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EFFECT OF DRYING METHODS ON DIETARY FIBER CONTENT IN DRIED FRUIT AND VEGETABLE FROM NON-TOXIC AGRICULTURAL FIELD

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ABSTRACT: Fruits and vegetables are rich in vitamins, minerals and dietary fiber. However, they spoil easily and their shelf-life is very short after harvest. Especially, fruits and vegetables from organic or non-toxic agricultural fields spoiled easily as it has not contained any preservation reagent. Converted into dried powder form is easy to preserve and use as ingredients. Drying methods may affect the quality of dried fruits or vegetables. Drying with higher temperatures resulted in loss of nutrients but little studies have showed the change in dietary fiber. So, the objective of this study was to compare the effect of drying methods on dietary fiber contents in pumpkin, yardlong bean, tomato, red cabbage and guava. Natural sun drying, hot air oven drying and freeze drying were used to dry those fruit and vegetables. Then, dried fruit and vegetables were grained into a powder and analyzed for dietary fiber contents. The results show that dietary fiber contents in dried pumpkin, yardlong bean, red cabbage and guava had the same tendency, which having higher amounts of dietary fiber from natural sun dry, hot air oven dry and freeze dry, respectively. While, in tomato showed higher content in hot air oven, freeze dry and natural sun dry, respectively. According to the results, it was concluded that the condition of natural sun drying may work efficiently to get higher dietary fiber content in fruit or vegetables.

Keywords: Fruits, Vegetables, Powders, Drying, Dietary fiber

1. INTRODUCTION

Fruits and vegetables are highly seasonal, rich in vitamins, minerals, dietary fiber, and available in various times of the year. In the high season, high productivity makes the selling price decrease a lot of products remain. Due to an oversupply in the market may result in the spoilage of large quantities. Fruits and vegetables from organic or non-toxic agricultural fields spoiled easily as it has not contained any preservation reagent. In areas having high productivity of non-toxic fruits and vegetables, it is necessary to consider how to make value of an oversupply in products.

Various processing techniques were applied to produce new products or preserve it for long use, while one of the most used techniques for preserving fruits and vegetables is to dehydrate and keep it as a dried products or powder, which are the key ingredients in dairy products, cereals, dietetic foods formulated, etc. Dehydration is a preservation technique, in which the moisture content is reduced to a level at which the product is physically or chemically stable [1]. The major function of converting fruits and vegetables into powder form is to maintain the stability and the functionality of the ingredients until they are utilized [2].Various drying methods have been studied and applied by many researchers [3]-[5] to produce dried fruit and vegetable [6], in addition to improving the products' qualities. In tropical countries dehydration of fruits and vegetables by the sun drying method is a popular practice due to its low cost. However, the quality of those products such as color, texture or dying period may result in different quality in different dying methods [7].

Recently, people are concerned more with their consumption quality and food nutrition. Especially, dietary fiber consists of non-digestible carbohydrates and lignin, which is intrinsic and intact in plants that have beneficial physiological effects in humans [8]. Additionally, dietary fiber intake has been linked to the prevention and management of many diseases [9].

It's challenging to preserve fruits and vegetables using dehydration techniques, while maintaining its nutrition value. Recently in Thailand, the common used methods by farmers or communities for drying agricultural products are sun drying because of its low cost and there is sunshine throughout the year. The day time temperature may rise up to 45-55^{o}C or to 60^{o}C in closed containers. A part from sun drying, the hot air oven drying is also wildly used in small enterprises or factories as it is advantageous for quality control. Moreover, freeze drying has become popular to use to produce health products as it remains higher nutrients when compared to other drying methods. So, to evaluate the

effectiveness of drying methods on nutritional value in fruit and vegetables, three methods of sun drying, hot air oven drying, and freeze drying were employed to make dried of fruit and vegetable, and objective to compare the dietary fiber contents in those fruits and vegetables. The results from this study are expected to be of benefit to farmers, commercial application or anyone who produces dried fruits or vegetables.

2. MATERIALS AND METHODS

2.1 Materials

The fruits and vegetables used in this study were planted and harvested as non-toxic in Nongsue district, Pathum Thani province, Thailand. A type of guava fruit (*Psidium guajava* Linn.) and four vegetables of pumpkin (*Cucurbita moschata* Decne.), yardlong bean (*Vigna unguiculata* sub sp. *Sesquipedalis*), tomato (*Lycopersicon esculentum* Mill.) and red cabbage (*Brassica oleraceae* var. *rubra*) were selected for this study as they are widely grown in this area.

2.2 Methods

All the fruits and vegetables was cleaned the skin of using a dry towel and then sliced into small pieces, having a volume of 5 x 10 x 5 mm^3. Sliced guava, pumpkin, yardlong bean, tomato and red cabbage were divided into four groups.

The first group was used for analysis as a fresh product.

The second group was put on the tray and dried under natural sun light until the moisture content was stable.

The third group was dried using hot air oven at 70ºC until the moisture content was stable.

The fourth group was dried using a freeze drying method. The materials of fourth group were put into a freezer (temperature -45ºC) for 24 hours, and then moved to a vacuum chamber for removing ice crystals as sublimation. Dried materials from the three methods were also used to analyze their physical, chemical, and nutritional properties as well as a fresh material.

2.3 Analysis

The fresh fruit and vegetables of guava, pumpkin, yardlong bean, tomato and red cabbage were analyzed for moisture content, ash, protein, and dietary fiber [10].

Moisture content was measured by drying in an oven at 105ºC for 24 hours. Ash was measured by burning in a muffle furnace at about 550ºC for 18 hours. Protein was measured by using a Kjeldahl methods and dietary fiber was measured by AOAC 2000 methods.

2.4 Statistical Analysis

The experiments were repeated three times, and the results were analyzed using SPSS program at the significant different at 95% confident level.

3. RESULTS AND DISCUSSION

3.1 Moisture content and nutrients in dried fruit and vegetables

A fruit of guava and four vegetables of pumpkin, yardlong bean, tomato and red cabbage were cut and dried under different drying methods of sun drying, hot air oven drying, and freeze drying. As shown in Table 1, the moisture contents of fruit and vegetables after the 36 hours of sun drying, the 24 hours of oven dried, and the 15 hours of freeze dried. The results showed that the three methods of drying had effectively decreased the moisture content in fruit and vegetables, however drying times and moisture contents were different.

Table 1 Moisture content of fruit and vegetables

Fruit/ Vegetable	Moisture Content (%)			
	Fresh	Sun dried	Oven dried	Freeze dried
Guava	87.92^{a}	9.60^{b}	6.27^{c}	4.73^{d}
Pumpkin	84.57^{a}	8.62^{b}	6.72^{c}	6.72^{c}
Yardlong Bean	88.74^{a}	7.41^{b}	5.58^{d}	6.82^{c}
Tomato	90.61^{a}	14.15^{b}	8.85^{c}	8.55^{d}
Red Cabbage	92.09^{a}	9.80^{c}	9.93^{b}	9.54^{d}

Note: a-d shown significant different ($p \leq 0.05$) in roll

According to the experimental results, the freeze drying method was significantly ($p \leq 0.05$) more effective in reducing the moisture content in most of fruit and vegetables, compared to those of sun drying or oven drying method. This effectiveness may be due to the process of freeze dying method, where the molecules of water in fruit or vegetable will be frozen and then removed.

Additionally, the amount of ash, protein, and dietary fiber in fresh fruit and vegetables is shown in Fig. 1. Fresh pumpkin contained the amount of ash, protein, and dietary fiber of 0.78%, 0.37% and 3.50%, respectively. While in a fresh yardlong bean contained 0.69% ash, 0.60% protein and

1.88% dietary fiber. Guava had ash, protein and dietary fiber of 0.69%, 0.19% and 2.03%, respectively. Red cabbage contained 0.89% ash, 0.25% protein and 2.96% dietary fiber. In addition to fresh tomato contained higher ash of 1.16%, but lower in protein of 0.03% and dietary fiber of 1.77.

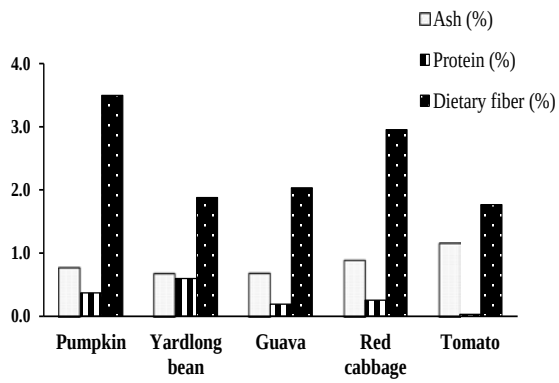

Fig. 1 The amount of ash, protein, and dietary fiber in fresh fruit and vegetables

3.2 Changing of nutritional contents in dried fruit and vegetables

3.2.1 Dried guava

The experimental results showed that the average nutritional contents of ash, protein and dietary fiber in sun dried guava were 15.66%, 1.17% and 21.86%, respectively. Dried guava (Fig. 2) by hot air oven remained 19.34% ash, 1.17% protein and 24.39% dietary fiber. While, dried guava from the freeze dry having ash, protein and dietary fiber of 12.68%, 1.18% and 18.01%, respectively. Figure 3 shown the differences of nutritional contents in dried guava from three different drying methods, sun drying was significantly different ($p \leq 0.05$) in higher protein and dietary fiber compared with hot air oven or freeze drying.

Fig. 2 Dried guava

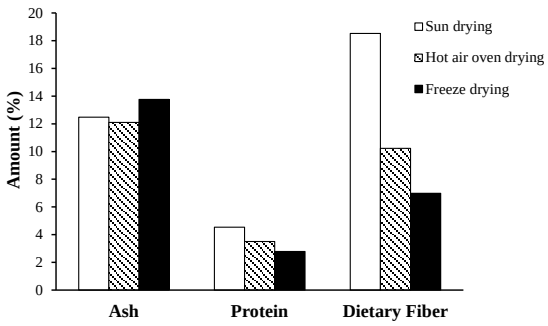

Fig. 3 Nutritional contents in dried guava

3.2.2 Dried pumpkin

Drying pumpkin by different drying methods (Fig. 4) of sun dry, oven dry and freeze dry were measured the amount of ash, protein and dietary fiber as shown in Fig.5. The differences of nutritional contents in dried pumpkin from sun drying was significantly different ($p \leq 0.05$) in higher protein and dietary fiber compared with hot air oven or freeze drying.

Fig. 4 Dried pumpkin

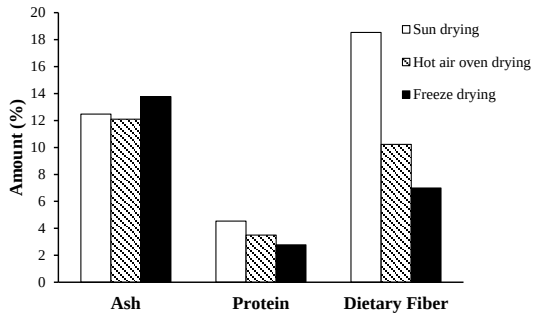

Fig. 5 Nutritional contents in dried pumpkin

3.2.3 Dried yardlong bean

Figures 6 and 7, shown the experimental results for dried yardlong bean, which had ash, protein and dietary fiber in sun dried yardlong bean of 12.48%, 4.54% and 18.53%, respectively. Dried

yardlong bean by hot air oven remained 12.10% ash, 3.51% protein and 10.23% dietary fiber. While, dried yardlong bean from the freeze dry having ash, protein and dietary fiber of 13.77%, 2.78% and 6.99%, respectively. Additionally, the differences of nutritional contents in dried yardlong bean from three different drying methods, freeze drying was significantly different ($p \leq 0.05$) in higher protein, while hot air oven drying showed higher in dietary fiber.

Fig. 6 Dried yardlong bean

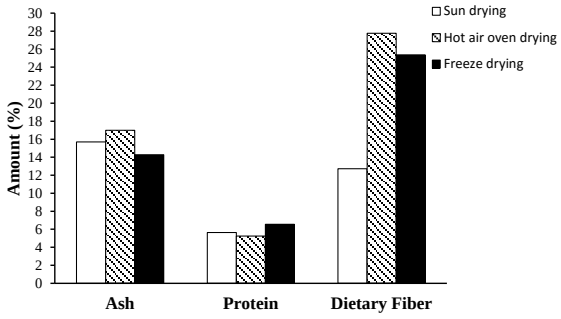

Fig. 7 Nutritional contents in dried yardlong bean

3.2.4 Dried tomato

As shown in Figs. 8 and 9, dried tomato by sun drying was significantly ($p \leq 0.05$) higher in the amount of protein (2.47%), while the amount of ash (19.85%) and dietary fiber (13.40%) were higher in hot air oven drying method.

Fig. 8 Dried tomato

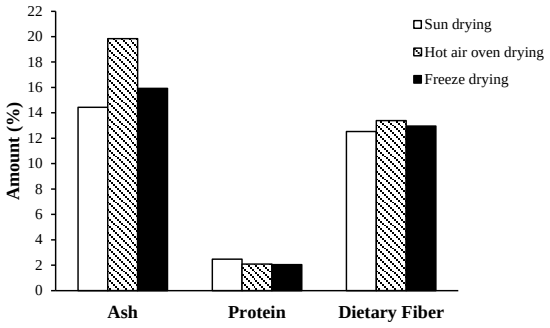

Fig. 9 Nutritional contents in dried tomato

3.2.5 Dried red cabbage

Nutritional contents of dried red cabbage (Fig. 10) by the three different drying methods were shown in Fig. 11, the amount of ash (14.68%) and dietary fiber (59.99%) in red cabbage using sun drying method were significantly ($p \leq 0.05$) higher than that using hot air oven or freeze drying. However, the amount of protein (5.61%) was higher in red cabbage using hot air oven drying method.

Fig. 10 Dried red cabbage

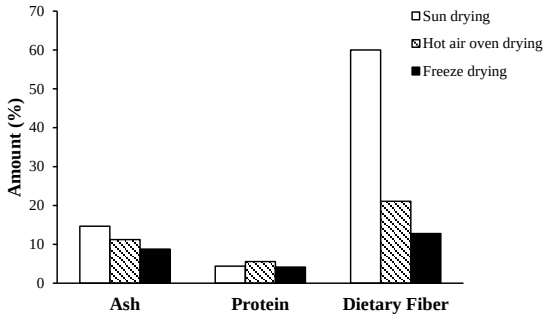

Fig. 11 Nutritional contents in dried red cabbage

Different drying methods have resulted in different quality of fruits and vegetables such as texture, color, moisture, nutritional contents, etc. Change in the quality of dried fruit or vegetable may due to the high temperatures and long drying

time [11]. Higher temperature have had an effect in the dark color, however it does not matter with the nutritional contents. Time of drying is more affected by the changing of nutrients.

4. CONCLUSION

It was clearly shown that the quality of the dried samples was greatly affected by the method used for drying, especially prior to drying. The results show that dietary fiber contents in dried pumpkin, yardlong bean, red cabbage and guava follow the same tendency, having higher amounts of dietary fiber from natural sun dry, hot air oven dry and freeze dry, respectively. While, tomatos showed higher content in hot air oven, freeze dry and natural sun dry, respectively. The results, concluded that the condition of natural sun drying may work efficiently to get higher dietary fiber content in fruit or vegetables. Sun drying is expected to be an important method of preservation, especially when taking into consideration for economic and ecological aspects.

5. ACKNOWLEDGEMENTS

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