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Modeling and Analytical Experimental Study of Hybrid Solar Dryer Integrated with Biomass Dryer for Drying Coleus Forskohlii Stems

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Abstract. Coleus forskohlii is a botanical that has been used since ancient times in Hindu and Ayurvedic traditional medicine. The root portion of the plant has been traditionally used for medicinal purposes and contains the active constituent and forskolin. Forskolin was named after the Finnish botanist, Forskal. Historically, it has been used to treat hypertension, congestive heart failure, eczema, colic, respiratory disorders, painful urination, insomnia, and convulsions. In this work an integrated Hybrid type of Solar dryer has been designed integrated with Biomass Energy and evaluated using experimental study of drying Coleus stems. Major components of this Hybrid dryer are solar collector, drying chamber and Bio-mass producing setup. The dryer has been modeled using the simple materials and tools. Then it will be evaluated using three methods like only solar dryer, only bio-mass and hybrid technique of solar dryer with bio-mass. Moisture content of the Coleus stems has been determined using three ways. A result shows that the Integrated Hybrid model produced the best optimum results. Hybrid model produced the moister content of the stems has been 12.3%, whereas Solar dryer produced 33% and Bio-mass produced 19.6%.

Keywords: Coleus Forskohlii Stems, Hybrid model, solar dryer, Bio-mass, Collector

1. Introduction

1.1. Coleus Forskohlii

Coleus forskohlii is part of the mint family of plants and has long been cultivated in India, Thailand and parts of SE Asia as a spice and as a condiment for heart ailments and stomach cramps. The stems of the plant are a natural source of forskolin, the only plant-derived compound presently known to directly stimulate the enzyme adenylate cyclase, and subsequently cyclic. This species is a perennial herb with fleshy, fibrous stems that grows wild in the warm subtropical temperate areas in India, Burma and Thailand. It is one of the 150 coleus species, which are commonly cultivated as ornamental plants, because of their colorful foliage. The stems of C. forskohlii, unlike other coleus species, are used for health purposes. Coleus forskohlii belonging to the family Labiatae was collected in 1973 from Dehra Dun in North India for targeted pharmacological screening for its phylogenetic relationship to a medicinal herb, C. amboinicus. Diterpene Forskolin was derived as active alkaloid from the stems.

Fig.1. Coleus forskohlii

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Fig.2. Coleus Stems

Figure 1 shows the Coleus Forskohlii and Figure 2 Shows the Coleus stems which we have taken for our work. In this work Hybrid model of Solar-Biomass system has been used to dry the Coleus Stems. It leads better performance than other methods.

1.2. Solar Dryer

Dehydration, or drying, is a simple, low- cost way to preserve food that might otherwise spoil. Drying remove water and thus prevents fermentation or the growth of molds. It also slows the chemical changes that take place naturally in foods, as when fruit ripens. Surplus grain, vegetables, and fruit preserved by drying can be stored for future use. People have been drying food for thousands of years by placing the food on mats in the sun. This simple method, however, allows the food to be contaminated by dust, air borne molds and fungi, insects, rodents, and other animals. Furthermore, open air drying is often not possible in humid climates. Although solar dryers involve an initial expense, they produce better looking, better tasting, and more nutritious foods, enhancing both their food value and their marketability. They also are faster, safer, and more efficient than traditional sun drying techniques. An enclosed cabinet-style solar dryer can produce high quality, dried foodstuffs in humid climates as well as arid climates. It can also reduce the problem of contamination. Fruits maintain a higher vitamin C content. Because many solar dryers have no additional fuel cost, this method of preserving food also conserves non-renewable sources of energy. This paper describes some of these dryers and discusses the factors that must be considered in determining what kind of dryer is best suited for a particular application. Drying products makes them more stable and in the case of foods, allow them to be stored safely for long periods of time. Safe storage requires protection from the growth of molds and other fungi, the most difficult of the spoilage mechanisms to detect and control. Solar dryers have the principal advantage of using solar energy – a free, available, and limitless energy source that is also nonpolluting. Drying most foods in sunny areas should not be a problem. Most vegetables, for example, can be dried in 2-1/2 to 4 hours, at temperatures ranging from 43 to 63 [degrees] centigrade (110 to 145 [degrees] Fahrenheit). A solar food dryer improves upon the traditional open – air systems in five important ways:

1. It is faster; food can be dried in a shorter amount of time.

2. It is more efficient .Since food stuffs can be dried more quickly; less will be lost to spoilage immediately after harvest. This is especially true of produce that moisture content. In this way, a larger percentage of food will be available for human consumption.

3. It is safer .Since foodstuffs are dried in a controlled environment, they are, less likely to be contaminated by pests, and can be stored with less likelihood of the growth of toxic fungi.

4. It is healthier. Drying foods at optimum temperatures and in a shorter amount of time enables them to retain more of their nutritional value – especially vitamin C.

5. It is cheaper. Using solar energy instead of conventional flues to dry products.

2. Literature Review

Dehydration is a common technique for preservation of agricultural and other products, including fruits and vegetables. In developing countries, the traditional method of dehydration is by open air, which often results in food contamination and nutritional deterioration [1]. Some of the problems associated with open-air drying can be solved through the use of solar dryers which are generally classified, depending on the mode of heating or operation, into: (a) direct, (b) indirect and (c) mixed mode systems with natural or forced circulation of the drying air. In the direct dryer, solar radiation passes through a transparent cover fitted on the top part of the dryer and is directly absorbed by the crop placed on the drying bed under the transparent cover. In an indirect dryer, air is heated in a separate solar collector and circulated through the drying bed where it picks moisture from the crop. The mixed mode possesses both features of the direct and indirect categories of solar dryers. In particular, dryers of the natural-convection variety are popular because they are cheap and simple to operate and maintain [2,3]. It was found that the rock pile stored enough energy to enhance nocturnal drying. The duration of crop drying in the solar dryer was shorter than that in the open air [4,5,6]. And also developed a solar air heater and tested it with and without thermal storage for drying agricultural products. They found that the drying process would continue at night when a thermal mass was used. They have developed a solar dryer with a thermal storage system. The dryer was tested with and without thermal storage. They found that the storage material reduced the drying period [7,8]. They used a phase change material to store thermal energy in a solar air heating system. There is, therefore, still need to backup the drying process in solar dryers with thermal mass. The dryer was tested in three operational modes (solar, biomass and solar–biomass) by drying fresh pineapple [10, 11]. Outdoors under different weather conditions. Results show that the dryer is capable of reducing the moisture content of pineapple slices to acceptable levels, and retaining part of the vitamin C in the slices. The drying process is fastest in the solar–biomass mode of operation while the efficiency of the system is most satisfactory in the solar mode. So consider these literatures in this work we have proposed the Solar-Biomass integrated Hybrid system to dry the Coleus Forskohlii stems.

3. Desing of Proposed System

Three – dimensional solar cells that capture nearly all of the light that strikes them and could boost the efficiency of photovoltaic systems while reducing their size, weight and mechanical complexity. The new 3D solar cells capture photons from sunlight using an array of miniature “tower” structures that resemble high-rise buildings in a city street grid. Figure 3 shows the proposed system work sequence. Then Figure 4 shows the model of solar system what we have proposed and Figure 5 shows the Bio-mass setup of our experiment. Figure 6 shows the setup model of our proposed Hybrid model of Solar – Biomass system.

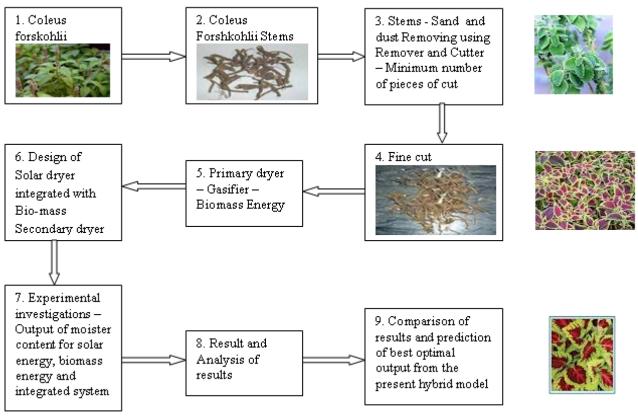

Fig.3. Work sequence of proposed Hybrid system

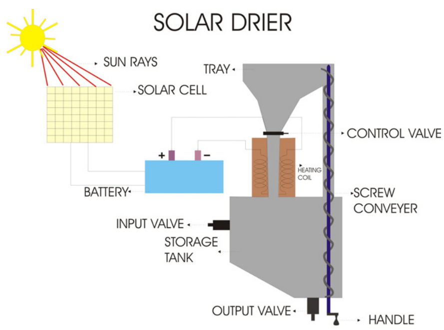

Fig.4. Model Design of Solar system

Fig.5. Model Design of Biomass system

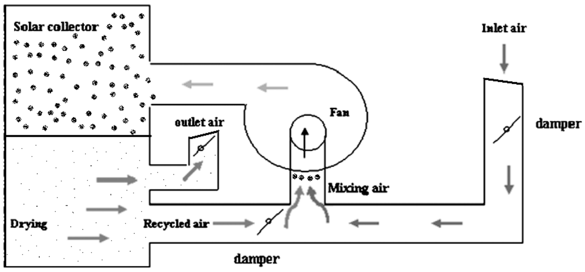

Fig.6. Model Design of Hybrid Solar -Biomass system

4. Results and Discussion

In this work we have proposed the Hybrid model of Solar – Biomass setup to dry the Coleus forskohlii stems. First we have tried with only solar model then the moisture content of the Coleus stems will be 33%. Because only solar system will produced lower percentage of performance while it reduced the moisture content from 87% to 33%. Later we have tried with our experiment setup of Bio-mass system it produced nominal percentage of moisture content that is 19.6%. Finally we have proposed the Hybrid setup of Solar-Biomass system to dry the Coleus stems. It produced the better percentage of moisture content that is our proposed hybrid model reduced the moisture content from 87% to 12.3%. Table 1 shows the output results of all the methods. Figure 7 shows that the graphics analysis of output.

Table.1. Comparative Results of Moisture Content of Coleus Forskohlii Stems

S.No	Solar Dryer model (Moisture content %)	Bio-mass dryer (Moisture content %)	Hybrid model (Solar dryer + Bio-mass Dryer) (Moisture content %)
1	33%	19.6%	12.3%

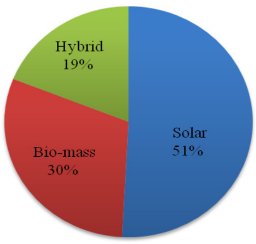

Fig.7. Comparison of output

5. Conclusion

The Solar Drier is analyzed with various temperatures and with different agriculture products which should be dried. The performance of solar cell, Battery, Heating coil, Screw conveyor, Tray and tank are verified thoroughly and find that are working properly. In this work an integrated Hybrid type of Solar dryer has been designed integrated with Biomass Energy and evaluated using experimental study of drying Coleus stems. The dryer has been modeled using the simple materials and tools. Then it will be evaluated using three methods like only solar dryer, only bio-mass and hybrid technique of solar dryer with bio-mass. Moisture content of the Coleus stems has been determined using three ways. A result shows that the Integrated Hybrid model produced the best optimum results. Hybrid model produced the moister content of the stems has been 12.3%, whereas Solar dryer produced 33% and Bio-mass produced 19.6%.

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