



## Evaluation of Moringa Bio-Gel as Alternative Cooking Energy Source among Women in Oyo State, Nigeria

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### Abstract

The study examined willingness to pay and constraints in the use of moringa bio-gel as alternative cooking energy source among women in Oyo State. A purposive random sampling technique was used to select 208 women from a total of 980 women that were trained on the use of moringa bio-gel. Both descriptive (percentages and mean) and inferential statistics (regression analysis) were used to analyse the data from the study. The average age of women was 36.7 and majority (91.8%) had one form of education or another. 95.2% are either employed in government job or were entrepreneurs. About half (55.8%) of the women live in urban areas and had a mean of 5 persons as household size. The major fuel used by 69.7% of the women was liquefied petroleum gas (LPG) and the average amount spent on cooking fuel/month was N3, 500, 65.9% of the women interviewed were willing to pay for moringa bio-gel as an alternative cooking energy source. Constraints associated with the use of the gel according to the women were that it is not affordable and it is not accessible as this ranked 1<sup>st</sup> and 2<sup>nd</sup> respectively. There was a significant relationship between education ( $B = 0.194$ ,  $P = 0.003$ ) and settlement pattern ( $B = 0.210$ ,  $P = 0.043$ ) and women's willingness to pay for moringa bio-gel. The project therefore recommends that strategies to increase the adoption of moringa bio-gel as an alternative cooking fuel be put in place by the government.

**Keywords:** Willingness, constraints, Bio-gel, alternative, cooking, fuel

### Introduction

Biofuels, simply put, are fuels that are derived from agricultural products; they are a renewable source of energy that can be used in many applications, from fueling vehicles to generating electricity and heating homes (Bušić *et al.*, 2018). Recently, biofuels have been attracting attention from various sectors and are considered to be “carbon-neutral”, which simply means that the amount of carbon dioxide which is created when burnt is equal to the amount of carbon dioxide used (Ofor and Nwufor, 2011). Biofuels burn efficiently and thus have zero emissions that can be harmful to the environment.

The energy problems of developing countries are serious and widespread with lack of access to sufficient and sustainable energy supplies affecting as much as 90% of the population. Globally, about 2.9 billion people depend on fossil fuels such as wood, charcoal and kerosene to cook their daily meals which generates harmful household air pollution (WHO, 2022). Rural and Peri-urban areas of developing countries are very dependent on these fuels due to increasing economic

hardship, poverty and lack of adequate national grid (Zaku *et al.*, 2013). The dependence of these people which are mostly at the base of the economic pyramid on fossil fuels pose economic, environmental, equity and health threats; undermining their abilities to engage effectively in productive activities or to improve their quality of life.

Prolonged burning of fossil fuels has affected the global climate, with its overall health effects overwhelmingly negative, affecting many social and environmental determinants of health (WHO, 2016). Fossil fuel burning causes the largest global air pollution which is a major public health concern. The release of several harmful and hazardous air pollutants contributes to excess mortality from cardiovascular, respiratory, and other diseases, causing premature death in older people while children are vulnerable to asthma and impaired lung function development (GBD, 2015; WHO, 2016; Banerjee, 2020). These reduces worldwide average life expectancy by nearly three years (Lelieveld *et al.*, 2020). The 2006 census (NPC, 2006) put the population

of Nigeria at 140,431,790, and this has risen to an estimate of 200 million. In Nigeria, about 67% of the population depends on fossil fuels (Ajah, 2013) and this has not improved overtime. Currently, about 134 million of the population still depends on fossil fuels for cooking and other essential household activities and this raises a lot of concerns because of its negative impacts on the environment, the users and other public health issues.

The Moringa biofuel have various advantages over fossil fuel in that it is eco-friendly, not injurious to health, ignites fast, reduce the stress of looking for coal/charcoal which is an advantage over fossil fuel that have negative impact on humans and the environment.

Access to a clean energy is particularly a gendered issue because in almost every society, women are primarily responsible for cooking their household meals. Women especially those that live in the rural areas have been known to cook with solid fuels which are one of the world's biggest killers and possess a treat to the environment (Lacey *et al*, 2017). Women are known to play key roles in food production in the home; they play significant and crucial roles in agricultural development and allied fields including crop and livestock production providing 65% - 89% of food (FAO, 2019). Women carry over 80 tons of fuel, water and farm produce for a distance of more than one kilometer over the course of a year (UN, 2013). They are key agents for development; they play a catalytic role towards achievement of transformational economic, environmental and social changes required for sustainable development (UN, 2013). Many of the world's most poor are women who are the most vulnerable group therefore, the introduction of this new trend (use of moringa biofuels) for cooking will go a long way to mitigate the burden in cooking. The use of biofuels, a form of green energy offset the traditional cooking (with stove or charcoal) which can drive the process of achieving at least four of the sustainable development goals (SDGs) of the federal government of Nigeria.

Life fuel bioenergy is a patented cellulosic moringa bioethanol cooking fuel (Patent number: NG/PT/NC/2018/2796) an innovation of Life builders NGO in partnership with research institutes was developed from *Moringa oleifera* stems (Taiwo and Life builders NGO; 2017, *unpublished article*) to increase the accessibility and ease of transition of rural/per-urban low income Nigerian households to a more sustainable and affordable alternative renewable energy. This is aimed to improve the quality of life of cooking households by bringing ease and comfort to users, safeguarding users from fossil fuel associated health and related hazards; enhance environmental sustainability and economic development. The purpose of this Study therefore, was to evaluate the use of moringa bio-gel as an alternative cooking energy source among women.

### **Hypothesis of the study**

**Ho:** There is no significant relationship between selected personal characteristics and willingness to

pay for moringa bio-gel as alternative cooking energy source among women

### **Methodology**

The study was carried out in Oyo State located in the South-west geopolitical zone of Nigeria. The state covers a total of 28,454 square kilometers of land mass and consists of 33 Local Government Area (LGA). The innovation funded by UNDP's Small Grant Fund, validated the production of alcohol mixtures from moringa stems; the energy-containing liquid bio-gel developed was demonstrated for domestic cooking to women in Oyo State. The *Moringa oleifera* stems previously left to rot (after harvesting the leaves for sale) were sourced from over 500,000 established stands, planted by over 100 trained and empowered farmers through a buyback strategy. The innovation involved several trials with researchers and agricultural officers from various institutions and regions of the country. Nine (9) Local Government Areas (LGAs) were purposively selected for the study out of the thirty three LGAs in Oyo State. These were Ido, Akinyele, Lagelu, Egbeda, Itesiwaju, Ibadan north, Ogbomoso north, Afijio and Oluyole. Three (3) villages were purposively selected from each LGA to make up twenty seven (27) villages, while nine (9) women were also purposely selected from each village which gave a total of 243 women but only 208 were available for interview. A structured interview guide was used together with Focus Group Discussion (FGD) to elicit information from the women. Major variables measured were willingness to pay and constraints associated with the use of the gel for cooking. The data obtained were subjected to descriptive statistical analyses such as frequency counts, percentages and mean. Inferential statistics (regression analyses) was used to find out the relationship between selected personal characteristic and willingness of women to pay for moringa bio-gel. Factors that can affect the selection of choice of green energy were ranked from 1<sup>st</sup> – 7<sup>th</sup> in descending order after the mean has been calculated. A three-point scale of “high, moderate and no constraint” was used to rank the constraints in the use of moringa bio-gel as alternative energy cooking source after calculating the weighted average. This was also ranked in descending order from 1<sup>st</sup> – 5<sup>th</sup>.

### **Results and Discussion**

#### **Personal characteristics of women**

Result in Table 1 show the personal characteristics of women in the study area. More than half (60.6%) of the women interviewed were between the age of 26 – 45 years with a mean age of 38.7 years. This indicates that women in the study area were still in their active and productive age. About fifty four percent (54.4%) of the women, 14.5%, 23.9% had tertiary, secondary and primary education respectively, while 7.2% had no education. This indicates that majority of the women interviewed were educated in one way or another. Education can help the women to understanding the technicalities involved in the use of some technologies (like the use of moringa bio-gel as an alternative

cooking fuel) introduced to them. Some of the women interviewed (46.2%) were employed into either Federal, State or local government services where they get their monthly income while 49% were entrepreneurs involved in one business type or another. A little above half (55.7 %) of the women are from urban areas, 36.1% were from the rural areas and 8.2% were from peri-urban areas. This is a pointer to the fact that literacy level is expected to be higher in the urban and peri-urban areas than in the rural areas. This categorization of rural, peri-urban and urban areas is based on the density of population, social amenities, development, education and employment opportunities available in these areas. About sixty seven percent (66.8 %) of the women had between 4-9 persons as household size with a mean of 6 persons per household. This means that there will be more mouth to feed and more cooking energy (moringa bio-fuel) will be needed to prepare meals for these ones.

#### ***Major cooking fuel and the amount spent on by women***

Table 2 show the result of major cooking fuel and the amount spent on it per month. The women (69.7 %) indicated that Liquefied Petroleum (LP) gas was the major cooking fuel used, this may be expected because majority of the women live in the urban and peri-urban areas where LP gas is one of the majorly available source of energy (according to response from the women). Also, majority of the women were educated and understands the benefits and advantage of using LP gas. Less than 12 % of the women use firewood, 7.7 %, use charcoal, and 8.2 % use kerosene. The choice of firewood and charcoal as a source of cooking energy by these women is due primarily to their financial capability, unaffordability of LP gas but have access to firewood and charcoal as alternative sources. On the average, the women spend N3,500.00 per month on cooking fuel. The amount spent on energy for cooking will depend on the economic status of the women and their household size. It can be asserted that the larger the size of the household the more the energy that will be expended on cooking and other alternative uses.

#### ***Willingness to pay for moringa bio-gel as an alternative cooking energy source***

Figure 1 show that 65.9% of the women interviewed were willing to pay for moringa bio-gel as an alternative cooking energy source. The reason adduced to this is that the women have been trained on the use of this energy source and a sample of moringa bio-gel was given to them to serve as test-case. The respondents have experienced its use and benefits and 5.7% were not ready to pay because according to them, they cannot afford to pay for the fuel. Of the respondents interviewed, 28.4% were under “maybe” which means if they can afford it but if they are financially capable they will be willing to pay for the fuel. Therefore one can deduce that willingness to pay for moringa bio-gel will be relatively related to financial capability, availability and accessibility to the fuel.

#### ***Benefits of using clean/green energy for cooking among women***

Table 3 shows the result of benefits of the use of clean/green energy for cooking among women. Out of the 100% of the women interviewed 86.5% responded that clean/green energy is easy to use, 40.4% submitted that it is not harmful, 29.3 % opined that it helps to sustain the environment while only 10.1 % agreed that it is affordable. Rosenthal *et al.* (2018) reported that the health of women using clean/green energy is likely to improve and that studies in Nigeria show that the use of clean fuel achieved significant reduction in blood pressure among pregnant women (Alexander *et al.*, 2017). Majority of the women interviewed cannot afford to pay for moringa bio gel because according to them it is expensive and is beyond their reach. According to the World Bank (2015), one of the biggest problems facing the use of biogas/green energy is low patronage because of overdependence on traditional fuel sources. Wood and charcoal for instance come at a little or no financial cost and are often the fuel of choice for those who live below the poverty line especially in the rural areas.

#### ***Factors to consider when selecting choice of clean/green energy***

Table 4 shows the result of factors to consider when selecting choice of clean/green energy. The women interviewed submitted that the impact of the green energy on their health is the 1<sup>st</sup> to be considered followed by ease of use, accessibility to the energy (green) and the impact of the energy source on the environment are also to be considered as these factors ranked 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> in the level of ranking. Efficiency of the green energy source, its cost and its appearance are also factors to be considered as they ranked 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> in the level of ranking. The aforementioned factors can affect consumers (women's) willingness to pay and adopt the use of green energy either positively or negatively. The women's first consideration is the health impact of the technology (moringa bio-gel for cooking), if it will not negatively affect their health and the ease of use of the fuel over fossil fuel. Accessibility to the fuel is another important factor that the women also considered before the adoption and continued use of the fuel. If the fuel is not accessible or if it is not within their reach in terms of cost of the fuel, the women will not be willing to pay and also will not adopt the use of the fuel. Although appearance of the product was the last factor that can affect the choice of selecting green energy, it also important especially to the producers of such product so as to make it attractive to the consumers of the product.

#### ***Constraints in the use of moringa bio-gel as an alternative cooking energy source***

Table 5 show the result on constraints in the use of moringa bio-gel as an alternative cooking energy source. Affordability of the product ranked 1<sup>st</sup> as a major constraint in the use of moringa bio-gel for cooking. The cost of a technology is a major determinant of its adoption, therefore, if the moringa bio-gel is too expensive, the women will not adopt it. SEforALL and CPI 2019 estimated that USD 4 billion in annual

investment is needed to achieve the Sustainable Development Goal (SDG) number 7 which is “universal access to clean fuels and technology for cooking by the year 2030”. Convenience of use, accessibility, ease of use and packaging of the product ranked 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> respectively. According to WHO (2020), around 3 billion people worldwide have no access to clean fuels or technologies of cooking, relying instead on burning biomass or solid fuels. The consequences therefore include deforestation, black carbon emissions and wide spread human exposure to harmful air pollution which is injurious to human health.

#### **Relationship between selected socio-economic characteristics and women's willingness to pay for green energy**

The result in Table 6 shows the relationship between selected personal characteristics and women's willingness to pay for moringa bio-gel as alternative cooking fuel. Educational level was significant (B= 0.194, P=0.003) at 0.05 % level of significance. This indicates that for every one additional year spent in school, willingness to pay for moringa bio-gel will increase by 0.194. Settlement type was also significant (B = 0.210, P = 0.043) and this shows that for every settlement in the urban areas, willingness to pay for moringa bio-gel will increase by 0.210. It can be deduced that education and settlement type have influence on willingness to pay for moringa bio-gel than other variables considered in this project. Also, major cooking fuel used by women was significant at 10% (B=0.124, P= 0.064). This shows that some selected personal characteristics will influence the choice of major cooking fuel.

#### **Conclusion**

The study concluded that almost all the women interviewed were educated and were, employed in one way or the other, live in the urban, peri-urban and rural areas. Majority of the women use LP gas for cooking and are willing to pay for moringa bio-gel if it is made affordable, available and within the reach of the women. The women also claimed that the gas is beneficial in that it has no negative impact on health and sustains the environment. However, high cost of moringa bio-gel will prevent its adoption and use.

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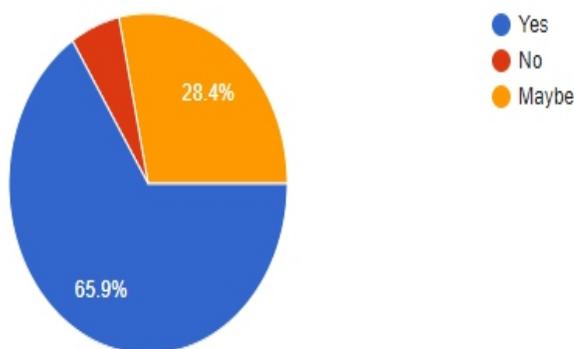
**Table 1: Personal characteristics of women** n=208

Variables	Percentage	Mean
<b>Age (years)</b>		
< 25	10.1	36.7
26-35	31.3	
36-45	29.3	
46-55	22.1	
> 55	7.2	
<b>Educational level</b>		
No formal education	8.2	
Primary school	23.9	
Secondary education	9.1	
Tertiary education	53.4	
<b>Occupation</b>		
Student	3.4	
Unemployed	1.4	
Employed	46.2	
Entrepreneur	49.0	
<b>Settlement type</b>		
Urban	55.8	
Peri-urban	8.2	
Rural	36.1	
<b>Household size</b>		
1-3	29.3	5 persons
4-6	60.1	
7-9	6.7	
>9	3.8	

Source: Field Survey, 2020

**Table 2: Major cooking fuel and amount spent on it by women** n=208

Parameters	Percentage	Mean
<b>Primary cooking fuel</b>		
LP gas	69.7	
Kerosene	8.2	
Charcoal	7.7	
Firewood	12.0	
Electric stove	2.4	
<b>Alternative source of cooking fuel</b>		
Ethanol	2.4	
Solar	12.0	
Biogas	2.9	
Coal	36.1	
Firewood	17.3	
Kerosene	29.3	
<b>Amount spent on cooking fuels/month(₦)</b>		
< 1000	11.5	₦3,500.00
1000 – 3000	41.9	
3001-5000	40.9	
> 5001	5.7	



**Figure 1: Respondents willingness to pay for clean/green energy source**

**Table 3: Benefit of clean/green energy** n=208

Benefits of clean green energy	*Frequency	percentage
Environ sustainability	122	29.3
Health benefits	168	40.4
Affordability	41	10.1
Not sure	82	20.2
Ease of use	180	64.3

Source: Field Survey, 2020. \*Multiple responses

**Table 4: Factors that can affect the selection of choice of clean/green energy**

Parameters	VI	I	U	LI	NI	Weighted Average	Rank
Health impact	105 (50.5)	23 (11.1)	7 (3.4)	5 (2.4)	13 (6.3)	0.69	1st
Ease of use	104 (50.0)	20 (9.6)	8 (3.8)	6 (2.9)	15 (7.2)	0.68	2nd
Accessibility to product	95 (45.7)	27 (13.0)	13 (6.3)	2 (1.0)	16 (7.6)	0.62	3rd
Environmental impact	95 (45.7)	29 (13.9)	13 (6.3)	6 (2.9)	10 (4.8)	0.62	4th
Efficiency of product	97 (46.6)	24 (11.4)	13 (6.3)	7 (3.4)	13 (6.3)	0.60	5th
Cost of product	86 (41.3)	25 (12.0)	24 (11.5)	8 (3.8)	10 (4.8)	0.56	6th
Appearance/ packaging of product	37 (17.8)	60 (28.8)	29 (13.9)	14 (6.7)	13 (6.3)	0.24	7th

Source: Field survey, 2020. \*Percentages are in parentheses

Key: VI = Very important, I = Important, U = Undecided, LI = little importance, NI = Not Important

**Table 5: Constraints in the use of moringa bio-gel as cooking energy source**

Parameters	Critical	High	Moderate	Rank
Affordability	120 (57.7)	30 (14.4)	12 (5.8)	1st
Convenience	126 (60.6)	12 (5.8)	10 (4.8)	2nd
Accessibility	21 (10.1)	42 (20.2)	10 (4.8)	3rd
Ease of use	21 (10.1)	8 (3.8)	1 (0.5)	4th
Packaging	3 (1.4)	6 (2.9)	1 (0.5)	5th

Source: Field survey, 2020. \*Percentages are in parentheses

**Table 6: Relationship between selected socio-economic characteristics and women's willingness to pay for green energy**

<b>Variable</b>	<b>B</b>	<b>B-coefficient</b>	<b>t-stat</b>	<b>Significance</b>
Educational level	0.194	0.232	3.021	0.003*
Age group	0.042	0.052	0.789	0.431
Household size	-0.075	-0.059	-0.833	0.406
Major cooking fuel	0.124	0.152	1.861	0.064**
Average amount spent	0.015	0.24	0.319	0.750
Settlement type	0.210	0.150	2.035	0.043*

*Source: Field Survey, 2020. \*Significant at 0.05%, \*\*Significant at 10%*