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EFFECTS OF CLIMATE CHANGE ON DRYING OF AGRICULTURAL PRODUCTS AND FOODS WITH TRADITIONAL SUN-DRYING TECHNIQUE

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ABSTRACT

Drying is one the preservation methods applied for making agricultural products and foods more stable. Sun-drying technique, as the simplest and oldest of the drying techniques used, has been used for years in the traditional drying of agricultural products and foods. Fruits, vegetables, grains, herbs, meat and meat products and dairy products are commonly dried by sun in spreading over a sheet on the ground. The moisture present is removed from the product by joint effect of heat and mass transfer in all of the drying techniques. In sun-drying technique, the product is dried until it reaches a safe humidity level for storage by direct exposure to the radiation coming from the sun. There exist external and internal parameters that affects the drying rate of the product. Internal parameters are mostly product-dependent but external parameters that can be classified as solar radiation, temperature, wind velocity and relative humidity are mostly depend on environmental factors. These parameters can be practically traced by microclimatic measurement devices. Since sun-drying has a seasonal dependency, in general it is carried out in July to September when external factors are satisfactory. Reasonable average temperature and relative humidity together with rainfall-free and cloud-free conditions are crucial for successful sun-drying application. In recent years, adverse effects of climate change can be observed with extreme temperatures, temperature fluctuations, and untimely rainfall events etc. Therefore, in this study, the possible effects of climate change on sun drying technique will be evaluated.

Keywords: Sun-drying, climate change, drying of agricultural products, drying of foods.

INTRODUCTION

Foods can become sustainable and stable by application of drying. Drying is one the preservation methods applied for making agricultural products and foods more stable and dates back to the Middle East and oriental cultures. Ancient people belonging to different cultures in the world get used to climate by adapting themselves in habitual practices. They use nature for local food sources required for their preservation to stay alive and establish communities

(Anonymous, 2022a). Grains, marine and meat products and also fruits and vegetables are dried for reduction of water activity to safe limits avoiding microbial growth (Jangam, 2011). Open-sun dehydration is a widely used by local people in small scale and also by drying industry. Meats are cured by using sun and also wind in early times of ancient people. In regions without enough sunlight or wind, fruits, vegetables and spices are dried by fire heating these foods in still houses (Anonymous, 2022a). Sun drying is one of the renewable energy sources provided by the nature. It is a green kind of technology without any generation of green-house gases. However, since environmental factors affects its existence there is a strong relation between sun-drying and climatic events. In this context, in this study, the characteristics, limitations of sun drying technique and the effects of climate change will be discussed.

Drying of Agricultural Products

Agricultural products mostly contain high levels of moisture content so regarded as highly perishable products. These products should be kept under temperature controlled environment and require sometimes some additional atmospheric conditions also. Especially fruits and vegetables has high amount of moisture (above 80%) that bacteria and fungi can easily grow on (Mishra et al., 2022; El-Mesery et al., 2022). High amounts of product losses occur (40-50%) due to adverse control of temperature during storage (inadequate refrigeration or freezing) (Mishra et al., 2022). Industrial and scientific developments provide ultra-modern drying techniques such as freeze drying microwave drying/infrared drying. However, the sun drying technique still exists today due to the almost lack of investment cost and practicality of application.

Drying of foods supply many advantages (Mishra et al., 2022).

- Extended shelf-life
- Availability of the products being out-of-season
- New alternative forms of product for consumption
- Reduced packaging, storage, transportation cost

Sun Drying Technique

Sun drying technique is the simplest and the oldest of drying technique used in drying the fruits and other products. Fruits, vegetables, grains, herbs, meat and meat products and dairy products are commonly dried by sun by spreading over a sheet on the ground. In sun-drying technique, the product is dried until it reaches a safe humidity level for storage by direct exposure to the radiation coming from the sun. Sun drying is strictly dependent on weather conditions and not applicable in regions having longer periods of wet seasons (Tan et al., 2022). Sun drying is a traditional type of drying method so preferred mostly people living in rural areas and in industrial production so far. In the selection of sun drying technique, being a natural renewable energy source and abundance of sun are the major concerns.

Sun drying methods can serve retaining of sensorial quality and nutritional composition but performed under uncontrolled conditions when compared with novel drying techniques (vacuum drying, microwave drying, freeze drying etc.).

Sun drying technique can be classified and applied in 5 different ways and given in detailed way in Table 1 (Mishra et al., 2022).

- Open Sun Drying
- Black Cloth Shade
- White Cloth Shade
- Conventional Solar Dryer
- Improved Solar Dryer

Table 1. Sun Drying Techniques

Sun Drying Techniques	Conditions	Consequences
Open Sun Drying (mean drying temperature : 26.8 °C)	Foods are left open under sun to dry	-
Black Cloth Shade (mean drying temperature : 26.7 °C)	The black cloth used absorbs greater heat due to radiation	Drying efficiency increases
White Cloth Shade (mean drying temperature : 24.5 °C)	White cloth does not absorb heat surrounding	Food is kept cooler due to white cloth White cloth acts as a barrier to dry Increased drying time
Conventional Solar Dryer (mean drying temperature : 32.6 °C)	Solar panels absorb the solar energy and give it to dry the foods	Quicker drying rate takes place
Improved Solar Dryer (mean drying temperature : 40.3 °C)	Hybrid passive mode of solar drying	-

Table 2. Advantages and Disadvantages of Sun Drying

Advantages	Disadvantages
Renewable energy source	Seasonal dependency
Simple and easy to apply	Contamination risk due to dust and rain Attracts birds and animals
Less investment costs	Non-uniformity in nutritional and sensorial quality, less sustainability in quality maintenance
Improved solar dryers help improvement in sensory quality	Excessive or inadequate drying is maintained

Sun drying efficiency depends on external and internal parameters. Internal parameters are mostly product-dependent. External parameters that can be classified as solar radiation, temperature, wind velocity and relative humidity are mostly depend on environmental factors. These parameters can be practically traced by microclimatic measurement devices. Since sun-drying has a seasonal dependency, in general it is carried out in July to September when external

factors are satisfactory. Reasonable average temperature and relative humidity together with rainfall-free and cloud-free conditions are crucial for successful sun-drying application. Advantages and disadvantages of sun drying technique is given in Table 2 (Indiatro et al., 2021; Mishra et al., 2022).

Climate Change and Sun Drying

The long-term more general weather conditions observed in larger areas are described by climate and weather is the short term behavior of atmosphere in a definite region. Temperature fluctuations and extreme rainfall events are indicators of climate change (Purwaningsih et al., 2022). Agricultural production is affected by temperature, rainfall distribution, wind speed and wind direction (FAO, 2015). Excessive long-term changes in temperature and precipitation trends are observed in climate change. Irregular weather conditions occur as a result of changing ambient pressure and humidity levels. Extreme conditions which are closely related with human life and natural systems are observed. Melting of the global ice sheets and sea level rise are results of climate change and affects the world with many international and local effects. Impacts of climate change in agricultural production is classified in Table 3 (Godde et al., 2021).

Table 3. Impacts of Climate Change on Agricultural Production

Direct impacts	Indirect impacts
Temperature levels	Pollinators
Rainfall distribution	Pests
Wind speed	Disease causing factors
Wind direction	Invasive and destructive pests or species

Food security is correlated with climate change in that; availability accessibility, utilization and stability of food is dependent on climate change. Technology uses raw material that is available. Climate change will hinder access to healthy nutritious food since ecosystem is adversely affected by climate change that limits access to many crops and other species. Increasing temperatures results in timeless precipitations events at the end floods occur in agricultural lands and hurricanes can occur as extreme events that destroys cold frames. As reported in Anonymous (2022b) floods also affect post-harvest practices as lastly flood occurred in Manisa, Turkey (August 2022) during sun drying of grapes caused significant losses in the crops.

CONCLUSION

Unfortunately, extreme temperatures, temperature fluctuations, and untimely rainfall events etc. are adverse effects of climate change observed in recent years. Climate change affects food production and therefore food availability. High temperatures in drying process causes loss of quality of foods. Since sun drying technique has seasonal dependency that is strictly correlated with climate change. Any adverse condition related to climate change would affect at first food availability and then food processing depending on natural resources. There are several drawbacks of sun drying such as infestation by micro-organisms, destruction by

animals or pests and over-drying or intermittent dehydration. Climate change will bring these negativities more effectively. Solar energy, a pioneer in renewable energy sources and an important way to reduce dependence on fossil fuels. In order to overcome these climatological problems, human should build their daily-life again. Less contribution to climatic changes as less release of green-house gases to the atmosphere and taking all preventive actions related to global warming. Use of renewable energy more, selecting green technologies in production and simplifying our lives positive contributions that should be concentrated on. Together with these preventive actions, use of enhanced form of sun drying that is solar drying systems that supplies higher drying air temperatures and higher drying rates in food drying is thought to be a promising method. Recent researches on solar drying systems and hybrid alternatives are also carried out. This can make drying with a renewable energy source possible even in adverse weather conditions.

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