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The Sustainability of Malaysia Purple Sweet Potato and Its Nutritional Value: Product Development Perspective

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Abstract

Purple sweet potato is a unique crop. With various health benefits and nutritional values, there are still a lacks consumption of this crop among consumers, especially Malaysians. Besides high in dietary fiber, it also has a low glycemic index, contain proteins, minerals, polyphenols, and anthocyanin. Therefore, it could become an alternative crop for people who have less fiber intake in dietary pattern. The crop also found as anti-oxidative, hepatoprotective, anti-inflammatory, anti-tumor, anti-diabetic, anti-microbial, anti-obesity, and anti-ageing effects. Purple sweet potato is an unpopular crop for Malaysians due to a lack of commercial food products based on this crop. Normally, only a few types of Malaysian desserts and traditional snacks are produced from purple sweet potato. Nevertheless, it is still neglected by Malaysian consumers. Without a doubt, purple sweet potato can be commercialized globally due to its various health benefits and nutritional values. To ensure the sustainability of Malaysia purple sweet potato, this local crop needs to be developed and produced in various types of food products such as cracker, bread, cakes and cookies to prolong its shelf life. Hence, it has good potential commercialization purposes through the product development process on a big scale.

Keywords: Purple Sweet Potato, Sustainability, Nutritional Value, Product Development, Malaysia

Introduction

Sweet potato or *Ipomoea batatas* is a crop that cultivated extensively for its nutritious and health-promoting values (FAO, 2012; Lee et al., 2012). It also plays an important role in food security. Moreover, sweet potato is a healthy food recommended by the FAO of the United Nations (Jang et al., 2019) because of the presence of beneficial nutrients such as β -carotene, anthocyanins, vitamin B1, B2, C and E as well as minerals such as Ca, Mg, K, and Zn (Liu et al., 2017; Kim et al., 2012). It is interesting to note that sweet potato is becoming a research focus in recent years due to its unique nutritional and functional properties. Besides that, carbohydrates, proteins, lipids, carotenoids, anthocyanins, conjugated phenolic acids and minerals in different parts (tubers, leaves, stems and stalks) of sweet potato (Wang et al., 2016).

The unique composition of sweet potato contributes to its various health benefits such as anti-oxidative, hepatoprotective, anti-inflammatory, anti-tumor, anti-diabetic, anti-microbial, anti-obesity, anti-ageing effects (Wang et al., 2016). Therefore, there has been increasing interest in using sweet potato for food formulation and human consumption due to their attractive nutritional profile. In addition, Zhu and Sun (2019) discovered that the health benefits of sweet potato are related to the attributes of various bioactive components such as dietary fibre, polyphenols, proteins, and minerals present in sweet potatoes.

Therefore, there is the possibility to use sweet potatoes in food formulation and production to enhance the nutritional values. According to Cui and Zhu (2019) and Zhu and Wang (2014), sweet potato root or tuber is rich in starch and has similar processing properties as cereals. Processing fresh sweet potato root can also extend its applications and shelf life, especially to the obese population, since scholars have proven it as an anti-obesity food (Wang et al., 2016). Not only that, but its root also tends to contain a high level of α -amylase (Cui & Zhu, 2019; Collado & Corke, 1999).

There are different types of sweet potato roots with different colours. For instance, orange-fleshed sweet potato, yellow-fleshed sweet potato, and purple-fleshed sweet potato are the major types. Among all, purple-fleshed sweet potato roots are of special interest due to anthocyanins and other polyphenols (Zhu, Cai, Yang, Ke, & Corke, 2010). Polyphenols contribute to the good antioxidant and other biological activities of the root. Whole sweet potato root is also rich in soluble and insoluble dietary fibres (Wang et al., 2016). High contents of dietary fibre and polyphenols may reduce starch digestibility (Singh, Dartois & Kaur, 2010; Zhu, 2015). Hence, sustaining sweet potato through food development will increase its value-added and commercialization level.

Literature Review

Sweet potato is the sixth important food crop and main carbohydrate source in the world. It is also known as a staple food source for many populations, especially in Africa, Indonesia, Central and South America, Japan, the Caribbean, Polynesia, Hawaii and Papua New Guinea (Giri, Ambedkar & Sakhale, 2019). According to Food and Agriculture Organization (FAO) (2016), sweet potato has become an important crop for developing countries but less important in some other countries. For instance, China is the major producer of sweet potato, contributing 80 to 85% of total production globally.

Nevertheless, Giri, Ambedkar and Sakhale (2019) reported that sweet potato is one of the most under-exploited food crops although it has various nutritional benefits. It can be seen as Grant (2003) revealed that in the past few years, sweet potato is also known for the "food security" or "famine relief" crop, particularly in developing countries. It is a low input crop and is used as a vegetable, a desert, a source of starch and animal feed (Bibiana, Grace & Juliu, 2014). They further stated that sweet potato in Nigeria is mostly consumed as a snack called asondo, roasted, boiled, used with fresh yams and sweetener in beverage production. Furthermore, this tuber crop and other tropical crops play a vital role in food security and nutrition and climate change adaptation (Giri, Ambedkar & Sakhale, 2019). The root and tuber crops are essential components of diet in many countries (Odebode, 2004).

In Malaysia, the Department of Agriculture Peninsular Malaysia reported in Vegetables and Cash Crops Statistics Malaysia (2018) that sweet potato production in Malaysia was only 4,634.79 metric tons, which is sixth compared to other crops like maize, tapioca, yam, sugar cane and yam bean. The planted area of sweet potato was 811.10 hectare (Ha), but the harvested area was only 601.17 Ha. The highest sweet potato

production in Malaysia was from Peninsular Malaysia compared to Sabah, Sarawak, and Wilayah Persekutuan Labuan. Their overall production was 41,245.0 Mt with 39266.60 Mt from Peninsular Malaysia compared to 1978.40 Mt for 2017. It can be seen the decline production rate of sweet potato from 2013 to 2017. For instance, in 2015, there was 48,378.90 Mt production in Peninsular Malaysia and 2.228.50 Mt in Sabah, Sarawak and Wilayah Persekutuan Labuan. Nevertheless, the production figure dropped in 2017.

Based on the sweet potato price, FAMA in 2015 reported that the farm price for sweet potato was RM1390 per tons, RM2190 per tons for the wholesale price and RM3300 per tons for retail price. The price increased in 2016 whereby RM1640 per tons for farm price, followed by RM2780 per tons for the wholesale price and RM4030 per tons for retail price. Nevertheless, all the sweet potato prices per tons decreased in 2017, whereby the farm price was RM1660 per tons, RM2600 per tons for the wholesale price and RM3850 for retail price. It clearly showed that local sweet potato, especially purple sweet potato (PSP), in Malaysia has low demand and lack of consumption among Malaysian households.

From a culinary perspective, sweet potato, especially purple sweet potato, is not the major ingredients in most traditional dishes, including Malay traditional food. Not only that, but dessert is also the only meal course that consumers normally use purple sweet potato in Malay traditional food preparation. Desserts such as *che mek molek* (Kelantan *kuih*) and *bubur keledak* are examples of Malay traditional food that use orange sweet potato but not purple. Most Malaysians only eat boiled sweet potato root, especially the purple sweet potato. Most children, adolescents and young adults do not prefer to eat purple sweet potato. It is a common phenomenon in the supermarket whereby most of the local PSPs are unsold compared to the other local vegetables. Due to that, its retail price is unstable, which was a little bit higher in 2016 but lower in 2017. Recently, few manufacturers have produced snacks from sweet potato to add snack varieties without promoting its health benefits to the population. Nonetheless, the local PSP with high nutritional values is still abandoned.

According to the United States Department of Agriculture National Nutrient Database (2015), the nutritional value for 100g of PSP contains water 77.28g; energy 86 kcalorie, carbohydrates 20.12g, protein 1.57g, total fibre, 3g and total lipid 0.05g. For vitamins, Vitamin A is 14187 IU, thiamine 0.078mg, riboflavin 0.061mg, niacin 0.557mg, vitamin B6 0.209 mg, Folate (vitamin B9) 11µg, vitamin C 2.4mg and vitamin K 1.811µg. On minerals, potassium is the highest mineral (337mg) in PSP. In addition, it contains sodium 55mg, phosphorus 47mg, calcium 30mg, magnesium 25mg and iron 0.61mg. For lipids, the amount of fatty acids on total saturated is 0.018g, total monounsaturated is 0.001g, and polyunsaturated fatty acid is 0.014g. Due to its nutritional value, many scholars researched PSP. Some of the products focused on by the scholars are dehydrated chips, flour, composite flour, puree, flakes, gluten-free cookies, biscuits, crackers, bread, flatbread, pancake, pasta, pasta-fibre rich, pasta-protein rich, pasta-RS enriched, noodles, spaghetti-Low GI, extrudate snack (fasting purpose), buns and chapati, cake, cookies and buns and non-alcoholic beverages (Giri, Ambedkar & Sakhale, 2019).

Björck, Liljeberg and Ostman (2000) reported that sweet potato is a valuable medicinal plant. It is an anti-cancer, anti-diabetic, and anti-inflammatory activities. They further contended that as a carbohydrate-rich food, sweet potato is also reported to have a low glycaemic index (<55), suggesting its suitability as a portion of food for diabetic people. Low glycemic food is normally used to treat type 2 diabetes mellitus and in weight management (Gelencsér, Gal, Hodsayi & Salgo, 2008). Accordingly, sweet potato is reported to have a low

GI, which is highly contained in the white-skinned sweet potatoes and is used as diabetic-friendly food.

Besides that, the purple-fleshed sweet potato (PSP) has the highest concentration of anthocyanins. Truong and Avula (2010) stated that their leaf is an excellent alternative to synthetic colour in food products. Besides that, it also contains phenolics with antioxidant and anti-inflammatory activities (Grace et al., 2014). The anthocyanin content in purple-fleshed sweet potato ranges from 32 to 1390 mg/100 g DW as measured by pH differential-spectrophotometry or HPLC (Xu et al., 2015). Furthermore, scholars reported that sweet potato has unique chemical constituents to prevent and treat various disorders. Recently, bioactivities reported in sweet potato included anti-oxidative (Ding, Ni & Kokot, 2015; Grace et al., 2015; Motsa, Modi & Mabhaudhi, 2015; Zhang et al., 2014; Wu et al., 2015), anti-diabetic (Zhao, Yan, Lu & Zhang, 2013) and anti-inflammatory (Wang et al., 2014).

PSP is also used in various cooking methods such as baking, boiling, dehydrating, and frying (Wang et al., 2016). It is also produced as sweet potato starch in commercial part (Zhu & Wang, 2014) and bioproducts (El Sheikha & Ray, 2015). Baking gives better retention of anthocyanins in PSP than steaming. This may be because acylated phenolic acids and sugars are more degraded in steam-cooked sweet potato than in baked sweet potato (Kim, Kim et al., 2015). Thus, suitable processing methods need to be used for maximum anthocyanin retention in purple sweet potato products. Anthocyanins in purple sweet potato have also been anti-obesity (Hwang, Choi & Han, 2011; Shin et al., 2013).

Overall, Wang et al. (2016) suggested that practical applications of underutilized sweet potatoes should be diversified as it remains much underutilized on commercial levels, focusing on optimization in formulations and processing techniques to maximize the retention of bioactive. It is also used as a new ingredient for the development of gluten-free products. Several value-added food products are being developed using sweet potato with functional elements. Sweet potato tubers could be processed into different primary products such as flour, chips, puree, and secondary products like biscuits, pasta, and noodles (Giri, Ambedkar & Sakhale, 2019). Therefore, sweet potato can be further developed as a sustainable crop for various nutritionally enhanced food products.

Many scholars are focusing on sweet potato, particularly the purple sweet potato. Mu, Sun and Ma (2019) studied purple sweet potato as snack food. They revealed that sweet potatoes had become a research focus in recent years due to their unique nutritional and functional properties. In addition, snack foods occupy an extremely important position in the food consumption market (Mu, Sun & Ma, 2019). The snack food meets the consumption habits and consumption fashion of modern people for their good colour, fragrance, and taste since they are convenient for eating and offer various nutrition.

In addition, they revealed that as a kind of snack food, sweet potato snack foods have huge market potential and broad development space and noted that in recent years, sweet potato processing enterprises had introduced new technology and equipment to improve the quality of their products. They suggested that new ideas in raw materials, ingredients, flavours, texture, production, and packaging are needed to enhance sweet potato consumption. Not only that, the new type of sweet potato snack foods with various shapes and tastes needs to be developed to meet the diversified demand of market consumption since sweet potato snack foods are developing toward health.

On the other hand, Sittisak, Fuengkajornfung, Sanprom and Weenuttranon (2019) focused on the quality of cracker from purple sweet potato flour substituted for wheat flour. They concentrated on the acceptance of consumer who thinks of health. Based on the three

types of crackers produced, the most appropriate recipe was the 1st recipe: wheat flour 400 g, sugar 14 g, salt 3 g, yeast 3 g, salted butter 80 g, shortening 80 g, water 180 g. The standard recipe is then brought to the substitution of purple sweet potato flour in the 25, 50, 75 percent (weight of total wheat flour), respectively. They found that the substitution of purple sweet potato flour of 50 percent had a satisfaction score between minimum in terms of taste and score to median score in terms of colour. The chemical composition of purple sweet potato flour that substitutes wheat flour in cracker found that anthocyanin was equal to 1.82 mg /100g. Furthermore, they suggested a study should be conducted on the shelf life of crackers made from purple sweet potato flour, which focuses on nutritional values of crackers made from purple sweet potato flour and producing purple sweet potato in other products.

Zhu and Sun (2019) researched steamed bread's physicochemical and sensory properties fortified with purple sweet potato flour. Freeze-dried PSP was incorporated into steam bread formulations of up to 50%. The results showed that PSP addition of up to 50% increased the antioxidant activities of steam bread while reducing the glycemic response. The total polyphenol/anthocyanin contents of steam bread increased with the increase of PSP level, although a portion of the polyphenols was lost during production. PSP addition of up to 50% had little effect on the water activity and water content of CSB and increased the hardness while decreasing the specific volume. Steam bread with 5–10% PSP improved the overall sensory acceptance.

PSP can be used in steam bread of up to 10% with wheat flour to enhance the functional properties of steam bread without compromising eating quality. Overall, the results showed that PSP is suitable for use as an active ingredient in baked foods and that the functionality of the products is largely associated with the level of PSP addition. Future research should be focused on further reduction in the glycemic index of steam bread with other functional ingredients. They revealed that their study might stimulate additional interest in developing healthy CSB fortified with functional ingredients to address the ever-rising medical conditions among Asian and Chinese populations.

In 2011, Owusu, Oduro and Ellis studied crackers' development from cassava and sweet potato flours using *Moringa oleifera* and *Ipomea batatas* leaves as a fortification. They aimed to develop crackers enriched with *Moringa oleifera* and *Ipomoea batatas* using 100% cassava and sweet potato flour for potential use by celiac. *Moringa oleifera* and *Ipomoea batatas* enriched butter and cream crackers were made from 100% cassava flour and 100% sweet potato flour using 100% wheat flour as the control. They conducted a preliminary preference test for butter crackers and cream crackers. The best cracker was chosen for further sensory evaluation by trained panelists who evaluated each product for colour, appearance, aroma, crispness, firmness, chewiness, taste, bitter after-taste, and overall acceptability. Their results focused on proximate analysis, total phenols and beta-carotene contents. The beta-carotene levels of the leaves ranged from 4.76 mg/100g to 11.54 mg/100g for the sweet potato leaves, with *Moringa oleifera* having the highest β -carotene content of 23.43 mg/100g. Phenolic content ranged from 3.16% to 6.92% for sweet potato leaves and 1.51% for *Moringa oleifera*.

In addition, they stated that sweet potato flour crackers and cassava flour crackers had 4.87 and 3.14; 3.31 and 3.20; 1.79 and 1.92; 4.23 and 3.29; 13.29 and 10.31; 77.38 and 81.28; 446.09 and 431.02 respectively for percentages of moisture, ash, fiber, protein, fat, carbohydrates and calories. They further contended that their study demonstrated the potential for industrial exploitation of cassava and sweet potato flour by processing snack

food items such as crackers suitable for gluten intolerants. Children can also consume the crackers, teenagers, and the elderly to provide additional nutrient and good snacking habit.

Wang, Nie and Zhu (2016) contended that practical applications of underutilized parts of sweet potatoes should be diversified, focusing on optimization in formulations and processing techniques to maximize the retention of bioactive. According to them, the current knowledge of the chemical composition of sweet potatoes and their bio-functions has been studied in-vitro and in-vivo. Nevertheless, leaves, stems and stalks of sweet potato remain much underutilized on commercial levels.

Conclusion

Thus, to promote the Malaysia purple sweet potato as novelty food product for the Malaysians and enhance the consumption of low-fat and high-fiber diet, the development of healthy cracker from local PSP warrant to produce. It is worth reiterating that the Malaysian purple sweet potato is high in fiber content, anti-obesity, antioxidant, low fat and can be an alternative snack for the Malaysian population. A study into the potential use of purple sweet potato as a healthy cracker is needed since a very limited study has been conducted to prove potential product commercialization.

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