Cassava Waste Management and Biogas Generation Potential in Selected Local Governments Areas in Ogun State Nigeria

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Agricultural product like cassava produces huge amounts of waste when processed to consumable goods. The waste generated is generally considered to contribute largely to environmental pollution. This study therefore investigates the waste management practice that is adopted by cassava processors in Ogun State, Nigeria. Five (5) Local Government Areas (LGAs) dominant in processing cassava were selected for the study on the basis of spatial location distribution; landmass and population. The survey involved the use of structured questionnaires administered to cassava processors of the selected LGAs. The Statistical Package for Social Sciences (SPSS) software application and descriptive statistics were used for data analysis. Results of the analysis show that majority (70%) of the cassava processors are females. Cassava peel constitutes 10% of the waste produced, of which 91% are heaped at refuse dump in most communities. Results also reveal that 86.3% of cassava residues are used for animal feeds. Other findings show that the peels when dried are used as bio-fuel for cooking and there is a significant potential for biogas production. From the data captured from respondent during the study, most processors are willing to pay for an improved waste management system. The study therefore suggests proper waste management of cassava waste to minimize environmental pollution.

Keywords: Solid Waste Management, Environmental Pollution, Agricultural Waste, Cassava Waste, Biogas Generation, Sustainable Technology.

Introduction

Solid waste management is the most pressing environmental challenge faced by urban and rural areas of Nigeria, with population exceeding 170 million people. Among several wastes generated by this huge population is agricultural waste. Improper handling of agricultural waste has raised a significant challenge in the past decades. In 2016, agriculture contributed 19.17% to Gross Domestic Product (GDP) of Nigeria, and it also generated large waste materials. Nigeria is involved in growing and production of so many food crops. One of such crops is Cassava, a starchy staple food crop which has ability to resist drought and diseases. In 2012, the production of cassava world-wide is valued at over 260 million tonnes, with Nigeria being the largest producer, contributing over 20% to global production (Asante-Pok, 2013; Omilani, Abass and Okoruwa, 2015). In Nigeria, cassava is mostly produced and processed by small-scale farmers at the family or village level. Cassava provides a reliable and inexpensive source of carbohydrate for people in Sub-Saharan Africa, especially in Nigeria where its production, processing and consumption is most predominant and significant on a global scale (Westby, 2008; Olukanni, Agunwamba and Abalogu, 2013). It also provides different job opportunities for both men and women, from the production stage till it gets to the final stage. There are indications that the

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domestic demand for cassava, particularly as a staple food, tends to outweigh the demands of the industrial sector. As farmers are unable to meet their demand, some industries are now engaging in direct production of their cassava requirements.

Globally, 60% of the cassava produced is mostly used for consumption in numerous forms by human while the animal food industry uses about 33% of the world production. The remaining 7% is used by industries to produce products such as textile, paper, organic acids, flavor and aroma compounds and cassava bagasse (Pandey et al., 2000). Three main types of residues are generated during the industrial processing of cassava: peels, solid and wastewater. These wastes are poor in protein content, but it residues are very rich in carbohydrate and are generated in large amounts during the production of 'garri' and cassava flour from the tubers. The cost associated with the handling and disposal of these wastes constitute a huge financial burden to the cassava processing industries in most rural regions of the country. As a result of this challenge, most rural cassava processors choose to dispose the cassava processing wastes generated into the environment. These wastes have been identified to be toxic to the environment (Barros et al, 2012; Olukanni et al., 2013; Omilani et al., 2015).

The technology of processing cassava roots includes predominantly, peeling, grating, de-watering, fermenting, drying, frying etc. The type and composition of the waste depend on the processing method and type of the technology used (Osunbitan, 2012). In most cassava processing communities, several tonnes of cassava peels are generated as a waste product from the processing activity and are generally considered to contribute largely to environmental pollution (FAO, 2004). With an expected increase in cassava production, it is also expected that waste generation will also continue to rise. Even though cassava peels can be used as feed for livestock, the quantities generated and the remoteness of many of the communities where processing takes place leave behind a lot of waste, which is burnt or left to rot, with lots of environmental consequences (Eze, 2010). Tonukari et al. (2015) presented a report of a cassava starch production center which produces 100 tons of tubers per day has an output of about 47 tons of by-products. This output may cause environmental problems when abandoned in the surroundings of processing plants or carelessly dispose. The basic form of cassava flour production is Sorting, Weighing, Peeling, Washing, Grating, Machine/Milling, Detoxification, Dewatering, Granulation, Drying Milling, Sieving and Packaging (Dada, Afolabi and Siyanbola, 2009; Aro et al., 2010).

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Management of cassava waste varies across several processing centers in the country and over 55% of waste generated from its processing is disposed in dump sites. This implies that a great number of cassava processors do not get benefit from the waste they produce (Sackey and Bani, 2007). Majority of the cassava peels in Nigeria are abandoned close to the processing site, while some are used for land filling or burnt. This approach causes serious threat to the environment and health hazard to the processors and neighborhood (Omilani et al., 2015). Oparaku et al. (2013) from their experiment expressed that cassava wastes can be used as a biogas substrate, either as a standalone raw material or in combination with livestock manure. Attempts have been made by various researchers to produce products such as organic acid, flavour and aroma compounds, methane and hydrogen gas, enzymes, ethanol, lactic acid, bio surfactant, polyhydroxyalkanoate, essential oils, xathan gum and fertilizer from cassava bagasse, peels and wastewater (Pandey et al., 2000; Sackey and Bani, 2007; Olukanni et al., 2013; Omilani, et al., 2015).

Furthermore, prior studies on cassava waste management (Sackey and Bani, 2007; Olukanni et al, 2013; Omilani et al, 2015) focused on different aspects of cassava waste management, however there is still dearth of literatures on studies that combines the potentials in the reuse of cassava waste, gender composition of cassava processors in Nigeria and also factors affecting the willingness to pay for cassava waste management in Ogun State. According to Echebiri and Edaba (2008), there is a high positive correlation between the increase of cassava production and the estimated demand for the commodity. It was also found that waste disposal habit of the people, corruption, work attitude, and inadequate plants and equipment among others are militating against effective waste management in Nigeria (Onu, Surendran and Price, 2014). From the foregoing, there is a need for a better management and utilization of these waste residues through a better waste management system. It is against this backdrop that this research investigates the potentials for an integrated cassava waste management strategy with a focus on Ogun State Nigeria. Furthermore, this study examined the waste management systems presently in use by cassava processors and their willingness to pay for value-added solid waste management system.

The main objective of this study is to investigate the cassava waste management methods in Ogun State. Other specific objectives of the study are to:

i. find out the method of waste disposal that is adopted by cassava processors in the selected local governments areas,

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ii. find out what cassava residues are used for in the selected cassava processing factories,

iii. find out the factors that influence processors' willingness to pay for improved waste management system and

iv. investigate if cassava waste generated in the selected local governments areas have the potential for the generation of bio-fuel.

Materials and Methods

This study focuses on five (5) local government areas (LGA) (Yewa North, Odeda, Ijebu North, Ijebu East and Remo North LGAs) (Figure 1). These local governments are dominant in processing cassava. A total of 500 questionnaires were administered to selected cassava processors with 100 questionnaires in each of the LGAs. Plates 1a, b and c show the activities in one of the cassava processing factories. In line with Omilani et al. (2015), survey research design was used for this study as it was found appropriate because the nature of the research requires the investigation of the opinions and experiences of a group of people by asking them questions.

Sample Size and Sample Technique

A good representation of the population was chosen for proper evaluation and analysis. The questionnaire was constructed to provide precise and accurate answers through close-ended questions. The questions were derived from the statement of problem, research questions, research objectives, and hypothesis for testing. Section A dealt with personal data of the respondents, while section B treated hypothetical questions. The questionnaires were administered to those that are educated while those that are not literate had the questionnaires read and interpreted to them in order to get their responses. A structured interview was also used to elicit information from the respondents.

Reliability of Instruments

The reliability test utilized in this research is Cronbach's alpha reliability test. Result obtained on a sample should be of a reliability of 0.70 or even higher before the research instrument can be used. This study makes use of tables, percentages and various statistical techniques in the presentation and analysis of the data collected at the significant level of 95% that is at 5% error limit. The data generated through the questionnaire were analyzed through the aid of a computer application, Statistical Packages for Social Sciences (SPSS). In specific terms, frequency distribution, simple percentage and mean were deployed in data analysis.

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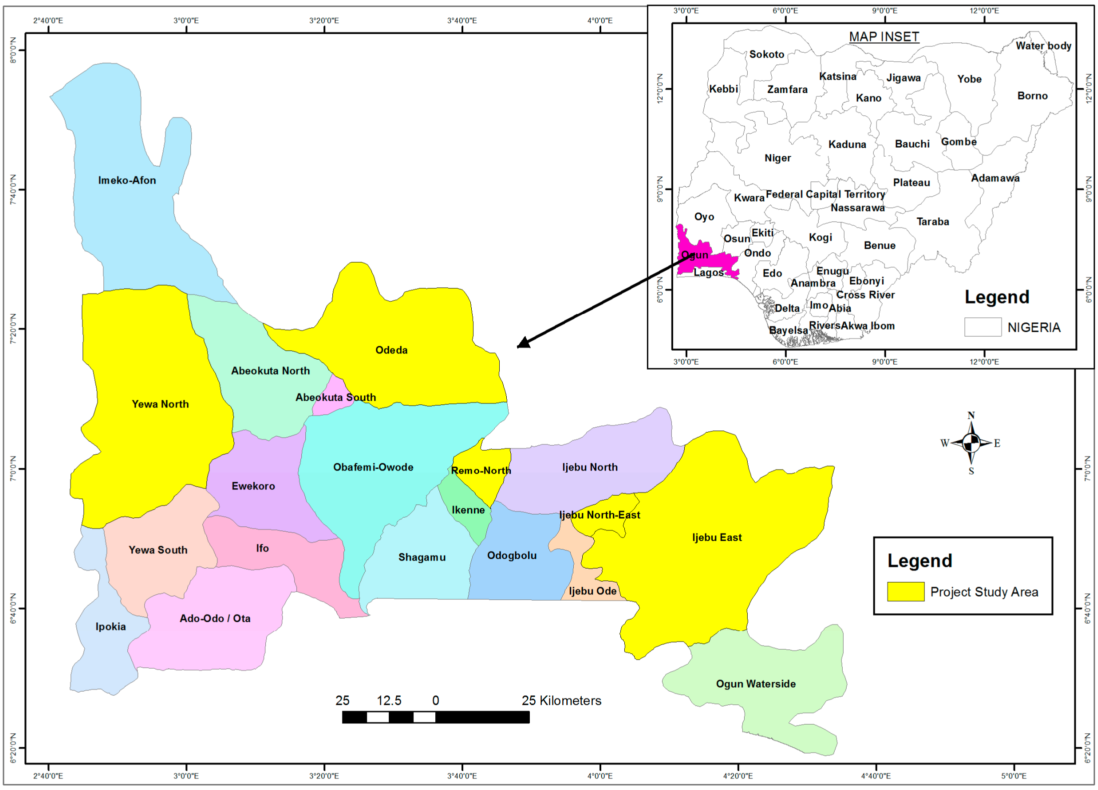

Fig 1: Map of Ogun State showing study areas in yellow

Plate 1a

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Plate 1b Cassava grinding machine in Operation

Plate 1c: Cassava Peels dump site

Results and Discussion

Figure 2 shows that majority of the cassava processors are females with over 70 percent. This according to Popescu et al. (2013) in their study titled "Managers' gender and SMEs production" implies that the productivity level will be higher.

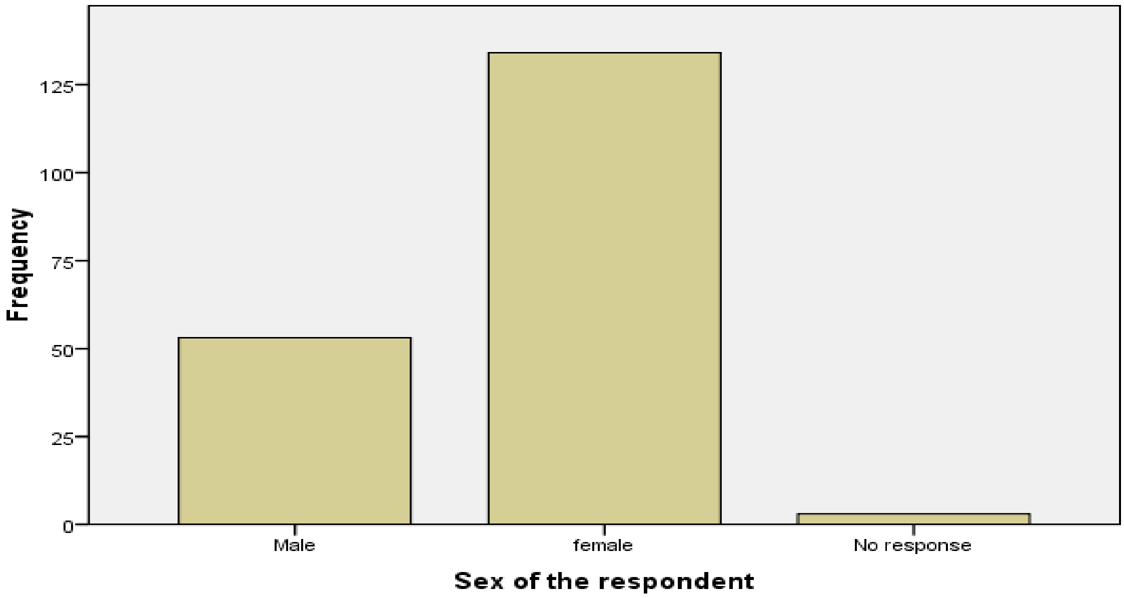

Figure 2: Gender Percentage of respondents

Figure 3 shows the age range of the respondents. 14.2% of the respondents are between the age of 20 and 29, 34% are between the age of 30 and 39. 30.5% and 20% are for ages between 40 and 49 years and 50 and above, respectively. From the result in Table 1, it is observed that a great number of cassava processors are in the age range of 30 and 49.

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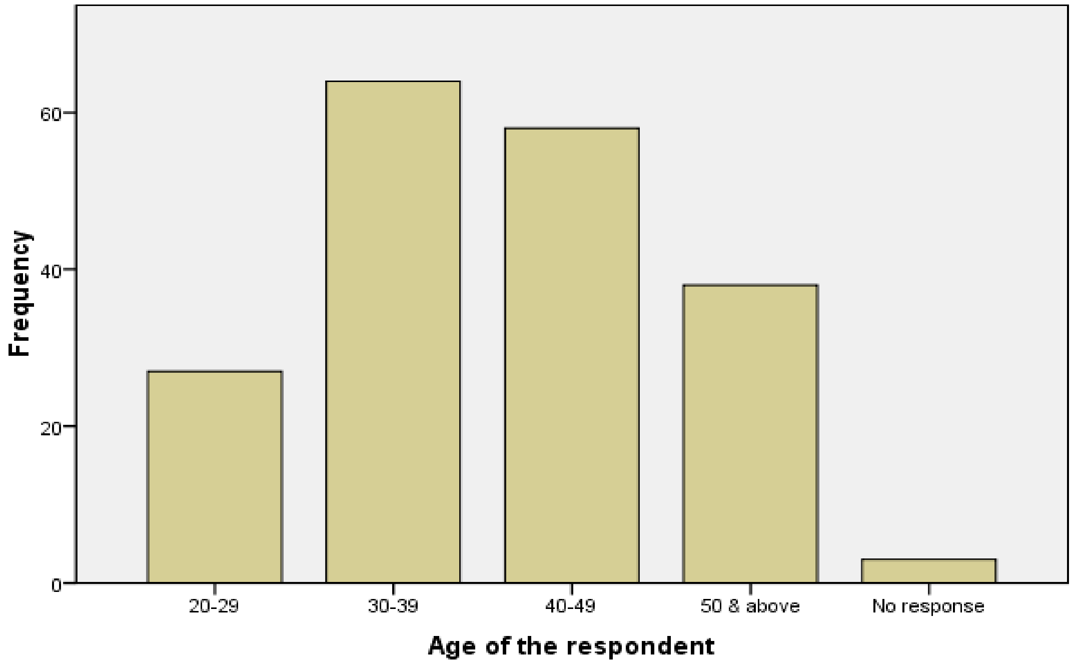

Figure 3: Age variation of respondents

Figure 4 shows that majority of cassava processes are women who work very hard to earn a living in order to take care of their families.

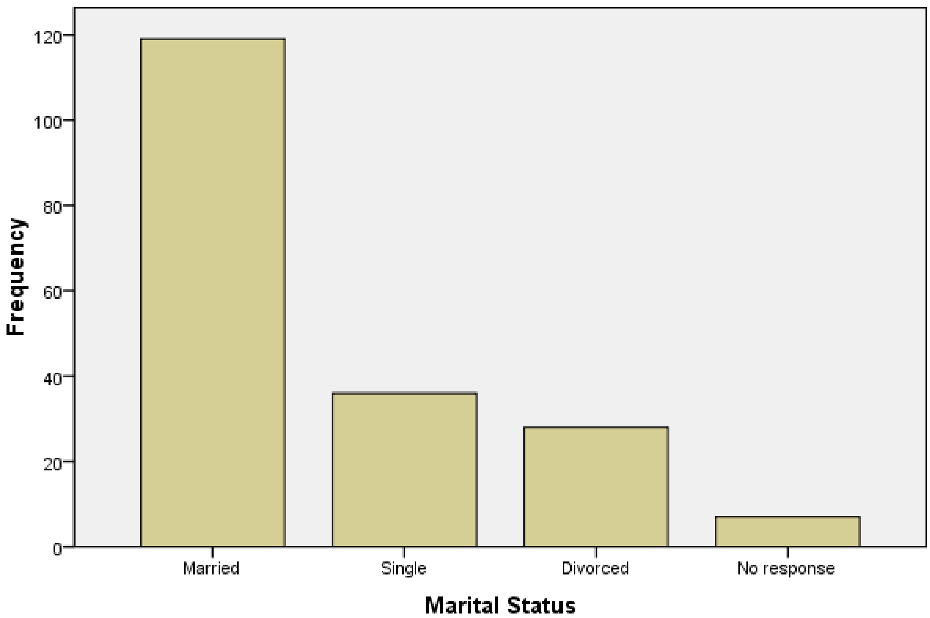

Figure 4: Marital Status of respondents

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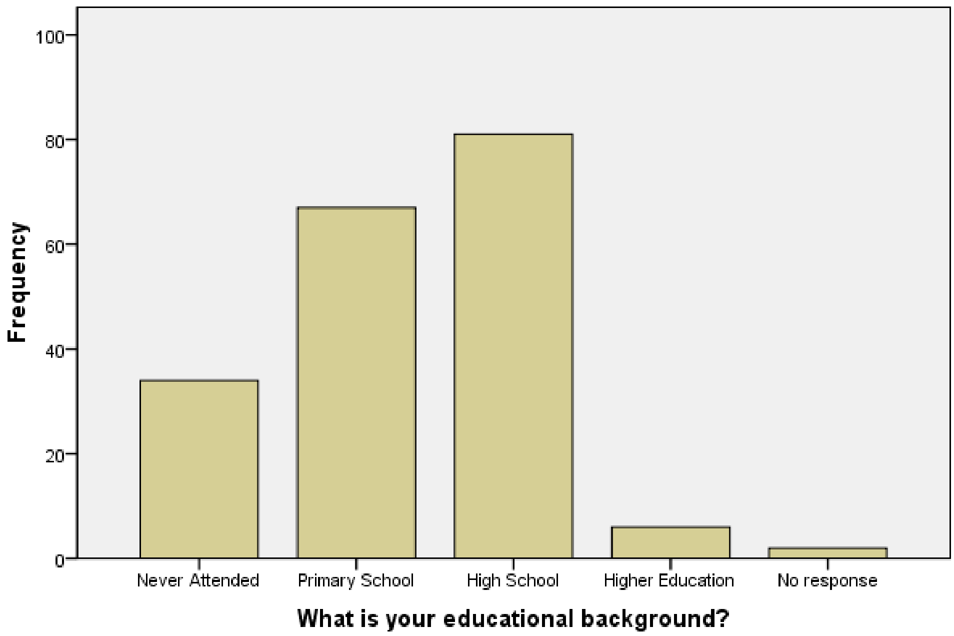

Figure 5: Education level of respondents

Figure 5 shows that majority of the processors have at least a primary and secondary school education.

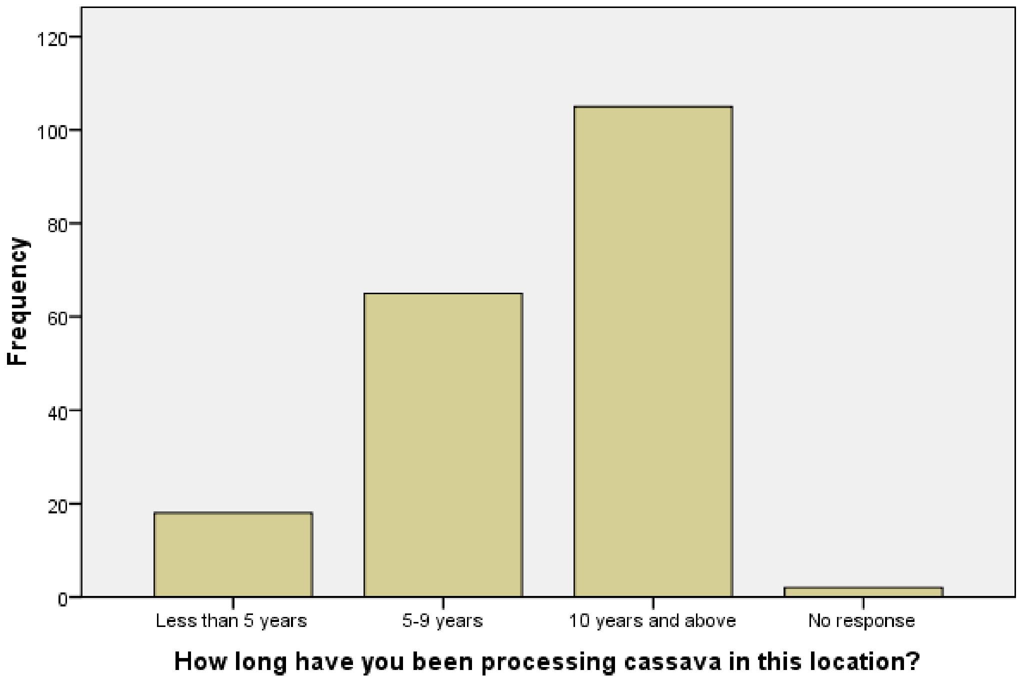

Figure 6: Education level of respondents

Figure 6 shows that processors with cassava processing experience of five years and above are greater in number. This according to some of them has improved their operations.

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Table 1: Cassava Processing Operations in the Selected LGAs

Major type of solid waste produced from the cassava processing operation		Percent	Valid Percent	Cumulative Percent
Valid	Cassava peel and Cassava pomace	86.8	86.8	86.8
	Cassava peel	10.5	10.5	97.3
	Cassava pomace	1.6	1.6	98.9
	No response	1.1	1.1	100.0
	Total	100.0	100.0	
How are the cassava solid wastes disposed?				
Valid	Cassava waste dump site	90.5	90.5	90.5
	Burnt near the factory	4.2	4.2	94.7
	No response	5.3	5.3	100.0
	Total	100.0	100.0	
What do you use cassava residues for?				
Valid	Animal feeds	97.3	97.3	97.3
	Fertilizer	1.6	1.6	98.9
	No response	1.1	1.1	100.0
	Total	100.0	100.0	
Willingness to pay for an improved waste management system				
Valid	Yes	74.7 {F= 87.3; M=12.7	74.7	74.7
	No	24.2 {F =17.4; M=82.6}	24.2	98.9
	No response	1.1	1.1	100.0
	Total	100.0	100.0	

Table 1 shows that over 86 percent of the respondents confirmed that cassava peels and cassava pomace are the major solid wastes generated. 10.5 percent indicated that cassava peel is the major solid waste they produce. However, 1.6 percent indicated that cassava pomace is the major solid waste they produce. This result indicates that majority of the cassava processing units are involved in the production of Garri and Fufu (Adebayo, Anyanwu and Osiyale, 2003). Coker, Achi, and Sridhar (2010) results showed that the percentage and composition of solid waste (Peels and bagasse) and liquid waste generated during cassava processing depends on the nature of the final product. Niringiye and Omortor (2010) study was on factors influencing willingness to pay for waste management. They found that age of the respondents has a negative and significant effect on WTP for waste management in Kampala city in Uganda. Coker, Achi and Sridhar (2010) did a study that focused on evaluating the cassava production activities in six selected cassava processing sites in Ibadan city. Results showed that the percentage and composition of solid waste (Peels and bagasse) and liquid waste generated during cassava processing depends on the nature of the final product. Irene and Richard (2007) in their study focused on the types of waste generated by cassava processing plants. The survey showed that the wastes generated were the cassava peels, fibrous material, chaff, wash water and liquor. The study did not investigate into the methods of waste management adopted

Table 1 shows that majority (90.5%) of the cassava processors dump the cassava waste generated at the cassava waste dump site. The table also indicates that 4.2% of the respondents burn the cassava solid waste generated near the factory. This according to Kolawole (2014) is a major source of environmental pollution. Table 1 indicates that 86.3 percent of the respondents use part

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of the cassava solid wastes directly as animal feeds or give to those that use them as animal feeds. However, 13.6 use the cassava solid wastes as fertilizer. Table 1 shows that majority (74.6%) of the respondents are willing to pay for an improved waste management system. The result further shows that 87% of the respondents who showed interest in paying for improved waste management system are female. This is in line with the result of Omilani, Abass and Okoruwa (2015). Their result showed that majority (68.73%) of the respondent who are female cassava processors were willing to pay for value added waste management system. The study compared the level of environmental pollution between small-scale cassava processing firms and large-scale cassava firms. Investigations conducted confirm that small-scale cassava processing affect environment more than large-scale. Awunyo-Victor, Ishak and Jasaw (2013) further revealed that the significant factors determining households willingness to pay for improved solid waste management (collection and disposal) are the posted cost of the service, age, educational level, household size and household's monthly expenditure. In addition, cost sharing of waste management is affected by family income. From the study of Oyegbami, Oboh and Omueti (2010) on the awareness of occupational and environmental hazards associated with cassava processing in south-western Nigeria, it was established that cassava processors were aware of occupational and environmental hazards associated with cassava processing.

Biogas Production Potentials

Table 2 shows the average cassava production capacity for factories in each of the LGA. 1000kg of cassava could produce 300kg of peels. Therefore, weight of cassava peels in each LGA would be the equivalent of (weight of cassava produced in kg × 300/1000). According to Wantanee and Rodtong (2004), 1kg of dry cassava tuber could produce 497.01 liters of biogas; and 1kg of fresh cassava tuber could produce 235.12 L of biogas. Therefore weight in kg of cassava peel will produce (weight in kg × 497.01) = volume in liters of Biogas.

Table 2. Biogas production potential from Cassava Peels

Local Government (5 factories)	Yewa North	Odeda	Ijebu North East	Ijebu East	Remo North
Cassava Production per day (kg)	7,500	10, 000	12, 000	8,750	7,500
Quantity of cassava peels (kg)/day	2, 250	3, 000	3, 600	2, 625	2, 250
Quantity of Biogas (Liters)	(2250kg × 497.01) = 1,118,272.5	(3000kg × 497.01) = 1,491,030	(3600kg × 497.01) = 1,789,236	(2625kg × 497.01) = 1,304,651.25	(2250kg × 497.01) = 1,118,272.5

Conclusion

The study revealed that there is no proper waste disposal method adopted by cassava processors in the selected LGAs in Ogun State. This is because the wastes generated are not been properly disposed and there was no significant difference in the waste disposal methods as adopted by the LGAs. This is because, majority of the respondents either use the residues from the cassava processing for feeding their live-stocks or use them as fertilizer. It is therefore evident that the respondents are not exposed to the income generating potentials of the cassava wastes.

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The study concludes that the major waste is from “garri” and “fufu” processing production. Though the cassava processors have an awareness of the health hazard associated with improper waste management, they prefer to dump the wastes at dump hills or burn them near the factories. The study concludes that majority of the cassava processors are female. Therefore, gender is a major determinant factor as it influences the processors’ willingness to pay. Also, majority of the cassava processors do not generate income from the waste generated from the cassava residues.

Finally, the study concludes that based on the quantity of cassava peels generated which are dumped and burnt by the cassava processors in the selected LGAs, there is a huge potential of biogas production from these wastes generated. This biogas can be used as a substitute for the firewood which is currently in use by all the cassava processors.

Recommendations

From the findings, the study therefore recommends the following:

i. That proper waste disposal method should be adopted by the cassava processors in Ogun State to minimize pollution and reduce health risk.
ii. There is need for awareness of the income generation potentials of cassava waste among the cassava processors in Ogun State.
iii. It is highly proposed that the waste water generated from cassava undergo proper treatment before it is discharged.
iv. Based on the biogas generation potentials of the cassava processing factories in Ogun State, it important that this resource be harnessed.

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