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Ethnobotanical Uses, *In-Vitro* Total Phenolic, Flavonoidic Content and Antioxidant Activity of Plants Consumed by Siamese Community of Tanah Merah, Kelantan, Malaysia.

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ABSTRACT

Antioxidant level within our biological system is crucial to be maintained, in order to control the amount of free radicals. Antioxidant can be acquired through various food sources which comprises of fruits, vegetables, spices and herbs, processed food supplements (natural or synthetic origin) and others. The main objective is to delineate the traditional uses and identify the *in vitro* total phenolic (TPC), flavonoidic content (TFC) and antioxidant capacity of *Boesenbergia pandurata*, *Curcuma longa*, *Melastoma malabathricum*, *Oroxylum indicum*, *Pandanus amaryllifolius*, *Sauropus androgynus* and *Vitex negundo* consumed by Siamese community of Tanah Merah, Kelantan. The TPC and TFC of aqueous plant extract were studied via Folin-Ciocalteu and aluminium chloride colorimetric method respectively. Antioxidant activity were determined by DPPH (2,2-diphenyl-1-picrylhydrazyl hydrate) assay and ferric reducing/antioxidant power (FRAP) assay. The TPC and TFC of the prepared aqueous extracts were in the range of 3.99-111.63 mg GAE/g dry extract and 9.79-67.86 mg CE/g dry extract, respectively. Percentage of inhibition was observed to be 42.82-73.11 %. Meanwhile, FRAP values were found to be in the range of 245.56-620.00 µmol Fe(II)/g dry extract. *V. negundo* showed highest TPC (111.63 ± 0.49 mg GAE/g dry extract). *S. androgynous* had highest TFC (67.86 ± 17.50 mg CE/g dry extract) and best ferric reducing/antioxidant potential of 620.00 ± 43.55 µmol Fe(II)/g dry extract. *B. pandurata* exhibited highest DPPH free radical scavenging activity of 73.11 ± 0.82 %. The finding shows that *V. negundo* to be a rich source of phenolics, while *S. androgynus* to be rich in flavonoids. The ferric reducing/antioxidant power were correspondingly high in *S. androgynus* which support the role of flavonoids as effective antioxidant compound. *B. pandurata* was found to be potential source of antioxidant following alternative mechanism as indicated by high DPPH antioxidant capacity. Ferric reducing/antioxidant power activity were strongly correlated to TPC and TFC compared to DPPH free radical scavenging activity.

Keywords: traditional uses, antioxidant activity, phenolic content, flavonoids, aqueous extract.

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INTRODUCTION

Antioxidants are substances capable of reducing reactive oxygen species (ROS). They are also known as reducing agent which reduces oxidising molecules in our body. Some of the common antioxidants are for example ascorbic acid, phenolic acids, flavonoids, tannins, coumarins, curcuminoids, gallic acid, vitamin A, C and E [1], [2], [3]. There are various forms of free radicles present within our system for example; hydroxyl radicals (OH), superoxide anion radical (O_2^-), hydrogen peroxide (H_2O_2) and singlet oxygen [4], [5]. Unregulated free radicles or reactive oxygen species within our system have been roots for many human health defects. Diseases such as cellular injury, ageing process, cardiovascular disease, diabetes, neurodegenerative diseases, and cancer are largely associated to free radicals [4], [5], [6]. Thus, antioxidant level within our biological system is crucial to be maintained, in order to control the amount of free radicals. Antioxidant can be acquired through various food sources which comprises of fruits, vegetables, spices and herbs, processed food supplements (natural or synthetic origin) and others [7].

Antioxidants not only gained intense attention in the field of human biological system but they also play pivotal role in the food industries. Antioxidant compound of synthetic origin have largely been used in food industries to control food lipid oxidation without which will led to food rancidity, loss of colour, taste and quality [8]. However, antioxidants of synthetic origin have in recent years shown toxic and carcinogenic side effects in the long run [9]. In concern of these findings, researches have been intensified to identify potential natural sources of antioxidant. Through such efforts, herbs and spices were found to contain rich source of natural antioxidant necessary for human intake [9], [10]. It was further explored into the knowledge and practices of traditional culture to study various plants consumed by local communities for its medicinal value and potential antioxidant capacity [11], [12], [13]. The use of the medicinal plants covers various forms of illness treatment among rural and village community throughout the world. However, as we progress into the modern era, the old practises have been left out and the knowledge is fading through time.

In Malaysia, the traditional culture and lifestyle are fast fading, leaving only the rural and village community to still practise traditional medicine and culinary as part of living. One of such community, still practices the use of herbs in daily diet are the Siamese community of Kampung Kuang, located in Tanah Merah, Kelantan, Malaysia. The Siamese community largely utilizes plants through herbal rice preparation, where rice cooked along with traditional herbs. Among the various plants being utilised by the Siamese community seven plants such as *Boesenbergia pandurata*, *Curcuma longa*, *Melastoma malabathricum*, *Oroxylum indicum*, *Pandanus amaryllifolius*, *Sauropus androgynus* and *Vitex negundo* have been selected for the study. These plants have been extensively used in various part of the world either as a culinary or as traditional remedies. Intensive researches are continuously being carried out in understanding the benefits of medicinal plant. This was created by the desperate need to accommodate for rising cases of disease among urban as compared to rural population. Diseases such as diabetes, high blood pressure, high cholesterol, cardiovascular diseases, cancer, obesity malnutrition and neurodegenerative diseases have been increasing in number and linked to daily diet of an individual. Since previous studies have shown a link between various types of diseases and antioxidants intake of our body, the importance to explore rich sources of antioxidant has amplified [6]. Thus this study will serve as an addition to the many valuable findings available on the antioxidant capacity of traditional plants being consumed. The selected plants could be exploited in future to further commercialise their health benefits.

MATERIALS AND METHODS

Fresh samples were collected from Kampung Kuang in Tanah Merah, Kelantan, Malaysia. Samples include *Boesenbergia pandurata* (Roxb.) Schltr., *Curcuma longa* L., *Melastoma malabathricum* L., *Oroxylum indicum* Vent., *Pandanus amaryllifolius* Roxb., *Sauropus androgynus* (L.) Merr. and *Vitex negundo* L. The details of uses of the plants in their lifestyle were recorded from the village folks. The plants were coded as follows; *Boesenbergia pandurata* (BP), *Curcuma longa* (CL), *Melastoma malabathricum* (MM), *Oroxylum indicum* (OI), *Pandanus amaryllifolius* (PA), *Sauropus androgynus* (SA) and *Vitex negundo* (VN). Fresh samples were first washed with distilled water to remove debris and dirt. Approximately 50 g of the appropriate plant parts (leaf/stem/root/rhizome) were cut into smaller pieces and extracted with distilled water using water bath at 70 ^{o}C for 2 hours. Extraction was carried out using method described elsewhere with slight modification [14]. The concentrated extracts were dried in oven at 55 ^{o}C and stored in cool and dry place till further use.

Total phenolic contents of the extract were determined using FC assay with slight modification [15]. Reaction mixture was prepared by mixing 0.5 ml of properly diluted aqueous extract, 2.5 ml (10%) of Folin-Ciocalteu reagent and 2.5 ml (7.5%) of sodium carbonate. After incubating for 90 min at room temperature, the absorbance was determined spectrophotometrically at 765 nm. Gallic acid was used as standard and the TPC was expressed as mg GAE/g d.e (dry extract).

Total flavonoid content was determined according to the colorimetric assay [16]. One ml of properly diluted aqueous plant extract was mixed with 4 ml of distilled water. At zero time, 0.3 ml (5 % w/v) $NaNO_2$ was added. After 5 min, 0.3 ml (10 % w/v) $AlCl_3$ was added. At 6 min, 2 ml (1 M) NaOH solution was added. The volume was made up to 10 ml by adding distilled water and the mixture were shaken vigorously. The absorbance was then measured at 510 nm. Catechin was used as a standard at various concentration (1.56 - 100 mg/L, r^2 =0.9945). The TFC was expressed as mg CE/g d.e (dry extract).

Radical scavenging activity of plant extracts against stable DPPH (2,2-diphenyl-2-picrylhydrazyl hydrate) was carried out spectrophotometrically, described elsewhere with slight modification [15]. Briefly, 0.75 ml of 1 mM DPPH was reacted with 0.75 ml of properly diluted plant extract. The sample mixture was kept in dark for 30 min at room temperature. Ascorbic acid was used as reference (AAE). The decrease in absorption was measured at 517 nm. Radical scavenging activity was calculated using the following equation;

$$\% \text{ inhibition} = [(AB-AA)/AB] \times 100$$

where, AB= Absorption of blank, AA= Absorption of sample at ~~(~~t=30min~~)~~.

FRAP assay was conducted as described by Benzie and Strain [17]. Briefly, 40 µl of properly diluted plant extracts were mixed with 3 ml of FRAP reagent, respectively. The mixture was incubated at 37 ^oC for 4 min and the absorbance was measured at 593 nm against blank prepared using distilled water and incubated for 1 hour instead of 4 min. FRAP reagent should be pre-warmed at 37 ^oC and should always be freshly prepared by mixing 2.5 ml of a 10 mM 2, 4, 6-tris(1-pyridyl)-s-triazine (TPTZ) solution in 40 mM HCl with 2.5 ml of 20 mM $FeCl_3$. $6H_2O$ and 25 ml of 0.3 M acetate buffer, pH 3.6. Calibration curve was prepared, using an aqueous solution of ferrous sulphate $FeSO_4$. $7H_2O$ at various concentration (200, 400, 600, 800 and 1000 µM, r^2 = 0.9924). FRAP values were expressed as µmol Fe (II)/g d.e (dry extract).

All the readings were measured in triplicate and were presented as mean ± standard deviation. Correlation analysis, t-test and Duncan's test were carried out by using SPSS software version 16.0.

RESULTS

Ethnobotanical uses

The details of plant parts used by the Siamese community from Kampung Kuang in Tanah Merah, Kelantan, Malaysia were collected from the local residents. Mostly leaves of the plants were consumed except BP and CL, where rhizomes are highly regarded useful. The studied plants are generally utilized in daily cooking as vegetables, for food colouring, flavour and fragrance. BP rhizome and OI leaves are served fresh as salad due to its good taste and flavour. The plants specific traditional uses for illnesses among the community are still vague for most of the plants consumed. Only few plants, such as the CL are known to be used for selected health complications. In overall, the plants are used mostly as a mixture of concoction in preparation of herbal rice. This is based on their ancestral belief of general health benefit. It is believed by the community that consumption of mixtures of plants in their diet will help to maintain health in overall and not specific conditions such as fever, cold, stomach ache, headache, nausea, diarrhoea and others. Table 1 give insight on specific uses of the selected traditional plants consumed by the Siamese community.

Table 1: Ethnobotanical uses of plants consumed by Siamese community.

Plant name	Family	Parts used	Traditional uses
B. pandurata (BP)	Zingiberaceae	Rhizome	In cooking / salad / herbal rice concoction
C. longa (CL)	Zingiberaceae	Rhizome	In cooking / treatment for gastric / herbal rice concoction
M. malabathricum (MM)	Melastomataceae	Leaves	In preparation of herbal rice concoction
O. indicum (OI)	Bignoniaceae	Leaves	In cooking / salad / herbal rice concoction
P. amaryllifolius (PA)	Pandanaceae	Leaves	Food colouring / fragrance for food / herbal rice concoction
S. androgynous (SA)	Phyllanthaceae	Leaves	In cooking / food colouring / herbal rice concoction
V. negundo (VN)	Verbenaceae	Leaves	Herbal rice concoction

Total phenolic and flavonoidic content (TPC & TFC)

Total phenolic and flavonoid content of the plants consumed by Siamese community were analysed and presented in Figure 1. The calculated value indicates that VN to be a rich source of phenolic and flavonoidic content. The plant (VN) showed 111.63 ± 0.49 mg GAE and 44.05 ± 3.37 mg CE per g of d.e, respectively. OI, PA, SA and MM showed high to moderate TPC with 108.51 ± 42.82, 77.26 ± 17.87, 56.08 ± 25.15 and 51.91 ± 5.79 mg GAE/g d.e, respectively. While, CL and BP exhibited lowest TPC value of 8.85 ± 2.25 and 3.99 ± 0.49 mg GAE/g d.e, correspondingly.

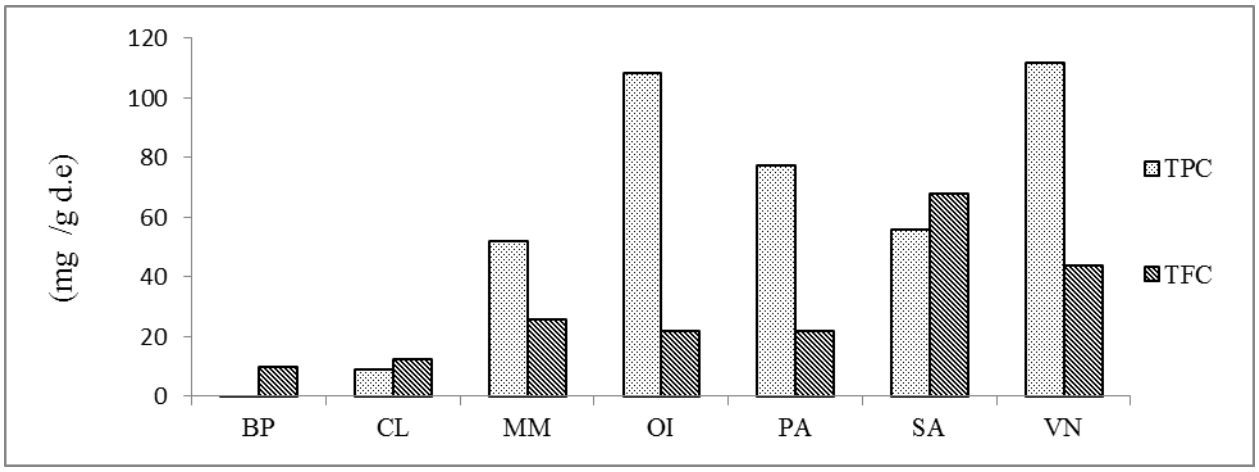

Figure 1. TPC and TFC of plants consumed by Siamese community.

The TFC was estimated with reference to a standard flavonoid catechin as catechin equivalent. TFC found to be highest in SA (67.86 ± 17.50 mg CE/g d.e) among all studied plants (Figure 1). This was followed by VN (44.05 ± 3.37), MM (25.60 ± 1.68), OI (22.02 ± 1.68), PA (22.02 ± 1.68), CL (12.59 ± 0.96) and BP (9.79 ± 1.50 mg CE/g d.e), respectively. CL and BP exhibited lowest TPC and TFC content.

Antioxidant activity

DPPH free radical-scavenging activity

Antioxidant capacities of the selected plants consumed by Siamese community were analysed using two methods i.e. DPPH free radical scavenging activity and ferric reducing/antioxidant power assay. The results showed that the tested aqueous extracts have different antioxidant potential from each other. Among

the seven plants analysed, all the plants were observed to be good antioxidant source except OI with 42.82 ± 1.66 % inhibitions (Table 2). While the other extracts displayed % DPPH inhibition more than 50 % at 100 µg/ml concentration. The highest % inhibition was detected 73.11 ± 0.82 (BP) followed by 72.57 ± 0.95 (PA), 71.93 ± 1.19 (CL), 65.71 ± 0.36 (SA), 65.57 ± 0.24 (VN) and 58.70 ± 0.38 (MM), respectively.

Table 2. Antioxidant activity of plants consumed by Siamese community.

Plant	(%) DPPH Inhibition	FRAP (µmol Fe (II)/g d.e)
B. pandurata	73.11 ± 0.82^{d}	281.11 ± 12.86^{a}
C. longa	71.93 ± 1.19^{d}	245.56 ± 15.95^{a}
M. malabathricum	58.70 ± 0.38^{b}	418.89 ± 8.32^{bc}
O. indicum	42.82 ± 1.66^{a}	436.67 ± 15.15^{c}
P. amaryllifolius	72.57 ± 0.95^{d}	380.00 ± 19.05^{b}
S. androgynous	65.71 ± 0.36^{c}	620.00 ± 43.55^{d}
V. negundo	65.57 ± 0.24^{c}	385.56 ± 17.71^{b}

Values are mean ± SD (n = 3). Values within the same column with different superscripts are significantly different (P < 0.05) as measured by Duncan's test.

The DPPH radical scavenging activity of the studied extracts were compared with commercial antioxidant (standard) such as AA and BHT, and results were expressed as AAE and BHTE per g d.e, respectively (Figure 2). It was calculated that 1.732 to 3.150 g of BHT is equivalent to one gram of the respective extract in order to produce equal amount of scavenging activity. Likewise, 0.43-0.80 g of AA furnish antioxidant activity equivalent to one gram of each extract.

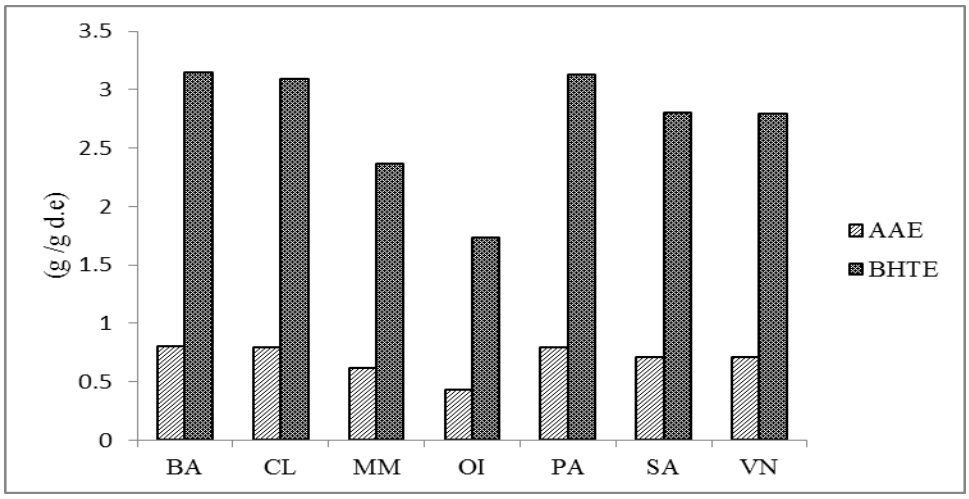

Figure 2. The AAE and BHTE of plant extracts consumed by Siamese community.

Ferric reducing/antioxidant power assay

As represented in Table 2, SA showed highest ferric reducing potential (620.00 ± 43.55), followed by OI (436.67 ± 15.15), MM (418.89 ± 8.32), VN (385.56 ± 17.71), PA (380.00 ± 19.05), BP (281.11 ± 12.86) and CL (245.56 ± 15.95 µmol Fe (II)/g d.e), respectively. However, BP and CL, displayed lowest FRAP activity among the seven tested aqueous extracts.

DISCUSSION

Ethnobotanical uses

Ethnobotanical uses refer to the traditional usage of plants and plant parts with medicinal values obtained from ancestral knowledge in treating illness and diseases [18]. Various parts of plants have numerous applications in traditional medicine. In the study it was found that among the selected plants, leaves are the most utilized plant part by Siamese community followed by rhizome in their daily diet as well as for various medical purposes. [19] also reported leaves are the most exploited plant material in various traditional and folk medicines across South East Asia including Malaysian tradition.

Total phenolic and flavonoidic content (TPC & TFC)

Plants with medicinal value are generally rich in bioactive compounds. One of the major groups of bioactive compounds being extensively studied is the polyphenolic group which comprises of flavonoids, phenolic acids, stilbenes and lignans [20]. These compounds have been proven to be essential in maintaining a balanced biological system and a key player in antioxidant mechanism. Due to the importance of the polyphenolics for the human biological system, the plants in this study were subjected to TPC and TFC analysis to uncover their phenolic and flavonoidic content. From the study, the trend of TPC observed among selected plants was VN > OI > PA > SA > MM > CL > BP in descending order. In comparison to the present study, hydroethanolic VN extract studied by [21] showed lower TPC but higher TFC values of 50.19 ± 0.49 GAE/g and 59.73 ± 0.44 QE/g extractable compounds, respectively. This indicated that water is more suitable solvent for phenolic extraction from VN as compared to hydroethanolic mixture. Meanwhile, a study by [22] on aqueous MM extract showed that TPC (33.44 ± 19.09 GAE mg/g d.e) was closely similar to the present finding. On the other hand, methanolic OI bark extract and ethanolic PA leaf extract in another studies found to contain 124.7 ± 4.36 mg of pyrocatechol equivalent/g d.e and 319.2 ± 15.9 mg GAE/100g plant sample, respectively [23], [24]. The TPC of methanolic OI bark extract is comparatively higher than the present findings due to the different parts of plant being used [25]. Meanwhile the TPC of ethanolic PA extract as compared to present study was lower and this can be justified by the difference in extraction solvent [26]. [27] found that aqueous SA extract contain 20.08 ± 2.59 mg GAE/g dry material, only half of the present phenolic content observed. However, in the present study BP (3.99 ± 0.49 mg GAE/g d.e) and CL (8.85 ± 2.25 mg GAE/g d.e) exhibited lowest TPC and found to be significantly different with VN ($p<0.05$, $p=0.000$). This suggested low TPC of BP and CL as compared to VN, which was also supported by Chan et al [28]. In addition to that, statistical analysis was conducted for the present results which showed that TPC of VN is not significantly different ($p>0.05$) from OI ($p=0.880$) and PA ($p=0.053$), indicating TPC of VN is quite similar to OI and PA. However, TPC of VN is significantly different ($p<0.05$) with respect to SA ($p=0.035$) and MM ($p=0.000$) supporting high TPC of VN than SA and MM.

Flavonoids are one of the subset that makes up the polyphenol group. Plants in general contain various polyphenol compounds and one of such sub-component is flavonoids [20]. Flavonoid contents in plants have been of deep interest among researchers to find possible rich source of the flavonoidic compound. Thus, in the current study TFC content of the selected plants were evaluated. The findings indicated TFC of the studied plants in the following order, SA > VN > MM > OI > PA > CL > BP. Similar studies on MM, OI, and PA extracts (methanol, chloroform, benzene and petroleum ether) showed that TFC was moderately high with respect to the aqueous extracts analysed in the present study [29], [30], [31], [32]. While, [33]and [34], observed similar trend, where BP (2.19 ± 0.02 mg CE/g dry weight) and CL (2.17 ± 0.12 mg CE/100g sample) exhibited lowest TFC among the studied plants. The difference in TFC among plants in various studies could be due to the various types of solvents being used for extraction as well as the geographical location of the obtained sample [35], [36]. Further analysis using t-test for TFC showed that there was no significant difference in TFC of SA and VN ($p>0.05$, $p=0.132$) as well as PA and OI ($p>0.05$, $p=1.000$), suggesting their similar behaviour, respectively. Moreover, TFC of SA-MM ($p<0.05$, $p=0.027$), SA-OI ($p<0.05$, $p=0.021$) and SA-PA ($p<0.05$, $p=0.021$), SA-BP ($p=0.009$) and SA-CL, ($p=0.011$) were significantly different form each other. Hence, statistical analyses supported considerably high TFC of VN and SA as compared to the other extracts tested. Correlation analysis showed positive correlation exists between TPC-TFC ($r = 0.796$) of the studied plants.

Antioxidant activity

DPPH can study the antioxidant capacity, FRAP, ABTS, ORAC, TEAC and TRAP assay. Among the wide number of methods available, DPPH assay has been regarded as simple and convenient procedure, independent of sample polarity which makes it a suitable method for antioxidant screening [37]. It shows the ability of an extract to reduce DPPH• radical. The reduction is a result of the antioxidant compounds in the extract, capable to donate an electron to the DPPH• radical, thus reducing it to DPPH (reduced) state. The reduction reaction/electron transfer indicates the presence of an electron donating/antioxidant compounds. As such, many antioxidant compounds in plants, primarily phenolic compounds are capable of donating electrons to free radicals. However, the rate of the antioxidant capacity varies from one plant to another. The trend observed in this study was BP > PA > CL > SA > VN > MM > OI, in decreasing order of DPPH free radical scavenging potential. Arguing the present findings, previous studies on the selected plants have demonstrated high DPPH scavenging value in various types of extraction solvent. Methanolic extract of BP studied by [36] showed 50 % inhibition at 71.46 µg/ml concentration. In a separate study by [23], ethanol and propylene glycol extract of PA as well as their mixtures showed DPPH inhibition of 69.61-86.36 %. Moreover, a study by [38] on fresh pure CL juice exhibited 64.6 ± 2.4 % inhibitions. The antioxidant potential of BP, PA and CL observed in the present study corroborated with the high antioxidant activity reported in literature (above 50% inhibition). Although, as compared to previous studies, BP, PA and CL aqueous extracts demonstrated superior radical scavenging activity (above 70% inhibition). On the contrary, methanolic MM extract studied by [22] showed only 20.5 ± 1.9 % inhibition, half of the present inhibition observed at 100 µg/ml concentration. However, OI extract exhibited lowest DPPH inhibition with 42.82 ± 1.66 % scavenging capacity with leaf aqueous extract. Related report on OI, methanolic bark extract exhibited 50% inhibition at 106.4 µg/ml, may be because of different plant material used [24], [39]. Moreover, subsequent t-test analysis for DPPH free radical scavenging potential showed that BP was insignificantly different ($p>0.05$) with CL ($p=0.316$) and PA ($p=0.580$), while, significantly different ($p<0.05$) with SA ($p=0.000$), VN ($p=0.000$) and MM ($p=0.000$). This implies that BP, CL and PA possess similar scavenging potential. Further supporting the t-test, Duncan's test revealed plants BP-CL-PA belonged to same subset as well as plants SA-VN. Plants that fall under same subset in the Duncan's test indicate that their DPPH values are not significantly different within subset. In contrast MM and OI both belonged to different subset each which explains that their DPPH were significantly different from the rest of the plants.

The antioxidant capacities of extracts evaluated by DPPH method were compared with standard references i.e. ascorbic acid (AA) and commercially used antioxidant, butylated hydroxyl toluene (BHT). The values of AAE and BHTE calculated for each aqueous extract has supported high antioxidant potential of plants consumed by Siamese community. It was estimated that 1 gram plant extract can furnish similar antioxidant activity equivalent to approximately 0.43-0.80 g of AA and 1.732-3.150 g of BHT, respectively. The present findings raise big question of food safety, as BHT commercial usage has shown health complication in the long run [9]. Also, the results indicated that small amount of extracts from natural sources required to provide sufficient amount of antioxidant effect to ensure similar scavenging activity as of synthetic antioxidants. Thus, natural antioxidants even in small portion are capable to balance the ROS and can be exploited in various applications.

Similar to DPPH method, FRAP assay has been extensively used due to modest work required during the analysis. The FRAP assay shows the potential of an extract to reduce Fe^{3+} to Fe^{2+}. This reduction is powered by the antioxidant compounds in the extract which are capable to donate an electron to the Fe^{3+} ion and reducing it to Fe^{2+} ion state. The reduction reaction/electron transfer indicates the presence of an electron donating/antioxidant compound in the extract. As such, FRAP analysis was conducted to study the potential of plants as antioxidant source. It was revealed that SA showed high FRAP antioxidant activity followed by other extracts in the downhill order of SA > OI > MM > VN > PA > BP > CL. Similarly, [27] have reported high DPPH and FRAP antioxidant activity of SA aqueous extract. Formerly, ethanolic BP and CL extract was studied by [40] and reported low FRAP activity of 606.39 ± 2.25 and 472.06 ± 1.46 µmol $FeSO_4$/100 g samples, respectively. The present findings on BP and CL are relatively higher compared to the previously reported values [26], [40]. The deviation in FRAP values can be associated with the type of solvents utilized during extraction and preparation of sample [35]. Nevertheless, different geological location hold another reason for the differences in FRAP values [31]. Furthermore, t-test analysis showed FRAP values of OI and MM ($p>0.05$, $p=0.220$), VN and PA ($p>0.05$, $p=0.778$) as well as BP and CL ($p>0.05$, $p=0.070$) were closely similar and were not significantly different in ferric reduction potential with each other. While, SA was significantly different from rest of the

extracts, indicating its highest FRAP activity from other studied extracts. Apart from that, the Duncan's test disclosed that BP-CL and SA respectively belonged to different subset emphasizing their values were significantly different. However, MM-PA-VN and MM-OI fall in different subset with plant MM appearing on both subsets. This explains that the FRAP values of MM was in close similar to PA-VN at the same time was close in range to OI, thus making MM to be categorised into the two different subset at the same time in the Duncan's test.

In general, antioxidant activity are often related to its polyphenolic contents, therefore, correlation analysis was carried out to study the relationship between composition (TPC, TFC) and antioxidant activity (DPPH, FRAP). In the present study, correlation analysis revealed positive correlation exists between TPC-FRAP (r=0.835) and TFC-FRAP (r=0.605). In contrary, negative correlation were observed between TPC-DPPH (-0.599) and TFC-DPPH (-0.239). On the basis of statistical analysis conducted, it can be deduced that phenolic and flavonoid content of the extracts have higher association with ferric reducing antioxidant activity compared to DPPH free radical scavenging activity. Similarly, [27] stated that there is a strong correlation between TPC-FRAP compared to TPC-DPPH. This shows that the phenolic and flavonoidic compounds present in the prepared extracts are probably more selective towards FRAP mechanism. Moreover, negative correlation observed indicates phenols and flavonoids are not necessarily accountable for free radical scavenging properties.

CONCLUSION

The present study unveils the potential of seven plants being consumed by Siamese community of Kampung Kuang in Tanah Merah, Kelantan, Malaysia. Thus by identifying the plants and parts used with added scientific study will disclose the potential and benefit of the plants consumed by this community. The plants studied contain significant amount of phenolic and flavonoidic compound which closely relates to considerable antioxidant potential. The present study showed that VN is a good source of TPC while, SA is rich in TFC, corresponded to high FRAP value among the studied plants. BP exhibited the highest DPPH free radical scavenging among the selected plants. The present finding suggests that the studied plants can be largely exploited for an affordable, organic and healthy food source for all level of income group as well as functional antioxidant compound in food industries.

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