

DESIGN AND CONSTRUCTION OF A CABINET SOLAR DRIER

Abstract

Two domestic solar dryers were designed and tested in Abraka, Delta State of Nigeria. One has a mirror reflector to concentrate sun – light energy into the dryer while other has no reflector. The dryer ovens were subjected to a number of experimental tests by drying/cooking six different food items in them. The analysis of the results obtained showed that the temperature and the rate of drying in the oven with reflector were higher than the one without reflector. The temperature and the rate of drying were higher in both ovens compared to the open – air drying. The total power obtained using the oven with reflector was 350.00W, while the oven without reflector gave 330.56W and the open air – drying recorded 233.15W. These could act as an alternative dryer to the conventional open air-drying and cooking for rural farmers in Nigeria and other tropical countries with similar circumstances.

Keywords: oven, reflector, solar energy, food items, ambient temperature

1.0 Introduction

In most developing countries in the tropics such as Nigeria, over 70% of the population lives in rural areas. These people are mainly farmers who preserve their farm products by drying. This drying is a process whereby the water content of a material is reduced to a level where it could be safely stored for future use without the need for refrigeration [1]. The conventional means of drying in these areas has been the use of firewood and the open-air sun drying [2]. Sun drying is only possible in an area where the sun allows food to be dried immediately after harvest [3]. Many cereal crops, vegetables, fruits, prawn and fishes are dried by spreading them sparsely on a prepared open place to receive direct sun light. The main advantages of open – air sun drying are low capital and operating cost and the fact that little expertise is required. The disadvantages of this method are contamination, theft and massive loss to birds, insects, rodents, domestic animals and sometimes being blown away by wind beyond recovery [4, 5]. Slow and intermittent drying has no protection from rain or dews that falls on the product and encourages mould growth. Sometimes the quality (colour and vitamin content) of the product may be diminished due to over – or under – drying [6]. Moreover, since sun – drying depends on uncontrollable factors, production of uniform standard products is not guaranteed [7].

This has necessitated the invention of a solar cabinet dryer to replace the conventional open – air sun drying. Solar cabinet dryer holds a very promising future for the developing countries economically since it burns no fuel and the materials for its construction are quite cheap and

readily available. It causes no air or water pollutions. It gives a faster drying rate by raising the temperature to about 10°C – 40°C above the ambient temperature. The faster drying reduces the risk of spoilage and improves the quality of the product. Solar cabinet dryer prevents the food from dust, insects, rodent and other animals because it is enclosed in a chamber. Moreover, it can act as an alternative means of cooking in the rural areas where electricity and other sources of energy are skeletal or non-existence. The purpose of this research work is therefore to produce a prototype solar cabinet dryer, which when mass – produced, can conveniently act as an alternative dryer to the conventional open – air drying for rural farmers in Nigeria and other countries with the same circumstances.

2.0 Construction of the dryers

Abraka is a town in the Niger Delta region of Nigeria. It lies on a geographical location coordinates of $5^{\circ} 47' 0'' \text{N}$ and $6^{\circ} 6' 0'' \text{E}$ [8]. Moreover, from a daily Metrological forecast, Abraka and its environs has about 28°C on a very cold day and about 40°C on a very hot day. This could conveniently represent a typical example of a tropical temperature. This is very important because the samples considered in this research work are

1. Groundnut,
2. Plantain chips,
3. Fresh pepper,
4. Fresh meat sliced to size,
5. Fresh fish
6. Raw egg

These crops could only be dried or cooked above a specific temperature. The minimum temperature for drying groundnut, fresh pepper and plantain chips is about 45°C to 50°C and for fish and slice meat, the temperature is from 60°C to 75°C . Raw egg needs a steady temperature of about 90°C to 100°C . Hence, this cabinet solar dryer was designed so that its output temperature does not fall below 45°C .

The materials for the construction of the dryers were sourced locally to minimize cost and maximize energy, since the rural farmers are the target. The following materials were used in the construction.

1. Transparent glass (4mm thick)
2. Aluminum foil sheet (0.45mm thick)
3. Nails
4. Hinges
5. Plywood
6. Plane mirrors
7. Wood
8. A very sensitive digital weighing machine
9. 3 thermometers (mercury in glass)

75 10. A timekeeper

76 11. A knife

77 12. A stool

78 13. A flat wooden plate

79 In the construction of the solar dryers, wood of about 5 mm² area was cut to dimension to build
80 the skeletal frame work to make the boxes very rigid and then nailed together. The boxes have
81 length of 80 cm, width 50 cm and a depth of 40 cm. Then the plywood was cut to specification
82 and used to cover 5 sides of each of the dryers, while the top space was left open for the plane
83 glass. The 2 length views were (80 x 40) cm², the 2 side views were (50 x 40) cm² and the
84 bottom corner was (80 x 50) cm². The parts, which form the outer covering of the dryers, were
85 nailed together using 1-inch nails. The position of the vent were marked with the tape and
86 chiseled out. A wire net was used to cover the vent from inside to prevent the samples from
87 being lost through it. A small plywood board was fitted to the outside so that the vent could be
88 slide open and closed to ventilate the oven and allow moisture to escape from it.

89 After the construction of the framework of the dryers, aluminum sheet of 0.45 mm thick was
90 measured according to the dimension of the dryers with the position of vents cut open with a
91 scissors. Then thin foam was used to line the inside and held with 1 – inch nail before folding the
92 aluminum sheet inside the boxes. The foam was lined uniformly so that the entire oven could
93 have a uniform heating effect. It will also act as an insulator between each of the wooden boxes
94 and the aluminum sheet. The aluminum sheet was then folded inside each of the boxes and
95 nailed to the wood. At this stage, a hole for the thermometer was drilled at the top of each of the
96 2 dryers with a perforator. The space for the door was measured and wood of equal dimension
97 was used to construct it. Two half-inch hinges were fixed to each of the doors with 1-inch nails
98 so that they could be opened and closed at will to load or remove the samples. All possible
99 openings between the door and the boxes were sealed up with thin foam nailed to the wood to
100 reduce heat loss whenever the door is opened or closed.

101 The inside compartment were all painted black to increase the rate of absorption of heat. The
102 plane glass was cut to size of about (50 x 80) cm² in dimension with a diamond blade and then
103 used to cover the open top of the ovens. An evostic gum was used to rub on the surface of the
104 boxes before fixing the glass. This is to hold the glass firmly to it. A 1 – inch plank was used to
105 line the sides of the glass and nailed to the each of the boxes. The transparent glass cover allows
106 the solar energy to get to the samples and at the same time reduce heat loss by convection,
107 conduction and radiation. The boxes were mounted with 4 legs of about 80 cm length using
108 wood of 5mm² to raise them off the ground.

109 Finally, the plane mirrors were cut to dimension of (80 x 25) cm² with a diamond blade.
110 Plywood was used to form a frame at the back of the mirror so that it could be mounted on the
111 top of the dryer length – wise (One on each top sides of the box). Four ($\frac{1}{2}$ – inch) hinges were
112 used to nail the mirrors to the top side of one of the boxes. The hinges were to ensure that the

mirrors could be rotated up to an angle of 120^0 for effective result. Then the dryer with mirror reflector was labeled as oven 1, while the dryer without the mirror reflector was oven 2. Figure 1 below shows the solar dryer with mirror reflector, while figure 2 shows the solar dryer without the mirror reflector.

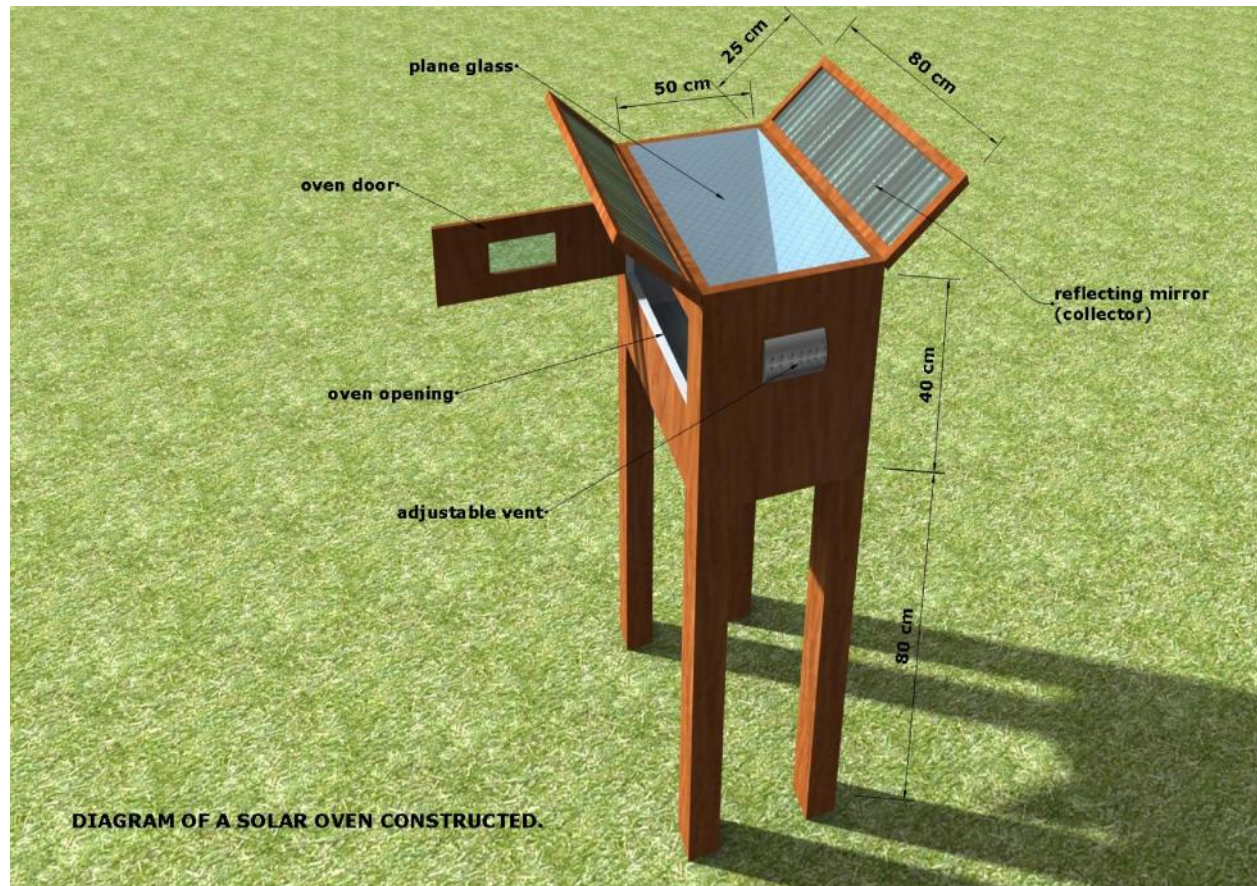
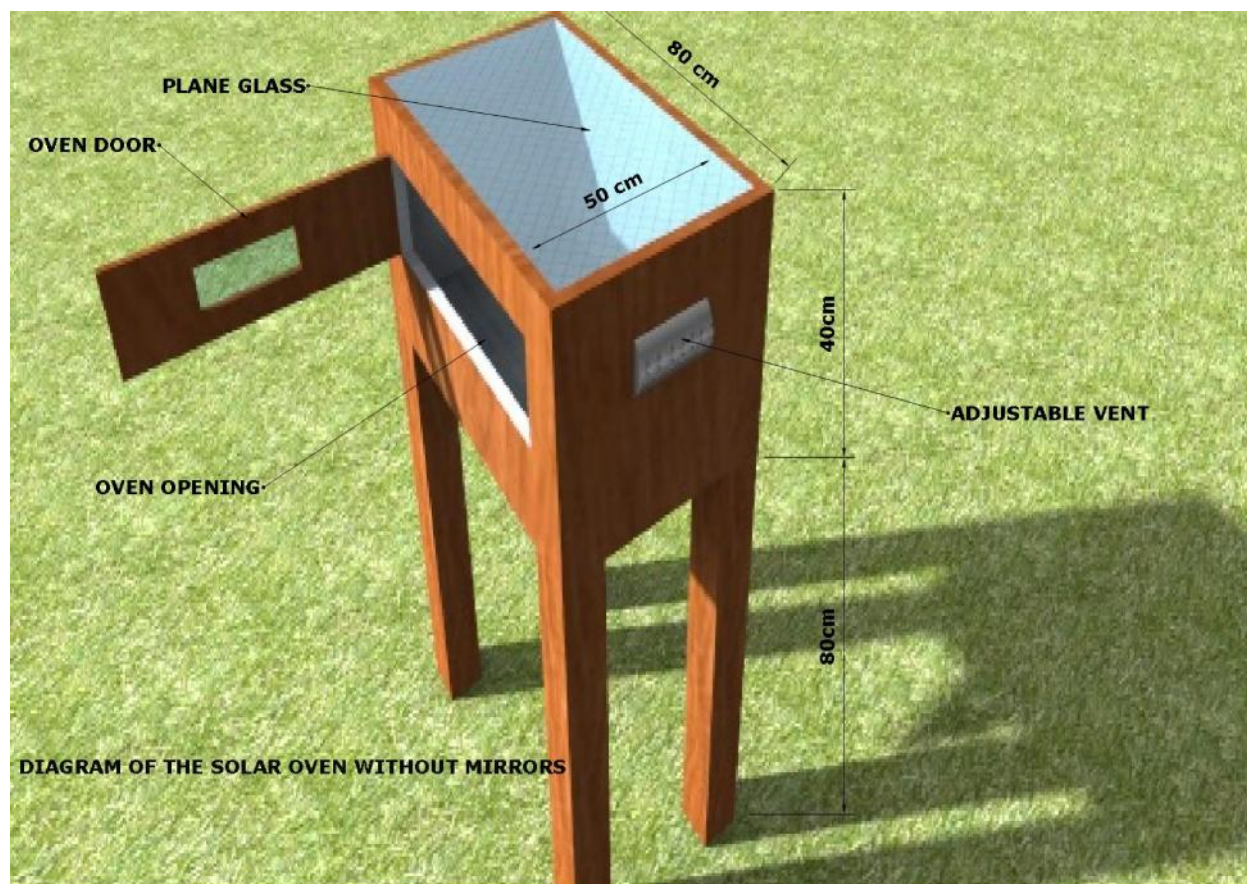


Figure 1: The solar cabinet dryer with mirror reflector



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121 Figure 2: Solar cabinet dryer without the mirror reflector

122 3.0 Data Collection and Result

123 At the beginning of each experiment, a thermometer each was placed on the 2 solar dryers and
 124 on the specimen for the open air – drying. The food samples to be used were weighed and
 125 labeled as follows

126 Specimen A were loaded into oven 1

127 Specimen B were loaded into oven 2

128 Specimen C was kept outside for open air – drying.

129 These constructed solar dryers were brought out into the open. Oven 1 was positioned facing the
 130 sunrise and the reflector mirrors tilted so that enough sun rays could be reflected back into the
 131 oven. Oven 2 was equally position in an open place to receive direct sun light. The specimen for
 132 the open air – drying was scattered on an aluminum plate (80 x 50) cm² which was painted black
 133 and then placed on top of a stool and positioned in an open place. The time, initial temperature
 134 and initial mass of each sample were recorded before being loaded into the dryers at the
 135 commencement of each days experiment and the process was repeated every one and half-hour.

The experiments were set up by 9.30 am each day and it runs until the temperature goes down about 3.30 pm. On the 1st and 2nd days, groundnut and sliced plantain were loaded together. On the 3rd and 4th days, fresh pepper and sliced meat were loaded together, while on the 5th and 6th days, only fresh sliced fish was used as sample. Then on the 7th day, raw eggs were cooked in the 2 solar dryers. The results are given in the tables below.

The precautions taken in this experiment to ensure maximum output are as follows:

1. The dryer was placed in an open place where nothing will cast its shadow on it.
2. The drying pan for loading the samples into the dryers were made of the same material with that of the control experiment for the open air – drying placed outside the dryers.

Tables 1 and 2 shows the measurements recorded for fresh groundnut on the 1st and 2nd days respectively. While tables 3 and 4 are the measurements recorded for sliced plantain on the 1st and 2nd days respectively. Figures 1 and 2 are the percentage rate of drying groundnut on the 1st and 2nd days respectively while Figure 3 is the temperature variation on the 1st day at different times of the day. Then Figures 4 and 5 are the percentage rate of drying sliced plantain on the 1st and 2nd days respectively while Figure 6 is the temperature variation on the 2nd day at different times of the day.

Table 1. Measurement for sample 1 (fresh groundnut) on the 1st day

Time (Hours)	Mass of 1A in (g)	Mass of 1B in (g)	Mass of 1C in (g)	Temp. of Oven 1 (°C)	Temp. of Oven 2 (°C)	Ambient Temp. (°C)
9.30 am	21.41	21.55	21.90	32.0	32.0	32.0
11.00 am	18.41	19.13	21.90	49.0	47.0	32.0
12.30 pm	14.20	15.35	20.48	57.0	54.0	38.0
2.00 pm	12.80	14.30	19.80	55.0	53.0	34.0
3.30 pm	9.80	13.30	17.76	42.0	41.0	30.0

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Average percentage loss in mass was computed according to [9]

$$\frac{a-b}{a} \times 100\% \quad 1$$

Where a = initial mass of the sample

b = final mass of the sample

$$\text{Percentage loss in mass of sample 1A} = \frac{21.41 - 9.8}{21.41} \times 100\% = 54.22\%$$

159 Percentage loss in mass of sample 1B = $\frac{21.55 - 13.30}{21.55} \times 100\%$ = 38.28%

160 Percentage loss in mass of sample 1C = $\frac{21.90 - 17.76}{21.90} \times 100\%$ = 18.90%

161

162 Table 2. Measurements for sample 1 (fresh groundnut) on the 2nd day.

Time (Hours)	Mass of 1A in (g)	Mass of 1B in (g)	Mass of 1C in (g)	Temp. of Oven 1 (°C)	Temp. of Oven 2 (°C)	Ambient Temp. (°C)
9.30 am	23.09	23.73	23.15	28.0	28.0	28.0
11.00 am	20.72	21.40	22.14	64.0	61.0	38.0
12.30 pm	18.94	19.57	20.69	59.0	56.0	37.0
2.00 pm	14.73	15.52	18.60	65.0	62.0	40.0
3.30 pm	10.31	13.51	17.90	49.0	47.0	30.0

163 Percentage loss in mass of sample 1A = $\frac{23.09 - 10.31}{23.09} \times 100\%$ = 55.35%

164 Percentage loss in mass of sample 1B = $\frac{23.73 - 13.51}{23.73} \times 100\%$ = 43.07%

165 Percentage loss in mass of sample 1C = $\frac{23.15 - 17.90}{23.15} \times 100\%$ = 22.68%

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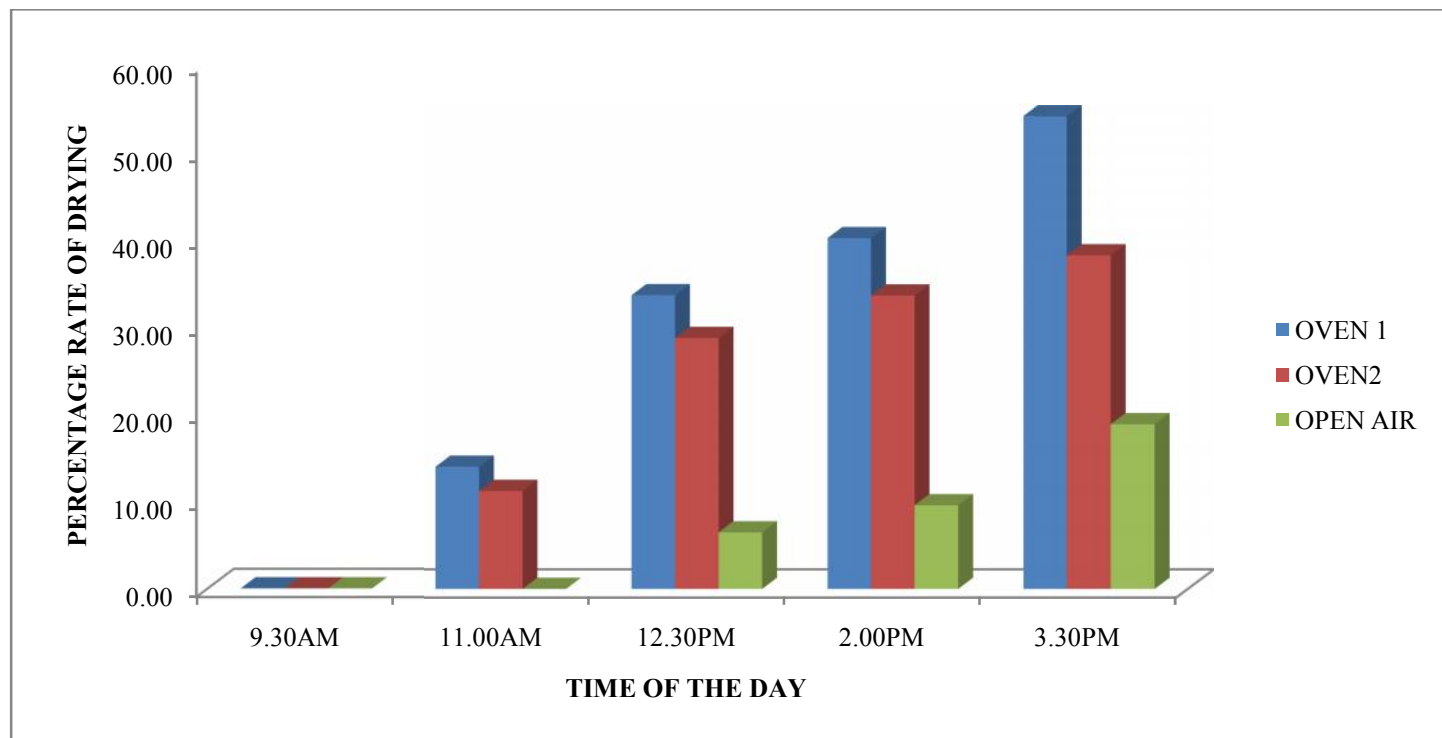


Figure 3; The percentage rate of drying groundnut on the 1st day

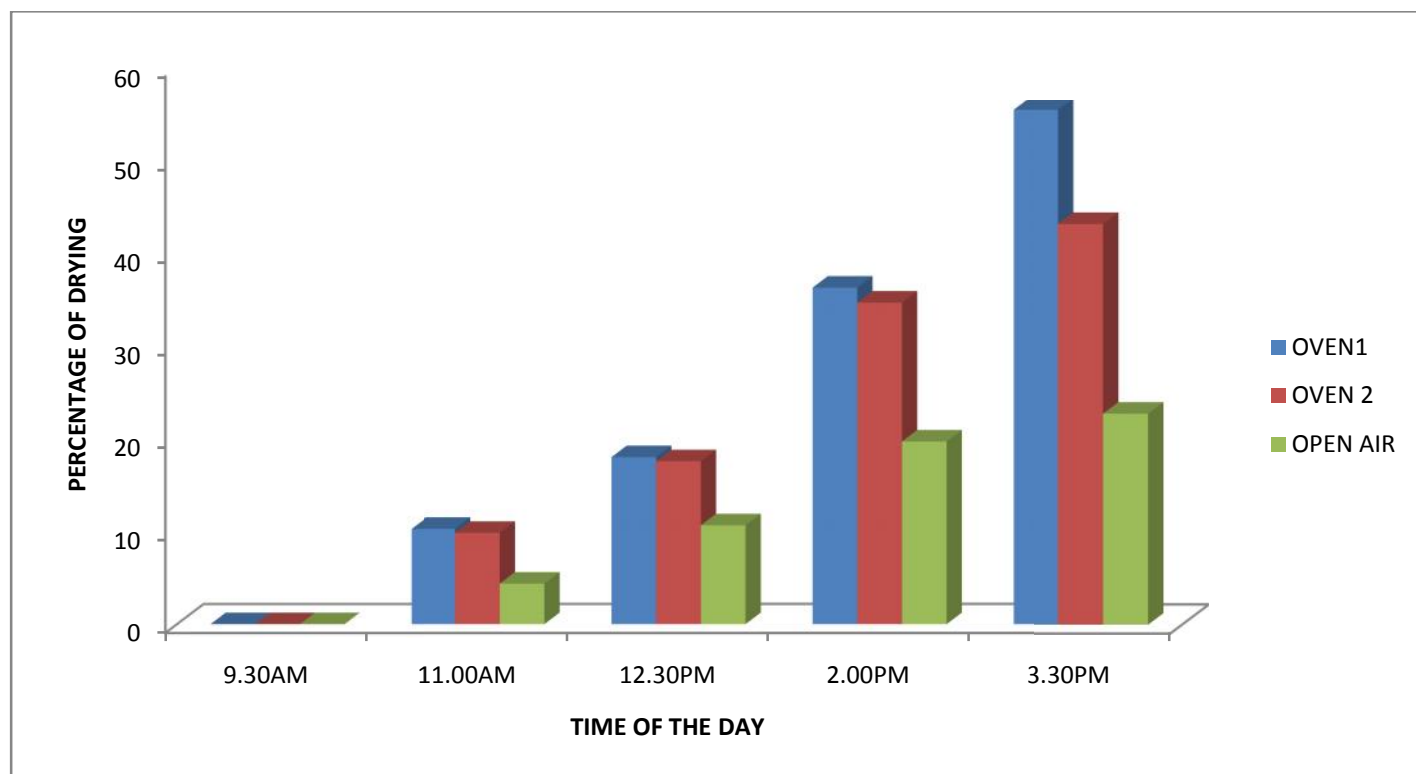


Figure 4: The percentage rate of drying groundnut on the 2nd day

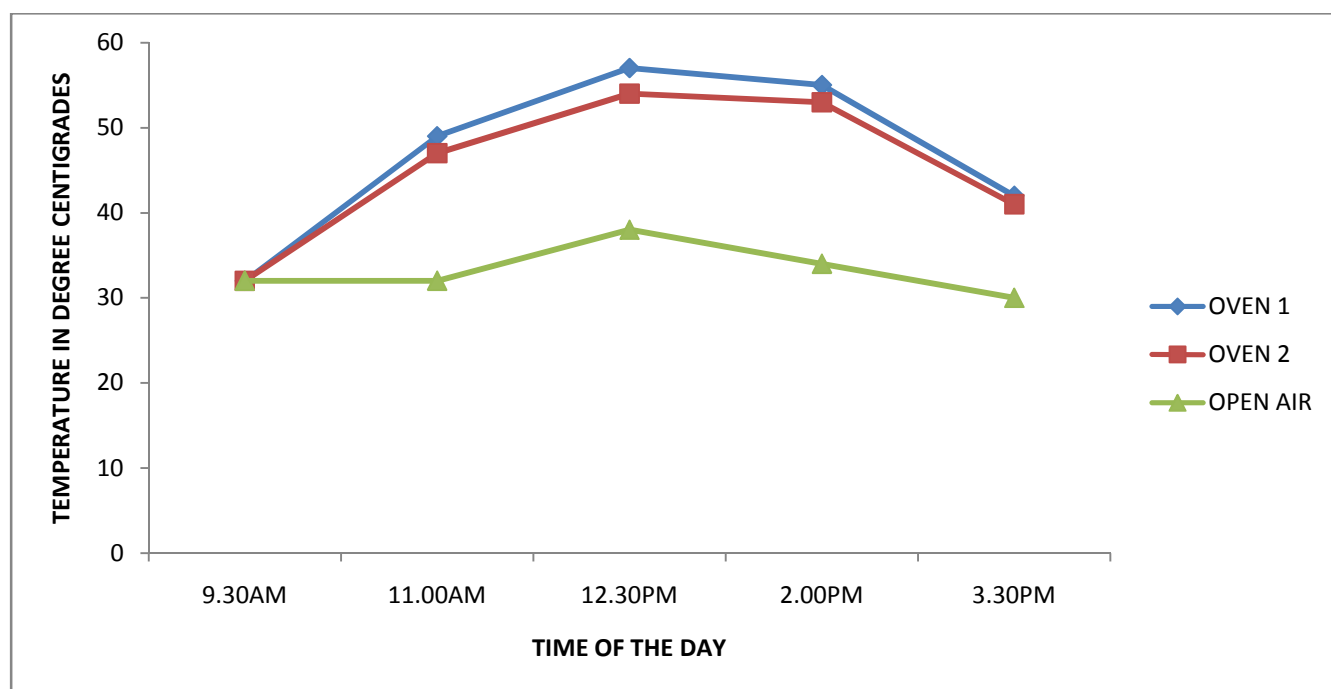


Figure 5. The plot of temperature variation against Time on the 1st day

Table 3. Measurements for samples 2 (Plantain) on the 1st day.

Time (Hours)	Mass of 2A in (g)	Mass of 2B in (g)	Mass of 2C in (g)	Temp. of Oven 1 (°C)	Temp. of Oven 2 (°C)	Ambient Temp. (°C)
9.30 am	22.61	23.54	20.18	32.0	32.0	32.0
11.00 am	16.81	20.60	18.61	49.0	47.0	32.0
12.30 pm	12.75	16.01	14.61	57.0	54.0	38.0
2.00 pm	10.57	13.19	13.02	55.0	53.0	34.0
3.30 pm	9.98	11.70	12.49	42.0	41.0	30.0

$$\text{Percentage loss in mass of sample 2A} = \frac{22.61 - 9.98}{22.61} \times 100\% = 55.86\%$$

$$\text{Percentage loss in mass of sample 2B} = \frac{23.54 - 11.70}{23.54} \times 100\% = 50.30\%$$

$$\text{Percentage loss in mass of sample 2C} = \frac{20.18 - 12.49}{20.18} \times 100\% = 38.11\%$$

189 Table 4 Measurements for samples 2 (Plantain) on the 2nd day

Time (Hours)	Mass of 2A in (g)	Mass of 2B in (g)	Mass of 2C in (g)	Temp. of Oven 1 (°C)	Temp. of Oven 2 (°C)	Ambient Temp. (°C)
9.30 am	28.53	25.18	26.08	28.0	28.0	28.0
11.00 am	17.24	17.18	19.51	64.0	61.0	38.0
12.30 pm	14.41	13.47	17.16	59.0	56.0	37.0
2.00 pm	11.32	10.24	15.17	65.0	62.0	40.0
3.30 pm	10.91	10.23	14.28	49.0	47.0	30.0

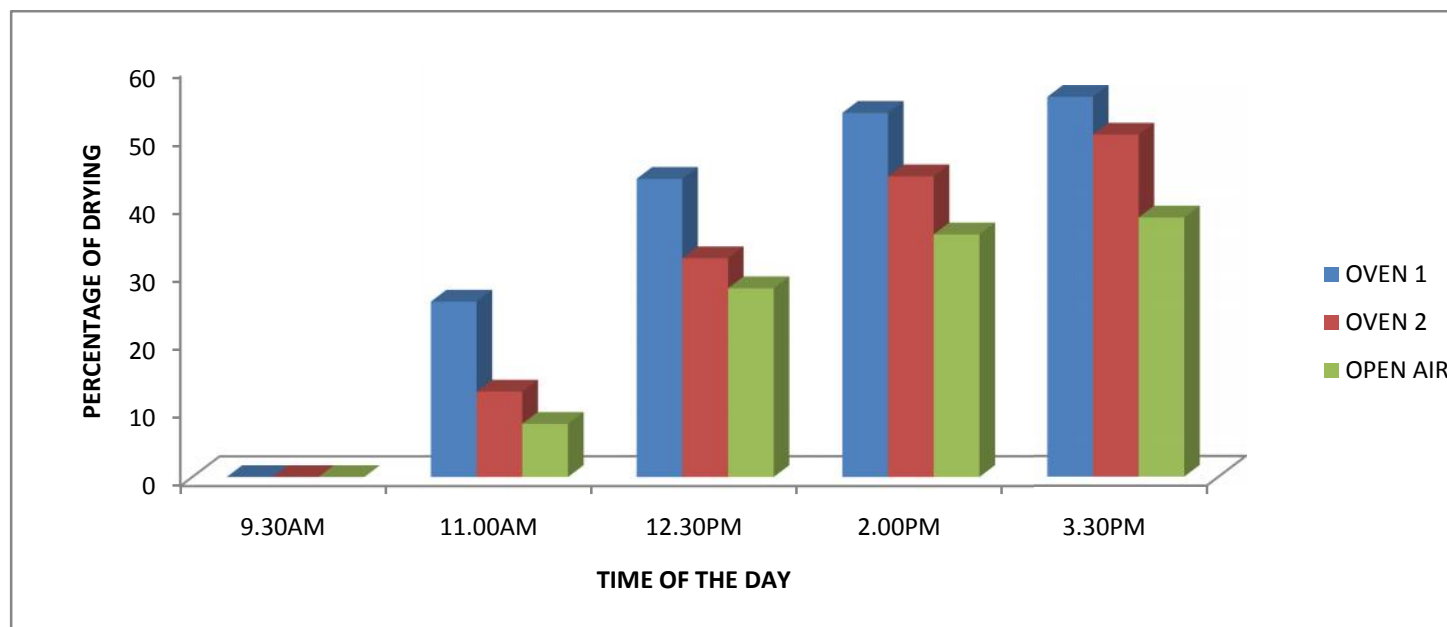
190 Average percentage loss in mass of sample 2A = $\frac{28.53 - 10.91}{28.53} \times 100\% = 61.76\%$

191 Average percentage loss in mass of sample 2B = $\frac{25.18 - 10.23}{25.18} \times 100\% = 59.37\%$

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193 Average percentage loss in mass of sample 2C = $\frac{26.08 - 14.28}{26.08} \times 100\% = 45.25\%$

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196 Figure 6 : The percentage rate of drying plantain on the 1st day

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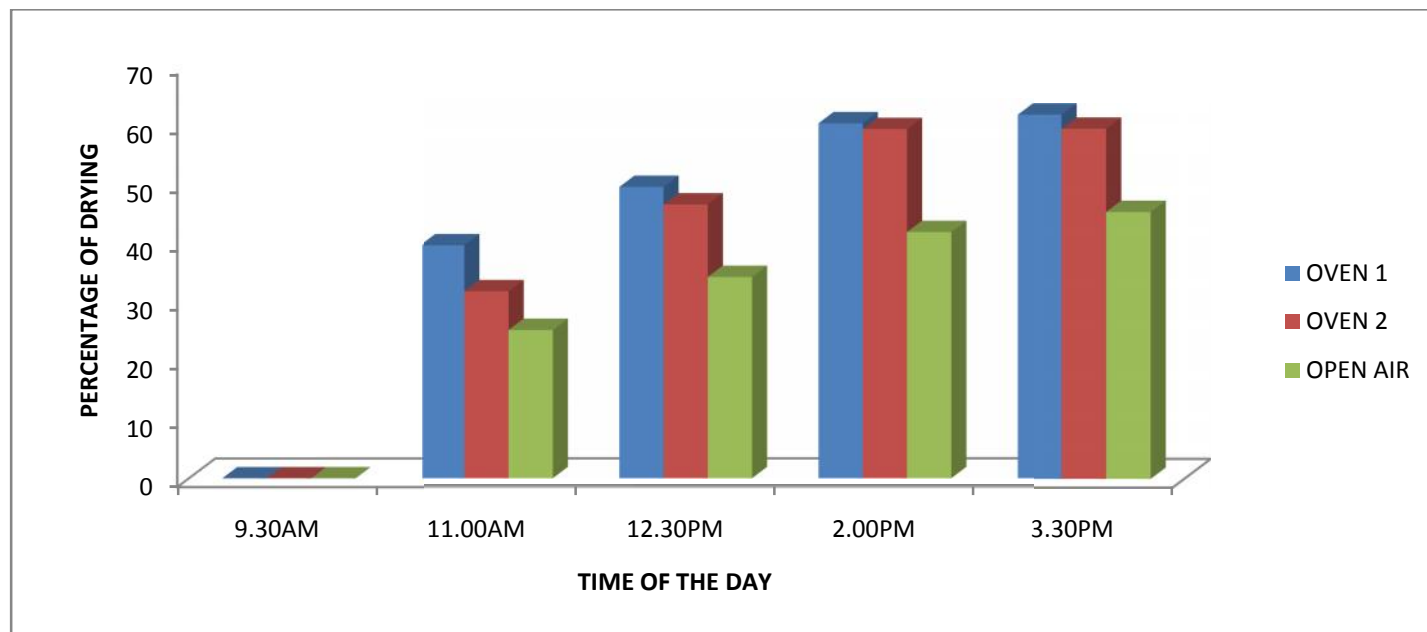


Figure 7: The percentage rate of drying plantain on the 2nd day

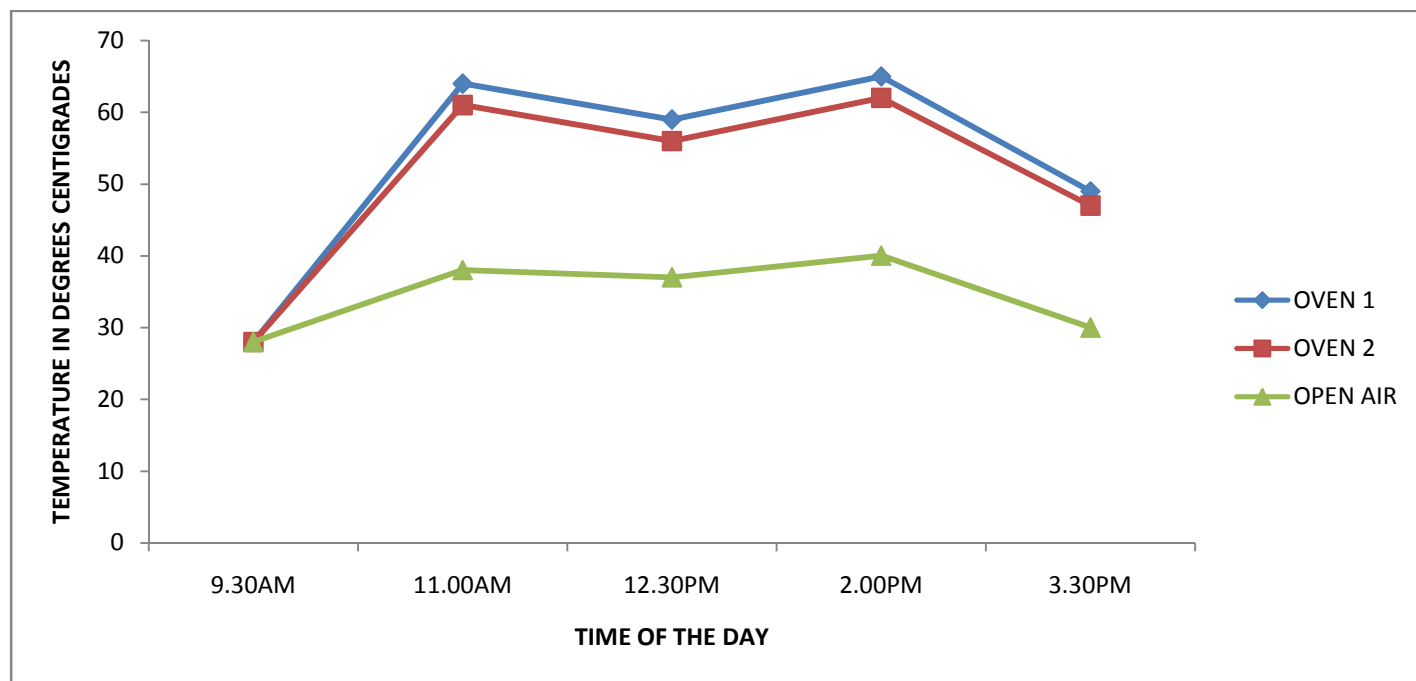


Figure 8: The plot of temperature variation against Time on the 2nd day.

Tables 5 and 6 shows the measurements recorded for fresh pepper on the 3rd and 4th days respectively. While tables 7 and 8 are the measurements recorded for sliced meat on the 3rd and 4th days respectively. Figures 7 and 8 are the percentage rate of drying fresh pepper on the 3rd

208 and 4th days respectively while Figure 9 is the temperature variation on the 3rd day at different
 209 times of the day. Then Figures 10 and 11 are the percentage rate of drying sliced meat on the 3rd
 210 and 4th days respectively while Figure 12 is the temperature variation on the 4th day at different
 211 times of the day.

212 Table 5 Measurements for samples 3 (Pepper) on the 3rd day

Time (Hours)	Mass of 3A in (g)	Mass of 3B in (g)	Mass of 3C in (g)	Temp. of Oven 1 (°C)	Temp. of Oven 2 (°C)	Ambient Temp. (°C)
9.30 am	20.51	21.82	20.66	28.0	28.0	28.0
11.00 am	16.52	18.11	18.71	52.0	50.0	38.0
12.30 pm	12.21	13.20	15.42	57.0	54.0	39.0
2.00 pm	7.59	9.47	13.01	72.0	66.0	42.0
3.30 pm	5.51	7.08	11.63	56.0	53.0	35.0

213 Average percentage loss in mass of sample 3A = $\frac{20.51 - 5.51}{20.51} \times 100\% = 73.14\%$

214 Average percentage loss in mass of sample 3B = $\frac{21.82 - 7.08}{21.82} \times 100\% = 67.55\%$

215 Average percentage loss in mass of sample 3C = $\frac{20.66 - 11.63}{20.66} \times 100\% = 43.71\%$

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217 Table 6. Measurements for samples 3 (fresh pepper) 4th day

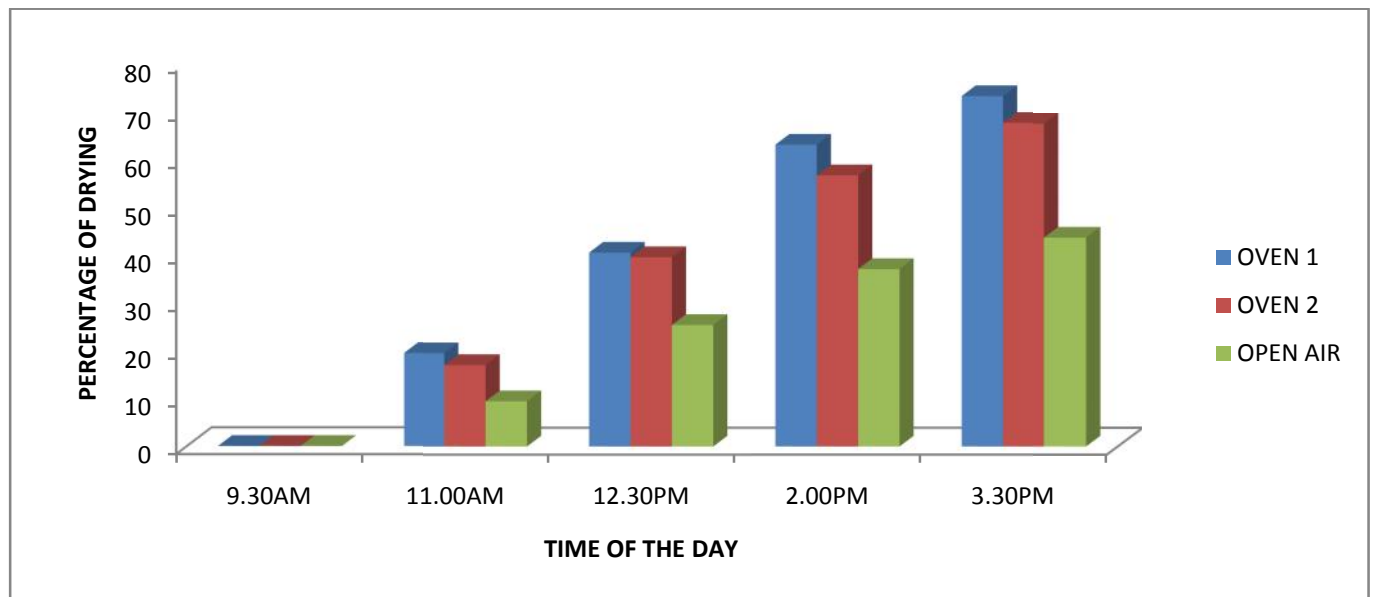
Time (Hours)	Mass of 3A in (g)	Mass of 3B in (g)	Mass of 3C in (g)	Temp. of Oven 1 (°C)	Temp. of Oven 2 (°C)	Ambient Temp. (°C)
9.30 am	24.21	23.70	23.97	31.0	31.0	31.0
11.00 am	14.48	14.91	16.77	67.0	62.0	38.0
12.30 pm	9.22	10.33	13.23	57.0	55.0	36.0
2.00 pm	5.31	8.19	10.86	73.0	65.0	45.0
3.30 pm	4.13	5.18	8.73	55.0	52.0	33.0

218 Average percentage loss in mass of sample 3A = $\frac{24.21 - 4.13}{24.21} \times 100\% = 82.94\%$

219 Average percentage loss in mass of sample 3B = $\frac{23.70 - 5.18}{23.70} \times 100\% = 78.14\%$

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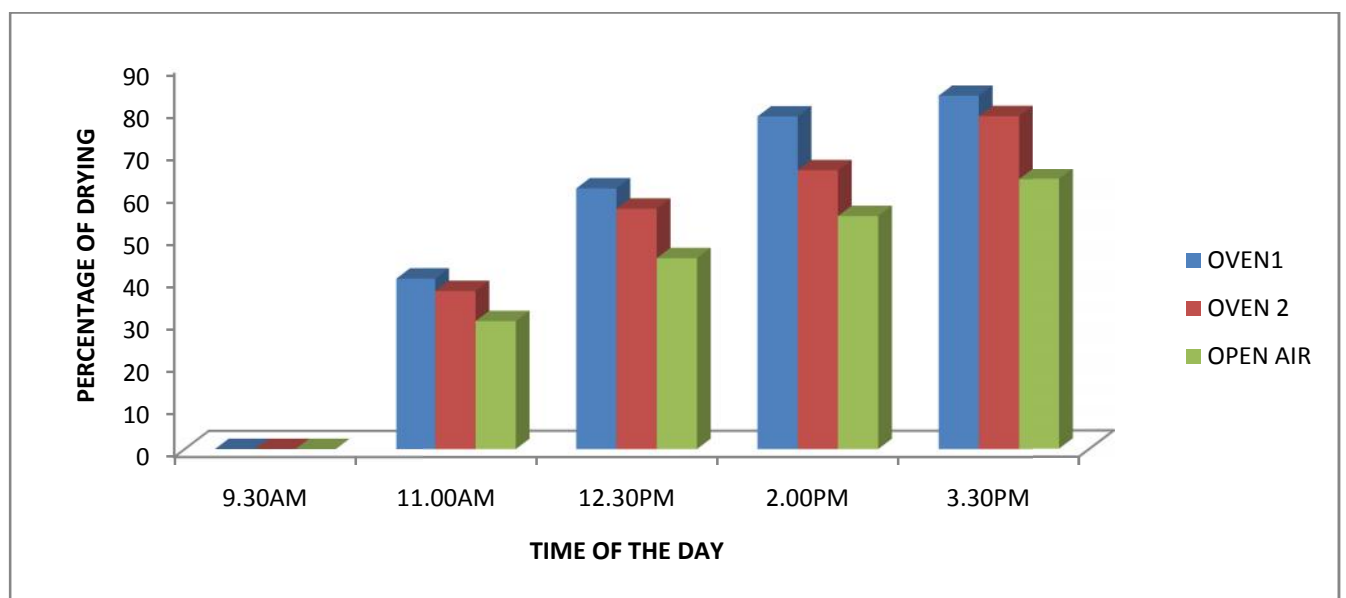
221 Average percentage loss in mass of sample 3C = $\frac{23.97 - 8.73}{23.97} \times 100\% = 63.36\%$



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223 Figure 9. The percentage rate of drying pepper on the 3rd day

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226 Figure 10: The percentage rate of drying pepper on the 4th day

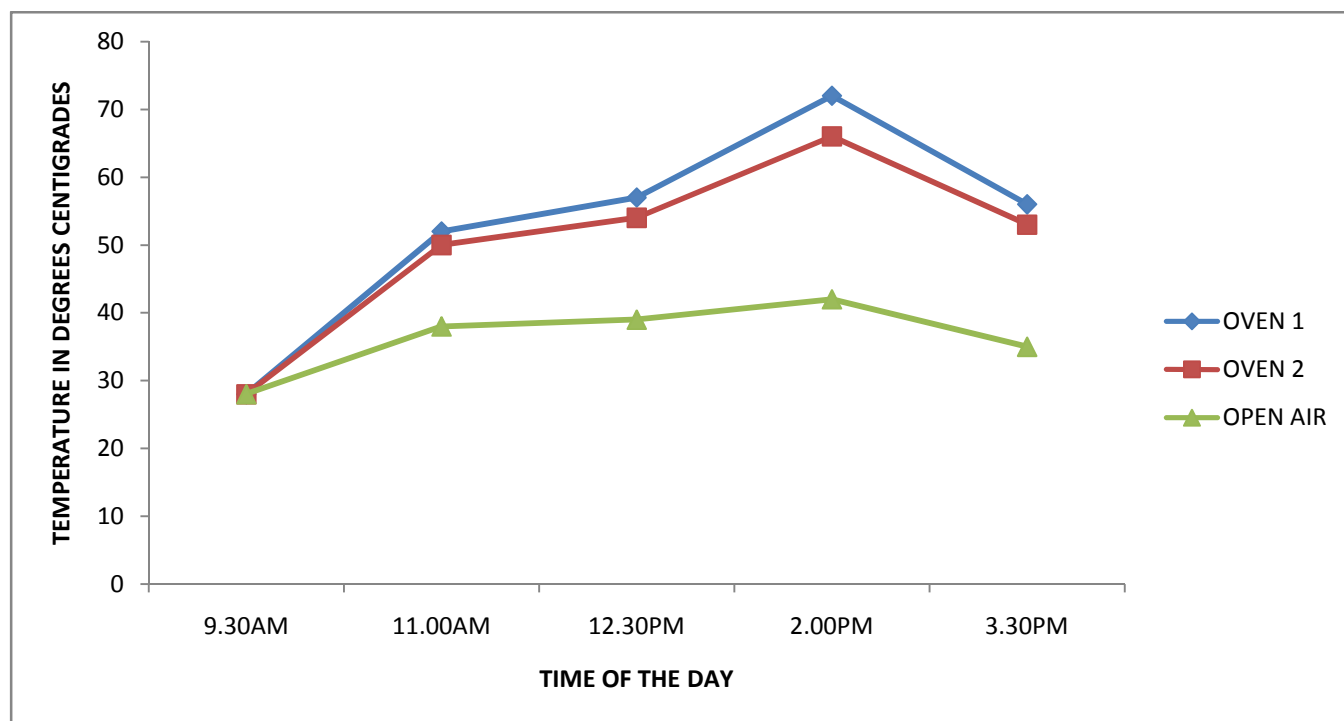
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233 Figure 11: The plot of Temperature variation against Time on the 3rd day.

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235 Table 7. Measurements for sample 4 (fresh Meat) on the 3rd day.

Time (Hours)	Mass of 4A in (g)	Mass of 4B in (g)	Mass of 4C in (g)	Temp. of Oven 1 (°C)	Temp. of Oven 2 (°C)	Ambient Temp. (°C)
9.30 am	21.79	22.48	22.17	28.0	28.0	28.0
11.00 am	17.62	18.23	18.18	52.0	50.0	38.0
12.30 pm	13.73	14.07	14.89	57.0	54.0	39.0
2.00 pm	9.81	10.41	11.67	72.0	66.0	42.0
3.30 pm	8.47	9.22	11.21	56.0	53.0	35.0

236 Average percentage loss in mass of sample 4A = $\frac{21.79 - 8.47}{21.79} \times 100\%$ = 61.13%

237 Average percentage loss in mass of sample 4B = $\frac{22.48 - 9.22}{22.48} \times 100\%$ = 58.99%

238 Average percentage loss in mass of sample 4C = $\frac{22.17 - 11.21}{22.17} \times 100\% = 49.44\%$

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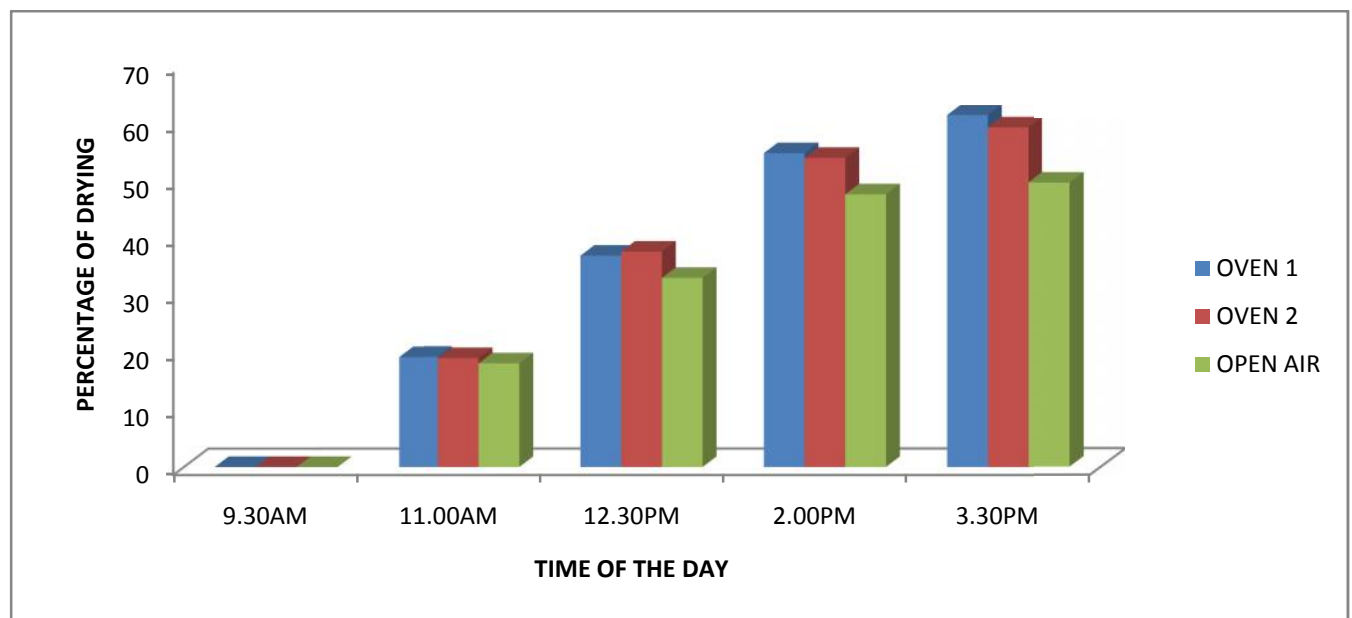
240 Table 8. Measurements for sample 4 (fresh meat) on the 4th day

Time (Hours)	Mass of 4A in (g)	Mass of 4B in (g)	Mass of 4C in (g)	Temp. of Oven 1 (°C)	Temp. of Oven 2 (°C)	Ambient Temp. (°C)
9.30 am	29.61	28.08	28.51	31.0	31.0	31.0
11.00 am	23.16	23.61	26.18	67.0	62.0	38.0
12.30 pm	17.14	18.96	24.88	57.0	55.0	36.0
2.00 pm	13.78	16.21	22.09	73.0	65.0	45.0
3.30 pm	11.89	13.62	20.83	55.0	52.0	33.0

241 Average percentage loss in mass for sample 4A = $\frac{29.61 - 11.89}{29.61} \times 100 = 59.85\%$

242 Average percentage loss in mass for sample 4B = $\frac{28.08 - 13.62}{28.08} \times 100\% = 51.50\%$

243 Average percentage loss in mss for sample 4C = $\frac{28.51 - 20.83}{28.51} \times 100\% = 26.94\%$



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245 Figure 12: The percentage rate of drying fresh meat on the 3rd day

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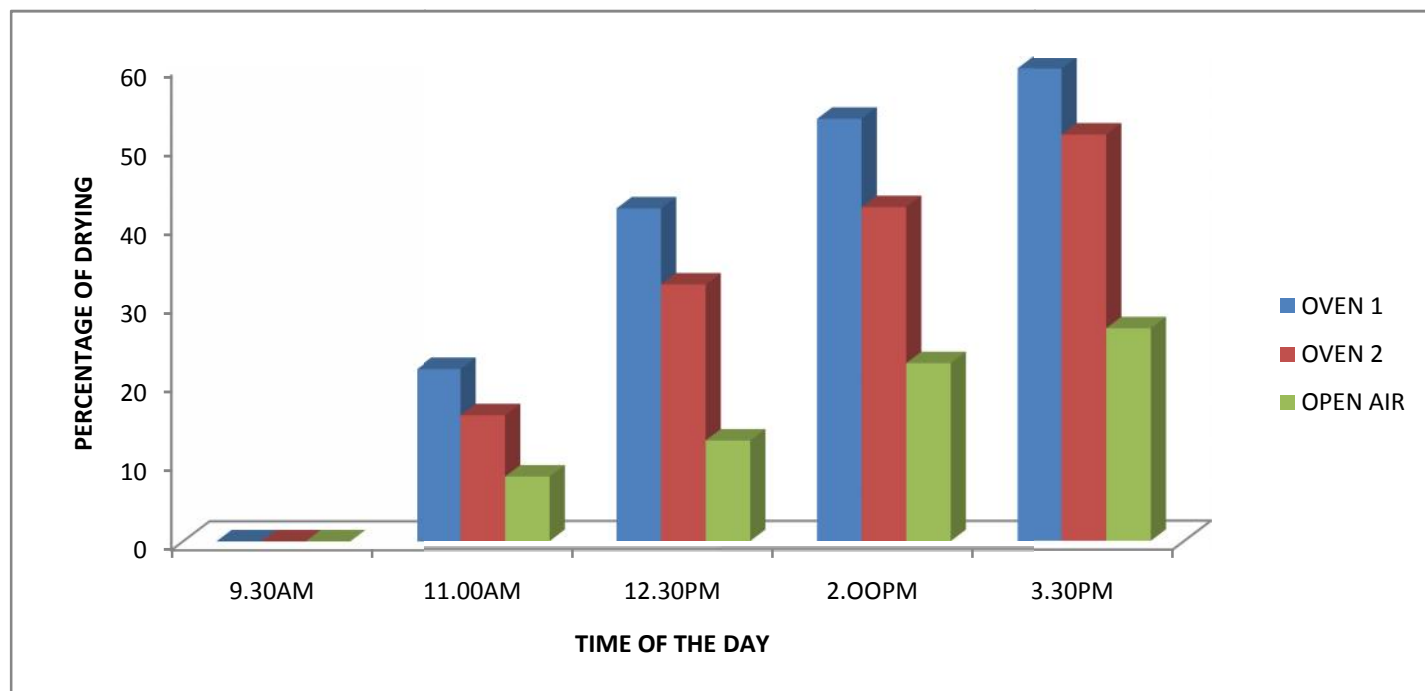


Figure 13: The percentage rate of drying fresh meat on the 4th day

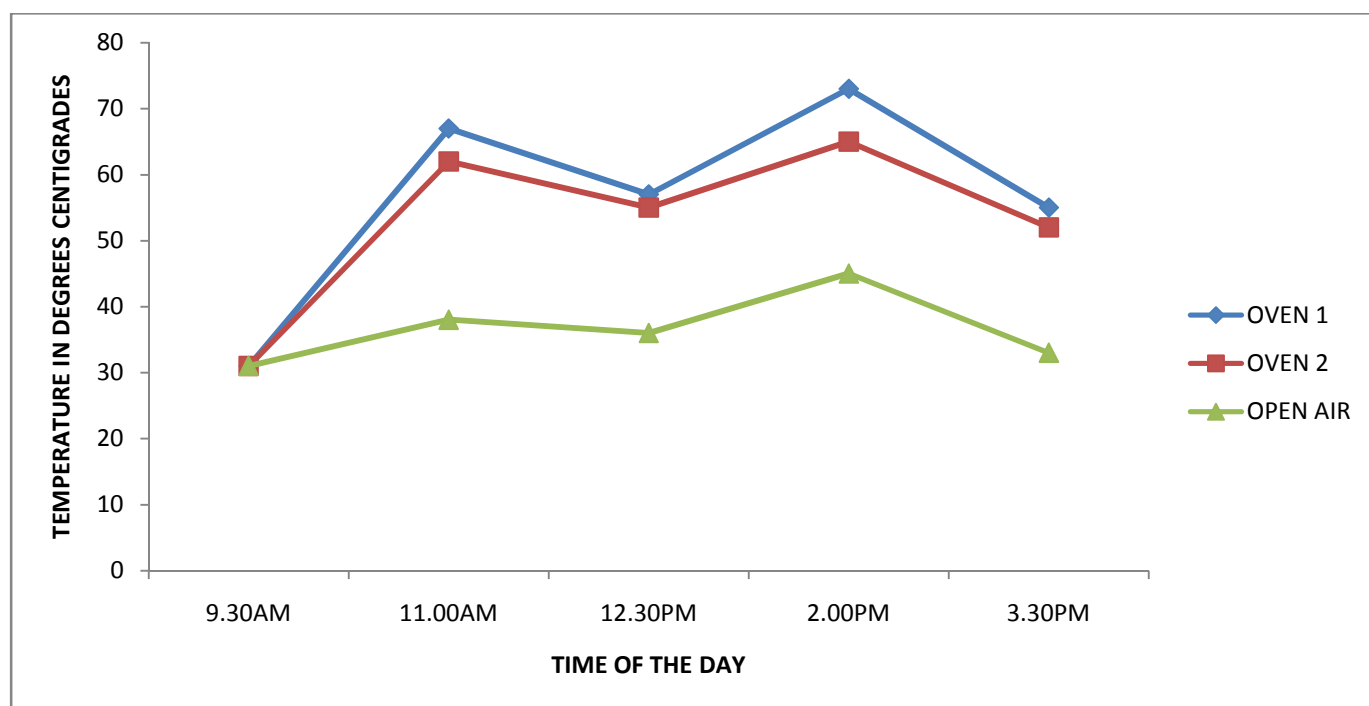


Figure 14: The plot of Temperature variation against Time on the 4th day

Tables 9 and 10 are the measurements recorded for sample 5 (fresh fish) on the 5th and 6th days respectively. Figures 13 and 14 are the percentage rate of drying fresh fish on the 5th and 6th days respectively. While Figures 15 and 16 are the plot of the temperature variation on the 5th and 6th days respectively at different times of the day.

Table 9. Measurements for sample 5 (fresh fish) on the 5th day

Time (Hours)	Mass of 5A in (g)	Mass of 5B in (g)	Mass of 5C in (g)	Temp. of Oven 1 (°C)	Temp. of Oven 2 (°C)	Ambient Temp. (°C)
9.30 am	21.63	22.93	21.83	28.0	28.0	28.0
11.00 am	17.82	19.31	19.16	52.0	50.0	38.0
12.30 pm	14.33	15.29	17.51	72.0	54.0	39.0
2.00 pm	11.56	12.66	14.81	71.0	66.0	42.0
3.30 pm	5.73	8.71	12.84	56.0	53.0	35.0

$$\text{Average percentage loss in mass for sample 5A} = \frac{21.63 - 5.72}{21.63} \times 100\% = 73.51\%$$

263 Average percentage loss in mass for sample 5B = $\frac{22.93 - 8.71}{22.93} \times 100\% = 62.02\%$

264 Average percentage loss in mass for sample 5C = $\frac{21.83 - 12.84}{21.83} \times 100\% = 41.18\%$

265

266 Table 10. Measurements for samples 5 (fresh fish) on the 6th day

Time (Hours)	Mass of 5A in (g)	Mass of 5B in (g)	Mass of 5C in (g)	Temp. of Oven 1 (°C)	Temp. of Oven 2 (°C)	Ambient Temp. (°C)
9.30 am	20.47	20.82	21.41	31.0	31.0	31.0
11.00 am	14.88	15.43	16.25	67.0	62.0	38.0
12.30 pm	11.92	12.22	13.77	79.0	74.0	45.0
2.00 pm	9.01	10.42	12.64	73.0	65.0	42.0
3.30 pm	7.15	9.98	11.60	55.0	52.0	32.0

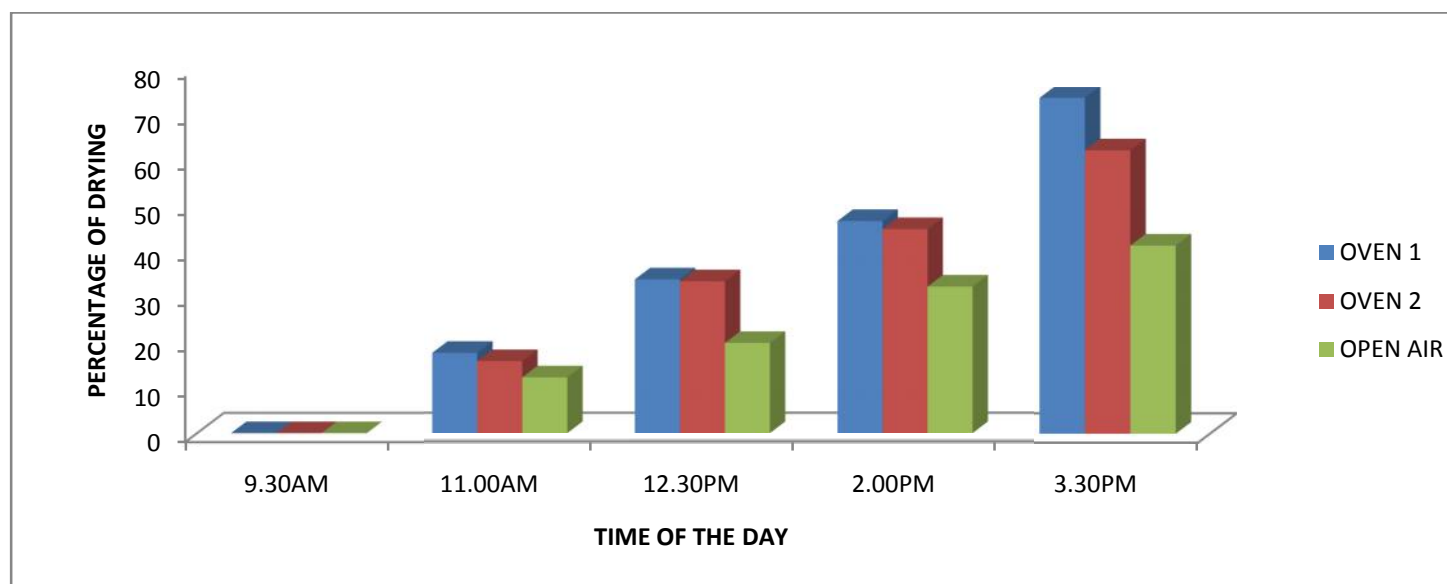
267 Average percentage loss in mass for sample 5A = $\frac{20.47 - 7.15}{20.47} \times 100\% = 65.07\%$

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269 Average percentage loss in mass for sample 5B = $\frac{20.82 - 9.98}{20.82} \times 100\% = 52.07\%$

270 Average percentage loss in mass for sample 5C = $\frac{21.41 - 11.60}{21.41} \times 100\% = 45.82\%$

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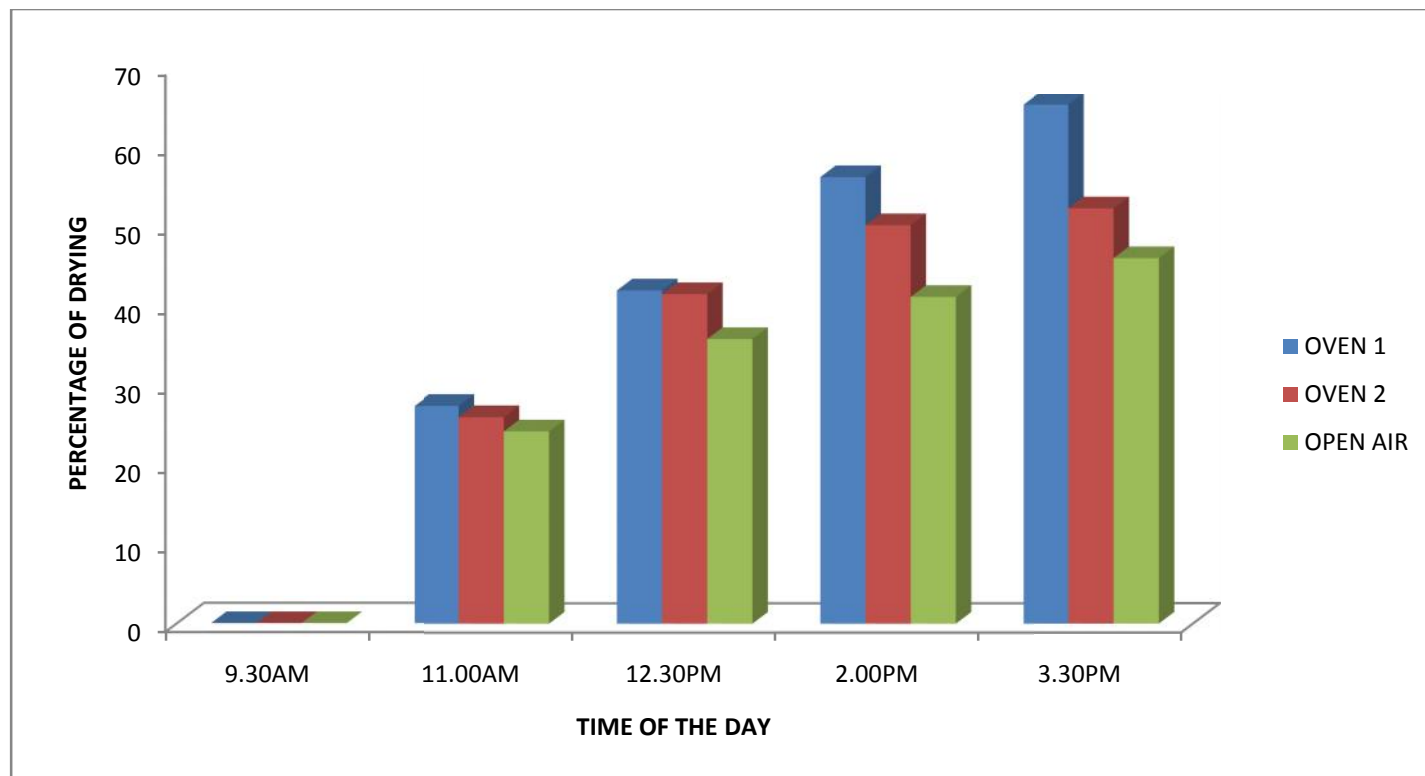


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274 Figure 15: The percentage rate of drying fresh fish on the 5th day

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277 Figure 16: The percentage rate of drying fresh fish on the 6th day

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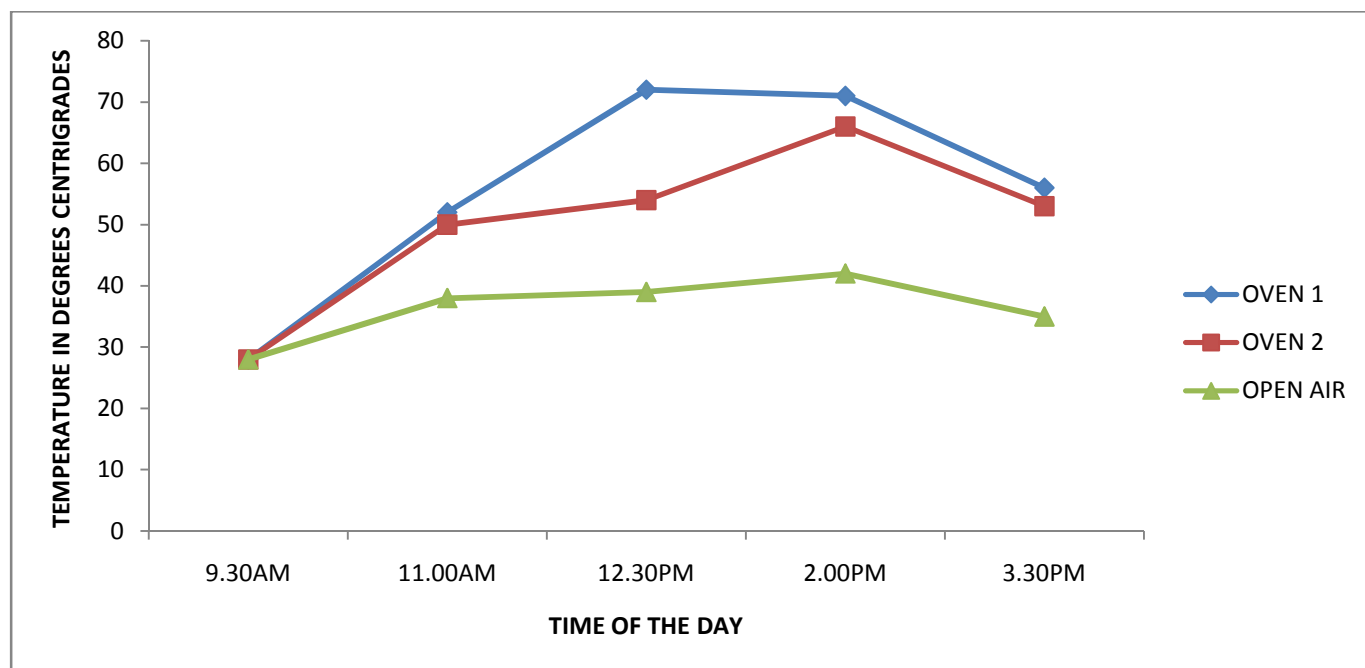


Figure 17: The plot of Temperature against Time on the 5th day

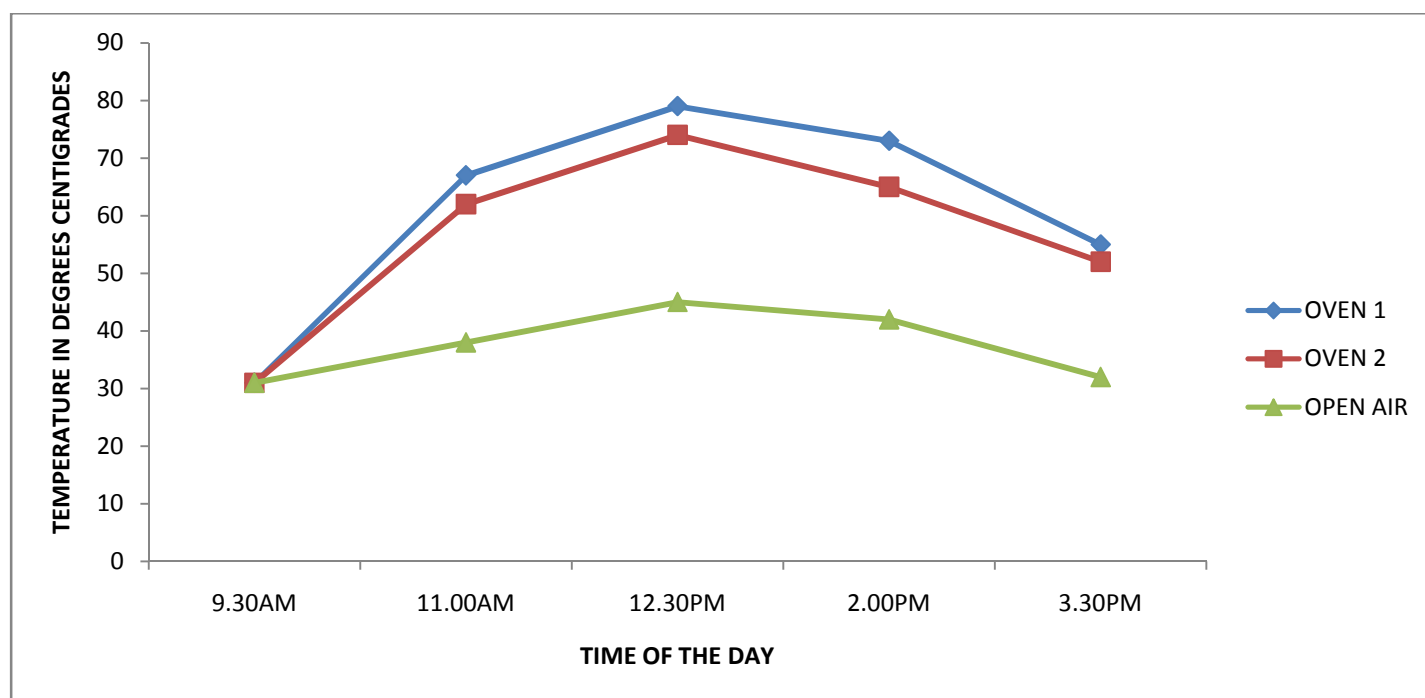


Figure 18: The plot of temperature against Time on the 6th day

Ovens 1 was able to cook egg for 3 hours 30 minutes at an average temperature of 68 °C, while oven 2 could cook a similar egg with the same mass for about 4 hours 20 minutes at an average temperature of 62 °C.

292

4.0 The power capacity of the solar dryers

The power capacities of the solar dryers were calculated using the Stefan – Boltzmann formula as stated by [10] in equation 2 as follows:

$$W = Ae\delta T^4 \quad 2$$

Where W = the power in watts

A = the surface area of the material in m²

E = the emissivity which depends on the nature of the surface. It is also equal to the absorptivity defined as

$$a = \frac{\text{Radiation energy absorbed by surface}}{\text{Radiation energy incidence on the surface}}$$

Surfaces where a = 1 are the best absorbers as well as the best emitters of radiation at the same temperature. Hence a surface with a = e = 1 is a black body.

δ = Stefan – Boltzmann constant (5.7 x 10⁻⁸ Js⁻¹m²°C⁻⁴)

T = the absolute in Kelvin.

For Oven 1, the highest temperature recorded is 79 °C = 352K.

The surface area of the oven = (80 x 50) cm² = (80 x 50) x 10⁻⁴ m²

Therefore the power is given as

$$W = 80 \times 50 \times 10^{-4} \times 1 \times 5.7 \times 10^{-8} \times 352^4 = 350.00W \quad 3$$

For oven 2, the highest temperature recorded is 74 °C = 347K.

Therefore the power is given as:

$$W = 80 \times 50 \times 10^{-4} \times 1 \times 5.7 \times 10^{-8} \times 347^4 = 330.56W \quad 4$$

For the open drying, the highest temperature was 45 °C = 318K

Therefore the power is given as

$$W = 80 \times 50 \times 10^{-4} \times 1 \times 5.7 \times 10^{-8} \times 318^4 = 233.15W \quad 5$$

317

318 **5.0 Conclusion**

319 From the results obtained above, Figures 3, 4, 6, 7, 9, 10, 12, 13, 15, and 16 shows that the rate
 320 of drying in the oven with reflector is higher than that without reflector. These are much higher
 321 than the open air – drying. Then the plots of the variations of temperature in the 2 ovens and the
 322 open air as shown in Figures 5, 8, 11, 13, 17 and 18, also reveals that the temperature inside the
 323 oven with reflector was higher than the one without reflector. Moreover, both are higher than the
 324 ambient temperature in all cases. In the course of this research work, the highest temperature
 325 recorded for the oven with reflector is 79⁰C, while the oven without reflector recorded 74⁰C.
 326 The highest ambient temperature recorded on the hottest day was 45⁰C. The difference between
 327 the power output of the 2 dryers and that of the open air is about 100W.

328 **6.0 References**

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