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Abd Elnaby Kabeel

Tanta University

Paul Durai Leon Dharmadurai

SNS College of Technology

Sathiyaseelan Vasanthaseelan

KPR Institute of Engineering and Technology

Prof. Dr. Ravishankar Sathyamurthy (✉ raviannauniv23@gmail.com)

KPR Institute of Engineering and Technology <https://orcid.org/0000-0002-2881-3455>

Bharathwaaj Ramani

KPR Institute of Engineering and Technology

Athikesavan Muthu Manokar

BS Abdur Rahman Crescent Engineering College: B S Abdur Rahman Crescent Institute of Science & Technology

Ali Chamkha

Kuwait College of Science and Technology

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Experimental studies on natural convection open and closed solar drying using external reflector

Abd Elnaby Kabeel^a, Paul Durai Leon Dharmadurai^b, Sathiyaseelan Vasanthaseelan^c, Ravishankar Sathyamurthy^{a,c}, Bharathwaaj Ramani^c, Athikesavan Muthu Manokar^d, Ali Chamkha^{e,f,*}

^a Mechanical Power Engineering Department, Faculty of Engineering, Tanta university Tanta, Egypt

^b Department of Automobile Engineering, SNS College of Technology, Coimbatore, Tamil Nadu, India.

^c Department of Mechanical Engineering, KPR Institute of Engineering and Technology, Arasur, Coimbatore, Tamil Nadu, India

^d Department of Mechanical Engineering, B.S Abdur Rahman Crescent Institute of Science and Technology, Vandalur, Chennai, 600048, Tamil Nadu, India

^e Faculty of Engineering, Kuwait College of Science and Technology, Doha District, Kuwait

^f Institute of Research and Development, Duy Tan University, Da Nang, 550000, Viet Nam

*Corresponding author Ali J Chamkha, Faculty of Engineering, Kuwait College of Science and Technology, Doha District, Kuwait alichamkha@duytan.edu.vn

Abstract

This work presents the experimental investigation on a solar food dryer equipped with external reflectors to enhance the rate of drying efficiency by removing the moisture content available in the anchovy fish. A comparison on conventional open solar drying is carried out to assess the parameters such as drying efficiency, moisture removal rate, and heat energy required for drying the anchovy fish using the modified solar dryer using natural convection technique. The physical examination results on the dried products proved that using modified solar dryer, the dried product are free from insects, dust. Also, it is found that the loss of colour from the product is minimum while compared to conventional open solar drying. The results showed that the thermal efficiency of dryer 1 and dryer 2 are comparatively higher as compared to that of conventional open solar drying and found as 16.73 and 19.34 % respectively.

Keywords: Fish, Moisture, Drying, Solar, Hygiene

1. Introduction

The increase in global population and economic prosperity is followed by an increase in material demands and energy consumption. Since the Earth's fossil fuel supplies are finite and will inevitably run out, the loss of these fuels is a danger to life on the world. Furthermore, the use of fossil fuels as a

32 source of energy has had a variety of environmental implications. Following the heavy use of coal, oil,
33 and natural gas over the past 150 years, many countries are now invested in renewable energy supplies.
34 Globally, there is an increasing realisation that expanded renewable energy adoption is vital for
35 mitigating climate change, generating new economic prospects, and delivering energy coverage to the
36 billions of people who already lack modern energy services. Solar energy has received a lot of interest
37 among renewable energy options because of its availability, free connectivity, and commercial
38 potential. Photovoltaic and solar thermal systems are two popular methods for using solar energy in
39 use (Dharmadurai et al. (2020); Bal et al. (2010); Mustayen et al. (2014)). The fish is washed cleanly
40 with the water and made it to dry for sometimes. Then the fish is made to be cut as per the requirement,
41 then again, the fish is cleaned and made it to dry for some time. The salt is applied on the layer of the
42 fish to kill the micro-organism. Then the salted fish is exposed to sun light as shown in the Fig. 1. At
43 present there are many methods for drying the fish namely open drying method, using electric dryer,
44 and using solar dryer. The salted fish is exposed to the sunlight till it attains 10 % moisture level. The
45 advantage of this process is that the capital cost is less and the more products can be dried at the same
46 time. The disadvantages of this method are that there is no hygiene and it takes more time to dry. The
47 dry fish can't be saved during the unexpected rain time.

Figure 1: Drying fish in Open Sun light in India

50 For centuries, drying of agricultural crops, vegetables, and fruits are carried out using open solar drying
51 technique (Fudholi et al. 2010; Mustayen et al. (2014); Jairaj et al. (2009)). There are several
52 drawbacks in open solar drying technique as it requires large space, labor and the time required for
53 drying is higher. The quality of products are also considered to be main influential parameter in open
54 solar drying technique as it was affected by unexpected rain, and foreign bodies left by the animals

55 and birds. To overcome these issues, a solar dryer was developed to create a hygiene food processing.
56 The dryer can be classified into two major groups, namely: (a) passive solar-energy drying systems,
57 (b) active solar-energy drying systems. Either passive or active solar dryer, it is further divided into
58 (a) direct (b) indirect and (c) mixed type. Indirect solar dryers can be either be forced circulation or
59 natural circulation mode (Fig. 2) ([Kumar et al. \(2016\)](#); [Ekechuku & Norton \(1999\)](#)). [Mohana et al.](#)
60 [\(2020\)](#) made a comprehensive review on different concepts on solar dryer design for drying food.
61 The solar dryer is a combination of different components. The component used in the solar dryer are
62 Insulators, outer cover, inner cover, glazing. The thermal Insulator is used to prevent the transfer of
63 heat from one body to another body. The thermal Insulator prevents the conduction and convection
64 modes of heat transfer, but it is quite challenging to control the heat transfer through radiation. An
65 excellent thermal insulator should possess less thermal conductivity. An increase in the thickness of
66 the thermal Insulator decreases the heat transfer. The Insulator is placed between the outer cover and
67 the inner cover. Some of the thermal insulator materials are polystyrene, glass wool, glass fiber,
68 polyurethane, mineral wool, wood, glass, cotton, paper, cork. The outer cover is used as the protection
69 layer for the dryer. The outer cover will give the shape for the dryer. The materials commonly used
70 for outer cover are wood, mild steel, galvanized iron sheet. The inner cover or absorber is the main
71 part of the dryer, and it is mostly painted in black for arresting the heat from the incident solar radiation.
72 The material primarily used are aluminum, mild steel, galvanized iron sheet. The glazing serves as an
73 essential part of transmitting the radiation inside the dryer for drying. The most commonly used
74 material is glass. The effect of absorber plate solar air collector on indirect solar drying was
75 experimentally investigated by [Essalhi et al. \(2017\)](#). The absorber plate was fixed with cylindrical fins
76 kept parallel to the absorber plate while the air flows over the cylindrical absorber of the solar collector
77 to dry the food products available in the solar dryer. Results showed that the effect of cylindrical
78 corrugations improved the drying chamber efficiency. On a 24- hour operation the mass of samples
79 kept inside the dryer was reduced from 997.3 to 135.13 g.
80 [Eltawil et al. \(2018\)](#) studied the enhancement of a solar tunnel dryer by coupling a flat plate collector
81 and a solar photovoltaic system to remove the moisture content available in peppermint effectively.
82 The photovoltaic panel is incorporated to run the DC fan for forced convection, while the direct solar
83 radiation is avoided by providing curtains. A comparison of open solar drying was made to study the
84 effect of tunnel dryer on single, double, and three layers of mint. With an energy payback time of 2
85 years, the dryer efficiency, overall efficiency, and photovoltaic efficiency were found as 30.7, 16.3,
86 and 9.3%, respectively. Also, it was estimated that the CO₂ mitigation for the entire lifetime was 31.8

87 tons. [Nabnean et al. \(2016\)](#) experimentally analyzed an innovative solar dryer to dry the osmotically
 88 dehydrated cherry tomatoes. A comparison was carried out to assess the performance of solar dryer
 89 over natural solar drying techniques. It was reported that there was a significant reduction in the time
 90 of drying while compared to that of natural drying. Similarly, the efficiency of the modified solar dryer
 91 was found in the range of 21-69 %.

92 [Sengar et al. \(2009\)](#) used a low-cost dryer to assess the performance, which was used for drying the
 93 salted and unsalted fish products. A comparison was also made between the solar dryer and open solar
 94 drying techniques. It was reported that the time taken to dry the fish using the proposed method was 8
 95 hours, while the open solar drying technique required 15 hours to reach the same amount of moisture
 96 content. It was also found that the average drying efficiency using salted and unsalted fish was 14 and
 97 11%, respectively, and the overall thermal efficiency of the system was found as 70.97 %.

98 With a moisture content of 48.8%-50.3% on a wet basis [Subarkah & Hendrarsakti \(2013\)](#)
 99 experimented the effect of drying anchovy fish using solar drying chamber technique. Even at
 100 temperature of 70°C it was found that there is no case-hardening. In order to optimize the results, the
 101 drying process is carried out in three different stages namely, drying the anchovy fish at 70°C for 150
 102 min followed by drying the fish at 50°C for 100 min, and finally drying at 40°C to attain equilibrium
 103 moisture content. [Koya et al. \(2015\)](#) undergone research to find the most efficient angle and direction
 104 for the solar radiation when the solar power is introduced by using Geographic Information System
 105 (GIS) in Kitakyushu city, Fukuoka Prefecture as an example. The results revealed that the south-facing
 106 angle of 25 degrees is the most efficient angle on the solar power for Kitakyushu city, Fukuoka
 107 Prefecture, Japan. The results are promising and required for the best utilization of solar energy in
 108 Japan. The method is applicable anywhere in the world with the availability of GIS data access.

109 [Subarkah & Hendrarsakti \(2013\)](#) conducted experiments to determine if the drying rate interval of
 110 anchovy fish shifts from steady to dropping when the essential moisture content is between 48.8 and
 111 50.3 % (wet basis). Even at temperatures of 70 °C, there is no case-hardening in these studies. To
 112 obtain the best results, the drying process should be done in three steps: drying at 70 °C for 150
 113 minutes, drying at 50 °C for 100 minutes, and finally drying at 40 °C before equilibrium moisture
 114 content is achieved.

115 To dry agricultural products [Lingayat et al. \(2017\)](#) designed and experimented a indirect solar dryer.
 116 Solar dryers are made up of a solar flat plate air collector with V-corrugated absorption plates, an
 117 enclosed drying cavity, and an exhaust air chimney. The collectors have a gross surface area of 2 m².
 118 The qualitative study for banana drying indicated that the moisture content of banana was decreased

119 from 356 percent (db) to 16.32 % in tray 1, whereas, from tray 2, tray 3, tray 4 and solar opendrying
 120 the moisture content available was found as 19.47 %, 21.15 %, 31.15 %, and 42.37 % respectively.
 121 From the results it was found that the overall thermal efficiency of collected as 31.5 % whereas, the
 122 chamber drying efficiency was found as 22.38%. The most critical and effective factor during drying
 123 is the temperature of the drying air. The humidity of the air, as well as the velocity of the air, are
 124 essential factors in improving the drying rate. An indirect solar dryer with forced circulation for drying
 125 the commodities utilizing a DC powered fan was analysed by Chandrasekar et al.(2018). The air from
 126 the solar collector was integrated to the drying chamber for improved kinetics of drying.
 127 Swami et al. (2018) performed a comparative analysis on solar dryers using rock bed, pebbles as heat
 128 storage to increase the efficiency of solar dryer with decreased drying time. To improve the overall
 129 system performance, Daghigh and Shafieian (2016) integrated a heat recovery system to drying
 130 chamber. The hot water from the storage tank is integrated with the help of a heat exchanger and the
 131 air is blown into the dryer for improved efficiency. The hot air reaches the drying main chamber, which
 132 holds the drying materials to dry completely. The mean outlet air temperature of the dryer was
 133 approximately 44.3°C at a volumetric flow rate of 0.0328 m³/s. At the end of the day, the system's
 134 exergetic performance reaching a peak, which was about 11.7 %. Azam et al. (2020) compared the
 135 drying performance of PV and solar collector integrated green house dryer. Pretreatments of the
 136 tomatoes was done before drying. Udomkun et al. (2020) reviewed the performance of different solar
 137 dryers for agricultural products in Asian and African regions. Murali et al. (2020) designed a dryer
 138 using solar-LPG dryer in a hybrid mode for drying shrimps. The moisture content available in the fresh
 139 shrimps was reduced from initial moisture content of 76.71 % to the final moisture content of 15.38
 140 %. Spall and Sethi (2020) designed a multi-rack solar dryer with reflectors for concentrating the solar
 141 radiation.
 142 From the various literature reviewed, it was clear that the existing method of open drying system has
 143 no hygiene because there is a chance of external attack from the birds and animals, and then the dust
 144 will fall on the food product during drying. The products cannot be saved during heavy rainfall. The
 145 drying period in the open sunlight is more. Even though there are several studies carried out in solar
 146 drying techniques, the use of external reflectors to focus the solar radiation on drying the food products
 147 is very limited to the knowledge. This study emphasizes a solar drying technique that uses external
 148 mirrors on the top of the solar dryer to dry the fish products collected from the local market. A
 149 comparative analysis is carried out to assess the performance of solar dryer over conventional open
 150 drying technique.

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Figure 2: Types of solar dryer

154 2. Experimental setup and procedure

155 The conventional open solar drying is carried out by placing the required amount of anchovy fishes in
 156 the basket and kept in the outdoor condition of Coimbatore. In the modified solar drying, the dryer
 157 with an effective area of 0.152 m² with width and height of 0.48 and 0.32 m respectively. The dryer is
 158 installed with a capacity of handling 3 kg of fish. Additionally, to improve the drying efficiency, top
 159 reflector is used to focus the solar radiation. Two trays are placed inside the dryer namely tray 1 and
 160 tray 2. Tray 1 is placed at the top and tray 2 is placed below the tray 1. The dryer is oriented east-west,
 161 and the reflector is oriented east-west. Two trays are placed inside the drying chamber and the product
 162 is placed to dry. The sun's rays would reach the glazing region and be reflected within the dryer. Since
 163 the black absorber is less reflective, heat is lost within the dryer. The trapped heat dries the put
 164 substance. The air difference will frequently expel moist air from the dryer and replace it with fresh
 165 air.

166 Experiments are carried out between 9:00 and 17:00 Hrs and the ambient temperature, dryer
 167 temperature (tray 1 and tray 2), basket temperature, relative humidity (ambient and dryer) are
 168 measured every hour. The wind velocity and solar intensity variations are measured using anemometer
 169 and solar power meter respectively. Temperature are measured using PT100 type RTD sensors. An
 170 electronic balance is used measure the weight of the anchovy fish while the relative humidity is
 171 measured using thermo hygrometer. The specification of the instruments used in the present study is
 172 given in Table. 1.

Figure 3: Graphical representation of modified solar drying technique with external reflector

Table 1: Specification of instruments used in the present study

S. No	Name of instrument	Range	Error (%)
1	Solar power meter	0-2500 W/m ²	±3.5 %
2	Anemometer	0-45 m/s	±4 %
3	Thermo hygrometer	0-100%	±2 %
4	RTD sensors (PT-100 type)	0-1000°C	±1.5 %
5	Electronic balance	0-2.500 kg	±0.001 %

3. Results and discussion

The effect of temperature and humidity has a vital part in the drying. For perfect drying, the temperature should be high and the humidity should be less. It is observed that the temperature inside the dryer tends to be more than the open drying temperature. The humidity is less for dryer drying compared to open drying. The temperature changes from time to time according to the incident solar radiation. The high temperature and low humidity inside the dryer is responsible for quick drying of products. But the temperature should not be so high because it will spoil the drying of the products. The hourly variation of wind velocity, ambient temperature, tray temperature, relative humidity, and solar intensity during experimental days using conventional open solar dryer is shown in Fig. 4. During the experimental days, it is observed that the relative humidity of open basket and the ambient is almost

186 equal and the temperature of basket is increasing steadily with respect to the incident rays falling on
 187 the fish. On increased solar intensity the relative humidity measured from the basket and ambient
 188 decreases. The relative humidity of day 2 is found to be in the ranges of 50-65%, while the relative
 189 humidity of day 3 and day 4 are found in the ranges of 35-55 and 37-56% respectively. With lower
 190 humidity, the temperature of basket reaches a peak value of 45 and 48°C during day 3 and day 4
 191 respectively. With higher moisture content available in the basket, the peak temperature recorded
 192 during day 1 and day 2 are found as 44 and 40°C while the relative humidity recorded during the peak
 193 solar intensity for the days are found as 50 and 48% respectively.

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Figure 4: Hourly variation of wind velocity, ambient temperature, tray temperature, relative

humidity, and solar intensity during (a) Day 1 (b) Day 2 (3) Day 3 and (4) Day 4 using conventional open solar dryer

Similarly, the hourly variation of wind velocity, ambient temperature, tray temperature, relative humidity, and solar intensity during the experimental days using modified solar dryer is shown in Fig. 5. It can be clearly seen from the experimental days that the influence of dryer configuration with reflectors increased the temperature of tray to a maximum of 60, 58 and 65°C with peak solar intensity in tray 1 for day 1, day 2 and day 3 respectively. On increased drying condition of fishes in the tray, the relative humidity inside the dryer reduced with increased solar intensity and tray temperature. The relative humidity measured inside the dryer ranged from 35-65% during the day 1 operation while the day 2 and day 3 showed 23-55 and 21-50 % respectively.

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Figure 5: Hourly variation of wind velocity, ambient temperature, tray temperature, relative humidity, and solar intensity during (a) Day 1 (b) Day 2 and (3) Day 3 using solar dryer

Figure 6: Conventional solar drying of anchovy fish (a) before and (b) after

Fig. 6 and 7 shows the conventional open solar drying and modified solar drying of anchovy fish before and after drying respectively. It is observed that the product which is opened dried has loosen more colour when compared to dryer drying. The colour of the product will retain when it has indirect exposure to the sunlight for drying.

Figure 7: Drying of anchovy fish using modified solar dryer (a) before and (b) after

3.1. Moisture content

Moisture content lost during drying process is defined as the ratio of difference in moisture content before and after drying to the initial moisture content available in the product. Mathematically it is expressed as (Akoy et al. (2006); Khalifa et al. (2012); Panchal et al. (2013)),

$$\text{Total moisture content loss} = \frac{M_1 - M_2}{M_1} \times 100 \% \quad (1)$$

Where, M_1 and M_2 are the sample mass before and after drying (kg)

For every two hours the samples are weighed in the electronic balance and mass of fish is recorded. The variation in mass of fish during the drying process using conventional open solar drying and modified solar drying is plotted in Fig. 8. It can be observed that the mass of fish using open solar drying is more while compared to mass of fish in tray 1 and tray 2.

While drying with different seasoning time period, the mass of anchovy fish is reduced exponentially with respect to time period as the moisture level in the fish is removed by drying with solar intensity. Also, it is observed that the mass of anchovy fish inside tray 2 is higher than tray 1 as it is directly exposed to solar radiation and additional solar intensity is focused to heat the product with external reflector. The amount of time taken to dry the 1.6 kg of anchovy fish using open solar drying technique is found as 96 hours while the solar dryer required an time of 56 hours. The variations in moisture removal from the anchovy fish using conventional open solar drying and modified solar drying is plotted in Fig. 9. It is observed that the initial moisture content available in the anchovy fish during conventional open solar drying and modified solar dryer with reflector is same at the start of experiment. On increasing the drying time, the moisture content available in the fish starts to decrease.

246 The amount of moisture present in the anchovy fish available in tray 1 and tray 2 are found as 23.3 ad
 247 27.2% respectively. The moisture content in tray 2 is higher to about 3.9% than the moisture present
 248 in tray 1. This is due to the thermal barrier by the insulator placed in tray 1 and also, tray 2 is kept just
 249 beneath the tray 1. Moreover tray 1 is exposed directly to the radiation from the sun and the reflected
 250 radiation from the mirror reduced the moisture content present in anchovy fish. On comparing the
 251 moisture content available in conventional open solar drying technique, the moisture content available
 252 in the fish is found as 32.68 %.

253
 254 Figure 8: Variation in mass of fish during the drying process using conventional open solar drying
 255 and modified solar dryer

256 3.2. Drying rate

257 The drying rate is defined as the difference in the amount of moisture content available before drying
 258 and after drying to the total time taken for drying the sample. Mathematically it is expressed as (Akoy
 259 et al. (2006); Khalifa et al. (2012); Panchal et al. (2013)),

$$260 \text{ Drying rate} = \frac{M_1 - M_2}{t_d} \quad (2)$$

261 Where, t_d is the time for drying sample (days)

Figure 9: Variation in moisture content using conventional open solar drying and modified solar drying

The drying rate of both the open drying and dryer drying is compared for fishes. The drying rate of fishes at open drying and dryer drying is 0.012 kg/h and 0.031 kg/h respectively (Table. 2). On comparing both the values, it is clear that the drying rate of dryer drying is much higher than the open drying. The time taken for drying the product is also less for dryer drying when compared to the open drying.

3.3. Dryer efficiency

The dryer efficiency of the solar dryer using proposed modification is mathematically expressed as (Akoy et al. (2006); Khalifa et al. (2012); Panchal et al. (2013)),

$$\text{Thermal efficiency of dryer, } \eta_d = \frac{(M_1 - M_2) \times h_l}{A_d \times I(t) \times t_d} \quad (3)$$

Where, η_d – Dryer Efficiency (%),

h_l – Latent Heat of Vaporization (kJ/kg),

A_d – Dryer area (m²)

t_d – time for drying sample (days)

$I(t)$ - Solar radiation (W/m²)

From the experiments it is found that due to direct exposure of the fish with direct solar radiation and reflected radiation from the mirrors, the upper tray (dryer 2) exhibits higher thermal efficiency than lower tray (dryer 1). The average daily efficiency of the modified solar dryer with external reflectors were found as 19.34 and 16.73% from dryer 2 and dryer 1 respectively.

3.4. Heat energy for drying

The heat energy used for drying the fish is defined as the product of dryer efficiency, latent heat of vaporization and mass of water removed. Mathematically it is expressed as (Akoy et al. (2006); Khalifa et al. (2012)),

$$\text{Heat used for drying} = m_w \times h_1 \times \eta_d \quad (4)$$

Where, η_d – Efficiency of dryer (%), M_w – amount of water removed (kg)

Similarly, the latent heat of vaporization is estimated using Equation (5) (Youcef-Ali et al. (2001); Akoy et al. (2006); Khalifa et al. (2012)),

$$\text{Latent heat of vaporization} = 4.186 \times 10^3 \left(597 - (0.56 \times T_p) \right) \quad (5)$$

Where, T_p – is the temperature of product (K)

Based on the amount of water removed from the dryer, dryer efficiency and latent heat, the amount of heat for drying the estimated for solar dryer drying is found as 362.3 kJ.

Table. 2 Comparison of drying rate, drying efficiency, energy saving time, amount of heat for drying, and heat conduction rate through dryer insulation

Date of experiment	Drying rate (kg/hr)		Drying efficiency (%)		Energy saving time (%)	Amount of heat for drying (kJ)	Heat conduction rate through dryer insulation (kJ)
	Dryer	Open solar drying	Dryer	Open solar drying			
07.05.2019	0.031	0.012	19.37	15.73	20.05	362.3	365.09
10.05.2019	0.029	0.013	21.05	15.85	21.20	361.2	364.24
15.05.2019	0.030	0.012	20.04	14.95	21.35	362.4	365.14
20.05.2019	0.028	0.013	21.34	15.93	21.50	360.2	363.15
25.05.2019	0.027	0.011	21.39	15.51	22.14	361.2	364.28
01.06.2019	0.025	0.015	23.54	14.21	22.25	362.1	363.17

297 **3.5. Percentage of time saving for solar drying**

298 The heat energy used for drying the fish is defined as the product of dryer efficiency, latent heat of
299 vaporization and mass of water removed. Mathematically it is expressed as (Akoy et al. (2006); Khalifa
300 et al. (2012)),

$$301 \text{ Energy time saving from dryer} = \frac{T_{open} - T_{dryer}}{T_{open}} \times 100 \% \quad (5)$$

302 Where,

303 t_{open} – time for drying in open solar drying (hrs)

304 t_{dryer} – time for drying in solar dryer drying (hrs)

305 Using the modified

306 **3.6. Heat conduction through insulator**

307 The rate of heat conduction through the insulator plays a vital role in heat transfer between the trays
308 for efficient drying the fishes. It depends of the temperature inside the dryer, thermal conductivity of
309 the insulator, ambient temperature and area of the tray. Mathematically it is given as (Holman (2008)),

$$310 \text{ Heat conduction rate through Insulator} = \frac{kA_d (T_d - T_a)}{t} \quad (6)$$

311 Where, k – Thermal Conductivity (W/m K),

312 T_d – Drying chamber temperature (K),

313 T_a – Surrounding ambient temperature (K),

314 t – Thermal insulator thickness (m)

315 The amount of heat conduction rate through the dryer insulation provided is provided in Table. 2. It is
316 seen that the rate of conduction through the dryer insulation is found as 365 kJ.

317 **4. Conclusions**

318 The following conclusions are derived from the experimental investigation:

- 319 • The drying is carried out using conventional open solar drying and modified solar dryer techniques
320 for drying anchovy fish.
- 321 • The product dried in dryer is free from dust and insects and also the loss of colour in the product
322 is less compared to open drying.
- 323 • The drying thermal efficiency of dryer 1 is 16.73% and the drying thermal efficiency of dryer 2 is
324 19.34%. The drying thermal efficiency is found to be higher in the dryer 2.

325

326

327 **Ethical Approval**

328 Not Applicable

329 **Consent to Participate**

330 Not Applicable

331 **Consent to Publish**

332 Not Applicable

333 **Authors Contributions**

334 Conceptualization, Methodology, Resources, Formal analysis, Writing - original draft
335 preparation, review and editing, Supervision and investigation were carried out by Abd Elnaby
336 Kabeel, Ravishankar Sathyamurthy, Ali Chamkha

337 Writing - original draft preparation, review and editing were carried out by Paul Durai Leon
338 Dharmadurai, Sathiyaseelan Vasanthaseelan, Bharathwaaj Ramani, Athikesavan Muthu
339 Manokar

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342 **Competing Interests**

343 The authors declare that there is no competing interest

344 **Availability of data and materials**

345 Not Applicable

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417

Figures

Figure 1

Drying fish in Open Sun light in India

Figure 2

Types of solar dryer

Figure 3

Graphical representation of modified solar drying technique with external reflector

Figure 4

Hourly variation of wind velocity, ambient temperature, tray temperature, relative humidity, and solar intensity during (a) Day 1 (b) Day 2 (3) Day 3 and (4) Day 4 using conventional open solar dryer

Figure 5

Hourly variation of wind velocity, ambient temperature, tray temperature, relative humidity, and solar intensity during (a) Day 1 (b) Day 2 and (3) Day 3 using solar dryer

Figure 6

Conventional solar drying of anchovy fish (a) before and (b) after

Figure 7

Drying of anchovy fish using modified solar dryer (a) before and (b) after

Figure 8

Variation in mass of fish during the drying process using conventional open solar drying and modified solar dryer

Figure 9

Variation in moisture content using conventional open solar drying and modified solar drying