REPORT FOR CONTROLLED COOKING TESTS

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INTRODUCTION

The Energy Systems Unit and Mechanical Engineering section of UIRI are providing technical support to Raising Gabdho Foundation in the development of a bioethanol stove.

Having developed the first prototype, there was need to understand the comparative advantages and probable challenges of cooking using bioethanol in the ethanol stove compared to other cooking alternatives for better marketing strategies and further improvement.

Raising Gabdho Foundation in collaboration with the Energy Systems Unit of Uganda Industrial Research Institute conducted Controlled Cooking Tests (CCT) in Kansanga, Kampala from 28th December to 12th January 2023 with the objective to compare the performance of the ethanol stove prototype versus alternative cooking technologies through preparation of a common meal prepared in Ugandan households.

DESCRIPTION OF COOKING TECHNOLOGIES AND FUELS USED

Cooking alternatives considered for the Controlled Cooking Tests are *Bioethanol, Electric Pressure Cooker (EPC), Liquefied Petroleum Gas (LPG), Carbonized briquettes, Charcoal*, and ordinary pressure cooker as a cooking vessel.

Bioethanol (> 94% alcohol content) sourced from Bukona Agro Processors Ltd was used in the ethanol stove prototype.

LPG used in the test was branded Meru gas. Carbonized stick briquettes from Raising Gabdho Foundation, and charcoal sourced from Kampala were used in RGF stove size 2.

The Electric Pressure Cooker is of 5 Liters capacity, Saachi brand, Model: NL-PC-5301 and rated 900W

TESTING TEAM

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Team leader RGF

Mambo Wilson.
Engineer-UIRI

Nakiyini Joan.
Adminstrator

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- Brian
  RGF Client, cook
- Pavin
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- Aisha
  RGF Client, cook
- Esther
  RGF Client, cook
- Chris
  Data entrant
- Robinah
  Support team member
- *Kevin*
  Support team member

METHOD USED AND PARAMETERS MEASURED

The CCT protocol from the Global Alliance for Clean Cook stoves was used to develop the protocol used in the study.

However, specific fuel consumption was not used as a measure for comparison since each technology considered used a different fuel. Instead, the six cooking alternatives were tested for cost of cooking, and total time required for preparing beans and posho for an average family of 4 people.

The cooks were first oriented about the controlled cooking test, shown how to use each of the cooking appliances, and then collectively engaged in the development of a common procedure for cooking beans and posho.

They were allowed to practice cooking using the various appliances for two days before starting to collect data. Every cook prepared 3 meals using each of the cooking technologies.

In each test, 0.75kg of dry beans were provided to the cook, sorted, washed and then soaked for at least two hours before boiling until they crack.

The beans were fried using 5 tablespoonfuls of oil and an average of 350g of ingredients comprising of 1tomato, 1 onion, 1carrot, 1 green paper, and salt.

The sauce was allowed to boil until it formed a thick soup. Posho was prepared by boiling 10 cups of water (1637g) and mingling with 5.5 cups of maize flour (664g). Before commencing each of the tests, initial weight of fuel added, room temperature, and start time were recorded.

The end time and weight of fuel remaining were also recorded immediately after completion of the cooking task.

Power consumption by the electric pressure cooker was read from a plug in power monitor which was reading cumulative power consumption.

The difference between the readings after and before the cooking task was the power consumption.

In addition to the quantitative dependant variables above, observations when cooking with the different technologies were noted down and feedback was obtained from cooks after every task.

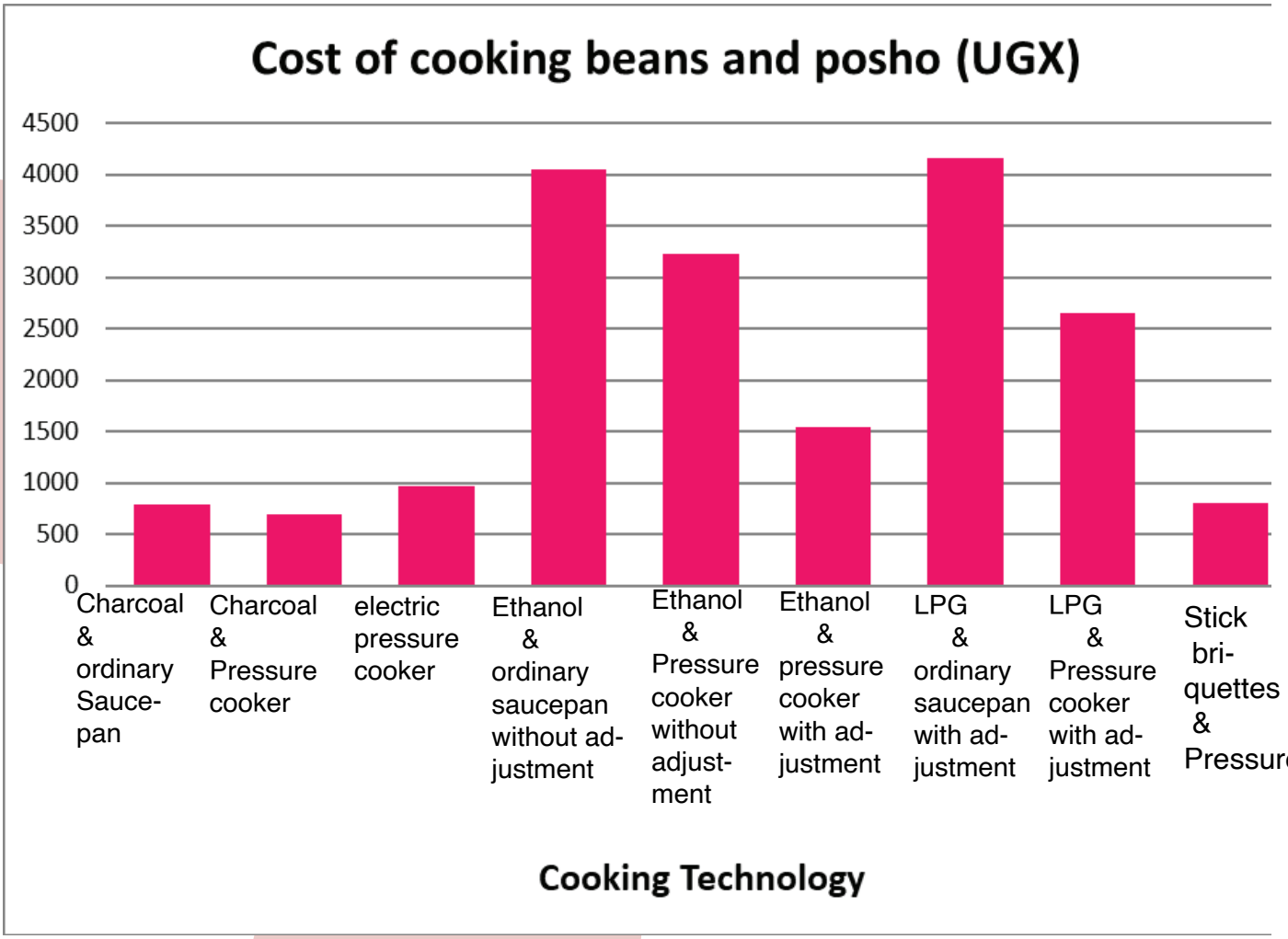
The ambient temperature during the test period was ranging from 21 oC to 30 oC.

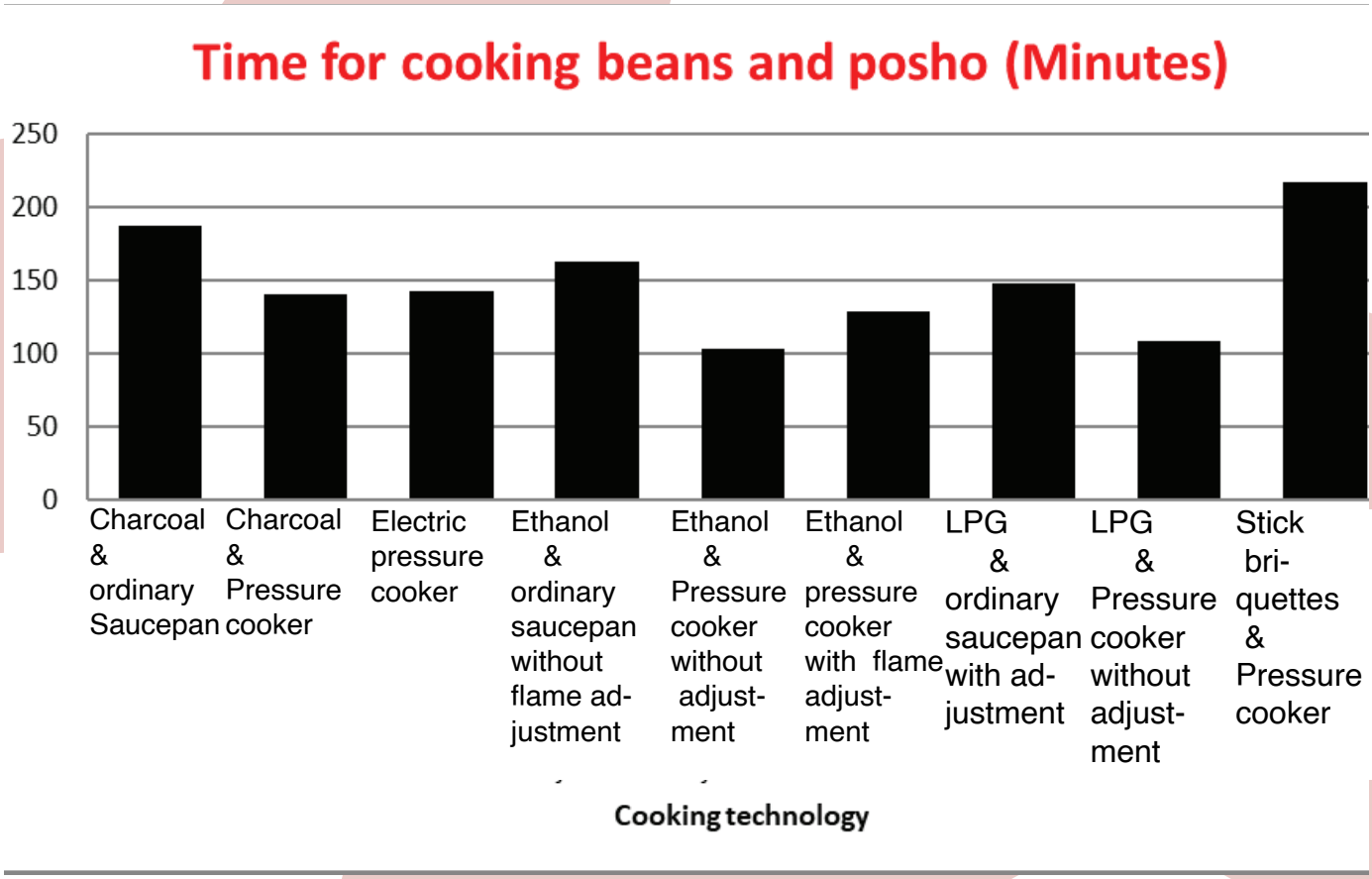
During the CCT, refilling 6Kg LPG in Uganda was costing 57,000 UGX which gave a unit cost of 9500 UGX per Kg, 2.65 Kg tin of charcoal was costing 3000 UGX which gave a unit cost of 1132.1 UGX/kg, Electricity was costing 885 UGX per kWh (VAT Inclusive) and carbonized stick briquettes from RGF were costing 1000 UGX/Kg.

RESULTS

Cooking Technology	Cost of cooking (UGX)	Cooking Time (Min)
Charcoal and ordinary saucepan	788	187
Charcoal and Pressure cooker	691	140
Electric Pressure Cooker	973	143
Ethanol and ordinary saucepan without flame adjustment	4050	162
Ethanol and Pressure cooker without flame adjustment	3230	104
Ethanol and Pressure cooker with flame adjustment	1542	129
LPG and ordinary saucepan with flame adjustment	4166	149
LPG and Pressure cooker with flame adjustment	2648	109
Stick briquettes and pressure cooker	809	217

NOTE: The time recorded includes the ignition time.


Cost of cooking beans and posho (UGX)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Charcoal & ordinary Sauce-pan
Charcoal & Pressure cooker
electric pressure cooker
Ethanol & ordinary saucepan without ad-justment
Ethanol & Pressure cooker without adjust-ment
Ethanol & pressure cooker with ad-justment
LPG & ordinary saucepan with ad-justment
LPG & Pressure cooker with ad-justment
Stick bri-quettes & Pressure
Cooking Technology


Time for cooking beans and posho (Minutes)
250
200
150
100
50
0
Charcoal & ordinary Saucepan
Charcoal & Pressure cooker
Electric pressure cooker
Ethanol & ordinary saucepan without flame ad-justment
Ethanol & Pressure cooker without adjust-ment
Ethanol & pressure cooker with flame adjust-ment
LPG & ordinary saucepan with ad-justment
LPG & Pressure cooker without adjust-ment
Stick bri-quettes & Pressure cooker
Cooking technology

ASSUMPTIONS MADE

- Beans are soaked before cooking
- Energy Efficient charcoal stove is used
- Remaining charcoal is extinguished and kept for the next cooking
- The charcoal quality is good and consistent

Observations and feedback

Charcoal

It takes long to ignite, produces dirt in the hands when using, burns with high heat, stable for mingling, smokes especially when lighting, and does not allow for regulation of fire intensity.

Participants appreciated the performance of RGF stove size 2 compared to other brands which they had been using earlier.

The good performance of stove in addition to good cooking practices adopted during the test made participants realize that it's possible to save on cost of cooking.

Electric Pressure Cooker

It is clean, fast, convenient, and cheap to cook using an electric pressure cooker.

However, participants reported the concern of power blackouts as experienced during the test period which may affect its uptake as a sole system for cooking.

Electric pressure cookers need to be promoted alongside other clean cooking alternatives in order to help during moments of power blackout.

The other challenge they envision is the high initial procurement cost for an ordinary Ugandan.

There is need for a loan scheme to ensure long term payment of the appliance.

Briquettes

They take very long time to ignite and burn with low heat intensity which prolongs cooking time. In addition, briquettes generated a lot of ash after cooking which was not pleasant.

The cooks used some little charcoal during ignition of briquettes that also generated fumes.

Participants liked briquettes for warming food after cooking due to their ability to burn longer with lower heat intensity than charcoal.

Ordinary Pressure Cooker

The CCT test results show that an ordinary pressure cooker is very necessary for savings in cost of cooking and time irrespective of the cooking fuel used.

The use of pressure cooker registered savings of 12% (95 UGX) for charcoal in RGF stove, 62% (2,511 UGX) for ethanol in ethanol stove prototype, and 36% (1500 UGX) for LPG. In a similar manner, time savings of 25% (47 minutes) for charcoal in RGF stove, 20% (33 minutes) for ethanol in ethanol stove prototype, and 27% (40 minutes) for LPG were registered when using a pressure cooker as opposed to the usual practice of using aluminium saucepans.

The study therefore recommends the use of a pressure cooker to save both cost and time irrespective of cooking fuel.

Bioethanol

It is easy to ignite, burns with a blue flame after adjustment, cooks faster, and convenient for indoor cooking.

The ethanol stove is stable when mingling and allows for adjustment of fire power which participants appreciated where low heat intensity is required towards completion of the cooking tasks.

Below are some of the concerns raised by participants and the probable way forward

- Half of the participants complained of ethanol scent and irritation of their eyes while cooking.

It requires cooking in a well ventilated area to minimize such complaints as evidenced during the CCT when the venue was relocated from a small kitchen to a spacious kitchen.

- The ethanol stove produces soot on the saucepan when not regulated which presents a challenge in the event that the users are not well trained on how to use it or when the flame adjustment cover is misplaced.

The soot shows that the canister releases more fuel than the required amount for complete combustion.

The surface area of the canister openings shall be reduced to ensure generation of a blue flame at maximum stove power operation.

In addition, the cover for flame adjustment should be fixed to minimize misplacement.

- Sharp handles of the fuel canister can lead to cuts during operation. There is need to cover the sharp edges with either wood or plastic material for safety of the user.
- The stove size needs some little adjustment to accommodate small cooking vessels for single men and women as well as a pressure cooker of 8 litres capacity for large families.
- Need for possibility of using the ethanol stove for grilling meat without affecting the food with ethanol scent.
- Ethanol is not readily available in the market within Uganda. There is need for it to be availed to users either through retail outlets located in communities or through installation of fuel dispensers at nearby petrol stations.

LPG

It is easy to ignite, clean and cooks faster.

However, the participants raised the concerns of safety and cost

CONCLUSION

In conclusion, bioethanol is a cheaper alternative to LPG, but may be more expensive than electric pressure cookers, charcoal, and briquettes when good practices are followed.

However, the cost of cooking with charcoal and briquettes may be higher than the study findings due to the variable quality of fuel, use of inefficient cooking stoves and appliances, and failure to extinguish fires after cooking.

To successfully replace the charcoal market, supportive policies are needed to lower ethanol costs to less than half a dollar per liter.

Additionally, the frequent power blackouts in Ugandan households limit the use of electric pressure cookers, making the ethanol stove a viable alternative.

With further improvements in prototype design, the ethanol stove can be promoted alongside a pressure cooker, slow heat retaining basket, and briquettes with efficient cooking appliances to maximize heat conservation and reduce fuel costs.

Overall, the use of bioethanol alongside,electric and ordinary pressure cookers, briquettes, improved cookstoves and slow heat retaining baskets present a promising solution to the high cost of cooking with traditional fuels in Uganda.

With the right policies and awareness campaigns, households can adopt these alternatives to reduce their cooking expenses