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DESIGN AND DEVELOPMENT OF AN INDUSTRIAL DRYER FOR NAGPUR ORANGE FRUIT

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Abstract: The purposes of this work were to design, construct & adaptation of a hot air dryer for Nagpur Oranges. It consisted of three units: Drying chamber, Blower & Heat Exchanger. The drying chamber is made up of M.S. sheet having dimensions 0.310m*0.300m*0.360m. The inner surface is made up of aluminum sheet about 2mm thick & outer surface is made up of M.S. sheet 50mm thick insulation. The bottom of dryer chamber is provided with heating system. Three aluminum trays having dim. 0.290m*0.2504m*0.009m were kept one above the other. All test samples were well equilibrated to the test conditions prior to testing. The time required for drying orange was considerably decreased with the increment in drying air temperature. It was seen that faster evaporation rates were observed at higher temperature thus drying time needed to reach specified moisture content was decreased. Among Sun drying, Freeze drying, Osmotic drying, Vacuum drying; Hot Air Drying is beneficial in many ways. The performance test was conducted at load and no-load condition.

Keywords: Design, Development, Hot air dryer, Nagpur orange, Industrial, Moisture content

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INTRODUCTION

India is the top agricultural country in the Globe. An agriculture sector plays a vital role in the economic growth of the country. It contributes 29.4% of Gross Domestic Product (GDP). Food is one of the most important product which are required by every citizen of the country where food and technology plays vital role. Food material differs from most other commercial commodities in several important ways. Food technology is a convenient and establishes means of food preservation and of the most relevant and challenging unit operation in chemical and food processing industries as well as a topic of continuous interest in food research industries. One of the requirement in Industry is to have relatively rapid processes and commensurate with high quality.

Orange

An Orange, specifically the sweet Orange (citrus sinesis(L)) is the most commonly grown tree fruit in the world. It was first grown in Iran around 600 years ago and later transferred to other parts of the World. Orange trees are widely cultivate in tropical and subtropical climates for the sweet fruit, is peeled or cut (to avoid bitter rind) and is consumed in different forms such as fresh fruit, concentrated juice and thin dried slices.

Juicy and sweet and renowned for its concentration of vitamin C, oranges make the perfect snack and add a special tang to many recipes; it is no wonder that they are one of the most popular fruits in the world.

You may already know that oranges are an excellent source of vitamin Cbut do you know just how important vitamin C and oranges are for good health?

Vitamin C is the primary water-soluble antioxidant in the body, disarming free radicals and preventing damage in the aqueous environment both inside and outside cells. Inside cells, a potential result of free radical damage to DNA is cancer. Especially in areas of the body where cellular turnover is especially rapid, such as the digestive system, preventing DNA mutations translates into preventing cancer. This is why a good intake of vitamin C is associated with a reduced risk of colon cancer.

Wastage of fruits and vegetables

Wills *et al*.(1998) stated that there was a high increase in production of vegetable and fruits from 112 million tons in 1970 to 203 million tons in 1994. The demand for vegetables by the growing population has not been met despite the increase. This is as a result of wastes that

result from biological and biochemical activities taking place in the fresh product and unfavorable storage conditions, inefficient handling, transportation, inadequate postharvest infrastructure and poor market outlets.

Rahman *et al*. (1992) estimated that as much as 25 % of some vegetables are wasted during peak production period. In Nigeria alone, up to 50 % of harvested tomatoes get spoilt annually (Musa-Makama*et al*., 2005) causing seasonal shortage and fluctuations in supply and prices. Fruits and vegetable can be successfully preserved by reducing their moisture content to a level that will discourage the activities of micro-organisms and fungi from deteriorating them. Microbial activities are not active when the moisture content of a product is below 10 %. Saravan (1999) reported that moisture content above 4.13 %(db)or 4% (wb) for vegetables will result to deterioration. Hence, harvested vegetables must be stored dry (5%moisture content wet basis) (FAO, 1981) to prevent attack and deterioration by activities of micro organisms and fungi.

Methods to prevent wastage.

Sun Drying has been one common means of food preservation. This method is totally dependent on weather and exposes the food items to microbes.

Osmotic drying is typical solid liquid contact process where the removal of water from a solid food is accomplished by immersion in a concentrated aqueous solution.

Freeze drying: Food products that are too sensitive to withstand any heat are often freeze-dried. Freeze dehydration is an operation in which water is removed from foods by transfer from the solid state (ice) to the gaseous state (water vapour). This operation (sublimation) can only be accomplished when the vapour pressure and temperature of the ice surface at which the sublimation takes place below those at the triple point. Food structure is affected differently dehydration. by sublimation than by other methods of dehydration because of a liquid phase during freeze dehydration.

Vacuum is often employed as a process for removing bulk and absorb water from a product combine with heat vacuum can be effective method of drying.

According to zomorodian (2006) an alternating and better drying system for high moisture fruit is either a dryer with continuous flow of heat or continuous movement of fruit. The flow of hot air may be same, opposite, across with respect to product.

Aims and Objectives

Designing hot air dryer to prevent the wastage of Nagpur Oranges

1. To determine the drying kinetics such as moisture content and drying rate for the drying process.
2. To measure moisture content in Nagpur Orange.
3. To determine mathematical models for thermal properties of Nagpur Orange and compare the same with the existing models.

Need of Hot Air Dryer

Nearly all types of spices, fruits and vegetables that are harvested must be preserved immediately. Rejection of these would lead to high economic losses. Dehydration is one of the oldest methods of food preservation and it represents a very important aspect of food processing. It is well known that reactions between food components are often accelerated during dehydration leading to reduction in quality and nutritional value.

Drying is a convenient and established means of food preservation. Drying of food product involves simultaneous heat and mass transfer phenomena. These transfer operations of food processing can be analyzed on the basis of physical and engineering principles. Exact application of these principles to food systems is usually difficult because of the complex and heterogeneous structure of food products and the physical, chemical, mechanical and biological changes that may take place during processing.

Hot Air Dryer

Conventional hot air drying is the most frequently used dehydration operation in chemical and food industry. In this case the drying kinetics is greatly affected by air temperature and material characteristics dimensions, while all other process factors exert practically negligible influence. Hence conventional hot air drying method will be designed and used in this work.

MATERIALS AND METHOD

Matured Nagpur Orange fruit (citrus sinesis(L)) of uniform size, shape with minimum defects were selected, weight of orange is measured found in average 84 grams.

All test samples were well equilibrated to the test conditions prior to testing. The system consists of heating element, centrifugal blower, drying chamber, heating chamber along with Anemometer, Hygrometer and digital Thermometer as shown in figure.

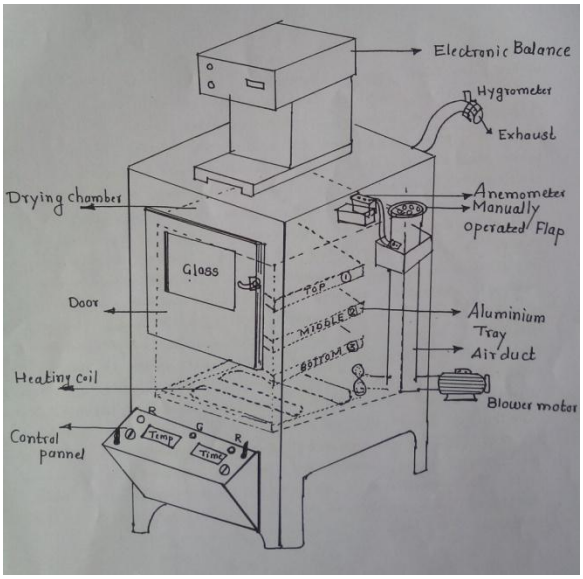

Fig. Hot Air Dryer

The drying chamber is made up of M.S. sheet having dimension of 0.310m*0.300m*0.360m. The inner surface is made up of aluminum sheet about 2mm thick and outer surface made of M.S. sheet 50mm thick insulation (Glass wool covered with compressed wooly cloth is provided on all sides of dryer) the outer surface of the dryer chamber is painted with a spray dye to prevent rusting of iron sheet surface. The front surface was used to load and unload the chamber. The bottom of dryer chamber is provided with the heating system consisting of 4 numbersof 500 Watt electric heater placed inside the duct. A relay was used to adjust the drying chamber automatically and this temperature was measured by iron constantan thermocouple. Three aluminum trays having dimension of 0.290m*0.2504m*0.009m were kept one above the other in drying chamber todetermine the drying characteristics of orange fruit in three different layers (bottom, middle and top). The air flow was adjusted by means of variable speed blower and manually operated adjusted flap at the entrance. Air flow rate was measured with anemometer (0.4m/sec to 0.3m/sec), LT Luston, type : AM 4201. Hygrometer sensor humidity sensor (adapter HA- 701, DC 1mv per% RH, resolution of 0.1% RH) was used to measure the relative humidity of the drying air. Moisture losses were recorded during drying process by means of electronic balance (Dhona 200D, type BL 0 to 220 grams, DC 12 volt, 0.1 Ampere with an accuracy of 0.1 mg). The drying chamber was then stocked with an orange and

test were conducted. This is referred as load test. The condition of no load and loadtest were then assessed and analyzed. The duration for the drying period was between 5 to 7 hours.

ADVANTAGES OF HOT AIR DRYER

1. It prevents the wastage of oranges.
2. It requires less time in comparing to other drying process.
3. It is simple & easy in handling.
4. It can be increases the drying rate by increasing the temperature of heating chamber.

DISADVANTAGES OF HOT AIR DRYER

1. It requires external power source.
2. Initial set-up cost of Hot Air Dryer is high.

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