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MINI REVIEW

The challenging concept of diversifying non-rice products from cassava by changing Indonesian people's behavior and perception: a review

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Abstract

Cassava is a popular crop in Indonesia and is known as local food from east Indonesia. It has gained popularity across the country due to its widespread cultivation and abundant carbohydrate content. In contrast to its potential, the Indonesian populace continues to predominantly consume rice, which is associated with health risks like diabetes, high blood pressure, and heart attacks due to its high glycemic index. This review aimed to assess the feasibility of a diversified approach to address this issue by capitalizing on cassava's versatility. Through a comprehensive analysis, we explore how strategic collaboration between the government, farmers, food scientists, and society could foster a shift from rice-centric diets to a broader range of cassava-based products. Advanced technological methods are examined as enablers of efficient food diversification. By highlighting the significance of internal and external strategies, including the introduction of novel cassava products such as *kasoami*, *kaopi*, *tiwul*, and cassava flour, we propose a multifaceted approach to decrease rice dependency while promoting dietary diversity and improved health outcomes for the Indonesian population.

1. Introduction

Cassava (*Manihot esculenta* Crantz) is one of the vegetable commodities in Indonesia and belongs to local food from east Indonesia. This commodity is planted in 792.95 hectares of agricultural area in Indonesia producing over one million tons per year. West Sumatera, South Sumatera, and Riau are the most productive regions producing cassava (Agricultural Department, 2018).

In Indonesia, cassava product is primarily used as a staple food (64%), while the rest is used as raw material for the starch industry, fuel, and animal feed (Djaafar and Rahayu, 2003). According to the latest statistics from (Agricultural Department, 2020), the aim for cassava consumption in Indonesia between 2020 and 2024 is 1.90 kilograms per capita per year. This means that cassava will be consumed by more than 60% of Indonesia's population. The advantage of cassava diversification is a substitute option for replacing rice as a staple food because cassava contains a high nutritional value and could prevent certain diseases, including diabetes, heart disease and high blood pressure.

While rice is one of the worldwide commodities, almost half of the human population consumes rice as their staple food, including in Indonesia. A long time ago, Indonesian people were getting used to consuming rice as a primary food on their daily menu. The average for consuming rice in 2018 is 111.58/ kg per capita per year (Indonesia Statistical Bureau, 2019). The main consequence of rice-eating habits is developing common diseases such as diabetes, and heart disease. These are faced by the Indonesian people. Based on this case, Indonesian people have to change their habit from consuming rice to consuming an alternative food such as cassava and their derived products. In general, Indonesian people preferred rice over other staple food. People regarded cassava as a cheap food (Simatupang, 2012). Where actually cassava could be redesigned and transformed into a new brand idea of staple food. Hopefully, a food diversification program could be the way to overcome this phenomenon.

Nowadays, food diversification has become an

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exciting issue to reach food security in the country. By redesigning local food products to global that most people in the world can consume in the world. Thus, food diversification can be understood as a more expansive presence of food variety over time, importantly, most diversification should be available for continuity production; moreover, the product of diversification should be accepted by people with the approaching behaviour intervention (Widyanti *et al.,* 2014). Diversification of food is also linked to health issues including obesity and malnutrition. This is critical to emphasize because the issue is linked to human health (Dwivedi *et al*., 2017). As a result, one of the aims that must be reached in Indonesia, which has a wide variety of indigenous foods, is to direct this concept of diversification. The other problem besides the ingredients or source of local food is the readiness of the government to make the diversification program successfully accomplished with collaboration from the entire government sector.

There are substantial numbers of consuming cassava in Indonesia. For example, in Java, 65% of cassava production was used for human consumption, mainly in the form of fresh tuber, *gaplek* (dried cassava) and *oyek* (mixed rice and cassava). In West Java, about 80% of cassava was consumed in a freshly boiled tuber (Saediman *et al.,* 2015). In terms of diversified food, there are many examples of processed local food such as *gaplek, oyek, rasi* (cassava rice), *getuk* and many more.

This study shows that behaviour intervention is effective in reducing rice consumption in Indonesia. This information campaign should consist of the positive effect of reducing rice consumption. Moreover, this campaign is related to food security that might happen in Indonesia and the food security that might happen in the future. This review paper is significant because it informs readers that in order to diversify a program, a behaviour intervention to alter people's perspectives and, hopefully, reduce rice consumption is needed. The campaign is a key component of Indonesia's diversification strategy, which attempts to introduce local foods as a viable alternative to staple foods. Apart from that, this campaign is a suitable platform to introduce food diversification to the global community and recognised the extra benefits of consuming non-rice as a staple food.

Nevertheless, to the best of our knowledge, no comprehensive review is available in this regard to report the potential utilisation of cassava for developing and improving the existing food products. Hence, this review focuses on the nutritional importance and local food diversification of cassava and its potential application for functional food products. In this context, the health benefits of cassava products have also been reported. Therefore, the finding from this review could be a valuable piece of work for cassava food products that may attract the attention of food researchers and industrial individuals. Furthermore, this review aims to describe the diversification of cassava products in Indonesia that could help Indonesian consumers consume non-rice products from cassava.

2. Theoretical framework

Food diversification has become an urgent and exciting topic in Indonesia. The main objective of this program is divided into two advantages. Firstly, to make local food become global food people around the world will know by redesigning the local food into the new local food product. This is intended to promote a local Indonesian crop, such as cassava, as a local food by introducing a new brand product, Beras Singkong (RASI), which is a ready-to-eat instant food. Secondly, Indonesian people slowly change their habits from consuming rice as staple to other local food like cassava. Also to discuss the problem by approaching Indonesian people's behaviour and the action that the government should accomplish to make the diversification program successful. The first consideration to discuss is the productivity of cassava in Indonesia.

2.1 Productivity of cassava

The big production of local cassava in Indonesia is in Central Java Province with 124.009-hectare growth per year and West Java Province with 64.579-hectare growth per year and West Java Province with 64.579-hectare growth per year. This number showed that the growth of cassava productivity areal in Indonesia increased by 2.58% from 2017 to 2018 (772.975 to 792.952 tons per year) (Indonesian Statistical Bureau, 2019).

In 2018, the largest number of cassava productivity in Indonesia is West Sumatra Province with 409.95 Ku/Ha, then followed by South Sumatera Province with 362.05 Ku/Ha, Riau Province with 345.67 Ku/Ha, Central Kalimantan Province with 303.76 Ku/Ha, South Kalimantan Province with 248.88 Ku/Ha, North Maluku with 268.52 Ku/Ha, Central Java Province with 263.48 Ku/Ha, East Kalimantan Province with 258.22 Ku/Ha and West Java Province with 253.18 Ku/Ha (Agricultural Department, 2018). These productivity numbers showed that cassavas are growing widely in every province in Indonesia (Figure 1). However, in Jakarta and Papua, Cassava has not grown well as in other Indonesian provinces.

The significant number of cassava productivity has affected some inland districts in Indonesia. For example,

https://doi.org/10.26656/fr.2017.7(5).962

in Buton (Maluku Island), cassava is one of their staple foods. Meanwhile, in Cimahi (West Java Province), people combine rice and cassava as the main food (Figure 2). Wigna and Ali (2011) make fermented cassava their staple food.

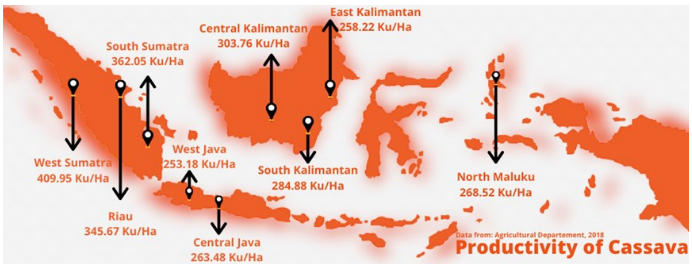

Figure 1. The productivity of cassava in Indonesia in 2018.

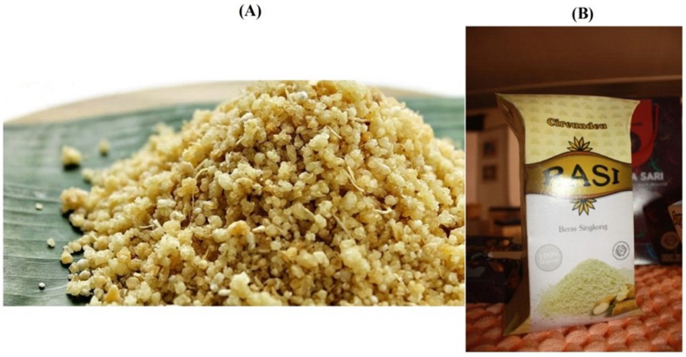

Figure 2. RASI (Cassava rice) from Cimahi, West Java is a diversification food product. (A) The shape of RASI (cassava rice), (B) The packaging of RASI from Cirendeu, Cimahi, West Java.

Rice productivity does not differ throughout the rainy season. During the dry season, however, the government can prevent rice harvest failures by planting rice in marshes (Agricultural Department, 2018).

2.2 Nutrition value of cassava

Cassava tubers have low protein content (0.7% to 1.3% fresh weight) (Ngiki *et al.,* 2014). The protein content of cassava flour, peels and leaves is low at approximately 3.6%, 5.5% and 21%, respectively (Iyayi and Losel, 2001). Therefore, cassava-based diets must be supplemented with methionine and lysine (Tewe and Egbunike, 1992). Nagib and Sousa (2007) reported that the total amino acid content of cassava is approximately 0.254 g per 100 g and lysine content is approximately 0.010 g per 100 g. The protein in cassava has high arginine content but low methionine, threonine, cysteine, phenylalanine, isoleucine and proline contents (Onwueme, 1978).

The protein content of cassava could be improved by adding protein sources into the diet or fermenting the cassava prior to adding it to the diet. Antai and Mbongo (1994) found that fermenting cassava peels using pure cultures of *Saccharomyces cerevisiae* has increased protein content from 2.4% in non-fermented cassava to 14.1% in fermented products. Oboh and Kindahunsi (2005) reported that fermenting cassava flour with the same culture improved protein levels from 3.3% to 10.9% and reduced the cyanide content. Fermenting cassava with rumen filtrate is believed to be the cheapest and most effective way for improving the protein content of cassava (Adeyemi and Sipe, 2004; Ubalua and Ezeronye, 2008). Adeyemi *et al.* (2008) observed a 237.8% increase in the crude protein value of cassava root meal when fermented with rumen filtrate. Eruvbetine *et al*. (2003) discovered that grinding cassava roots and leaves together in equal amounts before sun-drying improved the crude protein content and texture and reduced the cyanide content.

Additionally, a high-protein variety of cassava, called ICB300 has recently been developed by interspecific hybridisation between cassava and *Manihot oligantha.* This product could potentially improve the value of cassava in feed; for example, Nagib and Sousa (2007) found that ICB300 has ten times more lysine and three times more methionine than common cassava. Cassava has very low lipids. Gomes *et al.* (2015) reported that cassava has 0.1% lipids, and cassava flour contains 2.5% lipids, according to Hudson and Ogunsoa (1974). Previous research with another solvent to extract the cassava flour revealed a fat content of 2.5% lipids. On a 100 g tube of cassava, the lipid content is roughly 0.3 g (Hudson and Ogunsoa, 1974). The low level of lipids indicated that cassava has weak, fat-soluble vitamins. However, the content of carbohydrates in cassava is higher than in other plants. Cassava contains highly digestible starch. Cassava starch contains more than 17% amylose and 83% amylopectin, compared with maize starch with 28% amylose and 72% amylopectin. The comparatively higher amylopectin level indicated that the digestible starch might be higher in cassava than in other familiar starch sources. Resistant starch refers to starch degradation products that could escape digestion in the small intestine. Another possible explanation is that the amylopectin in cassava has a comparatively most extended chain length (Raphael *et al.,* 2011). Furthermore, amylose levels in rice range from 19 to 27%, with amylopectin content ranging from 53 to 58% (Sari *et al*., 2020). Cassava, on the other hand, has greater amylopectin content (about 72%). This indicates that a high resistant starch concentration will help consumers stay fuller longer.

3. Rice consumption in Indonesia

The average of consuming rice in 2018 is 111.58 per kg per capita per year (Indonesia Statistical Bureau, 2019). It is a high number of consuming rice and indicates that Indonesian people are habitually consuming rice. In Indonesia, common diseases such as

https://doi.org/10.26656/fr.2017.7(5).962

diabetes, and cardiovascular were caused by the high consumption of rice. Therefore, Indonesian people have to consider changing their lifestyles from consuming rice to consuming an alternative food such as cassava, and this approach could help the diversification program about local food.

For many years, this concept of primarily consuming rice has not changed, while other countries such as Malaysia and Japan, they have succeeded in reducing rice consumption. For example, Malaysia has reduced their rice consumption to 80 kilograms per capita per year, and Japan consumes only 60 kilograms annually. Ironically, as a rice-producing country, Indonesia has also become a rice importer country since 2009. If this condition continues, this country will face a serious problem related to food security. Food security is defined as a condition when most people could easily access sufficient, safe, and nutritious food to meet their dietary needs and food preference for an active and healthy life (World Food Summit, 1996).

High dependency on rice as a staple food has several adverse effects. First, it could be a constraint for developing local food resources, which gave implications on less research investment into non-rice-based foods. Second, obtaining food security with one or two food items can be viewed as a vulnerable national security point. Third, other foods need to be promoted as a staple food because rice supplies are likely decreasing year by year. Indonesia's population have reached more than 250 million people and are still dependent on rice imports. Therefore, the alarm of food security is starting to be a concern.

Moreover, the number of common diseases such as diabetes, and heart disease has increased in the past ten years. This is caused by rice's high glycemic index, which is around 56-78%, and it triggers different diseases. Meanwhile, local foods such as cassava have a glycemic index of 54 depending on how cassava is processed (Noviasari *et al*., 2015). Therefore, the importance of the food diversification program in Indonesia has to be started and focused on.

3.1 Diversification of cassava

Food diversification means having the presence of a wider food variety. It could also mean the enhancement of food availability, accessibility and stability (Food and Agriculture Organization of the United Nations (FAO), 2008). It can be understood as a more expansive presence of food by diversifying food varieties from various food sources over time, and it certainly will enhance household access to food security dimensions (Suyastiri, 2008). Food diversification refers to all types of interventions to improve the supply, access, consumption, and bio-efficacy of micronutrient-rich foods. Indonesia has a significant opportunity for implementing food diversification with a thousand varieties of local food. Almost every region in Indonesia has the potential for traditional food for becoming prominent staple food. In Indonesia, diversification from cassava products such as tapioca flour, mocaf flour, *gaplek*, *tiwul* and *kaoppi*. One of the famous diversification foods in Buton district and Wakatobi district is *Kaoppi*. Processing of cassava into *kaoppi* was through peeling, washing, grating, pressing, dewatering and fermenting, similar to the first several steps in *gari* making in Africa. At the end of the dewatering and fermenting stage, the dewatered cassava mash will become a solid cake called *kaopi. Kaopi* can be stored for some time until needed for use. For consumption, *kaopi* granules are steamed in a cone-shaped basket made of coconut leaf and put in a pot containing a small amount of water. The steamed food is called *kasoami* (Figure 3), and it is the most popular staple food consumed from cassava in that area.

Figure 3. Local food called Kasoami from Buton or Wakatobi.

Kaopi processing reduces cassava perishability and toxicity and could improve the shelf life and enhance nutritional values (Okorji *et al.,* 2003). In addition, *kaopi* processing could be one of the new foods made from cassava. At the same time, *kaopi* has potential as a source of income and food supply, ensuring food security, and promoting food diversification (Saediman *et al.,* 2015).

Another diversification product is cassava flour with enriched dietary fibre from virgin coconut oil (Widiastuti *et al.,* 2016). The cassava is processed into flour and mixed with coconut waste flour. Cassava's skin was removed, and then the cassava was cleaned and shredded. The shredded cassava was dried until it reached the maximum water content allowed and finally sieved at 60 meshes. In this study, cassava flakes are made with six ratios of cassava flour and coconut waste flour in a total of 100 g, such as 15 g margarine, 15 g sugar, 12 g salt, 20 mL coconut milk, 15 mL skim milk

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and 50 mL water. The Flakes contains fat 14.40%, 4.50% proteins, 76.31% carbohydrates, and 8.56% dietary fibre (Widiastuti *et al.,* 2016). Therefore, it can be used as a functional food where the flour can process and turn into another product such as cake and biscuits from the local food staples. Both diversification products are an example of the various local products that could be potentially new products from Indonesia. Other diversification products based on cassava are *gaplek* and *tiwul* (Figure 4). *Gaplek* (*Euphorbiaceae*) is a food commodity that is often found in rural areas at relatively cheap prices. While *tiwul* is a staple food substitute for rice and it is made from cassava. These foods could be turned into functional food.

Figure 4. Local food called *gaplek* and *tiwul.*

Functional foods have specific physiological advantages that distinguish them from regular foods. Functional foods may contribute to establishing healthy eating habits and reducing specific diseases and related comorbidities. Functional foods are food enriched with health-enhancing or disease-preventing ingredients (e.g., vitamins, minerals); and those are part of a standard diet and consumed regularly in normal quantities (Doyon and Labrecque, 2008). Prior investigations into explaining consumer behaviour toward functional foods have primarily focused on factors such as convenience, health benefits, price, preferences, taste, and other sensory attributes (Siró *et al.,* 2008). Recently, research efforts have explored the factors related to the consumers, such as hedonic pleasure, cognition and effect, knowledge, habits, trust, and perceived risk (Bimbo *et al.,* 2017). Although some recent reviews have identified various personal values or personality traits that influence consumer acceptance or consumption of functional foods, studies investigating how individual differences in broader behavioural dispositions relate to functional food consumption are still scarce (Bimbo *et al.,* 2017; Santeramo *et al.,* 2018).

The concept of functional foods contains active components that could improve health, reducing the drain on the economy caused by escalating health costs (Farr, 1997). Functional foods contain various biologically active compounds and are consumed in a current diet, contributing to maintaining a mental, optimal state of physical and mental health (Butnariu and Ioan, 2019). There are nine criteria to reach as functional food; contribution to the improvement of the diet and the maintenance and enhancement of health should be expected. First, the health benefit of the food or relevant components should have a medical and nutritional basis. Second, the appropriate level of consumption should be definable for the food or relevant components based on medical or nutritional knowledge. Third, the food or relevant components should be safe based on appropriate data. Fourth, the relevant components should be well-defined in terms of physicochemical properties. The product's composition should not be notably defective compared to the composition of nutritive components typically contained in similar types of foods. Fifth, the product should be consumed in common dietary patterns, rather than those consumed only occasionally. Sixth, the product should be in the form of ordinary foods. Finally, the food and relevant components should not be exclusively used as medical drugs (Farr, 1997).

The products of food diversification from Indonesia's local food are important in regards to the functional food criteria. The diversification products such as *kaopi* or *kasuami* (Saediman *et al.,* 2015) should fulfil the regulation of functional food criteria. In contrast, the product of flakes made from cassava combined with virgin coconut oil has reached the regulation of the Indonesian Standard for nutrient value. This step became a very prominent consideration of food diversification criteria. Therefore, the goal of providing society with healthy food could be reached perfectly.

3.2 The main problem of cassava diversification in Indonesia

Some researchers were identifying the problem in diversification programs in Indonesia. For example, the Road map of cassava's diversification problem can be seen in Figure 5. The food security program in Central Java Province did not go very well because it is obstructed by a culture that regards rice as the only leading staple food.

The native of Indonesia believes that consuming rice in their daily menu has had a connection with the cultural society for a long time ago. This stigma could be the cultural barrier related to food diversification. Furthermore, rice is also seen as a status symbol, while cassava is generally associated with poverty. Based on these reasons, it could be that the root problem of unsuccessful food diversification programs in Indonesia might have something to do with cultural and psychological barriers.

Local food consumption can have a positive impact on body health; for example, cassava, which has a high carbohydrate content of roughly 38%, can help consumers feel fuller for longer (Afandi *et al*., 2019). Furthermore, cassava is Indonesia's second most popular carbohydrate source, accounting for roughly 22% of total consumption, followed by corn (19%) and potatoes (5%) (Suyono, 2002).

The fundamental problem is the awareness system related to food diversification from non-rice products. Also, the people's mindset could be seen that consuming rice is one of the prosperous symbols, even though; other crops have more potential and have more nutrients with other extra benefits. Widyanti *et al.* (2014) revealed that the intervention of behaviour approaching changed people's mindset. For a long time, food has been assumed to provide a prominent role in society beyond just filling hunger, and it has several meanings, such as food providing information about the individual's identity and related to social interaction. The meaning of food can be seen from the choice of food made by people. Several decades ago stated that food preferences are influenced by cognitive factors (including attitudes, social norms and perceived controls), psycho-physiological factors (including neurochemical senses, chemical senses, food availability, mood, and stress) and developmental factors (including food exposure, social learning, and associative learning). In addition, Pike and Ryan (2004) included more factors such as awareness, knowledge, or beliefs about food in cognitive aspects. However, the cognitive approach to food preferences has been criticised for focusing on individual variables rather than other social variables (Ogden, 2010). In relation to developmental factors, particularly food exposure, Birch and Marlin (1982) stated that exposure more than 8 or 10 times during six weeks could change the preference significantly. The first phase of the study aimed to investigate knowledge and belief toward rice and rice consumption as a staple food. A survey was conducted to collect epidemiological data and information regarding the participants' eating habits, their knowledge of rice and non-rice foods, their belief and attitudes toward consumption of rice and non-rice foods, and their belief and attitudes toward consuming non-rice foods. The result showed that 60% of 119 students are eating rice three times a day, and 51.9% are unaware of decreasing rice consumption. While 56.8% of 44 homemakers eat rice three times a day and 45.5% are unaware of decreasing rice consumption, 58.8% of 17 workers are consuming rice three times a day, and 58.8% are unaware of decreasing rice consumption.

Food preferences and eating behaviour are difficult to alter because of many factors; Buttriss *et al.* (2004) reviewed various methods to change preferable food and eating behaviour and stated that intervention is one of the most common methods used. The intervention has four key issues to be addressed (Steg and Abrahamse, 2010): identification of the behaviour, examination of the behaviour, application of interventions to change the appropriate behaviour, and their determination and evaluation related to the behaviour itself. The choice of intervention strategies would be based on feasibility, cost -effectiveness, and availability of resources. For example, intervention could be in the form of persuasive communications, in terms of newspaper ads, flyers/ posters, or TV education messages. Other alternatives are group discussions, observational modelling, or any other applicable method. Any essential stakeholder

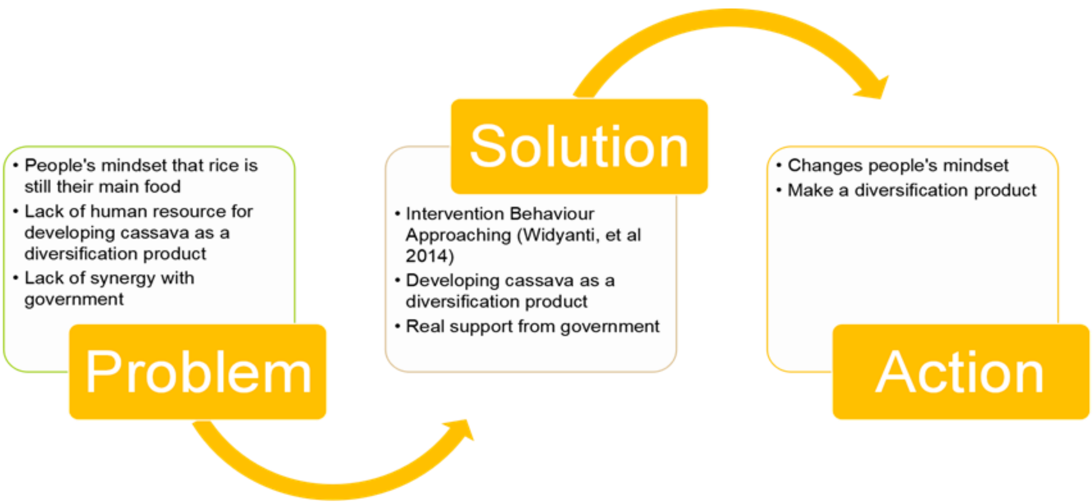

Figure 5. The road map of cassava's diversification problem.

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campaign could be the most effective treatment for changing behaviour. For example, the government may use electronic media to create a video campaign to reach out to the urban community that uses the internet, as well as the rural community, where the farmer is the key to spreading awareness about the campaign.

The diversification program needs real support from the government which would give strength to develop these programs. Saediman *et al.* (2015) reported that the profitability and value addition of making diversification products from cassava has a significant - adding process, and hence has a high potential for the attainment of food security and could increase the country's economic status.

The diversification program could be successfully achieved with the internal and external strategies working simultaneously. Although there is no exact data on how much cassava products can reduce rice consumption, the government has set a target of 1.90 kg/capita/year for cassava consumption. External efforts such as the advanced technology approaches to develop the diversification of food products become more efficient to society. Also, the marketing strategy should be considered to achieve this target. Technology shows its phenomenon in society as an impersonal matter and has the autonomy to change any field of human life into technical scope. At present, it seems complicated to separate human life from technology; even technology has become a human need. The strength of stakeholder collaboration between the government, farmers, food scientists, and society should be tight to achieve the diversification program successfully. The diversification of cassava products such *kasuami, kaopi, tiwul*, cassava flour and many more could be addressed to decrease the dependency on rice as a staple food, followed by the behaviour intervention approach. A good campaign should be done to make people interested that many other crops than rice could be used in many other crops than rice that could be used as substitute staple food (Hanafie and Alfiana, 2016).

4. Conclusion

To achieve successful programs of diversification cassava in Indonesia could be done by changing the behaviour and people's mindset from consuming rice to consuming non-rice as a staple food. Therefore, the stakeholder collaborations between the government, farmers, food scientists, and society should be working to achieve the target of the food diversification program. These factors should be taken seriously by the campaign until the diversification program is up and running, and people's mindsets are gradually changed to include non-rice as their main food. Also, the development of the product existing in Indonesia, such as *Kaopi, kasuami, tiwul*, and cassava flour, should turn into the new iconic local product with the help of technology.

Conflicts of interest

The authors declare no conflicts of interest.

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