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Evaluation of Energy Utilization in Bread Bakeries located in Gboko Town, Benue State, Nigeria

Ekhuemelo D. O. and Nyiliam L. I.
Department of Forest Production and Products, Federal University of Agriculture Makurdi, (Now, Joseph Sarwuan Tarka University, Makurdi) Nigeria
ekhuemelo.david@uam.edu.ng

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Abstract
*This research investigated energy utilization in bread bakeries located in Gboko town, Benue State, Nigeria. Snowball sampling technique was used to identify bakeries. Google Form semi-structured questionnaire was purposively employed to interview one respondent from identified bread bakeries. Results show that 24 bread bakeries were located in 6 Council Wards in Gboko. Bakeries were found in Gboko Central, Gboko East and Gboko North (16.7%, 25%, 33% while others were 8.3% in Gboko South, Gboko West and Mkar, respectively. Respondents were mostly males (54 %) who were predominately Christians (91%) within the age of 50 years old. Education of respondents was 63% tertiary who were basically bread bakers (83%). Firewood (50%) was foremost one-use type of energy source utilized followed by gas (33.3%). Firewood and electricity (62.5%), firewood and gas (33.3%) and firewood and charcoal (4.2%) were two-use energy utilized. Firewood, charcoal and electricity (95.7%, highest) in three-use type of energy. Most preferred energy source was firewood (54.2%); gas (29%), electricity (12.5%) and charcoal (4.2%). Reasons for preferred energy use were: low-cost (45.8%), convenience (33.3%) and availability (20.8%). Main source of firewood was firewood marketers (73.3%). Challenges in accessing firewood were unavailability (60%), far distance covered to access firewood (20%) and high cost of purchase (20%). Highest estimated expenses made weekly on firewood was between ₦5,00 and ₦10,000. Respondents were not aware (50%) that the use of firewood causes deforestation, they were not sure (66.7%) they will replant tree and they however had preference (93.3%) for choice of firewood. Ranking of preferred firewood species by respondents were Prosopis africana (*93.3%) >*Viltellaria paradoxa* (46.7 %) >*Burkea africana* (40%) >*Daniellia oliveri and Parkia biglobosa (13.3%) while Khaya senegalensis and Magnifera indica were 6.7% respectively. Respondents had no strategies in place (73.3%) to sustain continuous used of firewood bakeries, rather they claim the will energy source (20%) from firewood to others.*

Keywords: *Energy, Bread Making, Firewood, Electricity, Gas*

Introduction

Bread is the product of baking a mixture of flour, water, salt, yeast and other ingredients. The basic process involves mixing of ingredients until the flour is converted into a stiff paste or dough followed by baking the dough into a loaf (Aiyelari, 2007). Bread, a product of wheat, is a highly nutritious food eaten in one form or another by nearly every person on earth. Bread, which is an excellent source of vitamins, protein and carbohydrates, has been an essential element of human diet for centuries in all regions (Apud *et al*., 2009).

Bread baking operations especially those involving the baking in the oven are accomplished by the use of thermal energy and the heat for baking is derived from different fuel sources. Fuels are materials consumed by burning to generate energy suitable for human needs (Rajput, 2001). The major sources of energy used for bread baking in Nigeria are firewood, gas and electricity, which at the moment are not only scarce but expensive (Chang, 2006). This is due to epileptic nature of electricity supply from the national grid on the one hand and shortage in supplies of petroleum products and the continuous disappearance of natural forest products on the other hand.

Energy is one of the major factors required in production industries (El-Adly *et al.*, 2015). Fadare (2003) reported that energy cost in most cases surpasses the costs of other factors of production such as raw material, labour, depreciation and maintenance. In manufacturing industry, planning of energy strategies and policies must be essential with regards to energy consumption (El-Adly *et al.*, 2015). In Nigeria, major sources of energy for manufacturing industries include electricity, fossil fuels, firewood, charcoal, coal among others. However, electricity and fossil fuels are either not readily available or they are very expensive to sustain production industries.

Several authors have worked on energy requirements production industry. Utilization pattern of human and fuel energy in tea plantation in India was studied by Baruah and Bhattacharya (1996) studied. Bamgboye and Kosemani (2015) assessed energy input in cassava production in Nigeria. Chang *et al.* (1996) carried out a research to develop an energy model and a computer simulation model that could assess the supplies of electricity, fuel and labour for rice handling, drying, storage, and milling processes of rice processing complex in Korea. The study to determine the efficiency and pattern of energy usage in some selected cashew nut and palm-kernel oil processing mills in Nigeria was carried out by Jekayinfa and Bamgboye (2007). Also, Jekayinfa (2007) reported work done on Energy analyses of operations in certain mechanized farms and poultry processing operations in Nigeria was conducted by Jekayinfa and Bamgboye (2007). Adekanye *et al.*, (2020) studied analysis of energy use in cassava production in North-Central Nigeria.

There is insufficient data on energy expenditure in the bread making industry in Nigeria. This study was therefore aimed at evaluating energy utilization in bread bakeries in Gboko town, Benue State, Nigeria

Materials and Methods

Area of Study

The study was conducted in Gboko Local Government Area (LGA) of Benue State with particular emphasis on Gboko Town. Gboko LGA is domiciled in Benue state, North-central geopolitical zone of Nigeria and has its headquarters in the Gboko Town. The LGA is bordered by Tarka LGA to the north, Konshisha LGA to the west, Ushongo LGA to the south, and Buruku to the East, with the LGA made up of several towns and villages such as Gboko North, Gboko East, Gboko West, Gboko South, Yandev, Mbatierev, Mbayion, Mbatiav, Ipav. Although the Tiv people are the majority in Gboko LGA of Benue State, we still have the mixture of Hausa, Igbo, Igede, Idoma, Etulo, Yoruba and so on. Gboko LGA of Benue State is located on latitude 7.3368° N and longitude 9.0018° E. Gboko LGA is one of the most populated area in Benue state with the total population of 358,936 (NPC, 2006).

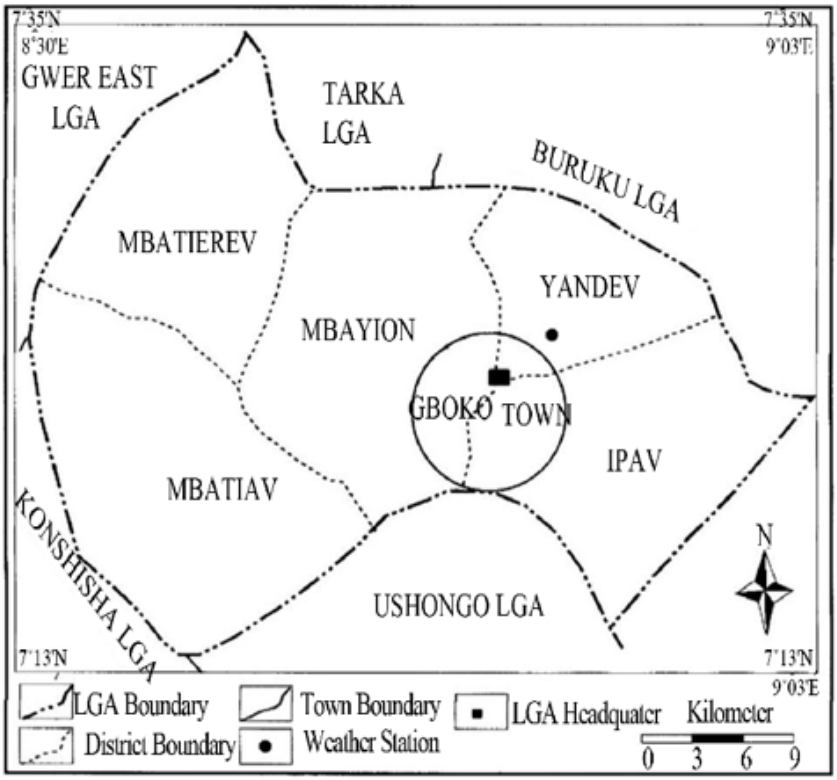

Plate 1: Map of Gboko Local Government Area showing some council wards

Experimental design

A snowball simple sampling technique was used to bread bakeries in Gboko. This was done by asking questions on location of any close by bakeries before getting to the bread factory within the study area. This also gives each individual independent chance of being selected. The identified bakeries were purposively chosen for administration of questionnaire.

Data Collection

A semi-structured Google Form questionnaire was used to interview respondents. The questionnaire was administered by the researcher to the respondents on a face to face basis. This procedure ensured that the questionnaire reach the correct desired number of respondents, as this had a tremendous positive effect on the retrieval process. The head and a staff from each bread bakery were interviewed each per bakery.

Instrument for data collection

The instrument for data collection was structured questionnaire which was administered to the respondents (owners and workers of bread factories/bakeries) by the researcher. The questionnaire was developed based on the objectives of the study. The questionnaire was structured into three sections: A, B and C. Section A was on Personal Data of Respondents, section B focused on the location of bread bakeries and section C addressed types of energy utilized in bread making industry in Gboko.

Data Analysis

The data collected is going to be presented in a tabulated form with focus on the major research questions in order to enable the researcher determine the results. Data collected were analyzed by the use table and charts.

RESULTS AND DISCUSSION

Table 1 shows the demographic characteristics of the respondents in bread bakeries in Gboko. The result shows that 54.2% were males while 45.8% were females. Main religion of respondents was Christianity (91.7%) while 8.3% were traditionalist. Their age distribution shows that the greater numbers of respondents were within the age range of 41 – 50 years (50%), 33% were between the ages of 31- 40 years and 16.7% were between 51 and above. Their level of education were primary leavers (4.2%), secondary school leavers (33.3%) while 62.5% had tertiary education. Occupation of respondents was mostly bread bakery (83.3%) followed by civil service job (16.7%). Majority of the respondents were married (79.2%).

There were more males than females in bread making business in Gboko. This may the attributed to the entrepreneurial nature of Tiv men in the study area. Generally, most men are enterprising and as bread winners in their families, they often engaged in different jobs to meet family needs. This was confirmed in the study where 79% of the respondents were married. There were more graduates involved the bread bakery in Gboko. This agrees with Ajekwe and Ibiamke (2017) who reported that Tiv business owners were mostly limited to modest formal education. They however observed that the trend was fast changing now as Tiv graduates were discovering opportunities to engage in entrepreneurship because of dynamics of economics in Nigeria. This suggests why up to 24 bread bakeries were identified within Gboko town alone.

Table 1: Demographic information of the respondents in bread bakeries in Gboko

Variables	**Respondents**	
	Frequency	**%**
Sex		
Male	13	54
Female	11	46
Total	**24**	**100**
Religion		
Christianity	22	91
Traditional	2	8
Total	**24**	**100**
Age		
Below 20	-	-
21 – 30	-	-
31 – 40	8	33
41 – 50	12	50
51 and Above	4	17
Total	**24**	**100**
Level of Education		
Primary	1	4
Secondary	8	33
Tertiary	5	63
No formal	-	-
Total	**24**	**100**
Occupation		
Farming	-	-
Civil Servant	4	16.7
Bread Baker	20	83.3
Total	**24**	**100**
Marital status		
Married	19	79.2
Single	5	20.8
Total	**24**	**100**

Table 2 revealed identified and categorized bakeries in 6 Council Wards in Gboko Town, providing insights into the distribution of bakeries across the different areas. A total of 24 bakeries were identified, with varying percentages distributed among the council wards. Gboko North had the highest number of bakeries, with a percentage of 33.3%, followed by Gboko East at 25% and Gboko Central with 16.7% bakries. Gboko South, Gboko West, and Mkar each had an 8.3% bakeries identified.

Table 2: Identified Bakeries in six Council Wards in Gboko Town

S/No	Name of Bakery	Number and percentage of Bakery F(%)	Council Ward
1.	Rahama Bakery		
2.	Erdy Bakery		
3.	Daily Delight Bakery		Gboko
4.	Delina Bakery	4(16.7)	Central
5.	Newlife Bakery		
6.	Freshy Bakery		
7.	Chichi Bakery		
8.	Tito Bakery		Gboko East
9.	LA Quixote Catering	6(25)	
10	St. Felix Bakery		
11	Becade Bakery		
12	Lymjil Bakery		
13	Kaafan Bakery		
14	Kravyns Confectionery & Bakery	8(33.3)	Gboko North
15	Kravyns Bakery		
16	Jescape Bakery		
17	Tikos Bakery		
18	Triune Bakery		
19	Harnarries Bakery	2(8.3)	Gboko South
20	Finechops Bakery		
21	Fidel Universal Buttered Loaf Sawa		
22	Chioma Bakery	2(8.3)	Gboko West
23	Notre Don Bakery		
24	Uni Mkar Bakery	2(8.3)	Mkar
	Total	**24(100)**	**6**

Figure 1 provides types of energy sources utilized in Gboko bakeries. The most prevalent energy combination is "Three-use: Firewood, charcoal & electricity," constituting a substantial 95.7% of the total energy mix utilization. Following closely is the "two-use: Firewood and electricity" category, contributing significantly to 62.5%. "Single-use: Firewood holds was the most preferred single use energy, accounting for 50.0% of the energy sources employed in these bakeries. Gas was noted as energy source and featured in both single-use (33.3%) and two-use (33.3%) scenarios. The three-use combination of "Firewood, electricity & gas" is employed in a smaller fraction of bakeries, representing 4.3% of the overall distribution. Less common but still present are "Two-use: Firewood & charcoal" and "Single-use: Charcoal," each contributing 4.2% to the energy mix. "Single-use: Electricity" rounds out the energy sources, representing 12.5% of the total energy

utilization in Gboko bakeries. This detailed breakdown provides insights into the diverse energy combinations adopted in Gboko bakeries.

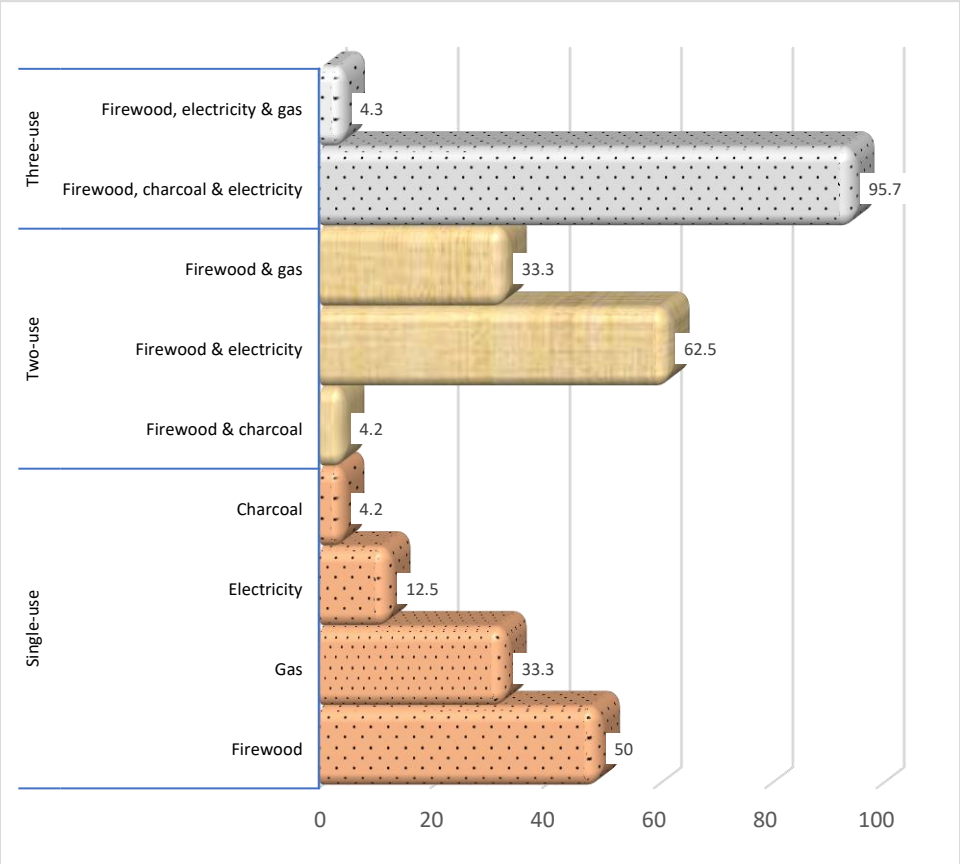

Figure 1: Types of energy sources used in Gboko bakeries

Figure 2 shows the most preferred type of energy sources in Gboko bakeries. Firewood was the most preferred (54.2%) followed by gas (29.1%), electricity (12.5%) and charcoal (4.2%). Reasons for firewood as the preferred energy source used in Gboko bakeries were that they convenient (33.3%), cheaper (45.8%) compared to other energy sources were readily available (20.8%).

Firewood was observed as the major energy source utilized in Gboko bread bakery. The reason may be to the fact that firewood energy is most abundant and renewable natural resources of this planet and particularly in Benue State. Gboko lies within Guinea savannah where many hardwood species are found. This finding agrees with Duvuna and Abur (2014) who reported that firewood was the major source of energy globally. Naibbi and Healey (2014) also reported that firewood used for cooking among households in the different States of Nigeria surpasses every other cooking fuel type. Firewood is the main fuel used in the rural areas of developing countries and

the continuous use of firewood for households and industries in Gboko could lead to deforestation and desertification.

Bread bakers in Gboko town preferred firewood as main source of energy because of its low cost and availability in comparison to petroleum products and electricity in the area which were readily unavailable and very expensive to break even in their business. Atela *et al.*, (2021), reported that while Nigeria is a foremost producer of crude oil, it is unable to refine petroleum products to meet local demands. As a result, households and some energy-based industries like bakeries resort to firewood and charcoal as sources of energy generation. Poor, irregular supply and high tariffs of electricity in Nigeria have also promoted the huge consumption of firewood and charcoal both for domestic and industrial uses (Bisu *et al.*, 2016). Baiyegunhi and Hassan (2014) reported that more than 80% of indigenous and urban dwellers in southern Africa, utilized firewood as a main or subordinate energy source. Firewood consumers source for firewood in woodlands and forests either for household and economic gains (Ibrahim *et al.*, 2021).

Figure 4 shows results of areas in Gboko bread bakeries where preferred energy was utilized. Results revealed that 45.8% of bakeries used their preferred energy for ovens in baking bread while it was mostly (54.2%) for oven and several purposes aside bread baking.

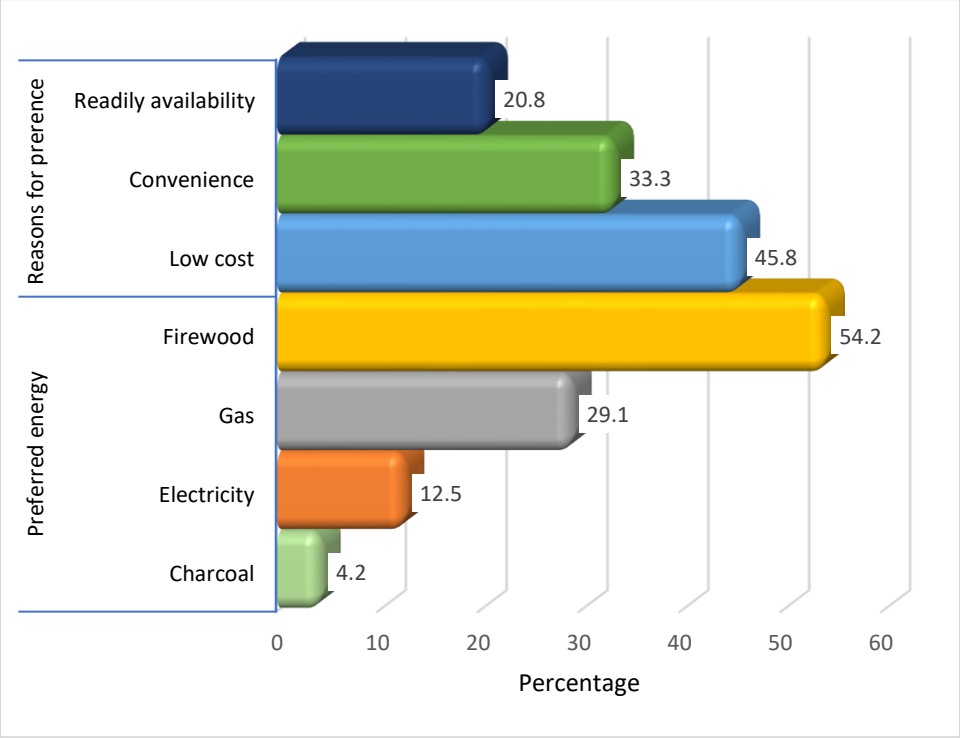

Figure 3: Most preferred type of energy used in Gboko bakeries and reasons for preference

Figure 4 shows where firewood was accessed by respondents. The results showed that they assess firewood from mostly from wood marketers (73.3%), wild or natural forest (8.5%), and Market (26.7%). Challenges faced by bakeries in Gboko in accessing firewood energy were far distance covered (26%) to source the product, unavailability (60%) and high cost (20%) (Figure 5).

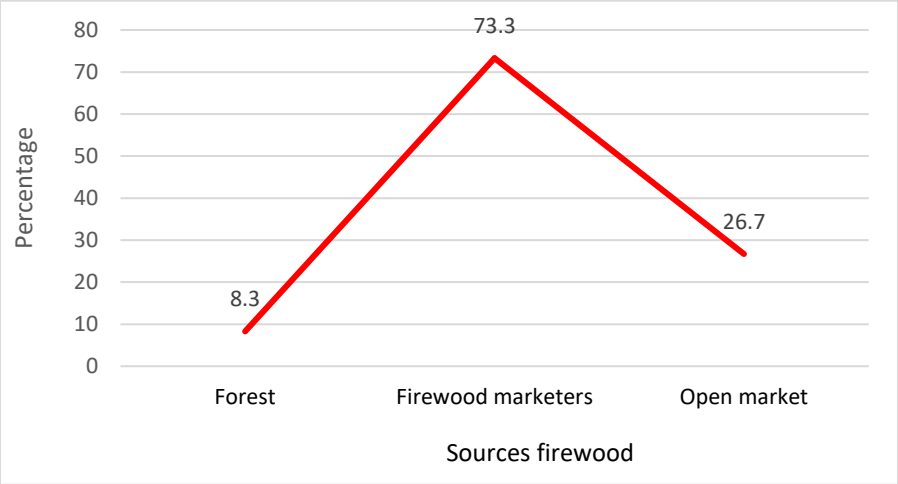

Figure 4: Places where firewood energy is sourced

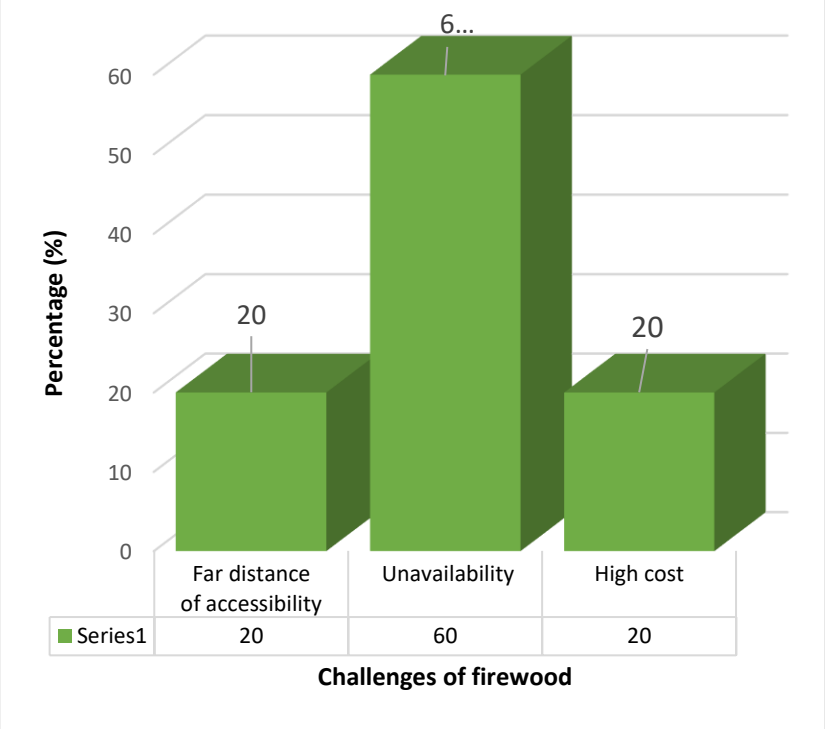

Figure 5: Challenges faced by respondents in accessing firewood energy source

Figure 6 shows the results for estimated weekly cost of purchasing firewood by respondents in Gboko bread bakeries. The highest amount spent weekly by respondents on firewood was between ₦5,000 and ₦10,000 (41.7%). This was followed by ₦ 11,000 and ₦ 15,000 (20.8%). Only 8.3%. respondents spent above ₦30,000 weeklies.

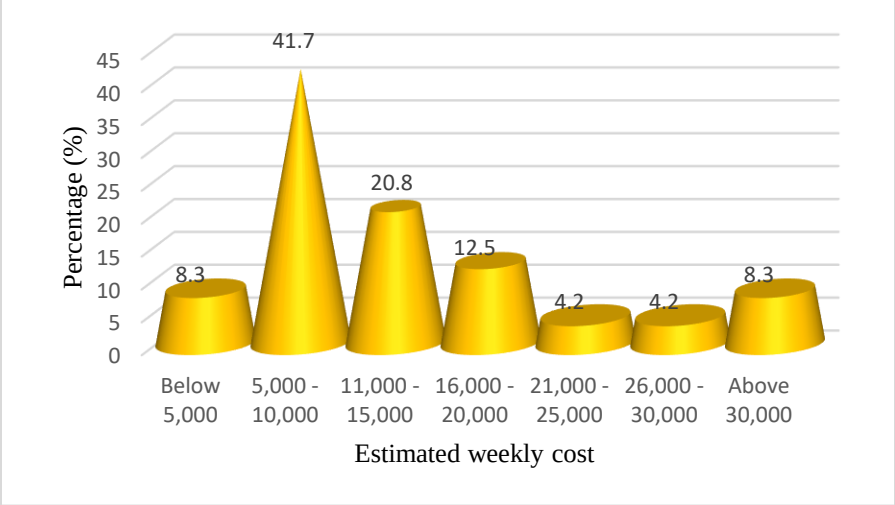

Figure 6: Estimated cost of firewood energy by respondents in Gboko bread bakeries

Figure 7 shows respondents' awareness of deforestation, ownership of forest plantation and firewood preference. Respondents (6.5%) said they owns their own personal forest plantations where they source their energy source while 86.7% of the respondents said they do not have their own personal forest plantations. Concerning awareness on use of firewood causing deforestation, 50% of the respondents said they were aware that uncontrolled usage of firewood causes deforestation while the remaining 25% of the respondents said they are not aware that firewood usage causes deforestation. In the aspect of intentions to grow trees for energy supply to bakery, 66.7% of the respondents said that they have the intentions to grow their own trees to supply energy to bakeries while the remaining 33.3% said they do not have the intentions to do so. On preference of species for firewood, 93.3% of the respondents said they have preference for wood species used as firewood while the remaining 6.7% of the respondents said they do not have any preference.

The findings presented in the research studies are in line with the broader literature on deforestation and sustainable forest management. Specifically, the study by Geist and Lambin (2002) highlights the significant impact of fuel wood consumption on deforestation. This is consistent with the results of other studies, such as Umar *et al.* (2016), which found that deforestation for domestic use leads to various environmental challenges, including vegetation losses, soil erosion, and loss of fauna habitats. These findings underscore the importance of sustainable forest management practices to mitigate the negative effects of deforestation and promote environmental conservation.

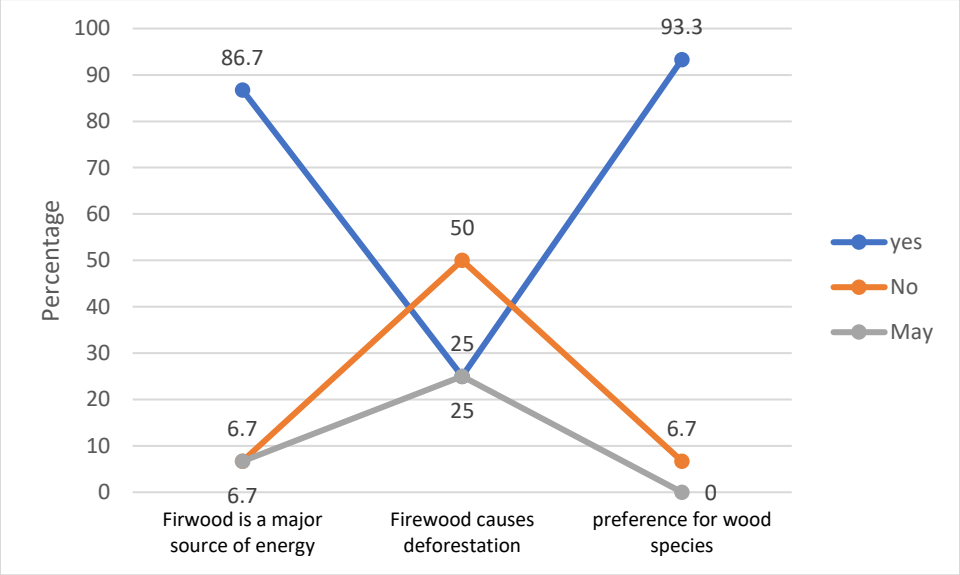

Figure 7: Respondents' responses to information on firewood use and its implications in Gboko bread bakeries

Table 3 shows results for most preferred species of the used by bakeries in Gboko. *Prosopis Africana* (*Gbaaye*in Tiv) had the highest rate of usage with 93.3%l daily.Other species utilized for energy in Gboko bread bakeries include: *Viltellaria paradoxa* (46.7%), *Burkea africana*(40%),*Daniellia oliveri and Parkia biglobosa* (13.3%) *while Khaya senegalensis and Magnifera indica* were 6.7%, respectively.

Finding from this study has also shown that respondents had most preference for *Prosopis africana* for firewood. The species is mostly used in Nigeria for charcoal production as reported by Ekhuemelo *et al.*, (2017); Ekhuemelo *et al.*, *(*2019), firewood, carving of mortar and pestle, bridge construction because of its hardness, less ash, high carbon and heating value (Agboola, 2004). The fruit from *Prosopis africana* is used in the preparation of a local condiment (Barminas *et al.*, 1998). This suggest that being multi-purpose tree, its conservation should be of paramount importance for sustainable utilization.

Figure 8 shows intended strategies to overcome future decline in firewood supply. Respondents (73.3%) supported changes in energy source for their bread baking business while 20% said they had no strategy in place to overcome future decline in firewood supply and 6.7% intended to plant their own forest plantation. Plate 2 shows heap of firewood use by Chichi bread bakery in Gboko East while Plates 3 and 4 show heaps of firewood use by Rahama and Daily Delight bakeries in Gboko Central.

Table 3: List and ranking of most preferred firewood species used in bakeries in Gboko

S/No	Botanical Name	Family	Language Name		F	%	Ranking
			Idoma	Tiv			
1.	*Prosopis africana*	Mimosoideae	Okpehe	Gbaaye	14	93.3	1
2.	*Viltellaria paradoxa*	Sapotaceae	Okume	Ichamegh	7	46.7	2
3.	*Burkea africana*	Legumes	Okachi	Gbaghongom	6	40	3
4.	*Daniellia oliveri*	Caesalpinioideae	Agba	chiha	2	13.3	4
5.	*Parkia biglobosa*	Mimosoideae	Ugba	Yiase	2	13.3	4
6.	*Khaya senegalensis*	Meliaceae	Opi	Haa	1	6.7	5
7.	*Magnifera indica*	Anacardiaceae	Mango	Ajah	1	6.7	5

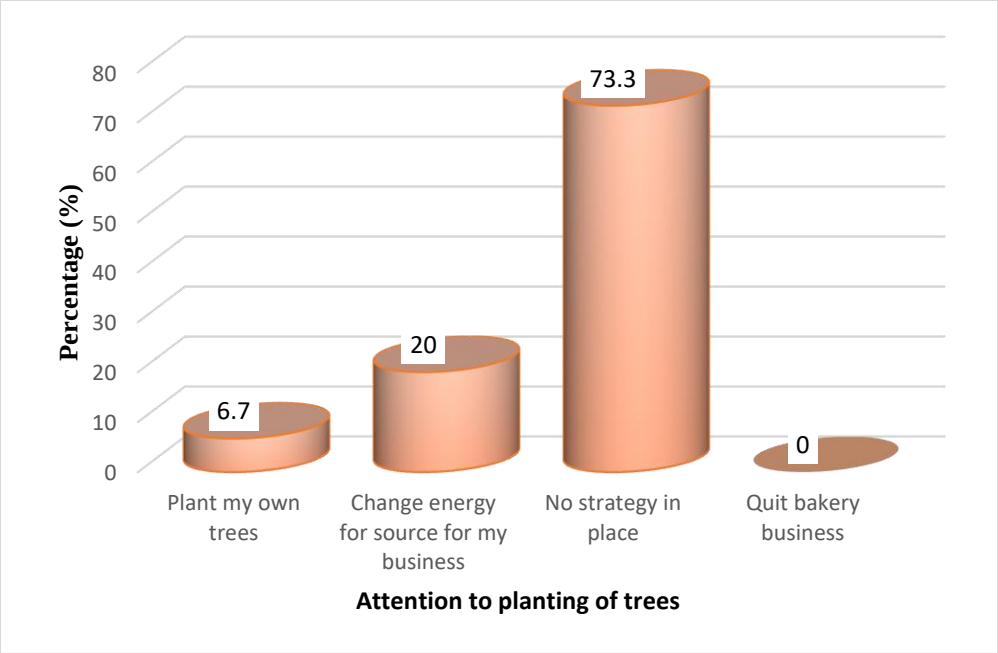

Figure 8: Intended strategy to overcome decline of firewood among bread bakers in Gboko

Plate 1: A heap of firewood use by Chichi bread bakery, Gboko East

Plate 2: A heap of firewood use by Raham bread bakery, Gboko East

Plate 3: Heap of firewood use by Daily Delight bakery, Gboko Central

Plate 4: Oven and heap of firewood in Daily Delight bakery, Gboko Central

Conclusion

Twenty-four bread bakeries were identified in Gboko town and owners predominantly rely on firewood as the main source of energy. Findings from the study revealed that respondents were more males than females in bread bakery business in Gboko. Firewood was the main one-use type of energy source utilized in bakeries, firewood and electricity were two-use energy utilized whereas it was firewood, charcoal and electricity that were three-use type of energy used in Gboko bakeries. The most preferred energy source was firewood while *Prosopis Africana* was the most preferred firewood species. Respondents' reasons for the use of preferred energy were low cost, convenience and readily available. Challenges faced by respondents in accessing preferred

firewood energy were unavailability, far distance covered to access firewood and high cost of purchase. Respondents were not aware use of firewood causes deforestation and were also not sure they will replant trees. They also had no strategies in place to sustain continuous used of firewood in bakeries, rather they claimed they will change energy source from firewood to others in future acute decline of firewood.

Recommendations

Based on the findings from the study, the following recommendations are drowned:

i. There should be a strategic plan for forest plantation bread bakers for sustainable utilization of firewood for their business.
ii. The use of other sources of energy should be reconsidered by the bread bakers in Goko.
iii. Both State and Federal Government should make alternative energy sources like electricity, solar energy .and gas available and affordable for small and medium business as well as households

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