

**REPORT OF TESTS ON USE OF SOLAR-TENTS  
FOR FISH DRYING IN THE GAMBIA**

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**ABSTRACT**

A substantial amount of the total annual landings of fish in the Gambia is sundried and this paper discusses the use of solar dryers for this purpose. Solar-tent dryers appear to have considerable promise particularly in terms of costs when local and low-cost materials are used for their construction. But, further work should be carried out to improve durability of the dryer, increase the loading capacity and improve its drying efficiency.

**INTRODUCTION**

The main problem that prompted research on the use of solar dryers for drying fish in the Gambia is the extent to which losses are encountered. Although attempts have never been made to systematically quantify losses, numerous and various observations suggest losses appear to be quite high and insect infestation prevalent, particularly during the rainy season.

Fish drying is an age-old tradition in the Gambia as in many African countries. Fish are commonly fermented prior to sun-drying on low wooden racks, the ground or rocks. Salting and drying are used in conjunction, but there are several problems and the products obtained are of low quality and short storage-life.

In an attempt to alleviate problems associated with losses in dried fish production the use of solar dryers has been investigated. This research is seen to directly correspond with government's development priorities, especially those aimed at increasing food production, and in particular, protein - food supplements, by way of preventing post-harvest losses.

Dried fish production has considerable potential in the country. In 1983, about 500 tonnes of cured fish were exported to neighbouring countries and Asia. About half of this was dried-salted fish and fishery products. The Catch Assessment Survey of the Fisheries Department has indicated that a total of 8455.5 tonnes were landed in 1983 by 'marine' (Atlantic Coast and low river) artisan fishermen, Demersal species account for 1952.2 tonnes of this total of which it is assumed that all the cassava fish (Otolithus typos) sharks and rays were sun-dried. The estimated total weight of cassava fish landed was 296.1 tonnes and of sharks and rays 376.9 tonnes. It is also assumed that 45-50% of the balance of 1658.1 tonnes of landed demersal fish would have been sun-dried within the year. Since only a small amount of this catfish (Arius Spp.) is normally smoked for local marketing, it is estimated that at least 60% of the 765.5 tonnes landed in 1983 was sun-dried mainly for export to neighbouring countries. Sea-snails are sun-dried all year round but data on the amount is not available.

This probably underestimates production. Large quantities of dried fish and fishery products are suspected to leave the country unrecorded each year.

This project has been undertaken, with a view to improving fish drying technology by using solar dryers constructed with low-cost and locally available materials to reduce losses in cured fish production.

### **OBJECTIVES**

The objectives of the research are both short-term and long-term.

- (a) The short-term objective is to conduct investigations on the use of solar-tents for drying fish, using low-cost, locally available materials to prevent infestation and reduce losses.
- (b) The long-term objective is to carry out essential extension services whereby the use of solar dryers will be demonstrated to local processors and fishermen who will be encouraged to use such facilities throughout the country.

### **PROJECT ACTIVITIES**

The research programme encompasses the construction of solar dryers; drying fish of different species and performing subsequent laboratory analysis, (ie moisture, ash, lipid and protein contents).

At the inception of work, solar tents of various dimensions were constructed but all had the same design: 2m (h) x 2m (L) x 2.5, (w); 2.5m (h) x 4m (L) x 3m (w); and 2.5m (h) x 6.3m (L) x 6.3m (w). The former was capable of drying about 15-20 kg; the second about 40-45 kg and the third 400-500 kg. Drying time for a satisfactorily dried product was about 3 days for all the dryers.

All fish samples were obtained frozen from factories, gutted and brined for about 16 hours. As brining is noted to be more effective than sprinkling salt on fish, it was the only salting method applied during the trials. The species used were mostly demersal fish and include the families Sciaenidae, Polynemidae, Scrombidae and Pomadasidae.

Laboratory analysis of wet and solar dried samples were performed, but the solar dried samples tested were all obtained from the tent with the smallest dimensions.

Various kinds of locally available materials were tried in an attempt to reduce cost and/or to improve the durability of the dryers. Imported wood was used for the construction of the first tent and 'rhun' palm sticks for the second and third.

Initially, officials of the Department were solely involved in the trials, washing, gutting, descaling, salting and drying fish. After obtaining some results and scaling up the design of the tents more fish was needed to load the dryers fully and at this stage local processors were integrated into the project.

The technical staff comprised of a Senior Fisheries Officer, Fisheries Field Assistants and a carpenter. There was no written timetable as fish were obtained periodically from factories, and later, from artisanal fishermen, dried for 2-3 days and stored at room temperatures. Experiments were conducted for a period of 6 months using the smallest size dryer, and after that time, extension services were launched involving local fishermen and processors thereby examining some possible approaches most appropriate in technology transfer of this kind to the Gambian fishing communities.

No techno-economic feasibility studies were carried out but experience has so far hinted that this type of venture can be viable mainly because:

- (a) Products can be dried within a short period allowing more to be produced than when sun-drying.
- (b) The number of individual pieces in a given batch for solar drying remains the same at the end of the drying time, whereas, the sun-drying the number of individual pieces started with is reduced at the end of the drying time due to severe infestation by maggots.
- (c) The solar tents are cheap and easy to construct (cost of one is about D200-D300) and take only a few hours with little labour to construct once the materials are available on site.

#### **PROBLEMS WITH THE SOLAR-TENT DRYER**

- (a) Procurement of appropriate materials such as UV resistant polythene in developing countries like the Gambia is difficult at times.
- (b) The polythene covering the tents is delicate and extreme care must be taken always during operations to prevent damage. Thunderstorms are potential hazards to the dryers.
- (c) Durability of the dryers needs improvement especially the netting on the air vents. These tend to tear easily after contact with 'salty air' from the sea.
- (d) The position of the drying racks on the sides of the tent, beneath which lie the black collectors, may cause sun-rays reaching the fish spreading on the racks before reaching the collectors below, and hence reduce the efficiency of the dryers. This situation might have contributed to case-hardening problems encountered during trials.
- (e) Local processors must be educated to use the facility correctly by ensuring that the air-vents are utilised properly during operations to give enough ventilation at the initial drying stage and help reduce case-hardening problems.

#### **RESEARCH METHODS AND ANALYTICAL PROCEDURES**

Various species of fish were descaled, gutted, brined and dried in solar tents. From each species 5-7 gms of flesh was removed from representative samples and the laboratory analysis for moisture content, ash and lipid were carried out. It is worthy to note that samples tested during these laboratory exercises were obtained from the solar-tent with the smallest dimension. All the exercises could not be performed for all the species due to lack of certain apparatus and chemicals.

#### **Determination of moisture content**

- (a) Moisture dishes with a layer of acid-washed sand in the bottom were left to dry overnight in an oven at 105°C. Removed from oven and placed in a dessicator for 30 mins to cool. Then weighed on an analytical balance ( $W_1$ ).

- (b) About 2.5g of representative sample of flesh was homogenised and placed in dishes and re-weighed ( $W_2$ ). All samples were in duplicate. Dishes were returned to the oven and left overnight. They were then removed from the oven and again desiccated for about 30 mins to cool and re-weighed ( $W_3$ ).
- (c) Percentage moisture calculated thus:

$$\text{moisture} = \frac{(W_2 - W_3) \times 100}{W_2 - W_1}$$

#### Ash determination

- (a) About 1.5kg of sample was weighed and placed in labelled crucibles which were pre-weighed when empty.
- (b) The contents were charred under bunsen burner flame and placed in a furnace.
- (c) After 30 minutes the samples were placed in a desiccator for about 20-30 minutes.
- (d) Crucibles were re-weighed and the percentage ash content calculated:

$$\% \text{ ash} = \frac{\text{weight of ash}}{\text{weight of sample}} \times 100$$

#### Lipid determination

'Soxhlet' extraction method was used.

#### Protein determination

'Kjeldahl' method was applied but only a single trial was performed due to lack of chemicals.

### RESULTS

**TABLE 1: Change in % moisture content during solar drying**

Drying times in O. hrs	Species					
	senegalensis (Ngouka)	P. jubelini (Sompat)	Epinephelus sp (Choff)	Cranx sp (Sacca)	Scomber sp (Njunna)	Sardinella spp (Yaboi)
0	79.3	79.9	78.9	72.2	76.6	75.1
7	51.4	43.3	42.6	47.6	52.2	26.9
14	32.9	30.0	31.4	34.8	36.6	21.5
20	25.2	23.3	24.1	27.3	27.3	21.5
28	19.1	20.0	20.5	22.3	22.3	13.3

**TABLE 2: Changes in weight (kg) during solar drying**

Drying time in hrs	Species					
	Ngouka	Sompat	Choff	Sacca	Njunna	Yaboi
0	0.27	0.30	0.43	0.40	0.79	0.13
7	0.20	0.19	0.38	0.30	0.69	0.08
14	0.13	0.17	0.21	0.25	0.49	0.06
20	0.14	0.15	0.19	0.22	0.36	0.06
28	0.12	0.12	0.17	0.20	0.27	0.05

**TABLE 3: Chemical composition of wet fish samples**

Species	%	%	%	%
	Moisture	Ash	Lipid	Protein
Ngouka	79.3	1.54	0.97	-
Sompat	79.9	1.72	0.44	-
Choff	78.9	1.60	1.02	-
Sacca	72.2	1.60	1.14	-
Njunna	76.6	1.99	2.07	-
Yaboi	75.1	1.97	3.69	-

**TABLE 4: Chemical composition of solar dried samples**

Species	%	%	%	%
	Moisture	Ash	Lipid	Protein
Ngouka	19.1	20.1	-	-
Sompat	20.0	15.5	2.5	-
Choff	20.5	14.9	3.2	-
Sacca	22.3	-	-	-
Njunna	22.5	19.3	6.08	43.0
Yaboi	13.8	-	-	-

## **DISCUSSION**

As indicated in the data provided, the ash and lipid contents of each species increased after drying. This, however, is assumed to be a relative increase as the total amount of these compounds remain unchanged. As a substantial amount of water was removed during drying this relative increase was observed. The increase in ash content is also a result of additional minerals taken into the fish flesh during brining.

Due to the deficiency in laboratory equipment, chemicals and other materials all intended analysis could not be carried out. The brine-strength was not measured because of lack of hydrometers.

Samples that were selected for storage trials were kept under ambient temperatures. Some were packaged in sealed plastic bags, others were left exposed. Those in the plastic bags were brittle but still of good edible quality after 6 months storage. The mackerel (Njunna) and sardinella (Yaboi) had, however, developed a somewhat rancid taste during storage. The exposed samples were mouldy and were infested with Dermestes beetles.

Apart from the sardinella all the other samples were sliced into pieces of various sizes. The sardinella samples were left as whole fish because these were small size individuals. This might have contributed to the achievement of low moisture content, as low as 20% within 28-30 hours in these species, because the thinly sliced or small whole fish have large surface area relative to their masses, and as such, this will speed the rate of diffusion by decreasing the distance from the centre of the fish flesh to its surface.

Observations have shown that the "Falling rate period of drying" (ie the phase at which the rate of movement of moisture to the surface of the fish is reduced and the drying rate becomes slower) is significantly shortened when the solar tents were used. This caused a tremendous reduction in the overall drying time especially when the small size fish were used in the trials.

Although some limitations have been observed in the use of solar-tent dryers, results obtained from these trials have been encouraging. The internal temperatures of the dryer are usually lethal to flies which occasionally enter, and products obtained are of good, clean and well-dried quality. During the trials only a few maggots were observed infesting the fish samples in the dryers. However, because the sample dealt with throughout the trials was less than a kilogram, the absence of heavy insect infestation could be understood not only as a result of the effectiveness of the dryer, but also that small quantities of wet fish attract fewer flies. More maggots were observed in fish in the larger dryers but these did not cause significant losses.

The major limitations in the use of solar-tent dryers for fish drying are:

1. Clear UV-resistant polythene and plastic mesh may be difficult to procure in developing countries like Gambia, and to improvise substitutes might not be an easy thing to do.
2. The construction technique, particularly in cladding the structure, needs improvement to improve the durability of the dryers.
3. Care must be taken at all time during operations as the plastic is delicate.

This report concedes that despite these problems, the use of solar-tent dryers for fish could be a vital factor in the development of our traditional drying technology. Acknowledging that about 35-75% of the wet fish landed by artisanal fishermen get spoilt or stale at landing or before reaching intended markets; and that all these spoilt fish must be dried to prevent further losses, the use of solar dryers as an improved technology should be highlighted.

It is a generally accepted view that the introduction of any new technology in developing countries is usually met with problems and constraints that are fundamentally socio-economic. For instance, traditional fish processors are especially obsessed with the weight of their products and prefer dried fish with some amount of moisture enough to give more weight and more money when marketed on wholesale basis. Hence, it is difficult to persuade processors to leave their fish in the dryers to dry to low moisture contents (ie as low as 20%). Consequently, if the application of solar dryers for fish is to fulfil its objectives under these circumstances, advice on improvement on packaging and storage methods using locally available, low-cost materials should be the follow-up to solar drying exercises to help prevent losses after processing.

It cannot be urged that the solar tent is not the ultimate design for a fish solar dryer. But, so far, it has shown considerable promise and should be given time and thought for modification to increase its capacity, efficiency and durability.

### **CONCLUSION**

The results of this research programme will be used by officials of the department as a basis for giving proper advice to local processors and promoting the use of solar tents in traditional fishing communities.

As the tents are cheap and easy to build the prospects for socio-economic cost-effectiveness are bright and should be investigated in-depth to give a broader perspective of solar drying in the Gambia. It is thought that once durability is enhanced the solar tent would become more attractive to local processors who may then invest in procuring the facility with the assistance of the Department.

Even though people have realised the effectiveness of the dryer, especially when used during the rains, most of them may not consider it worthwhile to search for materials and invest in one because other essential materials such as the UV resistant polythene and plastic mesh are not readily available in the country. It is important to note that, along the marine coast fishery women are the main persons engaged in fish drying and their present socio-economic status does not provide them with strength and funds to be able to procure all the needed materials and contract a carpenter to build the dryers. In this case, it is thought that the Fisheries Department should be intimately involved in assisting processors to set-up drying yards with related facilities and thereby arrange with these end-users to remit the cost incurred in instalments as agreed by the parties.

The social compatibility of the facility for the intended end-users is unquestionable. However, the people will also be more responsive to the idea if assistance is given to them by organising them into small associations at each site; providing the facility in the form of a fenced drying-yard with few tents, a platform for gutting, descaling and cleaning; a tank for salting and fermenting fish, and a small-size store. This, it is envisaged, will render the people a good sense of belonging and a chance to do something new and different on a collective basis to improve their lot.

### **RECOMMENDATIONS**

- Experiments on packaging and storage, using locally available, low-cost materials to reduce beetle infestation and subsequent losses should be conducted to align with improvement in drying technology.
- As transportation problems are not uncommon in the country, dried fish products destined for upcountry marketing or export should be appropriately packaged and stored to avoid losses.
- In line with Government's policy to improve the nutritional standard of Gambians and generate more financial benefits within the artisanal sector, this project has been seen as a potential source of boosting the cured fish trade; diversify the development strategies for the artisanal fisheries sector, and amongst other things, provide employment opportunities for nationals, especially the women.

To this end, it appears that there is a pressing need for more cooperation between the Gambia and participating countries; provision of funds and materials not only to construct dryers, but, to also build accompanying facilities such as platforms etc, and be able to purchase small amounts of fish to demonstrate to intended end-users how to use the facilities and prevent losses.

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