

Biofuel Production from Sensitive Plant (*Mimosa Pudica*) through Synchronized Biofuel Production Plant

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Research Article

Keywords: Mimosa pudica, synchronized ethanol plant, analysis

Posted Date: January 27th, 2023

DOI: <https://doi.org/10.21203/rs.3.rs-2518250/v1>

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Abstract

Mimosa pudica is among the medicinal herbal plant. It is a creeping annual or perennial herb often grown for its curiosity values; as the compound leaves fold inward and drop when touched and reopens within minutes later. It belongs to Fabaceae family. The general objective of these research work is to produce biofuel from sensitive plant using existing ethanol production plant. The sensitive plant was gotten from bushes at Moor Plantation, samples as used include 78% concentration of Hydrogen tetraoxosulphate (iv) acid (H_2SO_4), 3L, 6L and 9L of water was added with the mass of sensitive plant. The evaluation was carried out using the mass of dried sensitive plant (*Mimosa pudica*) such as replicate mass of sensitive plant (kg), volume of H_2SO_4 (L), volume of H_2O (L) added to ferment the feed stock, mass of ethanol produced after been distilled (kg), volume of ethanol produced (L), time and temperature used from each ethanol extraction. Also, it was observed that the average quantity of mean of mass of ethanol produced after been distilled from 0.5kg of sensitive plant (*Mimosa pudica*) to be 0.0404kg, average quantity of mean of volume of ethanol produced is 0.0454 L and the average quantity of mean of temperature is 74.68°C . It was concluded that the temperature of the ethanol produced increases as the mass of sensitive plant increases and its time of production of each replicate (0.5kg, 1.0kg, 1.5kg) also increases.

General Background

Plants have long served mankind as source of medicinal agent. Natural products have once served as source of all drugs (Shale, *et al.*, 1999). Herbal medicine involves the use of leaves, stem, flowers, fruits, seeds, roots rhizome and bark for healing of diseases. There can be little doubt that, the use of plants for healing purpose is the most ancient form of medicine known. The quest of the plant with medicinal properties continues to receive attention as scientists are in need of plants particularly of ethno botanical significance for a complete range of biological activities, which ranges from antibiotic to anti-cancerous. Several plants and herbs species used traditionally have potential antimicrobial and antiviral properties (Shelef, 2003; Zaika, 2008) and this has raised the optimism of scientists about the future of phyto-antimicrobial agent (Das, *et al.*, 1999).

Mimosa pudica is among the medicinal herbal plant. It is a creeping annual or perennial herb often grown for its curiosity values; as the compound leaves fold inward and drop when touched and reopens within minutes later. It belongs to Fabaceae family. The species is a native to South America and Central America, but is now a pan tropical weed. The other names given to this plant are humble plant, shame plant, touch me not (Deininger, 2004). This plant has history for use for the treatment of various ailments and the most commonly used plant part is the root, but leaves, flowers, fruit and bark can also be utilized (Ahmad and Beg, 2001; Deininger, 2004) and also about the antimicrobial activity of the plant (Palacios, *etal.*, 1991; Ojalla, *et al.*, 1999).

The seeds and other parts of *M. pudica* contain mimosine, a non-proteins alpha-amino acid that is known to cause hair loss and depressed growth in mammals. However an unlikely large dose would be necessary to cause such problems in humans. *Mimosa pudica* and other related species can become troublesome weed in tropical crops. The variety in Hawaii is reported to be toxic to livestock (Bigal, 2010; Ahmad and Beg, 2001). The leaves of *M. pudica* contain alkaloid mimosine. Root contains tannins, ash, calcium oxalate crystals and mimosine. It is susceptible to several herbicides, including dicamba, glyphosate, picloram and triclopyr (Stevia and Rebs, 2008).

Ethanol can also be used in modified diesel (compression ignition) engines; however, this is not common. The production and use of fuel ethanol can indirectly serve a variety of needs. On a community or individual level, ethanol fuel production is often viewed as a means to become independent of purchased fuels, to keep money within the local economy, and to provide an assured fuel supply in the event of shortages of petroleum fuels (Cheremisinoff,

2009). Ethanolic extract of leaves shows hypoglycemic activity in alloxaninduced diabetic rats (Sutaret *et al.*, 2015). Mimosa pudica root methanolic extract showed very good wound healing activity when compared to the standard drug gentamicin. The decoction of Mimosa pudica leaves shows anticonvulsant activity (Kannan *et al.*, 2009). Alcoholic extract of Mimosa pudica significantly decreases the volume of gastric acid secretion, PH, free acidity, total acidity and ulcer index with respect to control (Vinothapooshan and Sundar, 2010). Extracts of the plant have been shown in scientific trials to be a moderate diuretic, depress duodenal contractions similar to atropine sulphate, promote regeneration of nerves, and reduce menorrhagia. An antidepressant activity has been demonstrated in humans. Root extracts are reported to be a strong emetic (Guzman, 2005).

One of the largest components of the production cost and the efficiency, is energy based on its uses, will often be compromised in favour of other equally important factors. The need for such great attention to energy management has been highlighted by several published surveys of energy use in agricultural processing operation. This includes palm kernel oil processing.

Ethanol fuel production is a well-established commercial technology, but it is also a technology that has room to improve. On a national level, ethanol can improve balance of payments by displacing imported petroleum with domestically produced fuel. This may also provide increased rural employment and alternative markets for agricultural commodities. That is why research and development efforts in ethanol plant are ongoing. The research areas relating are feedstock, starch hydrolysis and fermentation process design, ethanol and by-product end uses, and site-specific integration of ethanol production with local agricultural economics.

The general objective of this research work was to produce ethanol from sensitive plant using existing ethanol production plant. While the specific objectives of the study is as follows;

1. To modify the existing ethanol plant.
2. To test the synchronized ethanol plant using sensitive plant (*Mimosa pudica*)

Review Of Past Work

Mimosa pudica L is a little, prostrate or climbing, fleeting bush. A few creators think of it as a woody spice. It is otherwise called dorme, dormidera, humble plant, marie-honte, mayhont, morivivi, honteuse, dozing grass, timawi, contact me-not, and numerous different names (Holm *et al.*, 2007). The plants which are helpful for recuperating sicknesses are called therapeutic plant. As per the WHO, "A restorative plant is any plant which, in at least one of its organs, contains substances that can be utilized for helpful purposes, or which are antecedents for chemo-drug semisynthesis." There are in excess of 500 therapeutic plants filling in our nation (Ghani, 1998).

It was first depicted from Brazil and is maybe local to much or the entirety of the New World Jungles (Liogier, 2008). It may arrive at 1 m in level when upheld on other vegetation and multiple m in even expansion. The rosy brown, woody stems are inadequately or thickly furnished with bended prickles. The root foundation comprises of a taproot and broad sinewy roots with knobs. The twigs are fine and adaptable and support leaves with a couple of sets of pinnae and 15 to 25 sets of elliptical handouts 3 to 12 mm long. The blossoms are pink and bunched in globose heads. The vegetable (case) is direct elongated, 1.0 to 1.5 cm long and 3 mm expansive, with bristles on the edges. The cases are brought into the world in gatherings and contain two to four earthy colored seeds. Today, it is skillet tropical in its appropriation (Howard, 2008).

Mimosa pudica L. develops on most very much depleted soils, even scalped or dissolved sub-endlessly soils with low supplement focuses. It requires upset soils to secure itself. Continued consuming may energize its spread in pastures

(Siregeret al., 2000). Delicate plant is conceal prejudiced and doesn't rival tall vegetation or develop under backwoods shelters. The species' underlying foundations produce carbon disulfide, which specifically represses colonization of the rhizosphere by mycorrhizal and pathogenic growths (Fenget al., 1998). This plant happens in croplands, plantations, pastures, cut regions, side of the road, and regions upset by development. It might develop as a solitary plant or in tangled bushes. Delicate plant develops from close to the ocean level up to 1,300 m in height and in regions with yearly precipitations from around 1000 to north of 2000 mm. The species is ice touchy (Ghani, 1998).

In the Philippines, delicate plant blossoms the entire year and may deliver upwards of 675 seeds for every plant each year (Ghani, 1998). The species is both breeze and honey bee pollinated (Chieng and Huang, 1998; Payawalet al., 2001). Air-dry seeds from Puerto Rico gauged a normal of 0.0065 ± 0.0002 g/seed. With no pretreatment, seeds from this assortment started developing 7 days in the wake of planting and arrived at a most extreme germination of 17% by 94 days. In another test, 80% germination was gotten in about a month with exchanging temperatures of 20°C and 40°C. This species has been effectively tried and suggested for disintegration control plantings utilizing potted material at a dividing of 60 x 60 cm.

Ethanol can be replaced by methanol, butanol, or some vegetable oils. Methanol and butanol can be used in place of gasoline or diesel fuel or to extend their use. Vegetable oils, on the other hand, can only be used to replace diesel fuel until more research demonstrates otherwise. The most significant alternative is methanol. It is a carbon-containing liquid alcohol (CH_3OH). It can be used in place of or blended with gasoline, just like ethanol. Methane serves as the primary feedstock for a chemical process that produces methanol. Coal and biomass can also be used to make methanol. The global methanol production industry is fairly large and makes use of natural gas as its feedstock. Special catalysts and a high temperature and pressure are required for the production of methanol. This procedure is typically only economical in very large industrial plants and is significantly more complicated than the production of ethanol.

Butanol is an alcohol with four carbons. Depending on where the hydroxyl is, it can have one of two chemical structures: 1 and 2 butanols ($[\text{CH}_3][\text{OH}][\text{CH}_2][\text{CH}_3]$) are both butanols. 1 butanol is produced by fermentation. Butanol, in contrast to ethanol and methanol, can be used in compression ignition engines in place of diesel fuel or in combination with it. It is made by bacterial fermentation of feedstock that contains starch or sugar and is made pure by distillation. In addition to the primary product, butanol, the bacteria produce acetone and ethanol. There are two drawbacks to producing butanol: 1) Butanol fermentation is more challenging than ethanol fermentation; (2) However, ethanol fermentation with yeast yields more useful fuel per unit of feedstock than butanol fermentation. During the war, commercial butanol production was possible. Butanol is no longer produced for commercial use as a fuel, however (Cliff and Ken, 2013).

Consolidated Bioprocessing (CBP)

In Consolidated Bioprocessing (CBP), ethanol together with all of the required enzymes is produced in a single bioreactor by a single microorganism's community. The process is also known as Direct Microbial Conversion (DMC). It is based on utilization of mono-co-cultures of microorganisms which ferment cellulose to ethanol. CBP seems to be an alternative approach with outstanding potential and the logical endpoint in the evolution of ethanol production from lignocelluloses materials. Application of CBP entails no operating costs or capital investment for purchasing enzymes or its production (Hamelinck *et al.*, 2005; Lynd *et al.*, 2005).

Distillation

This is a separation of mixtures based on the volatilities (boiling points) of the individual components that make up the mixture. The product which is of low volatility is called distillate while the substance so high boiling point that remain in the flask is called residue or bottoms. In acid hydrolysis, part of the acid and water is recovered in distillation.

Distillation and Dehydration

Under ideal conditions, an ethanol and water mixture can be separated based on their difference in volatility. Because ethanol is more volatile than water (ethanol vaporizes at 78°C whereas water vaporizes at 100°C), upon heating the ratio of ethanol-to-water in the vapor phase will become higher than that in the liquid phase. Therefore, in an ideal distillation column separation the overhead product will mainly be ethanol and water will be the main bottom product. An azeotropic mixture of ethanol (95.6%) and water (4.4%) will be reached upon completion of distillation operation, which is determined by the difference in the boiling points between water and ethanol (Fair, 2001). Because the ethanol water mixture from fermentation is far from being ideal, the actual ethanol recovery process is a multi stage and highly integrated process (Wankat, 1988). There are several dehydration processes to remove water from an azeotropic ethanol/water mixture. The first process is azeotropic distillation is addition of a solvent (e.g., Benzene, Cyclohexane or Monoethylene glycol) to break the ethanol-water azeotrope. When the additive is more volatile than water, separation is called azeotropic distillation and when it is less volatile than water, it is called extractive distillation.

Recently, distillation followed by molecular sieve dehydration operations have been used to recover a pure ethanol product of fuel-grade (>99.5%). Molecular sieves are crystalline metal aluminosilicates (zeolites) with a 3-D porous structure of silica and tetrahedral alumina (Kresge and Dhingra, 2004). Zeolite materials can strongly and preferentially adsorb water from vapor mixtures, thus they are able to remove the remaining 4.4% water content in the azeotropic mixture from the rectification column. Therefore, minimization of total energy input is a critical requirement for an economic design of an ethanol distillation/dehydration system. An alternative to molecular sieve material is corn grits (Ladisch and Dyck, 2009). Corn grits can selectively remove water from an azeotropic mixture and are advantageous in that the materials are bio-renewable, of low cost and easily disposable. However, a major drawback of the corn grits is its mechanical stability over a long period of time (Beery and Ladisch, 2001). The use of membranes to recover ethanol by “evaporation” (ethanol removal by vacuum applied at the permeate side of a membrane) is another technique which conserves energy by abolishing energy-expensive distillation. It is possible to concentrate ethanol from 80 to 99.5% by evaporation (Parisi, 1986). It can also reduce yeast ethanol (and inhibitor) toxicity problems if applied during fermentation.

Methodology

The materials used for the evaluation were 10kg of sensitive plant collected from the bushes of Moor Plantation which were divided into 3 section each, 1200 milliliter (78%concentration) of Tetraoxosulphate (vi) acid, 250mL beaker, 1000 mL measuring cylinders, 1000mL measuring cylinders bioreactor tank, watch, 60 liters of water and electronic balance. 25mL sulphuric acid and 10 liters of water was used to hydrolyze 0.5kg of sensitive leaves and was allowed for 120 minutes retention hour.

Heater was put on with the electric/induction motor for the stirrer of the mixture. The experiment was replicated five times using different quantity (mass) of sensitive leaves and which also cause an increase in volume of acid used (0.5 kg - 25 ml, 1.0 kg - 50 ml and 1.5 kg – 75 ml) respectively so that average product yield would be used. Tables 2 to

5 present results of ethanol production obtained for the chosen sample masses. Table 8 presents the rate of production of ethanol obtained for all sample sizes. Table 4 shows the properties of standard ethanol compared to the ethanol produced. Equation used in calculating the mean of ethanol produce (Yekeen, 2016).

$$R_T = R_1 + R_2 + R_3 + R_4 + R_5 \dots \dots \dots (3.1)$$

$$X = \frac{R_T}{N} \dots \dots \dots (3.2)$$

(Adelekan, 2012)

Where, X = Mean of the volume of ethanolin (kg)

R_T = Sum of the replicate of the ethanol produce (kg)

N = Total number of the replicate.

$$Y = \frac{MX}{N} \times \frac{100}{1} \% \dots \dots \dots (3.2)$$

Where, Y = Yield of ethanol extracted

X = mean of the ethanol

M = mass use for each experiment in producing ethanol

(Adelekan, 2012b)

The two models were developed by (Adelekan, 2012b) in determine the amount of ethanol produce in from Iroko timber and ethanol production from cassava (Adelekan, 2012a).

Table 1: Bill of Engineering Measurement and Evaluation (BEME)

S/N	Materials	Quantity	Unit Rate(₦)	Total cost (₦)
1	Board	1	15,000	15,000
2	Contacto	8	1,000	8,000
3	Box	1	45,000	45,000
4	Cable(2.5mm)	1	16,000	16,000
5	Thermometer	1	6,000	6,000
6	Stirrer	1	8,000	8,000
7	Slurry pump	1	15,000	15,000
8	Plumbing work		10,000	10,000
9	Condenser	1	12,000	12,000
10	Fermenter Pulley, V belt, Plate	1	40,000	40,000
11	Diesel	1	35,000	35,000
12	Acid (H ₂ SO ₄)	1.5 liters	3,000	3,000
13	Workmanship		35,000	35,000
14	Transportation		2,000	2,000
	TOTAL			203,500

Results And Discussion

Results

The following tables show the results of quantity of bioethanol produced from sensitive plants.

Table 2: Result of Milling of Sensitive Leave

Replicate	Mass of sensitive plant (Kg)	Time of milling (Sec)	New Weighing Mass (Kg)
1	0.5	0.35	0.312
2	0.5	0.37	0.315
3	0.5	0.37	0.314
4	0.5	0.38	0.319
5	0.5	0.36	0.314
Mean	0.5	0.37	0.315
1	1.0	1.04	0.759
2	1.0	1.08	0.768
3	1.0	1.05	0.765
4	1.0	1.02	0.758
5	1.0	1.03	0.765
Mean	1.0	1.04	0.763
1	1.5	1.40	0.952
2	1.5	1.35	0.956
3	1.5	1.37	0.956
4	1.5	1.35	0.955
5	1.5	1.40	0.957
Mean	1.5	1.37	0.955

Table 3: Pretreatment Result for Sensitive Leave (Feedstock)

Replicate	Mass of sensitive plant (kg)	Time of stirring (min)	Volume of water (l)	Volume of acid (l)
1	0.5	25	3.00	0.25
2	0.5	25	3.00	0.25
3	0.5	25	3.00	0.25
4	0.5	25	3.00	0.25
5	0.5	25	3.00	0.25
Mean	0.5	25	3.00	0.25
1	1.0	27	6.00	0.50
2	1.0	27	6.00	0.50
3	1.0	27	6.00	0.50
4	1.0	27	6.00	0.50
5	1.0	27	6.00	0.50
Mean	1.0	27	6.00	0.50
1	1.5	35	9.00	0.75
2	1.5	35	9.00	0.75
3	1.5	35	9.00	0.75
4	1.5	35	9.00	0.75
5	1.5	35	9.00	0.75
Mean	1.5	35	9.00	0.75

Table 4: Fermentation Result

Replicate	Mass of sensitive plant (kg)	Time of heating (hrs)	Temperature at which ethanol is extracted from water (°C)
1	0.5	2hr 30min	75.1
2	0.5	2hr 30min	73.9
3	0.5	2hr 30min	74.7
4	0.5	2hr 30min	74.2
5	0.5	2hr 30min	75.5
Mean	0.5	2hr 30min	74.7
1	1.0	2hr 35 min	74.2
2	1.0	2hr 35min	74.3
3	1.0	2hr 35 min	75.5
4	1.0	2hr 35 min	75.6
5	1.0	2hr 35 min	74.8
Mean	1.0	2hr 35 min	74.9
1	1.5	2hr 40 min	75.9
2	1.5	2hr 40 min	76.2
3	1.5	2hr 40 min	76.6
4	1.5	2hr 40 min	75.9
5	1.5	2hr 40 min	76.4
Mean	1.5	2hr 40 min	76.2

Table 5: Condensation Result

Replicate	Mass of sensitive plant (kg)	Volume of ethanol obtained (l)	Mass of ethanol extracted (Kg)
1	0.5	0.045	0.039
2	0.5	0.047	0.041
3	0.5	0.042	0.039
4	0.5	0.046	0.042
5	0.5	0.047	0.041
Mean	0.5	0.045	0.041
1	1.0	0.085	0.077
2	1.0	0.089	0.069
3	1.0	0.085	0.075
4	1.0	0.083	0.078
5	1.0	0.083	0.074
Mean	1.0	0.085	0.075
1	1.5	0.127	0.118
2	1.5	0.128	0.114
3	1.5	0.131	0.113
4	1.5	0.131	0.116
5	1.5	0.130	0.116
Mean	1.5	0.129	0.115

From the result Table 1, 2, 3 shows the mass of dried sensitive plant (*Mimosa pudica*), replicate, mass of sensitive plant (kg), volume of H₂SO₄ (l), volume of H₂O (l) added to ferment the feed stock, mass of ethanol produced after been distilled (kg), volume of ethanol produced (l), time and temperature used from each ethanol extraction. Also, from Table 1, it shows the average quantity of mean of mass of ethanol produced after been distilled from 0.5kg of sensitive plant (*Mimosa pudica*) to be 0.0404kg, average quantity of mean of volume of ethanol produced is 0.0454 L and the average quantity of mean of temperature is 74.68⁰C.

Furthermore, from Table 2, it shows the average quantity of mean of mass of ethanol produced after been distilled from 1.0kg of sensitive plant (*Mimosa pudica*) to be 0.0746 kg, average quantity of mean of volume of ethanol produced is 0.085 L and the average quantity of mean of temperature is 74.88⁰C.

In addition, from Table 3, it shows the average quantity of mean of mass of ethanol produced after been distilled from 1.5kg of sensitive plant (*Mimosa pudica*) to be 0.1154kg, average quantity of mean of volume of ethanol produced is 0.1294 L and the average quantity of mean of temperature is 76.2⁰C. From the result it shows that the temperature of the ethanol produced increases as the mass of sensitive plant increases and its time of production of each replicate (0.5kg, 1.0kg, 1.5kg) also increases.

Conclusions

In conclusion, the quantity of ethanol will depend on the amount of sugar or concentrated present in the sensitive plant (*Mimosa pudica*) used will lead to the amount of the ethanol to produce. The ethanol produce is very clear, pure fuel with as light odour. The boiling point is between 74⁰C to 77⁰C.

The result obtained reveals that ethanol yield at constant ratio of different quantity of sensitive plant. The results obtained are yielded at constant rate of 9.2%. It can be concluded that the production of ethanol from sensitive plant (*Mimosa pudica*) is possible locally in Nigeria, without depending on the edible ethanol sources.

Furthermore, ethanol yield from sensitive plant(*Mimosa pudica*). Even though it cannot yet replace saccharine and starchy materials, their consideration as possible substitute for grain based ethanol, stems from the fact that they reduce green gas Emission substantially thereby changing the emission calculation.

Recommendations

1. Fuel derived from sensitive plant is essential in order to overcome our excessive depend on petroleum for liquid fuels and also address the build-up of greenhouse gas that causes global climatic change.
2. Thus, if ethanol is made from sensitive plant it will result in a decrease in ethanol prices. Therefore, this will make the future of ethanol industries.
3. Establishing ethanol Industry in Nigeria will influence the development of the country and serve as work to the Nigerian workforce.
4. Bans should be made on the production of food ethanol and application of powerful tools of modern biotechnology to realize truly low costs.
5. Also, a breakthrough in genetically engineering an organism that will directly convert cellulose to ethanol will be more desirable in the production of cellulosic ethanol.
6. As the stock of fossil fuel is depleting, emphasis should be given to renewable (alternative) energy sources, such as sensitive plant and other agricultural waste. Public policy needs to encourage the development of bio-ethanol from biomass.
7. In terms of size reduction, sensitive plant must be cut into smaller size by the use of sharp cutlass and later sundry or oven dry to reduce the moisture content of the sensitive plant to a desirable degree and finally pounded with the use of mortar and pestle for easy fermentation process.

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