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PERFORMANCE ANALYSIS OF SOLAR DRYING SYSTEM FOR MARINE PRODUCT OF OMAN

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Abstract

In Many countries use of solar drying system is the order in food processing to save vegetables, fruits, coffee, tea, meat, fish and other crops. Solar heating system or solar drying system to dry foods and other product can make the quality of the product to be much better. The process of drying is removal of moisture mostly to protect the product for long time. The availability of good source information is lacking in some countries where solar drying system for food is needed.

This project presents the design and fabrication of suitable solar drying system for different fishes which needs drying for preservation. Also there will be analysis on different fishes in Oman. Black body radiation principle is used in this project for receive the heat from the sun. Solar drying system is requires two main things, heat and air flow. The design of this drying system taken care of the both heat and air velocity. The sun light is observed through the glass plate to the black color coated metal plate. The basic frame of the design is made up from of an insulating material (wood) of size 143cm x 53.5cm x 11.5cm, absorber plate sheet painted black of size 90cm x 50cm and a cover glass (6mm thickness) sizing 146cm x 53cm. Cool air enter from air inlet heat from chamber then worm the air cause and raise exit throw hot air exit. Ideally, the results gave as temperature between 45 C° and 60 C° in the chamber. The fish content of different weight depending on the type of the fish reducing about25% of moisture in three days of 10hours each day of drying. Works studied are catalogued with summaries.

Key Words: Solar drying, Fish drier, Drying chamber.

1. INTRODUCTION

Drying is a perfect way to preserve food and solar food dryers are an appropriate food preservation technology for a sustainable world. Also solar food drying is one of the oldest techniques to preserve the food, but every year millions of dollar worth of gross national product are lost through spoilage. Drying of food can change this trend and is useful in most countries in the world especially, those without a high humidity during the harvesting season. These savings can strengthen the economic situation of numerous developing governments as well as change the nutritional condition of these countries. Solar drying system requires two main things i.e. heat and air flow. Some of the solar drying system are mentioned below. Drying using the sun under the open sky for preserving food and agricultural crops has been practiced since ancient times especially in Oman. However, this process has the following disadvantages.

1. Spoilt products due to rain, wind, and dust
2. Loss of produce due to animals.
3. Deterioration in the harvested crops because of decomposition, insect attacks.
4. Existing method was very tedious, time wasting in terms of produce and consequently having so low hygienic level.

Solar drying system offers an alternative which can process food item in clean, hygienic and sanitary conditions that conform to national and international standards with zero energy cost. It saves time, energy and area as well as improves product quality. Solar drying makes the process more efficient and also protects the environment.

2. LITERATURE REVIEW

Sultanate of Oman has many source of animal in surplus fish which is not used for human consumption. According to Directorate General of Fisheries Resources Annual Statistics Report there are around 41496 tons of fish pelagic landings. 33000 tons used for human consumption, 9000 tons are exported and 666 tons are stored to be used as bait.

Sun drying of fish is an old method practiced in so many countries in the world. The main problem with the traditional sun drying of fish is the loss of dried products because of cats, dogs, rats, and bird, which might reach up to 30% - 40% and infestation with insects. These factors reduce local fisherman income source from fish. Fish in Oman especially sardines are traditionally dried by spreading or laying down on the sand along the beaches for a week in cool weather and 4 to 5 days in summer. On account of the abovementioned problems other solar drying

techniques are being considered. Several solar dryer designs have been fabricated and tested for different types of fish. Low cost solar tunnel dryer with integrated solar collector was developed and tested by Lutz and Muhlbauer (1986, pp.583-603). System is used for drying grapes and 1000 kgs can be dried within 4 to 7 days depending upon weather conditions. Two advantages of solar drying system are the reduction in drying time and reduction in mass losses. Osei Opare and Kukah (1988) showed that the keeping quality of fish improved when dried in solar cabinet compared to traditional sun drying. The objective of study is to investigate and compare sun drying and solar drying of fish under local conditions in terms of drying quality and rate of dried product. Drying of fish needs a safe place to spread the fish where dry air flow can pass over the fish and beside thin pieces. Sun is often used to provide the hot dry air. Clean air from any source will dehydrate the fish. Bala and Mondol (2001, pp.427-436) performed analysis of solar tunnel dryer with a plastic covered solar collector attached in series with the dryer. Four d. c solar operated fans supply hot air into the dryer. This dryer can handle 150 kg of fish with three sets of drying runs and the hot drying air at the collector outlet varies between 35.1^{o}C and 52.2^{o}C and the interesting part is that the moisture level reduces from 67% to 16.78% in 5 days of drying. Sablani et. al. (2002, pp.1662) summarized the potential advantages of solar drying techniques comparing with direct sun drying as following-

1. Reducing time of drying due to the high temperatures attainable in solar drying systems.
2. High temperature within dryer retards the activities of microorganism and insects.
3. Eliminated access of cats and birds.
4. Product is protected from dust and wind.
5. Increasing the storage life when product with lower moisture contents is achievable.

Solar drying tent is developed that deals with a small amount of fish. Later the design was successfully used in different countries by other researchers for drying fish. The center observed that the rate of drying fish was greater in the sun dried fish during the first 2 days than those inside the solar dryer because of greater flow of air around the sample. However, the drying rate at later stage is greater inside solar dryer. Quality of fish dried in the solar dryer is extremely good in terms of rancidity, odor and insect attack or microbial. Solar drier is made out of metal drum by Oparaku (2010, pp.8-16) with highest mean temperature of 70^{o}C with ambient temperature of 33.5^{o}C and three fresh water species of fish tested. Moisture reduction is an important aspect of fish drying and it is found to reduce in all the cases.

3. EXPERIMENTAL SETUP

Solar driers comprise of three main components namely a drying chamber in which food is dried, a solar collector that heats the air and some type of airflow system. The figure 3.1 below shows one type of solar drier with each of these three components labeled. The drying chamber protects the food from animals, insects, dust and rain. It is often insulated with sawdust to increase efficiency. The trays should have a plastic coating to avoid harmful residues in food.

Fig. 1 Diagram of the fish drier with details

Experiment setup consists of glass cover through which solar ray enters and falls on the solar collector thereby raising the temperature of air that enters into the chamber through the air inlet. Hot air is allowed to flow over the fish sample that is kept on the sliding wire mesh tray. Finally hot air escapes to the atmosphere through the hot air exit as shown in Fig. 1 above.

4. RESULTS AND DISCUSSION

Testing of the solar dry system to dry fish is done in the month of December for 10 days. The solar dry system is placed outside on the roof facing the direction of the sun. Three different varieties of fish are used to test the system. Fish samples are arranged on the drying chamber in the order of their weight to avoid moisture being trapped in the lower layer. The dryer door then closed and sealed. Result is recorded at an interval of three hours every day. Experiments are performed in the dryer with and without salt and the results are tabulated in the form of table as shown in Table 1 below.

Table 1 Chamber temperature and fish sample mass without salt with respect to time

Day	Time	Solar Dry without salt			
		Temperate C°	Sardine (g)	Skater bream (g)	Jake mackerel (g)
1	6:00	22	12	400	500
	9:00	31	12	400	480
	12:00	56	11.5	400	480
	15:00	43	11.5	370	460
	18:00	36	11.5	360	450
2	6:00	21	11.5	360	450
	9:00	40	11	350	440
	12:00	58	10	350	400
	15:00	48	10	310	370
	18:00	36	9.5	300	340
3	6:00	19	9.5	300	340
	9:00	45	9	270	300
	12:00	54	8	230	260
	15:00	49	8	210	240
	18:00	39	6	200	220

Chamber temperature has slight variation for a specified time due to the change in solar insolation with respect to the day of experiment. It is also observed that the chamber temperature is a function of time that attains maximum value at 12 noon irrespective of the day. Mass of fish sample decreases with respect to time irrespective of the fish species.

Table 2 Chamber temperature and fish sample mass with salt with respect to time

Days	Time	Solar Dry with salt			
		Temperate C°	Sardine (g)	Skater bream (g)	Jake mackerel (g)
1	6:00	22	12	400	500
	9:00	31	12	400	490
	12:00	56	11.5	400	490
	15:00	43	11.5	390	480
	18:00	36	11.5	380	480
2	6:00	21	11.5	380	480
	9:00	40	11	360	470
	12:00	58	10	360	460
	15:00	48	10	350	420
	18:00	36	9.5	350	400
3	6:00	19	9.5	350	400
	9:00	45	9	350	380
	12:00	54	8	320	360
	15:00	49	8	290	320
	18:00	39	7	260	300

Table 2 provides the hot air chamber temperature and mass of fish species for three different days and also at different times for solar drying of fish with salt. Chamber temperature has slight variation for different days for a

specified time due to the difference in solar insolation. Hot air chamber temperature is observed to be a function of time for a specified day with the peak value at 12 Noon. Mass of fish species decrease with respect to time irrespective of the variety of fish. The above mentioned results are common for both salt and without salt categories. Cross comparison between the salted and unsalted mass pro exposure to solar drying indicates that the decrease in mass is less for skater bream and jake mackerel fish varieties whereas the decrease in mass for sardine is almost the same.

5. CONCLUSIONS

Solar drying with the modified setup has proven advantages of hygenity and effective heating. High temperatures around 58^{o} can be achieved using the present technique. Source of energy is renewable without pollution. This idea is very much feasible in a country like Oman where bright sunshine is available almost the whole year. The mass reduction upto 30% is achieved due to this technique. Initial cost of manufacturing is less owing to the simple parts. Maintenance cost also is less. Once put into operation, operation cost is almost nil as the source of energy is absolutely free.

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