

Effect of Drying Methods and Storage Conditions on Quality of Purple Sweet Potato Leaves [†]

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Abstract: Purple sweet potato has been gradually increasing in terms of planting and consumption, but after harvesting the leaves of the sweet potato are often discarded as waste or used for animal feed. The aim of this study was to determine the effect of drying methods on the quality of sweet potato leaf powder and its storage capacity. The nutritional and antioxidant properties of powder were analyzed. The results showed that hot air-drying could preserve antioxidant properties better than sun drying method. Both methods could produce that product with high nutritional value, especially high amount of protein and fiber. It could be considered as a supplementation ingredient for food industry. Moreover, after storage at room temperature for 12 weeks, the slight increase of moisture content and decreased of antioxidant properties was found. Further, the application of this ingredient should be more investigated more in food application to improve the income for local farmers as well as reduce the waste that harm to environmental.

Keywords: sweet potato; antioxidants; drying method; nutritional value; storage

1. Introduction

Sweet potatoes are one of the five most important foods for developing countries. This food is considered a good source, supports health related problems and also contributes to food security [1]. Purple sweet potato contains many nutrients that are good for the body such as starch, protein, amino acids, vitamins A, B, C, E and more than 10 kinds of trace elements necessary for the body such as calcium, zinc, iron, etc. magnesium, potassium, sodium, phosphorus, etc. The production of sweet potato is increasing year by year and leaves of sweet potato is by-product after tuber harvest. Food waste is one of big consideration in recent year due to harmful to environment and economic [2]. Purple sweet potato leaves also contain many beneficial nutrients and at the same time contain a certain amount of antioxidants that can help support the reduction of diseases. It also produced various kind of foods as dried powder [3], soup [4], and another products. Recent research has shown that besides providing essential nutrients, antioxidants also support to immune system as well as health benefits as anticancer, antidiabetic, antioxidants [5–7].

However, due to the characteristics of purple sweet potato leaves, it contains high moisture content. Sweet potato leaves' ability to retain their nutritional value during processing will be crucial for providing food ingredient. Due to its affordability, drying is one of the suitable methods for preserving and producing many products from plants and waste materials [3,8–11]. Besides, sun drying is a natural drying method that has been used for a long time to preserve powder. However, during the wet season it is challenging to sun dry. Therefore, the purpose of this study was to compare the effects of sun and

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oven drying on the nutritional, antioxidant properties, and preservation characteristics of sweet potato leaves.

2. Materials and Methods

2.1. Preparation of Sample and Drying Conditions

Purple sweet potato leaves were harvested at local farm at Binh Tan district, Vinh Long province and transported immediately to the laboratory for further processing. The leaves were then divided into two parts and dried under two different drying conditions (sun drying and oven drying). For the sun drying method, the leaves were spread evenly on the tray and dried in direct sunlight (average temperature was about 31.8 ± 1.5 °C). While the oven dryer machine (UN75, Memmert, Germany) was controlled at 60 °C and air velocity was 0.5 m/s for the drying process of purple sweet potato leaves. The drying process was finished when purple sweet potato leaves reach moisture below 10%, which is the safe humidity for storage process [12]. The initial moisture content was analyzed, and the final moisture content was calculated based on the change of weight after drying. The drying time also recorded. The leaves after drying were finely ground and sieved through a 100-mesh sieve. The nutritional composition and antioxidant properties of the two powders were analyzed and compared. At the same time, 500 g of purple sweet potato leaf powder was stored in polyamide packaging covered with aluminum film and 90% vacuum-sealed was operated. Storage process was carried out at room temperature (25 ± 0.5 °C) and $70.8 \pm 5.9\%$ of humidity for 2, 4, 6, 8, 10, 12 weeks. Samples were evaluated for antioxidant properties and moisture content every two weeks.

2.2. Proximate Analysis

The proximate composition was determined by using standard AOAC methods (AOAC, 2005).

2.3. Antioxidant Properties

Total phenolic content was determined by the Folin-Ciocalteu colorimetric method [13] and expressed as milli gram gallic acid equivalents (mgGAE)/100 g on a dry weight basis (DW). Moreover, total flavonoid content was determined by the aluminum method [13] and expressed as milli gram quercetin equivalents (mgQE)/ 100 g DW. 2,2-diphenyl-1-picrylhydrazyl (DPPH) was determined following the method established by Tai et al. [13] and expressed percentage of inhibition of DPPH (%DPPH).

2.4. Data Analysis

All measurements were done in triplicate and presented as mean \pm STD (standard deviation). Statistical analyses were performed using Statgraphic Centurion XV.I (USA). One-way analysis of variance (ANOVA) was used to analyze the differences among data. Differences at $p < 0.05$ were significant.

3. Results and Discussions

Effect of Drying Method on the Nutritional and Antioxidant Properties of Sweet Potato Leaves

Table 1 summarizes the proximate composition of purple sweet potato leaf powders. The final moisture content of sun drying, and hot air-drying method were $8.97 \pm 0.18\%$ and $9.77 \pm 0.27\%$, respectively. To reach this moisture content, the drying time of sun drying (13 h) was longer than the hot air-drying method (10 h). The contents of ash, crude protein, crude fiber, and crude fat and carbohydrate in dehydrated sweet potato leaves are also showed the different. One way ANOVA showed significant ($p < 0.05$) differences between the contents for dry samples. The results were similar to Sui, Mu [14], who reported that different drying methods could lead to vary in nutritional properties. The study of Moguel-Ordóñez, Cabrera-Amaro [15] studied on *Stevia rebaudiana* (Bertoni)

leave, which reported that the sun drying process could maintain more nutritional value than hot air drying. Besides, it could be seen that dried purple sweet potato powder has high amounts of crude protein, crude fiber, which could be considered as a good source for supplementation to reduce the glycemic index or dietary fiber [16,17]. Besides, this source of ingredients could be highly potential used as a supplement to high-fiber, plant-based protein or low glycemic index products.

Table 1. Effect of drying methods on the proximate composition and antioxidant properties of sweet potato leaf powder.

	Sun Drying	Hot Air Drying	
Proximate compositions	Moisture	8.97 ^b	9.77 ^a
	Ash	10.9 ^a	9.87 ^b
	Protein	25.7 ^a	25.4 ^b
	Fiber	8.28 ^a	8.24 ^b
	Fat	3.25 ^a	3.28 ^a
	Carbohydrate	42.4 ^a	42.1 ^a
	Calories	301 ^a	296 ^b
Antioxidant properties	TPC (mgGAE/100 g DW)	6.04 ^b	6.35 ^a
	TFC (mgQE/100 g DW)	0.23 ^b	0.34 ^a
	DPPH (%)	60.1 ^b	65.3 ^a

Means values within the same row with different superscripts differ at $p < 0.05$.

When comparing the two drying methods, the process of drying purple sweet potato leaf powder with a drying device showed a higher ability to maintain the content of biological compounds when dried by the sun. The prolonged drying time may be responsible for the decrease in the content of biological compounds. In this process biological compounds can be decomposed by heat and direct sunlight. In addition, the DPPH assay is an excellent tool for determining the antioxidant activity of plant products [18]. The values of percentage of inhibition of DPPH were higher for the convection drying method. On the other hand, the values from the results of DPPH decreased in the sun drying method. DPPH could be related to the number of pigments and the loss of pigments could be explained by thermal oxidation and decomposition [19], which might be the main cause of the antioxidant activity decrease in leaf powders obtained by the sun drying methods. The nutritional profile of purple sweet potato leaf powder under two drying methods were slight change during storage. It could be seen that after 3 months of storage the moisture content was slightly increased but still lower than 10%.

Table 2. Effect of drying methods and storage period on nutritional values of dried sweet potato leaves.

Drying Method	Storage (Week)	Protein (%)	Lipid (%)	Carbohydrate (%)	Moisture Content (%)
Sun drying	0	25.7 ^a	3.25 ^a	42.4 ^a	8.97 ^a
	2	25.7 ^a	3.25 ^a	42.4 ^a	8.97 ^a
	4	25.7 ^a	3.25 ^a	42.4 ^a	8.97 ^a
	6	25.6 ^a	3.24 ^a	42.4 ^a	9.00 ^a
	8	25.6 ^a	3.23 ^a	42.3 ^a	9.01 ^{ab}
	10	25.5 ^a	3.23 ^a	42.3 ^a	9.03 ^a
	12	25.5 ^a	3.22 ^a	42.3 ^a	9.09 ^b
Hot air drying	0	25.4 ^a	3.28 ^a	42.1 ^a	9.77 ^a
	2	25.4 ^a	3.28 ^a	42.1 ^a	9.77 ^a
	4	25.4 ^a	3.28 ^a	42.1 ^a	9.77 ^a
	6	25.3 ^a	3.28 ^a	42.1 ^a	9.80 ^{ab}
	8	25.3 ^a	3.27 ^a	42.0 ^a	9.81 ^a

10	25.3 ^a	3.27 ^a	42.0 ^a	9.82 ^b
12	25.2 ^a	3.27 ^a	42.0 ^a	9.84 ^b

Means values within the same row with different superscripts differ at $p < 0.05$.

The content of biological compounds and antioxidant activity of purple sweet potato leaf powder was also maintained after 12 weeks of storage at room temperature. It can be seen that PA packaging with aluminum foil is effective in maintaining nutrients and biological compounds. Moreover, the 90% vacuum packaging condition has mostly removed the air in the packaging which helps prevent oxidation of the nutritional ingredients (Masniyom 2011). In addition, the aluminum film also has a light-blocking effect that helps reduce the transformation of light-sensitive compounds (Kwon et al. 2018).

Table 3. Effect of drying methods and storage period on antioxidant properties of dried sweet potato leaves.

Drying Method	Storage (Week)	TPC (mgGAE/100 g)	TFC (mgQE/100 g)	DPPH (%)
Sun drying	0	6.04 ^a	0.23 ^a	60.1 ^a
	2	6.04 ^a	0.23 ^a	60.1 ^a
	4	6.03 ^a	0.23 ^a	60.1 ^a
	6	6.00 ^a	0.21 ^a	59.6 ^a
	8	6.00 ^a	0.20 ^b	59.3 ^b
	10	5.97 ^a	0.20 ^b	59.0 ^b
	12	5.92 ^b	0.19 ^b	58.8 ^b
Hot air drying	0	6.35 ^a	0.34 ^a	65.3 ^a
	2	6.35 ^a	0.34 ^a	65.3 ^a
	4	6.35 ^a	0.34 ^a	65.3 ^a
	6	6.33 ^a	0.33 ^a	65.0 ^a
	8	6.32 ^a	0.33 ^a	64.8 ^b
	10	6.30 ^a	0.31 ^b	64.7 ^b
	12	6.29 ^a	0.31 ^b	64.5 ^b

Means values within the same row with different superscripts differ at $p < 0.05$.

4. Conclusions

Both methods, including sun drying and hot air-drying, can maintain the nutrient content of purple sweet potato leaves. The solar drying method is recommended because it uses natural energy sources and has little impact on the environment. However, it depends on the actual conditions that the appropriate method is used. The method of preservation in PA packaging with aluminum foil (90% vacuum) is recommended because product quality can be maintained after 3 months of storage. Due to high antioxidant compound, furthermore, studies on the application of purple sweet potato leaf powder not only for livestock but also food products should be considered in order to improve the usability of locally available raw materials and increase income for sweet potato growers.

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