Determination of Drying Characteristics of Some Vegetables

Ahmet Zeki Hepçimen and Necla Çağlarırmak*

Celal Bayar University, Saruhanlı College, Food Process Department, Saruhanlı- Manisa- Turkey

Abstract: Drying is, removing the water effect of distorting structure, from the food products with the effect of heat. Direct sun drying, greenhouse drying and supported by solar panel greenhouse combinations were done for drying vegetables. Eggplant, cauliflower, leeks, broccoli were dried. Dry matter and water activity values were measured for each of products on the systems of directly in the sun drying, drying in the greenhouse, the panel + greenhouse. Improvements of the conditions in the greenhouse and then with some modifications should be established such as optimization of the air velocity is thought to be achieved by faster drying.

Keywords: Drying, greenhouse, sun, vegetable.

1. INTRODUCTION

Food preservation, development and evolution of the food industry have been the most important key factors. The retention and storage of nutrients for a long time, in terms of nutrition is of great importance as well as the creation of value added economy. Technologies in fruit and vegetable processing industry are known to have a significant share of the total within the food industry. This rate is 18-20% of the total in the food industry [1].

Drying is the oldest method of preserving food, natural drying in the sun is more common and economic method than any other mechanical or technical methods such as drying in the greenhouse developed today [2]. Preservation of foods with various methods of connection and removal of the water with the water activity (aw) is lowered and brought to resist foods [3-6].

Drying foods such as cereals, fruits, and vegetables under the sun has been traditionally used for drying the product of many food products. On the other hand, this type of drying food product is vulnerable to weather conditions which affected quantity and quality of foods negatively. Mechanical drying techniques necessitate using electricity and fossil fuels that can cause both energy consumption and economical cost and environment pollution [7-10].

It is known that dried fruits and vegetables can contribute to nutrition even for preventing cancer. There are various studies and data about nutritional values of dried plant products [11-13].

In a study conducted by Hepçimen and Çağlarırmak (2009) [14] the combinations of food drying systems were analyzed. Review of solar tunnel dryer, indirect type natural convection solar dryers, counter flow drying cabinet, multi-shelf portable solar-powered dryer, ladder-type solar dryer, rotary column cylindrical dryer, indirect air heating and PV solar-powered grain dryer fan, etc. are systems used in the food industry.

Solar energy is at the core of the sun's radiant energy released by the fusion process, the sun in the form of hydrogen gas into helium causes the fusion process. Solar energy outside the Earth's atmosphere is roughly stable, and 1370 W/m² values, but the values of the earth vary between 0 to 1100 W/m^2, even a small portion of this energy from the world is many times greater than mankind's energy consumption. Studies on the use of solar energy gained momentum especially after the 1970s, and the cost of solar energy systems decreased in terms of technological progress has maintained itself as an environmentally clean source of energy [14, 15].

Solar energy as a heat transfer fluid collects various types, formats and devices. It is used for hot water heating in most homes. Solar energy system can be used for the food drying process especially supporting greenhouse drying systems. The countries that have the highest solar collectors are USA, Japan, Australia, Turkey and Greece. Turkey has 7.5 million m² of collector surface installed, so one of the leading countries in the world [15-17].

Drying characteristics of eggplant, broccoli, cauliflower, leeks were investigated in the researches. These dried products were added as ingredients to ready-made soups in the food industry. Drying eggplant bell was commonly used in the restaurants and homemade cooking. There were very less studies about drying process data and nutrients of investigated

*Address correspondence to this author at the Celal Bayar University, Saruhanlı College, Food Process Department, Saruhanlı- Manisa- Turkey; Tel: + 90 236 357 42 50; Fax: + 90 236 357 28 11;
E-mail: neclacaglarirmak@gmail.com

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dried vegetables. Thus, it was focused on including unit operations of drying process.

The aim of this study was determining drying behaviors of vegetables and fruits which were dried under the sun, in the greenhouse and in the greenhouse with supported solar panel. Circumstances of the physical and physicochemical parameters of the detection as well as drying techniques are based on different conditions.

2. MATERIALS AND METHODS

Samples dried in the greenhouse and the environments are as follows: 1- Dried eggplant (in greenhouse and sun-dried) 2- Dried broccoli (in the greenhouse and with solar panel), 3-Dried cauliflower (in the greenhouse and with solar panel) and 4-Dried leeks (in the greenhouse and with solar panel). The materials had total 4 treatments as mentions above. Research was established in Saruhanlı town of Manisa, in Turkey, during summer and winter.

The drying process and devices was designed and planned due to seasons. Summer season samples were dried under the sun directly and also in the green house. On the other hand, winter samples were dried in the green house supported by solar panel system. Greenhouse trial was built by plastic material.

Plastic flat sieves were used for direct sun drying process. Air fan which was placed on the green house wall, have been provided air flow and discharged moisture from the greenhouse. The air flow velocity was 1-2 m/s.

Drying kinetics measurements: Drying in the greenhouse, the sun and the solar panel were assisted in the greenhouse. Testo 454 Model Dryer measurements were made with a multi-channel measuring and recording system device.

The main parameters measured by this device, are the air speed, the product moisture, ambient humidity, temperature and water activity (aw). In addition, the loss of weight was measured in a 30 min.

Primarily produced by the solar system, according to the weather hot air from the drying chamber was used to test the material.

3. RESULTS AND DISCUSSION

The three drying behaviors were observed in the same Figure as seen Figure **1**. Modifications were made in the greenhouse trials conducted in drying in November (Figure **1**). Abandoned due to the rainy weather in winter drying vegetables we have connected to the solar panel to one side to dry the greenhouse are divided into two sections, so that the drying trials were performed with and without panel. The first day moisture losses, weight loss with panel section and without panel section of about 64g (14%) were the equivalent level. On other days, showing a similar trend in both with panel and without panel drying moisture loss in the last day, determined at about 53% and stood at 240g.

In the same days of the differences in temperature and humidity of the greenhouse, compartments were evaluated with and without panel. 2-3°C was measured as the temperatures differences in the day (27°C and

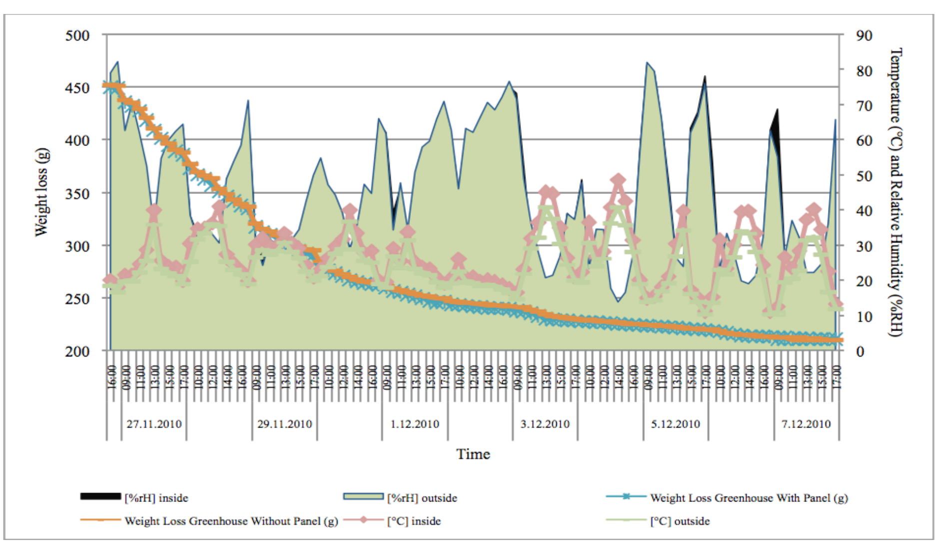

Figure 1: Drying characteristics of broccoli; data of the drying, moisture and temperatures.

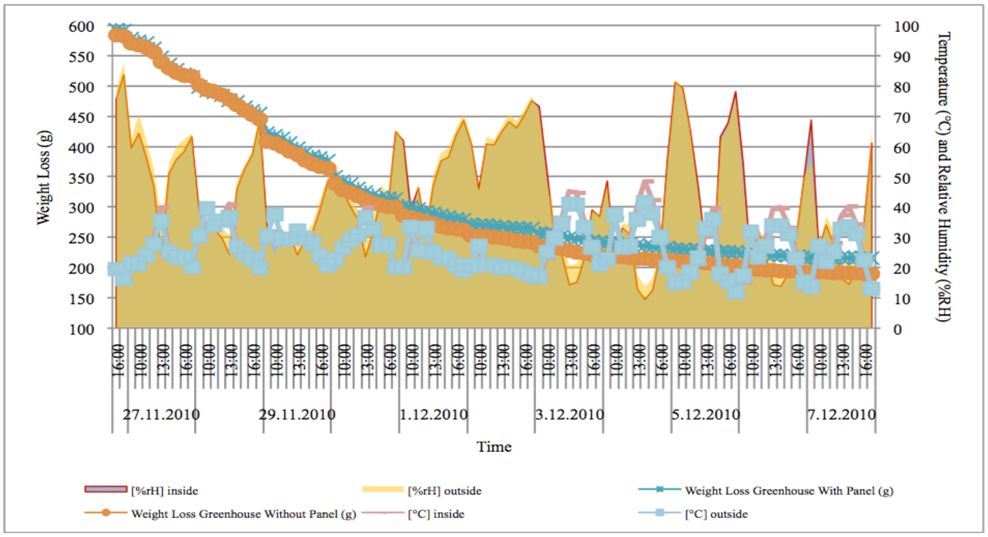

Figure 2: Drying characteristics of cauliflower; data of the drying, moisture and temperatures.

24°C). Humidity falls to about 3% RH (42% and 47%). Ultimately putting the solar panel in the greenhouse environment, a temperature rise of 3°C and 3% more dry weather have provided a similar way (Figure **1**). Exact data of investigated products could not be established in examined literature s so these data could not be compared_with literature data.

In the same year and season of broccoli due to the same weather conditions, the modifications were made for drying conditions of cauliflower as follows; in winter drying, vegetables were dried by connecting solar panel one side of panel, or without connecting solar panel. Drying characteristics and three graphic trends of drying cauliflower were determined in Figure **2**.

Moisture loss of the first day of panel section is 77g (13%) and without panel section is 68g (11%), respectively. On other days, showing a similar trend in the loss of moisture the latest greenhouse-paneled section 378g (64%) and without panel section 393g (67%) were reported in the research.

In the same days of the differences in temperature and humidity of the greenhouse compartments were evaluated with and without panel (Figure **2**). Temperatures have shown no significant differences during the days. Humidities were different about 2% RH (with panel section was about 43% RH and without panel section was about 45% RH).

In the same investigated year of broccoli and cauliflower, leek was dried in the same conditions, too. The drying graphics were obtained like broccoli and cauliflower. (Figure **3**). During the first day, moisture loss-were 137g in paneled section and 117g normal

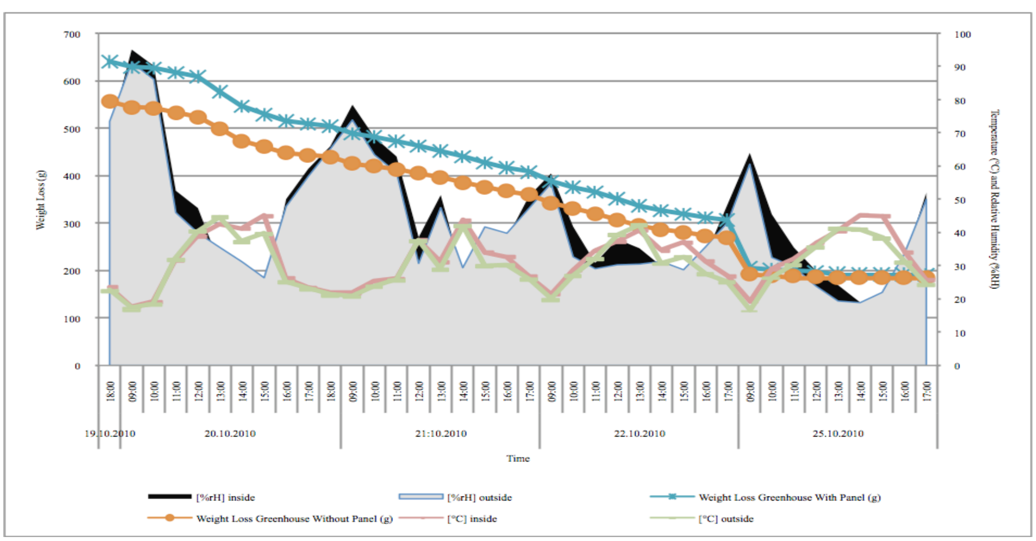

Figure 3: Drying characteristics of leek; data of the drying, moisture and temperatures.

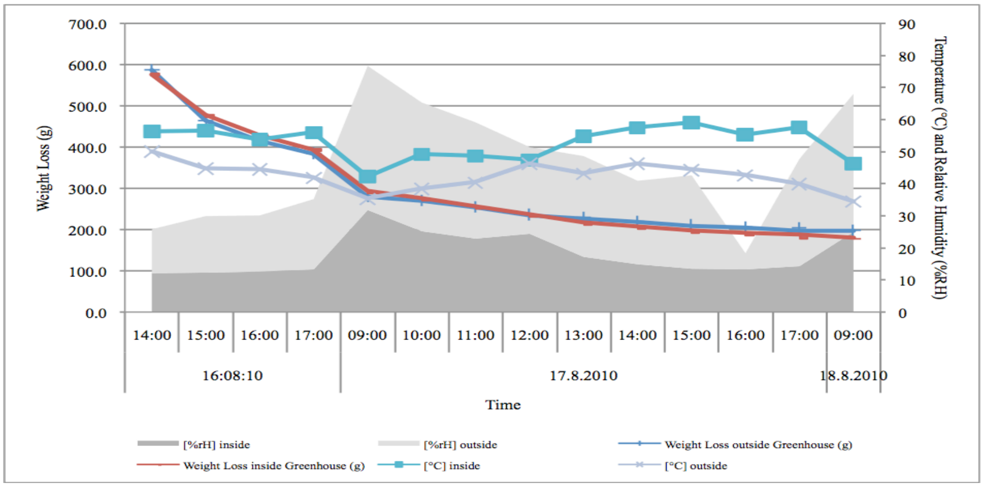

Figure 4: Drying characteristics of eggplant; data of the drying, moisture and temperatures.

section. In the second day, moisture loss-were 234g in paneled section and 196g in normal section of greenhouse. On other days, showing a similar trend was observed in the moisture loss. At the end of drying, total moisture loss in paneled section was 450g (70%) and 372g (66%) in without panel section of greenhouse.

In the same days, the differences in temperature and humidity of the greenhouse compartments were evaluated with and without panel. Day's average temperature difference of about 2°C during the entire drying amounted to 2% RH humidity rate differences were detected in the same way (Figure **3**).

The data of drying process characteristics of the leek and also other vegetables could not be found in the examined literatures. Results of drying characteristics studied vegetables could have not been compared with literatures, but there were some of data common dried products such as red peppers and tomatoes [10, 18-20].

Drying experiments were conducted in the drying trials, and data were given as graphics in the Figure **4**. About 1 cm thick slices of eggplants have been dried into pan dry in two days. The first day average temperatures of greenhouse were 56°C and 45°C respectively; relative humidities for same conditions were 18% and 33% respectively. The second day average temperatures were determined as follows; 52°C and 42°C respectively. The relative humidity ratios of second day in the same conditions were obtained as 20% and 33% RH. Differences temperature and humidity of greenhouse and outside for two days were 10°C and 9% respectively.

Moisture losses were measured in the greenhouse and under the sun conditions 182g 31% and 203g 34%, respectively. For second day, weight measurements of same conditions were (as gram and per cents) 390g; 69%, and 389g; 66% (Figure **4**).

4. CONCLUSION

Debra and O'Neil, (2011), [21] improved the quality of dried fruit consumption, diet, and obesity that prevent over-eating and calorie intake. Surveys were made between 1999 and 2004. Addition of antioxidants from fruits and vegetables are known to be important factors in the prevention of cardiovascular disease. Rate of consumption of vegetables in the name of balanced diet in terms of nutrient intake of minerals and vitamins has been proven to contribute significantly in this study.

Industrial and economic analysis of dried vegetables and fruit products, particularly in the greenhouse or in direct sunlight, the solar panel to be assisted drying indicate well results such as less cost, supplying renewable energy and assuring food safety. Otherwise when consumed fossil fuels, polluted environment, creating health risk and higher cost of energy will be formed for human beings or all of the habitats. Dried products take up less space, are easy to handle, and can be stored for a long time. Durable food products in the food groups were evaluated as the most useful.

In sunny weather, even with the use of greenhouse drying process a minimum level of environmental conditions affecting products are obtained. Animals, especially rodents and flies are very difficult to maintain, and their waste products are dried under the sun. In this context, at a cost of less protection from this type of products can easily be put into the greenhouse. Drying in the greenhouse is relative to normal faster drying, such products can be achieved. Our study is on the improvement of the conditions in the greenhouse and then with some modifications, for example, the optimization of the air velocity is thought to be achieved by faster drying.

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