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Drying temperature of corn silk tea: physical properties, total phenolic content, antioxidant activity and flavonoid content

Numphon Thaiwong[1,*] and Utumporn Chaiwong[2]

Abstract

Corn silk (*Stigma maydis*) has been used in traditional herbal medicine that it has been reported to be potentially antioxidant and healthcare applications. Corn silk may be used as fresh, however is commonly dried before being consumed as a tea or extract. Corn silk tea is produced by basic technology as drying process in terms of commercial product. Then, this research interested the suitable temperature for drying process of corn silk tea at 40, 50 and 60°C. The physical properties of corn silk tea including moisture content, water activity and color values were determined. The moisture content of dried corn silk at 40°C was significantly different from 50 and 60°C. The water activity of dried corn silk showed significantly different at all temperatures. Corn silk tea was studied the antioxidant activity (DPPH method), total phenolic content and flavonoids content in different solutions such as 95°C water, 50 %EtOH and 80 %EtOH. The result showed that the drying temperature and solution affected the total phenolic content. Dried corn silk at 40°C in 95°C water had the highest total phenolic content. Nevertheless, corn silk tea at different drying temperatures with 80% EtOH showed lower antioxidant activity, which was approximately 52.9 ± 0.8 to 61.4 ± 2.7 μg GAE/mL of free radical scavenging. Flavonoid content of corn silk tea at 50°C drying temperature with 95°C water showed the highest content, which was approximately 517.54 ± 10.21 mg CE/mL sample ($P<0.05$). Therefore, these results could be applied as a guide in the corn silk tea production for improving product quality.

Keywords: Corn silk tea, antioxidant activity, phenolic content, flavonoid content

[1]*Faculty of Sciences and Liberal of Arts, Rajamangala University of Technology Isan, Nakhon Ratchasima 30000, Thailand*

[2]*National Corn and Sorghum Research Center, Faculty of Agriculture, Kasetsart University, Nakhon Ratchasima 30320, Thailand*

**Corresponding author. E-mail: nthaiwong@hotmail.com*

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1. Introduction

Corn silk (*Stigma maydis*) is an imperative herb used as traditional medicine in many parts of the world such as Chinese, Turkey, United States and France. It has been claimed in many reports as the potential antioxidant and healthcare applications (Khairunnisa *et al*., 2012; Kulapichitr *et al.,* 2015; Zilic *et al*., 2016). In addition, it has been used as an ingredient of tea for the treatment of various diseases (Nawaz *et al.,* 2019). Corn silk contains a number of bioactive phytochemical compounds including phenolic compounds, flavonoids, flavone glycosides, anthocyanins, carotenoids and etc. (Senphan *et al.,* 2019). Especially, flavonoids possess strong antioxidant activity, free radical−scavenging capacity and inhibits protein glycation (Nawaz *et al.*, 2018). In tea processing, drying is a vital part of production that affects its antioxidant content and appearance which causes the commercial value of the tea (Chong *et al.,* 2012). Moreover, the antioxidant properties of corn silk tea could be affected by solvent types and boiling temperatures (Kilic *et al*., 2017) .The use of different extracting solvents for corn silk resulted the difference of bioactive phytochemical component (Nawaz *et al*., 2018). Thus, the present research aimed to study the suitable drying temperature for corn silk tea processing and to determine total phenolic content, antioxidant activity and flavonoid content in different solution as 95°C water, 50 %EtOH and 80 %EtOH .The study provides valuable data regarding the appropriate temperature for drying process of tea corn silk for achieving high antioxidant properties in terms of consumer and/or commercial development.

2. Materials and Methods

2.1 Sample preparation

Fresh corn silk from National Corn and Sorghum Research Center, Faculty of Agriculture, Kasetsart University was cut off from maize harvesting which had usually completely matured in 50 days. It was dried at 40, 50 and 60°C by hot air oven (Memmert, incubator, 749 liters, IF750, Germany) that controlled the moisture content between 9-15% as tea. Each sample of corn silk tea was prepared in different solutions as 95°C water, 50 %EtOH and 80 %EtOH (5 g of corn silk tea in 40 mL of each solution) by soaking in each solution for 15 min. The mixed corn silk tea and solution were filtrated by Whatman filter paper No.4. The supernatant was then determined as the total phenolic content, antioxidant activity and flavonoid content.

2.2 Moisture content and water activity analysis

Moisture content of corn silk tea was determined by Moisture Analyzer (SARTORIUS, MA−30). Water activity of corn silk tea was analyzed by Water Activity Meter (AQUA LAB, 4TE).

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2.3 Color measurement

Moisture content of corn silk tea was determined by Color meter (Hunter Lab, Ultra scan Vis).

2.4 Total phenolic content determination

Folin−Ciocalteu colorimetric method and gallic acid (a standard) were used to determine the total phenolic content of corn silk tea sample as follows Liu *et al*. (2011) and Jirarattanarangsri and Budprom (2017). The corn silk tea sample about 2.5 mL or Gallic acid (standard solution) about 2.7 mL was mixed with 200 μL Folin–Ciocalteu's phenol reagent. The mixture was kept in the dark at room temperature for 5 min and added 2 mL of 7% of Na_2CO_3 for stopping reaction. The mixture was incubated in the dark at room temperature for 90 min and measured the absorbance of the final solution with a spectrophotometer at 760 nm.

2.5 Flavonoid content determination

The corn silk tea was measured by the flavonoid content with the modifying method from Maneechai and Rintong (2016) which catechin was used as a standard. The corn silk tea sample of 1.5 mL was mixed with 2.8 mL of DI water. The mixed sample solution was added with 100 μL of 10% w/v of aluminum chloride in methanol and n 100 μL of 1M Potassium acetate buffer. The mixture was kept for 10 min at room temperature and final solution was measured with a spectrophotometer at 415 nm.

2.4 Antioxidant activity (DPPH assay)

The antioxidant activity of the sample was analyzed by using DPPH assay which was modified from Sarepoua *et al.* (2013) and Pratumthes *et al.* (2019). The corn silk tea sample in each solution was determined by DPPH (2,2−diphenyl−1−picryl−hydrazyl−hydrate) free radical method. The corn silk tea sample about 1 mL was added to 3 mL of freshly prepared DPPH solution (0.2 mM DPPH in 90 %EtOH). The mixtures were immediately shaken and kept in the dark at room temperature for 30 min. The absorbance of the final solution with a spectrophotometer was analyzed at 516 nm by a spectrophotometer (UV−Vis 160A).

3. Results and Discussion

3.1 Physical properties of corn silk tea

The study of drying temperature for corn silk tea showed the moisture content, the water activity and the color value in different temperatures (Table 1). The drying temperature of corn silk tea at 40°C was the highest value ($P<0.05$). The moisture content of corn silk tea at 50 and 60°C drying temperature showed non-significant differences in the range of 9.53 ± 0.14% to 9.75 ± 0.48%.

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The water activity of corn silk tea samples ranged from 0.45 ± 0.01 to 0.51 ± 0.01. The corn silk tea at 40°C had the highest value, and samples at 50 and 60°C were not significantly different. In general, the low level of water activity at less than 0.60 is not an issue of microbial stability. The use of higher temperature for drying can lead the lower of the moisture content and the water activity. Some research reported that black tea samples had the water content in the range of 6.88 ± 0.03% to 7.12 ± 0.06% (Dmowski and Ruszkowska., 2018). Moreover, tea samples from different countries such as China, Sri Lanka, India and Indonesia were reported. The water contents were 6.623 ± 0.0010% to 8.496 ± 0.0016%, and water activity were 0.370 ± 0.0059 to 0.502 ± 0.0120 (Dmowski and Ruszkowska, 2016). The water activity of Turkish green tea power was in the range of 0.31 ± 0.01 to 0.35 ± 0.02 (Topuz *et al*., 2014). The spray-dried green tea powder was the water activity in range of 0.21 ± 0.07 to 0.29 ± 0.03 (Susantikarn *et al*., 2016). The color value of corn silk tea in different temperature was significant different in *a** and *b** values (P<0.05). The *L** value of corn silk tea with drying temperature at 50 and 60°C was non-significant differences (P≥0.05). The corn silk tea with drying temperature at 40°C was the lowest lightness than corn silk tea with drying temperature at 50 and 60°C (P<0.05). The use of high temperature for Black Tea (*Camellia sinensis* L.) drying led to a loss of brightness (Teshome *et al*., 2013).

Table 1 Physical properties of corn silk tea

Temperature (°C)	Moisture content (%)	Water activity	Color		
			*L**	*a**	*b**
40	14.46 ± 0.72[a]	0.51 ± 0.01[a]	43.65 ± 1.53[b]	8.56 ± 0.46[a]	11.68 ± 1.39[b]
50	9.75 ± 0.48[b]	0.47 ± 0.01[b]	48.78 ± 0.82[a]	7.54 ± 0.89[b]	17.13 ± 0.30[a]
60	9.53 ± 0.14[b]	0.45 ± 0.01[b]	48.65 ± 1.68[a]	5.48 ± 0.14[c]	3.98 ± 0.18[c]

Note: Mean with different letter in the same column (a, b, c, d) are significant different at (P<0.05).

3.2 Total phenolic content

The study of drying temperature for corn silk tea showed the total phenolic content (Fig 1). The drying temperature of corn silk tea at 40°C was the highest values of total phenolic content in all solutions about 39.51 ± 1.89 μg GAE/mL of sample (P<0.05). These results showed the use of 95°C water for phenolic extraction was better than ethanol (50 %EtOH and 80 %EtOH). The polyphenol content of some selected organic and aqueous extracts of corn silk was about 101.99 mg GAE/g by the methanol extract, 93.43 mg GAE/g by ethanol extract,

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35.34 mg GAE/g by water extract and 6.70 mg GAE/g by ethyl acetate extract (Nurhanan *et al*., 2012). The use of 100°C water to brew the herbal tea gave the higher total phenolic content that brewed senna tea with 100°C water showed the phenolic compounds about 4.872 ± 0.005 mg GAE/g (Kilic *et al.*, 2017). Some research reported the use of hot water for corn silk extracting that the total phenolic compounds approximately 68.61 mg GAE/g dw (Cabrera *et al*., 2015). However, dried corn silks showed total phenolic contents in the range of 80.8 to 117.1 µg GAE/g (Sarepoua *et al*., 2013). The purple cob at eating–stage contained about 939.98–1112.86 mg GAE/100g DM of total phenolic content (Saikaew *et al.*, 2018). The difference of total phenolic contents might cause the extraction method as sample preparing, solution and/or method. Normally, plenty of compounds in phenol compound are an aromatic group with one or more hydroxyl groups. The hydroxyl group caused polar phenol compounds to be polar property, which would be dissolved in polar solvents (Haslina and Murtiari, 2017). Therefore, the order of highest polarity could be recommended for the solvent such as water, methanol, and ethanol, respectively.

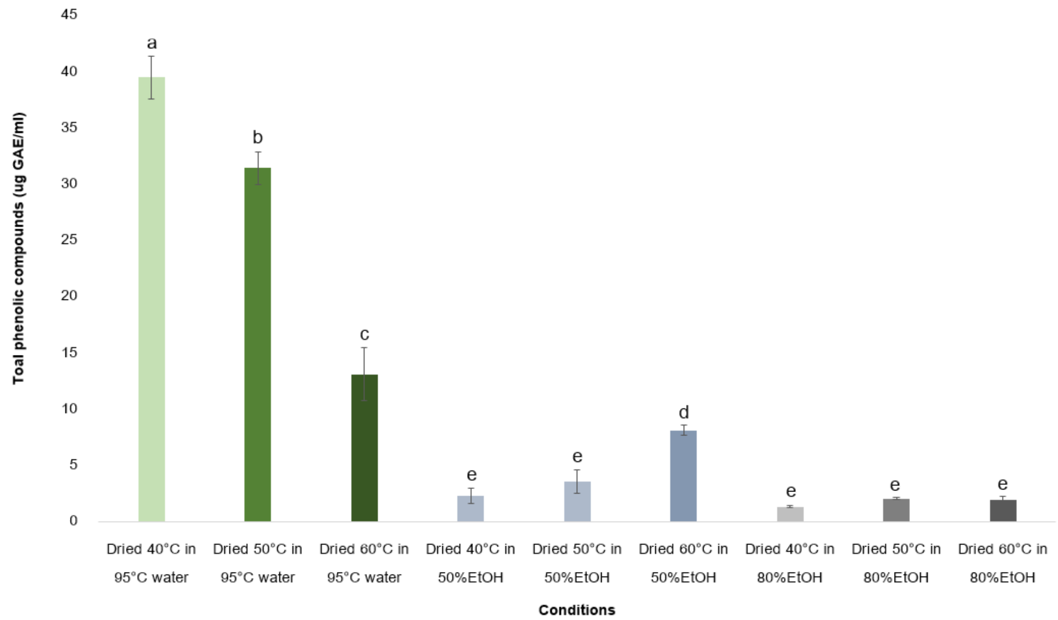

Fig 1 The phenolic content of corn silk tea samples in different solutions

3.3 Total flavonoids

The study of drying temperature for corn silk tea showed the flavonoid content (Fig 2). The use of 95°C of water to dilute the corn silk tea with 50°C drying temperature was the highest value of flavonoid content approximately 517.54 ± 10.21 mg CE/mL ($P<0.05$). The use of water as soluble dilution showed higher of total flavonoids values than the other. Flavonoid contents of *S. tomentosa* ranged between 36.27 and 40.83 mg CE/g dw (Dincer *et al*., 2013).

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Moreover, corn silk extraction by ethanol solvent (absolute ethanol with a ratio of 1:4) ranged between 14.66 ± 2.37 to 26.63 ± 3.09 mg CE/g extract (Ho *et al*., 2016). In addition, the total flavonoid of some herb extracts with methanol such as rosemary and green tea showed in the range of 23.7 and 225 mg CE/g of extract (Tsai *et al*., 2008). Generally, flavonoid contents are quite low especially in low temperatures and the type of solvent affects the total flavonoid. Then, the use of temperature less than at 80°C was not sufficient degrees to achieve the full benefits from the herbal plants (Kilic *et al*., 2017). However, the heat treatment of onion at 120°C resulted the highest value of total flavonoids in contrast with the total phenolics (Sharma *et al*., 2015). The increasing of flavonoid contents affects the change in whose formation, resulting in the heating or boiling of monomer formation via the hydrolysis of C−glycosides bonds (Manach *et al*., 2004; Sharma *et al*., 2015).

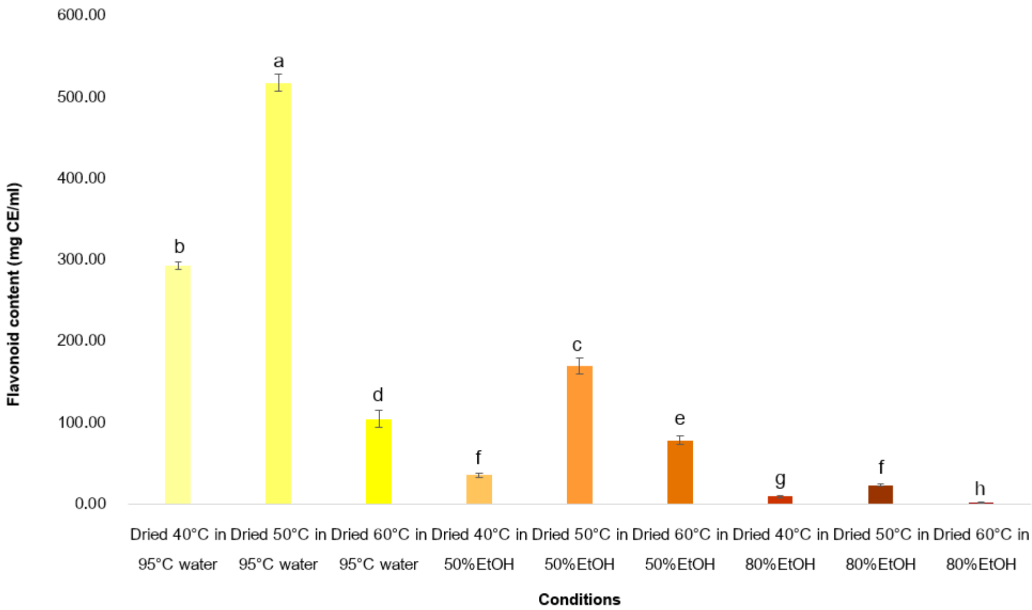

Fig 2 Flavonoid content of corn silk tea samples in different solutions

3.4 The antioxidant activity

The study of drying temperature for corn silk tea showed the antioxidant activity (Fig 3). This research resulted the drying temperature were not affected to the antioxidant activity excepting 80 %EtOH. In generally, the DPPH has higher solubility in less polar solvents. In this study, the effectiveness of solution for antioxidant activity was 80 %EtOH. In the other hand, the use of temperature at 55°C for drying mints leaves and basil leave was better than at 50°C. (Nhu Hao *et al*., 2018). Then, the use of 95°C water and 50 %EtOH to dilute the corn silk tea was the highest antioxidant in all dilution solutions in the ranged of 74.92 ± 0.13 to 78.35 ± 0.03 µg GAE/mL ($P<0.05$). Conversely, the extraction of Lebanese *Eryngium creticum*

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with 80% ethanol showed the highest antioxidant activity about 89.92% when compared with 40 %EtOH and 100 %EtOH (Hijazi *et al*., 2015). The other research reported that the antioxidant activity (DPPH assay) of black, green and yellow tea leaves was reported about 11.930 ± 0.434 to 12.241 ± 0.346, 13.109 ± 0.125 to 16.040 ± 0.503 and 16.846 ± 0.046 to 18.825 ± 0.094 μmoL/100 g, respectively (Kopjar *et al*., 2015). The antioxidant activity of corn silk tea showed the higher value than other teas because of flavonoids content. The effectiveness of antioxidant activity depends on a number of OH−groups and their position that OH−groups on 3′−, 4′−, 5′− position of B−ring of flavonoids increase the antioxidant activity of the compounds (Rice−Evans *et al*., 1995; Heim *et al*., 2002). In view of antioxidant activity, of which relates to the phenol compounds. The applicable activity is influenced by configuration and total group hydroxyl of phenol compounds (Haslina *et al*., 2019).

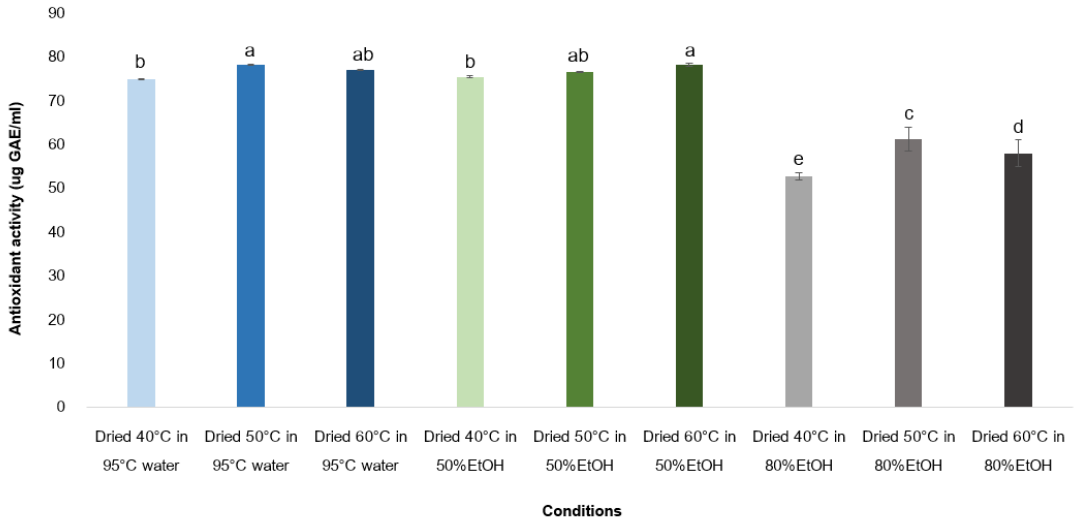

Fig 3 The antioxidant activity of corn silk tea samples in different solutions

4. Conclusion

The appropriate temperature for drying corn silk tea was at 50°C which temperature could give the effectiveness of corn silk tea properties. This corn silk tea was brewed at 95°C of hot water that showed the highest of total phenolic content, antioxidant activity and flavonoid content. The result showed that the consumption of corn silk tea is the good choice for people who wanted to get the good healthy.

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National Corn and Sorghum Research Center, Faculty of Agriculture, Kasetsart University, Nakhon Ratchasima 30320, Thailand.

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