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# STORAGE CHARACTERISTICS OF SOLAR-DRIED INDIAN MACKEREL

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## ABSTRACT

**Fresh *Rastrelliger kanagurta* (Indian mackerel) was thoroughly washed, eviscerated, cleaned and salted overnight with dry salt (fish : salt :: 5:1). Salted mackerel was dried in solar drier and on cement floor under direct sun for three days. The temperature inside the drier was 9-18°C higher than the ambient temperature. The rate of drying was higher in solar drier than on cement floor. The dried fish packed in 300-gauge polythene bags was subjected to biochemical, microbiological and organoleptic evaluation at regular intervals to assess the storage life. The overall quality of fish dried in solar drier was better than that of the fish dried on cement floor under direct sun.**

**Keywords: Fish drying, solar drier, Indian mackerel, storage characteristics**

## INTRODUCTION

In India, production of dried fish by and large continues to be a small-scale enterprise practised mostly by fisherman families. Various surveys carried out in the past (Srinivasan and Joseph, 1966; Joseph *et al.*, 1983, 1986; Basu *et al.*, 1989) revealed that the quality of dry fish available in the country requires much improvement. In spite of the fact that various innovations such as mechanical driers and solar driers (Chakraborty, 1976, 1978; Rao *et al.*, 1989) have been brought out, not much impact has been felt on the quality of dry fish available in the country (Joseph *et al.*, 1983, 1986). This most probably is because of the reason that these innovations have been capital-intensive and not within the easy reach of the fishermen who contribute a major share to the dry fish produced in the country. The Food Technology Division of the Bhabha Atomic Research Centre (BARC), Mumbai, has designed and fabricated a low-cost (Rs 5000.00 approx.) solar drier, which can dry 15 kg fish at a time. This study was undertaken to evaluate the performance of the solar drier in drying fish and to study the storage life of fish dried in the solar drier.

## MATERIAL AND METHODS

In this experiment the drier designed and fabricated by BARC was used. The body and tray of the drier are made of aluminium. The drier was fabricated with

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different parts, which could be easily dismantled and hence very easy to transport. There were three aluminium mesh trays, which could dry 15 kg of fish at a time. The body of the drier was painted black to absorb solar heat. There was an arrangement for ventilation at the top through which hot air laden with moisture could escape. Fresh air entered the drying cabinet through the small holes on the sides at the lower portion of the body. The photograph of the solar drier is presented in Fig. 1.

Three drying trials were carried out at CIFE using fresh mackerel each weighing approximately 30 to 35 g. All the fish used for the study were obtained from the local landing centre at Versova. Fish were thoroughly washed, eviscerated, cleaned and salted with dry salt (fish : salt :: 5 : 1) overnight. The fish were then dipped in water to remove adhering salt and dried. For the sake of comparison, conventional drying on cement floor was also employed adjacent to the drier. Samples were drawn at regular intervals during drying and analysed for moisture. Atmospheric temperature and solar-drier temperature were measured at regular intervals. During night, the fish in solar drier were left as it was, while the fish on cement floor were placed in a tray in single layer and kept in a room uncovered. Dried samples were packed in 300-gauge polyethylene bags and analysed at regular intervals for moisture (James, 1983), total volatile base nitrogen (TVBN, by micro-diffusion method of Conway, 1957), NaCl (FAO, 1981), thiobarbituric acid (TBA - Tarladgis *et al.*, 1960), ash and acid insoluble ash (AOAC, 1995) and total plate count (TPC, standard pour plate method - APHA, 1982).

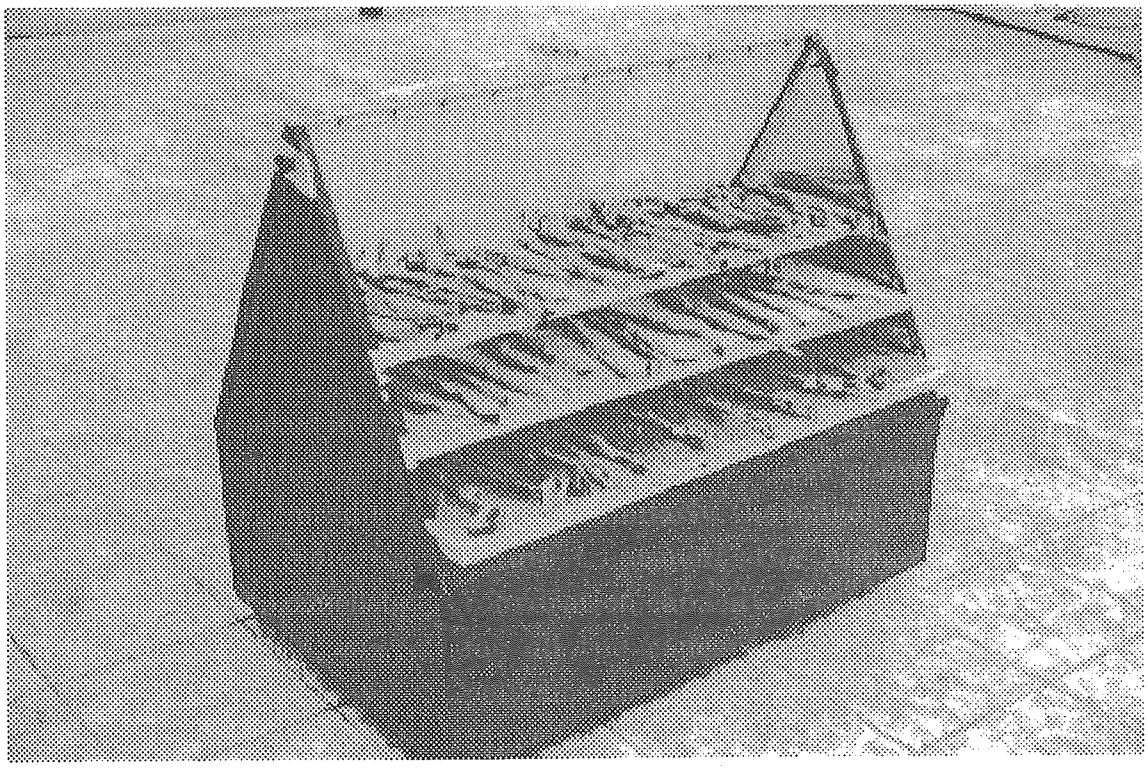

*Fig. 1. The solar drier used in the experiment*

Estimation of halophilic count (HPC) was done by the pour-plate method using standard nutrient agar medium containing 15% NaCl.

## RESULTS AND DISCUSSION

The variations in ambient temperature and the temperature inside the solar drier during the three days of drying period (between 9 A.M. and 6 P.M.) were recorded and are presented in Table 1. The temperature recorded was higher in solar drier and variations of 9 to 18$^0$C were recorded at different times of the day. Such increased temperature levels inside tent driers were also reported earlier by Doe *et al.* (1977), Sripathy and Balsaraswathy (1985) and Rao *et al.* (1989).

The composition of dried fish was analysed after three days of drying and are presented in Table 2. Moisture, ash and acid-insoluble ash were more in fish dried in direct sun on floor than the fish dried in the solar drier. This may be due to contamination of fish dried on the floor with sand.

**Table 2: Composition (%) of dried mackerel (wet-weight basis)**

| Parameter | Dried in sun | Dried in solar-drier |
|---|---|---|
| Moisture | 28.31 | 20.71 |
| Fat | 10.71 | 10.91 |
| Protein | 37.67 | 43.58 |
| Ash | 24.07 | 20.43 |
| Acid insoluble ash | 4.20 | 0.80 |
| Salt | 14.23 | 15.01 |

**Table 1: Variation in temperature ($^0$C) during three days of drying period**

| Time | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | First day | | Second day | | Third day | |
| | Solar drier | Ambient | Solar drier | Ambient | Solar drier | Ambient |
| 09.00 A.M. | 35 | 26 | 35 | 26 | 35 | 25 |
| 10.00 A.M. | 37 | 28 | 37 | 28 | 37 | 28 |
| 11.00 A.M. | 39 | 29 | 40 | 30 | 40 | 31 |
| 12.00 NOON | 45 | 30 | 45 | 30 | 40 | 31 |
| 01.00 P.M. | 50 | 32 | 50 | 32 | 50 | 32 |
| 02.00 P.M. | 50 | 32 | 50 | 32 | 50 | 32 |
| 03.00 P.M. | 50 | 32 | 50 | 32 | 50 | 32 |
| 04.00 P.M. | 48 | 30 | 48 | 30 | 48 | 30 |
| 05.00 P.M. | 40 | 28 | 40 | 28 | 45 | 28 |
| 06.00 P.M. | 35 | 26 | 35 | 26 | 34 | 25 |

The drying curve for mackerel is presented in Fig. 2. There was difference in the drying rates between the two types of drying. Drying rate was faster in the solar drier due to the higher temperature. The storage characteristics of fish dried under direct sun on floor and in solar drier are presented in Table 3. The values of all the parameters were higher in fish dried in direct sun on cement floor than the fish dried in the solar drier. The moisture content increased slowly in both the products with storage period. This may be due to the permeability of polythene to water vapour.

The initial TVBN value in solar-dried fish was 36.32 mg%, which increased to 61.12 mg% after four months of storage. In the case of fish dried on cement floor, the initial TVBN value was 41.37 mg%. There was a steady increase in TVBN value during storage and at the end of four months' storage, the TVBN value reached a level of 98.13 mg%. Similarly, lipid oxidation measured in terms of TBA value was less in solar-dried fish throughout the storage period in comparison to the value of fish dried on cement floor.

Throughout the storage period, TPC

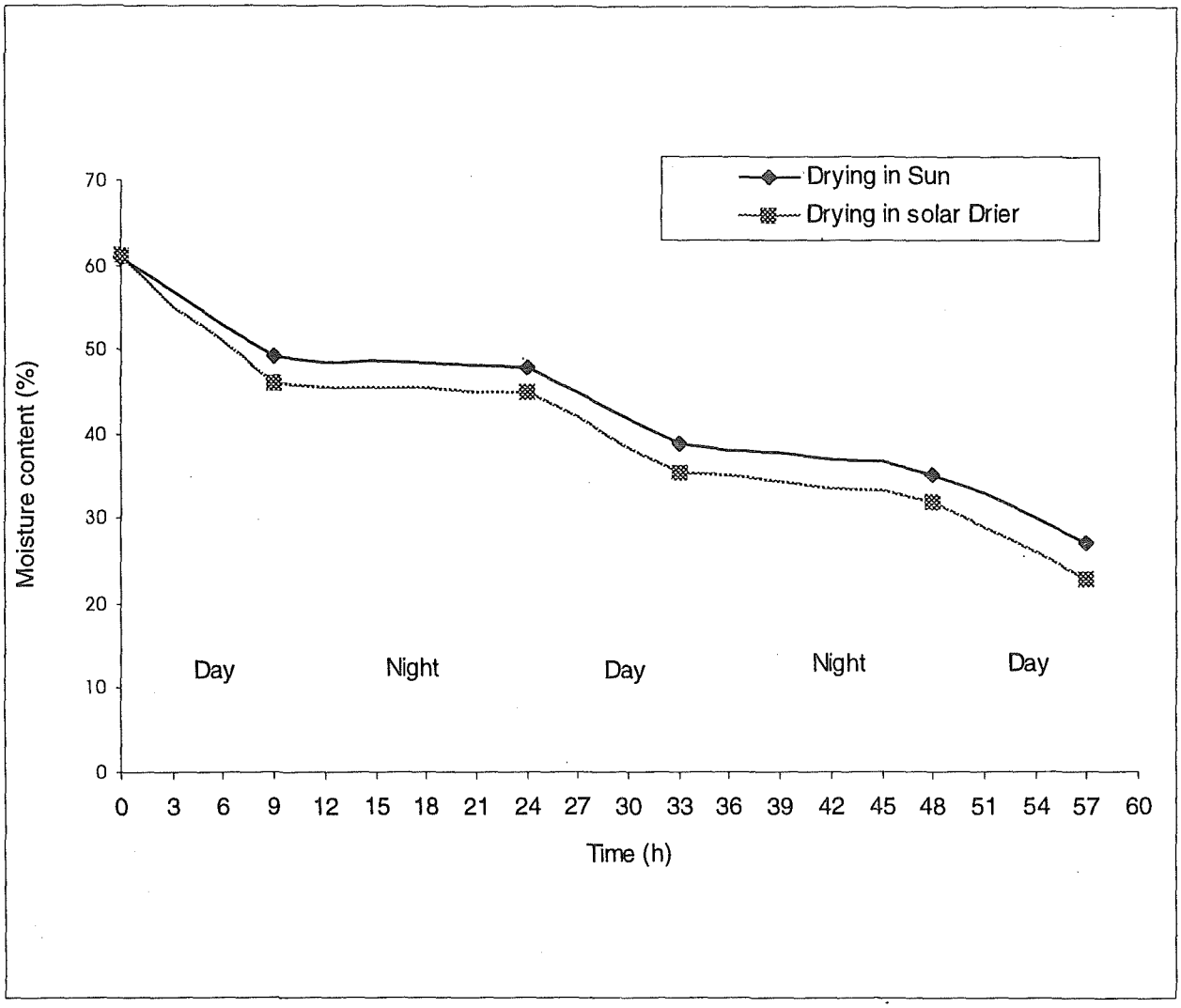


*Fig. 2. Drying curve for mackerel*

**Table 3: Comparative storage characteristics of mackerel dried in sun and solar-drier**

| Parameter analysed | | Storage period (mo) | | | | |
|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 |
| Moisture (%) | 1 | 20.71 | 21.83 | 21.88 | 22.98 | 22.99 |
| | 2 | 28.31 | 29.42 | 29.48 | 29.75 | 30.13 |
| TVBN (mg/100 g) | 1 | 36.32 | 43.92 | 47.53 | 53.72 | 61.12 |
| | 2 | 41.37 | 53.17 | 67.92 | 87.12 | 98.13 |
| TBA (mg/kg) | 1 | 0.37 | 0.39 | 0.45 | 0.57 | 0.62 |
| | 2 | 1.63 | 1.79 | 1.80 | 1.89 | 1.92 |
| TPC (cfu x $10^4$/g) | 1 | 8.10 | 6.30 | 7.10 | 7.90 | 8.70 |
| | 2 | 8.10 | 8.50 | 9.20 | 9.50 | 10.00 |
| Halophilic count (cfu x $10^3$/g) | 1 | 6.30 | 5.30 | 6.70 | 7.90 | 9.10 |
| | 2 | 6.30 | 7.20 | 8.70 | 8.70 | 12.00 |

1 = Dried in solar-drier
2 = Dried in sun

and HPC were higher in floor-dried samples than in samples dried in the solar-drier. The higher TPC and HPC in the floor-dried samples may be due to the higher moisture content and higher contamination from floor than the fish dried in the solar-drier. The higher TPC and HPC probably account for the higher protein degradation (higher TVBN value) and higher rates of fat degradation (higher TBA value).

Table 4 depicts the change in physical characteristics of the dried samples during the storage period. It was found that the changes in the floor-dried samples were faster. Development of a reddish discolouration and rancid smell was faster in floor-dried samples.

The red discolouration may be due to the growth of halophilic bacteria. A higher HP contributed to the rapid development of red colouration in the floor-dried samples. The rapid rate of quality loss in floor-dried sample compared to the sample dried in solar drier was well supported by changes in both the physical and chemical parameters studied.

It was found from the study that the fish dried in the solar-drier had better quality and longer shelf life. As mentioned by Sachithananthan *et al.* (1985), solar drier protects fish from prying birds, cats, wind-borne dust, etc., avoids contamination with sand, and drastically reduces or even sometimes, eliminates insect infestation.

**Table 4: Physical characteristics of solar-dried and sun-dried fish during storage**

| Storage period (mo) | Physical characteristics | |
|---|---|---|
| | Solar dried | Sun dried |
| 0 | Fresh appearance, bright colour, good fishy odour (G) | Fresh appearance, bright colour, good fishy odour (G) |
| 1 | No discolouration, no off-odour (G) | Mild rancid smell, no discolouration (F) |
| 2 | No discolouration, no off-odour (G) | Strong rancid smell, slight brownish discolouration (F) |
| 3 | Mild rancid smell, slight brown discolouration (F) | Strong rancid smell, brownish discolouration (F) |
| 4 | Mild rancid smell, slight brown discolouration (F) | Strong rancid smell, ammoniacal smell, dark brown discolouration, few mites (P) |

G = Good, F = Fair, P = Poor

The rate of drying was faster and the product was hygienic. So, it may be finally concluded that the solar drier developed by BARC is highly efficient in producing hygienically dried fish with longer shelf life as compared to fish dried on cement floor under sun.

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## REFERENCES

**AOAC,** 1995. Official Methods of Analysis (13th edition). Association of Official Analytical Chemists, Washington, D.C.

**APHA,** 1982. Recommended Procedure for the Examination of Seawater & Shellfish, American Public Health Association, Washington, D.C.

**Basu, S., Khasim, D. I., Gupta, S. S. and Rao, C. C. P.,** 1989. Quality of dry fish from markets in Andra Pradesh. *Fish. Technol.,* **28**: 114-118.

**Chakraborty, P. K.,** 1976. Solar drier for fish drying and fishery products. *Res. Ind.,* **21**: 192-196.

**Chakraborty, P. K.,** 1978. Technological development of artificial and solar drying of fish in India. Indo-Pacific

Fisheries Congress Proceedings. 18th Session, pp. 322-329.

**Conway, E. J.**, 1957. Microdiffusion Analysis and Volumetric Error. Crossby, Lockwood and Son Ltd, London, 465 pp.

**Doe, P. E., Ahmed, M., Muslemuddin, M. and Sachithananthan, K.**, 1977. Polythene tent dryer for improved sun drying of fish. *Food Technol. Aust.*, 29: 437-441.

**FAO**, 1981. The Prevention of Losses in Cured Fish. Food and Agriculture Organization of the United Nations, Rome, 87 pp.

**James, D. (ed)**, 1983. Proceedings of the Workshop on the Production and Storage of Dried Fish. Food and Agriculture Organization of the United Nations, Rome, 266 pp.

**Joseph, K. G., Muraleedharan, V., Kalaaimani, N. and Nair, T. S. U.**, 1986. Quality of cured fish from Tamil Nadu coast. *Fish Technol.*, **23**: 63-65.

**Joseph, K. G., Muraleedharan, V. and Nair, T. S. U.**, 1983. Quality of cured fishery product from Malabar and Canara coasts. *Fish Technol.*, **20**: 118-119.

**Rao, C. C. P., Basu, S. and Prasad, M. M.**, 1989. Studies on solar tent drier for fish drying. *In:* Balachandaran, K. K., Perigreen, P. A., Madhavan, P. and Surendran, P. K. (ed), Recent Trends in Processing Low-cost Fish. Society of Fisheries Technologists (India), Cochin, pp. 64-71.

**Sachithananthan, K., Trim, D. S. and Speirs, C. I.**, 1985. FAO Expert Consultation on Fish Technology in Africa. Food and Agriculture Organization of the United Nations, Rome, pp. 259-266.

**Srinivasan, R. and Joseph, K. C.**, 1966. A survey of the quality of salt-cured fish produced in the Kanyakumari District, Madras State. *Fish Technol.*, 3: 103-112.

**Sripathy, W. V. and Balasaraswathy, M.**, 1985. Harvest and Post-harvest Technology of Fish. Society of Fisheries Technologists, Cochin, 559 pp.

**Tarladgis, B. G., Watts, B. M., Younathan, M. T. and Dugan, L. Jr.**, 1960. Distillation method for the quantitative determination of malonaldehyde in rancid food. *J. Am. Oil Chem. Soc.*, **37**: 44-48.