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THE SHELF-LIFE OF ROUND SCAD DRIED BY USING DIFFERENT DRYING METHODS[1] /

by

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ABSTRACT

A verification study was conducted on the different techniques of drying split round scad *(Decapterus sp.)*. The efficiency of using the cabinet-type dehydrator, the mobile solar dryer and the traditional sundrying (as control) was evaluated based on drying time, product quality and financial requirements.

The use of the cabinet-type dehydrator was found to yield the best quality product (based on the organoleptic and microbial tests) and requires the shortest drying time of seven hours. Drying time with the solar dryer and that of sun drying were practically the same (9 to 11 hours). However, field trials conducted in coastal areas revealed that using the solar dryer is efficient with a drying time of from eight to 10 hours. The solar dryer still needs improvement for use in urban places such as Metro Manila.

INTRODUCTION

The demand for dried fish, one of which is round scad *(Decapterus sp.)*, locally known as "galonggong; is expected to increase. Being one of the most abundant and most common species in Philippine market round scad needs to be utilized through proper processing methods like drying.

1/ A PCARRD *assisted project.*

Among the drying methods used in the Philippines, direct exposure to sunlight is still the usual practice in rural villages. The abundance of solar energy in the country is the main reason for sundrying of fish. Sun drying or air drying is rather a long process since it takes two to three days to dry fish, besides, the keeping quality of sundried fish is quite short. Traditionally, fish are spread and dried in trays in which exposure of the product to various sources of contamination, such as dust, molds, temperature for drying and a continuous source of heat could not also be attained especially when weather condition is not good. Hence, sundrying is a seasonal method and processors have second thoughts on drying fish during the rainy season.

To counteract this problem, increasing research efforts have been under way so as to utilize and develop drying techniques which may yield better-quality dried products. The introduction and development of the solar dryer in the Philippines have given incentives and hope for bigger returns among food processors. Studies on the PEV (polyethylene vinyl) solar dryer conducted by Pablo (1978) claim that drying of marine products is effected in a shorter time than through ordinary sundrying. This mobile solar dryer was further improved to include a heater utilizing indigenous materials as fuel (Protacio, 1979). Thus, with the use of this solar dryer, one could process fishery products by drying even on rainy days. In addition, there is the cabinet-type dehydrator which can make use of LPG (liquefied petroleum gas), agro-wastes, coconut husk and other indigenous materials as sources of heat.

The inception of these non-traditional methods of drying and the use of preservatives on dried fish require further in-depth studies to provide better operating conditions and to optimize the drying process. Thus, several studies have been made by individuals and agencies involved in fisheries research. To name a few, Palomares *et al.* (1981) conducted a research study on the dehydration of fish and other marine products by comparing the use of three drying methods, namely: sundrying, artificial drying using a multi-heat source dryer, and a combination of the two methods. Drying tests on marine products using the solar dryer were undertaken to compare its performance with that of sundrying (Pablo, 1979; Camu et al., 1982). As to the problem of yeast and mold growth on dried fish, a study conducted by Bersamin *et al.* (1959) shows the anti-mold effect of sorbistat during the storage of round scads.

With this in view, a technology verification project was implemented in the Fisheries Utilization Division, BFAR, with PCARRD fund, to test the efficiency of drying techniques on split round scads, employing the available methods, namely: the cabinet-type dehydrator, the solar dryer, and direct sundrying.

With the energy crisis and the attendant increase in the prices of commodities, it is necessary that a processor can determine the best drying technique that could give the optimum quality product with the minimum operating cost. Hopefully, the problem could be solved through this project.

EXPERIMENTAL SCHEME

Performance Evaluation of the Three Drying Methods

This study was undertaken to compare the drying efficiency of the solar dryer, the dehydrator and the traditional method of sundrying. The standard procedure of preparing and drying round scads was followed.

Monitoring of operation for variables every hour was made on the ambient temperature of drying, relative humidity of the atmopshere, air velocity of the dryer's blower and weight of the product. Final drying time and the drying curve for each mode were determined.

As recommended by Palomares *et al.* (1981), dried samples were packed in 0.002-millimeter polyethylene plastic pouches for storage. Shelf-life study was done at room temperature (28 to 30°C) and refrigerating temperature (10 to 18°C).

Evaluation of the storage acceptability of dried round scads was made by organoleptic, microbiological and chemical tests. Sensory evaluation was conducted by a panel of seven tasters using the 9-point Hedonic scale.

The drying procedure used in previous trials was applied in similar manner. Time and temperature profiles on the solar dryer were recorded by installing a thermometer at predetermined sections of the dryer (Figure 5).

The study on storage of round scads was also made, using or applying the same tests as in the preceding study, except for refrigeration storage.

RESEARCH METHODOLOGY

Raw Materials and Equipment

Fresh, medium-sized (15 centimeters long or more) round scads were used in this experiment. They were purchased from the areas where they were processed and dried.

The solar drying employed was the mobile dryer which was developed by Project Sta. Barbara of the Philippine Navy in Cavite. It is basically trapezoidal in shape with transparent polyacetate sheet roof and sides. Fresh air enters the solar collector booster and is heated to provide the driving force for drying the products. Solar radiation is transmitted

through the plastic glazing and absorbed in the black surfaces. Other details of thisequipment are shown in Figure 1.

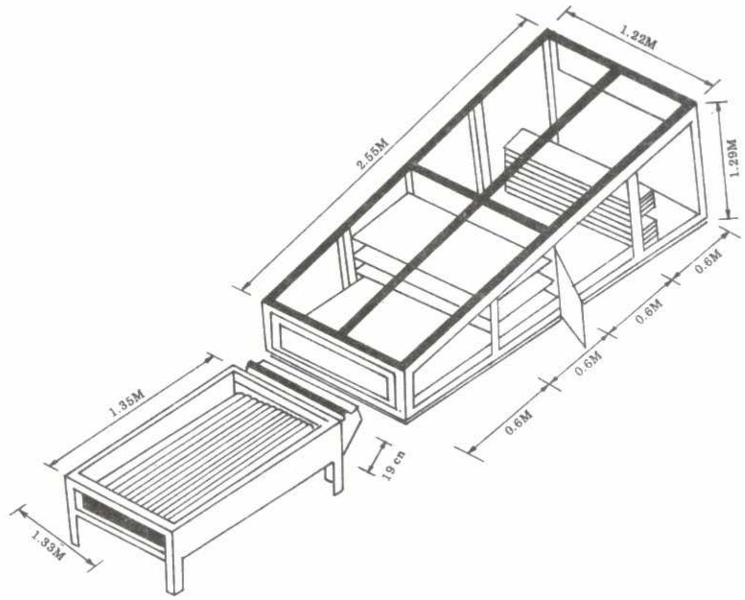

Figure 1. Perspective of the Mobile Solar Dryer

OTHER DETAILS	Main Unit	Booster/Solar Collector
Capacity, kg	70 to 85	-
Area occupied by the unit, sq. m.	3.0	1.8
Total Drying Area, sq. m.	8.6	-
No. of drying trays	14	-
Tray dimension (length, width depth), m.	1.2, 0.5, 0.03	
Inclination	16.86	

The dehydrator used was designed and fabricated by the Ramon Tagle Industries in Nangka, Marikina, Metro Manila. It is a fully enclosed, insulated, oven-type unit that can be used for any food product. It is provided with a fan, electric motor, and air vent to exhaust used air. Heat is derived from LPG and is diffused through a heavy hot plate, thus radiating it into the driving chamber. Other details of this equipment are given in Figure 2.

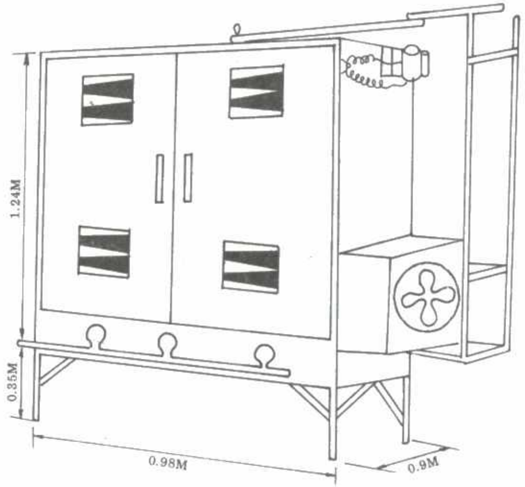

Figure 2. Perspective of the Cabinet-Type Dehydrator

OTHER DETAILS

Basic Dimensions	
Total length, m	0.98
Width, m	0.9
Total height, m	1.6
Area occupied by unit sq m	0.88
Total drying area, sq m	9.6
No. of drying trays	22
Accessories:	
Fan radius, m	0.61
Fan horse power	0.25
Capacity, kg of fresh fish	45

Other materials used are the brining vessels, drying traysand thermometer.

Standard Drying Procedure

A standard procedure based on previous experiments was followed throughout this study unless otherwise specified. Fish were cleaned, split along the dorsal fin, washed and brine-soaked. As recommended by Palomares *et al.* (1981) the fish samples were soaked in 15 percent brine for two hours. They were then drained and arranged on drying trays with skin side down, dried to the required moisture level of 30 to 40 percent. This was done by the gravimetric method. Samples were periodically examined for moisture content determination until the required weight of the final product was reached. Calculated weight of the dried product was estimated by the equation:

$$Wf = \frac{(1 - M_1)}{1 - M_f} \times W_1$$

Where:

Wf = Final weight of dried product

M_f = moisture content of final product

M_i = moisture content of fresh sample

W_i = weight of fresh sample

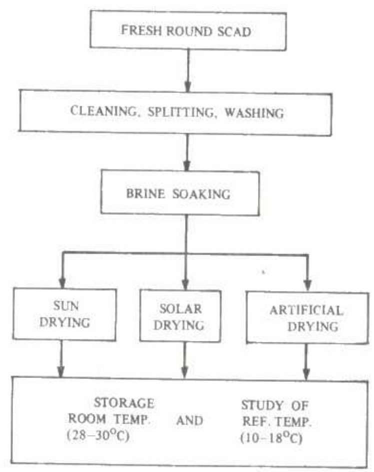

Figure 3. Experimental scheme on drying of round scad using different drying techniques.

Another method of determining whether or not drying is sufficient was done by subjective test, by pressing the thickest part of the fish flesh and checking if no mark or impression was left on the flesh and the mid section is dry enough.

Drying time, therefore, was estimated when dried samples attained the required moisture level.

RESULTS AND DISCUSSION

Experiments consisting of three trials were undertaken every year during the summer months of March to May, from 1980 to 1982.

Performance Evaluation of the Different Drying Methods

Drying Efficiency

The results of experiments on drying time and temperature of round scads dried by using the three drying methods are shown in Table 1. Drying curves are also given in Figure 4.

Table 1. Drying efficiency of different methods.

Drying Method	Drying Time (hr)*	Temperature (°C) **	Percentage of Moisture Content of Dried Product
Sundrying	10 (a)	32 to 42	34 to 38
Mobile Solar	11 (a)	32 to 54	34 to 40
Cabinet Type	7 (b)	60 to 65	34 to 36

** Means for three trials*

***Conducted at RH = 68 to 72%*

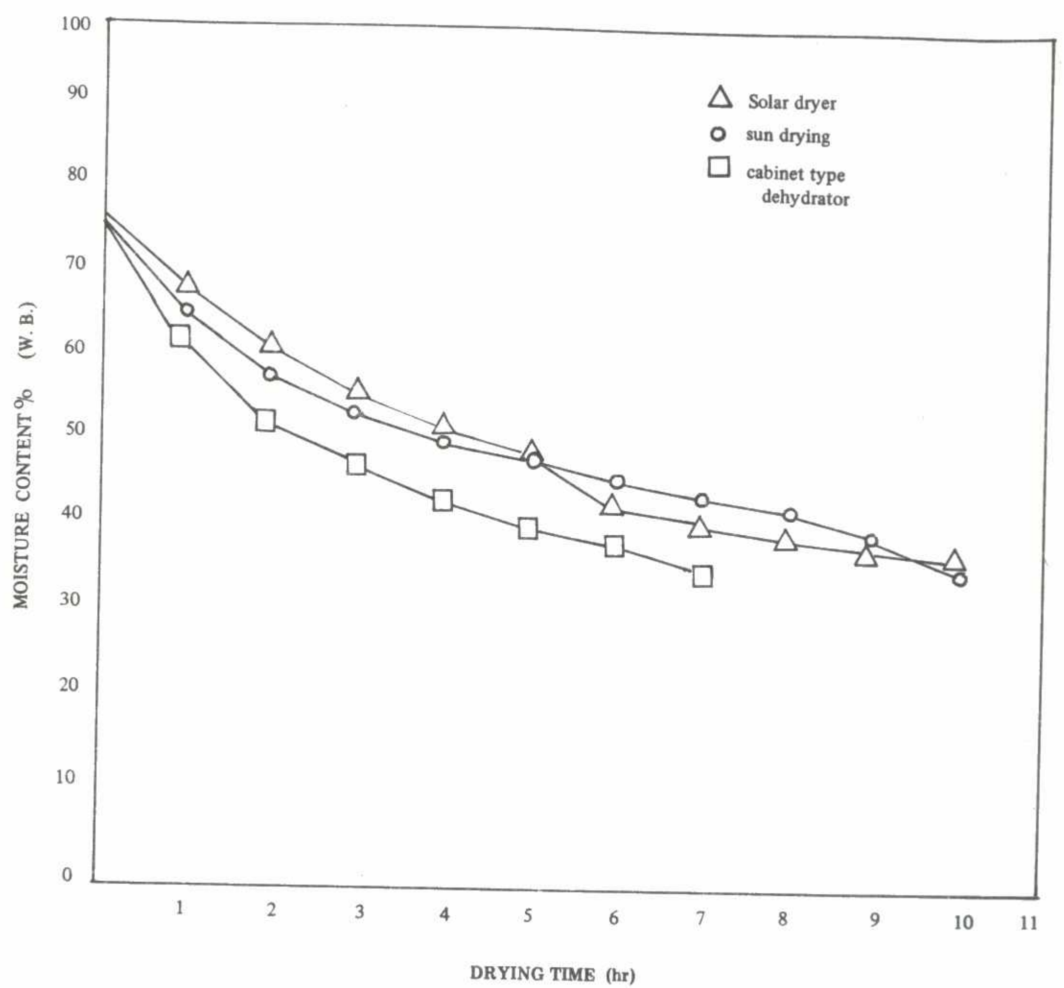

Figure 4. Drying curves for split round scad using three drying methods.

The cabinet-type dehydrator gave the shortest drying time of seven hours, while sundrying and solar drying took practically the same time. A shorter drying time was obtained from the cabinet-type dehydrator due to the ideal conditions set for drying of round scad. A constant temperature of 60 to 65°C and an air flow of 650 feet per minute were consistently set during the experiment. A warm-up time of five minutes was allowed for the dehydrator to reach 60°C before starting the drying process. On the other hand, more time was needed to dry round scads through sundrying or solar drying because of the fluctuating temperature and lack of air movement within the solar drying unit. This is further illustrated in Figure 5 where time and temperature profiles of the drying methods are given. The insignificant difference between sundrying (10 hours) and solar drying (11 hours) may be due to the following reasons and observations:

a) Drying rate is initially dependent upon the rate of air over the fish as moisture evaporates from the surfacesand is removed by the air. During the final stages of drying, as moisture migration to the surface becomes the controlling mechanism, the drying rate is then dependent upon air témperature (Waterman, 1976; Lupin, 1982). It can be seen in Figure 4 that solar drying incurred the slowest drying rate during the first five hours of drying. This was perhaps due to lack of air draft and circulation. The occurrence of moisture, condensed on the surface of the polyacetate film also signified that air flow was limited and, hence, drying was not sufficient. On the other hand, sundrying was faster than solar drying during this stage but slowed down thereafter.

b) During the last five hours of drying, higher temperature was obtained in the solar dryer over the ambient temperature. This explains the gradual increase in the drying rate of the solar dried product. However, case hardening was observed among the solar dried samples. Thus, there was a contrasting behavior on the drying rates of sundrying and solar drying during the initial and final stages of drying. The net effect of this was the almost equal drying time for the two methods.

Table 2 shows the mean score for different sensory attributes of dried round scads.

Mean score for odor, color, texture, taste and general acceptability of the final product dried by using the cabinet type dehydrator was significantly different from those dried by using the solar drier and by sun drying. No difference was noted for the solar dried and sundried products for the same sensory attributes.

Exposure of sundried samples to contamination and fly infestation tends to reduce their quality as shown by their low organoleptic scores. During drying on the solar dryer the fish undergo "case hardening", that is, the formation of a hard, sometimes horny and impermeable surface of the outer covering of a food item.

Table 2. *Mean scores for different sensory attributes of dried round scad using different methods.

Method	Odor	Color	Texture	Taste	General Acceptability
1. Direct Sundrying	(a) 7.1	(a) 7.3	(a) 6.6	(a) 6.8	(a) 7.0
2. Solar Dryer	(a) 7.3	(a) 7.2	(a) 7.1	(a) 6.8	(a) 7.1
3. Cabinet Tpe Type Dehydrator	(b) 7.6	(b) 7.6	(b) 7.8	(b) 7.8	(b) 7.7

**Mean Score of 7 panelists*

(a), (b) Members with the same superscript are not significantly different from one another.
Members with different superscript are significantly different from each other at P= .05%.

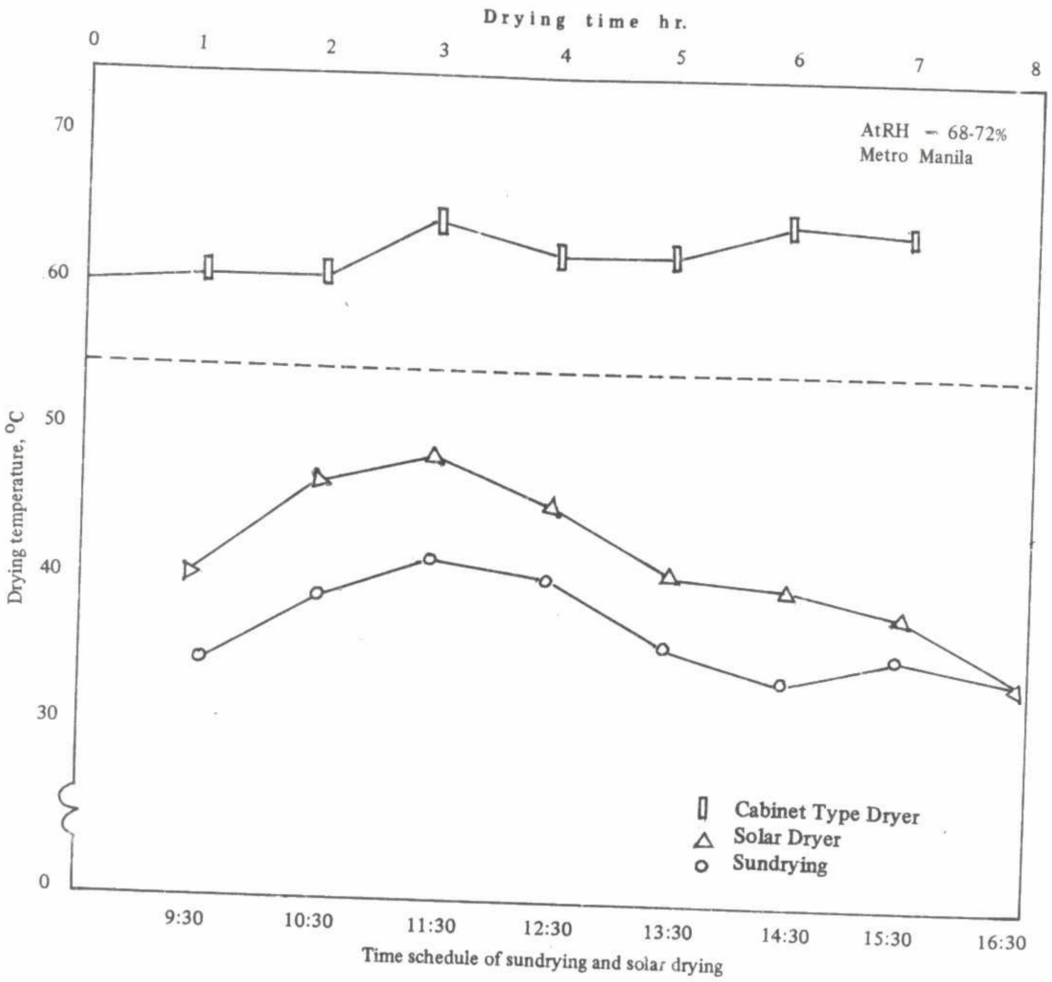

Figure 5. Time, temperature, profile of different drying techniques

Table 3 General acceptability and total bacterial count of dried roundscad using different methods of drying and stored at two temperatures.

Storage Period (Weeks)	Sun Drying Room Temp (a)		Sun Drying Ref Temp (b)		Solar Dryer Room Temp.		Solar Dryer Ref. Temp.		Cabinet-type Room Temp.		Cabinet-type Ref. Temp.	
	Gen. Acc.	Log. TBC	Gen. Acc.	Log. TBC	Gen. Acc.	Log. TBC	Gen. Acc.	Log. TBC	Gen. Acc.	Log. TBC	Gen. Acc.	Log. TBC
0	7.0	3.95	7.0	3.97	7.1	3.61	7.1	3.61	7.0	4.30	7.7	4.30
2	6.5	4.93	7.0	3.78	6.8	4.94	6.5	3.83	7.6	4.60	7.5	3.00
3	6.6	4.98	6.8	3.80	7.0	4.87	6.4	4.60	7.2	4.47	7.2	4.60
5	6.3	5.50	6.2	3.70	6.9	4.83	6.8	4.50	7.1	5.50	7.3	4.72
6	6.3	5.60	6.0	4.50	6.5	5.40	6.9	4.80	7.0	5.81	7.2	4.50
8	5.8	4.18	5.9	5.83	6.7	5.50	6.7	4.70	7.5	4.72	7.6	4.64
9	5.6	4.93	5.5	4.70	6.6	4.60	6.7	5.54	7.4	4.60	7.2	4.70
10	SPOILED		6.0	4.60	6.6		6.6	5.70	7.3	5.46	7.0	4.84
12			5.8	5.90	6.3	5.80	6.5	4.90	7.1	5.47	6.9	4.99
15			6.0	5.96			6.4	4.84	6.2	4.40	6.5	5.25
20			6.5	5.60			6.3	5.90	6.2	5.44	6.3	5.70
25			too dry				6.0	6.95	6.0	5.43	6.5	5.70

(a) Room Temperature : 28-30°C
(b) Refrigeration Temperature: 10-18°C

Storage Studies

Results of the study on storage of round scad dried by sundrying, through the solar dryer and the cabinet-type dehydrator and stored at room and refrigeration temperatures are shown in Table 3.

Sun dried samples stored at room temperature were still within the acceptability range until the ninth week, while refrigerated samples were still acceptable after 20 weeks. However, the texture of fish muscles appeared too dry; thus, observations of samples were terminated.

Samples dried through the solar dryer remained acceptable within 12 weeks at room temperature, while refrigerated samples were still very much acceptable even on the 25th week.

Again, samples dried by the cabinet-type dehydrator displayed longer shelf-life and more superior quality over the other samples. They were still highly acceptable even after 25 weeks.

Results of the total bacterial count(TBC) showed no remarkable trend among any of the samples. It was noted too, that there was no direct relationship of TBC with general acceptability scores.

Chemical analysis (Table 4) showed moisture content with a range of 34 to 41 percent; fat content, 0.15 to 0.16 percent; protein, from 46 to 48; salt, 11.20 to 11.30 and FFA, 0.03 to 0.35. Moisture content was verified by using the oven method.

Table 4. Chemical analysis of round scads dried by different methods a/

Samples Type of Dryer	Percentage of Moisture Content	Fat Content %	Protein Content	NaCl	Free fatty acid (FFA)
Sundried	34 to 38	0.16	48.0	11.30	0.036
Solar dried	34 to 41	0.15	46.04	11.27	0.035
Dehydrated cabinet type dehydrator	34 to 36	0.15	47.0	11.20	0.030

a/ Mean of triplicate analyses for each drying trials.

CONCLUSION AND RECOMMENDATIONS

A comparative evaluation of the different drying methods showed that, in general, the use of the cabinet-type dehydrator produces the best product and incurs the shortest drying time of about seven hours. With government support by way of establishing financial linkages, small-scale processors who use dehydrator utilizing LPG or agro-waste may prove to be a profitable endeavor.

The mobile solar dryer still requires improvement, especially its circulation system. In coastal areas however, it is efficient enough in terms of product quality and drying time.

With proper modification, the solar dryer can be extensively used even in urban areas. The idea of replacing the polyacetate covered doors with detachable sliding screen-covered panels may allow more air movement inside the unit, especially during the initial stage of drying. However, at the last stage when higher temperature is needed, the screen panels may be changed to sliding polyacetate panels. Another idea is to employ two types of solar dryers, one covered with screen along its side and the second is the existing structure. Since trials with the solar dryer require about 8 to 11 hours, which is about two days, the first day may employ the first type and the next day the second type. This way, continuous drying can be done.

Sun drying is still the most practical method. However, hygiene and sanitation should always be observed so as to produce better quality products.

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