: (a) Kerandang plant which grow in sand beach land, Yogyakarta; **(b)** Kerandang beans; **(c)** Peeled kerandang beans

Cowpea as one of the local bean types, there are two types of cowpea based on seed peel color, namely red and white cowpea (Figure 4). In Indonesia, cowpea is planted in various ecological zones from the lowlands to the highlands, dry climates to wet climates. Generally, cowpea is used as raw material for tempeh [4] and a mixture in traditional Javanese cuisine called *brongkos* and *gudeg krecek*.

(a) **(b)** **(c)**

Figure 4: (a) Cowpea plant; **(b)** Red cowpea and **(c)** White cowpea

Nutritional Content of Indonesia Local Beans

Local beans belonging to leguminous plants produce pods and a source of protein. The nutritional content of kerandang, *koro pedang,* mung beans and cowpea are presented in Table 1. Water, ash fat and carbohydrates content (Table 1) shows statistically significant differences between Kerangdang, *Koro pedang*, Mung bean, and Cowpea, except protein content between Mung bean and Cowpea not significant differences. Kerandang has the highest protein content among Indonesia local beans.

Component	*Kerandang* [8]	*Koro pedang* [9]	Mung bean [10]	Cowpea 11]
Water (%)	$12,7^{c}$	$13,5^{d}$	$12,5^{b}$	11^{a}
Ash (%)	$2,8^{b}$	$2,3^{a}$	-	-
Protein (%)	$37,3^{c}$	$35,3^{b}$	$22,9^{a}$	$22,9^{a}$
Fat (%)	$1,3^{c}$	$1,6^{d}$	$1,2^{b}$	$1,1^{a}$
Carbohydrate (by different) (%)	$45,9^{a}$	$47,3^{b}$	$62,8^{d}$	$61,6^{c}$

Table 1: Nutrition content of kerandang, koro pedang, mung bean, cowpea

Local beans also content minerals, such as calcium, sodium, potassium, phosphorus, magnesium, zink, mangannes, copper and iron. Also contain amino acid, such as glutamic acid aspartic acid, alanine, arginine, isoleucine, leucine, histidine, tyrosine and lysine. Several fatty acid also founded in local beans, such as palmitic acid, stearic acid, linoleic acid, oleic acid and linolenic acid [8, 9].

Indonesia Local Beans Product and Its Nutrition Content

Tempeh: Tempeh made from soybeans or the other local beans is authentic Indonesian food, centuries ago made on the island of Java, especially in Yogyakarta and Surakarta. In temporarily, Tempeh processed using local soybeans, given natural yeast from *waru* leaves or *jati* leaves and then wrapped with banana leaves so that it has a better taste.

Tempeh is one of the fermented beans technologies using pure culture *Rizopus* spp. or using tempeh starter which containing *Rhizopus oligosporus, Rizopus oryzae, Rizopus stolonifer* and *Klebsiella* [10]. Some lactic acid bacteria such as Lactobacillus spp., Pediococcus spp. and Streptococcus spp. plays an active role in the early stages of fermentation local beans into tempeh and has antimicrobial activity [11-13]. The presence of lactic acid produced by lactic acid bacteria will spurs *Rhizopus* spp. to grow.

Indonesia is known as the largest tempeh producer in the world. Tempeh production is not only in Indonesia but has worldwide such as in the United States, Canada, Mexico, Netherlands, Belgium, Australia and Africa [14]. Tempeh, generally consumed by the Indonesia people as a companion food for rice (*lauk*). Even now, tempeh has been developed from local beans in several regions in Indonesia, such as tempeh *koro benguk* in Yogyakarta, Central Java, East Java and South Sulawesi. Local bean tempeh products are presented in Figure 5. Local bean tempeh has good nutritional content, especially as a protein source. Local Bean Tempe also contains vitamins and minerals and even contains phenolic compounds that are good for the body health.

The local bean *koro pedang* has been used as raw material for tempeh processing. Tempe *koro pedang* has a protein content of 16.62%, 6.84% fat, 9.72% carbohydrate, diatery fiber 3.66% and brighter colors [15]. Tempeh kerandang has a brighter color than soybean tempeh and has a soft texture that is preferred by consumers. Kerandang tempeh has higher protein content (19.37%) than soybean tempeh (12.02%) and *koro benguk* tempeh (11.60%) [16] and contains essential amino acids and essential fatty acids which are good for the body health [17].

(a) **(b)**

Figure 5: Local beans tempeh **(a)** koro benguk tempeh and **(b)** kerandang tempeh

Cowpea has been also used as raw material for processing tempeh. Cowpea tempeh has a protein content of 31.91%, 2.52% fat, 41.27% carbohydrate and crude fiber 10.66% [18]. Tempeh can also be processed from Mung beans. Mung bean tempeh has a vitamin E content of 8.83ppm with antioxidant activity of 210, 74 106 mg/L [19].

Tofu: The second product of local beans which quite popular in the community is tofu. Consumption of tofu in Indonesia is the same as tempeh, which is a companion food for rice (*lauk*). Mung beans Tofu is a form of product diversification from local beans. Mung bean tofu has been produced in several cities, namely in the Palu City (Central Sulawesi), Madiun (East Java) and Sumedang (West Java). Mung bean tofu contains 9.04% protein with a protein digestibility as large as 70,99% [20].

Cowpea is one type of local bean that is widely developed in almost all regions of Indonesia. Substitution of soybeans as much as 20% with cowpea, produce a high yield tofu (158.77%), liked by consumer and contains 9.19% protein [21] This cowpea tofu has been developed in Central Java, especially in Tegal District [22].

Koro pedang tofu has a protein content of 26.41%, 2% fat, 26.06% carbohydrate and can be accepted by consumers [21,23]. The use of *kerandang* beans to substitute soybeans for tofu processing reaches 50% and the tofu produced has a protein content of 13.69%; 3.40% fat and 0.25% crude fiber and preferred by consumers [8].

Non-dairy Milk: Non-dairy milk is one form of local bean diversification products. Non-dairy milk processing is very simple and can be done on a household scale. As well as with soy milk, local bean milk is obtained by soaking and boiling of beans and then milled with the addition of water at a certain concentration and filtered to produce non-dairy milk [24,25]. Based on the research that has been done, non-dairy milk made from *koro pedang* beans (*Canavalia ensiformis*) has good functional value. Consumption of 9g of *koro pedang* milk can reduce cholesterol levels by 33.54% and serum triglyceride levels by 40.9% in hypercholesterolemia mice [26].

In the processing of household scale local powdered milk, local bean non-dairy milk is heated then added sugar and heating is continued until it becomes crystalline. Then milling is carried out until milk powder is obtained. While processing local bean powder milk in large industries can be done using equipment such as spray dryers, freeze dryers or dryer drums [27].

The processing of kerandang non-dairy milk powder using a spray dryer contain dissolved proteins in the amount of 16.08% - 23.86%, phenolic compounds of 1.33% - 7.55%, isoflavones genistein of 0.45 g / 100 g to 0, 61 g / 100g of milk powder and have antioxidant activity and are soluble at various pH (acidity levels) [24]. Thus, it can be said that kerandang non-dairy milk powder is safe for consumption and has functional value.

Non-dairy Milk Fermentation: The use of lactic acid bacteria in fermented beverages starts from the fermentation of mammalian milk to produce a product known as yogurt and kefir [28,29] But now a days, the use of lactic acid bacteria to produce fermented beverages is increasingly widespread, especially the use of lactic acid bacteria in the fermentation of local beans milk to produce a product called non-dairy milk fermentation [30-32]. The use of lactic acid bacteria provides benefits because these bacteria can suppress the growth of fungi and harmful bacteria, making food become longlife [33,34].

Lactic acid bacteria *Lactobacillus plantarum-pentosus* indigenous isolated from tempeh was produce β-glukosidase enzyme [33,35] Which can hydrolysis the isoflavones daizine and genistine into isoflavones daizein and genistein so antioxidant activity of kerandang non-dairy milk fermentation is increase and has anticancer properties [1,36]. These bacteria can also degradation of raffinose into saccharide such as sucrose, glucose, fructose and galactose [37] so the kerandang non-dairy milk fermentation easier to digest and does not cause flatulence.

Kerandang (*Canavalia virosa*) seeds contain antrinutrient factors (ANF) such as phytic acid (1.1%), tannin (5.8%), L-DOPA (4.3%) and cyanide acid (0.013%) which are toxic, concanavalin A, canavavin and canavalin [38,39]. However, antinutrients and toxic properties are not resistant to heat [38]. According to Djaafar et al. [40], Kerandang also contain HCN which is quite high (1133.9ppm) but with immersion for 48 hours (with water change every 6 hours) before processing can reduce HCN content to 16.8 ppm. In addition, the processing of tempeh and tofu cages decreased HCN content by 97.6% and 86.8% respectively [8,41].

Product	Beans	Nutrition	Benefit	References
Tempeh	Koro pedang	Protein (16.62%) Fat (6,84%) Carbohydrate (9.72%) Diatery fiber (3.66%)	Antioxidant activity, good protein source, good for body health	[15,16,18,19]
	Kerandang	Protein (19.37%)		
	Koro benguk	Protein (11.60%) Essential amino acids Essential fatty acids.		
	Cowpea	Protein (31.91%)		
		Fat (2.52%) Carbohydrate (41.27%) Crude fiber (10.66%)		
	Mung bean	Vitamin E content of 8.83 ppm.		

Product	Beans	Nutrition	Benefit	References
Tofu	Koro pedang	Protein (26.41%) Fat (2%) Carbohydrate (26.06%)	Antioxidant activity	[8,22-24]
	Kerandang (50%) Soybeans (50%)	Protein (13.69%) Fat (3.40%) Crude fiber (0.25%)		
Non-dairy Milk	Koropedang		Reduce cholesterol levels and serum triglyceride	[26]
	Kerandang	Proteins (16.08% - 23.86%) Phenolic (1.33% - 7.55%) Isoflavones genistein of 0.45g/ 100g to 0, 61g/ 100g of milk powder	Antioxidant activity	[24]
Non-dairy fermented Milk	Kerandang	Isoflavones daizein and genistein	Antioxidant activity and anticancer properties	[1,36]

Table 2: Products, nutrition and benefits of Indonesia local beans

Conclusion

Indonesia as an agricultural country has natural wealth as a food source. Local beans in Indonesia are very diverse and have the potential to be a nutritious food source. Local beans can be processed into various foods such as tempeh, tofu and non-dairy milk which are rich in nutrients and functional because they contain the amino acid, fatty acid, vitamins, minerals, and isoflavones.

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