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PERFORMANANCE AND ANALYSIS OF SOLAR HYBRID DRYER

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Abstract

Drying is an excellent way to preserve food and solar food dryers are an appropriate food preservation technology for a sustainable world. Drying preserves foods by removing enough moisture from food to prevent decay and spoilage. Water content of properly dried food varies from 5 to 25 percent depending on the food. The drying of product depends on external variables like temperature, humidity and velocity of air stream and internal variables which is a function of drying material and depends on parameters like surface characteristics (rough or smooth surface), Chemical composition (sugar, starch, etc.), physical structure (porosity, density, etc.) and size and shape of the product. The rate of moisture movement from the product inside to the air outside differ from one product to another and very much depends weather the material is hygroscopic or non-hygroscopic. Non-hygroscopic materials can be dried to zero moisture level while the hygroscopic materials like most of the food products will always have residual moisture content.

The solar dryer considered in this paper is the Distributed Passive Solar Dryer (DPSD) or Hybrid Dryer (HD). The product is located on trays or shelves inside an opaque drying chamber. Solar radiation is thus not incident directly on the products. Preheated air warmed during its flow through a low-pressure thermos phonic solar energy air heater, is ducted to the drying chamber to dry the product. Because the products are not subjected to direct sunshine, localized heat damage, do not occur. A typical Distributed Passive Solar Energy Dryer consist a drying chamber, an air-heating solar energy collector and turbo ventilator.

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Keywords:

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solar collector;
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1. Introuction

Most developing countries are unable to solve their food problems for the entire population because of the rapidly increas-ing number of people in their respective territories. This rapid population increase has a direct impact on food balance. The quality and quantity of food grains are deteriorating because of poor processing techniques and shortage in storage facilities. To maintain the right balance between food supply and population growth, reducing food losses during production time is mandatory. However, maximizing the food production capabilities of small farmers in rural areas is difficult. To solve the problem, drying has become one of the main processing techniques used to preserve food products in sunny areas. However, traditional open sun drying has some disadvantages. For the past few years, scientists and researchers have been trying to find the best alternative to overcome this problem. They invented various kinds of solar dryers for agricultural products and have continuously worked to improve these drye. [1]

Solar air heater is a type of energy collector in which the energy from the sun, solar insolation, is captured by an absorbing medium and used to heat air. Solar air heating is a renewable energy heating technology used to dry the agricultural products effectively and efficiently. A simple solar air collector consists of an absorber material, sometimes having a selective surface, to capture radiation from the sun and transfers this thermal energy to air via conduction heat transfer. This heated air is then ducted to the agricultural products such as chilies, grapes etc. Drying or dehydration of material means removal of moisture from the interior of the material to the surface and then to remove the moisture from the surface of drying material. Drying of seeds prevents germinations and growth and fungi and bacteria. The traditional age old practices of drying food crops in developing countries like India, Bangladesh etc. is spreading food products in open sun termed as open sun drying or natural sun drying .This natural sun drying is simple and economical but suffers from many drawbacks such as there is no control over the drying rate discoloration.

However, being unprotected from rain, windborne dirt and dust, infestation by insects, rodents and other animal, products may be seriously degraded to the extent that sometimes become inedible and the resulted loss of food quality in the dried Products may have adverse economic effects on domestics and international markets. Some of the problems associated with open-air sun drying can be solved through the use of a solar dryer which comprises of collector, a drying chamber and sometimes a chimney.[2] and [3]

1.1 Type of solar dryer

a) Direct solar

In these dryers, the material to be dried is placed in a transparent enclosure of glass or transparent plastic. The sun heats the material to be dried, and heat also biuldsup within the enclosure due to green house effect. The dryer chamber is usually painted black to absorb the maximum amount of heat.

b) Indirect solar dryers

In these dryers, the sun does not act directly on the material to be dried thus making them useful in the preparation of those crops whose vitamin content can be destroyed by sunlight. The products are dried by hot air heated elsewhere by the sun.

c) Mixed-mode dryers

In these dryers, the combined action of the solar radiation incident on the material to be dried amd the aie preheated in solar collector provides the haet required for the drying operation.

d) Hybrid solar dryers

In these dryers, although the sun is used to dry products, other technologies are also used to cause air movement in the dryers. For example fans powered by solar PV can be used in these types of dryers [2].

1.2 Solar Air Collector

The function of solar air collector is to absorb maximum solar radiation during sunshine hour falling on the collector. The front covers are made up of transparent glass material which act as a convection shield to reduced heat convection losses and produced green house effect. The glass plate thickness 8 mm and 600 cm^2 area. The absorber plate made up of aluminium sheet black painted with in contact of copper tubes of diameter 10 mm is located at the bottom of the plate. The thermal insulation (Glass Wool) of 5 mm thickness is place behind the absorber plate to prevent the convection or conduction heat losses

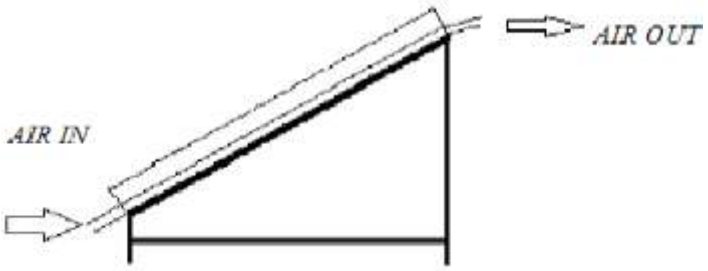

Figure 1. Solar Air Collector

1.3 Solar Drying Chamber

The design of solar air dryer is most important part of the solar drying system, as air circulation and moisture removal from the products affect a lot. In this work a rectangular chamber with front face tilt of 45^0 is used for the analysis. It consist of an enclosure with transparent glass cover of 4 mm thickness and square shape drying chamber of 4500 cm^2 cross section area. The material to be dried is placed on the trays. There are three trays placed inside the solar air dryer.

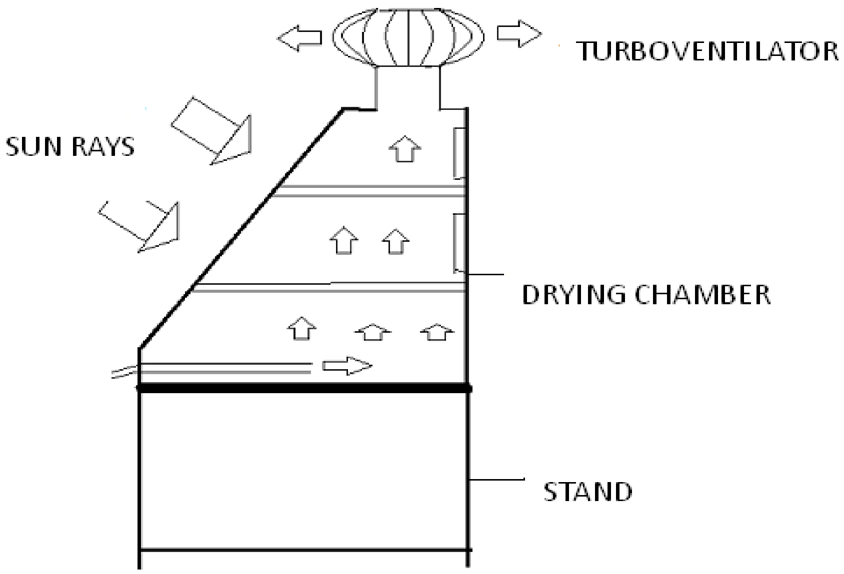

Figure 2. Solar Air Dryer

1.4 Turboventilatio

Turboventilation runs on external wind and creats necessary draught and maintain good air flow through solar dryer, No power required and unit is truly a renewable energy gadget. It acts as a booster to increase the rate of moisture removal and ultimetly reduceses the time taken for drying.

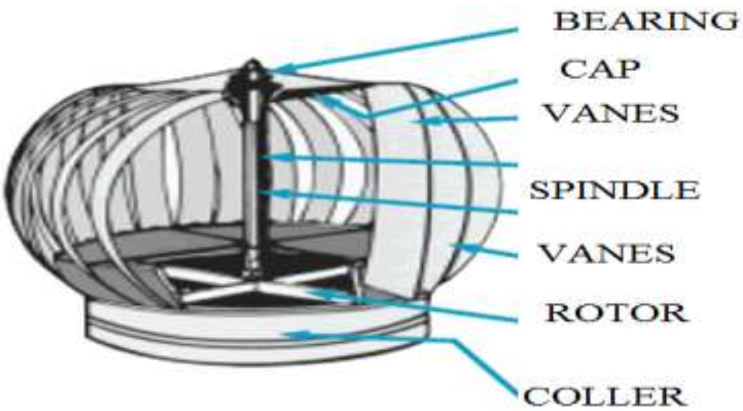

Figure 3. Turboventilation

2. Research Method

Solar hybrid dryer works on solar energy and wind energy combinely thus making it hybrid dryer. Solar air collector connected to drying chamber via air passage ducts.The ambient air passed into solar air collector through a single inlet. When solar radiations fall on the surface of solar air collector its heats up the air inside and warm air raises uo (because of density) and discharges into drying chamber via insulating air passage ducts. The hot air removes moisture present inside the product and discharges to the atmosphere via turbo ventilator operated by wind energy and hot air.

Figure 4. Experimental setup

DETAILS OF SETUP

(A) –SOLAR AIR COLLECTOR

(B) –SOLAR AIR DRYER

(C) – TURBOVENTILATOR

3. Result and Discussion

The experiments were performed with and without solar air collector and temperatures at different locations are recorded for the analysis. The testing carried out for 7 hours and the temperature were recorded on hourly basis by using digital thermometer of range -10^{O}C to 150^{O}C for drying of chilli, potato, spinach and green peas.

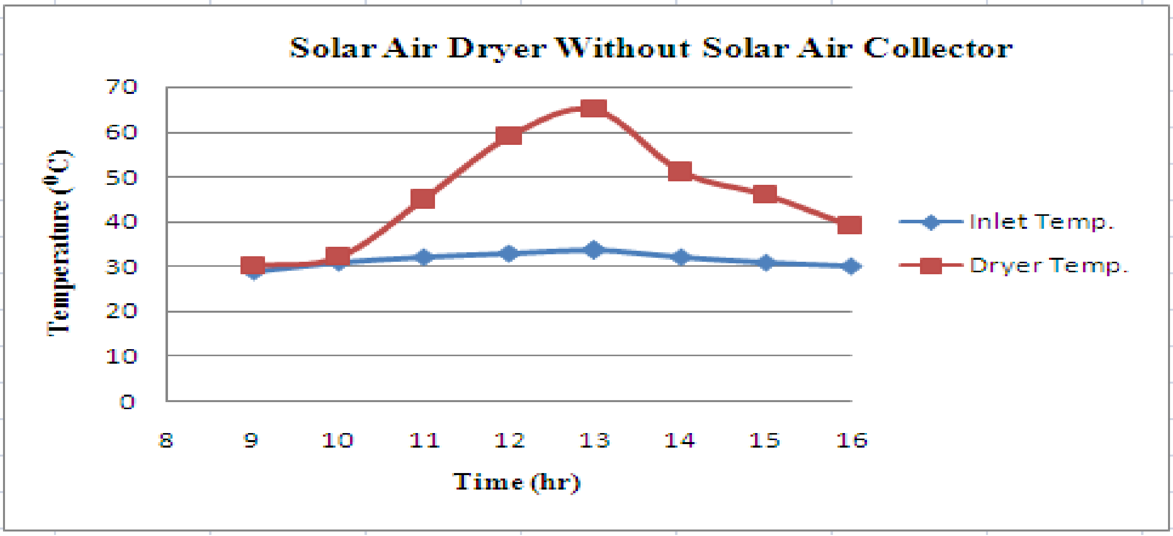

Figure 3.1 Temperature variation of air at inlet and inside solar air dryer without solar air collector with respect to time.

The variation in temperature of solar air dryer without solar air collector with respect to time during sunshine hour is shown in figure 3.1. The temperature of air is maximum in noon time (12 noon To 2 pm) it rises up to 65^{O}C.

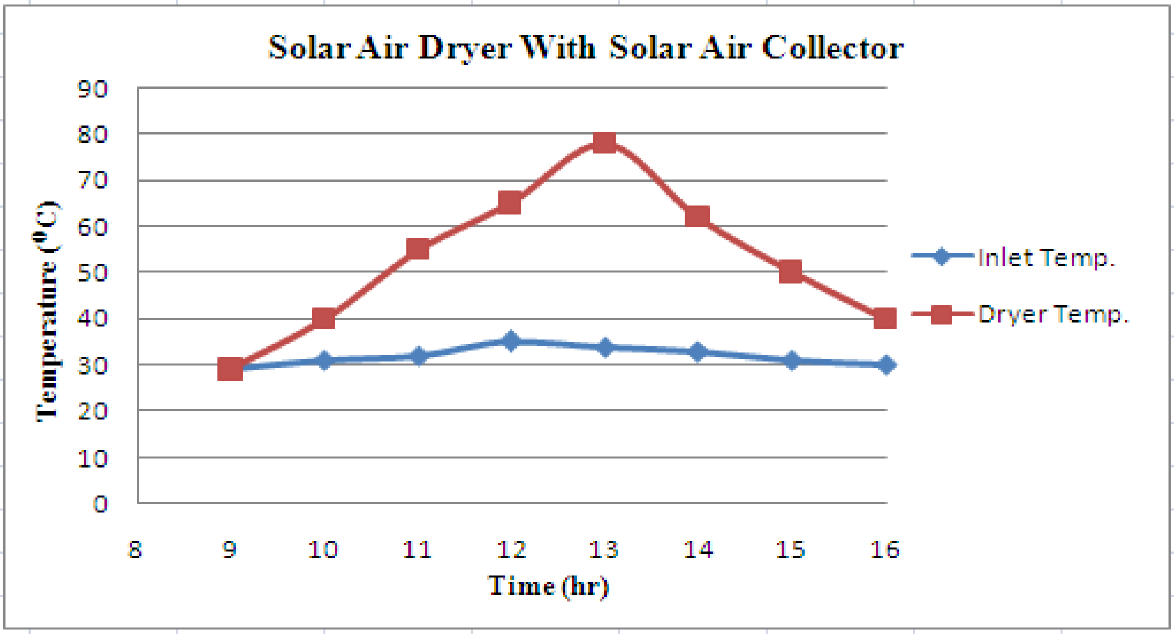

Figure 3.2 Temperature variation of air at inlet and inside solar air dryer with solar air collector with respect to time.

The variation in inlet and outlet temperature of solar dryer with solar air collector with respect to time during sunshine hour is shown in figure 3.2. The temperature of air is maximum in noon time (12 noon To 2 pm) it reses upto 78^{O}C.

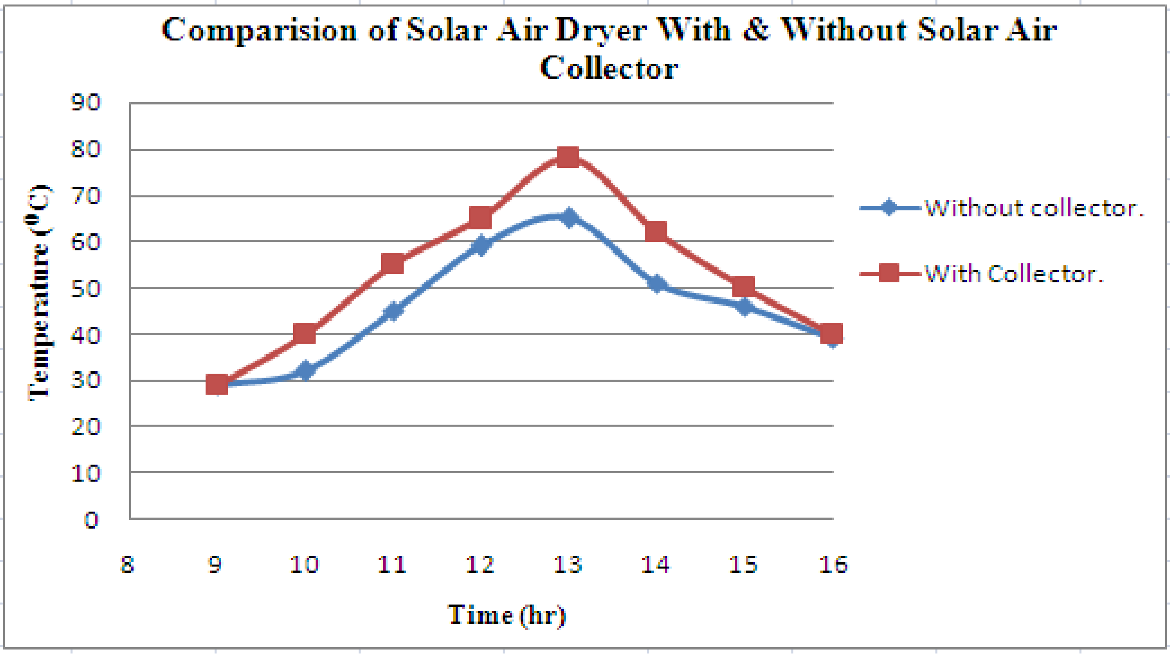

Figure 3.3 Temperature variation of air inside solar air dryer with and without solar air collector with respect to time.

Figure 3.3 shows comparision in temperature of solar air dryer with and without solar air collecter gives maximum temperature during noon time as comparitavaly without solar air collector.It shows maximum energy achieved possible by connecting solar air collector to the solar dryer.

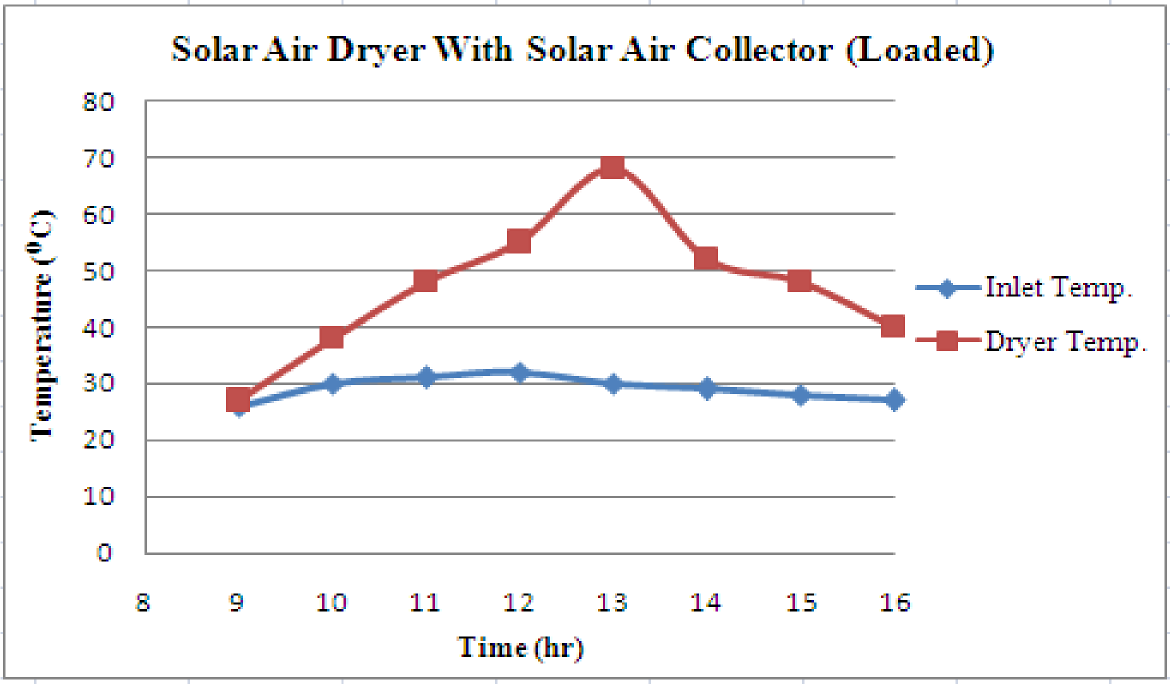

Figure 3.4 Temperature variation of air at inlet and inside solar air dryer (Loaded) with solar air collector with respect to time.

The variation in inlet and outlet temperature of solar dryer with solar air collector with respect to time during sunshine hour is shown in figure 3.4. The temperature of air is maximum in noon time (12 noon To 2 pm) it reses upto 68^{O}C.

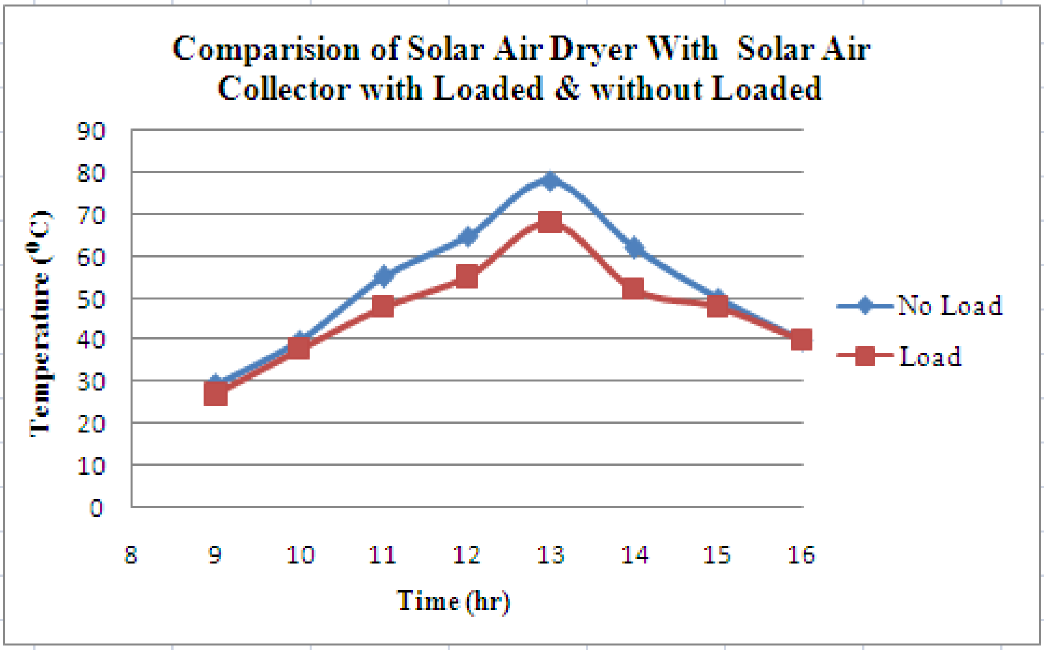

Figure 3.5 Temperature variation of air inside solar air dryer with solar air collector with and without loaded condition with respect to time.

Figure 3.5 shows comparision in temperature of solar air dryer with solar air collecter during loaded condition gives minimum temperature and without loaded condition gives maximum temperature during noon time it reses upto 68 and 78^{O}C respectively.

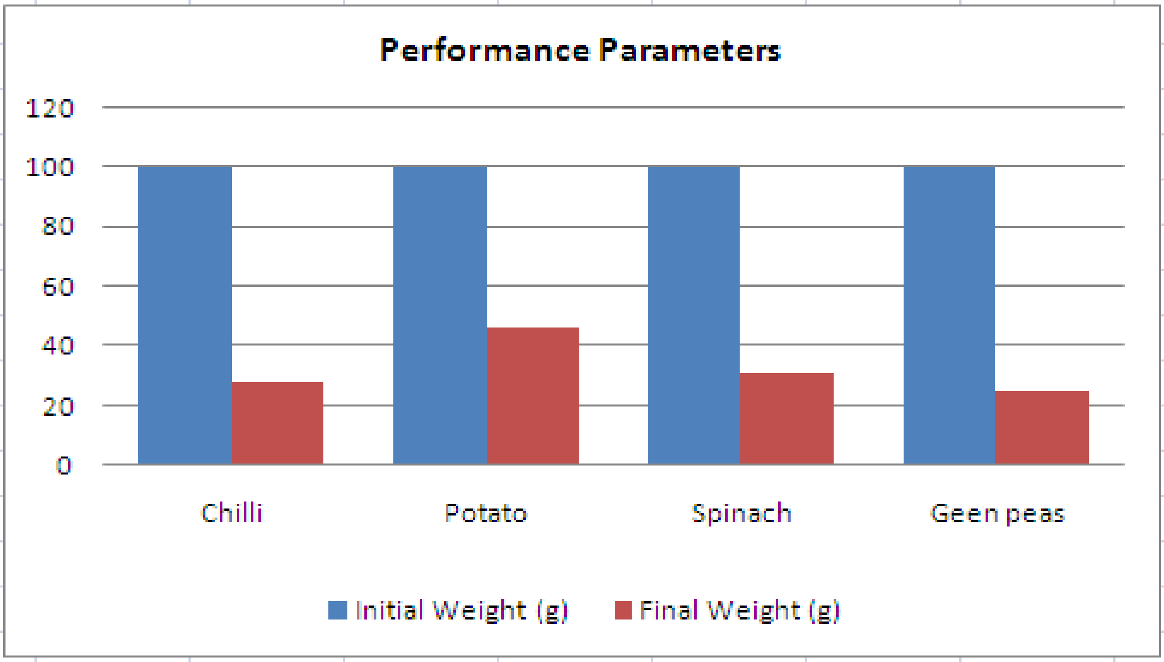

Figure 3.6. Variation of initial and final weight and moisture with respect to chilli, potato, spinach and green peas

The above figure 3.6 shows when solar air dryer with solar air collector dries agriculture products like chilli of initial weight 100 gm to final weight 28 gm, Potato of initial weight 100 gm to final weight 46 gm, Spinach of initial weight 100 gm to final weight 31 gm and Green peas of initial weight 100 gm to final weight 25 gm.

4. Conclusions

1) The experiment were performed on solar air dryer with and without solar aor collector, the maximum temperature rises from 9AM to 4 PM is 78 ^{O}C and 65 ^{O}C respectively with No load consdition.
2) Solar air dryer with solar air collector achived maximum temperature during noon time as campare to solar air dryer without solar air collector.
3) The solar air dryer with solar air collector dries products like potato, chilli, spinach and green peas of initial weight 100 gm to final weight 28, 46, 31 and 25 gm respectively.
4) Solar air dryer with solar air collectot dries agriculture products in 7 hours.
5) Turboventilation increases the rate of moisture removal and ultimetly reduceses the time taken for drying agriculture products.

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The main references are international journals and proceedings. All references should be to the most pertinent and up-to-date sources. References are written in APA style of Roman scripts. Please use a consistent format for references – see examples below (9 pt):

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