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Original article

Antioxidative properties of common ready-to-eat cooked foods and beverages in Thailand

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Background: Increased dietary antioxidant consumption is associated with decreased risk of oxidative stress-mediated diseases. Cooking process affects the quantity and quality of antioxidants in foods. In this study, we investigated the antioxidative properties of ready-to-eat (RTE) cooked meals.
Objective: To determine the total antioxidant capacity (TAC), total phenolic content (TPC), and total flavonoid content (TFC) in RTE cooked foods and beverages commonly sold in Thailand.
Methods: Thirty cooked food items were purchased from local fresh markets and canteens in Bangkok. The foods were categorized into Central food, Northern food, Northeastern food, Southern food, fast food, and beverage. Levels of TAC (by ABTS and DPPH methods), TPC, and TFC were determined in all food samples.
Results: The highest level of TAC was found in Southern Thai style fermented fish innards curry, followed by Stir-fried pork with Thai, and Stir-fried twisted cluster bean with shrimp. As for TPC, the highest level was observed in Stir-fried malindjo leaves with egg, followed by Stir-fried twisted cluster bean with shrimp, and Smoked dry fish with cassia leaves curry. The lowest TAC and TPC were found in Northern Thai style pork curry with rice vermicelli and Northern Thai style chicken curry with noodles, respectively. Among beverages, Americano coffee had the highest levels of TAC, TPC and TFC. The lowest levels of TAC, TPC and TFC were found in chrysanthemum juice. Hawaiian pizza and pork burger had the intermediate levels of TAC and TPC.
Conclusion: Antioxidant properties of common RTE foods of all regions of Thailand were firstly reported. The Southern foods, especially Southern Thai style fermented fish innards curry, Stir-fried twisted cluster bean with shrimp, and Stir-fried Melinjo leaves with eggs, had higher content of antioxidants than the foods from other regions. Smoked dry fish with cassia leaves curry and Steamed fish with Thai spicy sauce were the high antioxidant Northeastern dishes. Consumption of RTE foods with high antioxidant content would help attenuate oxidative stress and might be beneficial to prevent the development of chronic diseases related to oxidative stress.

Keywords: Dietary antioxidants, disease prevention, flavonoid, oxidative stress, polyphenol, ready-to-eat food, Thai food.

Oxidative stress is an imbalance of reactive oxygen species (ROS) production and antioxidant content in the body that causes deleterious damage to cellular biomolecules.[1, 2] ROS production progressively increases, but antioxidant capacity gradually decreases, with age resulting in increased oxidative stress. It is well-recognized that oxidative stress contributes to ageing[3] and development of chronic and degenerative diseases.[4] Consumption of healthy food containing dietary antioxidants is, therefore, recommended to delay ageing and reduce the risk of oxidative stress-mediated pathologies. Basically, plant-based foods have significantly much higher antioxidant content than the animal-based diets.[5] The foods rich in vegetables and fruits are considered as healthy diets and beneficial for disease prevention. Red wine is a good example of antioxidative food. Many studies show that phenolic compounds, especially resveratrol, in red wine reduces the progression of atherosclerosis and cardiovascular disease both *in vitro* and *in vivo* models.[6 - 8]

Thai foods have a wide variety. They contain a wide range of healthy ingredients including herbs, fruits, and vegetables. Many of Thai foods are

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recognized as healthy recipes. Thailand consists of four main regions including Central, North, Northeast, and South. Each region has its own typical local recipes. Many studies reported antioxidant properties and health benefits of Thai foods, but most of them investigated in raw food ingredients such as rice[9], fresh vegetables[10], medicinal plants[11, 12], fruits[13], and herbal beverages.[14] It is well known that cooking process affects the quantity and quality of phytochemicals including natural phenolic antioxidants.[15 - 17] Therefore, it is necessary to measure the antioxidant content in food after cooking to accurately identify the healthy food with high antioxidants. Study of antioxidant activity in cooked Thai foods is still scarce. At the present day, especially in the urban area, people have a fast-paced lifestyle. Urban people trend to buy the ready-to-eat (RTE) cooked foods from the fresh markets or supermarkets or convenient store rather than to cook foods by themselves at home. Consumption of RTE cooked meals is progressively increasing in the city. To help the consumers justify the healthy RTE foods to buy, the data of antioxidant content in the RTE foods selling in Thai food markets should be established.

Phenolic compounds are antioxidative molecules abundantly found in edible plants, and the well-known phenolic compounds are phenolic acids and flavonoids. The total antioxidant capacity (TAC), total phenolic content (TPC) and total flavonoid content (TFC) are widely investigated in fruits such as blueberry, cranberry, grape, and apple[18, 19], and vegetables such as *Solanum xanthocarpum* (yellow-berried nightshade), *Ocimum sanctum* (holy basil), *Acacia pennata* (acacia), *Ocimum basilicum* (sweet basil), *Petroselinum crispum* (long cariens), *Capsicum frutescens* (chili), *Eugenia siamensis* Craib (jambolan plum), *Cleistocalyx operculatus var. paniala* (Roxb.) (persimmon) and *Tamarindus indica* Linn. (tamarind)[20, 21], and most of them have high content of polyphenols and flavonoids.

In this study, we aimed to investigate the antioxidant contents of the common RTE cooked Thai foods. The selected foods were the typical recipes of each region of Thailand, and they were categorized into Central food, Northern food, Northeastern food, Southern food, fast food, and beverage. Levels of TAC, TPC, and TFC were measured in all food samples, and the contents were reported per 100 g food.

Materials and methods

Food sample preparation

The thirty common food items were selected for the study. The food samples were purchased from several areas of local fresh markets and cafeterias in Bangkok. The foods were categorized according to the origin of recipes into six categories, i.e., Central food, Northern food, Northeastern food, Southern food, fast food, and beverage. (Figure 1). Food samples (100 g) were combined with distilled water (DW, 100 - 500 mL) and blended using the food blender. (Table 1). The homogenized food samples were centrifuged at 4,000 x g for 10 min. Supernatants were collected and kept at - 20 or - 80°C for further measurements of TAC, TPC and TFC. (Figure 2). As for beverages, samples (150 g) were blended using the food blender without adding DW. Homogenized samples were collected and kept at - 20 or - 80°C until testing.

Total antioxidant capacity measurements by ABTS and DPPH methods

TAC was determined by ABTS and DPPH methods.[22] As for ABTS method, 2.5 mM 2, 2'-azino-bis (3-ethylbenzothiazoline-6-sulphonic acid (ABTS) reagent (Sigma-Aldrich, USA) was added with 1 mM 2, 22 -Azobis (2-methylpropionamidine) dihydrochloride (AAPH) reagent (Merck Millipore, USA) in phosphate buffered saline (PBS) and incubated at 68°C for 40 min to convert the non-radical ABTS to the ABTS radicals (blue/green color). The blue/green ABTS radical solution was diluted with PBS to attain the absorbance (734 nm) of 0.650 ± 0.02. In ABTS reaction, food samples or vitamin C standards or DW (5 μL) were combined with ABTS radical solution (295 μL) and incubated at 37 °C for 10 min in the dark. Absorbance at 734 nm was measured. Vitamin C standards (0.25, 0.5, and 1 mM) were used for generating the standard curve. TAC levels in food samples were calculated and expressed as milligrams of vitamin C equivalent antioxidant capacity per 100 grams of food (mg VCEAC/100 g food).

As for DPPH method, 2, 2-diphenyl-1-picryl-hydrazyl (DPPH) reagent (Sigma-Aldrich, USA) was dissolved in 80% (v/v) ethanol. The DPPH solution (violet color) was diluted with 80% ethanol to achieve the absorbance (517 nm) of 0.650 ± 0.02. As for the DPPH reaction, food samples or vitamin C standards or DW (5 μL) were combined with DPPH solution (295 μL) and incubated at room temperature for 30 min in the dark. Absorbance at 517 nm was measured. TAC levels were calculated and expressed as mg VCEAC/100 g food.

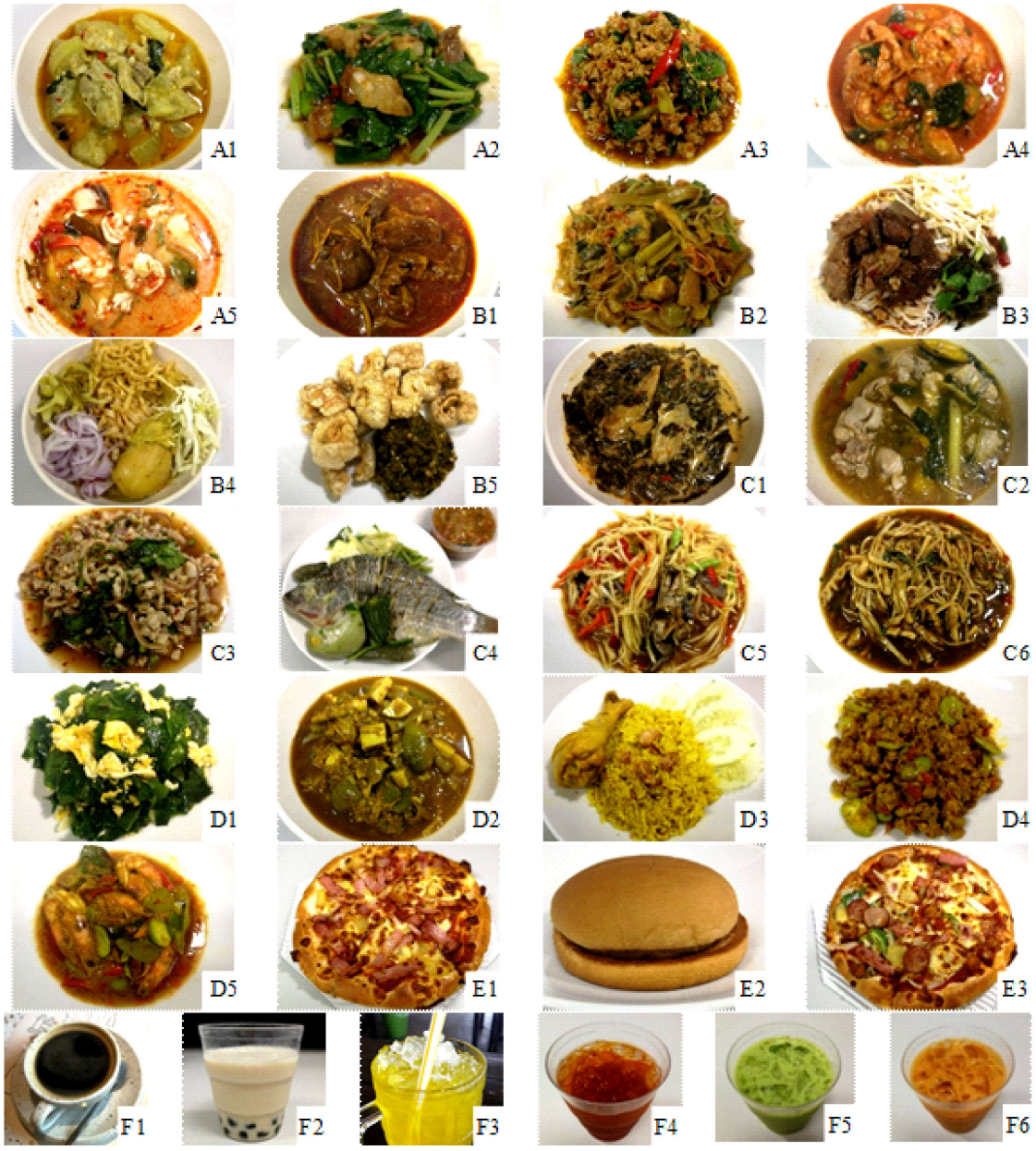

Figure 1. List of selected food samples. The food samples were classified into 6 groups including Central food (A1 - A5), Northern food (B1 - B5), Northeastern food (C1 - C6), Southern food (D1 - D5), fast food (E1 - E3), and beverages (F1 - F6). A1: Kaeng Kiew Wan Gai (Chicken and white gourd with green curry), A2: Kana Moo Krob (Stir-fried collards with crispy pork), A3: Pad Kra Pao Moo Sub (Stir-fried pork with Thai basil), A4: Panaeng Moo (Pork with Panaeng curry), A5: Tom Yum Kung (Thai hot and sour shrimp soup), B1: Kaeng Hang Lei (Northern Thai style pork curry), B2: Kaeng Hor (Northern Thai style mixed vegetable in mixed curry), B3: Khanom Jin Nam Ngiao (Northern Thai style pork curry with rice vermicelli), B4: Khao Soi (Northern Thai style chicken curry with noodles), B5: Nam Prik Num Kaep Moo (Pork snack with Northern Thai style green chili sauce), C1: Kaeng Khe Hlek (Smoked dry fish with assia leaves curry), C2: Kaeng Oom (Spicy chicken soup), C3: Larb Moo (Spicy minced pork salad), C4: Pla Nueng Nam Jim Jaew (Steamed fish with Thai spicy sauce), C5: Som Tam Poo Pla Ra (Spicy papaya salad with salted crab and fermented fish), C6: Soup Nor Mai (Spicy bamboo soup), D1: Bai Lieng Pad Kai (Stir-fried Melinjo leaves with eggs), D2: Kaeng Tai Pla (Southern Thai style fermented fish innards curry), D3: Khao Mok Gai (Thai muslim-style chicken and rice), D4: Kua Kling Moo (Stir-fried pork and twisted cluster bean with yellow curry), D5: Pad Sator Kung (Stir-fried twisted cluster bean with shrimp), E1: Hawaiian pizza, E2: Pork burger, E3: Super deluxe pizza, F1: Americano, F2: Bubble milk tea, F3: Chrysanthemum juice, F4: Lemon tea, F5: Matcha milk tea, and F6: Thai tea.

Table 1. List of the studied food items and density of homogenized food samples after preparation.

Food categories	RTE food weight (g)	Added DW before homogenizing (mL)	Density (g/mL) of homogenized food samples
Central food			
Chicken and white gourd with green curry	100	100	1.03 ± 0.00
Stir-fried collards with crispy pork	100	100	1.05 ± 0.00
Stir-fried pork with Thai basil	100	200	1.02 ± 0.00
Pork with Panaeng curry	100	300	1.03 ± 0.00
Thai hot and sour shrimp soup	100	100	1.03 ± 0.00
Northern food			
Northern Thai style pork curry	100	100	1.05 ± 0.00
Northern Thai style mixed vegetable in mixed curry	100	200	1.06 ± 0.00
Northern Thai style pork curry with rice vermicelli	100	100	1.03 ± 0.01
Northern Thai style chicken curry with noodles	100	200	1.04 ± 0.00
Pork snack with Northern Thai style green chili sauce	100	500	1.05 ± 0.00
Northeastern food			
Smoked dry fish with cassia leaves curry	100	200	1.06 ± 0.00
Spicy chicken soup	100	200	1.05 ± 0.00
Spicy minced pork salad	100	200	1.02 ± 0.00
Steamed fish with Thai spicy sauce	100	300	1.02 ± 0.00
Spicy papaya salad with salted crab and fermented fish	100	200	1.03 ± 0.00
Spicy bamboo soup	100	100	1.04 ± 0.00
Southern food			
Stir-fried Melinjo leaves with eggs	100	300	1.03 ± 0.00
Southern Thai style fermented fish innards curry	100	100	1.03 ± 0.00
Thai muslim-style chicken and rice	100	200	1.02 ± 0.00
Stir-fried pork and twisted cluster bean with yellow curry	100	200	1.07 ± 0.00
Stir-fried twisted cluster bean with shrimp	100	300	1.04 ± 0.00
Fast food			
Hawaiian pizza	100	200	1.03 ± 0.00
Pork burger	100	300	1.04 ± 0.00
Super deluxe pizza	100	200	1.03 ± 0.00
Beverages			
Americano	150	-	1.01 ± 0.00
Bubble milk tea	150	-	1.07 ± 0.00
Chrysanthemum juice	150	-	1.02 ± 0.00
Lemon tea	150	-	1.04 ± 0.00
Matcha milk tea	150	-	1.04 ± 0.00
Thai tea	150	-	1.04 ± 0.00

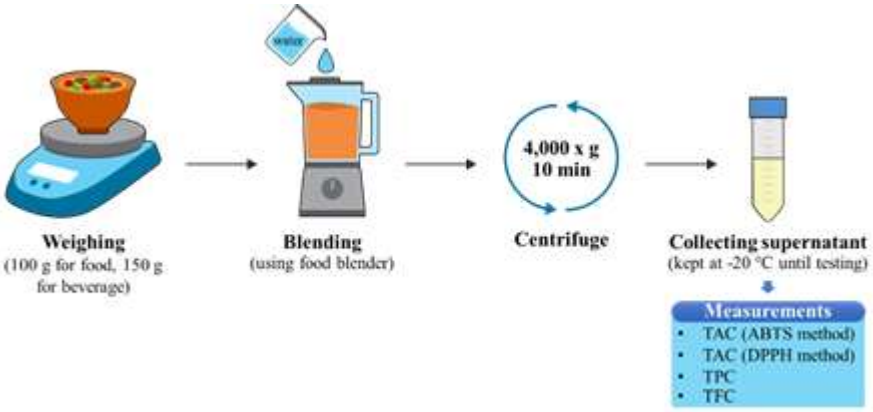

Figure 2. Schematic of food sample preparation in this study.

Total phenolic content measurement

TPC in food samples were measured by Folin-Ciocalteu's reagent (Merck Millipore, USA) according to the previous study.[23] Briefly, varied concentrations of gallic acid standards (25, 50, 100, 200 and 400 μg/mL) (Merck Millipore, USA), nt (200 μL) and incubated at room temperature for 5 min. Then, 2 M Na2CO3 (Merck Millipore) (30 μL) was added and incubated at room temperature for 2 h in the dark. Absorbance at 660 nm was measured. Standard curve of gallic acid was created. TFC levels were calculated from the standard curve and expressed as mg gallic acid equivalent per 100 grams of food (mg GAE/100 g food).

Total flavonoid content measurement

TFC levels in food samples were measured using spectrophotometric method.[24] Briefly, varied concentrations of catechin standards (0.031, 0.063, 0.125 and 0.25 mg/L) (Merck Millipore, USA), DW (blank), and food samples (50 μL each) were diluted with 320 μL of DW. Then, 5% (w/v) sodium nitrite (Merck Millipore) (15 μL) was added and incubated at room temperature for 5 min. After that, 10% (w/v) aluminum chloride (Merck Millipore) (15 μL) was added and incubated at room temperature for 6 min, followed by addition of 1 M sodium hydroxide (Merck Millipore) (100 μL). Absorbance at 510 nm was measured. Standard curve of catechin was generated. TFC levels were calculated from the standard curve and expressed as mg catechin equivalent per 100 grams food (mg CE/100 g food).

Statistical analysis

Data were reported as mean ± standard deviation (SD). GraphPad Prism 9.0 was used for all graphs and calculations. P - value < 0.05 was set as statistical significance.

Results

TAC measured by ABTS method in RTE foods

TAC levels were measured by ABTS method in all selected 30 food samples (Table 2). The higher and lower quantity of TAC were found in Southern food group, southern Thai style fermented fish innards curry (276.90 ± 162.05 mg VCEAC/100 g food) and Northern foods, Northern Thai style pork curry with rice vermicelli (9.94 ± 0.21 mg VCEAC/100 g food), respectively.

TAC measured by DPPH method in RTE food samples

TAC levels were measured by DPPH method in all food samples. (Table 2). The higher and lower quantity of TAC were found in Americano (219.10 ± 25.73 mg VCEAC/100 g food) and Hawaiian pizza (3.30 ± 0.88 mg VCEAC/100 g food), respectively.

TPC levels in RTE foods

The levels of TPC in all food items were determined. (Table 2). The higher and lower quantity of TPC were found in Southern food group, stir-fried Melinjo leaves with eggs (192.18 ± 16.59 mg GAE/100 g food) and Northern food group, Northern Thai style chicken curry with noodles (0.43 ± 0.16 mg GAE/100 g food), respectively.

TFC levels in RTE foods

The levels of TFC in all food sample were measured. (Table 2). The higher and lower quantity of TFC were found in Southern food group, stir-fried Melinjo leaves with eggs (556.74 ± 28.54 mg CE/100 g food) and Northern food group, Northern Thai style chicken curry with noodles (0.48 ± 0.09 mg CE/100 g food), respectively.

Discussion

High ROS generation and low dietary antioxidant consumption lead to oxidative stress that further involves in the development of ageing[25] and many chronic and degenerative diseases, for instances, cardiovascular disease[26] and kidney stone disease.[1, 27, 28] Therefore, increased intake of dietary antioxidants, particularly polyphenols, is recommended to be beneficial for disease prevention.[29, 30] In Thailand, antioxidant capacity and phenolic compounds of local fruits and vegetables and raw food materials were widely investigated[20, 31], but to the authors knowledge there has been no study that investigated the RTE food recipes and beverages.

In this study, we measured TAC, TPC and TFC, in common RTE Thai foods. We demonstrated that the Southern foods (Southern Thai style fermented fish innards curry, Stir-fried twisted cluster bean with shrimp, and Stir-fried Melinjo leaves with eggs) relatively had higher contents of antioxidants than food recipes from other regions. Remarkably, vegetable-rich diet (e.g., Smoked dry fish with cassia leaves curry) had higher antioxidant profile than diets rich in meats. (e.g., Spicy minced pork salad) As expected,

Table 2. TAC, TPC and TFC levels in RTE foods.

Food categories	TAC by ABTS method (mg VCEAC/ 100 g food)	TAC by DPPH method (mg VCEAC/ 100 g food)	TPC (mg GAE/ 100 g food)	TFC (mg CE/ 100 g food)
Central food				
Chicken and white gourd with green curry	38.26 ± 10.44*	23.67 ± 0.84*	10.03 ± 1.47*	3.36 ± 0.50*
Stir-fried collards with crispy pork	40.13 ± 0.54	41.97 ± 1.80*	24.20 ± 2.16*	10.54 ± 1.91*
Stir-fried pork with Thai basil	168.64 ± 21.46	56.50 ± 5.97	29.16 ± 2.28	34.26 ± 2.28
Pork with Panaeng curry	39.40 ± 3.05*	UD	13.89 ± 0.70*	39.45 ± 1.92*
Thai hot and sour shrimp soup	30.55 ± 0.29*	14.73 ± 1.64*	7.73 ± 1.10*	6.28 ± 0.36*
Northern food				
Northern Thai style pork curry	75.70 ± 2.03**	UD	2.37 ± 0.40	39.13 ± 3.21**
Northern Thai style mixed vegetable in mixed curry	34.59 ± 0.25**	15.74 ± 4.93	14.44 ± 0.86**	9.19 ± 3.43**
Northern Thai style pork curry with rice vermicelli	9.94 ± 0.21**	UD	11.69 ± 2.81**	0.48 ± 0.09**
Northern Thai style chicken curry with noodles	11.48 ± 0.83**	UD	0.43 ± 0.16	8.47 ± 1.02**
Pork snack with Northern Thai style green chili sauce	84.33 ± 6.21	UD	1.64 ± 0.19	270.93 ± 15.70
Northeastern food				
Smoked dry fish with cassia leaves curry	115.85 ± 14.20	60.30 ± 11.16#	55.71 ± 6.01	56.88 ± 2.27#
Spicy chicken soup	31.38 ± 0.68#	12.53 ± 3.04#	7.84 ± 0.58#	7.13 ± 0.25
Spicy minced pork salad	24.25 ± 2.66#	12.11 ± 2.23#	6.99 ± 1.53#	3.25 ± 0.69#
Steamed fish with Thai spicy sauce	123.89 ± 16.10	86.05 ± 12.87	43.75 ± 9.25	10.20 ± 1.26
Spicy papaya salad with salted crab and fermented fish	64.15 ± 2.88#	26.90 ± 4.86#	16.60 ± 1.18#	8.41 ± 0.57
Spicy bamboo soup	28.34 ± 3.87#	UD	11.58 ± 0.51#	12.12 ± 0.40
Southern food				
Stir-fried Melinjo leaves with eggs	11.58 ± 9.28##	UD	192.18 ± 16.59##	556.74 ± 28.54##
Southern Thai style fermented fish innards curry	276.90 ± 162.05	38.21 ± 5.47	23.11 ± 2.91	32.02 ± 5.67
Thai muslim-style chicken and rice	15.23 ± 3.08##	UD	11.69 ± 2.81	7.21 ± 0.89
Stir-fried pork and twisted cluster bean with yellow curry	75.18 ± 2.01##	32.37 ± 3.11	41.05 ± 1.52	20.48 ± 3.41
Stir-fried twisted cluster bean with shrimp	125.12 ± 7.49	94.50 ± 12.06##	113.81 ± 1.61##	105.78 ± 15.31##
Fast food				
awaiian pizza	49.23 ± 1.35	3.30 ± 0.88	18.03 ± 3.64	5.13 ± 0.44
Pork burger	45.20 ± 3.05	UD	11.65 ± 3.07	1.97 ± 0.60$
Super deluxe pizza	35.90 ± 4.33$	7.42 ± 4.54	19.67 ± 5.21	4.31 ± 0.62
Beverages				
Americano	222.85 ± 29.04	219.10 ± 25.73	57.97 ± 2.60	59.29 ± 8.75
Bubble milk tea	64.53 ± 1.50$$	UD	11.34 ± 2.63$$	6.03 ± 0.98$$
Chrysanthemum juice	7.11 ± 1.0$$	6.53 ± 0.38$$	1.74 ± 0.35$$	3.53 ± 0.13$$
Lemon tea	146.56 ± 18.55$$	147.47 ± 23.12	33.75 ± 2.03$$	22.26 ± 0.48$$
Matcha milk tea	167.35 ± 3.63	75.03 ± 7.52$$	46.30 ± 3.50$$	54.64 ± 5.24
Thai tea	146.34 ± 36.05$$	62.74 ± 67.28$$	31.08 ± 5.74$$	39.12 ± 3.54$$

UD: undetectable.

*$P < 0.05$ vs. stir-fried pork with Thai basil, **$P < 0.05$ vs. pork snack with Northern Thai style green chili sauce, #$P < 0.05$ vs. steamed fish with Thai spicy sauce, ##$P < 0.05$ vs. Southern Thai style fermented fish innards curry, $$P < 0.05$ vs. Hawaiian pizza, and $$$P < 0.05$ vs. Americano.

coffee had the highest antioxidant content compared with other beverages. The highest antioxidant content in the Northern food was found in Pork snack with Northern Thai style green chili sauce while the highest antioxidative Northeastern food was Steamed fish with Thai spicy sauce. As for Central food, the highest antioxidative dish was Stir-fried pork with Thai basil. Fast foods including pizza and burger had relatively low or moderate antioxidant contents. The infographic of antioxidant contents in foods measured in this study is shown in Figure 3. Our current data could help people decide to choose diets to consume according to their antioxidant contents. Although we did not have an experimental proof in this study, we suggested that consumption of RTE foods with high antioxidant contents would be more beneficial than intake of foods with low antioxidant contents for preventing development of oxidative stress-mediated chronic diseases. Based on our present findings, the highly antioxidative foods of choices included Southern Thai style fermented fish innards curry, Stir-fried pork with Thai basil Stir-fried twisted cluster bean with shrimp, Stir-fried Melinjo leaves with eggs (rich in polyphenols), Steamed fish with Thai spicy sauce, Smoked dry fish with cassia leaves curry, and Pork snack with Northern Thai style green chili sauce. As for beverages, black coffee (without sugar), matcha green tea, lemon (lime) tea, and Thai tea were recommended to consume, but bubble milk tea and chrysanthemum juice were not. We also suggested that beverages with highly sweet taste should be avoided or seldom taken even though they contain high antioxidant contents, for instance, Thai tea (containing high amount of sweetened condensed milk). Likewise, highly antioxidative recipes with salty taste were also recommended to avoid.

Figure 3. Infographic depicts the levels of TAC (measured by ABTS assay) and TPC in RTE food items determined in this study, ordered by the TAC levels.

Unexpectedly, high antioxidant content was found in the high-meat diet, Stir-fried pork with Thai basil. Also, Pork snack with Northern Thai style green chili sauce had high antioxidant content. These two recipes contained high amount of chili (*Capsicum spp.*). Chili is known as a significant source of natural antioxidants and polyphenols.[32] Therefore, we thought that the high antioxidative properties of Stir-fried pork with Thai basil and Pork snack with Northern Thai style green chili sauce would be attributed by chili. Furthermore, Stir-fried pork with Thai holy basil also contained *Ocimum tenuiflorum* L. or *Ocimum sanctum* L. (Kra Pao or holy basil), and that holy basil could also be another significant source of antioxidants.[33]

The Southern dish, Stir-fried Melinjo leaves with eggs, had high content of polyphenols. The main ingredient in this dish was the leaves of *Gnetum gnemon* (melinjo or baegu or Spanish joint fir). High contents of polyphenols, beta-carotene, lutein, and ascorbic acid in *Gnetum gnemon* young leaves was reported.[10] After cooking, the phenolic content in Stir-fried Melinjo leaves with eggs was still high, therefore, we considered this recipe as one of the high-antioxidant healthy diets. The other Southern recipes that had high antioxidant contents were Southern Thai style fermented fish innards curry and Stir-fried twisted cluster bean with shrimp. Southern Thai style fermented fish innards curry contained many vegetables such as eggplants, bamboo shoots, and pumpkins, and plausibly these vegetables were responsible for the high antioxidative action of Spicy fish offal soup. In Stir-fried twisted cluster bean with shrimp, the main ingredient was *Parkia speciosa* (twisted cluster bean or stink bean or bitter bean). Although the bean of *Parkia speciosa* has bad smell, it contains remarkably high amounts of polyphenols and total antioxidants.[34, 35] Additionally, its medical benefits such as anti-inflammatory and heart disease prevention have been demonstrated.[36, 37]

Smoked dry fish with cassia leaves curry, a Northeastern recipe, also had a considerable high content of antioxidants, and its antioxidative property was likely derived from *Senna siamea* (Lam.) H.S. Irwin & Barneby (Siamese cassia).[38] Americano black coffee had a remarkable high content of antioxidants compared with other tested beverages. There are several studies showings the medical benefits of caffeine. For examples, Nakayama T, *et al*. demonstrated that coffee inhibited cell proliferation and induced apoptosis of colorectal cancer cells both *in vitro* and *in vivo*.[39] In cervical cancer, caffeic acid was shown to inhibit tumor progression through its pro-oxidant property.[40, 41]

Limitation of this study should be mentioned, however. Only the antioxidant capacity and phenolic contents were determined in this study. Oxidative stress attenuation in cell culture model to confirm the antioxidative biological function of each of cooked food item was not investigated. All food samples were purchased from the local markets in Bangkok. They might not be the best representatives of the original genuine recipes of the North, the Northeast, and the South of Thailand.

Conclusions

Our present study demonstrated that the Southern foods, especially Southern Thai style fermented fish innards curry, Stir-fried twisted cluster bean with shrimp, and Stir-fried Melinjo leaves with eggs had the highest antioxidant contents compared with recipes from other regions of Thailand. Americano coffee had the highest antioxidant content compared with other beverages. Consumption of these highly antioxidative diets was recommended. It might provide the health benefit to prevent or reduce the risk of development of chronic diseases related to oxidative stress.

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Conflict of interest

The authors, hereby, declare no conflict of interest.

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