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Comparative studies of the physicochemical and functional properties of sweet potato (*Ipomoea batatas* L.) flour

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Abstract

This study aimed to determine the proximate compositions and functional properties of sweet potato flour from different varieties cultivated in Sabah, Malaysia, namely *Jepun*, *Kairot* and *Kaladi*. The results showed that the moisture content of all flour samples was below 14%. The fat and protein content of *Jepun* sweet potato variety were significantly different ($p<0.05$) as compared with *Kairot* and *Kaladi* sweet potato varieties. The ash and dietary fibre content of *Kairot* sweet potato flour were higher ($p<0.05$) compared to *Jepun* and *Kaladi* flours. In addition, *Kaladi* sweet potato had the highest carbohydrate content (82%). There were significant differences ($p<0.05$) in the values of L*, a* and b* for all sweet potato flours. The *Jepun* sweet potato flour had the highest foaming capacity, water absorption capacity, oil absorption capacity, swelling power and viscosity. Rapid Visco analyser revealed that significant differences were observed for pasting parameters such as peak viscosity, trough viscosity, breakdown viscosity, final viscosity and setback viscosity. The gelatinisation properties showed that *Kairot* sweet potato flour had the highest onset temperature, conclusion temperature and enthalpy while *Kaladi* sweet potato flour had the highest peak temperature.

1. Introduction

Sweet potato or its scientific name *Ipomoea batatas* (L.) belongs to the family Convolvulaceae where it is the seventh most important crop in the world after wheat, rice, corn, potatoes, barley and cassava. Sweet potatoes are one of the most important cultivars and foods in most countries, especially in the tropics and subtropics (Shekhar *et al.*, 2015). In 2018, the global and Malaysian production of sweet potatoes amounted to approximately 92 million and 38 thousand metric tonnes, respectively (FAOSTAT, 2020). The area planted with sweet potato in Sabah was 68 hectares in 2016 with the production reaching 500 tonnes (Department of Agriculture Sabah, 2020).

Soison *et al.* (2015) reported that differences in cultivation area would affect the colour of the flesh and skin of cultivated sweet potatoes. Hence, it will influence their physicochemical characteristics and nutritional compositions. Orange sweet potatoes have a mixture of phenolic acid and high levels of carotenoids. However, purple sweet potatoes have a higher content of anthocyanins than orange sweet potatoes. The nutritional composition of sweet potatoes is essential in meeting human dietary needs including carbohydrates, fibre, carotene, thiamine, riboflavin, niacin, potassium, zinc, calcium, iron, vitamins A and C and high-quality protein (Oke and Workneh, 2013).

Ahmed *et al.* (2010) reported that fresh sweet potatoes are perishable and difficult to store. Most developing countries face difficulties in the storage and transportation of sweet potatoes. Therefore, sweet potato tubers have been processed into food products that have a longer shelf life and better properties than fresh sweet potatoes. Examples of foods that can be processed from sweet potatoes are biscuits, muffins, noodles, breakfast foods and pies. Moreover, sweet potato tubers can be processed into flour which is more stable and not easily damaged. Sweet potato flour can be used to enhance the quality of food products such as colour, taste, natural sweetness and as a nutritional supplement (Ahmed, Akter and Jong-Bang *et al.*, 2010).

The climatic conditions in Malaysia are suitable for the cultivation of sweet potatoes, and the source of sweet potatoes is also readily available. Furthermore, there are

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various varieties of sweet potatoes available locally, each of which has different chemical composition values and functional characteristics. However, there is still no research conducted on the sweet potatoes cultivated in Sabah, Malaysia. Therefore, this research was conducted to investigate the physicochemical properties of sweet potato flour from three different varieties, namely *Jepun*, *Kairot* and *Kaladi*. In this present study, the proximate composition, functional properties and thermal properties of the sweet potato flours were determined.

2. Materials and methods

2.1 Raw materials

The sweet potato varieties, namely *Jepun*, *Kairot* and *Kaladi* were purchased from a local supplier in Kota Kinabalu, Sabah, Malaysia. *Jepun* variety is dark purple, whereas *Kairot* and *Kaladi* were orange and yellow, respectively (Figure 1). Matured sweet potatoes (3 – 3.5 months of age) selected were free from any physical injury, smooth and uniform in size and shape.

(A) (B) (C)

Figure. 1 Sweet potato varieties, (A) *Jepun*, (B) *Kairot* and (C) *Kaladi*

2.2 Sweet potato flour preparation

The tubers were washed carefully with tap water, cut into small pieces (about 1 cm) and placed in 0.2% sodium metabisulfite solution for 30 mins. The slices were dried with a cabinet dryer (Thermoline Scientific, Australia) at a temperature of 60±5°C until the absolute humidity was less than 14%. The dried tubers were ground using an electric blender (Waring 80011S, USA) for 5 mins, sifted using a sieve machine (Endecott Minor, England) to pass a 250 µm sieve. The flours were packaged in a polyethylene bag and stored at ambient temperature for further analyses.

2.3 Proximate and dietary fibre analysis

The moisture content, ash, crude fat, crude protein, crude fibre and dietary fibre were determined according to AOAC (2000) methods (protocol 925.10, 923.03, 920.85, 920.87, 991.36 and 991.43, respectively). The carbohydrate content was calculated as the difference between 100 and the total moisture content, ash, crude fat, crude protein and crude fibre (Mamat *et al.*, 2018). All analysis was done in triplicate.

2.4 Colour

The colour of the flour was analysed by following the procedure described by Siddiq *et al.* (2010) by using a Hunter Colorimeter (Hunterlab ColorFlex®, USA). The colour values were recorded as L* (0, black; 100, white), a* (-a, green; + a, reddish) and b* (-b, bluish; + b, yellowish).

2.5 Foaming capacity

The foaming capacity of the flour sample was determined by the method described by Chandra and Samsher (2013). A total of 1.0±0.1 g of flour was added with 50 mL of distilled water into a 100 mL measuring cylinder. The mixture is mixed and shaken for 5 mins until it forms a foam. The volume of the foam after 30 secs is expressed as the foaming capacity using the formula below:

$$\text{Foaming capacity (\%)} = \frac{V_2 - V_1}{V_1} \times 100$$

Where, V_1 = before whipping (mL), V_2 = after whipping (mL)

2.6 Water absorption capacity

The water absorption capacity measurement was performed using the method described by Bashir *et al.* (2017). A total of 3.0±0.1 g of flour sample was mixed into 25 mL of distilled water before being weighed into a centrifugal tube. The mixture was mixed for 30 mins at room temperature and centrifuged at 2500×*g* for 15 mins (Kubota 2100, Japan). The supernatant was decanted, excess moisture was removed by draining. Then, the centrifugal tube containing the sample is re-weighed. The accumulated weight is expressed as grams of water absorbed per gram of flour.

2.7 Oil absorption capacity

Oil absorption capacity was performed based on the method of Mancebo *et al.* (2015). A total of 0.1±0.01 g of flour sample was mixed with 1.0±0.5 mL of cooking oil (palm olein) (Bagus, Malaysia). The mixture was stirred for 1 min to dissolve the sample in oil. The tube is left for 30 mins. Then, it was centrifugated at 2500×*g* for 15 mins. The supernatant was removed using a pipette and the tube was inverted for 25 mins to drain the water, and the residue was weighed. The gain in weight was expressed as grams of oil absorbed per gram of flour.

2.8 Swelling capacity

Swelling capacity was measured using the procedure explained by Ikegwu *et al.* (2010). A total of 1.0±0.1 g of flour sample was weighed. Afterwards, the samples were transferred to a dry and re-weighed test tube. Then, 50 mL of distilled water was added to the test tube. The mixture was heated to different temperatures of 65, 75, 85 and 95˚C for 30 mins in immersion water. The mixture was cooled to a temperature of 28±2˚C and centrifugated at a speed of 2200 rpm for 15 mins to separate the gel and the supernatant. After the supernatant removed, the weight of the sediment was recorded.

2.9 Emulsion capacity

The emulsion activity was determined according to the method of Chandra and Samsher (2013). A total of 1.0±0.1 g of flour sample, 10 mL distilled water and 10 mL cooking oil (palm olein) was prepared in the calibrated centrifuge tube. Then, the emulsion was centrifugated at a speed of 2100×*g* for 5 mins at room temperature. The ratio of the height of the emulsion layer to the total height of the mixture was calculated as emulsion activity in percentage.

2.10 Pasting properties

The pasting properties were analysed by using the method of Noorfarahzilah *et al.* (2020) using a Newport Scientific Rapid Visco Analyser 4 (RVA-4) (Newport Scientific, Warriewood, Australia). A total of 3.0 g of sample (14% moisture) was weighed into the RVA aluminium canister. Distilled water was added until it reaches 28 g. The heating process was started at a temperature of 50˚C for 1 min. Then reheat to 95˚C for 7.5 mins and held at 95˚C for 2 mins. After that, the cooling process is carried out by lowering the temperature to 50˚C in 7 mins and held at 50˚C for 2 mins. From the RVA plots, the pasting temperature, peak viscosity, trough, breakdown, final viscosity and setback were recorded using the Thermocline Version 2.2 software (Newport Scientific). The viscosity was expressed in units of centipoise (cP).

2.11 Gelatinisation properties

The thermal properties of the flour sample were performed using a differential scanning calorimeter (DSC) (Perkin Elmer, Diamond DSC, USA). A total of 2.0±0.1 mg of sample was placed in an aluminium pan, and 6 µL of water was added using a microsyringe. After that, the pan was stored at room temperature for 1 hr to ensure the flour sample reaches equilibrium with the water. The sample was heated from 30˚C to 120˚C with a heating rate of 10˚C/min. An empty aluminium pan was used as a reference. Onset temperature, peak temperature, conclusion temperature, and enthalpy of gelatinisation (ΔH) were determined from the endotherm.

2.12 Statistical analysis

All experiments were conducted in triplicate. Data reported are averages of three determinations. The significance of differences ($p<0.05$) was assessed using analysis of variance (ANOVA) and Duncan's Multiple Range performed by Statistical Package for Social Scientists (SPSS software version 23.0).

3. Results and discussion

3.1 Chemical compositions

Proximate composition and dietary fibre of three different varieties of sweet potato flour are shown in Table 1. The moisture content was ranged from 9.05 to 10.27%. *Kaladi* variety had the lowest amount and significantly different with *Jepun* and *Kairot* varieties. Generally, the maximum allowable moisture content in the flour is 14%. In this study, the moisture content of all sweet potato flour samples was lower than 14%. High moisture content will encourage the growth of microorganism that affect the shelf-life of flour and nutritional value. Moreover, the low moisture content is a requirement for long-term food storage, and low humidity levels in food products will increase the concentrated nutrient content (Idowu *et al.*, 2013). The average ash content was ranged from 2.34 to 2.76%. The *Kairot* variety had the highest amount of ash and significantly different from the *Jepun* and *Kaladi* varieties. The results observed in this study were lower than reported by Mohd Hanim *et al.* (2014) for VitAto, Bukit Naga and Okinawan sweet potatoes flour (2.75 to 3.20%). Ash content is a representation of the mineral content of a food product. Ash in flour is reported to influence colour, giving a darker colour to final products. Flour generally low in fat. The crude fat content of sweet potato varieties was ranged from 0.49 to 0.87%. Similar findings were also reported by Ahmed, Akter and Jong-Bang *et al.* (2010). The crude protein content of sweet potato flours was observed between 3.02 and 5.30%, where *Jepun* variety had the highest and *Kairot* had the lowest. The results are in agreement with findings reported by Mohd Hanim *et al.* (2014) and higher than reported by Ndangui *et al.* (2014). The composition of crude protein strongly influenced by the effects of growing conditions such as temperature, water and fertilizer (Dupont and Altenbach, 2003). Protein is a vital macronutrient in the human diet for growth and health maintenance.

The crude fibre content of sweet potato flours was ranged from 1.95 to 2.70%. The mean crude fibre content of *Kairot* and *Jepun* sweet potato flours were significantly ($P<0.05$) higher than that of *Kaladi* sweet potato flour. The results recorded were lower than the

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findings reported by Dako *et al.* (2016). The average mean values for carbohydrate content were ranged from 69.89 to 74.16%. As shown by the result of statistical analysis, the mean carbohydrate content of *Kaladi* sweet potato flour was significantly (P<0.05) higher than that of both *Kairot* and *Jepun* sweet potato flours. Dietary fibre determination showed that the amount obtained was between 8.95 and 10.64, where *Kairot* sweet potato variety had the highest mean and significantly different from *Kaladi* sweet potato variety. The results were higher than reported by Kim *et al.* (2011) (7.22-10.87%) for eight different Korean sweet potatoes. Huang *et al.* (1999) reported that the mean total fibre contents (soluble and insoluble) were in the range of 2.01–3.87 g/100 g fresh weight for 18 sweet potato cultivars grown in Hawaii. The dietary fibre contents in sweet potato cultivars are depending on the genetics and growing conditions of the crops as well as the analytical methods (sieving or enzymatic method) (Wang *et al.,* 2016).

Table 1. Chemical composition of *Jepun*, *Kairot* and *Kaladi* sweet potato flours

Parameter (%)	*Jepun*	*Kairot*	*Kaladi*
Moisture	$10.27±0.56^{b}$	$10.22±0.06^{b}$	$9.05±0.04^{a}$
Ash	$2.34±0.01^{a}$	$2.76±0.11^{b}$	$2.40±0.13^{a}$
Crude fat	$0.87±0.12^{b}$	$0.49±0.09^{a}$	$0.52±0.02^{a}$
Crude protein	$5.30±0.06^{c}$	$3.02±0.01^{a}$	$4.04±0.02^{b}$
Crude fiber	$2.43±0.14^{b}$	$2.70±0.20^{b}$	$1.95±0.12^{a}$
Dietary fiber	$10.15±0.82^{ab}$	$10.64±0.45^{b}$	$8.95±0.47^{a}$
Carbohydrate	$69.89±0.98^{a}$	$71.66±0.49^{a}$	$74.16±0.64^{b}$

Values are expressed as mean±standard deviation (n = 3). Values with different superscript within the same row are significantly different (P<0.05). Values for ash, fat, protein, coarse fibre, dietary fibre and carbohydrates are based on dry weight

3.2 Functional properties

The functional properties of composite flours play an essential role in the manufacturing of food products (Hasmadi *et al.,* 2020). The foaming capacity, water absorption capacity, oil absorption capacity, emulsion activity and colour profiles of tuber flours are summarised in Table 2.

3.2.1 Foaming capacity

The foaming capacity was ranged between 5.77 and 7.69%. The highest foaming capacity was observed for *Jepun* variety and significant difference with *Kaladi* and *Kairot* varieties. Foaming capacity is greatly influenced by the amount of soluble protein in the flour, where the highest amount of protein content was observed in the *Jepun* variety. The values obtained were lower than the results reported for green gram flour and wheat flour. However, it was higher than potato flour and rice flour (Chandra and Samsher, 2013). Better foaming capacity of flour implies greater incorporation of air bubbles into the product. Legumes generally exhibit higher foaming capacity. Foam formation and stability depend typically on the interfacial film formed by proteins which keeps air bubbles in suspension and slows down the rate of coalescence (Sreerama *et al.*, 2012).

Table 2. Functional properties of sweet potato flours

Parameter (%)	*Jepun*	*Kairot*	*Kaladi*
Foaming capacity (%)	$7.69±0.00^{a}$	$5.77±0.10^{b}$	$7.25±0.00^{c}$
Water absorption capacity (g/g)	$1.11±0.16^{a}$	$1.00±0.03^{a}$	$0.90±0.01^{a}$
Oil absorption capacity (g/g)	$1.05±0.12^{a}$	$0.95±0.01^{a}$	$1.05±0.03^{a}$
Emulsion activity (%)	$12.00±0.00^{c}$	$6.00±0.00^{b}$	$4.00±0.00^{a}$
Colour:			
L*	$59.65±0.01^{a}$	$82.15±0.03^{b}$	$87.94±0.01^{c}$
a*	$13.63±0.02^{c}$	$17.51±0.00^{d}$	$3.29±0.02^{b}$
b*	$1.74±0.21^{a}$	$20.78±0.10^{c}$	$24.22±0.17^{d}$

Values are expressed as mean±standard deviation (n = 3). Values with different superscript within the same row are significantly different (P<0.05).

3.2.2 Water and oil absorption capacity

Water absorption capacity results showed that all of the sweet potato flours recorded similar values, where no significant differences were observed between those samples. According to Adejuyitan *et al.* (2009), proteins and carbohydrates were two major factors that influence the water absorption capacity of flours. The oil absorption capacity was ranged from 0.95 to 1.05 g/g. No significant differences were observed between flour samples. The results obtained were in agreement with the findings reported for whole legume flours (Du *et al.*, 2014) but lower than mango seed flour (Okpala and Gibson-Umeh, 2013) and tarap seed flour (Noorfarahzilah *et al.*, 2017). According to Yadav *et al.* (2012), high oil absorption capacity occurs due to the presence of a large hydrophobic group compared to the hydrophilic group on the surface of the protein molecule. The absorption capacity of oil plays an important role in further enhancing the taste in the mouth. Therefore, the oil acts as retention of flavour in food (Masri *et al.*, 2012). Ikegwu *et al.* (2010) reported that oil absorption capacity is useful to food interaction structure, especially in taste retention, improving food flavour and extending food life, especially in bakery or meat products.

3.2.3 Emulsion activity

The highest value of emulsion activity was observed for the *Jepun* variety (12.00%) followed by *Kairot* and *Kaladi* sweet potato flours. Ohizua *et al.* (2017)

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described that emulsion activity determines the maximum amount of oil in an emulsion that can be formed by protein at a given amount of flour. The emulsion activity of a food product depends on the oil content and protein concentration of the product, which is referred to as the ability of flour to emulsify the oil. Thus, low emulsion activity may be due to a lack of reaction between protein and fat content in flour samples (Masri *et al.*, 2012). According to Kaushal *et al.* (2012), the hydrophobic properties of proteins will influence the emulsion properties. Among the factors that influence emulsion activity include solubility, pH value and concentration. The protein capacity to enhance the formation and stabilisation of emulsions is vital for most applications in food products such as frozen cakes and desserts (Chandra and Samsher, 2013).

3.2.4 Colour profiles

The results of the colour analysis for all flour samples showed significant differences ($p<0.05$) for all colour parameters. The value of lightness (L) was found highest for *Kaladi* sweet potato flour, followed by *Kairot* and *Jepun* varieties. Meanwhile, *Kairot* sweet potato flour had the highest redness (a *) value among all of the flour samples. *Kaladi* sweet potato flour had the highest yellowness (b*) value. This could be due to the presence of carotenoid pigments and anthocyanins in these flour samples. Orange-fleshed sweet potato is an essential source of carotenoids (beta-carotene), whereas purple-fleshed sweet potatoes are rich in anthocyanins (Kim *et al.*, 2011).

3.2.5 Swelling capacity

The swelling capacity of three sweet potato varieties is depicted in Figure 2. The swelling capacity of sweet potato flour increases consistently with increasing temperature. *Kaladi* sweet potato flour had the lowest swelling capacity at 65°C and increased with increasing temperature. The increase in swelling capacity is highest at 95°C for *Kaladi* sweet potato flour followed by *Jepun* and *Kairot* sweet potato flours. The results obtained in the present work were lower than the values reported by Idowu *et al.* (2013). According to Ahmed, Akter and Jong-Bang *et al.* (2010), the low swelling capacity of flour is contributed by the presence of a substantial number of crystallites, which accelerate starch granular stability that decreasing the extent of granular swelling. Nuwamanya *et al.* (2011) described that flours with high amylose content tend to obtain high swelling capacity. Granular swelling has been shown to be influenced by many factors, among them are granular size, amylose content, starch damage and temperature (Mamat and Hill, 2018).

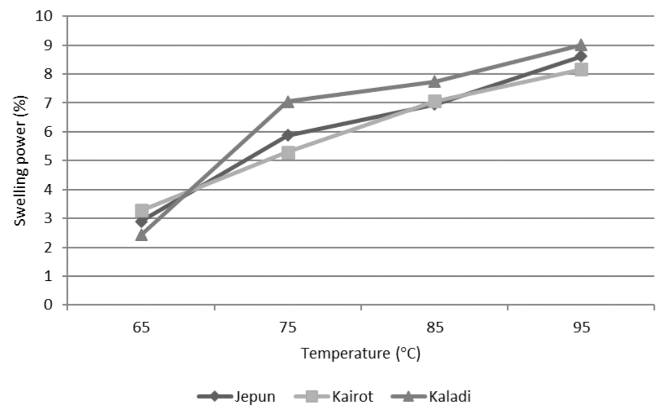

Figure 2. Swelling capacity of sweet potato flours at elevated temperature

3.3 Pasting properties

The pasting properties profile of three sweet potato flours is presented in Table 3. All the parameters measured were significantly differenced for all samples except for pasting and peak temperature. The highest point developed during the heating cycle is referred to as the peak viscosity. The peak viscosity is representing the equilibrium point between swelling and rupture of starch granules (Newport Scientific, 1995). The peak viscosity ranged from 386.33 to 852.00 cP. The highest peak viscosity recorded by *Kaladi* sweet potato flour, followed by *Kairot* and *Jepun* varieties. The results obtained were higher than the results presented by Ohizua *et al.* (2017) but lower than reported by Nabubuya *et al.* (2012). The peak viscosity of flour is influenced by the amylose content in the flour. Amylose affects the swelling capacity of the starch granules by restricting it and hence lowering the peak viscosity (Shimelis *et al.*, 2006). Lower amylose content was associated with a higher peak viscosity and a lower pasting temperature. Trough viscosity determines the ability of the paste or gel formed to withstand breakdown during cooling. The trough viscosities of sweet potato flours were ranged between 71.67 and 481.67 cP.

The breakdown viscosity determines the ability of the starch to withstand heating and shear-induced disintegration during cooking. At the point of breakdown, swollen granules disorder further and amylose polymers generally discharge into solution. *Kairot* sweet potato flour showed the highest breakdown viscosity (435.00 cP) while *Jepun* sweet potato flour had the lowest (255.33 cP). Sweet potato flours showed lower breakdown viscosity compared to the findings of white sweet potato reported by Julianti *et al.* (2017) (829 cP). Debet and Gidly (2007) described that the extent of breakdown depends on several factors such as type and amount of starch, the temperature gradient, shear force and composition of the mixture. The final viscosity of flours measured the re-association of the amylose

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Table 3. Pasting properties of sweet potato flours

Parameter	*Jepun*	*Kairot*	*Kaladi*
Peak viscosity (cP)	386.33±4.93[c]	508.67±15.14[b]	852.00±13.89[a]
Trough viscosity (cP)	131.00±4.00[c]	71.67±1.15[b]	481.67±11.59[a]
Breakdown viscosity (cP)	255.33±2.89[c]	435.00±12.49[b]	370.33±3.06[a]
Final viscosity (cP)	201.67±15.18[c]	106.67±4.93[b]	681.33±13.65[a]
Setback (cP)	70.67±11.24[c]	33.00±3.00[b]	199.67±4.16[a]
Peak time (min)	5.90±0.04[a]	5.94±0.34[a]	6.16±0.34[b]
Pasting temperature (˚C)	73.45±0.22[a]	75.45±0.48[a]	75.43±0.16[a]

Values are expressed as mean±standard deviation (n = 3). Values with different superscript within the same row are significantly different (P<0.05).

molecules during the cooling period after gelatinisation and a formation of a gel network (Noorfarahzilah *et al.*, 2017). The final viscosity of sweet potato flours ranged from 106.67 to 681.33 cP, the lowest for *Kairot* sweet potato flour and the highest for *Kaladi* sweet potato flour was observed. The results obtained were in the ranged as reported by Waramboi *et al.* (2011) for sweet potato from Papua New Guinea and Australia (65 – 1513 cP).

The setback viscosity is a measurement of the degree of re-association between the starch molecules involving amylose upon cooling. Final viscosity elucidates the ability of the material to form a viscous paste. The setback viscosity recorded for sweet potato flour samples were between 33.00 and 199.67 cP. It was observed that the sweet potato flours showing lower tendencies to retrograde, which are advantageous in food products. The higher the setback value, the lower the retrogradation during cooling and the lower the stale rate of the products made from the starch. Pasting temperature provides an insight into the minimum temperature required to cook the flour (Kaushal *et al.*, 2012). The pasting temperature ranged from 73.45 to 75.45°C. The pasting temperature recorded was lower than the pasting temperature reported for white, cream, and orange-fleshed sweet potato tubers (79.5°C to 82.73°C). The higher pasting temperature indicates the presence of starch that is highly resistant to swelling.

3.4 Gelatinisation properties

The gelatinisation properties of sweet potato flours are presented in Table 4. Onset (To), peak (Tp) and conclusion temperature (Tc) as well as enthalpy values (ΔH) were obtained from DSC measurements. The onset, peak and conclusion temperature of sweet potato flours were ranged from 70.11 to 73.02°C, 74.71 to 77.09°C and 78.60 to 80.62°C, respectively. *Kairot* sweet potato flour had the highest onset and conclusion temperature, while *Kaladi* sweet potato showed the highest peak temperature. The ΔH were ranged between 1.36 and 1.51 J/g, *Kairot* sweet potato flour had the highest, followed by *Kaladi* and *Jepun* varieties. There were no significant differences in ΔH values.

4. Conclusion

Sweet potato is a good source of energy where it can contribute more than 70% of the source of carbohydrate. Besides, it is also a good source of dietary fibre. Functional properties of all of the sweet potato flour investigated were lower in water and oil absorption properties compared to other typical flours. Pasting properties results found that low setback viscosity was observed for all flour samples, which could be related to lower retrogradation. Overall, *Jepun* sweet potato flour shows better nutritional and functional quality as well as thermal properties.

Conflict of interest

The authors declare that there are no conflicts of interest.

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Table 4. Gelatinisation properties of sweet potato flours

Parameter	*Jepun*	*Kairot*	*Kaladi*
Onset temperature, T_o (˚C)	70.11±0.50[b]	73.02±0.31[a]	72.93±0.20[a]
Peak temperature, T_p (˚C)	74.71±0.46[b]	76.92±0.05[a]	77.09±0.08[a]
Conclusion temperature, T_c (˚C)	78.60±0.50[b]	80.62±0.06[a]	80.53±0.09[a]
Enthalpy (ΔH) (J/g)	1.36±0.09[a]	1.51±0.10[a]	1.37±0.25[a]

Values are expressed as mean±standard deviation (n = 3). Values with different superscript within the same row are significantly different (P<0.05).

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