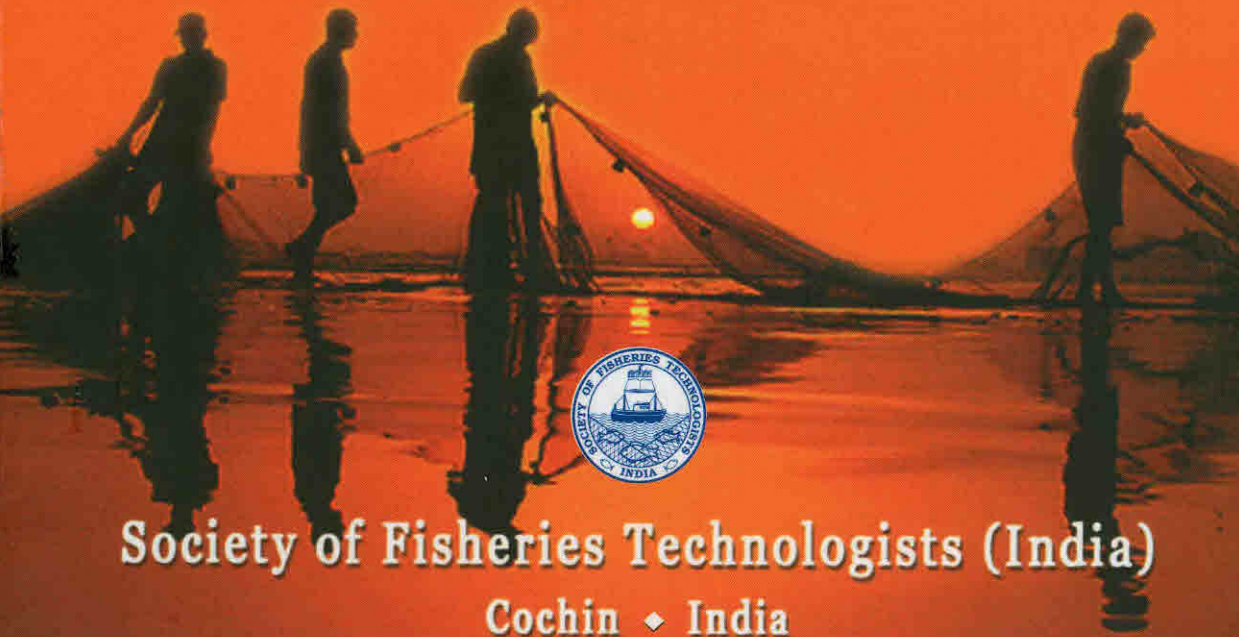


Coastal Fishery Resources of India

• Conservation and Sustainable Utilisation



Society of Fisheries Technologists (India)

Cochin ♦ India

Coastal Fishery Resources of India: Conservation and Sustainable Utilisation

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Conservation of Energy in Fish Drying

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Introduction

The total fish production in India is 6.4 million t of which about 3.4 million t is from inland and 3.0 million t from marine sources (Ayyappan and Diwan, 2007). Fish are an extremely perishable foodstuff. Spoilage occurs as the result of the action of enzymes (autolysis) and bacteria present in the fish, and also chemical oxidation of the fat which causes rancidity. At the high temperatures prevalent in tropical countries, bacterial and enzymic action is enhanced. Fish invariably become putrid within a few hours of capture unless they are preserved or processed in some way to reduce this microbial and autolytic activity and, hence, retard spoilage (Clucas and Sutcliffe, 1981; Trim and Curran, 1983). Salting and drying are traditional methods of preserving fish; they have been used for centuries and dried salted products are still popular in many areas, particularly in African, South Asian, Southeast Asian and Latin American countries. If the moisture content of fresh fish is reduced during drying to around 25%, bacteria cannot survive and autolytic activity will be greatly reduced, but to prevent mould growth, the moisture content must be reduced to 15% (Trim and Curran, 1983). The conventional method of drying is by exposing fish with or without salting to sun by spreading over the sand (Fig. 1).

Different types of solar dryers have been designed and developed in various parts of the world, yielding varying degrees of technical performance (Ekechukwu and Norton, 1999; Fudholi *et al.*, 2009). Basically, there are four types of solar dryers (i) direct solar dryers, (ii) indirect solar dryers, (iii) mixed-mode dryers and (iv) hybrid solar dryers. Solar dryers for agricultural and fish based products have been studied and reviewed by Curran and Trim (1983), Trim and Curran (1983), CSC (1985), Ekechukwu and Norton (1999), Bala and Janjai (2006), Fudholi *et al.* (2009), Sharma *et al.*, (2009) and Daghighi *et al.* (2010).

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Fig. 1: A view of traditional sun drying of fish in open beaches

Traditional method of drying fish in the open sun is hazardous as the product is vulnerable to contamination by sand, bacteria and fungus. Often, spoilage of fish takes place due to rain, moisture and dust, insect infestation and damage is caused by intruding birds and animals. Further, the process is labour intensive and time consuming and requires large areas for spreading the fish. In situations, where relative humidity is high, it is often difficult to dry the fish adequately. Modifications have been made in sun drying to reduce contamination. Sun drying on platforms and rack drying are the results of such attempts. By using the method of rack drying (bamboo racks), the quality of dry fish can be improved by reducing contamination by sand (Clucas and Sutcliffe, 1981). The rack drying can save some space compared to beach drying. A typical rack dryer is shown in Fig. 2. Major disadvantage in these drying techniques is that proper drying is not possible in adverse weather conditions, leading to spoilage of fish. Mechanical dryers were used to overcome these issues. Mechanical dryers using electricity or fossil fuels such as diesel oil and furnace oil, as the energy sources are available, but they are very energy intensive. When the quantity of fish to be dried is small or seasonal, batch dryers are used. Kiln dryer and cabinet or tray dryers represent the important types of batch drying equipment. A modification of the batch type dryers is the continuous hot air dryers. They are operated by passing the material on a conveyor belt with co-current or counter current hot air flow. Other important types of dryers are rotary dryers, drum dryers and osmotic dryers. Though, these dryers are of not much use in drying of fish products, hydrolysed products can be dried using them. But most of the mechanical dryers utilizes conventional energy sources such as fossil fuels which is not only very expensive but also produces CO_2

emission. Solar heating system is the most viable option as it is cost effective and eco-friendly.



Fig. 2: Rack dryer

In this paper, various solar drying systems for hygienic drying of fish and fish based products, developed at Central Institute of Fisheries Technology (CIFT), Cochin are briefly discussed.

Solar drying Systems developed by CIFT

Solar energy reaches the earth in scattered form. It has to be concentrated in order to use it for purposes such as drying. Designs of solar dryer vary from very simple direct dryers to more complex indirect designs which have separate collectors and drying chambers. The hot air from the collector is forced into the drying chamber. The most common type of collector is a bare galvanised iron plate which is painted matt black. These give a temperature increase of about 10°C and increase the air speed to about 5 m.s^{-1} . The collectors are covered with a transparent material to ensure uniform airflow.

PVC Tent Dryer

PVC tent dryer consisting of UV resistant, transparent plastic sheet covered on a triangular metallic frame was developed (Fig.3). Airflow due to natural convection is from bottom to the top and escapes through vent pipes. Provision has been given to increase the efficiency of the dryer

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by using coal tar filled base platforms to absorb and retain thermal energy even after sun shine hours. The advantages of this type of dryers are their low construction costs and simplicity of operation. However, like other types of solar dryer, there is relatively poor control over the relative humidity of the air in the dryer and, hence, poor control over drying rates.



Fig. 3: PVC tent solar dryer

Natural convection type Dryer

A natural convection type fish dryer with mild steel structural frames covered with UV stabilized polythene sheet was developed (Fig. 4). An indirect type air heating system was incorporated in the system. Utilization of black coated waste metallic turnings in the heating system helps to increase the heat transfer efficiency. Ascending forces from the air heating system causes the air movement. This type of dryers can achieve complete protection against weather, dust, insects, birds and rodents.

Domestic purpose dryer

The domestic purpose dryer has a capacity up to 5 kg to dry fish and other agro products (Fig. 5). It is made of marine plywood with external water proof coating, material handling trays with fibre netting, coated black surface covered with glass for solar energy absorption. The design features facilitate proper air movement and the investment requirement is low.



Fig. 4: Natural convection type dryer



Fig. 5: Dryer for household use

Forced circulation dryer

A forced circulation fish dryer was developed with UV resistant plastic covering (Fig. 6). Air is heated in a heat collector and the hot air is passed through a chamber with forced air circulation system. Photovoltaic panels are provided in the system so as to regulate the flow of air in accordance with the intensity of solar radiation obtained during the drying process. Battery back-up system is incorporated in this dryer.



Fig. 6: Forced circulation dryer

Multipurpose solar dryer

A multipurpose solar dryer was designed and developed with marine plywood body fitted with black coated aluminium sheet and covered with polycarbonate sheet (Fig. 7). Hot air movement inside the chamber is facilitated with the help of axial flow fans fitted inside the chamber. Additional electrical heating system is provided for utilization of the dryer during night or rainy season. Stainless steel netted trays are provided inside the dryer. The absorber aluminium plate is coated with special purpose black paint for maximising absorption of solar radiation.

Solar dryer with alternate electrical back-up heating system

A solar dryer having efficient heat absorption and utilization system, designed with alternate electrical back-up is shown in Fig. 8. Electrical



Fig. 7: Multipurpose solar dryer

back-up heating system with hot air circulation facility and well insulated design to avoid wastage of thermal energy are the added advantages of this dryer. Continuous flow of hot air is maintained with the help of photovoltaic cells and fans to enable faster drying rate. During sunny days, fish will be dried using solar energy and when solar radiation is not sufficient during cloudy or rainy days, electrical back-up heating system will be automatically activated to supplement the heating requirement. Thus, continuous drying is possible in this system to obtain a good quality dried product. Complete protection against weather, dust, insects, birds and rodents are achieved in this type of dryers.

Solar dryer with LPG back-up

This drying system utilises renewable solar energy supported by environment friendly LPG back up (Fig. 9). In sunny days, fish will be

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Fig. 8: Solar dryer with alternate electrical back-up heating system (Left: drying chamber; Right: solar collector panels)

dried using solar energy and when solar radiation is not sufficient as may happen during cloudy or rainy days, LPG back-up heating system will be automatically activated to supplement the heating requirement. This machine is ideal for drying fish, fruits, vegetables, spices and agro products hygienically and efficiently. The drying rate is faster and product quality is better compared to open drying in the sun.



Fig. 9: Solar dryer with LPG back-up

CIFT dryer SDL-250

A 250 kg capacity hybrid solar fish dryer developed with LPG/ biogas back-up heating system is shown in Fig. 10. One such dryer was installed at the Fish Processing Centre, Kattoor, Mararikulam South under MEDICOM-SGSY special project technology transfer scheme being implemented by Aryad and Kanjikkuzhi Block Panchayaths of Alappuzha district. In the solar fish dryer with LPG back-up heating system, water is heated with the help of solar vacuum tube collectors installed on the roof top (Fig. 10) and circulated through heat exchangers provided in the polyurethane foam (PUF) insulated stainless steel drying chamber. When solar radiation is not sufficient, LPG back-up heating system will be automatically activated to supplement the heat requirement, enabling continuous drying.



Fig. 10: CIFT dryer SDL-250 (right: dryer chamber; left: roof-top solar panels and hot water reservoir

CIFT dryer designs include small capacity dryers like solar tent dryers, Natural convection dryers etc. which will be useful to dry fish during sunny days. Solar tunnel dryers, solar fish dryers with alternate electrical back up, SDE-10, SDE-20 and SDE-50 and solar fish dryers with fire wood or biomass alternate back up heating system SDF-20, SDF-50 etc. can be efficiently used to dry fish hygienically and economically, using renewable solar energy which is abundantly and freely available.

Conclusion

There is a growing demand for environment friendly technologies based on renewable energy sources. Solar energy could play a vital role as an alternative energy source for the seafood processing industry.

Different types of eco-friendly and energy efficient solar dryers using alternative backup heating systems have been developed at CIFT for hygienic and continuous drying of fish and fishery products.

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