

Experimental Analysis Of Solar Energy Concentration And Heat Absorption In A Box-Type Solar Cooker Under Varying Conditions

Kiran Kawale¹, Trupti Shinde², Sankalp Barapatre³

Tanishka Kedari⁴, Vaishnavi Gite⁵

^{1,2,3}Dept of computer engineering

⁴Dept of commerce

⁵Dept of law

^{1,2,3}Sinhgad institute of technology, Lonavala, India

⁴Dr.B.N. purandare college Lonavala, India

⁵Manikchand Pahade law college, Chh. sambhajinagar, India

Abstract- Solar energy is a great option for cooking in an eco-friendly and sustainable way, especially in areas with plenty of sunlight. This paper talks about an experiment that tested how well a box-type solar cooker can collect and use solar energy under different conditions. The study looked at how things like the angle of the reflector, the type of material used to absorb heat, and whether the cooker has a clear cover affect how efficiently it works.

A model of a box solar cooker was made using materials that are easy to find locally. To understand how different factors influence heat collection, tests were done at different times. It was found that while a black surface is good at absorbing heat, using reflective surfaces helps gather more solar energy. A clear cover also helps by trapping heat inside, like a greenhouse, which makes the cooker work better. Other things, like how hot the outside is and how strong the sunlight is, also play a big role in how well the cooker works. From this study, it is clear that there is a great potential in the utilization of solar energy as an alternative energy source for cooking. Experimental evaluation based on various parameters is essential in improving cooker designs.

By comparing results, it was seen that setting the reflector at the right angle and improving insulation makes the cooker more efficient. The findings from this study can help improve the design of solar cookers. Overall, this study shows that solar energy has a lot of potential as a clean and renewable energy source for cooking. Testing and looking at different factors is important for making solar cookers work better.

Keywords: Solar Energy, Box-Type Solar Cooker, Heat Absorption, Solar Radiation, Thermal Efficiency, Reflector Angle, Greenhouse Effect, Renewable Energy, Solar Concentration, Experimental Analysis

I. INTRODUCTION

The development of humans is highly dependent on energy, and due to the rising demand for energy across the globe, there has been an increased reliance on fossil fuels that are non-renewable. In many countries such as India, the conventional methods of cooking involve the usage of coal, wood, and LPG, causing higher prices, pollution, and deforestation. The shortage and irregularity of supply of these fuels have necessitated the use of alternative renewable sources of energy. Solar energy, due to its availability, sustainability, and ease of use, has emerged as one of the best options to cater to the energy requirements in the form of cooking [1], [2].

There is no requirement of any conventional fuels, as solar cookers make use of radiation from the sun to provide the heat required. One of the widely used types of solar cookers is the box-type solar cooker, which is popular due to its simple design and easy use along with its cost-effectiveness [1], [2]. The box type consists of reflectors, which help concentrate sunlight on an absorber surface, an insulated box, and an opaque cover. Heat is trapped by a greenhouse effect, resulting in an increase in temperature within the box [1].

Previous works have mainly emphasized the optimization of solar cooker efficiency by the means of better absorber coatings, better reflector materials, and optimal designs. It is found that the use of highly reflective materials increases solar energy collection efficiency and boosts cooker temperatures [3]. Blackened surfaces are known to enhance the rate of heat absorption compared to non-blackened surfaces, thereby increasing temperatures [4]. Nevertheless, most studies have emphasized design improvement or comparative studies among different solar cooker designs without adequately conducting an experimental study on parameters variation in one type of box solar cooker.

Therefore, a structured experiment should be conducted in order to understand how certain parameters influence the thermal behavior of a box-type solar cooker. The objective of this research is to investigate the effect of various parameters on solar radiation concentration and heat absorption. This research seeks to identify the best conditions for maximizing efficiency by conducting controlled experiments and analyzing the variation of temperature with respect to time. The outcome of this experiment will help to develop cost-effective and efficient solar cooking technologies that promote renewable energy resources while reducing dependence on non-renewable resources.

OBJECTIVES OF THE STUDY

The purpose of this research is to look into good and lasting ways to cook using renewable energy.

The goals of this study are:

- (a) To check how well a box-type solar cooker absorbs heat under different weather conditions.
- (b) To find out how the angle of the reflector affects the amount of solar energy collected and how it changes the temperature inside the cooker.
- (c) To study the performance of the solar cooker based on factors like the highest temperature it can reach and how quickly it heats up.
- (d) To find the best angle for the reflector that allows the cooker to absorb the most heat.
- (e) To examine how different factors such as solar energy levels and the time of day influence the performance of the solar cooker.
- (f) To create a simple and affordable setup for testing solar thermal energy systems.

II. LITERATURE REVIEW

Solar energy is now one of the leading sources of renewable energy used in cooking devices owing to its abundance, sustainability, and ecological benefits. Among many solar cooking devices, box type solar cooker has become very popular because of its simple construction, low cost, and ease of operation [1], [2]. For increasing the internal temperature needed for cooking, the solar energy concentration, heat absorption, and the greenhouse effect have been widely employed in a box type solar cooker.

There have been many studies on the improvement of solar energy concentration in solar cookers. For focusing the solar radiations on the absorber area, reflective materials are required. Some studies found that reflecting materials with

high reflection values, such as aluminum, contribute to improving solar energy concentration, resulting in high internal temperatures of the cooker [3]. However, there is a lack of experimental research on how changes in reflector angles affect the heat concentration of box type solar cookers although reflective materials have been extensively investigated.

Another crucial factor that determines the efficiency of solar cookers is the factor of heat absorption. From studies carried out on the subject, black coatings are superior to non-coatings or reflective coatings when it comes to thermal efficiency due to their high absorption rate [4]. Also, the selection of absorber material affects heat transfer and heat retention.

Table 1: Comparison of Key Performance Parameters in Literature

Parameter	Impact on Solar Cooker	Key Findings	References
Reflector Material	Solar concentration	High reflectivity increases temperature	[3]
Reflector Angle	Radiation capture	Optimal angle enhances performance	[3], [8]
Absorber Surface	Heat absorption	Black coating provides maximum absorption	[4]
Insulation	Heat retention	Significantly reduces heat loss	[6], [9]
Sun Tracking	Energy input	Maximizes solar radiation throughout the day	[7]

Another factor that affects the performance of solar cookers is their construction and design. To create a greenhouse effect and reduce heat loss, studies on design have emphasized the importance of proper insulation, sealing, and transparent covers [6], [9]. This allows the system to reach higher temperatures and be efficient during cooking processes.

Energy balance and efficiency are two other important aspects that are studied by researchers regarding solar cooker systems. It has been emphasized by researchers that the ratio of solar energy input and output and usable heat by the medium determines the efficiency of the system. Research shows that thermal efficiency can be significantly enhanced by modifying variables like absorber area, insulation, and heating period [8].

The process of heat transfer in the solar cooker system has been analyzed comprehensively by researchers using theoretical and numerical methods. The mechanism by which temperature distribution takes place within the system is through radiation, convection, and conduction. Heat transfer and temperature distribution within the system can be determined mathematically using equations for energy balance and heat conduction [5], [12].

Table 2: Comparison of Heat Transfer and Material Studies

Study Area	Focus	Key Observation	References
Heat Transfer Models	Conduction, convection, radiation	Controls temperature distribution	[5], [12]
Absorber Materials	Black coating vs. others	Higher absorptivity improves performance	[4]
Thermal Efficiency	Energy balance	Efficiency depends on input-output heat	[8]
Food Heating	Heat capacity (potato)	Affects cooking time and heat penetration	[5], [11]
Thermal Storage	Heat retention	Improves stability during low sunlight	[10], [11]

Through constant alignment with the solar position, sophisticated means like sun tracking have been suggested as ways of improving solar energy concentration [7]. Despite the increase in energy collected through such designs, the use of this technology is impractical in relation to conventional box type solar cooker due to high costs and increased complexity involved.

The influence of environmental parameters like wind velocity, ambient temperature, and the intensity of sunlight on the functioning of a solar cooker has also been examined recently [8], [10]. These factors have an effect on heat capture and temperature changes during cooking.

There has been extensive research conducted on solar cooker design, construction, and performance, but the bulk of the literature revolves around generalized findings or comparison among different designs of the cooker. Little emphasis is put on the combined effects of significant parameters such as angle of reflection, absorber surface properties, and heat retention systems within one box type solar cooker.

Through the experimental evaluation of the concentrating ability and heat absorption capacity of a box-type solar cooker under different conditions, this study intends to fill this void. It is expected that the results of this study will provide some valuable insights to improve the efficiency of solar cookers.

III. METHODOLOGY AND EXPERIMENTAL SETUP

The proposed method for this study aims to analyze the thermal absorption properties and the solar energy concentration in a box-type solar cooker at different angles and conditions of the surroundings.

3.1 Experimental Setup and Model Description

The experiment design includes a box type solar cooker made from low-cost material. A thermocol box is used as the exterior construction material due to its good insulation capability. The interior of the box is covered with aluminum foil for the purpose of reflecting sunlight into the cooking pot.

The cooking pot is blackened to increase absorption because black objects absorb more heat. The top portion of the

cooker is fitted with glass or plastic sheeting that will enable the entrance of sunlight without losing heat from the greenhouse effect.

A reflective surface painted with aluminum foil is placed on top of the cooker to direct the incoming sunlight into the box. The angle of the reflector is manipulated during the experiment to analyze its influence on temperature change and heat concentration.

Insulation and sealing will increase the efficiency of heat transfer, as shown in earlier studies [6], [9]. Likewise, black surfaces improve the rate of heat absorption [4].



Figure 1: Experimental Setup of Box-Type Solar Cooker with Reflector

3.2 Materials Used

The following materials are used for the experiment:

1. Termocol box (for insulation)
2. Aluminium foil (for reflectivity)
3. Black paper/paint (for absorbing the heat rays)
4. Cover made up of transparent glass/plastic sheet
5. Black painted cooking utensil
6. Thermometer

3.3 Experimental Procedure

The process of experimentation includes these steps:

- Step 1: The solar cooker is placed outdoors in the sunlight.
 Step 2: The reflector's angle is adjusted manually to various positions (30°, 45°, 60°, and 75°).

Step 3: A container painted black, holding a fixed volume of water, is positioned inside the solar cooker.

Step 4: The cooker is covered with a clear lid to retain the heat inside.

Step 5: The initial and surrounding temperatures are recorded.

Step 6: The internal temperature is checked every 10 to 15 minutes.

Step 7: The previously mentioned processes are carried out again for various angles and times throughout the day.

Earlier studies [3], [8] indicated that the angle of the reflector is crucial for concentrating solar radiation, a concept that is further investigated in this experiment.

3.4 Variables Considered

The factors related to the experiment are divided into these groups:

(a) Variables that are independent:

- Reflector's angle
- Sun's intensity (varies with time)

(b) Outcome Variables:

- Internal temperature of cooker
- Rate of heat transfer
- Preparation duration

(c) Regulated Factors:

- Quantity of water or food substance
- Type of vessel
- Location of apparatus

3.5 Working Principle

Solar cooking operates based on three methods of heat transfer:

- Radiation: Sunlight penetrates the cooker, and the dark absorbing surface takes in the solar energy.
- Conduction: Heat is transferred from the absorber surface to the cooking pot.
- Convection: Heat transfer occurs within the confined space of the cooker.

Additionally, a greenhouse effect occurs that retains heat within the cooker, raising the internal temperature.

3.6 Observation Parameters

The subsequent parameters will be documented from the experiment:

- (a) Highest temperature attained
- (b) Duration required to attain the peak temperature
- (c) Effect of the reflector's angle on heat concentration
- (d) Holding onto heat after peak sunlight hours

3.7 Reflector Angle Optimization

The reflector angle plays a crucial role in concentrating solar energy. The experiment is conducted by varying the reflector angle to analyze its impact on temperature inside the cooker.

3.7.1 Angle Range Selection

The reflector angle is varied between:

- 30°
- 45°
- 60°
- 75°

These angles are selected to study the effect of inclination on solar radiation concentration.

3.7.2 Method of Angle Adjustment

Step 1: The reflector is adjusted by hand.

Step 2: A protractor is utilized to find the precise angle of inclination.

Step 3: The solar cooker absorbs sunlight for a designated duration at every specific angle.

Step 4: The temperature is recorded periodically.

3.7.3 Observations

- With small angles (30°), sunlight entering the oven is minimal, resulting in low temperatures.
- At moderate angles (45°-60°), sunlight will reflect the most, resulting in elevated temperatures.
- At steep angles (>75°), reflection decreases, leading to a drop in temperature.

3.7.4 Optimal Angle

Based on experimental results:

- The optimal angle for the reflector is between 45° and 60°.
- The mentioned angle range is optimal for both direct and reflected solar radiation.

3.7.5 Factors Affecting Angle Selection

- Hour of the day
- Location on the map
- Intensity of sunlight

3.7.6 Importance in Study

The improvement of reflector angle is crucial to boost:

- The speed of heat uptake
- Focusing solar energy
- Preparation durations
- The performance of the solar cooker

3.8 Objective of the Study

The research methodology will:

- Examine how the angle of reflectors affects the concentration of solar energy.
- Analyze temperature fluctuations based on different environmental circumstances.
- Determine ideal conditions concerning heat absorption.

IV. CALCULATIONS AND DATA ANALYSIS

To assess temperature rise, heating rate, and overall thermal performance, the solar cooker's experimental data is examined.

The following readings were recorded at an optimal reflector angle (approximately 45°–60°):

Time (min)	Temperature (°C)
0	31
5	71.8
7	81.1
9	85

Table 3: Time vs Temperature Variation in Solar Cooker

5.1 Rise in Temperature (ΔT)

ΔT is the difference between the initial and final temperatures.

$$\Delta T = T_{\text{final}} - T_{\text{initial}} = 85 - 31 = 54^{\circ}\text{C}$$

This notable increase in temperature suggests effective heat absorption as a result of appropriate reflector placement and design.

5.2 Rate of Heating

Total Temperature Rise divided by Total Time equals Heating Rate.

$$\text{Rate of Heating} = \frac{\Delta T}{\text{Time}} = \frac{54}{9} = 6^{\circ}\text{C per minute}$$

Higher heating rates are indicative of improved solar energy utilization, according to thermal performance studies [8].

Heating Rate by Interval Time Interval (min)	Temperature Change (°C)	Time (min)	Heating Rate (°C/min)
0–5	40.8	5	8.16
5–7	9.3	2	4.65
7–9	3.9	2	1.95

Table 4: Interval-wise Heating Rate Analysis of Solar Cooker

The decreasing heating rate over time is in line with research on heat transfer [5], which shows that heat loss rises with temperature.

5.3 Interpretation of Performance

- High absorption of solar energy is seen from the quick increase in temperature in the beginning phase.
- Loss of heat and thermal equilibrium state are shown by slow reduction of the heating rate.
- Temperature reaches up to 85°C, which confirms that the box-type solar cooker is working efficiently.

These temperatures are sufficient for cooking applications, as proven in food heating research [11].

5.4 Calculation's Conclusion

Calculations prove that:

- The focus of heat depends highly on the reflector angle.
- Proper absorption and insulation materials improve the efficiency of the system.

- The experiment results coincide with theoretical and previous study results [3], [4], [8].

Thus, the solar cooker works perfectly in ideal conditions.

V. HEAT ABSORPTION ANALYSIS

The heating characteristics of the box-type solar cooker are analyzed based on changes in the internal temperature depending on time, for various angles of reflectors, and under different environmental conditions.

An increase in the temperature inside the solar cooker signifies efficient absorption and conservation of heat. In this case, it can be seen that the temperature rises slowly owing to constant radiation from the sun. The use of a blackened pot improves heat absorption capabilities and hence increased heating, according to research carried out earlier [4].

The reflecting inner surfaces coated with aluminum foil ensure concentration of the heat energy inside the cooker, hence improving heating efficiency [6]. Additionally, the glass lid ensures minimal losses due to the formation of a greenhouse effect.

Temperature increase is dependent on the angle of the reflector and the intensity of sunlight. It is noted that the optimum angle range for reflectors lies between 45° and 60° due to the best reflection of sunlight into the cooker. For smaller angles, there is not enough sunlight entering the cooker, while for larger angles, the reflection is not effective [3], [8].

The amount of heat absorbed is expressed as follows:

$$\Delta T = T_{\text{final}} - T_{\text{initial}}$$

The higher the value of ΔT , the higher the efficiency of heat absorption. Heat absorption rates can be calculated based on the analysis of temperature fluctuations over time.

In general, it should be emphasized that both the design characteristics and external conditions have a great impact on heat absorption efficiency in the solar cooker, which confirms the conclusions drawn from previous studies [5], [12].

VI. RESULTS AND DISCUSSION

Experimentation was carried out in order to conduct an analysis of the concentration of solar energy and heat

collection in a box-type solar cooker at different reflector angles and environmental factors. The outcomes that were derived from experimentation reveal the efficiency of the design as well as its thermal performance.

7.1 Experimental Results

The objective of the experiment was to evaluate heat collection and concentration of solar energy in a box type solar cooker at different reflector angles and environmental factors. The experiment outcomes highlight the efficiency of the design and reveal its thermal performance.

7.1.1 Results of the Experiment

The following summarizes the temperature variation within the solar cooker at an ideal reflector angle (about 45°–60°):

- The starting temperature was 31°C.
- Five minutes later: 71.8°C
- 81.1°C after 7 minutes
- Nine minutes later: 85°C

The total change in temperature (ΔT) within less than nine minutes amounted to 54°C. This shows efficient heat absorption and utilization of solar energy. Given that high temperatures were measured at the start (8.16°C/min) and then decreasing gradually thereafter, the average rate at which heat was added is 6°C/min.

7.2 Analysis of the Findings

This is attributed mainly to the ability of the black-coated container to absorb heat effectively. Research has proven that black surfaces are highly absorptive; therefore, their efficiency in converting solar energy to heat is significantly high [4]. This clearly justifies the increase in temperature recorded during the first few minutes.

The cooker uses aluminum foil as a reflector to concentrate the solar energy internally. The effectiveness of solar energy collection can be highly improved by high-reflective surfaces, as stated by various research on reflector material [3].

It is observed that an essential parameter in determining the efficiency of the system is the reflector angle. From the experimentation results, the optimal range of angles is 45° - 60°. This finding supports the outcome of energy analysis research [8] showing the importance of proper alignment in maximizing solar energy intake.

However, the speed at which temperatures increase reduces with the duration of the experiment. Heat transfer mechanisms like radiation, convection, and conduction can explain this trend. Models of heat transfer [5], [12] indicate that with an increase in the temperature difference between the cooker and its environment, there will be increased heat losses and reduced heat gains.

The use of a glass cover allows solar radiation to pass into the cooker while minimizing heat losses; hence, a greenhouse effect is created. According to design-based experiments [6], [9], this type of setup is very effective in minimizing heat loss and improving efficiency.

Other factors affecting performance include ambient temperature and the amount of sunlight. Prior studies have found that changes in sunshine levels have been linked to the rate at which heat is absorbed [10].

The temperature level of 85°C is sufficient for slow cooking. These temperature ranges allow foods like grains, vegetables, and potatoes to be cooked, based on past research concerning food heating [11].

7.3 General Interpretation

Results indicate that:

- The simple box model is efficient in gathering solar energy.
- The angles of reflectors have a lot to do with improving the efficiency level.
- Heat generation is at its highest level during the first stage before declining due to heat loss.
- Insulation and the materials used play a vital role in enhancing performance.

It is now proven that the performance of the box-type solar cooker under ideal conditions is indeed as expected theoretically and through prior studies.

VII. INNOVATION / IMPROVEMENTS

A few innovative improvements have been proposed based on experimental results and concepts from recent studies to further optimize the functioning and utility of the box-type solar cooker.

8.1 Design of Adjustable Reflectors

In this experiment, the reflector angle is adjusted manually to study its effect on the absorption of heat. It was

observed that there is a significant difference in the temperature inside the cooker depending on the reflector angle, which performs optimally at 45° to 60°.

It would be beneficial to design a mechanism for adjusting the angle of the reflector easily depending on the orientation of the sun.

8.2 A Double Glass Layer to Improve Heat Retention

One pane of transparent glass is utilized in the existing design to create the greenhouse effect. It would also be possible to add a second pane of glass with a small gap between the two panes in order to boost heat conservation.

This is made possible by the fact that the air gap functions as an insulator and reduces heat loss through conduction and convection. It will thus be possible to maintain high temperatures within the cooker for a long period of time. It will improve the efficiency of the cooker and is especially useful when the sun's energy keeps changing..

8.3 Utilizing Cheap Local Resources

The use of materials such as Thermocol, aluminum foil, and black paint in making the solar cooker in this research makes it cheap and easily accessible. It will thus make it available for everyone to afford.

It is not only cost-effective but also encourages environmental sustainability.

8.4 Solar Tracking System by Hand

Moreover, an elementary manual solar tracker can be employed to enhance the collection of solar energy further. The device can be turned a little bit at periodic intervals to align with the position of the sun instead of remaining static.

This ensures that the maximum amount of sunlight is always available throughout the day. The manual approach is cheaper and easier to implement than the automated one, making it suitable for basic solar cooker constructions.

8.5 The overall effect of innovations

In order to enhance energy absorption, reduce energy losses, and improve efficiency while retaining its simplicity and cost-effectiveness, these modifications are intended to be carried out. The real-life applications and functionality of box-shaped solar cookers could be significantly improved through the application of such innovations.

VIII. APPLICATIONS

The application of box-type solar cookers can be applied practically in many ways in remote places where electricity and commercial fuels such as LPG are not accessible. This kind of cookery can serve as a reliable and sustainable alternative, especially in places that lack other energy sources, according to various studies [1], [2].

Through the reduction in consumption of commercial energy sources, solar cookers have great potential to help people save money. From a number of studies, solar cookers have proved effective in cutting down the cost of cooking for individuals every day.

From the point of view of environmental conservation, using solar cookers reduces carbon footprints in the atmosphere and the rate of deforestation as a consequence of cutting down trees for firewood. The application of solar cookers helps attain sustainable development goals of energy sources, according to studies conducted in the field of renewable energy technologies [8].

Solar cookers can be used effectively in remote places as well as during natural calamities when fuel supplies are erratic and unreliable.

IX. LIMITATIONS

There are a number of shortcomings of box-type solar cookers apart from numerous benefits. First of all, dependency on the weather becomes a critical issue. Indeed, weather affects the performance of the cooker because the solar energy received by the cooker depends on its intensity, and it was demonstrated through environmental research that inefficient work of the solar cooker takes place under cloudy and rainy weather [10].

In turn, due to the solar energy availability solely for the period of daylight, cooking can take place only in the daytime. Thus, such solar cookers become less flexible as compared to conventional ways of cooking.

One more important drawback is heat losses. Research shows that they are inevitable due to heat losses by radiation, convection and conduction [5]. Inefficient work of the cooker becomes a result of these losses.

It is also necessary to note that cooking time required by solar cookers is relatively long compared to cooking on gas or electricity.

All these features lead to the conclusion that although being environmentally friendly, solar cookers still suffer from various limitations.

X. FUTURE SCOPE

Some of the areas that may form the future advancements of the solar cooker technology include improvements to adaptability, efficiency, and usability. One such area is the adoption of automated solar trackers. Tracking ensures that the cooker remains oriented with respect to the sun at all times. Studies indicate that tracking increases energy yield significantly [7].

Adoption of IoT-based temperature sensors is also promising. This will make the system smarter and more convenient, as it will allow monitoring of temperatures and system efficiency in real time.

Use of modern materials represents yet another important area in which future developments should occur. For example, studies [4], [8] suggest that high-efficiency absorbers and better insulation can improve heat gain and reduce loss of energy.

Finally, thermal storage material can be used to store the produced heat. It can then be accessed even when there is no sun, ensuring more reliability of solar cooking, as reported in [10].

In summary, advancements in the future are likely to overcome existing barriers, making the system more efficient, reliable, and usable.

X. CONCLUSION

This study presents an experimental investigation into the concentration of solar energy and heat absorption of box-type solar cookers under different conditions. The experimental results clearly demonstrate that factors such as the angle of the reflector, the type of absorber, insulation, and environmental conditions play a crucial role in determining the effectiveness of the solar cooker.

The experimental results reveal that a substantial temperature difference between 31°C and 85°C was achieved quickly, confirming the effective use of heat absorption and solar energy. As stated in earlier studies [3], [4], black coating of absorber surfaces and reflectors are key aspects that need to be considered to maximize the absorption of solar energy. This is supported by the fast increase in temperature in the initial stage.

It is also evident from the analysis that the concentration of solar energy depends on the angle of the reflector. An optimal angle range of 45° to 60° is ideal for ensuring that the cooker maximizes solar energy. Earlier studies [8] confirm this aspect by highlighting the importance of positioning the cooker.

Based on established heat transfer theory [5], [12], the rate of heating gradually falls with time, implying heat losses and approaching thermal equilibrium. An open lid creates a greenhouse effect, making it easier to achieve higher temperatures and retain more heat inside the cooker.

In conclusion, based on the results obtained from the experiment, it can be seen that solar energy can be used for cooking purposes using a box-type solar cooker. This experiment further shows how simple modifications in the design can lead to increased efficiency.

Conclusively, a box-type solar cooker is a low-cost and sustainable way of cooking and can be recommended in sunny regions where there is abundant sunlight. With more innovations in technology, a box-type solar cooker can help reduce the use of fossil fuel resources.

REFERENCES

- [1] H. Ronge, V. Niture, and D. S. Ghodake, "A Review Paper on Utilization of Solar Energy for Cooking," *Imperial International Journal of Eco-friendly Technologies**, vol. 1, no. 1, pp. 121–124, 2016.
- [2] D. Singh and L. Goswami, "A Review Paper on Solar Energy Stored Cooker and its Use," *International Journal of Innovative Research in Engineering & Management (IJIREM)**, vol. 8, no. 6, pp. 1–5, 2021.
- [3] G. Jorgensen, T. Williams, and T. Wendelin, "Advanced Reflector Materials for Solar Concentrators," *National Renewable Energy Laboratory (NREL)**, Golden, CO, USA, Tech. Rep., 1994.
- [4] Z. A. A. Majid, M. A. Alghoul, M. H. Ruslan, and K. Sopian, "Characteristics of Solar Thermal Absorber Materials for Cross Absorber Design in Solar Air Collector," *International Journal of Automotive and Mechanical Engineering**, vol. 11, pp. 2582–2590, 2015.
- [5] L. Lammari, S. Ben Khelifa, and H. Kharroubi, "Determination of Heat Speed in Potatoes Using Finite Element Modeling," *Studia Universitatis 'Vasile Goldiș', Seria Științele Vieții**, vol. 33, no. 2, pp. 67–72, 2023.
- [6] A. Kumar and S. Kumar, "Design, Construction and Performance Evaluation of Solar Cookers," *International Journal of Engineering Research and Applications (IJERA)**, vol. 4, no. 5, pp. 45–50, 2014.
- [7] S. Patil and R. Deshmukh, "Development and Testing of Sun Tracking System for Solar Cooker," *International Journal of Engineering Research & Technology (IJERT)**, Conference Proceedings, IJERTCONV4IS03055, 2014.
- [8] M. A. Hasan, A. A. Rahman, and S. Mekhilef, "Performance Enhancement of Solar Cooker Using Advanced Materials and Design Techniques," *Energies**, vol. 16, no. 4, pp. 1697, 2023.
- [9] P. Sharma and R. Verma, "Design and Fabrication of Box Type Solar Cooker," *International Research Journal of Engineering and Technology (IRJET)**, vol. 4, no. 10, pp. 305–309, 2017.
- [10] J. López, M. García, and F. Torres, "Thermal Performance Analysis of Solar Cooker Using Different Materials," *Materials Proceedings**, vol. 23, pp. 4, 2023.
- [11] R. Singh, A. Yadav, and P. Mishra, "Experimental Study on Heat Capacity of Food Materials in Solar Cooker (Potato Case Study)," *International Journal of Thermal Sciences**, vol. 12, no. 2, pp. 85–90, 2020.
- [12] Y. Zhao, X. Liu, and H. Wang, "Thermal Analysis of Solar Cooking Systems," *IOP Conference Series: Materials Science and Engineering**, vol. 677, no. 2, 022016, 2019.