

## Dehydration of Fruits by Different Methods

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### Abstract

The main objectives of this research are to choose the most effective pretreatment method for dehydration of apple fruit, to produce dehydrated apple and strawberry and to evaluate the quality of products obtained by different drying methods such as vacuum oven drying and freeze drying method.

In this research, pretreatment of apple slices was done by two different methods; blanching in 50° Brix sugar syrup or soaking in 1 % ascorbic acid. Strawberry was not necessary for pretreatment. After pretreatment, apple slices and strawberries were dehydrated by two different drying methods. Comparative studies were made on the quality of products in term of color, flavor, texture and nutritional values such as protein, fiber and vitamin C content of the products. The basic parameters such as yield percent of products, rehydration ratio and shelf-life of products were also examined.

**Key words:** effective pretreatment, drying methods, vacuum oven drying, freeze drying, blanching

### Introduction

Fruits and vegetables provide an abundant and inexpensive source of energy, body-building nutrients, vitamins and minerals. Their nutritional value is highest when they are fresh, but it is not always possible to consume them immediately. There are various preservation methods: heating, drying, and the use of additives such as salt and sugar. In times of scarcity, preserved food can be sold for a good price (James and Bas Kuipers, 2003).

Drying is one of the preserving methods. The moisture level of agricultural products is decreased to 10-15 % so that the microorganisms present cannot thrive and the enzymes become inactive. Before drying, the fruits have to be thoroughly washed and cut into pieces if necessary. Sometimes extra preparation is needed to retain the product's color and to minimize nutrient loss (James and Bas Kuipers, 2003). Freeze-Drying has gained enormous acceptance as a method of drying, which can result in a product of the highest quality compared to the other common methods of drying. Freeze-drying is a low temperature-low pressure simultaneous heat and mass transfer operation which is often used in pharmaceutical, fine chemicals, biotechnology and food industry to dehydrate materials susceptible to degradation during high temperature drying. The procedure permits the preparation of a dried product of low mass that can be shipped at ambient temperature and readily reconstituted by re-hydration at the point of use. (Mukhopadhyay Punam, 2010)

The main objectives of this research are to produce wholesome, safe, nutritious and acceptable foods to consumers throughout the year, to compare the quality of products obtained by different drying methods and to contribute the techniques of dehydration to small and medium scale cottage industry for producing the dehydrated products not only for domestic consumption but also for export marketing.

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## Materials and Methods

### Materials

Fresh, mature and firm apple (*Malus domestica*) fruits cultivated in Chin State, and fresh, mature and firm strawberry (*Fragaria x ananassa*) cultivated in Pyin Oo Lwin Township were used for dehydration. Sugar was obtained from local markets. Ascorbic acid (analar grades) was also purchased from Able chemical store, Mandalay.

### Method of Preparation

Each type of fruits was washed and trimmed (for strawberry) or peeled (for apple), followed by halving or cutting into uniform pieces (6.5 cm length and 0.5 cm thickness for apple) and weighing. The weighed slices of apples were pretreated by two methods: the first method was blanching in hot sugar syrup followed by soaking in hot sugar syrup and the second method was soaking in ascorbic acid. It was not necessary to carry out pretreatment for strawberry.

After pretreatment, the samples were dehydrated by two different methods. In the first method, the samples were dehydrated in vacuum oven at 60 °C for 12 hours (for apple) and 18 hours (for strawberry) and cooled down to room temperature. In second method, the samples were pre-frozen in deep freezer at – 50 °C for 5 hours and the pre-frozen samples were dehydrated in freeze dryer at -50°C for 24 hours (for apple) and 36 hours (for strawberry). Finally, dehydrated fruits were placed in air-tight plastic bags and stored in a cooled dry place.

### Methods of Analysis

The essential parameters showing the quality of each type of dehydrated fruits such as moisture content, pH, acidity, ash content, color, flavor, texture and nutritional values such as protein, fiber and vitamin C content of the products were determined. The basic parameters such as yield percent of products, rehydration ratio and shelf-life of products were also examined.

## Results and Discussion

The effects of different pretreatment methods on dehydration of apple fruit were examined by using vacuum oven drying method and freeze drying method and the results were recorded in Table (1) and (2). It is found that the color, texture, rehydration ratio of product obtained by ascorbic acid treatment was better than sugar syrup blanching treatment. Therefore, ascorbic acid treatment was used for dehydration of apple fruit.

The effects of different drying methods using freeze-drying method and vacuum-oven drying methods on dehydration of apple fruit were recorded in Table (3) and (4). It can be clearly seen that color, and texture of product obtained by freeze drying method was more attractive. Although the moisture content of both method was within acceptable range, rehydration ratio and yield percent were higher in the freeze-drying method. Therefore, the freeze-drying method is more suitable for dehydration of apple fruit.

Nutritional values of dehydrated apple obtained by different methods were also examined by different drying methods and the results were recorded in Table (5) and (6), respectively. From comparative studies of these values, it is found that

protein, carbohydrate and vitamin C content of product obtained by freeze-drying method was higher than that of vacuum oven drying method.

The effects of different drying methods on dehydration of strawberry were also studied and the results were recorded in Table (7). It can be seen that dehydrated strawberry obtained by freeze-drying method had attractive red color, good texture and there is less volume changes in final product whereas those obtained by vacuum oven drying method had unattractive brown color, hard and shrink texture. Nutritional values of dehydrated strawberry obtained by different drying methods were also determined and the results are recorded in Table (8). It can be seen that protein, fiber and vitamin C content of product obtained by freeze-drying method was higher than that of vacuum oven drying method.

### **Conclusion**

Chemical compounds control enzymes in fruits, causing browning and loss of vitamin C. Blanching of apple in sugar syrup and soaking in ascorbic acid solution help retaining color fairly well during drying and storage. It has potential advantages of less heat damage, good blanching effect, less enzymatic browning, better retention of flavor and energy saving because no phase changes occurred during freeze-drying. It is necessary to freeze fruits and vegetables at  $-50^{\circ}\text{C}$  prior to freeze-drying. Fast freezing is the most practical way to form small ice crystals. Therefore, in this work, pre-freezing of fruits and vegetables were done in deep freezer (at  $-50^{\circ}\text{C}$  for 5 hr) prior to freeze drying operation.

From comparative studies of physico-chemical properties and nutritional values of products obtained by different methods, it can be concluded that the color, texture, yield percent and nutritional values of products obtained by freeze-drying method were better than vacuum oven drying method. Moreover, it is found that these products have lighter weight and lack of much volume changes. Although the color, texture and yield percent and nutritional value of products obtained by freeze drying method is better, the cost is much higher.

From the economic point of view, therefore, it can be concluded that vacuum oven drying method is suitable for commercial production of less heat sensitive fruits such as apples while freeze-drying method is for dehydration of heat sensitive fruits such as strawberries that could not be dehydrated by other drying method to obtain good quality product.

**Table (1) The Effect of Different Pretreatment Methods on the Physico-Chemical Properties, Yield Percent and Shelf-life of Dehydrated Apple Fruit Obtained by Vacuum Oven Drying Method**

Fresh Apple Slices =100g  
 Ratio of Apple Fruit and Sugar Syrup =1:1(w/v)  
 Sugar Syrup Concentration =50°Brix  
 Blanching Time in Sugar Syrup=10min at 100°C  
 Drying Temperature = 60°C  
 Drying Time =12 hours

Fresh Apple Slices= 100g  
 Ascorbic Acid Concentration = 1% (w/v)  
 Soaking Time in Ascorbic Acid Solution =10 min at (27-30°C)  
 Drying Temperature = 60°C  
 Drying Time = 12 hours

Sample No.	Pretreatment Method	Moisture Content %	pH Value	Acidity % (w/v)	Rehydration ratio	Yield %	Shelf-life (months)	Organoleptic Properties
1	Sugar syrup Blanching	6.0	5.57	0.0145	2.9	33.6	10	White color, too hard texture, sweet flavor
2*	Ascorbic acid treatment	5.49	5.68	0.0201	3.5	15	10	Yellow color ,soft texture, sweet flavor, shrink

\*Optimum Pretreatment Method= Ascorbic Acid Treatment



**Figure (1) Dehydrated Apple with sugar syrup treatment (Vacuum Oven Drying Method)**



**Figure (2) Dehydrated Apple with ascorbic acid treatment(Vacuum Oven Drying Method)**

**Table (2) The Effect of Different Pretreatment Methods on the Physico-Chemical Properties, Yield Percent and Shelf-life of Dehydrated Apple Fruit Obtained by Freeze Drying Method**

Fresh Apple Slices =100g  
 Ratio of Apple Fruit and Sugar Syrup =1:1(w/v)  
 Sugar Syrup Concentration =50°Brix  
 Blanching Time in Sugar Syrup=10 min at 100°C  
 Freeze Drying Temperature = -50°C  
 Drying Time = 24 hours

Fresh Apple Slices= 100 g  
 Ascorbic Acid Concentration = 1% (w/v)  
 Soaking Time in Ascorbic Acid Solution =10 min at (27-30°C)  
 Drying Temperature = -50°C  
 Drying Time = 24 hours

Sample No.	Pretreatment Method	Moisture Content %	pH Value	Acidity % (w/v)	Rehydration ratio	Yield %	Shelf-life (months)	Organoleptic Properties
1	Sugar syrup Blanching	6.79	4.52	0.0201	1.53	37	12	White color, hard texture, too sweet
2*	Ascorbic acid treatment	6.14	7.26	0.00536	3.8	15	12	Yellow color, soft texture, sweet flavor,

\*Optimum Pretreatment Method= Ascorbic Acid Treatment



**Figure (3) Dehydrated Apple with sugar syrup Treatment (Freeze Drying Method)**



**Figure (4) Dehydrated Apple with ascorbic acid treatment (Freeze Drying Method)**

**Table (3) The Effect of Different Drying Methods on the Physico-Chemical Properties, Yield Percent and Shelf-life of Dehydrated Apple Fruit with Sugar Syrup Blanching**

Fresh Apple Slices = 100g  
 Ratio of Apple Fruit and Sugar Syrup = 1:1(w/v)  
 Sugar Syrup Concentration = 50 °Brix  
 Blanching Time in Sugar Syrup =10 min at (100) ° C

Sample No	Method	Drying Time (hrs)	Moisture content	pH value	Acidity % ( w/v)	Rehydration ratio	Yield %	Shelf-life (months)	Organoleptic Properties
1	Vacuum Oven Drying at 60°C	12	6.0	4.32	0.01005	2.2	33.61	10	White color, too hard, candy like texture, sweet flavor,
2*	Freeze Drying At -50°C	24	6.79	4.52	0.00536	1.53	36.85	12	White color, hard texture, sweet flavor,

\*Optimum Drying Method =Freeze Drying Method

**Table (4) The Effect of Different Drying Methods on the Physico-Chemical Properties, Yield Percent and Shelf-life of Dehydrated Apple Fruit with Ascorbic Acid Treatment**

Fresh Apple Slices = 100g  
 Ratio of Apple Fruit and Ascorbic Acid Solution = 1:1(w/v)  
 Concentration of Ascorbic Acid = 1% (w/v)  
 Soaking Time in Ascorbic Acid Solution =10 min at 100 ° C

Sample No	Method	Drying Time (hrs)	Moisture content	pH value	Acidity % ( w/v)	Rehydration ratio	Yield %	Shelf-life (months)	Organoleptic Properties
1	Vacuum Oven Drying at 60°C	12	11	5.49	0.0201	3.5	15	12	Yellow color, hard texture good flavor, volume reduce
2*	Freeze Drying At -50°C	24	11.2	6.14	0.0145	3.8	15	12	Pale yellow color, soft texture, good flavor, less volume change

\*Optimum Drying Method =Freeze Drying Method

The values of moisture content, pH, acidity, rehydration ratio and yield percent were determined at the laboratory of Industrial Chemistry Department, Yadanabon University

**Table (5) Comparison of Nutritional Values of Fresh Apple Fruit and Dehydrated Apple Fruit with Sugar Syrup Blanching Obtained by Different Drying Methods**

Sr. No	Composition	Fresh Apple Fruit		Dehydrated Apple *(Experimental Values)	
		*Experimental Value	** Literature Value	Vacuum Drying (60°C)	Oven Method
1	Protein	0.06	0.26	0.25	0.31
2	Carbohydrate	19.52	13.81	56.74	58.15
3	Moisture	82.06	85.56	6.0	6.79
4	Total Fiber	0.16	2.4	0.17	0.14
5	Vitamin C	0.06	0.046	0.14	0.16
6	Ash	0.87	-	0.16	0.25

\*The nutritional values of fresh apple fruit and dehydrated apple fruit were determined at laboratory of Myanmar Pharmaceutical and Food Stuff Industries (Sagaing) Ministry of Industry.

\*\*<http://en.wikipedia.org/wiki/Apple>

**Table (6) Comparison of Nutritional Values of Fresh Apple Fruit and Dehydrated Apple Fruit Obtained by Different Pretreatment Methods Using Freeze Dryer**

Sr.No	Composition	Fresh Apple Fruit		Dehydrated Apple *(Experimental Values)	
		*Experimental Value	** Literature Value	Sugar Syrup Blanching	Ascorbic Acid treatment
1	Protein	0.06	0.26	0.31	2.13
2	Carbohydrate	19.52	13.81	58.15	79.51
3	Moisture	82.06	85.56	6.79	6.14
4	Total Fiber	0.16	2.4	0.14	0.086
5	Vitamin C	0.06	0.046	0.16	0.22
6	Ash	0.87	-	0.25	0.21

\*The nutritional values of fresh apple fruit and dehydrated apple fruit were determined at laboratory of Myanmar Pharmaceutical and Food Stuff Industries (Sagaing) Ministry of Industry.

\*\*<http://en.wikipedia.org/wiki/Apple>

**Table (7) The Effect of Different Drying Methods on the Physico-Chemical Properties, Yield Percent and Shelf-life of Dehydrated Strawberry**

Fresh Strawberry = 100g

Sample No	Method	Drying Time (hrs)	Moisture content	pH value	Acidity % ( w/v)	Rehydration ratio	Yield %	Shelf-life (months)	Organoleptic Properties
1	Vacuum Oven Drying at 60°C	18	8	4.45	0.3968	2.2	11.55	10	Brown color, shrink texture
2	Freeze Drying At -50°C	36	10	4.25	0.7616	2.08	11.7	12	Red color, good texture, less volume change

\*Optimum Drying Method =Freeze Drying Method

**Table (8) Comparison of Nutritional Values of Fresh Strawberry and Dehydrated Strawberry Obtained by Different Drying Methods**

Sr. No	Composition	Fresh Strawberry Fruit		Dehydrated Strawberry *(Experimental Values)	
		*Experimental Value	**Literature Value	Vacuum Oven Drying Method (60°C)	Freeze Drying Method (-50°C)
1	Protein	0.96	0.67	6.74	7.13
2	Moisture	95	90.95	8	10
3	Total Fiber	0.96	2	6.90	7.57
4	Vitamin C	0.13	0.058	0.15	0.28

\*The nutritional values of fresh strawberry and dehydrated strawberry were determined at laboratory of Myanmar Pharmaceutical and Food Stuff Industries (Sagaing) Ministry of Industry.

\*\*<http://en.wikipedia.org/wiki/Strawberry>



Figure (5) Dehydrated Strawberry (Freeze Drying Method)



Figure(6)Dehydrated Strawberry (Vacuum Oven Drying Method)



Figure (8)Dehydration of Strawberry by Vacuum Oven Drying Method



Figure (7) Dehydration of Strawberry by Freeze Drying Method

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