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Simulation of solar dryer performances with forced convection experimentally proved

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Abstract

The aim of our study is to determine the drying curve and the change rate of drying by solar energy on two plant materials, olive pomace, and colocynth, depending on solar radiation. The dynamics of drying is monitored using an indirect solar dryer operating in forced convection, located at the UDES west of Algiers. We determine the influence of some parameters on the drying kinetics. We used two plant materials according to well-defined quantities which are characterized by different initial moisture content(Mafart P., 1991) .In order to verify the reliabilityof the dryer to dry different products with different humidity, we studied the variation of the solar radiation, drying rate and variable ambient temperatures at the end of work we simulate using a software results in the change of obtaining plans designating the experimental curves obtained after the change of several parameters such as air temperature along the path in the dryer, as well as mass loss and speeds drying products subjected to drying.

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Keywords: solar drying, drying kinetic; simulation, experimental result, solar irradiance; drying parameters.

Nomenclature:

X (t): Water content at any instant t (kg_{water} / kg $_{DM}$)
M (t): Wet product mass (kg)
M_s: Dry matter mass (kg)
M_i: Initial mass of product before drying (kg)
M_f: Mass of final product after drying (kg).
X_{eq}: Equilibrium moisture of product (%).

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1. Introduction

The solar crop drying is a practice that dates back several centuries that was outdoors. It has been used for drying grains, meat and other agricultural products for consumption in the long term. Much of the world's production in dried fruits and vegetables continues to be dried by conventional methods such as outdoors. However, large-scale production limits the use of outdoor drying because it suffers from several drawbacks, among them, the inability to control the drying process properly, uncertainties of weather, cost of labor, need for large areas, infection by insects and other foreign matter. Solutions involving proposed solar devices such as solar dryers. A properly designed solar dryer can alleviate the disadvantages of open sun drying and makes the industry and the quality of the final product can be improved .The use of flat plate collectors for air drying of food products in recent years has become a common technique (Jean Claude Charpentier, 1996) because of energy required by drying process and increase energy cost in recent decades (Daguenet .M, 1985). To succeed in such an operation, it is essential to involve drying chamber with an appropriate sensor operating temperatures allow a return in an interesting range, a short drying time and good quality dried product.

The experimental study is to measure following physical parameters:

• Temperature of various sub systems of indirect solar dryer;
• Overall solar radiation received and diffused in horizontal plane and global solar irradiance received on inclined sensor;
• The relative humidity of the air inside and outside of the drier;
• The weight loss products during drying.

The experimental apparatus on which measurements were performed essentially:

✓ A solar dryer with forced convection indirect kind;
✓ The equipment measures physical parameters;
✓ A data acquisition system type FLUKE HYDRA.

2. Materials and methods

Studied the solar dryer (figure 1) was designed and produced by UDES (Unit Solar Energy Development in BOU ISMAIL-). This is a system that converts solar energy into heat energy, through a heat transfer fluid (air).

The air preheated in a plane solar air is sucked through a centrifugal fan through ventilation duct through which propels a drying chamber in which are arranged the products to be dried. In this chamber, the air passes through rack in normal direction to surface. At outlet of dryer, the air is discharged to outside.

(a) **(b)** **(c)**

Figure 1: solar dryer elements: (a) general view of the solar dryer (b) drying cabinet; (c) Rack dryer