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Design and Experimental Study of a Hemispherical Solar Cooker: Application to Food Cooking

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present work is an experimental study of a glazed hemispherical solar cooker. It consists of a hemispherical concentrator made of reinforced concrete with a smooth inner part lined with a self-adhesive aluminium mirror film with a reflectivity of 95%. This reflector enables all the sun rays to be reflected onto the absorber. The hemisphere has a radius of 0.59 m, a height of 0.46 m and an exposure area of 0.1535 m^2 for the half angle of the apex of the focus with the axis passing through the centre. Experimental data on the evolution of the temperature of the air trapped in the device on

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October 26, 2022 showed a maximum temperature of 63°C. The temperature under the glazing indicates a maximum value of 51°C, for an ambient temperature of 35°C. The maximum irradiation of 700W.m^{-2} obtained around 11:45 a.m. The second test, carried out on October 28, 2022, was designed to heat 1.5 litres of water. The results indicate a maximum temperature of 91.7°C for the water, obtained from 10.45a.m and 1.33pm. However, the air temperature under the glazing gave a maximum value of 67°C. The ambient air temperature was 37°C. The day of April 21,2023 is devoted to experimental studies on cooking and frying sweet potatoes. The maximum temperature was 97°C, obtained from 11:30 a.m, for an air temperature of 80°C under the glazing, obtained from 10:50 a.m. with maximum irradiation of 957.1 W.m^{-2}. A value of 130°C is obtained at 13:21pm for the oil heating test and a maximum temperature of 68°C for the internal air at an ambient temperature of 32.9°C. The irradiation value reached a maximum of approximately 306.8W.m^{-2}.

Keywords: Irradiation; reflector; hemispherical; solar cooker; concentration.

1. INTRODUCTION

Findings indicate that over 900 million people in sub-Saharan Africa still use traditional unprocessed solid biomass fuels for cooking (Oluwatosin et al., 2022). This presents a significant risk, as these fuels generate high levels of toxic particles and biomass smoke and 95% of the world's population use wood, charcoal and agricultural waste (IEA, 2022). Wood fuels account for around 90% of energy consumption in most households in developing countries (FAO, 2010). In Burkina Faso, 85.5% of households use biomass (wood energy, agricultural residues) (Nebie, 2019). This is accelerating desertification in Sahelian countries. Given these difficulties, the various nations have no choice but to diversify their energy resources in view of the energy, environmental and security context. Solar energy will be an important alternative for sub-Saharan countries such as Burkina Faso. Our country is one of the 25 countries in the world with a large solar deposit, and this opportunity could help to reduce the use of petroleum products for cooking. At a time when energy savings and ecological issues are important, the use of solar cookers seems to be a good compromise in sunny developing countries (Nebie, 2019). To work at high temperatures, the incident optical flux needs to be increased, which could be achieved by concentrating solar radiation.

These systems generally include a reflective surface designed to concentrate solar energy on an absorbent surface, resulting in a large increase in heat. The advantage of this method is that high temperatures can be reached, making it ideal for heating water in solar kitchens (Nebie, 2019). The first historical use of solar energy to cook food was published by the Swiss Scientist Horace de Saussure (1767). However, the real development of solar cookers began in 1950. Since then, several different types of solar cooker have been developed and have been the subject of theoretical and experimental studies throughout the world. A solar concentrator is defined as a device that concentrates the sun's rays on a target in order to recover maximum energy. The main purpose of the concentrator depends on the application (SMT, 2016).

There are several solar cooking systems, including: concentration-type solar cooking systems such as paraboloid cookers (Lentswe et al., 2021), indirect-type solar cooking systems (Craig et al., 2017, Esen, 2004, Getnet et al., 2023, Balachandran and Swaminathan, 2022, Zamani et al., 2017, Getnet et al., 2023). They work like dryers with the collector separate from the receiver. Box-type solar cooking systems (Sagade et al., 2017, Soro et al., 2020, Wassie et al. 2022, Harmim et al., 2016, Coccia et al., 2021). These systems are not intended to reflect the sun's rays accurately, but the rays that penetrate the box help to raise the internal temperature to a cooking level. The use of solar cookers should be a common means of cooking in Burkina Faso, located in the sub-Saharan region where 900 million people do not have their own cooking appliances (refhub.elsevier.com, sb1). Because of its geographical location, this country benefits from an annual solar flux of 1024 kWh.m^{-2} (refhub.elsevier.com, sb2). The SRTA (Stationary Reflector/Tracking Absorber) concept was created in 2008 by Berland (Steward, 1975). According to this concept, a spherical concentrator always concentrates solar radiation along a line passing through the centre of the sphere, as shown in Fig. 1. The SRTA system, built and experimentally tested by Shay Cohen et al. (2016), has demonstrated the applicability of this system for collecting solar heat at intermediate temperatures. The efficiency achieved was virtually independent of operating temperature, over a wide range up to 200°C. Higher temperatures up to 300°C were achieved using thermal oil as high-temperature fluid (HTF). The prototype solar cooker in the form of a box equipped with an asymmetrical CPC with an acceptance angle of 60° was built by A. Hamim et al, using resources and materials available in Adrar. The internal dimensions of the box housing the cooking utensils are $0.7 \times 0.28 \times 0.14\ m^3$. The objective was to heat 4.5 litres of water. The test started at 11:06 a.m with an initial temperature of 20.8°C and an ambient temperature of 17.4°C. The boiling temperature was reached after 198 minutes (Harmim et al., 2013). A system has been designed, produced and tested for solar cooking (SMT et al., 2024). It uses a spherical reflector as a concentrator, mounted on two frames for better orientation towards the sun. The system's engineering enables it to achieve a theoretical average geometric concentration of 720 and a theoretical efficiency of 0.42. As a result, the system is easy to handle, since only one azimuth angle is tracked. An optional tilting of the reflector also enables the system to be used in equatorial and tropical zones when the sun is close to the zenith. A series of tests was carried out around 20 November in Ouagadougou, Burkina Faso, at an angle of latitude of 12.21°. Tests for heating oil in a pot successively reached a maximum temperature of 184°C at 1:00 p.m. on the first day and 221°C on the second day at 1:30 p.m. Boiled sweet potatoes, fried sweet potatoes, spaghetti and fish dishes were cooked within a reasonable time

2. DESCRIPTION OF THE STUDIED DEVICE

We present here a glazed hemispherical solar cooker. It has been designed at Thermal and Renewable Energy Laboratory (L.E.T.RE). Experimental work has been carried out on it, which consists of recording changes in the air temperature inside and outside our device during the cooking of various foods in the course of irradiation. Figs. 1 and 2 shows the device used for our study.

It consists of a hemispherical concentrator made of reinforced concrete with a smooth inner surface lined with a self-adhesive aluminium mirror film with a reflectivity of 95%. This reflector enables all the sun's rays to be reflected onto the absorber, the cooking pot. The hemisphere has a radius of 0.59m, a height of 0.46m and an exposure area of 0.1535 m^2 for the half angle of the apex of the focus with the axis passing through the centre. The opening surface is closed by a glass pane that lets the irradiation rays through, and this pane has the property of trapping infrared rays inside the appliance. This raises the temperature inside the concentrator, making cooking easier.

An under-glazed hemispherical concentration system differs from other systems, which first heat a black plate with or without fins, then recover heat from the plate with a fluid by convection. The device that we propose uses the sunspot corresponding to the actual image of the sun formed in the focus of a hemispherical concentrator which by effect of concentration, generates a very hot zone The heat from that zone can be directly transmitted to the circulating air. The device proposes to heat the air and cooks the food using the combined effects of the greenhouse effect and concentrated radiation, without solar system tracking One more advantage of the hemispherical concentrator with reference to Fig. 3, is that the portion of the axis on which it concentrates is always in the bowl of the hemisphere.

Fig. 1. Experimental device

Fig. 2. Hemispherical reflector

Table 1. Cost analysis of the prototype is shown in the following table

Materials	Price
Reinforced concrete hemispherical concentrator	$30
Self-adhesive reflector	$77
Metal support for cooking pot	$23
Black painted cooking pot	$8
Glazing +coverage structure	$142
Manpower	$50
Total cost	$330

The hemispherical portion, corresponding to a hub, is closed by a transparent glazing intents to cause a greenhouse effect trapping the infrared rays, while the reflecting surface of the hemisphere causes a concentration. This system as described does not use any receiver. The air is directly absorbing the heat produced by the concentrator. The concentration effect can be considered as a burning spot actually corresponding to the real image of the sun, and this spot may directly heat the surrounding air. Furthermore, inside the concentrator is a mobile iron fireplace where a pot or a frying pan can be placed (absorber). This absorber can be painted in black to absorb as much of the reflected rays as possible. The choice of this hemispherical concentrator cooker is simply justified by its quality and efficiency of permanent concentration throughout the day, whatever the position of the sun. The glass used allows the action of wind speed and other external parameters to be neglected, and also contributes to increasing the temperature inside the enclosure through the greenhouse effect. The moving focus allows us to manually track the sun's spot (focal point) inside. The reflector is permanently positioned with a 12° inclination corresponding to the latitude of the site. It is the fireplace that will be moved to follow the focal point. The following table gives the estimated cost of the system.

3. DEFINITION AND OPERATING PRINCIPLE

A solar concentrator is defined as a device that concentrates the sun's rays on a target in order to recover maximum energy. A hemispherical concentrator cooker does not focus on a single point, but on an axis parallel to the sun's rays and passing through the centre of the sphere. It is on this axis that an absorber or receiver should be placed (Ouédraogo et al., 2020). The study on the hemispheric concentrator and the type of receiver to be placed on the focal axis showed that for an aperture half-angle of less than 23°, a cavity receiver is recommended, whereas for a larger aperture half-angle, a conical receiver is suggested (SMT et al., 2018).

In the Gaussian approximation, when a light beam arrives parallel to the axis of the hemispherical concentrator, which is an astigmatic surface, all the reflected rays converge at the focus of the concentrator. In a zone called the aberration caustic, the reflected rays form a luminous spot at the plan the of the least confusion. The reflected rays are tangent to the surface of this zone (TSM et al., 2019) as shown in Figs. 1 and 2. The parametric equation of the caustic known as the Nephroid equation is:

$$\begin{cases} R_d = R\sin^3\varphi \\ Y = \dfrac{R}{2}\cos\varphi(1+\sin^2\varphi) \end{cases} \qquad (1)$$

Y position of the plane of least scattering

The reflection at point M of the ray forming an angle has the equation of a straight line (CM) Khaled (2008).

$$R_d\cos(2\emptyset) + Y\sin(2\emptyset) - R\sin\emptyset = 0 \qquad (2)$$

With Rd and Y the coordinates of the point of intersection (T) of the caustic and the line (CM). To position the receiving cavity on the y axis, we need to determine the coordinates Rd and Y of the point (T).

Rd: The radius of the plan of the least confusion (m).
Y: Position of the plane of least confusion on the y-axis (m).
$\emptyset$: The opening angle at the centre (°C).
φ : The opening angle at the focus (°C) .

Solving this equation involves replacing the expression for Rd and Y in equation (1) and for a value of $\emptyset$=30°C we have φ=22°C.

So with this value of φ, we obtain Rd = 1.5610^{-2} m and Y=0.33m.

Taking into account the apparent diameter of the sun and to better calibrate the receiver, the radius Ra inside the receiver or the radius of the plan of the least confusion has the following expression:

$$R_a = (\mathrm{R}\sin\emptyset + R_d)*\frac{\cot(2\emptyset)}{\cot(2\emptyset+0,266)} - \mathrm{R}\sin\emptyset \quad (3)$$

The hemispherical concentrator cooker we used has a radius R= 0.59 m and we also know the value of ∅=30°C. Equations (1) and (2) give us

$R_a =$ 3.45 10^{-2} m Y= 0.33 m et R_d =1.5610^{-2}m

Ra: minimum radius of the cooking pot (m).

Y: position of the pot in relation to the reflecting surface (m).

The geometric mean concentration is calculated, using the equations (1, 2, 3 and 4):

$$C_{gm} = \left(\frac{R\sin\emptyset}{R_a}\right)^2 \quad (4)$$

We obtain a geometric mean concentration $C_{gm} = 244$

Ky et al. (2018) have shown that following the apparent path of the sun, the plan of the least confusion describes a semicircle of radius Y inside a hemispherical concentrator, illustrated in Fig. 5. The value of the radius of the semicircle is close to half the value of the radius of the concentrator.

Fig. 3. Sunspot formation (TSM et al., 2019)

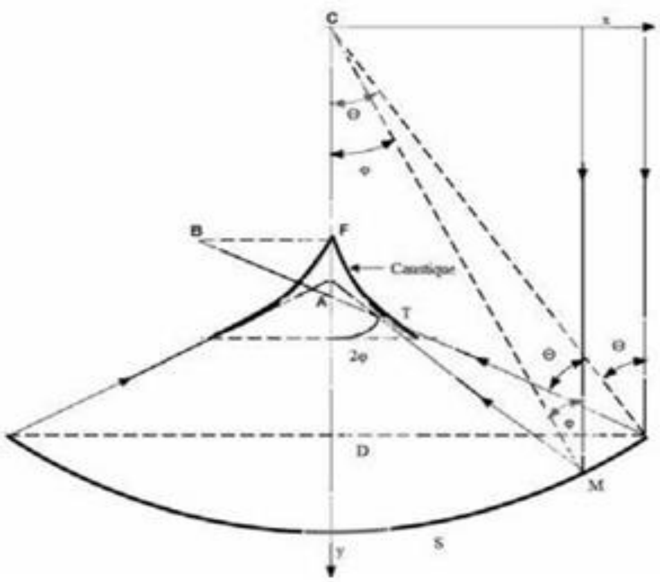

Fig. 4. Caustics of a hemispherical or spherical concentrator (Khaled, 2008)

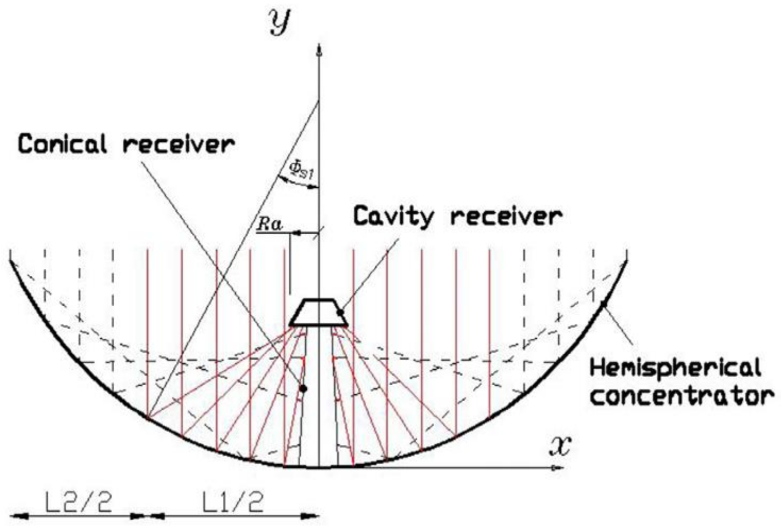

Fig. 5. Hemispherical concentrator with mixed conical and cavity receiver (TSM, 2018)

4. MATERIALS AND METHODS

In this work, we used type K thermocouples with armoured sheaths to measure the temperature of the receiver, the air inside the hemisphere, the ambient air and the outside and inside of the glass. A Hukseflux SR03-05 pyranometer used to measure incident solar irradiance on the horizontal plane. It is used to measure changes in direct illuminance on a horizontal plane. It has a sensitivity of 7.64μV(W.m^{-2}). A GRAPHTEC Midi LOGGER GL200A automatic data logger, programmed at a rate of 5 minutes, to which the thermocouples and pyranometer are connected. This device records changes in temperature using the thermocouples.

Table 2. Technical characteristics of the pyranometer, type K thermocouples and Midi logger Gl200A

Tool	Temperature range	uncertainty
Type K thermocouple	-40 à 1000°C	±1.5%
SR03-05 pyranometer	0 à 1600 W.m^2	±1.8%
Midi LOGGER GL200A	-100 à 1730°C	±(0.1% freading+0.3°C)

Fig. 6. Midi LOGGER GL200A

Fig. 7. SR03-5 Pyranomete

A USB key is used to store recorded data. With the measurement equipment, an aluminum pot painted black on the outside was used during all tests. For temperature measurements, we used 3 type K thermocouples. The thermocouple measuring ambient air temperature is exposed to the open air. The thermocouple measuring the air temperature inside the device is suspended inside the device. A thermocouple is always inserted inside the absorber to record the heating or cooking temperature of the food.

5. RESULTS AND DISCUSSION

We carried out the first measurements without internal load, just to observe the evolution of the temperature of the air outside and inside the device.

Test 1. The aim of this first test is to measure the evolution of the air temperature trapped inside our hemispherical reflector. The evolution of irradiation during the day of October 26,2022 is indicated by the following curve.

Fig. 8 shows the daily variation of irradiation obtained on this day. Maximum irradiance of 700 ($W.m^{-2}$) at 11:45a.m; but the irregularities observed on the curve can be explained by the presence of clouds. The Fig. 9, shows the various changes in air temperature in the system.

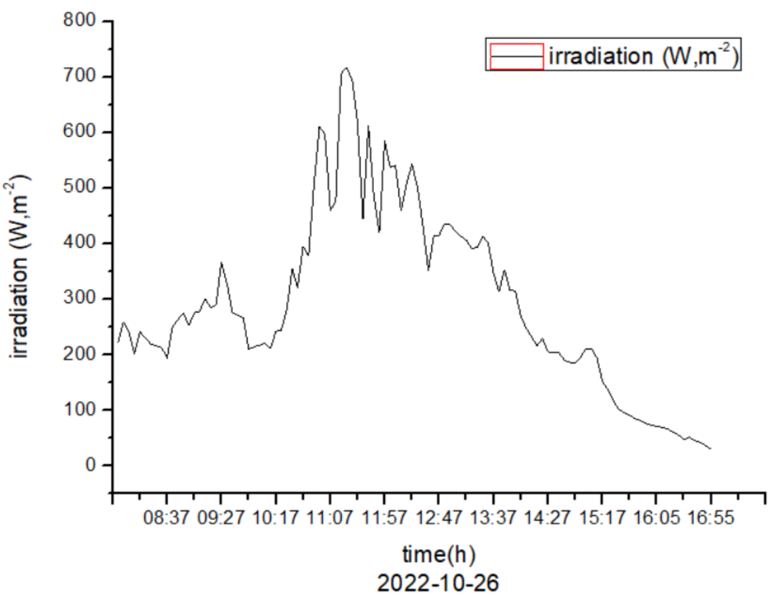

Fig. 8. Irradiation curve for the day of 26 October 2022

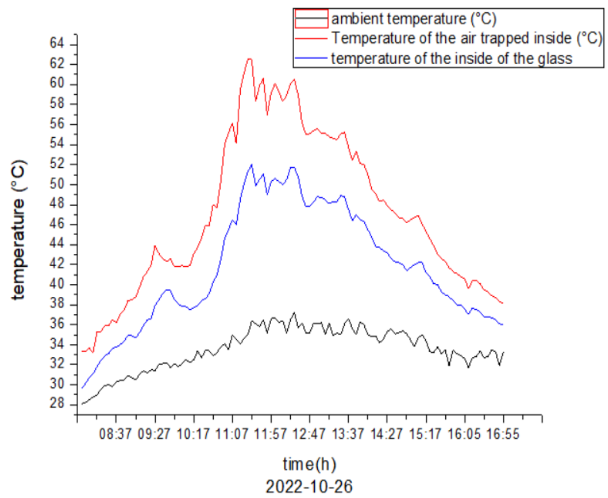

Fig. 9. Curve of internal air temperature and ambient temperature as a function of time of day 2022-10-26

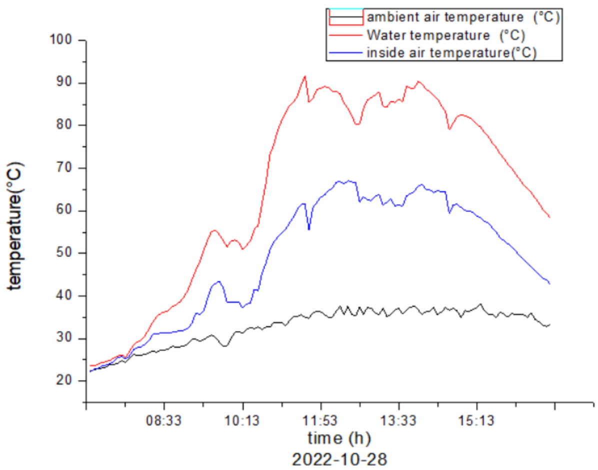

Fig. 10. The evolution of hot water and outdoor air temperatures

Fig. 9 shows the temperature evolution of the unloaded system. The results of measurements taken during the day on October 26, 2022 indicate a maximum temperature of 63°C for the air trapped in the hemispherical reflector, obtained from 11 a.m. onwards. The temperature on the inside of the glass pane reached a maximum of 51°C. However, the ambient air temperature is 35°C. These temperatures are obtained under the following radiation evolution during the day of October 26, 2022.

Test 2: The aim of this test is to heat water with the system. The device is used to heat water on October 28, 2022. The quantity of water heated is 1.5L. Fig. 10 shows the evolution of hot water and outside air temperatures.

Fig. 10 shows that temperature values evolve progressively, with a maximum water temperature of 91.7°C reached at 10:45 am. This temperature was achieved in 30 minutes by Gianluca Coccia et al. (2016) using a new, low-cost solar cooker featuring a high-performance Fresnel lens. The temperature of the trapped air was 67.1°C at 11:53 am. The ambient air temperature is 37°C. This irregularity in the curves is justified by the presence of cloud shading.

Fig. 11 shows the irradiation for the day of April 20,2023.

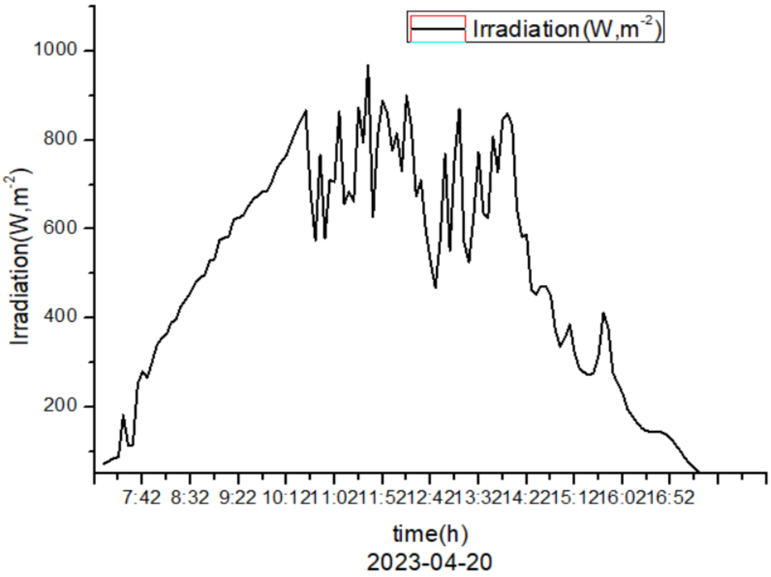

Fig. 11. irradiation trends for the day of 20-April 2023

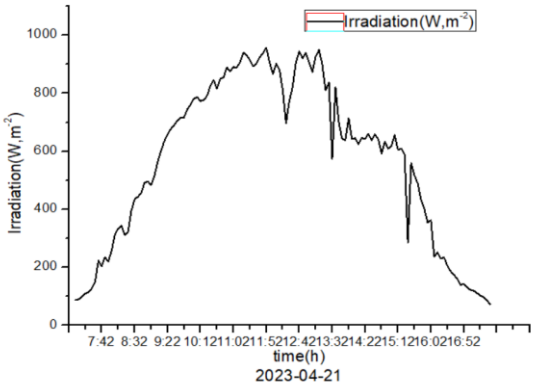

Fig. 12. Irradiation during the day on April 2023, 21

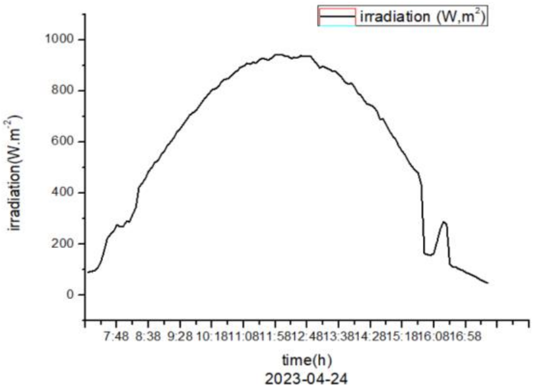

Fig. 13. Irradiation during the day on April 2023,24

Fig. 11 shows the results of the experiment on April 20,2023. The results show a maximum irradiation of 957.1 W.m^{-2} at 11:52 a.m. The irregularities observed on the curve are due to the passage of clouds.

Test 3: the day of April 21,2023 is dedicated to cooking and frying sweet potatoes.

Figs. 12 and 13 show the results of the experiment on April 21, 2023 and April 24, 2023. The results show a maximum irradiation value of 950 W.m^{-2} for the day of April 21, 2023 and a value of 960 W.m^{-2} for the day of April 24,2023. The irregularities observed on the curves are due to the passage of clouds.

Fig. 14 shows the evolution of the cooking temperature of sweet potatoes.

Fig. 14 shows the results of the experiment on April 21, 2023. The maximum temperature is 100°C, obtained at 11:30 a.m, for an under-glazing temperature of 80°C obtained at 10:50 am with maximum irradiation of 957.1W.m^{-2}. The ambient air temperature has a maximum value of 35°C.

Test 4 for bean cooking

Fig. 17 shows the cooking temperature for beans.

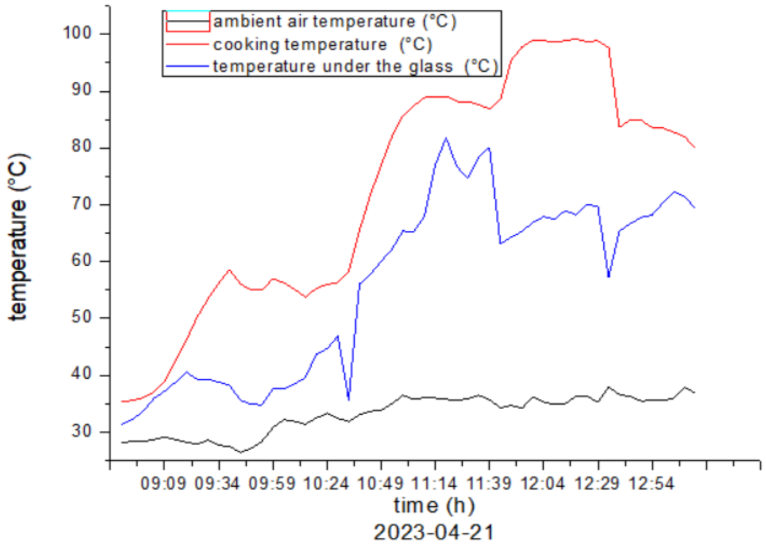

Fig. 14. Evolution of cooking and frying temperatures for sweet potatoes

Fig. 15. A dish of fried potatoes

Fig 16. Sweet potato cooking (1Kg)

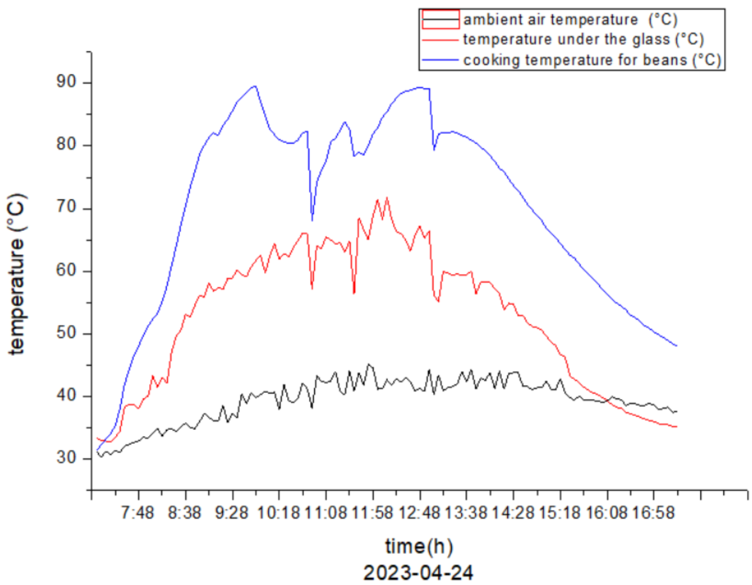

Fig. 17. Cooking temperature for beans

Fig. 18. Baked bean dish

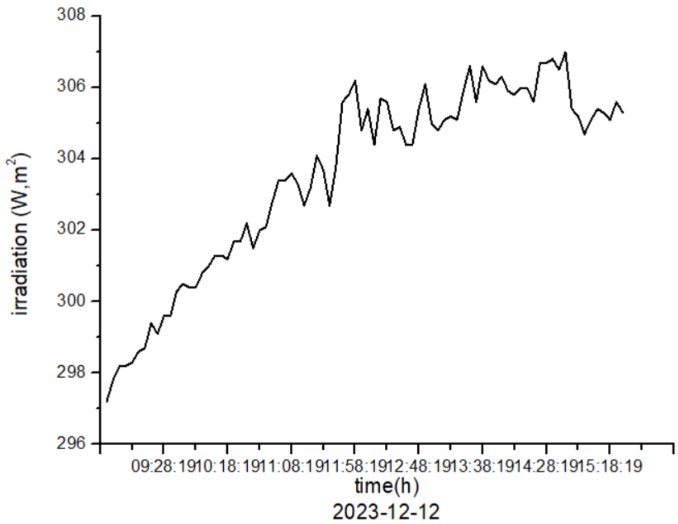

Fig. 19. Irradiation for day 2023-12-12

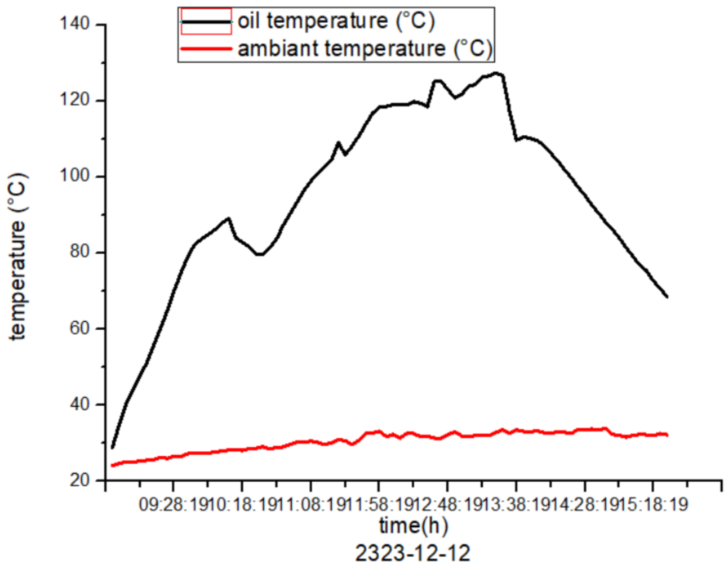

Fig. 20. Oil heater (1l oil)

Fig. 17, shows a maximum temperature of 90°C obtained from 9:28am to 12:48pm for bean cooking, with a maximum under-glass air temperature of 70°C obtained at 12:00 pm. We have a maximum ambient air temperature of 40°C.

Test 5 aimed to heat 1 litre of oil

Fig. 19, shows the irradiation trend during heating the oil.

The maximum irradiation value on this day is 306.7 W.m^{-2}, obtained at 2:33pm.

Fig. 20, shows temperature trend during heating oil.

Fig. 20, shows the progressive evolution of oil temperature, with a value of 130°C obtained at 1:21pm for the oil, a maximum temperature of 68°C for the internal air and an ambient temperature of 32.9°C. These temperatures evolve with the curve of irradiation.

Calculating the efficiency of our device

Useful power, $$P_u = \frac{\left(m_{pot} \times c_{p_{pot}} + m_{oil} \times c_{p_{oil}}\right) \times \Delta T}{\Delta t} \quad (5)$$

$\Delta T = T_{Max\ of\ oil} - \overline{T}_{am}$ (°C)

Δt :oil heating time (s)

m_{pot} : the weight of the pan, (Kg)

$c_{p_{pot}}$: the heat capacity of the pot (Kj.Kg^{-1}.K^{-1})

m_{oil} : mass of oil (Kg)

$c_{p_{oil}}$: the heat capacity of the oil (Kj.Kg^{-1}.K^{-1})

Absorbed power (Pa):

$$P_a = S_{pot} \times \overline{I}_{RD} \quad (6)$$

We will suppose $\overline{I}_{RD} \approx \overline{I}_G \times 0.90$ (7)

This correlation takes into account the sky's cloud cover

S_{pot} : hemispherical reflector's exposure area (m^2)

$\overline{I}_{RD}$: Average direct irradiation for the day of measurement

$\overline{I}_G$: Average overall irradiance for the day of measurement.

We used the measurement data for oil heating because there was no oil evaporation during heating. The efficiency of our system is around 20%, which is quite low because not all the hemispherical reflector is reflecting on the absorber. We can also see that there is a great deal of heat loss between the hemisphere and the glass.

6. CONCLUSION

Solar radiation can be considered one of the most suitable energy sources for cooking food. It is therefore important to promote progress in solar cooking systems, particularly with regard to their efficiency and cooking times. In this work, we designed, built and tested a new low-cost solar cooker (designed from concrete under a glazing), underwent a series of tests carried out in Ouagadougou, Burkina Faso. We tested water heating, cooking of foods such as sweet potatoes, frying and bean cooking. We also recorded the evolution of irradiation during these experiments. The first test consisted on measuring the air trapped inside the unloaded hemispherical reflector. It was carried on October 26,2022 under an irradiation of 700 W.m^{-2}. We obtained an air maximum temperature of 63°C. The second test, carried out on October 28, 2022, was designed to heat 1.5 litre of water. Under an irradiation of 860 W.m^{-2}. The results show a boiling water temperature of 91.7°C obtained between 10:45am and 1:33pm. The day of April 21, 2023 was devoted to experimental studies on cooking and frying sweet potatoes under an irradiation of 950W.m^{-2}. The maximum temperature of cooking spot is 100°C, obtained at 11:30 a.m, for an under-glazing temperature of 80°C is obtained at 10:50 am. We succeeded in cooking bean with our system under irradiation of 306.7 W.m^{-2}. The device is used to heat oil, under an irradiation of 306.7 W.m-2. The maximum temperature reached by the oil is 130°C. In terms of sustainability and durability, our solar cooker poses no serious environmental problems such as pollution, global warming and greenhouse gas emissions.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models

(ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Balachandran, S., & Swaminathan, J. (2022). Advances in indoor cooking using solar energy with phase change material storage systems. *Energies*, 15(22), 8775. http://dx.doi.org/10.3390/en15228775

Coccia, G., Aquilanti, A., Tomassetti, S., Ishibashi, A., & Nicola, G. D. (2021). Design, manufacture, and test of a low-cost solar cooker with high-performance light concentrating lens. *Solar Energy*, 224, 1028–1039. http://dx.doi.org/10.1016/j.solener.2021.06.025

Cohen, S., & Grossman, G. (2016). Development of a solar collector with a stationary spherical reflector/tracking absorber for industrial process heat. *Solar Energy*, 128, 31-40. https://doi.org/10.1016/j.solener.2015.05.036

Craig, O. O., Dobson, R. T., & VanNiekerk, W. (2017). A novel indirect parabolic solar cooker. *Journal of Electrical Engineering*, 5, 137–142. http://dx.doi.org/10.17265/2328-2223/2017.03.003

Esen, M. (2004). Thermal performance of a solar cooker integrated vacuum-tube collector with heat pipes containing different refrigerants. *Solar Energy*, 76(6), 751-757. http://dx.doi.org/10.1016/j.solener.2003.12.009

Getnet, M. Y., Gunjo, D. G., & Sinha, D. K. (2023). Experimental investigation of thermal storage integrated indirect solar cooker with and without reflectors. *Results in Engineering*, 18. http://dx.doi.org/10.1016/j.rineng.2023.101022

Getnet, M. Y., Gunjo, D. G., & Sinha, D. K. (2023). Experimental investigation of thermal storage integrated indirect solar cooker with and without reflectors. *Results in Engineering*, *18*, 101022. http://dx.doi.org/10.1016/j.rineng.2023.101022

Harmim, A., Boukar, M., & Amar, M. (2016). Experimental exergy analysis and optimum water load of a solar cooker. *American Journal of Modern Energy*, 2(6), 48–53. http://dx.doi.org/10.11648/j.ajme.20160206.13

Harmim, A., Merzouk, M., Boukar, M., & Amar, M. (2013). Développement et expérimentation d'un nouveau cuiseur solaire stationnaire. *Revue des Énergies Renouvelables*, 16(2), 337–346. https://www.researchgate.net/publication/260081327_Developpement_et_experimentation_d'un_nouveau_cuiseur_solaire_stationnaire

http://refhub.elsevier.com/S0038-092X(24)00191-9/sb1

http://refhub.elsevier.com/S0038-092X(24)00191-9/sb2

International Energy Agency. (2022). *SDG7: Data and projections*. IEA. https://www.iea.org/reports/sdg7-data-and-projections

Khaled, M. (2008). Design and construction of a spherical concentrator. Mentouri Constantine University, Constantine, Algeria. https://scholar.google.fr/citations?user=Sc3LdqsAAAAJ&hl=fr

Ky, S. M. T. (2016). Analyse des images optiques des concentrateurs solaires: Application pour la conception de fours à pain. *Ouaga I Pr Joseph KI-ZEBO*, Ouagadougou, Burkina Faso. https://www.researchgate.net/publication/350712937_Experimentation_et_analyse_thermique_d'un_concentrateur_hemispherique_stationnaire_sous_les_conditions_climatiques_a_Ouagadougou_Burkina_Faso

Ky, S. M. T., Dianda, B., Ouedraogo, E., Ouedraogo, S., & Bathiébo, D. J. (2018). Novel natural convection process: Indirect solar dryer built with spherical concentrators, application to tomato drying. *Elixir Thermal Engineering*, 122, 51615–51620. https://www.researchgate.net/publication/327476990_Novel_Natural_Convection_Process_Indirect_Solar_Dryer_Built_with_Spherical_Concentrators_Application_to_Tomato_Drying

Ky, S. M. T., Zoungrana, B. A., Boro, D., Dianda, B., Ouédraogo, S., Ouédraogo, A., Kam, S., & Bathiébo, D. J. (2024). Conception, réalisation et testing of a solar cooker built with a spherical reflector in Burkina Faso. *Solar Energy*, 272, 11297. https://doi.org/10.1016/j.solener.2024.112497

Ky, T. S. M., Dianda, B., Ouedraogo, E., Pakouzou, B. M., Kam, S., & Bathiébo, D. J. (2019). Theoretical optical analysis of a spherical or a planar diopter on a hemispherical concentrator. *Arabian Journal for Science and Engineering*. https://doi.org/10.1007/s13369-019-03812-y

Ky, T. S. M., Pakouzou, M., Dianda, B., Ousmane, M., Kam, S., & Bathiébo, D. J. (2018). Air heating in a steady hemispherical concentrating system for various applications. *International Journal of Current Research*, 10(2), 65449-65454. http://www.journalcra.com/article/air-heating-steady-hemispherical-concentrating-system-various-applications

Lentswe, K., Ae Mawire, P., Owusu, P., & Shobo, A. (2021). A review of parabolic solar cookers with thermal energy storage. *Heliyon*, 7(10), e08226. https://doi.org/10.1016/j.heliyon.2021.e08226

Nebie, J., Daho, T., Toubreoumya, G. C., Zongo, S., Zeghmati, B., & Chesnau, X. (2019). Modélisation des paramètres de fonctionnement d'un cuiseur solaire de type boite sous les conditions météorologiques du Burkina Faso. *Journal of Physical Sciences*, 1, C19A8. http://www.soaphys.org/parutions/

Oluwatosin, D., Ola, K., & Olayinka, A. (2022). The impacts of the use of biomass solid fuels for household cooking in sub-Saharan Africa: A review. *Research Square*, 1–32. http://dx.doi.org/10.21203/rs.3.rs-1840692/v1

Ouédraogo, S., Ky, T. S. M., Konfé, A., Kam, S., & Bathiébo, D. J. (2020). Expérimentation et analyse thermique d'un concentrateur hémisphérique stationnaire sous les conditions climatiques à Ouagadougou, Burkina Faso. *Journal of Physical Sciences*, 2(1), C20A04.

DOI: 10.46411/jpsoaphys.2020.01.04

Sagade, A., Samdarshia, S. K., & Panja, P. S. (2017). Experimental determination of effective concentration ratio for solar box cookers using thermal tests. *Solar Energy*, 159, 984–991.

http://dx.doi.org/10.1016/j.solener.2017.11.021

Soro, D., Sidibé, M., Doumbia, Y., Touré, S., & Marí, B. (2020). Theoretical and experimental studies of a box-type solar cooker in unfavorable climatic conditions. *Smart Grid and Renewable Energy*, 11, 51–60.

http://dx.doi.org/10.4236/sgre.2020.114004

Steward, W. G., & Kreith, F. (1975). Stationary concentrating reflector cum tracking absorber solar energy collector: Optical design characteristics. *Applied Optics*, 14(7), 1509–1512. https://doi.org/10.1364/AO.14.001509

Wassie, H. M., Getie, M. Z., Alem, M. S., Kotu, T. B., & Salehdress, Z. M. (2022). Experimental investigation of the effect of reflectors on the thermal performance of box-type solar cooker. *Heliyon*, 8(12), e12324.

http://dx.doi.org/10.1016/j.heliyon.2022.e12324

Zamani, Z., Mahian, O., Rashidi, I., Lorenzini, G., & Wongwises, S. (2017). Exergy optimization of a double-exposure solar cooker by response surface method. *Journal of Thermal Science and Engineering Applications*, 9(1), 1-7. http://dx.doi.org/10.1115/1.4034340

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