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Effect of drying method on total phenolic content of apple (Golden delicious) slices

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Abstract : Drying is one of the most common ways to preserve agricultural products. The main purpose in drying fruits is to reduce their water activity, losses and transportation costs since most of the water are taken out from the product during the drying process. Apple is one of the major fruits consumed all over the world and it has an important role in the human healthy because it is one of the best sources of bioactive compounds. Due to a high level of water in apples, they need to storage in specified conditions or drying for reducing water activity to decrease of microbiological activity. The aim of this study was to evaluate the effects of different drying methods (air drying, sun drying, oven-drying, cabinet drying and microwave drying) on the total phenolic contents of apple slices. Drying methods have significant effects on the total phenol contents. Apple slices were dried by oven drying at 70 º C and oven drying at 50 º C methods had the highest and lowest amount of phenolic contents respectively. In conclusion, it can be suggested that special care should be taken when preserving food for later use.
Keywords : drying methods, apple slices, phenolic content.

Introduction

Apple is one of the major fruits consumed all over the world and it has an important role in the human healthy because it is one of the best sources of bioactive compounds[1-3]. Apple decreases the cardiovascular and cancer disease [4,5]. Apple is a good source of phenolic compounds and it can protect the human body against oxidative stress by scavenging oxygen free radicals [6,7]. Due to a high level of water in apples, they needto storage in specified conditions or drying for reducing water activity to decrease of microbiological activity[8]. Drying is one of the oldest methods known for the preservation of agricultural products such as fruits and vegetables and it is an important means of enhancing resistance to degradation due to a decrease in water activity. Drying of agricultural products enhances their storage life, minimizes losses during storage, and save shipping and transportation costs [9]. The quality of a dried product is indicated by its color[10]. It is not only an indicator of changes proceeding in the material during drying, but also an important attribute affecting attractiveness of a food product. Extraction of phenolic compounds is influenced by the drying procedure before theextraction[9]. The drying of plants inhibits microbial growth but it can give other changes on the quality of plants; such as loss of bioactive compounds and antioxidant activity and other health-promoting properties [11]. Many drying methods such as oven drying, microwave and freeze-drying are used to preserve medicinal herbs[12,13].All of thermal drying methods (microwave, sun and oven-drying) resulted in decrease of the total phenolic of plants[14]. Also most, methods of drying including air, hot air, sun and freeze-drying had adverse

effects on the antioxidant activity [15].The main factor in drying plants is the drying time and the shorter drying times maximized phenolic compounds and antioxidant activity [16].

The objective of the present study was to compare different methods for the drying of plants on the total phenolic contents of yellow apple fruit by six drying methods such as air drying in sun, air drying in shade, oven drying (50 and 70 ° C), microwave drying (360 W) and drying cabinet.

2. Material and methods:

2.1. Raw material

Apples (Golden delicious) were purchased from a local supermarket and were picked and stored in a refrigerator (5°C) until use. The apples were cored with a household tool and cut into cubes. The samples were divided into six groups, each group of samples weighed 100 g. The sliced apple samples were subjected to dryers immediately after cutting to avoid surface enzymatic browning.

2.2. Drying of samples

The apple slices were dried by different drying methods until final moisture content (5–6%, wet basis).The methods were air-dried, sun-dried, microwave drying (360 W), drying cabinet, oven-dried at 50 o C and 70 o C. The drying process was continued until no moisture content was recorded (the samples was dried until it reached the equilibrium moisture content, otherwise no change in moisture content). All dried samples were crushed and powdered; the material that passed through 80-mesh was used for extraction purposes.

2.3. Preparation of extracts

100 g of each group of samples were macerated with 1.0 L of ethanol at room temperature. The whole extracts were filtered and their solvent was evaporated under vacuum at 40° C and the yield of extraction was evaluated.

2.4. Determination of total phenolic content

The total phenolic contents of samples were determined by Folin-Ciocalteu phenol reagent method [17,18]. Briefly, 100 µL from each sample was mixed with diluted Folin-Ciocalteau reagent (1/10, 100 µL). After 1 min of reaction, Sodium carbonate (2%, 2 mL) and distilled water were mixed into them, and then the tubes were vortexed and incubated for 30 min at room temperature. The absorbance was read at 720 nm. The analyses were performed in triplicates. The standard curve was prepared using 10 to100 µg/L solutions of gallic acid in methanol. Total phenolic contents were expressed as gallic acid equivalents (mg gallic acid: per dry weight of extract).

3. Results and discussion

The yield and total phenolic content are shown in Table 1; the highest yield of extraction was from sun drying and lowest yield was from cabinet drying. The results showed drying method has significant influence on the content of phenolic compounds. The highest values of total phenolic content of apple slices was observed in in the oven drying (70 ºC), followed in the air drying in shade (Table 1) and the lowest amount of phenolic compounds was observed from oven drying in 50 °C.

Table 1- yield and total phenolic contents of apple slices were dried by different methods

Drying Method	Drying Temperature	Drying Time	Yield (%)	Total Phenolic Content (Mg Gallic Acid/Dried Extract))
Air drying in shade	8º C	144	25.23	0.393±0.3
Sun drying	20º C	76 h	28.92	0.38±0.31
Cabinet drying	60ºC	7 h	17.25	0.376±0.38
Microwave drying	360 w	4 h	27.14	0.337±0.29
Oven drying (50°C)	50ºC	16 h	27.28	0.234±0.19
Oven drying (70ºC)	70ºC	12 h	27.98	0.419±0.26

Air-drying is a traditional, low cost technique that is used to lower the water content of herbs at low temperatures. The drying at low temperatures protects against the degradation of the active constituents, but it is slow and metabolic processes may continue longer, which may lead to quality loss of the aromatic plants and subsequently of the produced added value products [19].

Oven drying and drying cabinet are the most frequently methods used for food dehydration. A major disadvantage associated with these methods is damage the flavor, color and nutrients in dried products [20].The main feature of a cabinet dryer is its small size and versatility. The main problem with cabinet dryer is difficulty in even distribution of heated air over or through the drying material.

Sun drying is still the most common method used to preserve agricultural products in most tropical and subtropical countries .this method has the advantages of simplicity and the small capital investment. On the other hand, there are many technical problems which are uncertainties like rain and cloudiness, contamination from outer sources and lack of control over drying conditions. It requires large areas and long drying time. The final product may be contaminated from dust and insects and suffer from enzyme and microbial activity. It is limited to climates with hot sun and dry atmosphere with strong winds. In any case of drying, economically feasible drying should be fast[20,21].

Microwave drying is an alternative method to the conventional drying. In microwave drying, the product is exposed to very high-frequency electromagnetic waves. The advantages of using microwave energy are penetrating quality, which effects a uniform heating of materials upon which radiation impinges; selective absorption of the radiation by liquid water; and capacity for easy control so that heating may be rapid if desired. The great interest in this technology is due to the high capacity of penetration of these waves, that heat not only on the surface but also inside the food. This speed up the drying process and can improve the quality of the final product [22].

The long drying time of product placement in the atmospheric oxygen can have such adverse effects on the quality as reduction in the amount of phenolic compounds [23]. Moreover, exposure to high temperatures disrupts cells and may also result in the release of oxidative and hydrolytic enzymes. These enzymes are capable of oxidizing phenolic compounds.

The loss of phenolics compounds during drying might be due to the process conditions, in particular the temperatures and the duration used [24,25].

Thermal processing can affect the phytochemicals by thermal breakdown that affect the integrity of the cell structure which then resulted in the migration of components, leading to losses by leakage or breakdown by various chemical reactions involving enzymes, light and oxygen [26].

The loss of phenolics compounds was found with oven drying at 50ºC (0.234%) and highest level of phenolic compounds was found from oven drying at 70 º C than the other drying treatments set. Our results was agreement with Martínez-Las Heras et al that showed the extracts from persimmon leaves dried with air at 100ºC gave the highest total phenolics concentration, followed by extracts from lyophilized leaves, and then the extracts from air dried leaves at 180ºC and from shade dried leaves[27].

According to Mrad et al the decrease in total phenolics content during drying can be attributed to the binding of polyphenols with other compounds (proteins) or to alterations in the chemical structure of polyphenols which cannot be extracted or determined by available methods[28].

Polyphenolics compounds may be deteriorated depending upon many factors other than heat treatment; these included the activity of polyphenol oxidase, organic acid content, sugar concentration and pH [29].

Also the results showed that the microwave dried apple fruits exhibited the lowest total phenolics contents after oven drying in 50 °C, our results is agreement with other studies. Rabeta and Vithyia found that the microwave drying does not cause any significant changes in total phenolics content of Vitexnegundo tea[30]. Crozier et al reported losses of conjugated quercetin of 64% and 65% in microwaved onions and tomatoes, respectively[31].

4. Conclusion

The purpose of the present study was to evaluate the effect of different drying methods on the total phenolic content of apple slices. The major quality problems faced during apple drying loss of flavor, discoloration and poor rehydration characteristics of the dried apple slices. Drying is an industrial preservation method in which water content and water activity of the fruits and vegetables are decreased by heated air to minimized biological, chemical and microbial deterioration. Drying is a process of simultaneous heat and mass transfer. To obtain the dehydrated product of high quality, the drying process should be such that it allows effective retention of color appearance, flavor, taste and nutritive value, comparable to fresh vegetables. The technique of drying is probably the oldest method of food preservation practiced by mankind for the extension of food shelf life. The use of artificial drying to preserve agricultural commodities is expanding, creating a need for more rapid drying techniques and methods that reduce the large amount of energy required in drying processes. Because of apple is an antioxidant product used for several medicinal purposes, New and innovation techniques that increase drying rates and enhance dried apple slices quality are receiving considerable attention.

5. References

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