The Comparison's Food Nutrition of Roasting of Cocoa Bean From Some Private Company in Thailand and Taiwan

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***Abstract*— Cocoa, a fruit product of *Theobroma cacao* L., is the third most important agricultural crop in the world. Cocoa is the main ingredient in chocolate manufacture. The consumption of cocoa is increasing due to the demand in international market and chocolate industries. The aim of this research paper studied and compared on food nutrition of cocoa beans some private company in Thai and Taiwan. The results found that total calories, calories from fat, crude fat, saturated fatty acids, dietary fiber, cholesterol, cholecalciferol (Vitamin D3), and total flavonoids content of cocoa beans from Thailand were higher than Taiwan. On the other hand, carbohydrate, ash, calcium, iron, potassium, and ergocalciferol (Vitamin D2) of cocoa beans from Taiwan. Therefore, this research paper is the first report database on food nutrition from private company in Thailand and Taiwan. For the future can be applies to advance cocoa research, sharing to smart farmer for cocoa industries.**

Index Terms*: *Food Nutrition, Thai, Taiwan, Cocoa beans

I. Introduction

Cocoa, a fruit product of *Theobroma cacao* L. (*Malvales: Sterculiaceae*), is the third most important agricultural crop in the world and also have long story about high antioxidant. The cocoa beans, it is an important commodity in the world and the major ingredient in chocolate manufacture. Now a day the consumption is increase in the demand of cocoa at the international market and chocolate industries (Fig. 1, 2).

The world production and consumption of cocoa in 2018, the highest consumption of cocoa was in Europe as 1,852 thousand tonnes. In addition, the highest production of cocoa was from Cote devoirs as 2,000 thousand tonnes. The most production area is in tropical countries in Africa (76%), Latin America (16%), and Asia & Oceania (7%) (UNCTAD, April 2018). Recently, Thai government is introducing cocoa as new economic crop in the country by promoting and planning for cocoa industry (Fig 2). Food nutrition is including 1) Macronutrients such as carbohydrates, protein, fiber, fat, essential fatty acids, water and alcohol (ethanol). 2) Micronutrients such as minerals; macro minerals, trace minerals, vitamin and Phytochemicals. Phytochemicals (Phytonutrients) are biological substances found only in plants. One of them is Polyphenols: Flavonoids. Cocoa is an important source of Polyphenol, which is a healthy antioxidant. It can be seen that cocoa has many beneficial nutrients [1]. The aim of this research paper studied and compared on food nutrition of cocoa beans some private company in Thai and Taiwan.

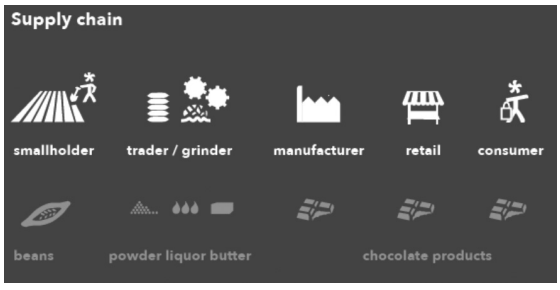

Fig. 1. Supply chain of cocoa [2].

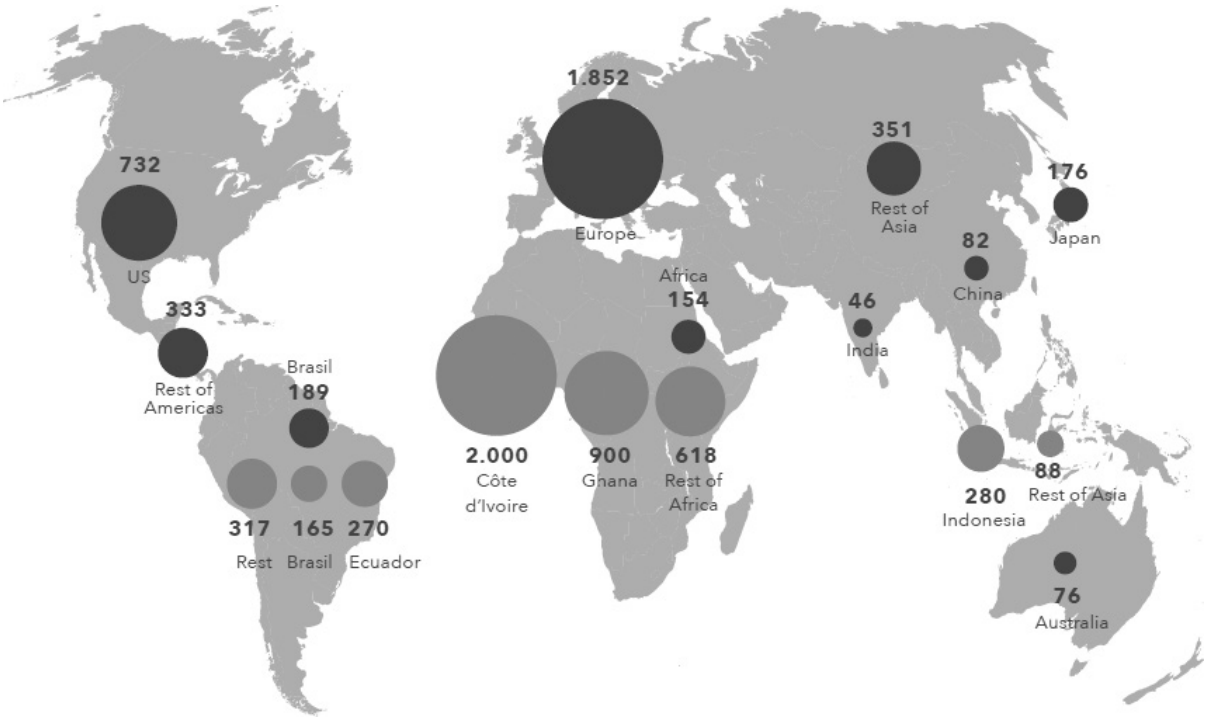

Fig. 2. Production and consumption of cocoa in the world in 2018 [2].

II. Materials and Methods

A. Cocoa bean sample preparation

Thai cocoa beans sample Chumphon#1 from Thai coffee-cocoa company after processing at 120˚C within 20 minute, formula A (cocoa beans from Thailand) and formula B (cocoa beans from Taiwan) from Taiwan company as same condition.

B. Analysis Methods

- Calories
- Calculation formula: [9(crude fat)+4(Crude protein)+4(carbohydrate-dietary fiber)].
- Calories from fat
- Calculation formula: [9(crude fat)].
- Carbohydrate
- Calculation: (100-moisture-ash-crude protein-crude fat).
- Saturated fatty acids

The analysis of saturated fatty acids is according to the method of DOH food 0961800343 announced.

- Trans fat
  The analysis of trans fat is according to the method of DOH food 0961800343 announced.
- Sodium
  Refer CNS 12869/N6231, A.O.A.C. 969.23 and A.O.A.C. 973.54.
- Moisture
  Refer CNS 5033 and CNS 2770-3.
- Ask
  Refer CNS 5034 and CNS 2770-9.
- Crude protein
  Refer CNS 5035 and CNS 2770-5.
- Crude fat
  Refer CNS 5036 and CNS 2770-4.
- Total sugar
  Calculation formula: [Glucose+Fructose+Sucrose+Lactose+Maltose] Refer CNS 12634/N6223.
- Dietary fiber
  Refer AOAC methods of analysis (1990) 15ED and AOAC methods of analysis (2000) 45.4.07(AOAC985.29).

DOH = Department of Health
CNS = National Standards of the Republic of China
AOAC = Association of Official Analytical Chemists

All analysis methods under Agriculture and Aquaculture Product Inspection and Certification, Department of Food Science, National Pingtung University of Science and Technology, Taiwan (http://www.caapic.npust.edu.tw/)

C. Total flavonoid content analysis

Total flavonoid content analysis by High Performance Liquid Chromatography (HPLC) technique from Agriculture and Aquaculture Product Inspection and Certification, Department of Food Science, National Pingtung University of Science and Technology, Taiwan (http://www.caapic.npust.edu.tw/)

C.1 Extraction of Flavonoids from cocoa bean

About 1 g (accurately weighed to 0.0001 g) of cocoa bean was extracted with 25 mL of 95% ethanol under 200 rpm shaking for 24 hr. After filtration, the filtrate was adjusted to 25 mL with 80% ethanol and stored in an amber bottle. In solid form, 0.1 to 1 g

(accurately weighed to 0.0001 g) was first dissolved with 10 mL of 80% ethanol. After centrifugation at 1,000 x g for 10 min, the supernatant was collected and the precipitate was then extracted with 5 mL of 80% ethanol twice. Finally, the supernatant was combined with previous supernatant and adjusted to 25 mL with 80% ethanol. Liquid sample were directly diluted with 80% ethanol to the concentrations appropriate for colorimetric analysis [3].

C.2 Estimation of total flavonoid content

1) Aluminum Chloride Colorimetric Method, The aluminum chloride colorimetric method was modified from the procedure reported by [3-6]. Quercetin was used to make the calibration curve. Ten milligrams of quercetin was dissolved in 80% ethanol and then diluted to 25, 50 and 100 µg/mL. The diluted standard solutions (0.5 mL) were separately mixed with 1.5 mL of 95% ethanol, 0.1 mL of 10% aluminum chloride, 0.1 mL of 1M potassium acetate and 2.8 mL of distilled water. After incubation at room temperature for 30 min, the absorbance of the reaction mixture was measured at 415 nm with a Shimadzu UV-160A spectrophotometer (Kyoto, Japan). The amount of 10% aluminum chloride was substituted by the same amount of distilled water in blank. Similarly, 0.5 mL of ethanol extracts or 15 flavonoid standard solutions (100 ppm) were reacted with aluminum chloride for determination of flavonoid content as described above.

2) 2,4-Dinitrophenylhydrazine Colorimetric Method The current method was modified from the procedure described by [6-7]. (±)-Naringenin was used as the reference standard. Twenty milligrams of (±)-naringenin was dissolved in methanol and then diluted to 500, 1000 and 2000 µg/mL. One milliliter of each of the diluted standard solutions was separately reacted with 2 mL of 1% 2,4-dinitrophenylhydrazine reagent and 2 mL of methanol at 50˚C for 50 min. After cooling to room temperature, the reaction mixture was mixed with 5 mL of 1% potassium hydroxide in 70% methanol and incubated at room temperature for 2 min. Then, 1 mL of the mixture was taken, mixed with 5 mL of methanol and centrifuged at 1,000 x g for 10 min to remove the precipitate. The supernatant was collected and adjusted to 25 mL. The absorbance of the supernatant was measured at 495 nm. The ethanol extracts of propolis and 15 flavonoid standard solutions (1000 ppm) were similarly reacted with 2, 4-dinitrophenylhydrazine for determination of flavonoid content as described above [3-4].

C. Statistical analysis

Statistical analysis was using PASW Statistics 18 software. Difference between two means was evaluated using t-test. Differences were considered significant when the *P*-value was less than 0.05. (Values was expressed as the mean (SD) at n = 3)

II. Results and Discussion

Table I presented the results from Thai cocoa beans analysis was including total calories; 576±2 kcal/100g. and calories from fat; 497±2 kcal/100g, crude protein; 13.1±0.3 g/100g, crude fat; 55.2±0.2 g/100g, saturated fatty acids; 35.74±0.1 g/100g, carbohydrate; 28.7±0.2 g/100g, sodium; 4 g/100g, moisture; 1.3±0.3 g/100g, ash; 1.7±0.2 g/100g, dietary fiber; 22 g/100g, cholesterol; 21.7±0.2 mg/kg, calcium; 923±3 mg/kg, Iron; 24.8±0.3 mg/kg, potassium; 8170±5 mg/kg, Ergocalciferol (Vitamin D2); 1.83 mg/kg, Cholecalciferol (Vitamin D3); 2.69±0.1 mg/kg and total flavonoids content 131.74±0.24 mg/100 g. (Table I) respectively.

In addition, the results from Taiwan cocoa beans analysis was including total calories; 535±3 kcal/100g. and calories from fat; 425 kcal/100g, crude protein; 14.3±0.4 g/100g, crude fat; 47.2 g/100g, saturated fatty acids; 25.6 g/100g, carbohydrate; 33.4±1.8 g/100g, sodium; 3 g/100g, moisture; 2.3±0.5 g/100g, ash; 2.8±0.7 g/100g, dietary fiber; 20.15±3.1 g/100g, calcium; 1300±1.3 mg/kg, Iron; 31.7±0.3 mg/kg, potassium; 9400±5 mg/kg, Ergocalciferol (Vitamin D2); 2.1±1.3 mg/kg, and total flavonoids content 4.84±0.7 mg/100 g. (Table 1) respectively.

Therefore, this report was compare 24 items of food nutrition from Thai and Taiwan cocoa bean after roasted at 120˚C within 20 minute. Especially for phytochemicals; total flavonoids content from Thai cocoa bean was very high more than 100 mg/100 g. (Table I). Similarly to [8] the comparison of cocoa beans from China, Indonesia and Papua New Guinea. This database will be benefit for deep future research about phytochemicals (flavonoids content) in cocoa beans (Fig 3).

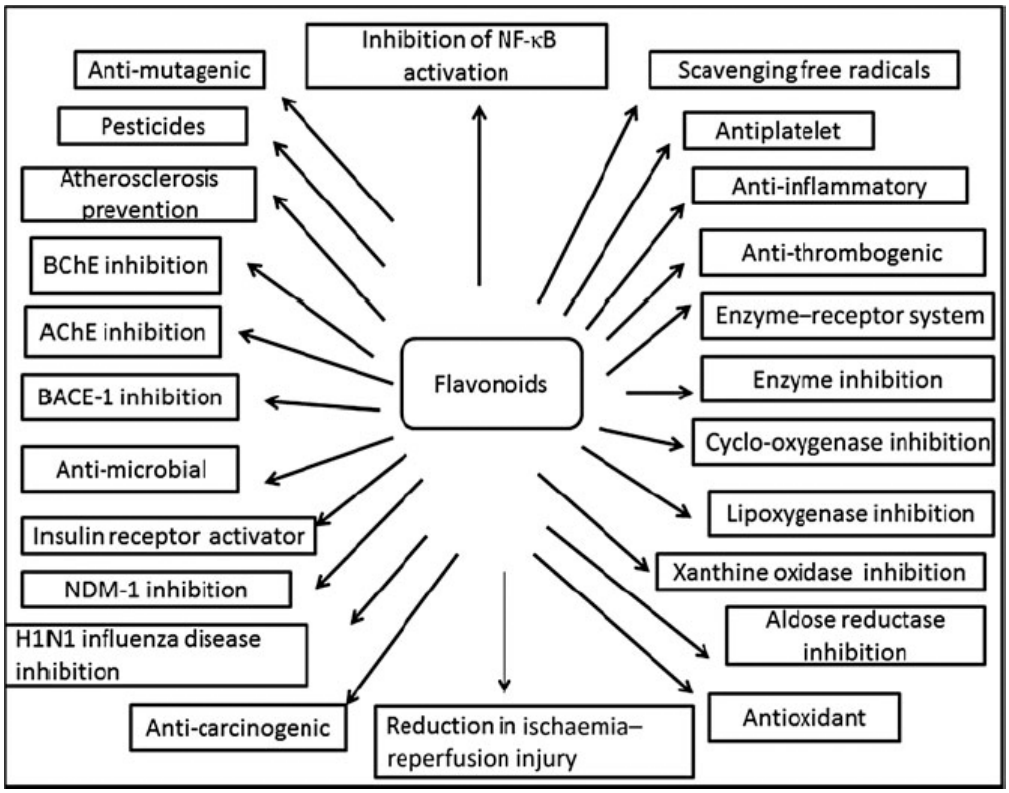

Fig. 3. The beneficial effect of flavonoids [9].

TABLE I
THE FOOD NUTRITION OF THAI AND TAIWAN'S COCOA BEANS

No	Items	Thailand cocoa bean (A)	Taiwan cocoa bean (B)	Units
1	Total calories	576±2a	535±3b	kcal/100 g
2	Calories from fat	497±2a	425b	kcal/100 g
3	Crude protein	13.1±0.3a	14.3±0.4a	g/100 g
4	Crude fat	55.2±0.2a	47.2b	g/100 g
5	Saturated fatty acids	35.74±0.1a	25.6b	g/100 g
6	Trans fat	N/A	N/A	g/100 g
7	Carbohydrate	28.7±0.2b	33.4±1.8a	g/100 g
8	Sodium	4a	3a	g/100 g
9	Moisture	1.3±0.3a	2.3±0.5a	g/100 g
10	Ash	1.7±0.2b	2.8±0.7a	g/100 g
11	Total sugar	N/A	N/A	g/100 g
12	Glucose	N/A	N/A	g/100 g
13	Fructose	N/A	N/A	g/100 g
14	Sucrose	N/A	N/A	g/100 g
15	Lactose	N/A	N/A	g/100 g
16	Maltose	N/A	N/A	g/100 g
17	Dietary fiber	22a	20.15±3.1b	g/100 g
18	Cholesterol	21.7±0.2a	N/A	mg/kg
19	Calcium	923±3b	1300±1.3a	mg/kg
20	Iron	24.8±0.3b	31.7±0.3a	mg/kg
21	Potassium	8170±5b	9400±5a	mg/kg
22	Ergocalciferol (Vitamin D2)	1.83b	2.1±1.3a	mg/kg
23	Cholecalciferol (Vitamin D3)	2.69±0.1a	N/A	mg/kg
24	Total Flavonoids Content	131.74±0.2a	4.84±0.7b	mg/100 g

N/A = Non-detectable

III. Conclusion

This research using 24 items for analysis. The results found that total calories, calories from fat, crude fat, saturated fatty acids, dietary fiber, cholesterol, cholecalciferol (Vitamin D3), and total flavonoids content of cocoa beans from Thailand were higher than Taiwan. On the other hand, carbohydrate, ash, calcium, iron, potassium, and ergocalciferol (Vitamin D2) of cocoa beans from Taiwan. Therefore, this research paper is the first report database on food nutrition from private company in Thailand and Taiwan. For the future can be applies to advance cocoa research, sharing to smart farmer for cocoa industries. For the future research can be applies to advance and sharing to smart farmer and add value for cocoa industries (in term of cocoa industry value chain Fig 4).

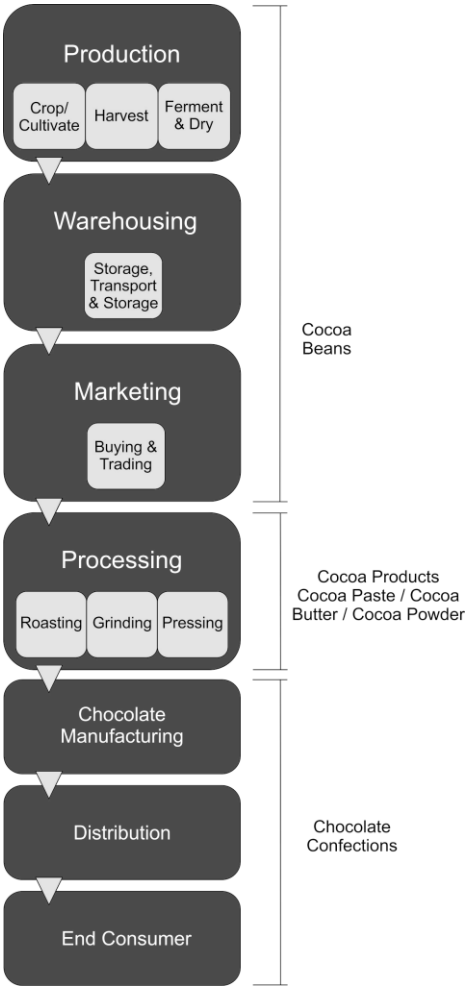

Fig. 4. Cocoa industry value chain [10].

Acknowledgment

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