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Micro Mineral Contents in Thai honey

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Abstract

Honey extraction is an important beekeeping practice and involves the removal of honey from the combs and its isolation as a pure liquid. Honey contains many carbohydrates, proteins, enzymes, amino acids, lipids, vitamins, and minerals. The aim of this study was to determine the levels of micro mineral contents of 47 Thai honey using Inductive Coupled plasma-optical emission spectrometry (ICP-OES; model Optima 8300). The contents of Cr, Cu, Fe, Mn, and Zn in Thai honey were found in the range of 0.009-0.489 mg/kg, 0.31-2.482 mg/kg, 1.028-10.26 mg/kg, 0.146-8.16 mg/kg and 0.526-9.461 mg/kg, respectively. The honey from the north of Thailand usually harvested in the dry season had concentrations of mineral elements significantly higher than honey from other regions, except for concentration of Mn was found relatively high in rambutan honey from the southern Thailand. Comparing among plant species, the total micro mineral contents in honey were ranked from high to low as follows: longan, mangosteen, korlan, lychee and sunflower, respectively. The result showed that the only Zn concentration in 12 honey samples from Chiang Mai province had the significantly higher value than 10 honey samples from Lamphun province ($p<0.05$). The micro mineral contents in Thai honey were below the permitted limit of Thai and international legislation and regulations.

Keywords: Trace element, mineral, Lamphun, Chiang Mai, Thailand

INTRODUCTION

The essential minerals in diet are necessary for humans. Essential minerals are sometimes separated to major minerals and trace minerals. These two groups of minerals are equally important, but trace minerals are needed in smaller amounts. Essential micro minerals for humans, such as chromium (Cr), copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) are abundant, and constitute as a part of enzymes, hormones as well as structural proteins, and they also have vital functions in human metabolism. Food are the main sources of nutrient elements supply for human body [1]. Honey is one of the most complex minerals produced and is a sweet food made from nectar of different plants. Botanical origin of honey can be of wild or nature and agriculture or orchard. In the northern part of Thailand, *Apis mellifera* is preferred by large commercial beekeepers, mainly for producing honey to export to other countries. The properties and compositions of honey, such as color, sugar content, pH, moisture content, chemical, physical, microbiological characteristics, prophylactic properties and adulteration are used to determine its quality and value [2, 3]. The compositions of micro minerals per 100 g honey were reported by Stefan, etc. as follows: Cr 0.01-0.3 mg, Cu 0.02-0.6 mg, Fe 0.03-4.00 mg, Mn 0.02-2.00 mg and Zn 0.05-2.00 mg [4]. Thus, the honeys are safe food for normal intake. Consuming at a relatively high level, the minerals in honey can cause several toxic effects on tissues, organs as well as the health of human.

Cr toxicities cause inflammation and necrosis of skin and nasal passages, allergic contact dermatitis, the gastrointestinal tract and renal failure [5]. High intake of Cu induces toxic symptoms, including nausea, vomiting and diarrhea, weakness, stomach cramps, jaundice, dizziness and headaches [6]. Fe overload causes organ damage, such as liver, heart, pancreas, thyroid, and the central nervous system and eventually leads to organ failure [7]. However, reports on Mn and Zn toxicities via oral intake were relatively rare [8, 9]. Research study comparing the levels of micro mineral contents of different plants and regions in Thai honey has been very limited. Thus, the main objective of this study was to investigate the concentrations of five micro mineral contents in honey of Thailand.

METHODS

Honey samples

Total 47 honey samples as follows: longan (n=22), lychee (n=4), mangosteen (n=3), korlan (n=3), sunflower (n=3), sesame (n=2), rambutan (n=2), para rubber (n=1), bitter bush (n=2), coconut (n=1), macadamia (n=2), bittervine (n=1) and red gum (n=1) were collected from different regions of Thailand. Total of 41 honey samples were produced in the rural, except for 2 bitter bush honey, 1 bittervine honey and 3 korlan honey were produced in the mountain from apiculture producers of southern, eastern, central, northeastern and northern regions during a year. Upon collection, the samples were stored in sterile tubes with screw cap and immediately transferred into -10 ^{0}C temperature before analysis. Botanical origins of each sample were declared by the producers.

Trace elements determination

The method of high temperature dry oxidation (HTDO) adapted from 985,01 method of the AOAC [10] was conducted in this study. Samples were prepared according to 920, 180 method of the AOAC [11]. Each 5 g of honey was dried in a porcelain crucible at 100 °C, and heated to 550ºC for 4 h as adapted from 920, 180 method of the AOAC [11].

Then, 5 ml of HCl was added and gauged to 10 ml with distilled water (dilution 1:2). The detection limits for the trace elements were determined as the concentration corresponding to triplicate samples of twenty blanks using Inductive Coupled plasma-optical emission spectrometry (ICP-OES; model Optima 8300).

Measurement wavelengths were applied to each trace element as follows: Cr (267.716 nm), Cu (324.752 nm), Mn (259.372 nm), Zn (213.857 nm) and Fe (259.939 nm). The standard curves for mineral determinations were constructed by using a series of standard ICP multi-element MERCK® IV mineral solutions. Detection limit values of elements were 0.001, 0.002, 0.002, 0.001 and 0.002 mg/kg for Cr, Cu, Mn, Zn and Fe, respectively. The percentages of recovery ranged from 96-100 for the studied elements was as accepted by United States Environmental Protection Agency [12]. Reagent-grade chemicals, including nitric acid (69%), hydrogen peroxide (30 %) and hydrochloric acid (37%) were purchased from QRec®, New Zealand.

Statistical analysis

Data were calculated at minimum to maximum, mean and median as all samples were three independent experiments. Statistical analysis was by Kruskal-Wallis and Mann-Whitney U tests. A probability of 0.05 or less was considered as statistically significant. Data were analyzed using IBM SPSS software Version 19.

RESULTS AND DISCUSSION

The highest Cr level (0.489 mg/kg) was found in longan honey. The average Cr concentration of the samples was 0.048 mg/kg, which was not above the standard regulation of the allowed contaminant level [13]. The detected Cr level was similar to the report from Chile (0.03-1.92 mg/kg) [14], and significantly higher than honey from Switzerland (0.005-0.037 mg/kg) [4] and Turky (0.002-0.037 mg/kg) [15] ($p<0.05$). Typical dietary intakes of the Cr range from 0.6-1.6 μg/kg body weight/day [16], thus, taking the honey at 3 teaspoon/ day can likely reach the daily requirement of Cr.

The highest Cu level (2.482 mg/kg) was found in longan honey. The mean Cu concentration of the samples was 1.029 mg/kg, which was below the maximum allowed contaminant level (20 mg/kg) in food in Thailand) [17]. The detected Cu level is higher than honey from New Zealand (0.009-0.7 mg/kg) [18], China (0.308-0.036 mg/kg) [19] and USA (0.001-0.8 mg/kg) [20] but lower than the Finland honey (17-41 mg/kg) [21]. Typical dietary intakes of the Cu range from 1.25-4.1 mg/person/day [16] , thus taking the honey is as safe for human because of its much lower Cu content than the permitted level.

The highest Fe level (10.26 mg/kg) was found in longan honey. The mean Fe concentration of the honey was 3.03 mg/kg. The detected Fe level was similar to the honey from Chile (0.10-6.97 mg/kg) [14], Turkey (1.8-10.2 mg/kg) [15], USA (1.4-7.7 mg/kg) [20] and Switzerland (0.136-9.852 mg/kg) [4]. Maximum total safety daily intake of Fe is 60-75 mg [22]. Honey is safe food with iron overload.

The highest Mn level (8.16 mg/kg) was found in rambutan honey, whereas the mean Mn concentration in all honey samples was 1.18 mg/kg. The detected level is higher than the honey from Chile (0.01-6.97 mg/kg) [14], New Zealand (0.18-4.75 mg/kg) [18], USA (0.001-2.44 mg/kg) [20] and Turkey (0.32-4.56 mg/kg) [15]. Typical dietary intakes of Mn range from 2.00-7.4 mg/person/day [16], thus, the honey is likely a safe food for Mn overload.

The maximum Zn concentrations were 9.461 mg/kg in longan honey. The average Zn level was around 2.022 mg/kg, which is below the maximum allowed contaminant level (100 mg/kg) in food in Thailand [17]. The detected Zn level was higher than that from Switzerland (0.016-4.133 mg/kg) [4], Chile (0.01-4.93 mg/kg) [14], New Zealand (0.20-2.46 mg/kg) [18], Lithuanian (0.564-5.000 mg/kg) [23], USA (0.33-1.33 mg/kg) [20], and Poland (0.51-7.85 mg/kg) [24]. But Zn concentrations in Thai honey were lower than honey from Turkey (1.1-12.7 mg/kg) [15]. Typical dietary intakes of the Zn ranging from 8-16 mg/person/day [16], thus, the honey is likely a safe food for Mn overload.

Comparing among plant species, the total micro mineral contents in honey were ranked from high to low as follows: longan, mangosteen, korlan, lychee and sunflower, respectively.

Longan Honey is mainly produced in the northern part of Thailand to export to other countries. The study found that honey from the north of Thailand usually harvested in the dry season had the concentrations of mineral elements higher than other honey from other regions, except for Mn was found relatively high concentrations in rambutan honey from the southern Thailand. The differences observed between the minimum and maximum element values are presented in Table 1.

Table 1: Concentrations (mg/kg) of micro minerals from honey in different regions of Thailand Table captions

Region	Cr	Cu	Fe	Mn	Zn
Northern (32)	0.009-0.489	0.456-2.482	1.028-10.26	0.18-2.941	0.526-9.461
Southern (4)	0.015-0.026	0.505-0.743	1.214-2.195	4.431-8.160	1.130-2.018
Eastern (3)	0.017-0.344	0.571-0.908	2.688-3.617	0.899-1.868	0.589-1.238
Central (4)	0.014-0.027	0.310-1.065	2.614-3.491	0.198-0.233	0.909-1.092
Northeastern (4)	0.015-0.027	0.311-1.473	1.118-3.212	0.146-0.571	0.804-2.056

As well as the study of Rashed and Soltan revealed that honey contained different mineral concentrations highly depend on the types of flowers utilized by bees [25]. Chiang Mai and Lamphun provinces are main location for longan honey production and export. The test of medians of mineral value in longan honey from Chiang Mai and Lamphun province showed a significant difference in Zn level ($p < 0.05$). Longan honey from Chiang Mai province found the median concentrations of heavy metals higher than the longan honey from the Lamphun province. Differences observed in the median element values are presented in Table 2.

Table 2. Concentrations (mg/kg) of median trace elements of longan honey from Chiang Mai and Lamphun provinces

Province	Cr	Cu	Fe	Mn	Zn
Lamphun (10)	0.016	1.181	3.266	0.502	2.153
Chiang Mai (12)	0.017	1.295	3.925	0.588	2.518
p-value	0.571	0.115	0.069	0.135	0.039*

Sometime, Equipment materials used during harvesting, processing and storage of honey can have corrosive effect due to the acidic property of the honey [14,15, 26]. Moreover, common sources of materials are from mining and industrial wastes, vehicle emissions, fertilizers, paints [27] and pesticides [6] that can contaminate of honey in a bee swarm area. The study by Stefan, etc showed that the micro minerals in the different honey samples and regions occurred due to the environmental or geographical factors or climatic conditions [4].

CONCLUSION

Almost all of the honey from the north of Thailand usually harvested in the dry season had concentrations of trace elements higher than honey from other regions. Fe level (10.26 mg/kg) was found to be the highest among the minerals and the greatest in longan honey. The results support the conclusion that the microminerals composition of honey depends on plant type and geographical locations. However, the levels of the minerals in Thai honey were met international standards and baseline of food safety. Some micro mineral contents from honey are essential to maintain the metabolism of the human body.

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