ISSN: 2349-6495

Drying of Millet using Solar Dryer

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***Abstract*—**The purpose of food preservation is to allow it stay longer and as well save resources. Drying of farm produce could be sun drying or solar drying. Farm produce could also be dried using other means of drying such as using kerosene dryer ,electric dryer or it could be processed to either finished or semi-finished products. Sun drying is very good method of drying but the problem it has is unsteady solar radiation which make some of the farm produced get spoilt. Sun drying also has a problem of micro-organism growth before the food is dried due to fluctuation of solar intensity. This work centred on the use of solar dryer for millet drying. The solar dryer has a capacity of holding up to 30Kg of grain. The area of the solar dryer used in the experiment was $0.48m^2$.The experimental result obtained showed that solar dryer enhances drying of farm produce. The weight reduction of 10kg to 3.4kg was achieved using the solar dryer. The maximum atmospheric temperature recorded during the experiment was 30°C.

Keywords*—*Drying, moisture, preservation, solar drying, sun drying.

I. INTRODUCTION

Drying is a simple process of moisture removal from a product in order to reach the desired moisture content and is energy intensive operation [1].Several process technologies have been employed on an industrial scale to preserve food products; the major ones are canning, freezing, and dehydration [2]. Energy is important for the existence and development of humankind and is a key issue in international politics, the economy, military preparedness, and diplomacy [3]. To reduce the impact of conventional energy sources on the environment, much attention should be paid to the development of new energy and renewable energy resources [4]. Solar energy, which is environment friendly, is renewable and can serve as a sustainable energy source. Hence, it will certainly become an important part of the future energy structure with the increasingly drying up of the terrestrial fossil fuel. However, the lower energy density and seasonal doing with geographical dependence are the major challenges in identifying suitable applications using solar energy as the heat source. Consequently, exploring high efficiency solar energy concentration technology is necessary and realistic [5]. Solar energy is free, environmentally clean, and therefore is recognized as one of the most promising alternative energy recourses options. In near future, the large-scale introduction of solar energy systems, directly converting solar radiation into heat, can be looked forward. However, solar energy is intermittent by its nature; there is no sun at night. Its total available value is seasonal and is dependent on the meteorological conditions of the location. Unreliability is the biggest retarding factor for extensive solar energy utilization. Of course, reliability of solar energy can be increased by storing its portion when it is in excess of the load and using the stored energy whenever needed [6]. “Sun drying” is the earliest method of drying farm produce ever known to man and it involves simply laying the agricultural products in the sun on mats, roofs or drying floors [7]. This has several disadvantages since the farm produce are laid in the open sky and there is greater risk of spoilage due to adverse climatic conditions like rain, wind, moist and dust, loss of produce to birds, insects and rodents (pests); totally dependent on good weather and very slow drying rate with danger of mould growth thereby causing deterioration and decomposition of the produce [8]. The process also requires large area of land takes time and highly labour intensive. With cultural and industrial development, artificial mechanical drying came into practice, but this process is highly energy intensive and expensive which ultimately increases product cost. Recently, efforts to improve “sun drying” have led to “solar drying”. In solar drying, solar dryers are specialized devices that control the drying process and protect agricultural produce from damage by insect pests, dust and rain. In comparison to natural “open drying”, solar dryers generate higher temperatures, lower relative humidity, and lower product moisture content and reduced spoilage during the drying process. In addition, it takes up less space, takes less time and relatively inexpensive compared to artificial mechanical drying method. Thus, solar drying is a better alternative solution to all the drawbacks of natural drying and artificial mechanical drying. The solar dryer can be seen as one of the solutions to the world’s food and energy crises. With drying, most agricultural produce can be preserved and this can be achieved more efficiently through the use of solar dryers. Traditional solar fruit drying is often a slow process impeded by the high humidity, haze, and intermittent clouds experienced in tropical regions [9]. In sunny, arid places, solar crop drying is a relatively simple process, and can often be accomplished without the need for a solar dryer. The warm, dry air's high capacity to take on moisture quickly removes moisture from fruits. Although simply exposing fruits to direct sunlight will often be sufficient for drying, crop dryers are often utilized to protect fruits from dirt, insects, and contamination. In humid, tropical climates, however, drying can be impeded [10]. With the humid air's reduced capacity to absorb moisture from the drying fruits, using a solar crop dryer coupled with a solar concentrator helps to improve the drying rate by increasing internal dryer temperature and radiation [11]. Today, large-scale mechanized dryers are often used to dry fruits in industrialized countries. These machines force air heated by boilers across the fruits to quickly dry them. This improved process, however, is often not viable in many developing countries. The large amount of capital needed for machinery is often prohibitively expensive for small-scale farmers in rural areas. The fuel or electricity to power the machine may not be available or affordable, in addition to leading to environmental problems associated with greenhouse gas emissions [12]. For these reasons, this dryer only considers non mechanized solar crop dryers, and in particular, a dryer design commonly found in Tanzania. So that the solar concentrators can be used in a developing country context by rural farmers with no technical knowledge or skills, each solar concentrator tested was subject to certain restraints. The total cost of the concentrator found in Tanzania was not to exceed $30, and materials must be readily obtainable in developing countries. It must have a lifetime of at least three years, with no repairs during the first year. The concentrator must be able to be transported by one or two people, and must be modular so that it can be adapted for dryers of various sizes. A farmer without technical construction skills must be able to build the concentrator, and lastly, it must be fixed with no sun tracking or moving parts.

II. MATERIALS AND METHOD

Material Collection

The millet used in the experiment was the millet harvested from Crop Sciences Department, University of Nigeria, Nsukka. The crop was planted by October 2014 and was allowed to attain maturity stage before harvesting. The grain was threshed after harvesting to remove some the leaves and to get the millet put together for its weight determination.

Experimental Method.

The millet was measured to determine the weight before drying in other to ascertain the lost in moisture content after drying. Two thermometers were used in the experiment. One was used to determine the atmospheric temperature during drying and the other one was used to determine the inside temperature of the solar dryer. The millet was poured into the solar dryer tray and put inside the dryer for appropriate drying of the grain.

III. RESULTS AND DISCUSSION.

The result showed that solar dryer was used to reduce the moisture content of millet so as to preserve it for a longer time. The weight of the millet reduced gradually from 10kg to 3.4 kg. This result indicated that 6.6 Kg of water was removed from the grain using solar dryer in drying it. The atmospheric temperature of the day fluctuates during the experiment as a result of unsteady nature of solar radiation. The atmospheric temperature fluctuates from 30°C to 26°C during the experiment. The maximum solar dryer temperature recorded was 42°C.

Table 1: weight of millet

Number of Days	1	2	3	4	5	6	7	8	9	10
Weight(Kg)	10	8.4	7.6	6.3	5.9	4.7	4.3	3.8	3.6	3.4

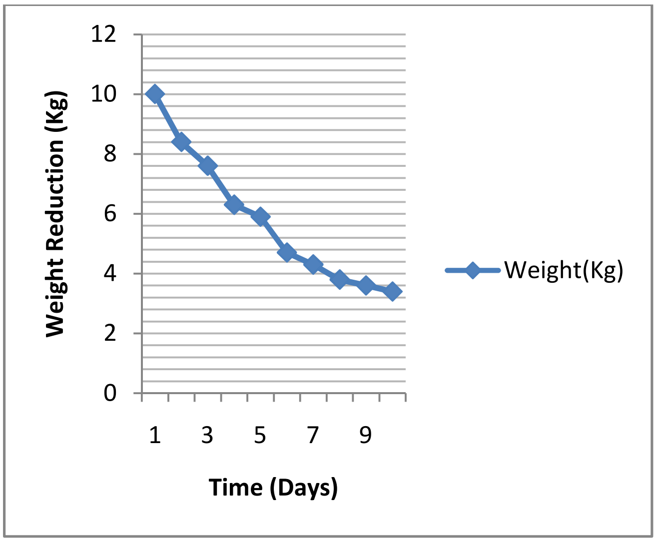

Fig. 1: A graph of weight reduction (Kg) versus Time (Days)

Table 2: Atmospheric Temperature

Number of Days	1	2	3	4	5	6	7	8	9	10
Temp(°C)	30	27	29	26	30	27	29	27	28	26

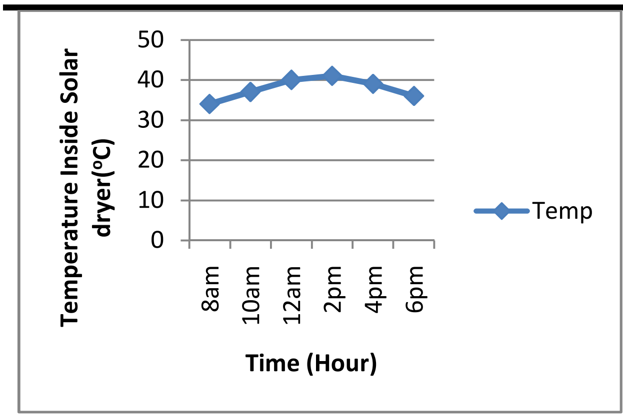

Fig. 2: A graph of Temperature (°C) Inside Solar Dryer versus Time (Hours) on day 4

Table 3: Hourly Temperature inside the solar dryer on day 4

Time (Hours)	8am	10am	12pm	2pm	4pm	6pm
Temp(°C)	34	37	40	41	39	36

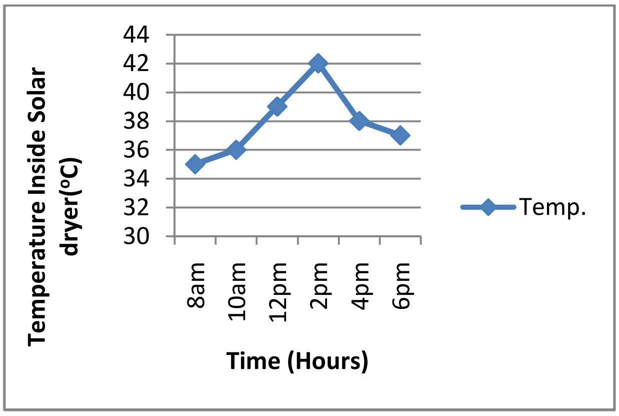

Fig.3: A graph of Temperature Inside Solar (°C) Dryer versus Time (Hours) on day 5.

Table 4: Hourly Temperature Inside the Solar Dryer on day 5

Time (Hours)	8am	10am	12pm	2pm	4pm	6pm
Temp(°C)	35	36	39	42	38	37

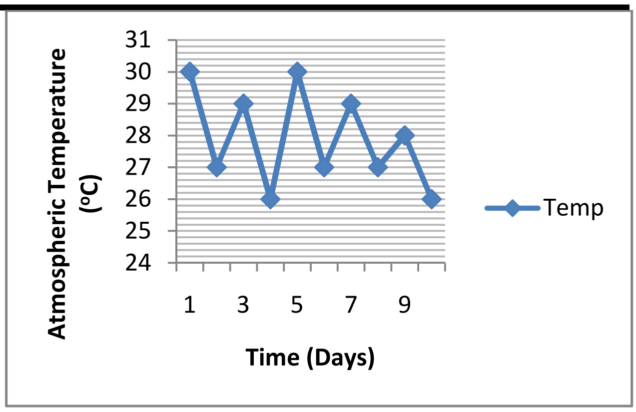

Fig. 4: A graph of atmospheric temperature (°C) versus Time (Days)

IV. CONCLUSION

Solar drying of crops and farm produce using solar dryer is a faster way of preservation. Sun drying is a traditional method of farm produce preservation which has a lot of shortcomings. This work discussed extensively the use of solar dryer in farm produce preservation.

REFERENCE

[1] Ugwuoke E.C and Eze N.N et al (2015), Performance Evaluation of Solar Still, International Journal of Scientific and Technology Research, Nigeria PP 1.

[2] Visavele G.L, Hii C.L, Jangam S.V et al, (2012). Solar Dryer Fundemental,Applications and Innovations ,pp1.

[3] Feyza Akarslan (2012). Solar-Energy Drying Systems, Modeling and Optimization of Renewable Energy Systems, Dr. Arzu Şencan (Ed.), ISBN: 978-953-51-0600-5,InTech,Availablefrom: http://www.intechopen.com/books/modeling-and-optimization-of-renewable energy-systems/solar-energydrying- systems-and-applications

[4] Feyza Akarslan (2012). Solar-Energy Drying Systems, Modeling and Optimization of Renewable Energy Systems, Dr. Arzu Şencan (Ed.), ISBN: 978-953-51-0600-5, InTech, Available from:

[5] http://www.intechopen.com/books/modeling-and-optimization-of-renewable-energy-systems/solar-energydrying- systems-and-applications

[6] Xie, W.T., Dai Y.J., Wang, R.Z., Sumathy, K., 2011. Concentrated solar energy applications using Fresnel lenses: A review *Renewable & Sustaınable Energy Revıews*, Vol. 15(6), pp. 2588 – 2606.

[7] Bal, L. M., Satya, S., Naik, S.N., Solar dryer with thermal energy storage systems for drying agricultural food products: A review. *Renewable and Sustinable Energy Revıews*, Vol.14(8), pp. 2298-2314.

[8] Vidya Sagar Raju R, Meenakshi Reddy .R (2013)Design and Fabrication of Efficient Solar Dryer Int. Journal of Engineering Research and Applications pp.1445-1458.

[9] Blake Ringeisen , Diane M. Barrett (2014) Concentrated solar drying of tomatoes Energy for Sustainable Development 19 (2014) 47–55Contents lists available at ScienceDirect, USA.

[10] Forson FK, Nazha MAA, Akuffo FO, Rajakaruna H(2007). Design of mixed-mode naturalconvection solar crop dryers: application of principles and rules of thumb. RenewEnergy ;32(14):2306–19.

[11] Blair R, Calota G, Crossman A, Drake F, O'Keefe K(2007). Design of a solar powered fruit and vegetable dryer.