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Indigenous Soybean-Alternatives from Gunung Kidul, Yogyakarta

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Abstract. More than a third of protein intake of Indonesian is fulfilled from soyfood. Unfortunately, soybean is mainly obtained through importation; it is the second largest import agri-food commodity (after wheat) in Indonesia. Almost 70% of soybeans consumed by Indonesian is imported from other countries. This study aimed to explore potential soybean-alternatives from Gunung Kidul, Yogyakarta – Middle Java, Indonesia. Gunung Kidul, with its karst region domination, harsh climate condition and strong indigenous culture, kept many potential indigenous soybean-alternatives. Qualitative data were gathered by using Focus Group Discussion and in-depth interview with 24 key persons from Pucung- and Mertelu- villages, Gunung Kidul Regency. This in-depth study identified eight indigenous soybeans alternatives which then enable to be processed into three soyfood alternatives, those are: *Tempe Benguk, Tempe Mlanding, and Tempe Klenthang*. There were 10 traditional techniques in processing these commodities. A quantitative review using Hedges'd effect method had also been performed to compare the nutritional quality of those identified soybean alternatives. This analysis revealed that only five of those alternatives that has been scientifically published but still under-utilized. *Mucuna pruriens* and *Canavalia gladiata* have comparable crude protein (d+, ±Vd: -2.05, ±1.01) and calcium content (2.02, ±1.01), respectively, if set the soybean as comparison. There were five main negligence reasons of these alternatives, *i.e.,* complicated handing, potential poisonous, rarely found, less preferred, and less economic value. Fermentation seems to be the best traditional processing approach in utilizing these soybean alternatives. Advance processing technique seems promising for increasing the value of these alternatives.

1. Introduction

Since 1950s, protein malnutrition became a leading problem in nutritional science worldwide related to stunting, a retarded growth [1]. This topic led the international concern after the protein gap rising between east and west [1, 2]. This issue became the main focus of research along 19th century [1]. But then "protein" theory failed after the issue about micronutrients related to stunting was rose [1, 3]. Nonetheless, current research revealed that protein quality intake related to the circulated amino acid on the blood and has strong correlation with stunting [4, 5].

However since many years ago, stunting became a significant national issue worldwide, also in Indonesia. UNICEF together with WHO and World Bank [6] reported that on the global scale, more than 165 million children under five were stunted. It was recorded that one of three children in Indonesia

is stunting [7]. The national prevalence of stunting remains high above 36% along these last five years [7]. This issue became national anxious since stunting has strong correlation on the low of future human source quality from many aspects, *i.e.* intelligence, and vulnerability on the non-communicable disease [8, 9, 10, 11]. However the malnutrition during the golden age, the first five years of life, seems unfixable and unable to be paid off on the later life [12, 13, 14].

Nonetheless, evaluation on the report from FAO (Food and Agriculture Organization of the United Nations) and BPS (Indonesian Bureau of Statistics), more than a third of protein intake of Indonesian is fulfilled from soyfood [15, 16, 17, 18]. Unfortunately, soybean is mainly obtained through importation; it is the second largest import agri-food commodity (after wheat) in Indonesia [15, 16, 18]. Almost 70% of soybeans consumed by Indonesian is imported from other countries [15, 17]. This study aimed to explore potential soybean-alternatives from Gunung Kidul, Yogyakarta – Middle Java, Indonesia. Gunung Kidul, with its karst region domination, harsh climate condition and strong indigenous culture, kept many potential indigenous soybean-alternatives.

2. Materials and methods

Qualitative data were gathered by using Focus Group Discussion and in-depth interview with 24 key persons from Pucung- and Mertelu- villages, Gunung Kidul Regency. FGD was performed by making a round table discussion with about eight discussion members and led by a moderator. The researchers directly led the discussion. The enumerators helped the process by recording the whole process of FGD. The FGD was initiated the discussion related to food and nutrition security, particularly about how satisfy the people on the available locally legumes. The discussion flowed until all possible identified forgotten legumes were identified. From this FGD, the key persons who gave significant information about these potential sources were continued to be recruited to get involved in further in-depth interview.

A quantitative review Hedges'd effect method had also been performed to compare the nutritional quality of those identified soybean alternatives. There were three main stages on this review, *i.e.* literature search and selection method, studies coding, and statistical analysis. Effect size as the "Hedges'd" was applied to quantify the crude protein and calcium content between soybeans and soybean alternatives. To calculate how large the different between the nutritional components of the alternatives from the soybeans, the soybeans pooled into a control group and the alternatives pooled into an experimental group. Therefore the positive effect size indicates that parameter observed is greater in the alternative legumes and vice versa [19].

3. Results and discussion

From the FGD and in-depth interview, it was revealed that as many as eight legumes other than soybean that usually be consumed by the people in Gunung Kidul, Yogyakarta (Table 1). Those legumes are *Kacang Benguk, Kacang Tholo, Lamtoro, Kacang Koro, Kacang Koro Pedang, Biji Kecipir, Biji Klenthang*, and *Kacang Gude*. These legumes even are consumed more regularly than soybean. From these legumes, Kacang Benguk (*Mucuna pruriens*) has the highest yield production capacity, *i.e.* about 3 kg per once harvested period per 2 m^2. This is more than three times higher than other beans. If the rain comes more regularly, then these legumes are potentially to be harvested more than once a year. Unfortunately, Gunung Kidul has very low rain density. Therefore it is quite challenging to cultivate various crops in this area. However, these alternatives are easier to be grown in Gunung Kidul compared to soybeans. This is due to the characteristic of soybeans which need more water and lower temperature. Gunung Kidul has limestone soil type and dry-warm climate type which is unsuitable for soybean cultivation. These alternatives relatively adaptive with drought and harsh climate condition compared to the soybeans. However, since the rain in Gunung Kidul is low, all of these alternatives only enable to be harvested once a year.

Table 1. Identified soybean alternatives from Gunung Kidul, Yogyakarta

Soybean alternatives, local name	Morphology	Scientific name	Production quantity*
Kacang Benguk	Harder than soy bean	*Mucuna pruriens*	3 kg
Kacang Tholo	Brown yellowish, black spot on the hilum	*Vigna unguiculata*	1 kg
Lamtoro	Green, slimy	*Leucaena leucocephala*	0.5 kg
Kacang Koro	Small, flat, brown reddish	*Canavalia ensifomis*	0.5 kg
Kacang Koro Pedang	Big flat, reddish	*Canavalia gladiate*	1 kg
Biji Kecipir	Round, dark brown	*Psophocarpus tetragonolabus*	0.5 kg
Biji Klenthang	Brown, covered by a tin pale brown layer	*Sesbania grandiflora*	0.5 kg
Kacang Gude	Black, small size, soy bean-like	*Cajanus cajan*	1 kg

Note: *yield during rainy season with harvest period about three to four months and cultivated area about $2m^2$

Although those legumes are harvested once a year, some legumes like *Benguk* and *Lamtoro* are available daily since many villages supply the legumes each other's. Hence, the legumes are often readily available in the local market. These legumes even more common and available than soy bean in Gunung Kidul, Yogyakarta. These legumes easy to be found in "Pahing" market and "Wage" traveling salesman. The price is equal to soy tempeh.

A quantitative review had also been performed to compare the nutritional quality of those identified soybean alternatives. This analysis revealed that only five of those alternatives that have been scientifically published [20, 21, 22, 23, 24, 25, 26] but still under-utilized (Figure 1). *Mucuna pruriens* and *Canavalia gladiata* have comparable crude protein (d+, ±Vd: -2.05, ±1.01) and calcium content (2.02, ±1.01), respectively, if set the soybean as comparison. Those five identified soybean alternatives belong to food source with high level of protein since contain more than 20% of crude protein [20, 21, 22, 23, 24, 25, 26].

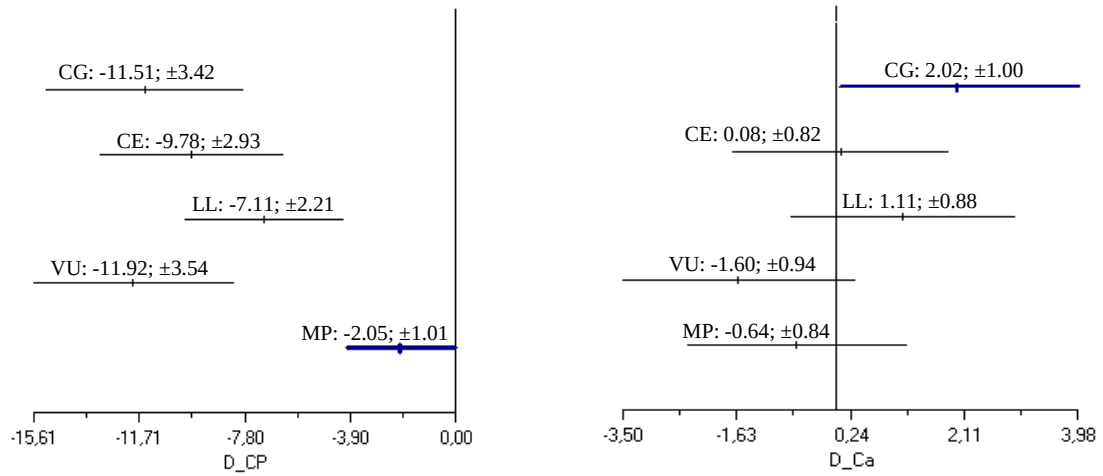

Figure 1. Forest plot of Hedges'd effect (d+) and pooled standard deviation (±Vd) comparing the soybean alternatives to soybean (a) Crude Protein and (b) Calcium.
Note: MP: *Mucuna pruriens;* VU*: Vigna unguiculata;* LL*: Leucaena leucocephala;* CE*: Canavalia ensifomis;* CG*: Canavalia gladiate*; D_CP: Hedges'd effect from Crude Protein Content; D_Ca: Hedges'd effect from Calcium Content.

There were five main negligence reasons of these alternatives, *i.e.,* complicated handing, potential poisonous, rarely found, less preferred, and less economic value. Some potential anti-nutrition and poison from these alternatives are phytin, lectin, trypsin inhibitor activity, tannin and cyanide [22].

Table 2. Traditional processed product of soy-bean alternatives, its ingredients, and processing method

Processed product	Ingredients	Processing method
Goreng bawang (fried beans)	Bean, garlic, kaffir lime leave, salt, oil	Fried with garlic seasoned
Thokolan (sprouted)	Bean, sprouted media	Placed in humid media, let the bean sprouted for 1-2 days
Bothok, pepes, bongko	Garlic, shallot, chilly, lemon grass, ginger, turmeric, galangal, coconut meat, leek, banana leaves	Seasoned, wrapped with banana leaves, steamed
Porridge	Palm sugar, coconut milk	Boiled with excess water till flabby
Trancam (fresh salad)	Garlic, shallot, chilly, other vegetables, coconut meat	Fresh bean mixed with cucumber, cabbage, grated coconut
Urap (cooked salad)	Garlic, shallot, chilly, lemon grass, ginger, galangal, coconut meat	Cooked bean mixed with cooked vegetables like papaya leave, spinach, then added with seasoned grated coconut
Brongkos (milky soup)	Garlic, shallot, chilly, lemon grass, ginger, turmeric, galangal, coconut meat, leek, other vegetables	Soup mixed with young jackfruit, coconut milk/candlenut, garlic, shallot, pepper, coriander
Clear soup	Garlic, shallot, other vegetables	Clear soup mixed with green leaves
Tempe (fermented)	Starter	Boiled, soaked, peeled, inoculated, warapped, fermented
Tempe kemul	Garlic, coriander, turmeric, salt, wheat flour	Fried with flour cover

There were 10 traditional techniques in processing these commodities (Table 2). However, fermentation seems to be the best traditional processing approach in utilizing these soybean alternatives. These alternatives enable to be processed into three soyfood alternatives, those are: *Tempe Benguk, Tempe Mlanding,* and *Tempe Klenthang.* However, the phenomenon of the consumer shifting on the food preference seems urgent to be taken into account for further development. If the preference on these traditional processed is assessed, the young generation prefers to have easy and up-to-date food product like nugget, sausage, snack-bar, flakes breakfast cereal, *etc.* Advance processing technique seems promising for increasing the value of these alternatives.

4. Conclusion

Indonesia has many soybean alternatives which potential to be developed for strengthening the national food and nutrition security. Those identified soybean alternatives has comparable protein and calcium content compare to soybeans. Considering the cultivation aspect, nutritional value, and economic value, Kacang Benguk (*Mucuna pruriens*) seems to be the optimal choice. It has three times higher yield and belongs to adaptive crop category, has the closest crude protein content to the soybean, and enable to be processed and fermented into *Tempe Benguk*. Advance processing technique seems urgent to be developed for increasing the value of these alternatives.

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