บทความวิจัย

คุณค่าทางโภชนาการ แร่ธาตุ และฤทธิ์ต้านอนุมูลอิสระของพื้นท้องถิ่นจังหวัดเชียงราย ประเทศไทย

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บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาคุณค่าทางโภชนาการ แร่ธาตุ และฤทธิ์ต้านอนุมูลอิสระของช้าเรือด (*Caesalpinia mimosoides* Lam.) เพี้ยฟาน (*Clausena excavata* Burm. f.) และ ดีปลากั้ง (*Phlogacanthus pulcherrimus* T. Anderson) ซึ่งเป็นพื้นท้องถิ่นที่ใช้ในการบริโภคในจังหวัดเชียงราย ประเทศไทย ปริมาณไขมัน โปรตีน คาร์โบไฮเดรต ใยอาหารและเถ้าอยู่ในช่วง 2.27-4.25, 19.65-27.86, 41.09-54.39, 9.80-16.31 และ 4.27-12.69 กรัมต่อ 100 กรัมน้ำหนักแห้ง ตามลำดับ พืชทั้งหมดพบแร่ธาตุทั้ง 12 ชนิด (N, P, K, Ca, Mg, Mn, S, B, Na, Fe, Zn และ Cu) ดีปลากั้งพบแร่ธาตุ Zn, Fe, Mg และ Ca ในปริมาณสูง ผลการศึกษาฤทธิ์ต้านอนุมูลอิสระพบว่า ช้าเรือดให้ปริมาณการต้านอนุมูลอิสระสูงที่สุด (92.36 ไมโครโมลTE/กรัม) และ ให้ปริมาณสารฟินอลิกรวมสูงสุดเช่นกัน (221.65 มิลลิกรัม GE/กรัม).

คำสำคัญ: สารต้านอนุมูลอิสระ แร่ธาตุ โปรตีน ช้าเรือด เพี้ยฟาน ดีปลากั้ง

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Nutrition Information, Element and Antioxidant Activity of Native Plant in Chiang Rai, Thailand

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ABSTRACT

The aim of this study was to investigate nutritional content, element and antioxidant activity of *Caesalpinia mimosoides* Lam., *Clausena excavata* Burm. f. and *Phlogacanthus pulcherrimus* T. Anderson, the local plants consumed in Chiang Rai, Thailand. The amounts of fats, proteins, carbohydrates, crude fibers and ashes ranged from 2.27-4.25, 19.65-27.86, 41.09-54.39, 9.80-16.31 and 4.27-12.69 g per 100 g dry weight, respectively. All of plants consisted of 12 minerals (N, P, K, Ca, Mg, Mn, S, B, Na, Fe, Zn and Cu). *P. pulcherrimus* T. Anderson provided high content of elements especially Zn, Fe, Mg and Ca. The result of antioxidant activity analysis revealed that C. *mimosoides* Lam. represented the highest DPPH radical scavenging activity (92.36 μmol TE/g) and also presented the highest total phenolic content (221.65 mg GE/g).

Keywords: Antioxidant, Minerals, Protein, *Caesalpinia mimosoides* Lam., *Clausena excavata* Burm. f., *Phlogacanthus pulcherrimus* T. Anderson

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Introduction

Several local plants distributed worldwide and were documented but still less known about macro- and micronutrients [1]. These edible wild plants provided minerals and medicinal values. Medicinal plants were utilized by about 80% of the marginal communities around the world. Nutrition played an important role in human life processes and energy utilization. Nutrient contents of five medicinal plant species *(Bupleurum falcatum, Valeriana officinalis, Forsskalea tenacissima, Lavandula angustifolia* and *Otostegia limbata)* collected from Northwest Pakistan were determined for nutritional values, macronutrients (Ca, Mg, Na and K) and micronutrients (Fe, Cu, Pb, Zn, Ni, Cr, Co and Mn) [2]. Nutritional value of some plant species was also achieved by Bahadur *et al.* It was found to contain proteins, crude fibers, fats and oils, moisture, ash contents, carbohydrates and 16 elements (Na, Mg, Al, Si, P, S, Rb, K, Ca, Fe, Mn, Ti, Ni, Cu, Zn and Cl) [3]. Moreover, the nutritional composition of some local vegetables *(Jatropha curcas, Myrianthus arboreus, Celosia argentea, Gnetum africanum* and *Ocimum gratissimum)* from Delta State, Nigeria was investigated. The result revealed that they contained amounts of nutrients such as crude proteins, crude lipids, carbohydrates, moisture, ashes, crude fibers, and mineral elements (Na, Ca, K, Mn, Fe, Zn, P and Cu), thus could be beneficial for consumption as dietary supplements [4]. Nutritional Status of *Ceratonia Siliqua* L. was also examined. It contained high levels of carbohydrates (75.92%) with crude fiber, protein and fat contents of 7.30%, 6.34% and 1.99%, respectively. *C. Siliqua* L. was also a rich source of Fe, Ca, Na, K, P and S [5]. There are several plant species in Thailand that have been investigated the nutritional and mineral compositions. Nutrient and mineral content of *Hydnocarpus anthelminthicus* cultivated in Thailand presented the highest composition of protein (7.24%), fat (26.15%), fiber (12.75%), K (721.67 mg), Ca (122.47 mg), Fe (5.23 mg), Na (3.30 mg), Mg (86.58 mg) and Cr (1.67mg) [6]. Furthermore, *Moringa oleifera* that obtained from 11 different provinces in Thailand exhibited the highest of protein (19.15-28.80%) and also contained of essential element e.g. Ca (1510.41-2951.13 mg), K (1504.23-2054.05 mg) and Fe (20.31-37.60 mg) [7].

Antioxidants could prevent oxidative stress to against diseases, e.g. cancer, diabetes, aging, hypertension, atherosclerosis and neurodegenerative disorders, making it interesting to evaluate the effect of antioxidants from plants to decrease the risk of various diseases. For example, *Allium ampeloprasum* subsp. *persicum* leaves showed good total antioxidant capacity and H_2O_2 scavenging activity [8]. *Phlomis armeniaca* also had antioxidant potential and could be an effective alternative compound for preventing Alzheimer's disease and diabetes [9]. There was widespread interest for antioxidant activity in several plants, including *Paederia foetida* and *Erechtites hieracifolia* that presented IC_{50} values in a range of 4.53 - 8.46 mg/mL [10].

Furthermore, antioxidant capacities of Australian herbs revealed that all of plants had antioxidant activities [11].

The local plants found in Chiang Rai, Thailand (*Caesalpinia mimosoides* Lam., *Clausena excavata* Burm. f. and *Phlogacanthus pulcherrimus* T. Anderson) were commonly used and consumed by local people (Figure 1). However, the nutrient value and chemical composition of all local plants have not been investigated before. Therefore, it was interesting to examine all these plants in terms of nutritional composition, mineral content and antioxidant activity. All of local plants contributed with nutrition sources and essential chemical value could be developed to commercial product for local people in the future.

(a) (b) (c)

Figure 1 (a) *C. mimosoides* Lam., (b) *C. excavata* Burm. f. and (c) *P. pulcherrimus* T. Anderson from Chiang Sean district, Chiang Rai province.

Materials and Methods

Nutritional and mineral information

All of 3 native plants (*C. mimosoides* Lam., *C. excavata* Burm. f. and *P. pulcherrimus* T. Anderson) were harvested from local area of Chiang Sean district, Chiang Rai province in January 2019. The samples leaves were dried, weighed (100 g), ground and performed proximate analysis using AOAC method to quantify the composition of fat, protein, carbohydrate, crude fiber and ash of all samples [12]. After that, the samples were quantified for mineral composition. Sodium (Na) and potassium (K) were quantified by Atomic Emission Spectroscopy (AES) method. Atomic Absorption Spectroscopy (AAS) method was used to quantify magnesium (Mg), copper (Cu) calcium (C), manganese (Mn), iron (Fe), and zinc (Zn). Total amounts of nitrogen (N), sulfur (S), boron (B) and phosphorus (P) were measured by Kjedahl, $BaCl_2$ method, Azomethine-H and Vanadomolybdate, respectively. The experiments were performed in triplicate.

Total phenolic content and antioxidant activity

All of 3 plant samples were dried, weighed (100g), ground and extracted by methanol (Merck, HPLC grade, Germany). Then, the sample solution were filtered and evaporated to get a crude extracts with the rotary vacuum-evaporator. The antioxidant activity was examined by DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method, slightly modified from Brand-Williams *et al.* [13] and Miliauskas *et al.* [14]. The crude extracts (0.025 g) were dissolved in 10 ml methanol. The 3 ml of DPPH solution (0.06 mM) were added and mixed with 77 (38 or 19 in additional assays) µl extract solution (final mass ratio of extract- DPPH ratios were approximately 3:1, 1.5:1, 0.75:1). The samples were kept in the dark for 15 min at room temperature. Then, the absorbance (515 nm) was recorded by UV/visible light spectrophotometer. All treatments were performed in triplicate. Trolox was used as a standard antioxidant. Results were expressed in µmol TE/g.

The total phenolic content was determined using the Folin-Ciocalteu reagent. Gallic acid was used as a standard for the calibration curve. The 0.2 ml of extract solution and 0.2 ml of Folin-Ciocalteu reagent were mixed. After 4 min, 15 % Na_2CO_3 (1 ml) was added. The mixture was kept at room temperature for 2 h. The absorbance (760 nm) was measured. The total phenolic concentration evaluation was performed in triplicate. Results were calculated as the mg average of gallic acid per g extract [15].

Statistical analysis

Statistical significance was determined by analysis of variance (ANOVA) with adjustment for multiple comparisons with Turkey's test. Values were expressed as means ± standard deviation. Values with different superscripts were significantly different ($P \leq 0.05$).

Results

Nutritional and mineral information

Nutrient composition of all local plants was shown in **Table 1.** *C. mimosoides* Lam. presented the highest protein content of 27.86 g per 100 g dry weight. *P. pulcherrimus* T.Anderson exhibited the highest production of fat (4.25 g per 100 g dry weight), crude fiber (16.31 g per 100 g dry weight) and ash (12.69 g per 100 g dry weight), whereas, *C. excavata Burm.* f. provided the highest carbohydrate content of 54.39 g per 100 g dry weight. The result of mineral content was shown on **Table 2.** The experiment revealed that *P. pulcherrimus* T. Anderson showed the highest content of K, Ca, Mg, Mn, B, Fe and Zn. *C. excavata* Burm. f. resulted the highest content of S, Na and Cu. The highest nitrogen content was found in *C. mimosoides* Lam. while phosphorus composition was not different among three species.

Table 1 Nutrient compositions of local plants

Nutrient compositions (g per 100 g dry weight)	*C. mimosoides* Lam.	*C. excavata* Burm.f.	*P. pulcherrimus* T.Anderson
Protein	27.86 ± 0.115^{a}	19.65 ± 0.061^{c}	22.48 ± 0.072^{b}
Fat	2.27 ± 0.017^{c}	4.16 ± 0.026^{b}	4.25 ± 0.046^{a}
Carbohydrate	47.65 ± 0.070^{b}	54.39 ± 0.066^{a}	41.09 ± 0.036^{c}
Crude fiber	14.18 ± 0.026^{b}	9.80 ± 0.036^{c}	16.31 ± 0.056^{a}
Ash	4.27 ± 0.036^{c}	8.69 ± 0.053^{b}	12.69 ± 0.062^{a}

Values are means ± standard deviation of triplicate determinations. Values in the same row with different superscripts are significantly different ($P \leq 0.05$).

Table 2 Mineral contents of local plants

Mineral contents	*C. mimosoides* Lam.	*C. excavata* Burm.f.	*P. pulcherrimus* T.Anderson
N (%)	4.44 ± 0.055^{a}	3.20 ± 0.061^{c}	3.66 ± 0.053^{b}
P (%)	0.41 ± 0.017^{a}	0.42 ± 0.065^{a}	0.53 ± 0.056^{a}
K (%)	2.00 ± 0.072^{c}	3.41 ± 0.079^{b}	4.13 ± 0.036^{a}
Ca (%)	0.19 ± 0.026^{c}	1.75 ± 0.036^{b}	2.58 ± 0.053^{a}
Mg (%)	0.32 ± 0.026^{c}	0.50 ± 0.056^{b}	2.04 ± 0.066^{a}
Mn (mg/kg)	56.32 ± 0.085^{b}	50.67 ± 0.662^{c}	237.89 ± 1.040^{a}
S (%)	0.14 ± 0.003^{c}	0.23 ± 0.005^{a}	0.16 ± 0.006^{b}
B (mg/kg)	13.92 ± 0.082^{c}	16.30 ± 0.056^{b}	22.27 ± 0.108^{a}
Na (mg/kg)	361.80 ± 1.153^{c}	570.65 ± 0.879^{a}	487.49 ± 1.136^{b}
Fe (mg/kg)	30.06 ± 0.095^{c}	59.74 ± 0.865^{b}	99.88 ± 1.054^{a}
Zn (mg/kg)	31.68 ± 0.095^{c}	60.44 ± 0.550^{b}	82.62 ± 0.110^{a}
Cu (mg/kg)	7.13 ± 0.066^{b}	18.00 ± 0.624^{a}	6.91 ± 0.098^{b}

Values are means ± standard deviation of triplicate determinations. Values in the same row with different superscripts are significantly different ($P \leq 0.05$).

Total phenolic content and antioxidant activity

Total phenolic content and antioxidant activity were presented in **Table 3.** It was revealed that *C. mimosoides* Lam. provided the highest antioxidant activity (192.36 umol TE/g) and total phenolic content (221.65 mg GE/g). While, *C. excavata* Burm. f. and *P. pulcherrimus* T. Anderson had a fewer amount of DPPH radical scavenging activity and total phenolic content.

Table 3 Total phenolic content and antioxidant activity of local plants

Type of plant	DPPH radical scavenging activity (μmol TE/g)	Total phenolic content (mg GE/g)
C. mimosoides Lam.	192.36 ± 1.564^{a}	221.65 ± 1.064^{a}
C. excavata Burm.f.	0.35 ± 0.007^{c}	34.69 ± 0.621^{b}
P. pulcherrimus T.Anderson	6.31 ± 0.065^{b}	7.20 ± 0.078^{c}

Values are means ± standard deviation of triplicate determinations. Values in the same column with different superscripts are significantly different ($P \leq 0.05$).

Conclusion and Discussion

Nutrient composition of *C. mimosoides* Lam., *C. excavata* Burm. f. and *P. pulcherrimus* T. Anderson consisted of fat, protein, carbohydrates, crude fiber and ash in the range of 2.27-4.25, 19.65-27.86, 41.09-54.39, 9.80-16.31 and 4.27-12.69 g per 100 g dry weight, respectively. All of plants contained N, P, K, Ca, Mg, Mn, S, B, Na, Fe, Zn and Cu elements. *C. mimosoides* Lam. exhibited the highest total phenolic content and DPPH radical scavenging activity (221.65 mg GE/g and 192.36 μmol TE/g).

C. mimosoides Lam. revealed to have a high content of protein, which was higher than those found in *Momordica charantia* leaves (27.46 g per 100 g dry weight) [16] and *Amaranthus hybridus* L. leaves (17.92 g per 100 g dry weight) [17]. Moreover, *C. mimosoides* Lam. had higher protein content than other three varieties of *Brassica oleracea* var. acephala (20.71 - 21.76 g per 100 g dry weight) [18]. Additionally, it was higher in protein than *Phoenix dactylifera* L. that provided only 2.2–3.45 g protein per 100 g dry weight [19]. *P. pulcherrimus* T. Anderson contained 16.31g crude fiber per 100 g dry weight which was a higher amount than those found in *A. hybridus* L. (8.61 g crude fiber per 100 g dry weight) [17]. Besides, it had higher amount of fiber than the family Anacardiaceae of plant species in Nigeria (0.54 g per 100 g dry weight) [20].

There are some elements that have several functional benefits. For example, zinc provides a structural function for several enzymes in cell and involve in the synthesis and degradation of biochemical compound, including transcription and translation of gene expression [21]. Calcium participates in bone growth and muscle and neurologic function. Iron is a principal element of hemoglobin, myoglobin, and the cellular respiratory cytochrome complex. Copper is important mineral for catalyze oxidation−reduction enzymes and collagen synthesis [22]. Furthermore, magnesium shows as benefit for active growth and also enhance plant defense mechanism [23]. *P. pulcherrimus* T. Anderson contained the most valuable elements and also had higher amount in some plant species. For example, some plant species in Nigeria such as *Dennettia tripetala, Spondias mombin, Gambeya albida Monodora myristica,* and *Canarium schweinfurthii* exhibited less mineral contents (e.g. K, Ca, Mg and Fe) than that found in *P. pulcherrimus* T. Anderson [18]. Moreover, *P. pulcherrimus* T. Anderson was also found to have higher amounts of K, Ca, Mg, Fe, Zn than *A. hybridus* L. [17]. It was also revealed that Ca, Zn and Fe from 15 improved varieties of cowpeas in Tanzania were less in amounts than those found in *P. pulcherrimus* T. Anderson [24]. *P. pulcherrimus* T. Anderson had the highest content of magnesium element which was higher than that presented in *Terfezia boudieri* with 0.182 g per 100 g dry weight [25]. Furthermore, *P. pulcherrimus* T. Anderson contained a significantly higher quantity of Zn (82.62 mg/kg) than *Allium hookeri,* an ethnic medicinal food plant used among Adi tribes of India (23.5 mg/kg) [26]. Additionally, the macro-mineral composition (K, Na and P) of *P. pulcherrimus* T. Anderson was considered to be higher than edible wild plants from Northeast India, e.g. *Diospyros peregrine, Holboellia latifolia, Illicium griffithii, Persea fructifera* and *Malus sikkimensis* [27]. However, nutritionals and minerals content of plant species were different following agro-climatic regions. It was found that *P. pulcherrimus* leaves corrected form 6 different provinces in Thailand (Chiang Mai, Nan, Phayo, Phetchabun, Phrae and Bangkok) in June-October 2013 exhibited varying nutrient and mineral compositions [28]. *P. pulcherrimus* leaves of this research unassociated with previous study, it may be cause the different period of sample correction and soil fertility in different area that effected the content of nutritionals and minerals. Additionally, *Tupistra albiflora* K. Larsen's, the plant that grown in Chiang Rai province also provided the nutrient compositions similarly with this experiment [29].

Comparing with other native plant varieties, the total phenolic content of *C. mimosoides* Lam. (221.65 mg GE/g) was higher than from *Laurus nobilis* leaves which contained 46.79 mg GAE/g [30]. Several plants also showed low total phenolic content (5.20-8.10 mg GE/g), such as thyme (*Thymus vulgaris* L.), sage (*Salvia officinalis* L.), and marjoram (*Origanum majorana* L.) [31]. In the previous results, six traditional herbal infusions from Eastern Anatolia region of

Turkey showed total phenolic content ranged from 27.9 to 80.4 mg GE/g [32]. *C. mimosoides* Lam. also presented a higher antioxidant activity compared to other plant species e.g. *Phoenix dactylifera* L. (4.06-8.60 μmol TE/g) [33] and some selected Amazonian medicinal plants (1.1-117.4 μmol TE/g) [34]. The experiment revealed that *C. mimosoides* Lam. exhibited the highest total phenolic content and antioxidant activity. The previous experiment indicated that an antioxidant capacity correlated with total phenolic content. It was found that phenolic compounds contributed to the antioxidant capacities of Argentinean herbs [35] and *Boerhavia erecta* [36]. Many plant species worldwide were discovered to have great antioxidant capacities. Antioxidants had potential to reduce the oxidative stress in cells and prevent human diseases, including cancer, cardiovascular diseases, inflammatory diseases, anti-hyperglycemia and anti-hypertension potential [37-38]. From the studies of local plants in Chiang Rai, diet or pharmaceutical products from these ethnic food sources could be considered as valuable sources of nutritional elements, antioxidants and phenolic compounds. These ethnic food sources have potential to develop for diet or pharmaceutical products.

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