CONTROLLED COOKING TEST STUDY FOR NIGERIA

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Lead Author: Anthony Mbukobong Akpasoh

Contributing Authors: Veronica Brendan Edeminam (PhD)

Photos and Illustrations: Tovero Energy Ltd

Recipes: Anthony Mbukobong Akpasoh and Veronica Brendan Edeminam (PhD)

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PREFACE

In Nigeria, about 50% of the population depend on wood as a source of cooking fuel. After Malaria and HIV/AIDS, smoke from open fire is the next biggest killer as it results in over 95,000 deaths annually in Nigeria. The use of firewood also diverts scarce resources that could be put to better use by families on education, health, and nutrition because it is expensive. To address this challenge, the Federal Government of Nigeria has prioritized access to clean cooking for all. Past interventions have focused on using improved cookstoves and LPG as clean cooking technologies. Efforts to promote Electric Pressure Cookers (EPCs) as a clean cooking technology is still at an infant stage in Nigeria.

As per its Nationally Determined Contribution (NDC) commitments, the Nigeria Energy Transition Plan 2021 advocates the replacement of traditional cooking fuels particularly firewood and charcoal with cleaner biomass fuels and LPG as a transition, and with electric and biogas stoves to reduce emissions.

As part of the support to achieving the 2023 clean cooking target in Nigeria, Tovero Energy Ltd, with support from Groupe Seb and MECS conducted a controlled cooking test study to measure the energy, time, and cost of cooking traditional dishes across different cooking technologies. This Controlled Cooking Test study aims to shed light on three important areas.

- The cost of cooking the same meals with different cooking technologies.
- The time spent cooking the same meals across different cooking technologies.
- The amount of fuel or energy consumed cooking the same meals across different cooking technologies.

The study also examined the concerns around the taste and texture of the food cooked with electric pressure cookers, and the convenience of the cooks across the cooking technologies used in this study. This controlled cooking test is an effort to provide reliable data to back up the inclusion of electric pressure cookers as a clean cooking technology that is cost-effective, fast, and clean.

This study presents complex findings around energy and cooking in an easy-to-understand way so that households, utility companies, distribution companies, and policy-makers can make better informed decisions about cooking fuels and technologies to promote for the clean cooking transition in Nigeria.

Dr. Veronica Brendan Edeminam

Chief Executive Officer

Tovero Energy Ltd

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Abbreviations

CCT – Controlled Cooking Test

E-Cooking – Electric cooking

EPC – Electric Pressure Cooker

ICS – Improved Cook Stoves

KG – Kilogram

kWh – Kilo watt hour

LPG – Liquified Petroleum Gas

MECS – Modern Energy Cooking Services

1.0 Introduction

Cooking with polluting biomass wood has become one of the biggest sources of household air pollution in the Global South leading to increasing deaths caused by diseases such as pneumonia, asthma, lung cancer, acute respiratory infections, etc. Over the years there have been efforts by multilateral international organizations, governments, and the private sector to introduce safer cooking fuels and technologies to combat this menace. This has led to the roll-out of Improved Cook Stoves (ICS), LPG cookers, biogas cookers, electric induction cookers etc.

Electric cooking or e-cooking has been identified as one of the promising approaches to solve the growing household air pollution associated with cooking with open fire biomass cooking technologies. Reports from MECS has shown that cooking with electricity is mainly practiced in the urban part of Nigeria with access to grid electricity (Carlin, Esteve, Omonuwa, and Sherwood, 2021). Although electricity access in Nigeria has gradually improved over the years, the transition from biomass cooking fuels to electric cooking is slow. The adoption of e-cooking in Nigeria is low and this is attributable mainly to the unreliable power supply in most parts of Nigeria. Other reasons for avoiding cooking with electric cookstoves include, food taste, fear of electrocution, perceived long cook time, and lack of repair shops for these equipment.

This study presents the results of controlled cooking tests carried out using three cooking technologies in Nigeria which are Kerosene stove, LPG stove, and Electric Pressure Cooker (EPC). The objectives of the controlled cooking test are to;

1. Determine the cost of cooking the same meals across different cooking technologies.
2. Evaluate the time of cooking same meals across different cooking technologies.
3. Investigate the energy consumption of cooking the same meals across different cooking technologies.

Other minor objectives of this controlled cooking test was to show some Nigerian traditional meals that can be cooked using electric pressure cookers.

This controlled cooking test study serves to spread awareness of the benefits of electric cooking in Nigeria. One of which is that gives the cook the ability to multi-task while cooking.

This controlled cooking test study aims to support the Nigeria Energy Transition plan 2021, and The Climate Change Act 2021 in transitioning from biomass to cleaner and more efficient cooking technologies. This study presents complex findings around energy and cooking in an easy-to-understand way so that households, utility companies, distribution companies, and policy-makers can make better informed decisions about cooking fuels and technologies to promote for the clean cooking transition in Nigeria.

2.0 Overview of the Cooking Fuels and Technologies in Nigeria

Nigeria is a diverse country with a population of over 200 million. The country is diverse in culture and food and there are diverse cooking technologies that are used across the country to prepare food. Some of them are explained as follows;

Firewood

Wooden material used for fuel is called firewood. According to a survey by the Nigerian Bureau of Statistics as cited in Ajala (2022), about 68.3% of Nigerian households still use solid biomass (charcoal and firewood) for cooking. There are health challenges associated with prolonged use of firewood, and the trees felled to make firewood are rarely replaced, thereby leading to deforestation which is a great contributor to climate change (Imam, 2022).

Cooking with firewood also presents gender issues because women and girls in most rural communities are responsible for sourcing firewood and they are exposed to the firewood smoke when cooking. In some cases, women and girls spend as much as 6 hours fetching and preparing firewood (Obi, Adeboye, and Aneke 2014). Access to firewood is high because it can be easily gotten from farms, gardens, and it is sold in small units in neighbourhoods.

Firewood cooking. Source: (National Accord, 2021)

Charcoal

Charcoal, which is another cooking fuel commonly used in Nigeria, is formed when wood or carbonaceous material is burned. Traditional charcoal is produced by cutting trees and burning them. Wildlife is also endangered when trees are cut down for charcoal. In addition to biodiversity loss from the use of charcoal, burning charcoal releases high levels of carbon dioxide and carbon monoxide into the atmosphere because charcoal is pure carbon (Dhanesha, 2021). Workers that produce charcoal are at higher risks of respiratory health problems, such as chronic bronchitis, respiratory health problems, and cough (Dhanesha, 2021). Charcoal is easily accessible because it is usually sold in small units and can be gotten by burning wood that is easily accessible.

Charcoal for cooking. Source: (Wolf, 2023).

Briquettes

Briquettes are solid fuel made from carbonized biomass, or non-carbonized biomass that is subsequently carbonized using different technologies (Mwampamba, Owen, and Pigaht, 2013). Briquettes can be made from coconut shells, sawdust, nut shells, tree branches/twigs, paper, firewood, corn stalks, sugar cane waste, etc.

Briquetting, which is the process of making briquettes, starts with waste collection, size reduction, drying and compaction of the waste by an extruder (Imam, 2022). The collected wastes are compressed in a briquette press machine to generate a uniform shaped briquette that can be used to ignite fire and generate energy (Imam, 2022). The whole point is to get raw materials which are considered wastes and compress them into solid fuel of a convenient shape that can be burned like wood or charcoal (Imam, 2022).

Briquettes are one of the options for clean cooking transition in Nigeria because the raw materials are naturally abundant, especially in the rural areas. Briquettes are often preferred because they are smokeless and cleaner than lump charcoal but emissions from briquettes still harm the environment. In Nigeria, focus is given to briquettes because of its health and environmental advantages over firewood and charcoal, and the abundance of the raw materials. However, Briquettes are relatively new in Nigeria because of the absence of technology to produce briquettes in large quantity to meet the demand.

Charcoal Briquettes. Source: Ngureco (2022)

Kerosine stoves

Kerosine is one of the by-products of crude oil and it is one of the commonly used cooking fuel in rural and urban households in Nigeria. Cooking with kerosine can produce high level of pollutants and high levels of smoke emissions especially when cheap wick stoves and lamps are used. The emissions cause health problems and indoor air pollution (Arku et al, 2020).

Kerosine stove. Source: Author’s photography (2023)

Kerosine is sold in litres at petrol stations and small retail outlets all over Nigeria. Thus, it is easy to access especially from the small retailers. According to the National Bureau of Statistics (2023), the average price of Kerosine per liter is 1,200 NGN in June 2023. The retail outlet where the Kerosine for this controlled cooking was purchased sold a liter of Kerosine at 1,000 NGN. For this controlled cooking test study, 1,200 NGN per liter will be used to calculate the price of cooking with Kerosine.

Liquified Petroleum Gas (LPG) Stove

Liquified Petroleum Gas (LPG) is smokeless and produces less CO_2 than other cooking fuels. It is a highly efficient cooking fuel and burns cleanly with very low emissions when compared to other cooking fuels such as kerosine, charcoal, firewood, etc.

LPG Stove. Source: Author’s photography (2023).

In Nigeria, LPG is sold in cylinders, measured in Kilograms, and can be sold at gas stations and small retail outlets especially in the urban areas of the country. One of the major challenges facing LPG adoption in Nigeria remains its distribution across the country. . According to the National Bureau of Statistics (2023), the average price of LPG per KG is 800 NGN in June 2023. This is the same price that 1 KG of LPG was sold by the retailer for this controlled cooking test. 800 NGN per kg will be used to calculate the cost of cooking with LPG in this controlled cooking test study.

Electric cookers

There are several devices that use electricity for cooking such as induction cookers, hot plates, and electric pressure cookers. In this controlled cooking test study, the focus is on electric pressure cookers. Cooking with electricity depends on electricity reliability and access. Electricity tariffs as regulated by the electricity regulatory commission (NERC) depends on the duration of supply to a particular area. The tariff class have been set to Band A, B, C, D and E customers for residential, business, industry, special customers, and street lighting respectively. Within the different class there are further classification to show the duration of electricity supply to each area with the highest being a minimum of 20 hours each day. This controlled cooking test was done at the Tovero Energy cooking lab at Calabar, Cross River State, which is under the Port Harcourt Distribution company. On the morning of the CCT study (26th July, 2023), electricity units were purchased and the price of electricity per kWh was at 111.61 NGN. See picture below,


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Thank you for trusting us with your bill payment, your transaction is successful.

Token:	3853-0366-3033-4198-4267
Unit:	44.8
Transaction ID:	230726386186
Order Reference:	F19-F4FDD
Utility ref:	2607202325675030
Amount:	5,000.00
Service/Utility:	PhED_Electricity
Date:	Wed 26th Jul, 2023 13:40:41

Customer's Details

Meter:	0171100044097
Name:	Hillary Obong
Address:	1 Effa Ekpenyong Street N/A MAPR:2102.04/63061.32
Email:	veroedeminam@gmail.com
Phone Number:	07035151088

Electricity unit bought for the controlled cooking test. 1 unit of electricity = 111.61 NGN.

The Tefal brand of Electric Pressure Cooker used for this controlled cooking test was donated by Groupe Seb. The wattage is 1,000 watts and the size of the EPC is 5.7 litres.

The cooking technologies used for this controlled cooking test study are LPG stove, Kerosine stove, and Electric pressure cooker.

3.0 Controlled Cooking Test Results

3.1 Foods cooked in the test

Culinary typology in Nigeria

Nigeria has a rich cultural and ethnic diversity and food is prepared and consumed in ways that express this diversity. The focus of this controlled cooking test study is on dishes prepared in Nigeria. The four largest ethnic groups in Nigeria which to some extent defines the regions in Nigeria are; Hausa/Fulani in the North, Yoruba in the South-West, Igbo in the South-East and the Efik/Ibibios in the South-South regions of the country respectively. Some meals are distinct to these regions while there are some other meals that are generally prepared and eaten by Nigerians across different cultures. An analysis is shown below in table 1 below.

Table 1: Some Traditional dishes in Nigeria across regions

S/N	Region	Ethnic group	Traditional dishes
1.	North	Hausa/Fulani	Tuwo Masara, Tuwo Shinkafa, Miyan Zogoli, Miyan kuka, etc.
2.	South-East	Igbo	Egusi, Ofe Nsala, Onugbu soup, Abatcha, Okpa, Oha soup, etc.
3.	South-West	Yoruba	Amala and Ewedu, Gbegiri
4.	South-South	Ibibio/Annang among others	Afang Soup Edikan Ikong, Ekpang Nkukwo, Fisherman soup, Atama soup, Editan soup.
	Entire regions	All ethnic groups	Bean Porridge, Jollof rice, Yam porridge, Plantain porridge. Okro Soup, etc.

Water boiling test, yam porridge cooking, and plantain porridge cooking was done for this controlled cooking test study. The water boiling test is a standard protocol that measures how efficiently a stove uses fuel to heat water in a cooking pot (Todd, Scott, and Leary, 2023).

The choice of Yam and Plantain porridge for the CCT study is because these foods are eaten by almost all tribes in Nigeria.

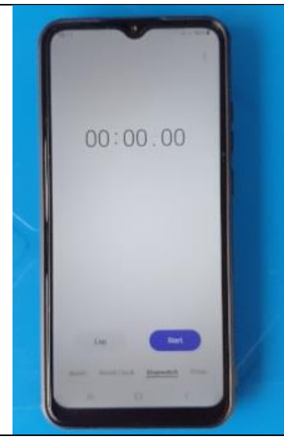
3.2 Pre-cooking arrangements

Several equipment was gathered for the controlled cooking test. These equipment were useful for the CCT study. They are explained below.

Table 2: Equipment used for the controlled cooking test study.

Equipment	Use	Picture
LPG stove	A 3kg LPG stove was used for the controlled cooking test.	
Kerosine stove	The Kerosine stove was used for the controlled cooking test.	
Electric pressure cooker	The Tefal brand of Electric Pressure cooker was used. The EPC is 1,000 watts and 5.7 litres in capacity. The inner pot of the EPC is the non-stick pot.	
Kitchen scale	To measure the weight of the food ingredients used for the cooking. All ingredients used for the controlled cooking test across all cooking technologies were the same measurement.	

Industrial scale	This was used to measure the weight of the LPG stove, before each test and after each test.	
Energy smart meter	To measure the energy consumed using the electric pressure cooker.	
Pots	5.5 litre aluminum pot was used for the cooking test on the kerosine stove and the LPG stove. The pot has a lid.	
Wooden spatula	To stir the food in the electric pressure cooker because the inner pot of the EPC is non-stick.	

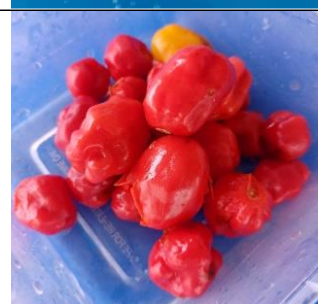
Stopwatch	To measure the time used in cooking. The stopwatch is put on immediately the cooking technology is turned on and stopped immediately the cooking technology is turned off.	

A laptop was used to record the data in a spreadsheet. The CCT was undertaken by two staff members of Tovero Energy Ltd. Their tasks also involved recording data and taking sample pictures.

The food ingredients were bought from the open market a day before the controlled cooking test was carried out (26th July, 2023). The reason was to ensure that all the items are prepared properly and all equipment are set to carry out the test the next day. Since the test was carried out at the Tovero Energy Ltd cooking laboratory in Calabar, Cross River state, the food items were bought from Marian market, a very popular market along Ndidem Usang Iso Road, Calabar, Cross River State, Nigeria. The items bought are shown below;

Table 3: Food items used for the controlled cooking test study.

Food items bought	**Picture**
Fresh yam	
Half ripe plantain	

Fluted pumpkin leaves (also known as Ugu leaves)	
Salt	
Red bell fresh pepper	
Onions	
Palm oil	

Scent leaves	
Bouillon cubes	
Dried Oyster mushrooms	
Dried locust bean powder (also known as Iru or dawadawa)	

3.3 Cooking Process and results

3.3.1 Water boiling test

The ingredients used for the water boiling test are tap water, pot, kettle, and the Electric Pressure cooker. The water was fetched from the tap for all the cooking technologies, and measured into the EPC, and pot (1.5 litres of water). The stopwatch is turned on immediately the cooking technology is turned on and the stopwatch is turned off immediately the cooking technology is turned off.

The results for the water boiling test are shown below in table 4.

Table 4: Test result for water boiling test

Variables	EPC	Kerosene stove	LPG stove
Price per unit of cooking fuel/electricity	111.61 NGN per kWh	1,200 NGN per liter	800 NGN per kg
Quantity of water used for the water boiling test	1.5 litres	1.5 litres	1.5 litres
Energy at start of cooking for EPC/Weight at start of cooking for Kerosine and LPG stove	36.3277 kWh	2.172 Kg	6.80 kg
Energy at end of cooking for EPC/Weight at end of cooking for Kerosine and LPG stove	36.5025 kWh	2.147 Kg	6.75 kg
Amount Fuel/Energy Used for cooking consumed for the water boiling test	0.1748 kWh	0.025 Kg	0.05 kg
Temperature at start of water boiling test	Room temperature	Room temperature	Room temperature
Temperature at the end of the water boiling test	100 degrees Celsius	100 degrees Celsius	100 degrees Celsius
Water boiling time	08.28 minutes	10.25 minutes	9.13 minutes
Cost of energy used in the water boiling test (NGN)	19.42 NGN	30 NGN	40 NGN

Pictures of the cooking technologies for the water boiling test. Source: Author's photography (2023).

The electricity in the location where the controlled cooking test was conducted is 220 volts. The electricity used is on-grid electricity.

3.3.2 Yam porridge cooking test

The ingredients used for the yam porridge cooking test were measured using the kitchen scale shown in Table 2 and the same measurements of ingredients was used across the three cooking technologies for this Yam porridge cooking test.

Table 5: Recipe and measurements for the Yam porridge cooking test

Ingredient	Measurement
Diced fresh yam	418 grams
Chopped Onions	46 grams
Fresh pepper (Blended red bell pepper)	45 grams
Chopped fluted pumpkin leaves	57.83 grams
Palm oil	111 grams
Dried Oyster mushrooms	11 grams
salt	1/2 teaspoon
Locust bean powder	1 teaspoon
Bouillon cube	8 grams
Chopped Scent leaves	5 grams

Pictures of ingredients used for the Yam porridge cooking test. Source: Author's photography (2023).

Pictures of ingredients used for the Yam porridge cooking test. Source: Author's photography (2023).

The same process was used to cook the yam porridge across all cooking technologies to avoid bias of the test results. The cooking process is detailed below;

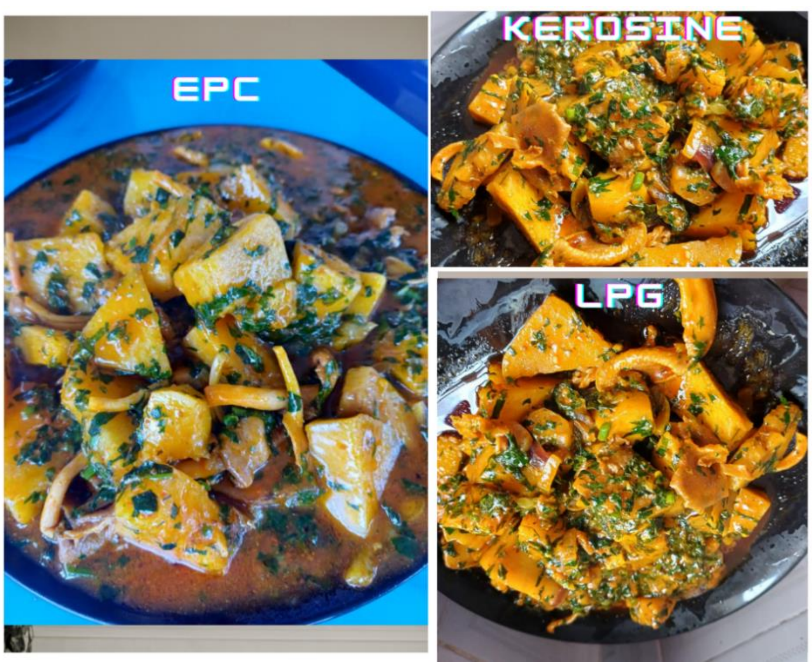
1. Put the chopped yam in the cooking pot and add room temperature water. The quantity of water added to the yam is shown in Table 6 below.
2. Add the Bouillon cube, blended red bell pepper, locust bean powder, salt, and dried oyster mushroom to the mix in number 1 and cook.
3. When the food is cooked, add the chopped onions, chopped fluted pumpkin leaves, chopped scent leaves, and palm oil to the food. This time, stir the food to evenly mix the ingredients. This mix is allowed to simmer for 2 minutes, and it is ready to be served.

Note that for the EPC, after 2, depressurize, before opening the EPC to add the ingredients mentioned in number 3 of the process. The result of the CCT study for yam porridge is shown below.

Table 6: Test result for Yam porridge cooking test

Variables	EPC	Kerosene stove	LPG stove
Price per unit of cooking fuel/electricity	111.61 NGN per kWh	1,200 NGN per liter	800 NGN per kg
Quantity of water used for the Yam porridge cooking test	75cl	1 litre	1 litre
Energy at start of cooking for EPC/Weight at start of cooking for Kerosine and LPG stove	36.5235 kWh	2.147 Kg	6.75 kg
Energy at end of cooking for EPC/Weight at end of cooking for Kerosine and LPG stove	36.8368 kWh	2.052 Kg	6.575 kg
Amount Fuel/Energy Used for cooking consumed for the cooking	0.3133 kWh	0.095 Kg	0.175 kg
Temperature of water at the start of cooking	Room temperature	Room temperature	Room temperature
Yam porridge cooking time	27.2 minutes	47.35 minutes	32.06 minutes
Cost of energy used in cooking (NGN)	34.97 NGN	114 NGN	140 NGN

The water requirement for cooking on LPG and Kerosine stove was more than the water requirement for cooking with the EPC. The reason for this difference is due to the vapour retention property of the EPC when it is sealed.



Sample of Yam porridge cooked across different cooking technologies. Source: Author's photography (2023).

3.3.3 Plantain porridge cooking test

The ingredients used for the plantain porridge cooking test were measured using the kitchen scale shown in Table 2 and the same measurements of ingredients was used across the three cooking technologies for this plantain porridge cooking test so that variability in measurements of the food ingredients does not bias the results of the test.

Table 7: Recipe for the plantain porridge cooking test

Ingredient	**measurement**
Chopped half ripe plantain	419 grams
Bouillon cube	8 grams
Salt	1 teaspoon
Grounded locust bean powder	1 teaspoon
Chopped fluted pumpkin leaves	58 grams
Chopped scent leaves	5 grams
Chopped onions	38 grams
Dried pepper (Grounded)	1 teaspoon
Palm oil	111 grams

Pictures of ingredients used for the plantain porridge cooking test. Source: Author's photography (2023).

Pictures of ingredients used for the plantain porridge cooking test. Source: Author's photography (2023).

The same process was used to cook the plantain porridge across all cooking technologies to avoid bias of the test results. The cooking process is detailed below;

1. Put the chopped half ripe plantain was put in the cooking pot and add room temperature water to the plantain. The quantity of water added to the plantain is shown in Table 8 below for the different cooking technologies.
2. Add the Bouillon cube, dried pepper, locust bean powder, salt, and dried oyster mushroom to the mix in number 1 and cook.
3. When the food is cooked, add the chopped onions, chopped fluted pumpkin leaves, chopped scent leaves, and palm oil to the food. This time, stir the food to evenly mix the ingredients. This mix is allowed to simmer for 2 minutes, and it is ready to be served.

Note that for the EPC, after 2, depressurize, before opening the EPC to add the ingredients mentioned in number 3 of the process. The result of the CCT for plantain porridge is shown below.

Table 8: Test result for Plantain porridge cooking test

Variables	**EPC**	**Kerosene stove**	**LPG stove**
Price per unit of cooking fuel/electricity	111.61 NGN per kWh	1,200 NGN per liter	800 NGN per Kg
Quantity of water used for the plantain porridge cooking test	50cl	75cl	75cl
Energy at start of cooking for EPC/Weight at start of cooking for Kerosine and LPG stove	36.862 kWh	2.052 Kg	6.575 kg
Energy at end of cooking for EPC/Weight at end of cooking for Kerosine and LPG stove	37.1016 kWh	1.996 Kg	6.46 kg
Amount Fuel/Energy Used for cooking consumed for the cooking	0.2396 kWh	0.056 Kg	0.115 kg
Temperature at start of cooking	Room temperature	Room temperature	Room temperature
Plantain porridge cooking time	19.03 minutes	24.39 minutes	21.08 minutes
Cost of energy for cooking the plantain porridge (NGN)	26.74 NGN	67.2 NGN	92 NGN

Sample of Plantain porridge cooked across different cooking technologies. Source: Author's photography (2023).

The electricity voltage at the time of the study was 220 volts. The controlled cooking test for the EPC was done using Grid power.

4.0 Analysis of cooking test results and presentation of findings

4.1 Analysis of water boiling test results

The water boiling test results show EPC is the cheapest and fastest cooking technology compared to LPG and kerosine stoves, other factors such as cost of cooking technology fuel remaining constant. The next cheap cooking technology fuel is kerosine stove, but the LPG stove boiled the water faster than kerosine stove. Several studies however show that kerosine stoves have higher emissions than LPG stoves (Giwa, Nwaokocha, and Odofuwa, 2019; Adeniji, Ana, and Ige, 2015).

4.2 Analysis of yam porridge cooking test results

The yam porridge cooking test results show that EPC is the most cost-effective and fastest cooking technology compared to LPG and kerosine stoves, other factors such as cost of cooking technology fuel remaining constant. Cooking with kerosine stove also cost lesser than cooking with LPG, however, cooking with LPG was faster than cooking with kerosine stove.

4.3 Analysis of plantain porridge cooking test results

The plantain porridge cooking test results show that it is cheapest and fastest to cook with Electric Pressure Cooker than cooking with LPG and kerosine stoves, other factors such as cost of cooking technology remaining constant. Cooking the plantain porridge with kerosine stove was cheaper than cooking with the LPG stove, but the LPG stove cooked the plantain porridge faster than the kerosine stove.

Other findings were that cooking with electric pressure cooker required less water. The reason for this result is that the electric pressure cooker conserves heat and water vapour when the pot is sealed during cooking, which helps in the cooking process.

For reliability of results, the following steps were taken;

- The pots were allowed to cool before they were used for the next cooking test. The EPC was also allowed to cool before it was used for another round of cooking.

- The same pots were used for the Kerosine stove controlled cooking and the LPG stove-controlled cooking tests.

- The food ingredients were measured to ensure it was the same quantities of ingredients that was used to cook across all the cooking technologies.

- The same cooks cooked the meals across the cooking technologies to control for differences in cooking methods.

5.0 Summary, Conclusion, and Recommendations

5.1 Summary

The controlled cooking test was carried out in the Tovero Energy Ltd laboratory at Calabar under controlled conditions. The controlled cooking test was carried out with the following objectives.

1. Determine the cost of cooking the same meals across different cooking technologies.
2. Evaluate the time of cooking same meals across different cooking technologies.
3. Investigate the energy consumption of cooking the same meals across different cooking technologies.

The Tefal brand of Electric Pressure Cooker used for the test was donated by Groupe Seb. In addition to the known fact that e-cooking is the cleanest form of cooking, the controlled cooking test showed that cooking with electricity is the cheapest and fastest form of cooking. While cooking with kerosine stove cost less than cooking with LPG, cooking with LPG is faster than cooking with kerosine stove.

The controlled cooking test study further revealed that cooking with EPC requires lesser water than cooking with Kerosine stove and LPG stove because of the pressurizing feature that allows the heat generated during the cooking process to recirculate inside the pot. Another advantage of cooking with the EPC that was used for this study is the convenience it provides to the user. The EPC can be set to cook for a specific time, after which it turns off by itself when the set time elapses. This convenience allows the cook to multi-task without the fear of cooking incidences.

5.2 Conclusion

The findings of this controlled cooking test study is consistent with the findings of other cooking tests and this has formed the basis for the promotion of e-cooking as the most cost-effective clean cooking option.

The results of this controlled cooking test with regards to the cost of cooking might change if the unit costs of the different cooking technologies change significantly. In Nigeria where this study is carried out, there are still challenges of electricity access and reliability. At the location of the Tovero Energy Ltd laboratory where this test was carried out, there is constant electricity supply 4 days of the week. It was within the days of constant electricity that this test was carried out.

5.3 Recommendations

The results of the findings show the Electric Pressure Cooker is the cheapest and fastest cooking technology when compared to LPG and kerosene stove. Including EPCs in cooking technologies stack in household across the country will help them enjoy these benefits. Another advantage of the EPC is the convenience that it gives to the user.

The adoption of e-cooking is tied strongly to the reliability of existing grid infrastructure across the country. The grids therefore need to be strengthened to support this transition. The target of the Nigeria's National Determined Contribution (NDC) to reduce emissions through clean cooking with a target population of 48% by 2030 (Nigeria Clean Cooking 2023) can be met with the promotion of the adoption of eCooking in urban areas with relatively stable electricity supply, together with LPG for locations where access to electricity is still a major challenge. Encouraging the adoption of e-cooking technologies will provide employment for those engaged in its production, sale, use, repair, and maintenance of the e-cooking technologies. Policies should be made to make the e-cooking sector lucrative for private sector investment. These policies can be in the form of providing adequate infrastructure and environment to promote production and assembling of devices other than imports.

For the future, to promote the adoption of e-cooking in Nigeria, an eCookbook should be developed to show in detail the traditional meals that can be prepared in Nigeria across different geographical and cultural regions using an Electric Pressure Cooker (EPC). This will promote the use of EPC in the areas of the country with access to electricity and reliability. The wider impact will be cleaner air, reduced emissions, better health for cooks, and an environment that leads to improved economic and leisure lifestyles.

For development actors, cooking with electricity can reduce cooking costs, mitigate the negative health consequences of indoor air pollution, and create new opportunities for income development. Thus, developmental organisations can set up pay-as-you-go schemes to promote the use of electrical energy efficient cooking appliances for the population whose livelihoods they seek to improve.

This CCT study only considered meals that are eaten across Nigeria. A more detailed Controlled cooking test study to incorporate other regional based traditional meals such as soups is recommended.

Massive sensitization of stakeholders such as utility companies, government, policy-makers, distribution companies and households should be carried out to promote the adoption of e-cooking because of the social, economic, environmental, and health benefits of cooking with electricity.

Further studies to determine the payback period of using EPCs would be insightful considering the high initial cost of purchasing Electric Pressure Cookers.

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