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Research Article

LOCAL VEGETABLES TRADITIONALLY USED FOR REDUCING HYPERGLYCEMIA IN SURAT THANI PROVINCE, THAILAND

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ABSTRACT

Objective: High blood sugar can lead to diabetes, a chronic illness which is becoming a public health challenge in the 21st century in Thailand. The aim of this study was to survey the local vegetables traditionally used by traditional healers for reducing hyperglycemia and normally consumed in Surat Thani Province and to analyze the total phenolic content (TPC) in these local vegetables.

Methods: Data were collected using in-depth interview of traditional healers from nine districts of Surat Thani Province, and TPC of the extracts of vegetables collected was determined by Folin–Ciocalteu reagent method.

Results: A total of 16 local vegetables have been found to be used by traditional healers for reducing blood sugar: *Ocimun tenuiflorum* Linn., *Musa acuminate* Colla, *Cassia siamea* (Lam.) Irwin and Barneby, *Coccinia grandis* (L.) Voigt, *Pandanus amaryllifolius* Roxb., *Vigna unguiculata* (L.) Walp. subsp. *Unguiculata*, *Ipomoea aquatic* Forssk., *Phyllanthus emblica* Linn., *Solanum torvum* Sw., *Anacardium occidentale* Linn., *Momordica charantia* Linn., *Moringa oleifera* Lamk., *Archidendron jiringa* Nielsen, *Azadirachta indica* A. Juss. var. *Indica*, *Parkia speciosa* Hassk., and *Micromelum minutum* (G. Forst.) Wight and Arn. In addition, the TPC results showed that the extract of *A. occidentale* Linn. exhibited the highest TPC (8.0±0.11 mg gallic acid equivalent (GAE)/g fresh weight) followed by the extract of *M. minutum* (G. Forst.) Wight and Arn. (3.99±0.10 mg GAE/g fresh weight).

Conclusion: Local vegetables in Surat Thani were shown to be a good source of TPC, and the data from this study can serve as fundamental information for promoting consumption of selected local vegetables for diabetes prevention in the future.

Keywords: Local vegetables, Blood sugar, Total phenolic content, Surat Thani Province.

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INTRODUCTION

Hyperglycemia is one of the characteristic features of the metabolic syndrome (also known as syndrome X), which is associated with an increased risk of developing type II diabetes [1]. According to the statistics of the International Diabetes Federation (2017), it is estimated that around 1 in 11 of the adult population globally have diabetes. This number of people with diabetes is increasing rapidly in every country due to an imbalance in dietary intake, physical inactivity, and excess body weight as well as to genetic and physiological factors [2]. Similarly to Thailand, data from the Ministry of Public Health in 2017 reported the prevalence of diabetes rose from 2.3% in 1991 to 8.9% or approximately 5 million individuals in 2014.

A number of studies have provided evidence that consumption of fruits and vegetables may reduce the risk of various diseases such as cancer [3] and cardiovascular disease [4], including type II diabetes mellitus, for example, El-Beshbishy and Bahashwan (2012) demonstrated that aqueous extracted from basil (*Ocimum basilicum*) inhibit alpha-amylase and alpha-glucosidase activities, the enzymes involved in breaking down starch, *in vitro* [5]. In addition, the review of Reyad-ul-ferdous *et al*., in 2015, suggested that extract of *Abutilon indicum*, plant grown extensively in Bangladesh, India, and Pakistan, can inhibit glucose absorption and stimulates insulin secretion in streptozotocin-induced diabetic rodents [6]. The authors also revealed that phenolic compounds in plants account for the observed beneficial effects of the extracts.

Medicinal plants have attracted public interest recently and have been proposed as an alternative approach to prevent and treat diabetes mellitus due to less side effects of natural products and toxicity of modern synthetic drugs used for reducing blood sugar in diabetic patients such as acarbose, miglitol, or voglibose [7]. However, the evidence of beneficial effects of local vegetables, which are commonly consumed, especially in the area of Southern Thailand, is scarce and need more investigation. Therefore, the objectives of this study were (1) to survey the local vegetables used by traditional healers in Surat Thani Province for reducing hyperglycemia and (2) to determine the total phenolic content (TPC) in the extracts of these local vegetables.

METHODS

The study area

The area of the survey is located between 8°38′ and 9°34′l atitudes and 98°58′ and 99°56′ longitudes in the Southern part of Thailand, Surat Thani Province. Nine districts across this region were randomly selected for data collection, including: Muang (no. 1), Kanchanadit (no. 2), Koh Samui (no. 4), Chaiya (no. 6), Khiri rat Nikhom (no. 8), Tha Chang (no. 11), Khian-Sa (no. 14), Wiang Sa (no. 15), and Phunphin (no. 17), as highlighted in Fig. 1.

Data collection

The study was conducted during March 2015–February 2016. Data related to the utilization of local vegetables for reducing hyperglycemia were first reviewed from the literature search of traditional remedies for the treatment of diabetes in Southern Thailand and then rechecked using in-depth interview of traditional healers from nine districts in Surat Thani Province. Local healers in each of the nine districts were selected purposively, based on data of registered folk medicinal practitioners of the Department of Thai Traditional Medicine, Surat Thani Provincial Health Office. Semi-structure questionnaire was used for collecting the ethnomedicinal data: Locality, vernacular plant names, plant parts used, method of preparation, and method of administration.

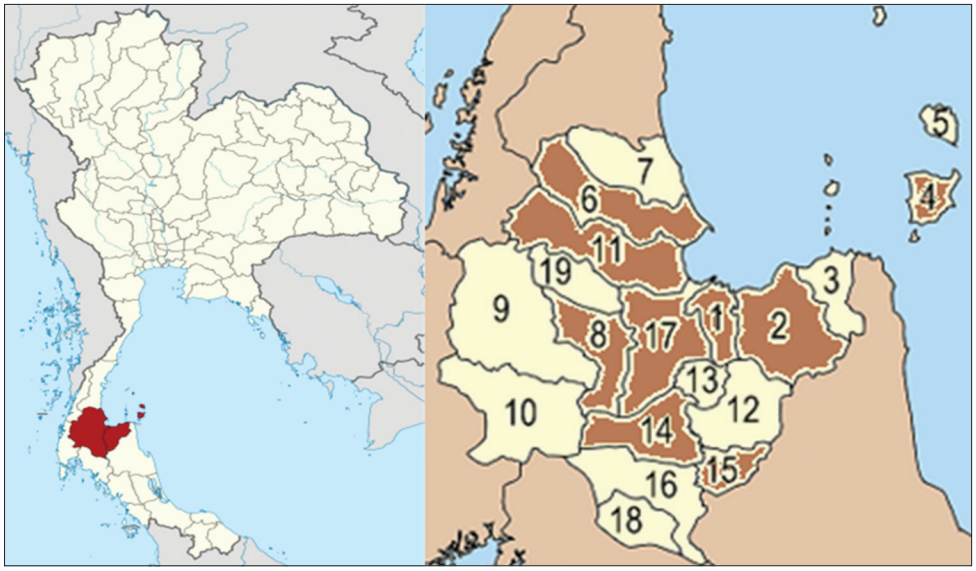

Fig. 1: Study area - Surat Thani Province, Thailand (modified from https://no.wikipedia.org/wiki/Surat_Thani_(Province))

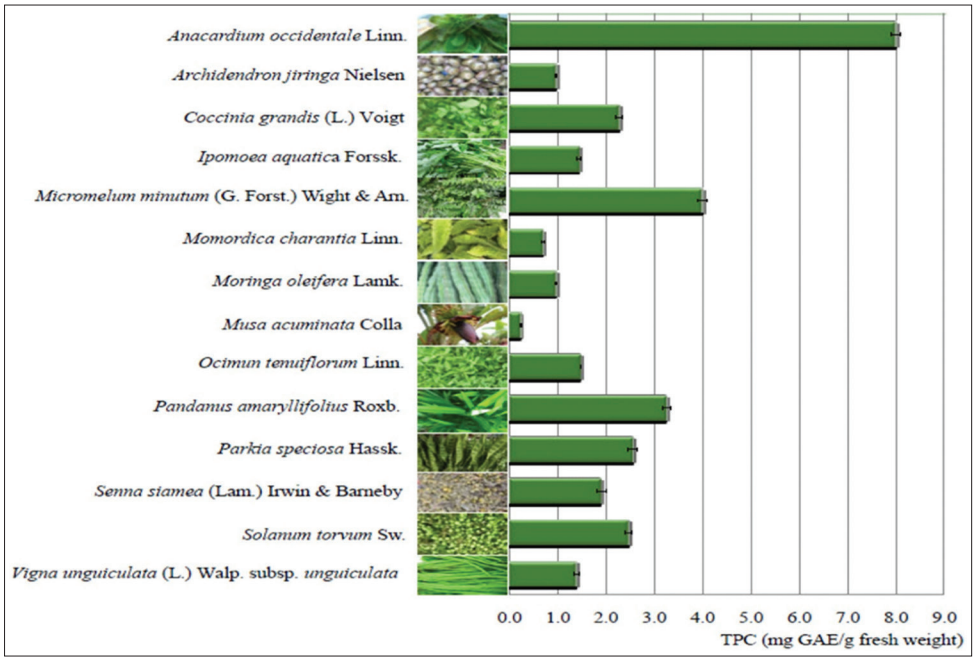

Fig. 2: Total phenolic content in a water extract of local vegetables used by traditional healers for reducing hyperglycemia. Results are expressed as mean±SD of triplicate samples

In addition, the samples of local vegetables, as pointed out by the informants (traditional healers), were also collected from the study site for checking the scientific name and determining TPC.

Preparation of aqueous plant extracts

Vegetables were collected from three local markets in Muang district of Surat Thani, during the month of August 2015. All plants were extracted using water since this solvent may better represent the normal consumption than using organic solvents. The preparation was done by grinding 50 g of the fresh plant with 50 ml of ultrapure Milli-Q water using a small food processor (Moulinex Optiblend Duo, KRUPS, France). The mixture was then centrifuged at 4000 rpm for 10 min (Universal 32, Hettich, D-78532, Tuttlingen, Germany) and the supernatant was collected for analysis.

Determination of TPC

TPC was measured in three independent experiments using a Folin–Ciocalteu procedure as used by Waterhouse (2002) with some modification [8]. Briefly, 1 ml of plant extract was added to 1 ml of 50% Folin–Ciocalteu phenol reagent (diluted 1:1 in distilled water) and allowed to react for 5 min at room temperature. Subsequently, 1 ml of 2% sodium carbonate solution (Na_2CO_3) was added, adjusted volume with distilled water to 10 ml and incubated for 30 min at room temperature. The absorbance of the extracts and a matching blank was spectrophotometrically measured at 765 nm using a spectrophotometer (UV1100 Techcomp, China). A standard curve was prepared using different concentrations (0–1000 µg/mL) of aqueous gallic acid solution. TPC was calculated as gallic acid equivalent (GAE) mg per g of the sample based on a standard curve.

RESULTS AND DISCUSSION

Ethnobotanical data

The results of the present study showed that 16 local vegetables which are commonly consumed in Surat Thani Province and traditionally

Table 1: Local vegetables used for reducing hyperglycemia/treatment of diabetes by traditional healers in Surat Thani Province

Scientific name	Family	Local name	Area found*	Part used	Uses/Preparation
Anacardium occidentale Linn.	Anacardiaceae	Mamuang -himmaphan	1, 2, 4, 6, 8, 11, 14, 15, 17	Aerial parts	Consumed fresh with diet
Archidendron jiringa Nielsen	Leguminosae - Mimosoideae	Look-niang	1, 8, 14, 15, 17	Seed and seed coat	Cut into small pieces and consumed fresh, or used for cooking
Azadirachta indica A. Juss. var. *Indica*	Meliaceae	Sadao	11, 14	Aerial parts/leaves	Dried and boiled with hot water. The infusion is drunk daily, or Balanced and consumed with a diet
Coccinia grandis (L.) Voigt	Cucurbitacae	Phak-tamlueng	1, 2, 4, 6, 8, 11, 14, 15, 17	Leaves	Blanched or consumed fresh with diet
Ipomoea aquatic Forssk.	Convolvula-ceae	Phak-bung	1, 2, 4, 6, 8, 11, 14, 15, 17	Whole plants	Blanched and consumed with diet, or used for cooking
Micromelum minutum (G. Forst.) Wight and Arn.	Rutaceae	Samui, Hatsakhun	1, 2, 4, 11, 14, 15, 17	Aerial parts/leaves	Consumed fresh with diet
Momordica charantia Linn.	Cucurbitaceae	Mara-Kee-nok	1, 2, 4, 6, 11, 17	Fruits	Blanched or consumed fresh with diet Processed into a refreshing beverage, or Dried and soaked in hot water for drinking
Moringa oleifera Lamk.	Moringaceae	Ma-rum	1, 11, 14, 17	Leave, pods	Leaves are dried and boiled with water for drinking. Seeds used for cooking
Musa acuminate Colla	Musaceae	Hua-plee	1, 2, 4, 6, 8, 11, 14, 15, 17	Flowers	Blanched or consumed fresh with diet
Ocimun tenuiflorum Linn.	Lamiaceae	Ka-phrao	1, 2, 4, 6, 8, 11, 14, 15, 17	Leaves	Leaves are dried and soaked in hot water. The infusion is drunk daily
Pandanus amaryllifolius Roxb.	Pandanaceae	Toei-hom	1, 2, 4, 6, 11, 14, 17	Roots	Roots are cut into small pieces and boiled with hot water, filtered, and drunk regularly
Parkia speciosa Hassk.	Leguminosae - Mimosoideae	Sa-tor	1, 2, 4, 6, 8, 11, 14, 15, 17	Leaves, pods, seeds	Leaves and pods are dried and boiled with water for drinking. Seeds used for cooking
Phyllanthus emblica Linn.	Euphorbiaceae	Ma-kham-pom	1, 6, 17	Fruits	Consumed fresh with some salt, or processed into beverage and drink after meal 3 times a day
Senna siamea (Lam.) Irwin and Berneby	Leguminosae - Caesalpinioideae	Khi-lek	1, 2, 6, 8, 11, 14, 15, 17	Aerial parts/ flowers	Used for cooking purposes
Solanum torvum Sw.	Solanaceae	Ma-khuea-phuang	1, 2, 4, 6, 8, 11, 14, 17	Fruits	Consumed fresh or use for cooking
Vigna unguiculata (L.) Walp. subsp. *unguiculata*	Leguminosae - Papilionoideae	Thua-fak-yao	1, 2, 4, 6, 8, 11, 14, 15, 17	Pods	Consumed fresh, blanched or used for cooking

*1=Muang, 2=Kanchanadit, 4=Koh-Samui, 6=Chaiya, 8=Khiri rat Nikhom, 11=Tha-Chang, 14=Khian-Sa, 15=Wiang-Sa and 17=Phunphin

used by traditional healers for reducing blood sugar in the study area (Tables 1), namely: *Ocimun tenuiflorum* Linn. (holy basil), *Musa acuminate* Colla (banana blossom), *Cassia siamea* (Lam.) Irwin and Barneby (Thai copperpod), *Coccinia grandis* (L.) Voigt (ivy gourd), *Pandanus amaryllifolius* Roxb. (pandanus palm), *Vigna unguiculata* (L.) Walp. subsp. *Unguiculata* (yard long bean), *Ipomoea aquatic* Forssk. (morning glory), *Phyllanthus emblica* Linn. (Indian gooseberry), *Solanum torvum* Sw. (Turkey berry), *Anacardium occidentale* Linn. (cashew leaves), *Momordica charantia* Linn. (bitter gourd), *Moringa oleifera* Lamk. (horse radish tree), *Archidendron jiringa* Nielsen (Djenkol bean), *Azadirachta indica* A. Juss. var. *indica* (neem leaves), *Parkia speciosa* Hassk. (Stink bean), and *Micromelum minutum* (G. Forst.) Wight and Arn. (Hatsa khun).

The number of plant species found in this study is lower than other medicinal plants survey studies [9,10] as we recorded only the edible plants that are normally consumed as vegetables in the diet in Surat Thani region. All of the plants recorded were growing either in the peripheral of the homesteads or were available for consumption in the local market on a regular basis. Most of them can be grown all year round, only for *A. indica* A. Juss. var. *indica* and *P. emblica* Linn. are available especially in the winter season, and *A. jiringa* Nielsen and *P. speciosa* Hassk., which can be grown only in the rainy season.

Among these vegetables, the families most frequently used were Leguminosae (4 species), and the parts of plants most used for the treatment of diabetes/reducing blood sugar were leaves, fruits, and seeds, respectively. Sometimes, plants were used in combinations for enhanced antidiabetic efficacy. In addition, the preparation method was mostly infusion with hot water and taken orally or consumed fresh/ cooking.

TPC

The TPC was determined by Folin–Ciocalteu Reagents, and the results (Fig. 2) showed that the extract of *A. occidentale* Linn. exhibited the highest TPC (8.0±0.11mg GAE/g fresh weight), followed by the extract of *M. minutum* (G. Forst.) Wight and Arn. (3.99±0.10 mg GAE/g fresh weight), and *M. acuminate* Colla extract showed the lowest TPC value (0.24±0.02 mg GAE/g fresh weight).

The TPC results of this study are in line with the study of Chanudom and Tangpong (2011), which reported that among 13 Thai traditional

plants investigated, *A. occidentale* Linn. extracted with ethanol were found to have high content of total phenolic and possess the highest total antioxidant capacity compared to other plants [11]. Since the TPC in the present study was extracted using water, the concentration was considerably lower than as reported in other studies for Thai local vegetables [11,12]. However, this solvent may better represent the normal consumption than using organic solvents.

Previous studies found the dose-dependent relationship between TPC and the activities of alpha-amylase and alpha-glucosidase, the enzymes involved in breaking down starch, *in vitro* [13,14]. In addition, the animal study of Zhang *et al*. [15] further demonstrated that the phenolic content found also correlates with the reduction of blood glucose levels in diabetic mice. For this reason, Thai local vegetables with high phenolic content can be good natural sources for chronic non-communicable disease prevention and control, especially diabetes mellitus.

Some study limitations should be noted. Even though the TPC analysis was performed in three independent experiments, which was prepared from vegetables collected from three different markets, they were all from a single district, Muang Surat Thani. In addition, only 14 out of 16 local vegetables can be collected for TPC analysis by the time of sample collection (August, 2015), except *A. indica* A. Juss. var. *indica* (Sadao), and *P. emblica* Linn. (Ma-kham-pom) because these two local vegetables are available only in the winter season, between November and January.

CONCLUSION

The survey documented 16 local vegetables which are commonly consumed in households and traditionally used by traditional healers for reducing blood sugar in Surat Thani Province. Among these plants, *A. occidentale* Linn. (cashew leaves) exhibited the highest TPC, which may provide health-promoting advantages. The data from this study can serve as fundamental information for promoting consumption of selected local vegetables for diabetes prevention and treatment in the future.

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