Green Drying of Herbs Using Solar Dryers: A Performance Study

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ABSTRACT

Now a days India is going through a difficult situation of energy segment, at present India is spending annually more than 160 Million tons of coal, in excess of 100 Million tones of petroleum products and mineral oil and around 250 Million tones of other conventional energy to meet our industrial, agricultural, domestic and commercial requirements. It is found in research that around 400 million tons of oil imports and 800 million tons of coal import in addition to the local resources will be needed in 2030 to sustain the projected 8% growth rate in India. The Conventional energy is exhaustible ending soon, polluting and also reason for the global warming. Generation of process hot air using fossil like electricity, diesel, furnace oil, coal, firewood etc, is very much common practice in almost all industrial and agricultural processing units, Nagpur, being the solar city of India as per govt, which had higherrate of solar radiation 5.8 KWhr/m^2/day is yet to tap the proper use of solar energy for application like drying of herbs. In this research work study the authors have Conducted the experiments in solar drying of selected green herbs of central India

Keywords: Drying Characteristics,Solar Dryer, Green Drying.

I. INTRODUCTION

Drying is quite important and vital and critical operation in any industry or Agricultural Industrial process requiring substantially high amount of conventional energy. India spends annually about 1.80 Million KL of fuel oil which is same as that for meeting 60% of the thermal type energy for processing the products India to get final products, with an average rate of solar radiation of the potential of 4-7 kWh/m2/day, has huge potential to make utilization of solar energy as alternate source of energy for conventional energy. The central India city, like Nagpur which is having has rate of solar radiation of 05.8 kWh/m2/day. With about 300 clear and sunny days and in summer temperature goes up to 48^{o}C has been declared as a solar city by Govt. of India. As per department of AYUSH, by the Govt of India sources, about 40% of Indian forest products including green herbs are soured from central India in and area around Nagpur including the Satpura Hills of Madhya Pradesh region also. Since the Satpura Hills region is being recognize to be as the Biotech Zone,Amongst other Natural herbs by government, this region quite suitable for the growth of stevia plants which is a Natural Herbal sweetener. These herbs are being perishable in nature needed to be dried as primary process as part of thepost harvest system for further application. So these few Green Herbs having great importance in central Indiaregion along with their benefits considered for the study of green drying. This paper giving highlights on studies on stevia. Stevia herb known as alternative to the sugar without any side effect which giving steviol and steviocides. These natural Herbal Sweetner available in this region grown very well in semi-humid subtropical regions on 200-400 meters above sea level, with 1500-1800 mm of rainfall and temperature extremes rounds of minus 6 ^{0}C to plus 43 ^{0}C . The fully grown plant survives to 5 years and can be larger, up to 1.8 m along with 20 sub branches of leafs per plant. So as far the wether conditions are concern, Nagpur Region is best for Stevia plant cultivation.

Green dried herbs retain the noteworthy amount of their original colour, aroma and healing qualities in them. Green drying of herbs is not really that difficult but it does require some careful scientific and systematical attention to each and every plant’s attributes. So that its properties can be retain for the further application in medical field and in food processing fields are concern.

II. THE DRYING OPERATION

The leafy parts of most herbs are dried best around temperatures of 35^0 to 40^0 C. For the better drying of the herbs, theair flow around them is very important, along with the heat, grater air circulation which makes a lower drying temperature possiblefor green drying of the herbs.Theseherbs contain the volatile oils which needed to be dried in the shadow not in the sun, where these volatile oil would decompose or vaporize. Conventional methods used of drying are.

1. Oven Drying
2. Microwave drying
3. Air Drying
4. Dehadrator Drying
5. Flower –Press Drying
6. Freezing Herbs :

Crop drying or drying Herbs is energy intensive process but very important for the preservation of harvested crops for further application. Herbs are dried to the equilibrium moisture or water content which will allow for sage and storage for the further processing of the herbs. The equilibrium moisture or water content (EMC) is important parameter because that will indicate whether the product will lose or reabsorb moisture at the specific ambient temperature and relative humidity. For most of the Indian Green Herbs desired moisture content on drying is around 9 to 12%. The traditional method for drying crop in this region is sun drying in open environment. While sun drying gives the advantages of no energy cost and its disadvantages are uneven drying, animal and insect infestation, exposure to rain, grater possibility of spoilage and excessive handling which results in high labor costs and human contamination.

In order to select an appropriate dryer and the drying parameters such as temperature and drying time, it is very important to understand the drying behavior of the material which is to be dried. This principle helps to forms the basis of these drying studies. These studies are conducted to determine moisture loss characteristics, physical and biochemical changes of specific Herbs.

III. SOLAR DRYING OPERATION

Solar drying systems give an attractive option to make use of solar energy. These solar drying systems can be quite compact, suitable and useful for farmers in this region and for the agricultural industry. Solar drying systems can be mainly classified as direct or indirect types and whereflow of air may be forced or natural convection. For industrial applications or for drying for large application, mixed mode types of dryers whichmakes utilization of solar energy as well as conventional fuelsalong with forced convection are recommended for the use in this mixed flow. For the small and poor formers of this region, properly designed and simple solar cabinets of low cost will be recommended for use. Solar Drying phenomenon will now be viewed as only important process for the production of storable and primary green herbs in this region. Drying will now be also be considered as an integrated operation for food processing operations, with technology as well as entrepreneurship combined together to create successful business that will helps to create many entrepreneurs and employment in the suicide hit and drought hit areas of Nagpur as well as other part of the india.

Crop or herbs drying is the process of removing water or moisture from food by passing over hot air through it or over it, This hot air is needed to evaporate the moisture or amount of water content contained within the solid products, and air flow is important to remove the vapour from the products. For more effective drying process, air should be quite hot, dry and moving and moisture must travel from inside of the product to the product's surface area quickly, because as this is the place wherethe exchange of moisture with the air occurs. There are usually two stages in a typical drying process:

- The first state is the removal ofmoisturefrom the surface of product.

- The second stage is the removal of internal moisture form inside the solid material product.

The drying process is therefore further divided into a “constant rate” period and a “falling rate” period process. During the constant rate of drying process period, if the outer surface of the material is still wet and the rate of drying is given by evaporation of free moisture from the product’s outer surface or near outer surface areas of the products. The rate of drying is very much dependent on the vapor pressure gradient between surface of the product and the air. Air velocity,temperature of Drying air, shape and size of the drying particles can significantly affect the rate of drying operation.

Most of the natural products in this region including our selected herbs for the studies like Stevia leaf amongst the other herbs needed to be dried Green so as to retain their properties and qualities for better effectives in further application. Therefore there is a great demand for dryers for creating the green dried material that will remaingreen even after the drying so as to retain its properties. Since the market size being quite large and with better and easy availability of solar radiations, solar dryers could be emerges as the most cost effective and energy efficient alternative for such applications in the green drying of various herbs. The main objectives in this research works is to carry out “Studies on drying characteristics, effectiveness and development of solar dryers for green drying operation of stevia leaves and other selected herbs in region of central India for more effective drying purpose.

IV. THE DRYING CHARACTERISTICS

The Drying characteristics of Herbs are calculated by passing heated air through a surface layer of the material and measuring the quantity of moisture changes with time until the equilibrium condition is approached. The drying curve which is a plot of herb moisture content in product with the drying time for the selected product is used for describing moisture loss (or drying behaviors) of herbs during the green drying operation. Drying curves are used to represent the influenced of the factors which majorly affect the rate of drying for green herbs the e.g. temperature air velocity,size of particle and thickness. Green drying in the falling rate period, which is usually the dominant period of crop drying is assumed to be a moisture diffusion process occurs in herbs. That is the diffusion of moisture or water content from within to the crop’s surface is the rate controlling process. Most drying studies use the analytical solution according to Fick’s Law of diffusion as shown in figure1. Figure 3 to figure 6 shows Comparison of Drying Characteristics for green herbs.

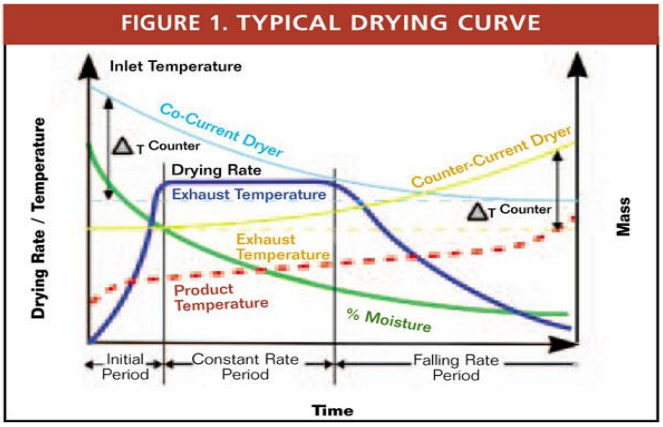

Fig.1: During Processing, drying occurs in three different periods, or phases, which can be clearly defined

The important required physical characteristic parameters for each crop are as follows:

1. Bulk density at various forms.
2. Drying rate at different drying conditions of herbs.
3. Upper limits of drying rates and temperatures.
4. Equilibrium moisture content.
5. Product qualities at different drying process.

6. Pressure drop across the product bed.

The main objectives of the field trial are as follows:

1. To optimize the technical performance of these solar dryers in a scalable size at the field level.
2. To determine the other requirements for the end users to profitably application of these dryers and to monitor the economic impact of the drying facilities on their operations according to the applications.
3. To determine the drying characteristics of other high value crops and herbs for possible inclusion in the year round utilization schedule.
4. To transfer the information of the dryers in terms of publication and to private sectors and governmental extension agencies for the more use of the solar energy.
5. Solar dryer comprises of an air collector drying chamber and an air circulations system. Heated air in solar air collector chamber was forced through the foods or crop by a blower for fast removal of moisture. During the drying period temperature of dry air, relative humidity,rates of air flow, solar radiation, and lose of mass were measured using equipments continuously in different part of the dryer using various devices. Drying time is calculated with mass ratio as exponential and polynomial correlations.
6. The experimentation will be carried out in constant temperature and uniform humidity.
7. Temperature of Dry air can be the very important factor affecting the drying kinetics of herbs rather than the effect of the relative humidity.
8. The proposed experimental study will be performed to find out the drying characteristics of herbs by using the hot air, solar tunnel and open sun drying methods. For the constantvelocity of air and air temperature in the range of about 40-60 deg. C.
9. For solar drying experiments a solar tunnel dryer are constructed at a very low cost with locally and easily obtainable materials will be evaluated.

V. THE SOLAR DRYERS

Solar dryers shown in fig. 2 can be classified based upon the exposure of the crop to direct type or indirect type solar radiation or the method of air flow though the dryer which may be by natural or forced convection energy. Supplementary other heating sources can be used in dryer to ensure that drying conditions are maintained in the solar dryer in rainy season or at night, or when very large quantities of material are being dried in dryer. Heat exchangers may also have to be built into the drying system so as to ensure good product quality of the herbs or crop.

Solar dryers are constructed with the following important futures, viz.

1. A Cabinet for holding the product- Product is usually placed on a drying trays or a bin.

2. All absorber plate usually made of galvanized sheet which are painted flat black-This is the flat plate which receives and absorbs the solar radiation for drying operation and whose temperature raises as a result, Heat is then transferred from this hot plate to the air flowing over and the dryer for effective drying.

3. The transparent cover- This is the clear cover placed over the absorber plate and usuallyglassmade or clear plastic. This is done to reduce heat loss from the absorber device plate to the surroundings.

4. Air Movement – Natural or forced type convection may be employed. Simple dryers use natural type convection where the buoyancy of the heated air is used to create a draught or pressure difference through the dryer. For large crop volumes forced air movement using axial or centrifugal electric fans are recommended for fast removal of moisture.

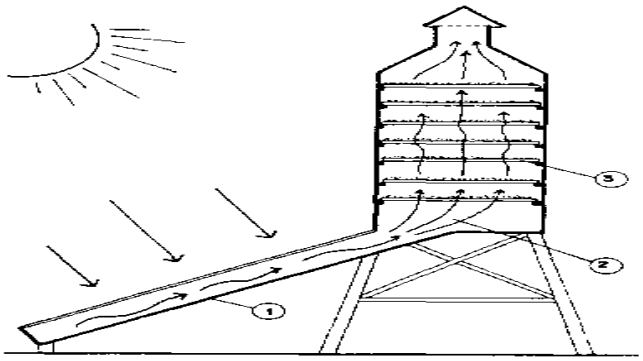

Figure 2: Typical layout of solar dryer

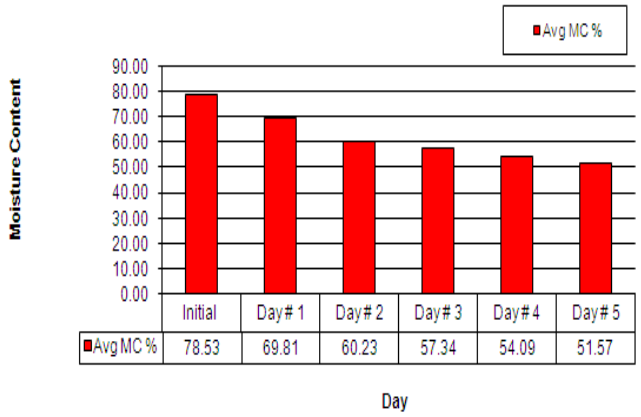

Figure 3: Typical moisture content A of Sun dried green material

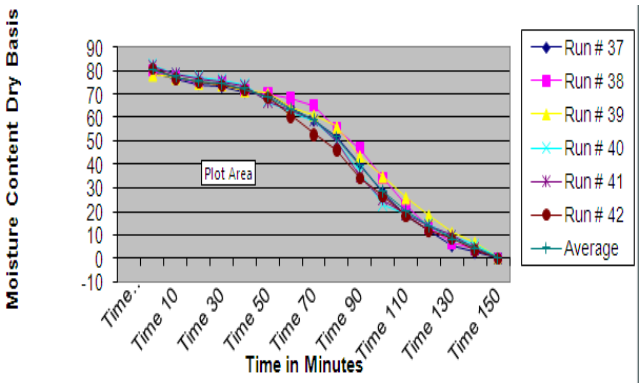

Figure 4: Typical drying characteristics on dry basis

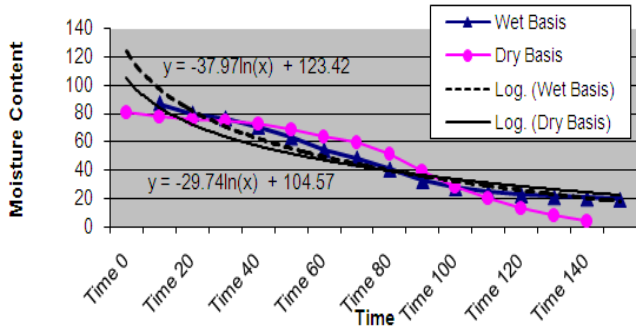

Figure 5: Comparison of Drying Characteristics

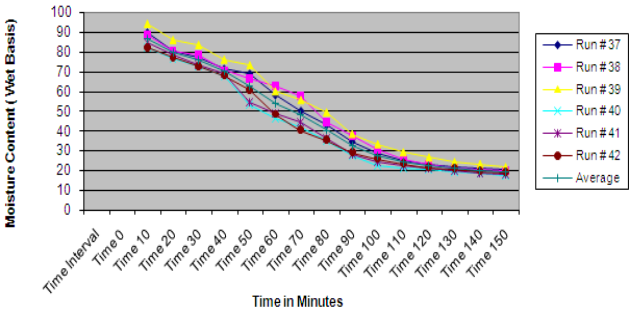

Figure 6: Typical drying characteristics of raw material - wet basis

VI. CONCLUSION

Under this experimental investigation for thermal performance of solar air heater gives the temperature difference of atmospheric air and wooden box of solar air heater of near about 20 to 25 ^{0}C on a moderate sunny day. It is suitable air heater for creating the hot air of space heating and agricultural drying applications of the herbs and other crop which can be consider as the primary process agricultural industry

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