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Characteristics of Powders Produced from Different Parts of Sweet Potato

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Abstract
Sweet potato or scientific name called (Ipomoea batatas (L.) Lam.) is one of the nutritious staple food crops that mostly planted in the tropical regions. Different parts of the sweet potato plant may offer various benefits, but there is a lack of understanding on the properties to link with its potential applications. The objective of this study is to determine the characteristics of powders produced from different parts of sweet potato including stem, leaves, tuber and skin. The analyses were done using powder flow analyser to perform the cohesion test, Powder Flow Speed Dependency test (PFSD test) and caking test. All samples were fixed at 70ml volume for each experiment. The finding showed that the powder of sweet potato stem, leaves, tuber and skin are categorized as free and stable powders and also prone to cake.

Keywords: sweet potato, flow ability, cohesion, caking, PFSD test

Introduction
Sweet potato (*Ipomoea batatas*) is a tropical staple fruit crop of *Convolvulaceae* family, identified by long trailing vines and leaves of different shapes (Sullivan, Asher, & Blarney, 1997). Sweet potato is a very vital crop in developing countries by considering its fast growing duration of 90-120 days. In Malaysia, among the tuber crops, sweet potato ranked second next to cassava and has been cultivated on a small scale since the 17th century (Mohd Hanim et al.,2014). Sweet potato contains high nutritional contents including vitamins A and C, fibers, carbohydrates, potassium, iron and high quality protein that can fulfil human nutritional needs (Mais and Brennan, 2008). This crop plays various roles in the human diets either for supplemental or a luxury food. Besides, sweet potato can also be applied to various products like drinks (wine, liquor, vinegar), sugar production, biscuits, flour, pasta, alcohol and many more (Ellong, Billard, & Adenet, 2014). For this reason, annual sweet potato-based edible food products are reported to be over 135 hundred million metric tons worldwide (Mohd Hanim, Chin, & Yusof, 2014). The benefits offered by sweet potato are not only exclusive to the tuber part, since other parts of this plant also have different amount of appreciable nutritional compounds. For example, sweet potato leaves are rich in ß carotene, calcium, iron, zinc, protein, vitamin B and the crop is highly tolerant of diseases, pests and have high moisture than other leafy vegetables in the tropics. The annual yield of sweet potato tops is much higher than many other green vegetables and can be harvested several times a year. The nutritional value of sweet potato leaves is being acknowledged, as the understanding between health and diet increase. Sweet potato leaves may become good leafy vegetables with their high nutritive value and also antioxidants (Islam, 2003). Other than leaves and tuber, parts such as stem and skin also have high potential in providing nutritional benefits, hence, further exploration in this avenue is required. One of the practical ways to utilize the sweet potato parts is by converting them into powders. It will give advantages in technological potential of food development. Thus, this study aimed to determine the characteristics of powder flow properties produced from different parts of sweet potato.

Materials and methods
Different parts of sweet potato samples were supplied by local farmers in Semenyih, Selangor, Malaysia.

Preparation of samples
The leaves and stem were separated and cut down to 2 to 3 cm to become small pieces and then placed onto the aluminium foil. The skin of tubers was peeled and the tubers were cut into small pieces and separated onto the aluminium foil. All the samples were dried at 60°C for 72 hours in a conventional oven (OF-G22W, Jejo Tech, Korea). The dried samples were ground using a Mill Grinder (Retsch, SM200 Rostfrei, Germany) prior to sieving using 250µm mesh. The produced powders of different sweet potato parts were kept in a chiller (4˚C) for further analysis.

Flowability analysis
The flow properties of different parts of sweet potato were analysed using probe Powder Flow Analyser attached to a texture analyser (TA-XT plus, Stable Micro Systems, Surrey, UK) (Benkovic and Bauman, 2009). The caking test, cohesion test and powder flow speed dependency test (PFSD test) were performed. All samples were fixed at 70 mL volume for each experiment. The caking test, cohesion test, and PFSD test were ran and triplicated except for caking test. A conditioning cycle was performed at the beginning of the test to remove user loading variation by moving the blade

downward and upward through the powder column at a tip speed of 50 $mm.s^{-1}$.

Results and discussion

Flowability analysis

Flowability of powders is an important property since it will affect the behaviour of the powders during storage, handling and processing. This property may be depends on a few factors such as temperature, pressure and humidity (Teunou et al., 1999). Table 1 exhibits the flow characteristics of powders from different parts of the sweet potato plant. Based on the finding, all samples were categorized as free flowing powders with cohesion index below 11. This may be due to small particle size of the powders that has been sieved at 250 µm during the preparation stage. Smaller particle size of powder is more cohesive and the ability to flow is becoming more difficult. The reason for the flowability reduction for smaller particle sizes is due to the increase of surface area per unit mass of the powders. More surface contacts or surface area lead to high resist flow resistance.

Based on Table 1, the tuber powders have the highest cohesion index of 3.01, followed by leaves, skin and stem respectively. Meanwhile, all the samples were considered as stable powders since the flow stability values were closed to 1. Flow stability index near to 1 indicates that the powders will not easily change.

Figure 1, shows tin speed versus compaction coefficient of different parts of sweet potato powders. Stem powder has the highest compaction coefficient followed by leaves, tuber and skin powder respectively. Based on the finding, compaction coefficient of all samples decreased at high tin speed. This indicates that as the flow speed increases, the powders become freer to flow. The smaller the particles, the freer the powder to flow.

Caking is a phenomenon where food powders are transformed into a sticky unwanted material. It can cause deterioration in powders quality and functionality. Cake strength can be affected by a number of factors such as particle to particle interactions, packing efficiency and moisture content (Benkovic and Bauman, 2009). The tuber powder had the highest cake strength of 21336.52 g.mm and mean cake strength of 853.85 g compared to leaves, stem and skin powder as shown in Table 1. Figure 2 illustrates the cake height ratio of all the powders. The cake height ratio increased as the number of compaction cycle increased. High cake height ratio indicates a higher tendency for the powders to caking, which related to having high mean cake strength and high cake. Hence, the finding indicates that all the samples have a high tendency to caking.

Table 1: Flow characteristic properties of different parts of sweet potato powders.

Parameter	Stem	Leaves	Tuber	Skin
Cohesion index	1.63±0.03	2.9±0.07	3.01±0.05	2.1±0.07
Flow stability	0.95±0.01	0.92±0.01	1.01±0.06	0.86±0.10
Cohesion coefficient 50 mm/s	495.34±4.96	488.09±23.56	717.08±69.52	204.36±6.71
Cake strength (g.mm)	2272.25	8275.04	21336.52	9336.97
Mean cake strength (g)	307.25	344.82	853.85	577.27

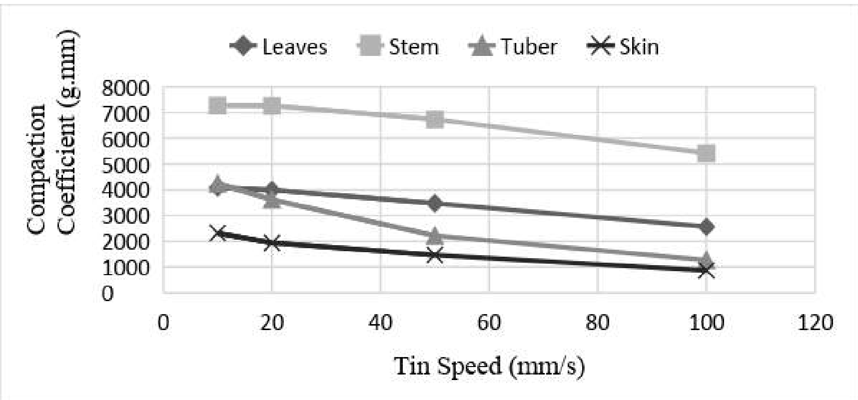

Figure 1: Tin Speed versus compaction coefficient of different parts of sweet potato powders

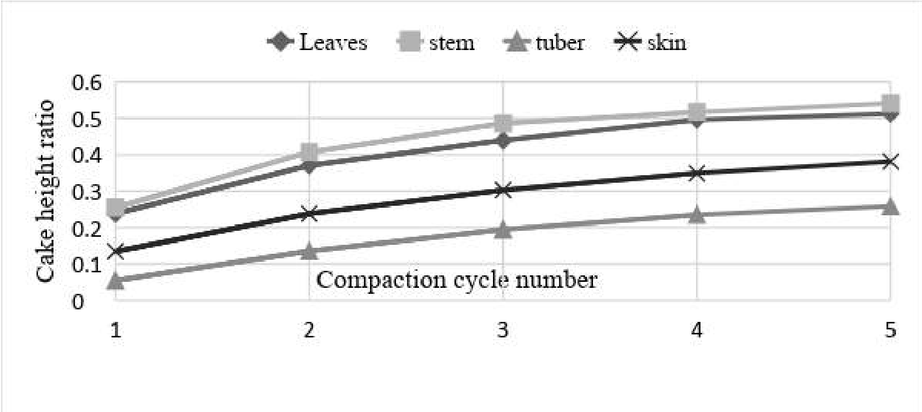

Figure 2: Caking height ratio versus compaction cycle number of different parts of sweet potato powders.

Conclusions

In flowability analysis, the powder of sweet potato stem, leaves, tuber and skin are classified as stable powders and free flowing. They were also becoming more likely to caking. Based on this study, different parts of sweet potato produce different powder properties value. Thus, further explorations are needed to apply the advantages as new applications.

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