Households' Willingness to Pay for Biofuel Gel in Lagos State, Nigeria: A Contingent Valuation Study

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Authors' contributions

This work was carried out in collaboration between both authors. Author DAO conducted the field work, performed the statistical analysis, managed the literature search, wrote the protocol and wrote the first draft of the manuscript. Author OAT managed the analyses of the study. Both authors designed the study, read and approved the final manuscript.

Original Research Article

ABSTRACT

The study was carried out to determine the willingness to pay (WTP) for Biofuel gel among households in Lagos State, Nigeria. A total of one hundred and seventy-five households using multiple sampling procedure were interviewed using a well-structured questionnaire. Data were analysed using descriptive statistics and Logit regression model. The study showed that the mean willingness to pay for Biofuel gel was ₦280 (US $0.78) per litre. The study further revealed that there was significant relationship between the socio-economic characteristics of the households and their willingness to pay for biofuel gel. Variables such as bid amount and household income had significant effect on the willingness to pay for biofuel at 1%. Bid amount had a negative coefficient of -0.0233655 on willingness to pay for biofuel gel. The study therefore recommends that price policies can be implemented in the form of price subsidies to foster the consumption of biofuel gel (clean fuels) in the study area, as respondents are more sensitive when it comes to their wallets and had identified high cost of the product as a major constraint for not consuming biofuel gel.

Keywords: Households; biofuel gel; willingness to pay; Logit; consumption; Nigeria.

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1. INTRODUCTION

Alternative fuels are needed more than ever in today's world and the study of biofuel is very timely because conventional fuels and fossil fuels reserves are gradually depleting; however, as the global population and energy demand continues to grow [1], they depend on these fuels [2]. According to [3], using more of biofuels as an alternative source is important because scientists estimate that non-renewable fossil fuels will be exhausted from the world within the next century. For this reason, the Nigerian government and the world are pursuing alternative for sources of fuel to lessen the dependency on conventional fuels. One attractive alternative source of fuel is biofuel [4]. Although the cost of producing biofuel are generally higher compared to fossil fuels production [5,6]; poor infrastructure, weak national agricultural research systems, high import costs on equipment and inputs, and an often-unfavourable business environment makes it more challenging in the developing world [7].

Therefore, production will be required in an industrial-scale, and cost reductions are still needed for cost competition in order for biofuel to be a viable alternative source of fuel [8]. Nigeria has the capacity to be a leading exporter of biofuels [9,10]. However, little has been done by the Nigerian government to promote the development and the use of agro-energy in that they are yet to adequately satisfy the preconditions for such program to be successful [10]. This has led to low level of biofuel production activities in Nigeria despite promising features and the existence of the Nigerian Biofuel Policy and Incentives (NBPI) [11]. These policies and incentives are efforts to reduce greenhouse gas emissions, enhance local livelihoods within the production chains, serves as socio-economic driver and expand the nation's renewable fuel sector while reducing its reliance on fossil fuel [10,12]. In other for biofuel project to be achievable and successful, sufficient information and planning is required to actualize its benefits. It is necessary to know how households' value and support renewable energy source in this case biofuel gel and their Willingness To Pay (WTP) a reasonable price for it is a relevant issue [13].

1.1 Objectives of the Study

The broad objective of this study was to determine household's willingness to pay for biofuel gel in Lagos State, Nigeria.

The specific objectives are to:

i. Describe the socio-economic characteristics of the households.
ii. Determine price household are willing to pay for Biofuel gel
iii. Determine the factors influencing households WTP for biofuel gel.

1.2 Hypothesis of the Study

The hypothesis of the study was stated in the null form as follows:

Ho: There was no significant relationship between socioeconomic factors and willingness to pay for biofuel gel in the study area.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Lagos State, Nigeria. Lagos State is Located in the South-west Nigeria. The State lies on the geographical coordinates of 6°35'N, 3°45'E, the State is bounded in the North and East by Ogun State. In the west it shares boundaries with the Republic of Benin, and stretches over 180 kilometers along the Coast of the Atlantic Ocean in the South [14]. There are 20 Local Government Areas (LGAs) in Lagos State. The state has a population of about 9,113,605 according to National Housing Census exercise conducted in 2006 and land area of 3,577km^2 [14]. However, according to Lagos State Government the population of Lagos state resident is approximately 16 million as at 2015 and according to projections will hit the 30 million by 2025. As described by administrative division, Nigerian congress, Lagos State is arguably the most economically important state of the country; it is the nation's largest urban area. For decades Lagos has been the epicentre of Nigeria's economic and social development and continues to be, it is a major financial centre and would be the fifth largest economy in Africa, if it were a country [15].

2.2 Goods to be Valued

The object to be valued in this study is a cooking gel (biofuel gel) over a conventional kerosene. More specifically, we assess the consumers' WTP for biofuel gel over a conventional kerosene. If the following four conditions are satisfied. First, a biofuel gel should produce no

fume which could affect the health of the respondents. Second, during the course of cooking, it must not dirty cooking gadgets. Third, the gel must produce high heat intensity when cooking and lastly, it must be easy to light up.

2.3 Method for Measuring WTP for Biofuel Gel: The CV Approach

The WTP for biofuel gel should be understood as a case of a non-market good including environmental goods. The household's WTP for a non-market good constitutes the underpinning rule for the benefits of the associated policy [16], and can be gauged using certain preference techniques, a representative one of which is the CV technique. [17] concluded that the CV method is able to generate credible information that can be applied in relation to decisions regarding administration and jurisdiction. The CV approach is likely to be in accordance with the general notion of microeconomics [18].

2.4 Data Collection and Sampling Methods

A multi-stage sampling procedure was used in the selection of respondents. The first stage involved the purposive selection of three (3) out of the twenty Local Government Areas (LGAs) in Lagos State noted for bio-fuel gel production. In the second stage, a random selection of three (3) communities from each of the Local Government Areas was done. The third stage involved the purposive selection of ten (10) bio-fuel gel users by snowball technique and random selection of ten (10) non-user households from each of the community. This leads to a total of 180 respondents divided into 90 bio-fuel gel users and 90 non-users gel users. However, 175 questionnaires returned valid 90 non-users and 85 bio-fuel gel users.

2.4.1 Payment vehicle designing (Designing Bid Amount)

In this study, the design of hypothetical prices (bids) is based on questionnaire pre-test survey of forty respondents who are randomly selected from each of the Local Government Area. The pre-test survey was an open-ended question of "how much are you willing to pay for a litre of biofuel gel? Expunging the outliers' bids, the average of the price they are willing to pay is determined, this forms the computational basis for the stated price/litre aforementioned. The data generated were used to develop the bid

vector (b_1.....b_n). In terms of the different structure of bid prices of 25% and 25% increment and decrement from the initial bid. The bid designs captured the WTP ranges quite well and elicited the respondents' WTP (yes or no) for biofuel gel.

2.5 Analytical Tools

Descriptive statistics were used to analyse the socio-economic data. Contingent Valuation Method (CVM) was used to determine the total willingness to pay of the respondents for biofuel gel. The maximum likelihood estimation of the Logit regression coefficient was used to determine the mean willingness to pay. The Logit model was equally used to determine the factors influencing the households' WTP.

The Log it regression model was stated thus

$$Li = Log\frac{Pi}{1-Pi} = \frac{1}{1+exp-(\beta0+\beta1X1)} \qquad (1)$$

Pi = Respondents probability of acceptance to the bid offered
βo = Constant/ Intercept
βi = Coefficients to be estimated
$1-Pi$ = Respondents probability of non-acceptance to the bid offered
Xi = Set of independent variables

$$Li = \frac{1}{1+exp-(\beta0+\beta1X1+\beta2X2+\beta3X3+\cdots\beta11X11)} \qquad (2)$$

X_1 = Bid amount (₦)
X_2 = Sex of the respondent (male = 1, female = 0)
X_3 = Age of respondent (years)
X_4 = Years of Biofuel gel Consumption (years)
X_5 = Household size (number of persons)
X_6 = Year of Formal Education (years)
X_7 = Marital Status (married = 1, 0 otherwise)
X_8 = Estimated Annual income (₦)
X_9 = Awareness of the product (Aware= 1, Otherwise = 0)
X_{10} = Main Occupation of consumer (Government Staff = 0, Private Staff = 1, Self Employed = 3)
X_{11} = Knowledge on renewable energy (1 = Yes, No idea = 0)
X_{12} = Development of renewable energy (1 = Yes, No = 0)
X_{13} = Familiarity with Climate Change (1 = Yes, No idea = 0)
μ = Error term.

Li is a proxy for WTP. It represents the dependent variable which is a dummy of the binary choice Logit model adopted to determine

the factors influencing households WTP for biofuel gel. It is defined as "1" if respondents accept bids elicited and "0" if not. X_1 represents the bids elicited in the dichotomous choice contingency valuation method (DC-CVM) survey. This is the variable price (shadow price), X_2 is the variable for the sex of the respondents. Where the respondent is male, the dummy takes the value of "1" and when female, it takes the value of "0". The age of the consumers (X_3), X_4 shows the number of year respondents have been using biofuel gel. X_5 is a variable for the household size, indicates the number of people available per household by the respondents in the study area. The year of education (X_6) shows the numbers of years a respondent spent in a formal institutional setting, X_7 reveals the marital status of the respondents, where the respondent is married "1" and "0" otherwise. X_8 variable indicates the respondents estimated annual income in Naira while the awareness of the product (X_9) is a dummy. Where the respondents stated they are aware, the dummy takes the value "1" and if not "0". (X_{10}) variable shows the main occupation of the respondents. Where Government staff takes the value of "1", Private staff takes the value of "2" and self-employed takes the value "3". X_{11} is the knowledge on renewable energy. Where respondent with the knowledge takes "1" and respondent with no idea takes "0". Development of renewable energy (X_{12}) is a dummy. Where the respondents stated they supported the development of renewable energy, the dummy takes the value of "1" and when otherwise, it takes the value of "0" while X_{13} represent respondent's familiarity with greenhouse gas. Where respondent who are familiar takes "1" and respondent with no idea takes "0".

The unrestricted mean WTP (P+) according to (Cooper and Loomis, 1992) was calculated from the coefficient derived by the model as follows:

$$P^+ = \frac{a}{|\beta|} \qquad (3)$$

This has the possibility of producing the undesirable negative WTP, the restricted WTP (P+) adopted for this study was shown as

$$P^+ = \frac{1}{|\beta| * \text{In}(1 + exp^{bo})} \qquad (4)$$

Where, bo = intercept, β = coefficient of the bid Total WTP = Mean WTP * Total population of respondents.

3. RESULTS AND DISCUSSION

3.1 Descriptive Statistics of the Survey

3.1.1 Descriptive statistics of the household's willingness to pay for biofuel gel

Table 1 presents the socioeconomic characteristics of the respondents. The Table revealed that 40.0% of the bio-fuel gel users were between 41 and 50 years while 47.9% of the non-users were between 51 and 60 years. The mean age of bio-fuel gel users was 43.5years and that of the non-users was 46.6 years. Sex distribution of the respondents shows that 42.4% of the bio-fuel gel users were male and 57.6% of them were female, while 55.6% of the non-users were male and 44.4% of them were female. Majority (80.0%) of the bio-fuel gel users and 73.4% of non-users were married while the remaining 20% of bio-fuel gel users and 26.6% for non-users are either single, divorced or widow. Most respondents of both bio-fuel gel user and non-users (bio-fuel gel users, 87.1% and non-users, 64.4%) have spent above 10 years studying in a formal educational institution. The mean years of schooling are 15.5 years and 13.5 years for both bio-fuel gel users and non-users respectively. This implies that the majority of the respondents had formal education. This may be attributed to the fact that the study was carried out in the urban populace where majority of the populace were highly educated or in higher learning and these set of people were also willing to respond to the research upon administering questionnaires. Education has always played a huge role in determine the preference for technology and consequently the welfare of the people [19].

It is expected that education would provide people with opportunities to access information and understand the benefits of renewable fuel such as bio-fuel gel. This corroborates the fact that high level of education will raise the preference of the benefit that renewable energy inherits [20,21]. Most (77.6%) bio-fuel gel users and 52.2% of non-users had household size less than 5. The mean household size for users of bio-fuel gel was 4 persons per house while that of the non-user was 6 persons per house suggesting an urban moderate family size [19]. From the Table 1, 43.5% of the bio-fuel gel users earned between ₦201,000 and ₦300,000 monthly while majority 38.9% of the non-users earned between ₦101,000 and 200,000. The mean monthly estimated income for all

investigated users of bio-fuel gel was ₦253,811.76 while that of the non-users was ₦159,356.40. This implies that the bio-fuel gel users earn more than non-users, which may imply that they have the financial endowments to afford bio-fuel gel.

Table 1. Socioeconomic characteristics of respondents

Variables	Biofuel users		Non-biofuel users	
Age (Years)	**Frequency**	**Rel. Freq.**	**Frequency**	**Rel. Freq.**
Less than 20	-	-	-	-
21-30	5	5.9	13	14.4
31-40	29	34.1	20	22.2
41-50	34	40.0	13	14.4
51-60	12	14.1	43	47.9
Above 60	5	5.9	1	1.1
Total	**85**	**100.0**	**90**	**100.0**
Sex	**Freq.**	**Rel. Freq.**	**Freq.**	**Rel. Freq.**
Male	36	42.4	50	55.6
Female	49	57.6	40	44.4
Total	**85**	**100.0**	**90**	**100.0**
Marital status	**Freq.**	**Rel. Freq.**	**Freq.**	**Rel. Freq.**
Single	10	11.8	17	18.9
Divorced	3	3.5	4	4.4
Widow	4	4.7	3	3.3
Married	68	80.0	66	73.4
Total	**85**	**100.0**	**90**	**100.0**
Years of formal education	**Freq.**	**Rel. Freq.**	**Freq.**	**Rel. Freq.**
1-5	-	-	8	8.9
6-10	11	12.9	24	26.7
>10	74	87.1	58	64.4
Total	**85**	**100.0**	**90**	**100.0**
Household size	**Freq.**	**Rel. Freq.**	**Freq.**	**Rel. Freq.**
Less than 5	66	77.6	47	52.2
5-10	19	22.4	43	47.8
Total	**85**	**100.0**	**90**	**100.0**
Estimated monthly income (₦)	**Freq.**	**Rel. Freq.**	**Freq.**	**Rel. Freq.**
<100,000	4	4.7	30	33.3
101,00-200,000	13	15.3	35	38.9
201,000-300,000	37	43.5	17	18.9
301,000-400,000	23	27.1	7	7.8
401,000-500,000	8	9.4	1	1.1
>500,000	-	-	-	-
Total	**85**	**100.0**	**90**	**100.0**
Main occupation	**Freq.**	**Rel. Freq.**	**Freq.**	**Rel. Freq.**
Government	29	34.1	34	37.8
Private Staff	30	35.3	32	35.6
Self-Employed	26	30.6	24	26.7
Total	**85**	**100.0**	**90**	**100.0**
Are you familiar with green house gas?	**Freq.**	**Rel. Freq.**	**Freq.**	**Rel. Freq.**
No idea	9	10.6	48	53.3
Heard about it	34	40.0	34	37.8
Know about it	42	49.4	8	8.9
Total	**85**	**100.0**	**90**	**100.0**

Source: Computed from Field Survey Data, 2018

Table 2. Knowledge on renewable energy

Questions	Category	Freq.	Rel. Freq.	Freq.	Rel. Freq.
Knowledge of renewable energy	Yes	83	97.6	62	68.9
	No	2	2.4	28	31.1
	Total	**85**	**100.0**	**90**	**100.0**
Development of renewable energy	Supportive	85	100.0	79	87.8
	Against	-	-	11	12.2
	Total	**85**	**100.0**	**90**	**100.0**

Source: Computed from Field Survey Data, 2018

Table 3. Number of years of using biofuel gel

Years of consumption of biofuel	Freq.	Rel. Freq.
Less than 3	30	35.3
3-5	55	64.7
Total	**85**	**100.0**

Source: Computed from Field Survey Data, 2018

Table 4. Awareness of biofuel gel

Awareness of the product	Freq.	Rel. Freq.
Aware	113	64.6
Not Aware	62	35.4
Total	**175**	**100**

Source: Computed from Field Survey Data, 2018

3.1.2 Total value of biofuel gel

The total value for biofuel gel by the households was obtained by calculating the restricted mean willingness to pay. In order to examine the household acceptability of Biofuel gel in monetary terms, we estimated the mean WTP for biofuel gel.

3.1.3 Restricted means WTP computation

The restricted mean WTP is given as $P+ = 1/ |\beta| * \ln (1+ \exp^{bo})$

$1/0.0233655 * \ln (1+ \exp^{6.552772}) = ₦280.51$
$42.79814256 * \ln (702.1851676) = 42.79814256 * 6.554197141 = ₦280.51$

The mean willingness to pay for biofuel gel per respondent was ₦280.51 per litre.

The currency rate of Naira versus US Dollars as at 24th July, 2019 was ₦360 to a dollar. Therefore, the mean willingness to pay for biofuel per respondent was ₦280.51 per litre, equivalent to US$0.78.

3.1.4 Factors influencing respondents' WTP for biofuel gel

The factors influencing respondents' WTP for biofuel gel is presented in Table 3 were analysed by using logistic regression model. The Table revealed seven variables that significantly determine the consumer's willingness to pay for biofuel gel in the study area, which are; bid amount, household size, years of education, marital status, income and awareness and knowledge on renewable energy.

The bid amount poses a significant negative relationship on the respondents' willingness to pay for biofuel gel. This implies that as bid amount increases by one unit, the respondents' willingness to pay also decreases by -0.02337. The bid amount was significant at 1% level of significance which implies that the bid amount highly affects the decision of the respondents in the study area. This is in line with assertions by [22] and [23] in that the negative sign indicates that as the bid amount increases, the respondents would be less likely to pay. This implies that a higher bid amount induces a lower likelihood of saying yes to an offered bid.

Household size of respondents had a negative coefficient of -8.88509 and it is statistically significant at 5%. This means a unit increase in the household size will reduce their WTP for biofuel gel in the study area. This is because more individuals would be competing for the few

available resources, incomes are measured by dividing income by a scale increasing in household size. This is in line with the assertations by [24] and [25] who all find evidence of negative association of household size with per capita energy consumption.

Years of education were statistically significant at 5% probability level with a positive coefficient. A unit increase in the years of education of a respondent tends to increase the willingness to pay for biofuel gel by 1.70358. This implies that increase in the years of education had a positive influence on the willingness to pay for biofuel gel by the respondents in the study area. Likewise, more education generally implies higher income. It may thus be that the estimated education effect is just an ill observed income effect, which is consistent with typical rankings of fuels according to necessities and luxuries [26].

With respect to income, the coefficient of 0.0000248 implies that one unit increase in household income would increase the likelihood of paying more for biofuel gel, meaning that income is a major determinant of biofuel gel consumption among household in the study area. The result further revealed that income is significant at 1% and had a positive relationship in influencing household decision to consume biofuel gel. This implies that as households' disposable income increases, more money may

be available for the purchase and consumption of biofuel gel. Numerous studies [27,28,29,30, 31,32] point to income as the major driver behind the uptake of modern fuels. When incomes increase respondents are more likely to opt for biofuel gel.

Respondents awareness of biofuel product increase their willingness to pay for the product. The result indicate that awareness was statistically significant and had a positive relationship with the respondents' willingness to pay for biofuel gel. With the coefficient of 2.206199, which implies that increase in the awareness of the environmental benefit of the product will have a positive influence on the households' willingness to pay for the product. This is in line with the findings by [33] who concluded that increasing consumer awareness about biofuel would provide a double benefit, as increased knowledge on biofuel and knowledge of the positive characteristics of biofuel would both increase WTP. The loglikelihood ratio (LR) statistics exhibited appropriate signs and was significant at 1% probability level, meaning that the explanatory variables included in the model explained the probability of WTP of the respondents and thus the null hypothesis which says there was no significant relationship between socioeconomic factors and willingness to pay for biofuel gel in the study area was thereby rejected.

Table 5. Factors influencing respondents' WTP for biofuel gel

Variables	Coefficient	Std. error	P>/Z/	Z values
Bid Amount	-0.0233655	0.0054457	0.000***	-4.29
Gender	-0.15538898	0.852499	0.855	-0.18
Age	-0.0462302	0.050856	0.363	-0.90
Years of Biofuel consumption	-0.5050794	0.3641154	0.165	-1.39
Household size	-8.885087	5.146096	0.084*	-1.73
Year of Education	1.703575	1.021332	0.095*	1.65
Marital Status	-3.28556	3.86141	0.395	-1.54
Income	0.0000248	7.78e-06	0.001***	3.18
Awareness	2.206199	1.190802	0.064*	1.85
Occupation	-0.1032114	0.5360884	0.847	-0.19
Knowledge of renewable energy	-2.448717	1.313505	0.062*	-1.86
Development of renewable energy	0.4326812	0.421008	0.304	1.03
Familiarity with GHG	-0.0287694	0.8292343	0.972	-0.03
Constant	6.552772	5.899465	0.267	1.11
Number of Observation		175		
Log likelihood		-23.64017		
Prob > chi2		0.0000		
LR chi2(13)		55.10		
Pseudo R2		0.5382		

Source: Computed from Field Survey Data, 2018
***Significant at 1%, **Significant at 5%, *Significant at 10%

4. CONCLUSION AND RECOMMENDA-TION

The study tried to determine household's WTP for biofuel gel in Lagos State, Nigeria using a CV approach. The CV survey was successful in eliciting the WTP value from the households. We found that the mean WTP for biofuel gel per litre was estimated to be ₦280.51 ($0.78). The study further reveals that bid amount, household size, year of education, income, awareness of the product and knowledge on renewable energy are important determinants influencing household's willingness to pay for biofuel gel in the study area.

Our findings can be utilized in deciding the proper levels for the economic incentives on biofuel gel consumption to enable easy transition from conventional (dirty) fuel to biofuel gel. This is necessary so as to align with the WHO recommendations and global trends in meeting the Sustainable Development Goals / Seven (SDG 7) that aims to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030 [34].

CONSENT

As per international standard written participant consent has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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