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SOLAR TUNNEL DRYER AS AN INCOME GERERATION UNIT FOR FISHERMAN

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Abstract- The study revealed that local practice of drying fish in open sun drying poses problems such as high moisture content, uncontrolled drying and contamination. These problems can be avoided by proper use of improved methods such as the solar tunnel dryer, which results in faster drying of fish. The experiments were conducted without fish and with fish to evaluate the performance of solar tunnel dryer. The average 28 % saving in time was observed using solar tunnel dryer over open sun drying method with average drying efficiency of 19 %. The economics was calculated for drying of peeled prawns (*Parapaeneopsis stylifera*) by solar tunnel dryer and open sun drying system on the basis of business as a whole. The economics of the solar tunnel dryer is presented in term of Net present worth, Benefit- Cost Ratio (B-C Ratio), Payback period, Profitability index and Internal rate of return. The pay back period for solar tunnel dryer was found to be 2.84 years.

Introduction

A 100 kg/ batch capacity solar tunnel dryer for fish drying was designed and developed. The solar tunnel dryer consists of drying chamber area of 10 m x 3.75 m. It is a semi cylindrical shaped tunnel dryer made up of GI pipe (4 cm dia, B class) frame structure covered with UV stabilized semi transparent plastic film of 200 μm thick. It consists of metallic frame, developed through 6 hoops of GI pipes bent to 3.75-meter diameter. One end of the frame consists of an Iron Gate of 1.5 x 1.8 m size in constructed for loading and unloading of the fish. The cement-plastered bottoms of the tunnel dryer were painted with dull black paint for solar energy absorption. The air vents from south sides were been provided on the drying chamber for intake of fresh air. The sliding five trolleys with four trays (2x1 m) made up from anticorrosive aluminum wire mesh and framed in aluminum L channels were provided to place the moisture-laden product for drying. Three numbers of circular shaped chimneys made from MS sheet were provided at top of the structure to expel the moist air from the drying chamber. The axial AC fan were provided at east and west side of the dryer to expel the moist air so as to control the inside temperature. The technical specifications of 100 kg capacity solar tunnel dryer for fish drying is shown in Table 1. The details of solar tunnel dryer is shown in Plate1.

Material and Methods

The performance evaluation of 100 Kg capacity solar tunnel dryer was carried by conducting the no load test and full load test with fish material in comparison with open sun drying. The weighed dried fish were immediately packed in polythene bags (15 micron thick) after complete drying and stored at ambient temperature for determination of the biochemical, organoleptic properties of dried fish were evaluated and recorded after immediate drying and at the regular interval of one-month upto thee months of fish drying. The economics of the solar tunnel dryer is presented in term of Net present worth, Benefit- Cost Ratio (B-C Ratio), Payback period, Profitability index and Internal rate of return.

RESULT AND DISSCUSSION

No load test of solar tunnel dryer

It is observed that during winter season (Fig.3), the average temperature inside solar tunnel dryer was found to be 50.39 ^{0}C with corresponding relative humidity 11.92 % which was the lowest value. The corresponding ambient temperature, relative humidity and solar intensity were found to be 33.97 ^{0}C, 14.38 %, 445.58 w/m^2 respectively. The maximum average temperature inside the solar tunnel dryer was found to be 52.41 ^{0}C at center of solar tunnel dryer followed by north side (51.06 ^{0}C) and south side (47.69 ^{0}C). The minimum average relative humidity (Fig.4) inside the solar tunnel dryer was found to be 11.40 % at the center of solar tunnel dryer followed by north side (12.19 %) and south side (12.27 %). The increased relative humidity at south side could be attributed to incoming fresh air through air inlets provided at south side of solar tunnel dryer.

It is observed that during summer season, the average temperature inside solar tunnel dryer was found to be 64.70 ^{0}C with corresponding relative humidity 10.67 % which was the lowest value (Fig.5). The corresponding ambient temperature and relative humidity and solar intensity were found to be 38.57 ^{0}C, 16.17 %, 649.17 w/m^2 respectively. It was observed that, the maximum average temperature inside the solar tunnel dryer was found to be 65.69^{0}C at center of solar tunnel dryer followed by north side (64.94 ^{0}C) and south side (63.48

^{0}C). The minimum average relative humidity inside the solar tunnel dryer was found to be 10.37 % at the center of solar tunnel dryer followed by north side (10.71 %) and south side (10.92 %).

Load test of solar tunnel dryer for fish drying

The variation of temperature, relative humidity and solar radiation intensity with respect to time is shown in Figure 6. It was observed that, the maximum temperature inside solar tunnel dryer at upper tray and lower tray was found to be 60.99 ^{0}C and 56.09 ^{0}C with average relative humidity 31.45%. It was found that the average temperature and relative humidity inside the solar tunnel dryer were 45.14 ^{0}C and 39.22 % respectively while average ambient temperature and relative humidity were 30.71 ^{0}C and 36.90 % respectively.

Drying time required for fish drying under STD

The moisture reduction and drying period required for different treatment of fish species during the load test of solar tunnel dryer is summarized in Table 2. It is observed that the drying of unsalted Peeled Prawns (*Parapaeneopsis stylifera*) required 15 hours inside the dryer placed on upper tray as compared to 27 hours in open sun drying method. The salted fish required 13 and 25 hours to reduce up to 16.18 % (wb) inside the dryer and in open sun respectively.

The variation in moisture content and moisture ratio during the full load test for prawns types of fish material loaded inside the solar tunnel dryer (100 kg/batch) is depicted in corresponding Fig. 8 and Fig.9. Economics of Solar tunnel dryer for fish drying.

The total cost of construction of the solar tunnel dryer has been estimated as Rs. 87,500. The cost incurred on drying includes the fixed cost and variable cost. The result obtained from the economic evaluation of solar tunnel dryer for drying of tiny peeled prawns in term of different economic indicators is shown in Table 3. The net present value of investment made in solar dryer for drying of peeled tiny prawns under solar tunnel dryer is Rs. 20,86,165.32. The pay back period for solar tunnel dryer was found to be 2.84 years. The benefit cost ratio, profitability index and Internal rate of return calculated for solar tunnel dryer are 1.21, 11.08, 23.90 respectively.

Conclusion

1. The average 28% saving in time was observed using solar tunnel dryer over open sun drying method.
2. The average drying efficiency of fish dried by solar tunnel dryer was found about 19%.
3. Thus solar tunnel dryer can be proposed as a suitable alternative to the local method of drying fish with average payback period of 2.84 years.

Acknowledgement

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Table 1-Technical specifications of solar tunnel dryer for fish drying

SN	Particulars	Specifications	Material
01	Collector Area, Sq.m	37.5	--
02	Width of dryer, m	3.75	--
03	Length of dryer, m	10	--
05	Drying tray area, sq.m.	1.6 (1.6m x 1m)	Al. wire mesh
06	Number of trays	04 on each trolley	Ms angle
07	Number of trolleys	05	----
10	Height of tunnel, m	2	--
11	Glazing , UV stabilized	200 µm	Plastic sheet
13	Chimney, m	3 Nos, dia: 0.30	20 SWG MS
14	Fresh air vent area, sq.m	0.05	--
15	Exhaust Fan, 410 Wp, 1400 rpm	2 Nos, Brushless AC	---

Plate 1- Outside and inside view of STD for fish drying

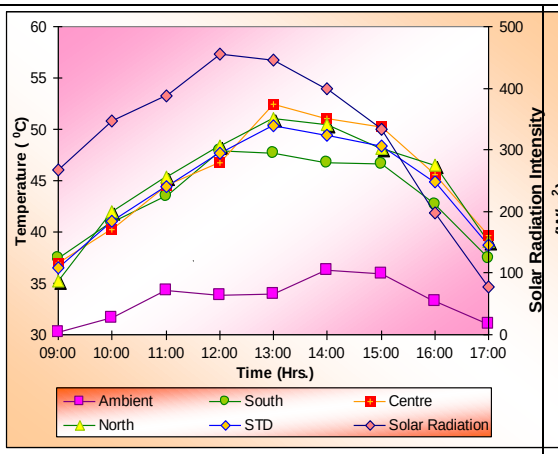

Fig. 3-No load during winter (Temp.)

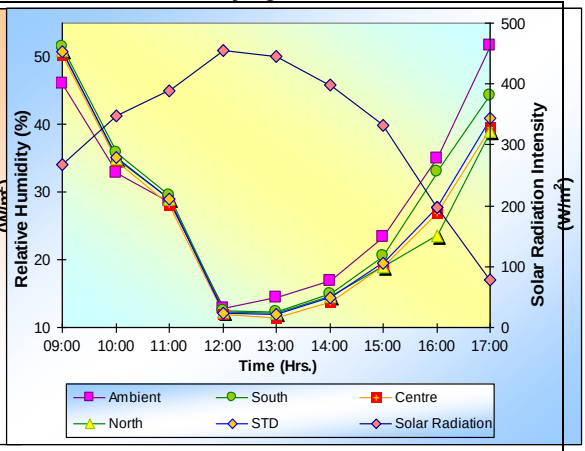

Fig.4- No load during winter (Rh)

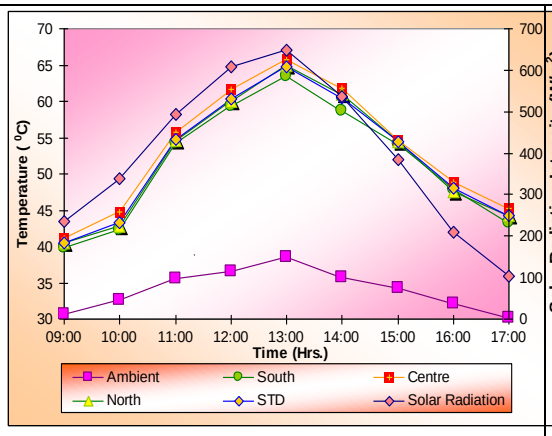

Fig. 5- No load during summer (Temp.)

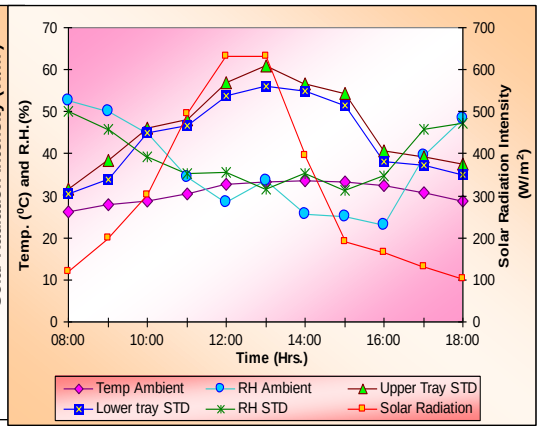

Fig. 6- Variation of temperature and Rh inside STD during load test

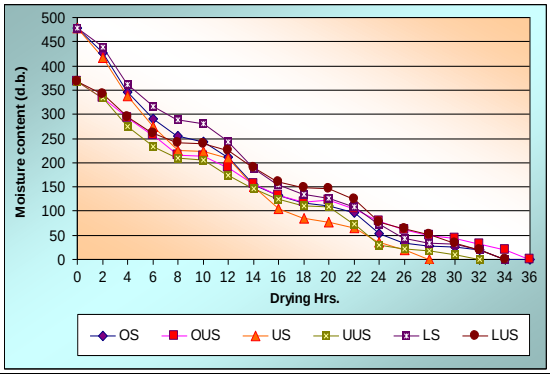

Fig. 8- MC(%) of Prawns

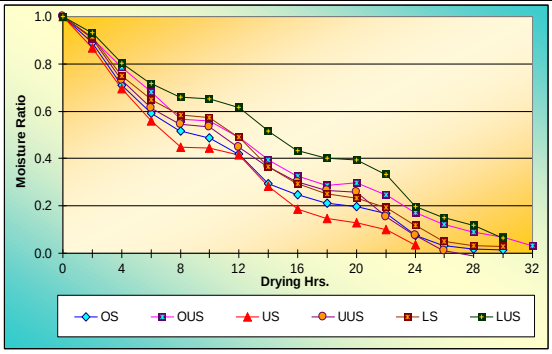

Fig. 9- MR(%) of Prawns

Table 2- Moisture content and drying time for drying of fish in STD (100 kg/batch)

Tray	Prawns IMC=78.45(% wb)		Golden anchovy IMC=69.64(% wb)		Sardine IMC=81.53(% wb)		Anchovy IMC=79.66(% wb)	
	FMC	Time,h	FMC	Time,h	FMC	Time,h	FMC	Time,h
US	16.00	22	16.11	20	17.68	20	16.00	26
UUS	15.33	24	16.27	24	16.52	24	16.31	29
LS	16.16	24	15.87	23	16.23	24	15.76	28
LUS	15.75	26	15.77	26	16.02	27	16.88	31
OS	16.18	34	15.84	29	15.75	33	16.66	33
OUS	15.64	36	16.29	32	15.22	36	16.33	36

Table 3- Economic indicators for drying peeled tiny prawns

S.N.	Economic Indicators	Solar tunnel dryer
1.	Capital investment	Rs. 1,88,353
2.	NPW at 10% D.R.	Rs. 22,74,518.32
3.	NPV at 10% D.R.	Rs. 20,86,165.32
4.	BCR	1.21
5.	Profitability index	11.08
6.	Pay Back Period	2.84
7.	IRR	23.90