

CIFT Machineries in Fish Processing

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Major areas of technological interventions in the field of fishery engineering cover the design and development of fish processing equipment and machinery, energy-efficient and eco-friendly solar fish dryers, fuel-efficient fishing vessels and fibreglass canoes, indigenous electronic instruments for application in harvest and post-harvest technology of fish, quality improvement of Indian fishing fleet and energy and water optimization techniques for fish processing industries, and development of tools and techniques for non-destructive evaluation fish quality and freshness sensor. Focused areas include the development of cost-effective solar dryers with LPG, biomass, Infrared or electrical backup heating systems, fish descaling machines, Fish freshness sensors, etc. Post-harvesting processing of fish is important to reduce wastage, increase shelf-life, add more value to the products and ensure higher returns. The major engineering interventions for fish post-harvest operations, processing, and value addition are given in subsequent sections.

1. Solar dryers

Fisherfolks catch fish as major aquatic products to sell in the local market, and in case of over catch tremendous losses occur due to inadequate cold chain management facilities in the developing countries. Alternatively, the fisherman could convert the excess catch of fish into a value-added product *i.e.* dried fish. For example, In India, about 20-30% total catch of fish is dried for export and or local consumption. Drying preserves fish from decay by removing moisture from fish, thereby arresting the growth of bacteria, the action of enzymes, and the chemical oxidation of the fat. Open-air sun drying is the traditional method employed by fisherfolks in India to dry fish and fishery products. It denotes the exposure of a commodity to direct solar radiation and the convective power of the natural wind. This form of energy is free, renewable, and abundant in any part of the world, especially in tropical countries. However, it often results in inferior quality of product due to its dependence on weather conditions and vulnerability to the attack of dust, rain, insects, pests, and microorganisms. Also, it requires a longer drying time (Murali et al. 2019).

Solar drying is an alternative that offers numerous advantages over the traditional method and is environmentally friendly and economically viable in developing countries. In solar drying,

a structure, often of very simple construction, is used to enhance the effect of solar radiation. Compared to sun drying, solar dryers can generate higher air temperatures and consequential lower relative humidity, which are conducive to improved drying rates and lower final moisture content of the products. However, there exist some problems associated with solar drying i.e. reliability of solar radiation during a rainy period or cloudy days and its unavailability during nighttime. To overcome this limitation, an auxiliary heat source and forced convection system are recommended for assuring reliability and better control, respectively.

ICAR-Central Institute of Fisheries Technology (CIFT), Cochin, has already developed low-cost, energy-efficient, and eco-friendly dryers like Solar cabinet dryers, Solar tunnel dryers, Infrared dryers, etc for uniform and hygienic drying of fishes. These dryers are also suitable for drying agricultural products like fruits, vegetables, spices, and condiments.

1.1.Solar-gasifier hybrid dryer (50 kg)

In this dryer, water was utilized as a sensible heat storage (SHS) material as well as heat transfer fluid and biomass gasifier as an indirect backup heat source (Fig 1). In this dryer, during sunny days fish will be dried using solar energy and during off-sunshine hours i.e. cloudy/ rainy days, and night biomass-based gasifier unit will be fired to supplement the heat requirement (Murali et al. 2023). Water is heated with the help of solar vacuum tube collectors installed on the roof of the dryer and circulated through heat exchangers placed in the PUF-insulated stainless steel drying chamber. Thus, continuous drying is possible in this system without spoilage of the highly perishable commodity to obtain a good quality dried product. This dryer is ideal for drying fish, fruits, vegetables, spices, and agro products. This dryer is ideal for drying fish, fruits, vegetables, spices, and agro products. It helps to dry the products faster than open drying in the sun, by keeping the physicochemical qualities like colour, taste, and aroma of the dried food intact and with higher conservation of nutritional value.



Fig. 1. Photograph of Solar-gasifier hybrid dryer developed at CIFT, Kochi

1.2. Solar dryer with LPG backup (50-60 kg)

ICAR-CIFT designed and developed a novel system for drying fish using solar energy supported by environment-friendly LPG backup (Fig. 2). In this dryer during sunny days fish will be dried using solar energy and when solar radiation is not sufficient during cloudy/ rainy days, LPG backup heating system will be automatically actuated to supplement the heat requirement. Water is heated with the help of solar vacuum tube collectors installed on the roof of the dryer and circulated through heat exchangers placed in the PUF-insulated stainless steel drying chamber. Thus, continuous drying is possible in this system without spoilage of the highly perishable commodity to obtain a good quality dried product. A programmable logical controller (PLC) system can be incorporated for automatic control of temperature, humidity, and drying time. Solar drying reduces fuel consumption and can have a significant impact on energy conservation (Murali et al. 2020; Murali et al. 2021).



Fig. 2. ICAR-CIFT Solar-LPG hybrid dryer

1.3. Solar dryer with electrical backup (20 kg)

Effective solar drying can be achieved by harnessing solar energy from specially designed solar air heating panels and proper circulation of the hot air across the SS trays loaded with fish (Fig. 3). Food-grade stainless steel is used for the fabrication of chamber and perforated trays which enable drying of fish hygienically. Since the drying chamber is closed, there is less chance of material spoilage by external factors. An alternate electrical backup heating system under controlled temperature conditions enables the drying to continue even under unfavourable weather conditions like rain, cloud, non-sunny days, and night hours so that bacterial spoilage due to partial drying will not occur. Improved shelf life and value addition

of the product fetch higher income for the fisherfolk. The eco-friendly solar drying system reduces fuel consumption and can have a significant impact on energy conservation.



Fig. 3. ICAR-CIFT Solar-electrical hybrid dryer

1.4. Solar dryer with electrical backup (40 kg)

The dryer consists of four drying chambers with nine trays in each chamber (Fig. 4). The trays made of food-grade stainless steel are stacked one over the other with a spacing of 10 cm. The perforated trays accomplish a through-flow drying pattern within the dryer which enhances drying rates. Solar flat plate collectors with an area of 7 m² transmit solar energy to the air flowing through the collector which is then directed to the drying chamber. The capacity of the dryer is 40 kg. Electrical backup comes into a role once the desired temperature is not attained for the drying process, particularly during rainy or cloudy days.



Fig. 4. ICAR-CIFT Solar-electrical hybrid dryer

1.5.Solar tunnel dryer

ICAR-CIFT developed a low-cost, energy-efficient solar tunnel dryer for bulk drying of fish and fishery products. This dryer can be used by fishermen or small-scale fish processing units for bulk drying during seasonal higher catch/excess landing of fish. The capacity of the solar tunnel dryer is 50 kg with a floor area of 12 m² (Fig. 5). The materials of construction are UV-stabilized transparent polythene sheet for the roof cover, black absorber sheet for the floor, supporting frames of CPVC, and GI rod. Three ventilator fans of 0.5 hp were provided for air inlet and moisture removal. The trays with tray holders were placed inside the dryer for spreading and hooking the fish for drying. This tent dryer was designed as a stand-alone system as it does not require any external power source/electricity. The fans were operated through a solar PV panel fitted on the rooftop of the dryer and associated battery setup. It is also affordable and suitable for Indian fisherfolk.



Fig. 5. ICAR-CIFT Solar-tunnel dryer

1.6. Less Emission Biomass dryer (20-30 kg)

The dryer consists of a drying chamber, blower, biomass furnace, and hot air recirculatory system. The capacity of the dryer is 30-40 kg with 10 trays. The tray dimension is 0.9m x 0.45m. The drying chamber dimension is 0.9 m x 0.9 m. The biomass furnace capacity is 25 kg (wood) with the dimension 0.77 m x 1.76 m x 1.42 m. It is provided with a blower of 0.5 hp and an axial fan of 0.25 hp. This dryer is suitable for drying all types of materials including fruits, vegetables, spices, and condiments. It will be highly economical to operate where biomass availability is abundant and free of cost. The cost is approximate Rs.1.5 lakhs.



Fig. 6. ICAR-CIFT Biomass dryer

2. Fish Descaling Machines

2.1. Fish descaling machine with variable drum speed

The fish de-scaling machine is designed and fabricated to remove the scales of fish easily. This equipment can remove scales from almost all types/sizes/ species of fishes ranging from marine to freshwater species like Sardines, Tilapia to Rohu. The machine is made of SS 304 and has a 10 kg capacity (Fig. 7). It contains a 1.5 HP induction motor and a Variable Frequency Drive (VFD) to vary the speed of the drum depending on the variety of the fish load. The drum is made of a perforated SS 304 sheet fitted in a strong SS Frame. A water inlet facility is provided in the drum for easy removal of the scales from the drum so that the area of contact to the surface will be greater for the removal of scales. The water outlet is also provided to remove scales and water from the machine. An Electronic RPM meter was

attached to the de-scaling machine which directly displays the RPM of the drum. The speed of the drum is a factor influencing the efficiency. The machine takes only 3-5 minutes to clean 10 kg fish depending on the size.



Fig. 7. Fish de-scaling machine with variable drum speed

2.2. Fish de-scaling machine with fixed drum speed- tabletop

The fish de-scaling machine is designed and fabricated to remove the scales of fish easily. This equipment can remove scales from almost all types/sizes/ species of fishes ranging from marine to freshwater species like Sardines, Tilapia to Rohu. This machine is made of SS 304 and has a 5 kg capacity. It contains a 0.5 HP AC motor with a proper belt reduction mechanism to achieve the required drum speed of 20-30 rpm. The body is fabricated in dismantling type one-inch square SS tube with a suitable covering in the electrical parts (Fig. 8). The drum is made of a perforated SS sheet fitted in a strong SS Frame having suitable projections to remove the scale and provided with a leak-proof door with a suitable lock.

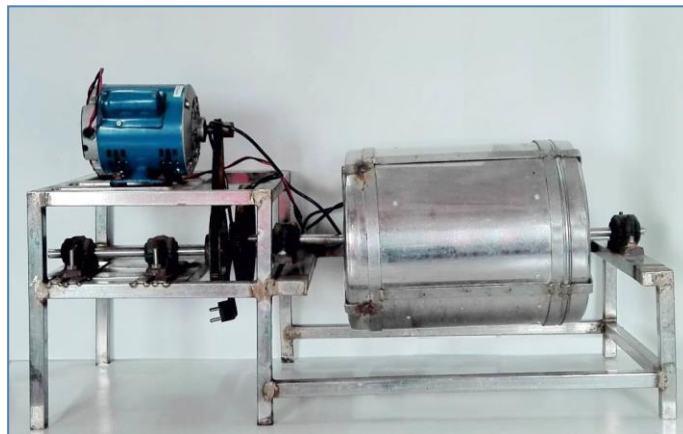


Fig. 8. Fish de-scaling machine with fixed drum speed

2.3. Hand operated Fish descaling machine

The fish descaling machine is designed and fabricated to remove the scales of fish easily. This equipment can remove scales from almost all types/sizes/ species of fishes ranging from marine to freshwater species like Sardine, Tilapia to Rohu (Fig. 9). This machine is made of SS 304 and has a 5 kg capacity. The body is fabricated by dismantling a type 1-inch square SS tube. The drum of 255.5 mm diameter and 270 mm length is made of a perforated SS sheet fitted in a strong SS Frame having suitable projections to remove the scale and provided with a leak-proof door with a suitable lock. A pedal is fitted on the side to rotate the drum manually (Delfiya et al. 2019).



Fig. 9. Hand-operated fish de-scaling machine

3. Fish meat bone separator

A Fish Meat Bone Separator with variable frequency drive (VFD) to separate pin bones from freshwater fishes was designed and developed (Fig. 9). This can be used at a range of 5-100 rpm. With a unique belt tighten system developed; the new machine can be easily adapted to any species and need not be customized for specimens during the design stage. In existing imported models, only two speeds are possible which restricts the yield efficiency in a single-span operation and also limits easy switching of the system for utilizing specimens other than

for which the yield has been originally customized. The meat yield of this machine was about 60% against 35% in imported models. The capacity of the machine is 100 kg/hour.



Fig. 10. Fish meat bone separator

4. Refrigerated Mobile fish vending kiosk

ICAR-CIFT has designed and developed a mobile fish vending kiosk for selling fish in the closed chilled chamber under hygienic conditions at the consumer's doorstep. The mobile unit is mounted on a frame with wheels at the bottom. The kiosk can carry 100kg fish with 20kg under chilled storage display in a glass chamber and remaining in an insulated icebox. The main components of the kiosk are a fish storage & display facility, a hand-operated descaling machine, and a fish dressing deck with a washbasin, water tank, cutting tool, waste collection chamber, and working space. The vending unit has been fabricated using stainless steel (SS 304 Food Grade). The stored fish is covered with a transparent glass cover through which consumers can see the fish and select according to their choice of purchase. A kiosk is attached with a hand-operated descaling machine for the removal of scales. The fish coming out of the de-scaler is free of scales, dirt, or slime. It also reduces human drudgery and avoids cross-contamination, consuming less time. Fish dressing deck with washbasin is also designed conveniently to prepare fresh clean fish under hygienic conditions. The unit also extends the

quality of fish for 4- 5 days and increases the marginal benefit to fish vendors. It also helps change the practice of unhygienic handling and marketing of fish.



Fig. 11. Refrigerated mobile fish vending kiosk

Suggested Readings:

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- Murali, S., Amulya, P. R., Alfiya, P. V., Delfiya, D. A., & Samuel, M. P. (2020). Design and performance evaluation of solar-LPG hybrid dryer for drying of shrimps. *Renewable Energy*, 147, 2417-2428.
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