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FACTORS INFLUENCING THE QUALITY OF ORANGE PEEL TEA

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Abstract – *The aim of this study was to develop the technological process of making herbal tea bags from orange peels. In order to achieve this purpose, the effects of blanching, drying conditions, and mixing ratio of orange peels, green tea, and stevia were examined. The results showed that orange peel blanched in hot water at 80°C for 6 minutes helps to retain the green color and has high sensory value. Upon being dried at 70°C for 210 minutes, the total polyphenol content is 420.69 mg GAE/g dry weight with a final moisture content of 9%. With the mixing ratio of 70% orange peel, 25% green tea, and 5% stevia, the product has the highest sensory value, specifically color (3.84), flavors (4.07), tastes (3.61), and sweetness (3.92) and with total polyphenols of 516.51 mg GAE/g dry matter and antioxidant activity of 119.18%.*

Keywords: antioxidant activity, herbal tea, orange peels, total polyphenol content.

I. INTRODUCTION

King orange originated in Vietnam and belongs to the family of citrus hybrids with many different scientific names, such as *Citrus nobilis*, *Citrus reticulata*, or *Citrus sinensis*. Vietnam annually produces and consumes millions of tons of orange juice products and orange juice. However, large quantities of orange peels are underused and wasted around factories, leading to losses in potential financial profit. Orange peels contain a rich source of fiber, vitamins, and flavonoids that offer health benefits. In addition, orange peels also have I-stachydrin, hesperdin, surantin, and aurantinic acid, which help to reduce cholesterol levels, blood pressure, and the risk of heart disease. The amount of essential oil D-limonene in orange peels is considerably high, around 90%, which also produces a pleasant aroma [1]. Although orange peels bring health benefits due to having nutritional value and high antioxidant content [2], there is a lack of studies conducted on products made from orange peels. As a consequence, the potential use of orange peels has not gained much attention. For this reason, it is crucial to research a technological process for producing orange peel tea that can offer health benefits and be used as a functional food for people with diabetes, high blood pressure and obesity. It is hoped that with this new research direction, the market of tea bag products will be promoted.

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II. LITERATURE REVIEW

Orange peels contain a lot of pectin, flavonoids, and essential oils, and are rich in substances such as copper, calcium, fiber, vitamin A, vitamin B6, and especially vitamin C, which accounts for 136 mg/100 g and is much higher than that of the orange pulp [2]. Orange peels are a valuable medicinal herb, used in Vietnamese traditional medicine to improve the digestive system due to their high quantity of fiber. Moreover, vitamin C in orange peels helps reduce inflammation and colds, and flavonoids are good for cardiovascular functions [1, 2]. Currently, there have been many studies on tea bags such as asparagus, moringa, spring flowers, hibiscus flowers, centella asiatica, noni fruit, guava leaves, and pomelo peels; these have several typical uses such as clearing heat, detoxifying the body, supporting the digestive process, supporting heart health, and reducing stress. According to Tran Thanh Truc et al. [3], Nam Roi pomelo peels blanched in hot water at 100°C for 60 seconds maintain the green color and preheated at 60°C to 8% final moisture content helps maintain the color and quality.

Similarly, the appropriate blanching time and temperature for asparagus are 90°C and 5 minutes with a drying temperature is 55^{o}C for 7 hours, and when mixed with 15% stevia, asparagus tea will get the highest sensory score of 17.44 points [4]. In a recent study, tea from mangrove apples retained the highest quality and number of antioxidant substances when dried at a temperature of 70^{o}C for 210 minutes. The mixing ratio of 65% mangrove apples and 10% pandan leaves gives a high sensory value, with total polyphenol content of 270.52 mg GAE/100 g dry matter), and antioxidant activity of IC50 67.59 μg/mL [5]. Another study was carried out by Nguyen Kim Phung et al. [6] on wood-apple tea, finding that under a drying temperature of 55^{o}C for 7 hours with a mixing ratio of the flesh and green tea (9:1), the resulting product has a high sensory value with a total polyphenol content of 30.87 mg GAE/100 g dry matter), and antioxidant activity of 20.66%. The results of the taste preferences are considerably high, with an overall rating of 5.8 points out of 7.

In this study, the authors examined the effects of blanching temperature and blanching time, drying temperature and time, and mixing ratio of ingredients on the quality of orange peel tea, resulting in an appropriate process that retains nutritional values and maintains the original health benefits that orange peels offer.

III. METHODOLOGY

A. Ingredients, chemicals, and equipment

Ingredients: The Vietnamese King orange peels were purchased from the Milano cafeteria in Tra Vinh Province. After that, they were washed several times with clean water until drained and then thinly sliced (2–3 mm thickness), with a length of 2–3 cm, and a width of 0.5 cm.

Chemicals: Folin – Ciocalteu reagent (Novozyme, Denmark), DPPH (Sigma - Aldrich, USA), methanol (Merck, Germany), ethanol (Merck, Germany), acid galic (Merck, Germany), and Na_2CO_3 (Merck, Germany).

Equipment: hot air oven, 4-digit analytical balance, UV-VIS spectrophotometer (Genesys 6. Thermo spectroic USA), Vortex, and portable colorimeter.

B. Research methods

Factors affecting the quality of orange peel tea were tested through the following experiments:

Experiment 1: Investigation of orange peel blanching on orange peel quality

The experiment consisted of 2 factors: the blanching temperature at 3 levels, 70^{o}C, 80^{o}C, 90^{o}C, and blanching time at 3 levels, 2 minutes, 4 minutes, and 6 minutes. Raw orange peels were washed, cut into pieces of about 2 cm, washed with salt water, and washed several times with clean water. The resulting orange peel was separated into 100-gram samples, which were then blanched with hot water at the same temperature and time as above. Monitoring indicators: sensory evaluation of the colors and bitter taste of orange peels.

Experiment 2: Investigation of the drying conditions on orange peel quality

Samples were tested at different drying temperatures, 55°C, 60°C, 65°C, 70°C and 75°C, and dried until the moisture content was below 10%. The resulting orange peel was separated into 100-gram samples, which were sliced and dried in a convection dryer. Monitoring indicators: humidity changes every 30 minutes, total phenol content, antioxidant activity DPPH.

Experiment 3: Investigation of the mixing ratio of ingredients on orange peel tea's quality

The different mixing ratios of three ingredients were tested, including orange peels, green tea, and stevia. Monitoring indicators: sensory evaluation, analysis of moisture content, total polyphenols, and antioxidant activity DPPH of the samples.

C. Analysis methods

- Moisture: moisture was determined by the drying method, in which the weight was perceived at a constant level (based on Vietnam Standard No 4415:1987) [7].

- Sensory evaluation: Sensory evaluation was evaluated based on taste preferences. The sensory evaluation committee consists of 60 members with expertise in food quality assessment [8].

- The content of phenolic compounds was determined using the Folin – Ciocalteu method, the gallic acid standard curve was developed,

Table 1: The ratio formula of orange peels and auxiliary ingredients

Ratio	Orange peels	Green Tea	Stevia
1	60%	40%	0%
2	60%	35%	5%
3	60%	30%	10%
4	65%	35%	0%
5	65%	30%	5%
6	65%	25%	10%
7	70%	30%	0%
8	70%	25%	5%
9	70%	20%	10%

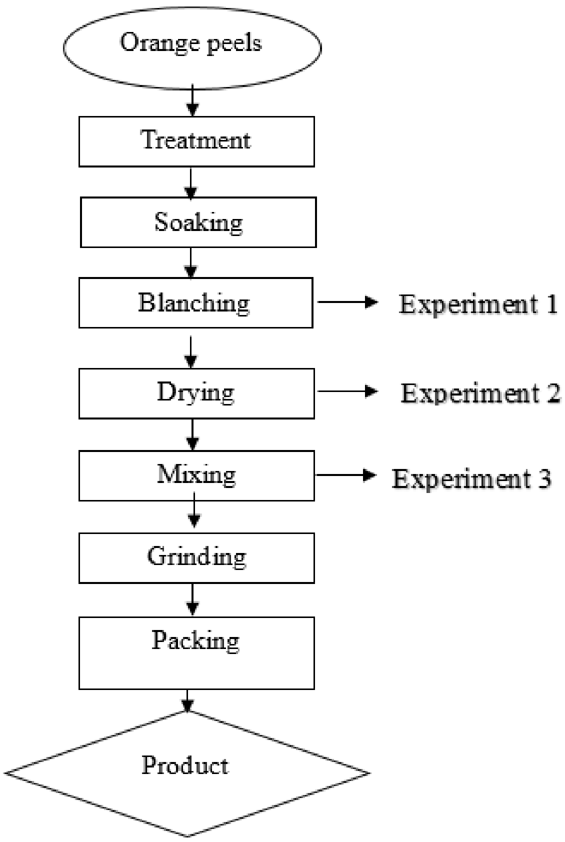

Fig. 1: Process of producing orange peel tea

and TPC content was determined based on the standard curve [9].

- Antioxidant activity analysis was based on DPPH (2.2–Diphenyl–1–icrylhydrazy), measuring the capacity to neutralize DPPH free radicals. 25 mg aliquots of the dry extracted samples were each dissolved in 10 ml of methanol. 3.0 ml of DPPH solution in methanol (6x10-3 mM) was then mixed with 38 ml of the extract solution. The samples were kept in the dark for 15 minutes at room temperature before measuring absorbance [10].

D. Data analysis

Experimental results were replicated three times and statistically processed using JMP 9.0.2 (SAS Institute Inc., 2011; USA) and Microsoft Excel 2007 (Microsoft Corp., 2007; USA). The data show the mean of 3 replicates within the significance value ($p < 5\%$).

IV. RESULTS AND DISCUSSION

A. Basic physicochemical composition of ingredients

The process of making tea from Vietnamese King orange peel is influenced by many factors such as ingredients and technology. Initial factors such as moisture content, total phenolic content, and antioxidant capacity play an important role, directly affecting the quality of the product. Some ingredients of the peel were therefore analyzed at a preparation step for further experiments.

Table 2: Some ingredients of raw orange peel

Parameters	Quantity
Moisture (%)	77.6 ± 0.03
Total phenolic content (mg GAE/g dry matter)	1399.43 ± 2.92
Scavenging activity (%)	168.19 ± 3.64

In addition to the basic chemical components in orange peels, previous studies also indicated that green tea contains phenolic compounds which include flavanols, flavonols, other flavonoids, and phenolic acids. Specifically, the antioxidant activity DPPH is 794.295 (μmol TEAC/g dry matter) and the total polyphenol content is 1549.898 (mg GAE/g dry matter) [11].

Besides, stevia was also an ingredient that contains an important component, stevioside, which is a kind of glucoside that is 250 – 300 times sweeter than saccharose. Stevioside is a sweetener that does not produce energy, does not increase weight and is especially good for those who abstain from sugar [12].

B. Effects of the blanching process on product quality

Effects of the blanching process on sensory value of treated peel

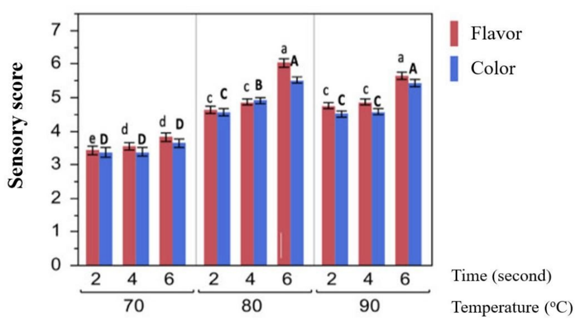

Fig. 2: Effects of blanching temperature and time on sensory value

Note: Different letters represent the differences in treatments at the significance level $p < 0.05$

Hot water blanching is a technique that has been widely applied to pretreat agricultural products in order to increase the drying speed. At the same time, blanching is employed to reduce the bitter taste of orange peels and increase the sensory value of the product. Other compositions such as pectin, vitamin C, total polyphenols, and antioxidant activity DPPH in ingredients will change when the blanching time is modified. The results of the sensory analysis showed that there was a significant difference in the preferences for color and taste of the samples under various conditions of temperature and blanching time. When samples were blanched at 80^{o}C for 6 minutes, the sensory values of color and taste were 5.51 and 6.03, respectively. Moreover, when samples were blanched at 90^{o}C for 6 minutes, sensory values of color and taste were 5.43 and 5.65, respectively. Furthermore, when samples were blanched at 70^{o}C for 6 minutes, rating sensory values of color and taste were lower at 3.83 and 3.65, respectively. When blanched at 70^{o}C, samples had a strong bitter taste. With a temperature of 80^{o}C for 6 minutes, the green color of the orange peels was still maintained, which is a typical color of Vietnamese King orange. This can be due to the fact that when orange peels are blanched, the polyphenol oxidase enzymes are inactivated, a portion of the microorganisms is destroyed, and the chlorophyll pigment is retained after drying. But if the blanching time and temperature are increased, it leads to the loss of dissolved substances into the blanching water, and the acid in the vacuole will leak. The product quality is improved by changing the specific physical properties of the samples such as the permeability of the cell membrane, analyzing wax, and forming small surface cracks of the product. As a consequence, this will affect the chlorophyll pigment [13].

C. Effects of drying temperature on peel quality

Effects of drying temperature on moisture change over time

The survey results showed that there was an inverse correlation between the temperature and the drying time of the products in the range. Higher drying temperatures resulted in faster drying speeds and shorter drying times. In this experiment, the drying temperature was at 55^{o}C, 60^{o}C, 65^{o}C, 70^{o}C, and 75^{o}C. Figure 3 shows that the drying curve of the sample increased with a growth of temperature, and the drying curve was at its smallest at 55^{o}C and its largest at 75^{o}C.

When a drying experiment was conducted at a lower temperature, the moisture content in the ingredients decreased slowly. The reason is that the difference in pressure on the surface of the ingredients and the partial pressure in the air is small. Consequently, the drying time was longer. Therefore, when drying at 55^{o}C, the longest drying time was 450 minutes. On the contrary, when the drying temperature increased, the drying speed also rose. It can be explained that when the ingredients are heated, the process of diffusion of moisture to the outside increases. As a result, when drying at 75^{o}C, the drying time is only about 180 minutes to get the demanded moisture.

It can be concluded that temperature is a factor affecting the drying process and thus affects the quality of the product. When the drying temperature is high, the process of diffusion of moisture to the outside is fast. However, it will form a hard layer on the surface to prevent the water from leaking into the outside environment. If the drying temperature is too low, the slow drying speed will allow conditions for microorganisms to develop, therefore, affecting the quality.

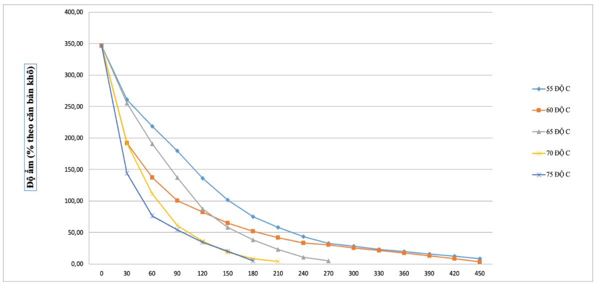

Fig. 3: Drying curves at different temperatures

Effects of drying temperature on total polyphenol content of treated peel

The total polyphenol content of Vietnamese King orange peels is different at different drying temperatures ($p < 0.05\%$). Figure 4 shows the highest total polyphenol content recorded in samples dried at 70^{o}C was 487.14 mg GAE/g dry matter. When the drying temperature was increased from 55^{o}C to 70^{o}C, total polyphenol content also rose from 378.91 mg GAE/g dry matter to 487.14 mg GAE/g dry matter. On the contrary, total polyphenol content decreased to 468.13 mg GAE/g dry matter if the drying temperature was down to 75^{o}C. This phenomenon is similar to the result of Hien et al.'s study that when drying mangrove apples at 70^{o}C, the total polyphenol content was 275.52 mg GAE/g dry matter) [5]. Similarly, when wood apples were dried at 70^{o}C for 150 minutes, the total polyphenol content was 30.87 mg GAE/100g dry matter [6]. According to Abhay et al., thermal decomposition plays a crucial role in polyphenol degradation when dried at a higher temperature, from 75^{o}C to 90^{o}C; at a temperature of 70^{o}C, most of the enzymes are decomposed during the drying process [14].

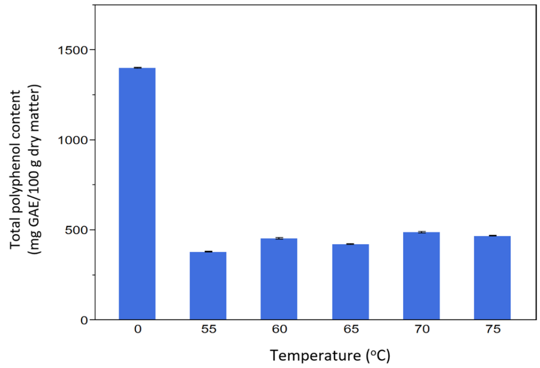

Fig. 4: Effects of drying temperature on total polyphenol content

Effects of drying temperature on DPPH free radical quenching capacity of treated peel

The results from Figure 5 show that there were significant differences in DPPH antioxidant activity at different temperatures. It is reported that samples dried at 70^{o}C had the highest antioxidant activity with an inhibition percentage of 119.18%; followed by 203.19% and 317.44% at 55^{o}C, and 60^{o}C, respectively. Moreover, samples had the lowest antioxidant activity with an inhibition percentage of 377.9% at 75^{o}C.

From the above outcomes, DPPH antioxidant activity mainly depends on temperature. When the drying temperature is too low or too high, it reduces the capacity of orange peels to quench DPPH free radicals. It was demonstrated that low drying temperature will prolong drying time, so the contact time between ingredients and the air lasts longer. This promotes oxidizing the substances in the orange peels. On the other hand, at high drying temperatures, the compounds with antioxidant capacity are decomposed, thus reducing their antioxidant capacity. This is in line with the research on dried Black Fungus (Auricularia Auricula-Judae), where 70^{o}C is the most preferred temperature, which provides the highest quality and retains the most nutrients [15]. Figure 5 describes the antioxidant activity of the extracts dried at different temperatures with the capacity to quench DPPH free radicals.

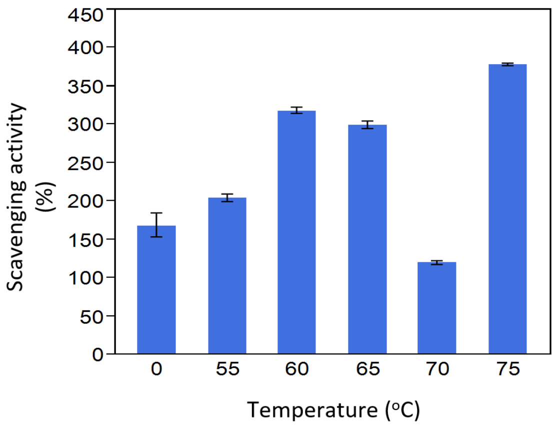

Fig. 5: Effects of drying temperature on DPPH free radical quenching capacity

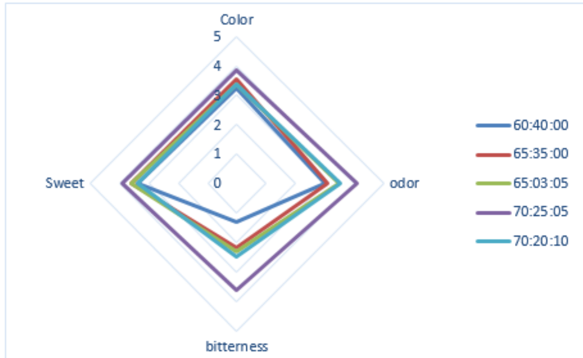

Fig. 6: Effects of mixing ratio on sensory value of orange peel tea

Figure 6 shows the sensory evaluation in terms of color, flavor, taste, and sweetness of orange peels after being mixed with green tea and stevia. It is shown that color, flavor, and taste are strongly affected by the composition of the mixture. Based on the results of sensory evaluation, it is possible to determine the optimal mixing ratio. With the mixing ratio of orange peel: green tea: stevia (70%: 25%: 5%), the highest preference for clarity and color, flavor, taste, and sweetness was 3.84; 4.07; 3.61; 3.92, respectively. On the contrary, with the mixing ratio of orange peel: green tea: stevia (60%: 40%: 0%) the lowest preference for clarity and color, flavor, taste, and sweetness was 3.23; 3.0; 1.3; 3.38, respectively.

With the mixing ratio of 70% orange peels, 25% green tea and 5% stevia, the final product has beautiful and bright color and tasty flavor with the highest preference for all indicators, including clarity, flavor, and taste.

The final tea bag sample, with a composition ratio of 70% orange peels, 25% green tea, and 5% stevia, was analyzed for total polyphenol content and antioxidant activity, yielding values of 516.51 mg GAE/g dry matter and 119.18%, respectively.

V. CONCLUSION

Results from the study showed that with the blanching temperature at 80^{o}C for 6 minutes, drying temperature at 70^{o}C for 210 minutes, and the mixing ratio of 70% orange peel, 25% green tea and 5% stevia achieves the highest sensory values with a total polyphenol content of 516.51 mg GAE/g dry matter, and antioxidant activity with an inhibition percentage of 119.18%. The results contribute to perfecting the technical process of orange peel tea production.

REFERENCES

[1] Shahwar D, Raza MA. Identification of flavonoids with trypsin inhibitory activity extracted from orange peel and green tea leaves. *Journal of Science Food Agricuture*. 2013;93(6): 1420–1426.

[2] Nazir A, Itrat N, Shahid A, Mushtaq Z, Abdulrahman SA, Egbuna, et al. Orange peel as source of nutraceuticals. In: Egbuna C, Sawicka B, Khan J. (.eds) *Food and agricultural byproducts as important source of valuable nutraceuticals*. Cham: Springer International Publishing. 2022; 97–106.

[3] Tran Thanh Truc, Mai Thanh Thai, Mai Diem Trinh, Nguyen Trong Tuan. Research on herbal tea bags processing technology for pomelo peel of Nam Roi cultivar (Citrus grandis (L.) Osbeck). [Nghiên cứu công nghệ chế biến trà túi lọc từ vỏ bưởi Năm Roi (Citrus grandis (L.) Osbeck)]. *Can Tho University Journal of Science [Tạp chí Khoa học Đại học Cần Thơ]*. 2021;57: 10–20.

[4] Nguyen Thi My Trang, Vu Ngoc Boi, Dang Xuan Cuong. Effect of processing factors on the quality of asparagus (Asparagus officinalis L.) tea bag. [Nghiên cứu ảnh hưởng của một số yếu tố công nghệ đến chất lượng của trà túi lọc măng tây]. *Journal of Fisheries Science and Technology [Tạp chí Khoa học Công nghệ – Thuỷ sản]*. 2015;2: 66–71.

[5] Nguyen Thi Hien , Nguyen Kim Phung, Nguyen Thi Hong Tha, Nguyen Hong Phuc. The production process of mangrove tea. [Nghiên cứu quy trình sản xuất trà túi lọc bần]. *Vietnam Journal of Chemistry [Tạp chí Hóa học Việt Nam]*. 2020;58(6E12): 120–125.

[6] Nguyen Kim Phung, Nguyen Thi Hien, Pham Bao Nguyen. The production process of wood-apple tea. [Nghiên cứu quy trình sản xuất trà trái quách]. *Journal of Analytical Sciences [Tạp chí Phân tích Hóa, Lý, và Sinh học]*. 2019;24: 178–182.

[7] Pham Van So, Bui Thi Nhu Thuan. *Food testing*. *[Kiểm nghiệm lương thực, thực phẩm]*. [Lecture] Hanoi University of Science and Technology. 1991.

[8] Kemp SE, Hollowood T, Hort J. *Sensory Evaluation: A practical handbook*. UK: John Wiley & Sons. 2009; 47–139.

[9] Folin O, Ciocalteu V. On tyrosine and tryptophane determination in proteins. *The Journal of Biological Chemistry*. 1927;27: 627–650.

[10] Brand-Williams W, Cuvelier ME, Berset C. Use of a free radical method to evaluate antio-xidant activity. *Food Science and technology*. 1995;28(1): 25–30.

[11] Lin YS, Tsai YJ, Tsay JS, Lin JK. Factors Affecting the Levels of Tea Polyphenols and Caffeine in Tea Leaves. *Journal of Agricultural and Food Chemistry*. 2003;51(7): 1864–1873.

[12] Ramesh K, Singh V, Megeji NW. Cultivation of stevia [Stevia rebaudiana (Bert.) Bertoni]: A comprehensive review. *Advances in Agronomy*. Academic Press. 2006;89: 137–177

[13] Deng LZ, Mujumdar AS, Zhang Q, Yang XH, Wang J, Zheng ZAl, et al. Chemical and physical pretreatments of fruits and vegetables: Effects on drying characteristics and quality attributes–a comprehensive review. *Critical reviews in food science and nutrition*. 2019;59(9): 1408–1432.

[14] Abhay SM, Hii CL, Law CL, Suzannah S, Djaeni M. Effect of hot-air drying temperature on the polyphenol content and the sensory properties of cocoa beans. *International Food Research*. 2016;23(4): 1479–1484.

[15] Trinh Thanh Tam, Nguyen Quoc Cuong, Tu Phan Nam Phuong, Dong Thi Anh Dao. The effects of drying conditions on the nutritional compositions of black fungus Auricula-judae powder. [Nghiên cứu ảnh hưởng của điều kiện sấy đối lưu đến thành phần dinh dưỡng của bột nấm mèo Auricularia auricula-judae]. *Journal of Science and Technology [Tạp chí Khoa học & Công nghệ]*. 2011;6(A): 176–182.