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PRODUCTION OF LIQUID BIO-FUEL FROM CASSAVA PEEL USING PILOT SCALE PLANT

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ABSTRACT: *Liquid fuel creation from inexhaustible sources could be utilized as a part of transportation now that there is an expanding request worldwide because of constant consumption of petroleum derivative and developing worry for natural security. The objective is to produce liquid fuel from cassava peel, determine the quantity of the liquid fuel produced from cassava peels and make necessary recommendations. The materials used for the production of the liquid fuel are Cassava peels,* H_2SO_4 *(Tetraoxosulphate (vi) acid) and Water and the cassava peels that was collected in a polythene bag from cassava market, waste dump site at Orita Challenge Ibadan, Oyo State was washed with cleaned water thoroughly and all extraneous materials were removed, samples of cassava peel were then weighed on weighing balance to determine the weight of each quantity after peeling which were chopped into smaller pieces and were transferred into pretreatment chamber where volume of tetraoxosulphate(vi) acid was added and were thoroughly mixed for about 30 minutes before heating was applied in the fermenter chamber after the slurry have been pumped into the fermenter chamber. The heating process took place for another one hour, and then the steam passing through the condenser was cooled before collection at* 78^oC*. Afterwards, its mass and volume of the liquid fuel produced were determined. At the end of this study, the Mass of cassava peels increase ranges from 1kg to 5kg sample, volume of water ranges from 5000ml to 9000ml, amount of concentrated* H_2SO_4 *ranges from 35.00ml to 55.00ml, moisture content ranges from 24.00% to 28.00%, temperature ranges from* 74.50^oC *to* 78.50^oC*, which shows that increase in the mass of cassava peels, volume of water, amount of concentrated* H_2SO_4*, moisture content and temperature leads to increase in the quantity of liquid bio-fuel produced. The result above shows that the lowest volume of the liquid fuel was obtained from 0.91kg of the sample in 1hr 30 minutes while the highest volume of bio-fuel was obtained from 4.85kg of the sample, at 1hr 50 minutes and time of production leads to increase in the quantity of liquid fuel produced. It is then concluded that the more liquid bio-fuel is produced when the fermentation process of cassava peels are done using concentrated Tetraoxosulphate (VI) acid than making use of cultured living organism as enzymes to speed up the rate of chemical reaction which may occur for days before fuel can be produced and recommended use of pilot scale plant for biomass production of liquid fuel instead of using laboratory methods for bio-fuel production which takes longer time.*

KEYWORDS*:* Cassava Peel, Liquid fuel, Pilot Scale, Fermenter

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INTRODUCTION

Cassava (Manihot esculenta) was obscure to the Old World before the disclosure of America. There is archeological proof of two noteworthy focuses of root for this yield, one in Mexico and Central America and the other in northeastern Brazil. The primary Portuguese pioneers found the local Indians in Brazil developing the cassava plant and Pierre Martyr wrote in 1494 that the "toxic roots" of a yucca were utilized as a part of the arrangement of bread. It is trusted that cassava was acquainted with the western shore of Africa in about the sixteenth century by slave traders. The Portuguese conveyed it later to their stations around the mouth of the Congo River, and it is at that point spread to different territories. Cassava is a perennial woody bush with an eatable root, which develops in tropical and subtropical regions of the world. Cassava began from tropical America and was first brought into Africa in the Cango bowl by the Portuguese around 1558. Today, it is a dietary staple in a lot of tropical Africa (IITA, 2009). It is wealthy in sugars, calcium, vitamins B and C, and fundamental minerals. Be that as it may, supplement creation contrasts as per the assortment and the age of the collected harvest, and soil conditions, atmosphere and other natural components amid development.

Likewise, in excess of 288 million tons of cassava were created worldwide, of which Africa represented 52%. As of late, Nigeria created 46 million tons, making it the biggest maker. Cassava creation relies upon a supply of value gram cutting. The augmentation rate of planting material is low contrasted with stem cutting are mass and exceptionally transient as they go away in a couple of days. In Sub-Saharan Africa (SSA) cassava is principally a subsistence trim developed for sustenance by little scale agriculturists who offer the excess. It develops well in poor soils with constrained work prerequisites. It furnishes nourishment, security and generally intercropped with vegetables, estate crops, (for example, coconut, oil palm and espresso), yam, sweet potato, melon, maize, rice, groundnut, or different vegetables. As indicated by Vuilleumier (1993), cassava is exceptionally flexible and its subsidiaries (starch) are material in numerous kinds of items, for example, nourishments, dessert shop, sweeteners, pastes, compressed wood, materials, paper, biodegradable items, monosodium glutamate and medications. Cassava chips and beds are utilized as a part of creating a feed and liquor generation. It is a tropical root trim that fills in as a sustenance, security and pay age edit for millions if individuals in Sub-Saharan Africa and different districts in the creating scene (Scott and Well, 2012).

Ethanol otherwise called ethyl liquor or grain liquor is a combustible, drab synthetic compound. Beverages with at least 0.5% ethanol are called alcoholic. Its substance equation is C2H5OH, also composed as C2H6O.It is utilized as dissolvable on the grounds that it can break down different synthetic compounds and isn't extremely dangerous .Yeast make a large portion of the ethanol that individuals utilize (Oyeleke and Okansanmi, 2008). Liquid fuel can be utilized rather than gas in autos and other. Motors can utilize unadulterated ethanol or ethanol blended with fuel. Huge

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Worldwide interests and endeavors are right now being coordinated at the advancement and generation of enhanced types of sustainable power source and new fuel wellsprings of which bio-fuel are urgent. This is in perspectives of the absolutely unavoided capable fast approaching weariness of petroleum product solves. The most driven objective so far in regard of the advancement and abuse of sustainable power sources have all the earmarks of being that verbalized by the European Renewable Energy as indicated by European Renewable Energy Council in March 2007,the Heads of states and Governments of the 27EU Member state received a coupling focus of 20% sustainable power source in definite vitality utilization by 2020 and 100% by 2050.Combined with the responsibility to enhance vitality proficiency by 20% until 2020 and to diminish green house gas emanations by 20% or separately 30% if there should arise an occurrence of a future for the European association and for the following ages. With a specific end goal to achieve the coupling by and large focus of no less than 20% sustainable power sources and in addition an adjusted sending in the warming and cooling, power and transport divisions is required (Duku and Hagan, 2011).

Adelekan (2012) reports a far reaching audit on the possibilities of tropical harvests and fertilizer as wellspring of bio-fills. The work sets that the biofuels, for example, biogas, bio-ethanol and biodiesel are solid and sustainable choices for enchancing worldwide vitality security. In perspective of the progressing consumption of fossil diesels quicker worldwide research intrigue ought to be coordinated at creating known and new wellsprings of these energizes. Coordinated endeavors ought to be made by partners worldwide to empower the utilization of bio-powers given their diverse points of interest of securing the earth and alleviating environmental change. Research assets ought to be additionally coordinated at building up the possibilities of known vitality yielding plants and others yet obscure to contribute towards guaranteeing worldwide vitality security. Ignored tropical and non tropical harvests distinguished ought to be investigated for their vitality yielding capacities and convey them to the standard of enthusiasm of ordinary agrarian bio-fuel explore. The present capability of bio-powers to upgrade energy security is restricted universally, the immense volume of bio-fills required to substitute for non-renewable energy sources is past the present by and large limit of worldwide agribusiness. For instance in the year 2006/2007, the United States utilized 20 percent of its maize reap for ethanol creation, which supplanted just 3 percent of its oil utilization (Wyman et al., 2005).

Notwithstanding worldwide yield creation increments in a few years, these increments are as yet not satisfactory to give bio-energizes in adequate amounts. The likelihood of more huge uprooting of petroleum derivatives ought to be conceivable with the joining of woody biomass as a major aspect of the hold asset base for bio-fuel generation. Along these lines more prominent changes in supply of bio-fuel creation ought to be conceivable through the incorporation of different assets of which backwoods timber is a characteristic decision (Demirbas, 2011).

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CONVERSION OF CELLULOSIC BIOMASS TO LIQUID FUEL

Yang and Wyman (2004) has described different bioconversion forms, utilized for cellulosic biomass, a general procedure includes four primary advances: measure diminishment and pretreatment, hydrolysis, and maturation. The feedstock lattice turns out to be more open to chemicals after pretreatment; and polysaccharides, chiefly cellulose, can be separated to lessening sugars which are the substrate for microbial aging. At long last, decontamination as far as refining and lack of hydration is expected to meet fuel showcase prerequisite. Cellulose is the part of prime intrigue and can be synthetically (by corrosive) or enzymatically hydrolyzed to glucose, which is the real substrate in ethanol maturation. Hemicellulose has a less minimized structure than cellulose and can be fundamentally corrupted or solubilized amid pretreatment. On the off chance that hemicellulose is effectively expelled from the mind boggling and corrupted to oligo or mono xylose, these littler atoms can be additionally changed over to other side-effects. Inside the muddled meshwork, lignin considerably affects other existing connections. The most vital impact is the upgrade of the quality of hydrogen-bonds between polysaccharides, which thusly expands the dependability and unbending nature of the cellulose-hemicellulose structure. This kind of assurance effectively diminishes the shot of infiltration of divider corrupting proteins, and fills in as a viable boundary to vermin and maladies to ensure the plant body (Brett and Waldron, 1996). Be that as it may, this insurance is not favored in bio-preparing since it limits protein availability to the inner polysaccharides.

METHODOLOGY

Materials

The materials used for the production of bio-fuel from cassava peel includes;

i. Cassava peels
ii. H_2SO_4 (Tetraoxosulphate (vi) acid)
iii. Distilled Water

This study makes use of the complete pilot scale liquid fuel production plant designed and developed by Adewumi (2018).

Equipment and Apparatus

The equipment and apparatus employed in the research work include;

i. Cassava grater
ii. Measuring cylinder
iii. Hand glove
iv. Polyethylene bag

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v. Heater
vi. Pretreatment chamber
vii. Fermenter chamber
viii. Weighing balance
ix. Thermometer
x. Stop watch
xi. Moisture meter
xii. Beaker
xiii. Collector (container)

Method

Cassava peels were washed with clean water thoroughly and were collected in a clean polythene bag from Cassava market, waste dump site at Orita Challenge, Ibadan, Oyo State. Samples of the cassava peel were then weighed on weighing balance in order to ascertain weight of the feedstock per experiment. The moisture content was determined through the use of moisture meter and it was chopped into smaller pieces using cassava grater, while the samples were reweighed. After then it was transferred into pretreatment chamber of the constructed Bio-Ethanol Plant, with addition of distilled water and concentrated Tetraoxosulphate (vi) acid H_2SO_4 .Thorough mixing was performed for 30 minutes with the aid of metal rod stirrer connected with an impeller in the pretreatment chamber, before the slurry was pumped into fermenter where the mixture was further stirred and heat was applied to the fermenter chamber through the heat band. The heating process took place for the intervals of more than an hour, then the steam pass through a condenser, which reduced the liquid temperature before collection. Afterwards the liquid fuel was allowed to cool down and its mass and volume was determined.

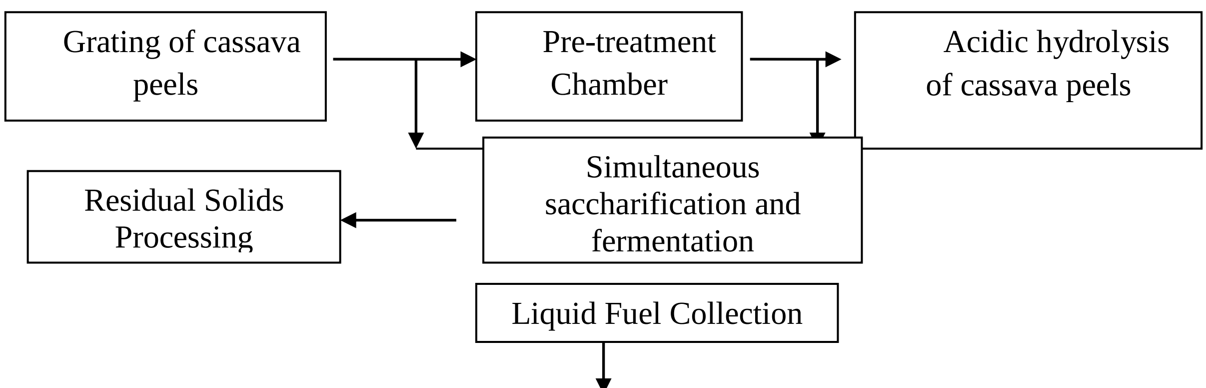

Figure 1: Production Process Flow Chart (Source: Field Work, 2018)

Description of Apparatus

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i. **Pretreatment chamber:** Is a chamber where water and acid is thoroughly mixed with the aids of impeller mounted at top connected with the stirrer to agitate the slurry and transports it to the fermenter through the connection of pipe.
ii. **Thermometer:** A thermometer is placed in the vapour of a boiling pure liquid will record its boiling point.
iii. **Stop watch:** A Stop watch is a hand held time piece designed to measure the amount of time elapsed from a particular time when it is known.
iv. **Fermenter Chamber:** Apparatus for carrying out fermentation where thorough stirring of mixture is carried out.
v. **Hand glove:** Hand glove is a garment covering the whole hand to resist chemical reaction with the hand.
vi. **Moisture meter:** It is an instrument used to measure the moisture content of cassava peel.

Figure 2**: Moisture Meter**

RESULTS AND DISCUSSIONS

RESULTS

The increase in mass of cassava peels, volume of water, amount of concentrated H_2SO_4, moisture and temperature of moisture content in which parameter was replicated five times are summarized in Table 2. Cassava peels were washed with clean water thoroughly and were collected in a clean polythene bag from Cassava market, Waste dump site at Orita Challenge, Ibadan, Oyo State. Samples of the cassava peel were then weighed on weighing balance to check their weight for each quantity after peeling as well as the moisture content was determined through the use of moisture meter and it was chopped into smaller pieces using cassava grater then the samples were reweighed. After then it was transferred into pretreatment chamber and volume of water with the addition of concentrated Tetraoxosulphate (vi) acid H_2SO_4 was introduced where thorough mixing was performed for 30 minutes with the aid of metal rod stirrer connected with an impeller before the slurry was pumped

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into fermenter where the mixture was further stirred and heat was applied to the fermenter chamber through the heat binder .

The heating process took place for the intervals of more than an hour ,then the steam of ethanol was cooled before collection by collector at 78^{O}C. After wards the steam was allowed to cool down and its mass and volume was determined. The Mass of cassava peels increase ranges from 1kg to 5kg sample, volume of water ranges from 5000ml to 9000ml, amount of conc. H_2SO_4 ranges from 35.00ml to 55.00ml, moisture content ranges from 24.00% to 28.00%, temperature ranges from 74.50^{o}C to 78.50^{o}C, which shows that increase in the mass of cassava peels, volume of water, amount of concentrated H_2SO_4, moisture content and temperature leads to increase in the quantity of bio-fuel produced as shown in Figure 3 and 5.

Table 1: Increase in Mass of Cassava Peels, Volume of Water Added, Amount of Conc. H_2SO_4, Moisture Content and Temperature.

Replicate	Mass of cassava peels sample (kg)	Mass of cassava peels after reduction (Kg)	Volume of water added (ml)	Amount of conc. H_2SO_4(ml)	Moisture Content %	Temperature ^{0}C
1	1	0.91	5000	35.00	24.00	74.50
2	2	1.89	6000	40.00	24.50	74.80
3	3	2.87	7000	45.00	25.45	75.00
4	4	3.86	8000	50.00	26.80	77.30
5	5	4.85	9000	55.00	28.00	78.50

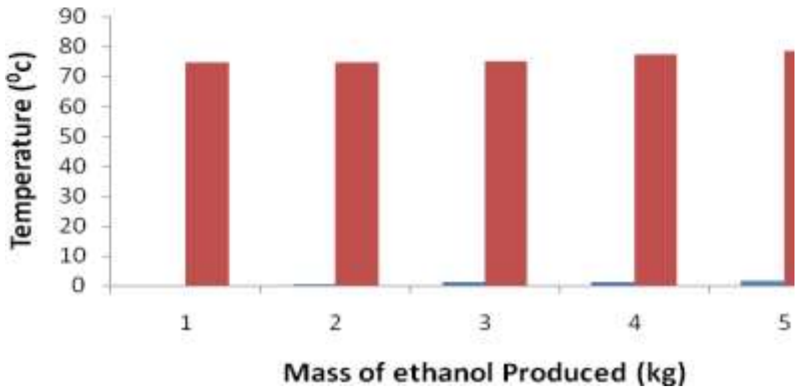

Figure 3: **Temperature of the ethanol against the mass of ethanol produced**.

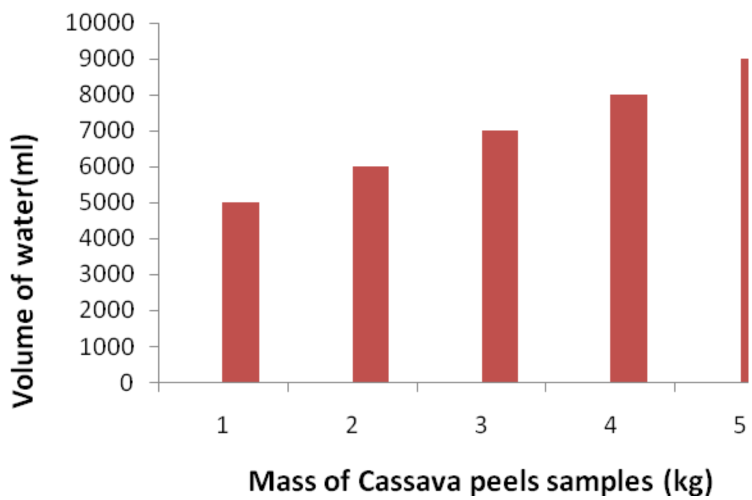

Figure 4**: Volume of water against mass of cassava peels**.

Discussion on the time required to produce each volume of Bio-Fuel

The time required to produce each volume of liquid fuel in which parameter were replicated five times are summarized in Table 3. At the end of the experiment, 0.29 litres was produced from 0.91kg of cassava peels in 1hr 30 minutes, 0.76 litres was obtained from 1.89kg of the sample in 1hr 35 minutes, 1.56 litres was obtained from 2.87kg of the sample in 1 hr 40 minutes, 1.98 litres of ethanol was obtained from 3.86kg of sample is 1hr 45 minutes and 2.21litres ethanol. The result

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above shows that the lowest volume of ethanol was obtained from 0.91kg of the sample in 1hr 30 minutes while the highest volume of ethanol was obtained from 4.85kg of the sample, in 1hr 50 minutes and time of production leads to increase in the quantity of bio-fuel produced as shown in Figure 2 and 4 respectively.

Table 2: Time Required to Produce Liquid Fuel

Replicate	Mass of cassava after reduction (kg)	Time of production	Liquid Fuel produced	
			Mass (kg)	volume(l)
1	0.91	1 hr 30 minutes	0.20	0.29
2	1.89	1 hr 35 minutes	0.56	0.76
3	2.87	1 hr 40 minutes	1.23	1.56
4	3.86	1 hr 45 minutes	1.45	1.98
5	4.85	1 hr 50 minutes	1.75	2.21

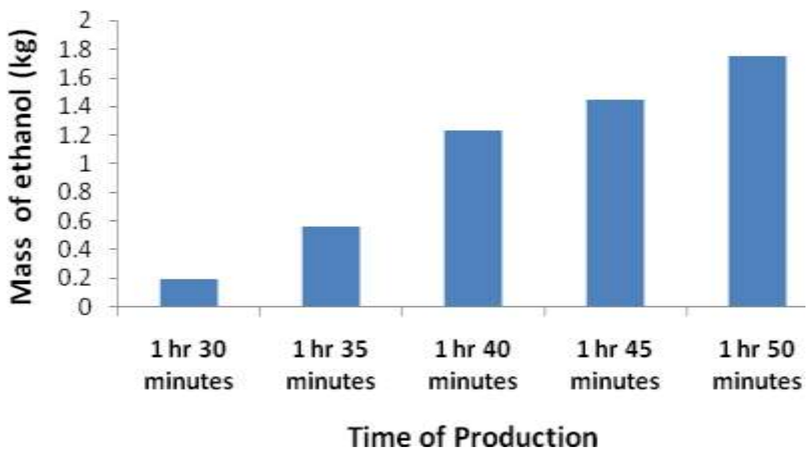

Figure 5: **Mass of liquid fuel against the time of production.**

Conclusions

The following conclusions were drawn from this research work.

i. Liquid fuel produced was confirmed to be bio-ethanol due to its properties like vapourization point 78^{o}C, pH of 7, and density of 927kg/m^{3}, using the liquid fuel production plant.
ii. The retention period for production of ethanol was drastically reduced using the constructed ethanol production plant, compare to the laboratory production of ethanol using the same feedstock and concentrate. It takes a minimum retention period of One hour, thirty minutes for the plant production, while it takes a minimum of seven days for the laboratory production of ethanol.
iii. The increase in mass, volume of water and concentration of acid, leads to an increase in the quantity of bioethanol produce.
iv. Water was separated in the fermenter chamber before collection in order to make the fuel useable.

Recommendations

The following are recommended for further research on the project.

i. Research should be conducted using feedstock other than cassava peel to produce liquid fuel.
ii. Since ethanol can be used in our internal combustion engine as fuel, there is need for engineers to focus more on commercialization of the ethanol production, so as to solve energy issue in the nation and world at large .
iii. Government and other multinationals should fund research in area of alternative energy production.

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