

# Study of the Fermentescibility of *Typha Domingensis* in Mode Mesophilic

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## Abstract

To assess the energy potential of the species *Typha domingensis*, tests were conducted in the laboratory to determine assess the amount of biogas produced per liter of fermentor per kg dry matter (ms). Thus, after 37 days of fermentation in a digester 1000ml containing 150g biomass production cumulative biogas obtained is 8955 ml titrating 40.4% methane, is 59.70 ml / g of biomass (1 , 611 /g/ j) or 0.24 l / l / j). This plant species has an identical biogas that of *Euphorbia Tirucalli* digested in the same conditions of temperature and preparation. However *Typha* biogas produces less than the stomachs of cattle (0,65l / lj) but more than the sewage sludge (0,11l / lj).

**Key words:** *Typha domingensis*; invasive species; biogas; contents of paunch; potential methanogene.

## 1. Introduction

According to the United Nation Development Programme (UNDP), poor countries are most affected by environmental degradation and that rich countries do not have sufficient access to non-polluting energy services at affordable cost.

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The Senegal is no exception to this finding. *Typha domingensis* revolving manner produces considerable amounts of biomass that could produce biogas from methane fermentation. Access to energy and environmental friendliness are the pillars of sustainable development according to the UNDP [10]. Indeed, poor countries are disproportionately affected by environmental degradation and limited access to non-polluting energy services at affordable cost. This finding is also true in Senegal, where access to energy poses many problems especially for the neediest populations.

United Nations Fund for Food statistics reveal that Senegal annually loses about 40,000 hectares of forest to meet their basic energy needs, especially in rural areas. This leads to both a decrease in fuelwood potential, the gradual disappearance of wildlife and disruption of ecosystems. *Typha* is an aquatic plant of the family Bulrush found in tropical wetlands and aquatic environments, subtropical and Mediterranean. This is a rhizomatous perennial herb that belongs to the class of monocots. *Typha* usually found at the edge of rivers, creeks, lakes or canals, water depths not exceeding 1.5 m. *Typha* propagation is by cuttings and seedlings [4]. *Typha domingensis* is an invasive plant species that threaten biodiversity and causes many problems in the socio-economic activities including agriculture, livestock, fisheries, etc. ... [1].

The presence of *Typha* in the Senegal River delta contributes to the economy of the local people by making mats, matches strand fences of houses, etc. However, the strong growth of *Typha* in the National Park of Djoudj (PNOD) has adverse effects on biodiversity, the economy and the health of local populations by the obstruction of access to waterways. It interferes with fishing, reduced agricultural production and promotes the persistence of waterborne diseases such as bilharzia and malaria [12].

According to UNDP and GEF, in the Delta, on the Senegalese left bank, the amount of biomass estimated fraiche is 3.05 million tons, which corresponds to about 520 000 tonnes of dry matter available per year. The only Lake Guiers has 12,058 hectares of *Typha* (data calculated from satellite data). In the area in Dakar Technopole, the area invaded by *Typha* is estimated at 8 hectares corresponding to a fresh biomass of 800 tons and 160 tons of dry matter (PERACOD 2012). The valuation of *Typha domingensis* by biogas could be an opportunity to turn a negative constraint for local populations into a clean source of energy for cooking and lighting, but also for soil improvement through the use of digestate from process of biogas production.

This study aims to investigate the fermentability of *Typha domingensis* and compare its biogas to other biomasses of Senegal (*Euphorbia Turicalli*) Panse cattle and drain mud) that were fermented under the same conditions temperatures. With satisfactory results, this abundant biomass, renewable and mobilized could be valued by biomethanation bellies like cattle, latex plants and septage.

## **2. Materials and Methods**

### **2.1. Materials**

#### **2.1.1. *Typha domingensis***

The raw material is collected fresh in the suburbs of Dakar and then sent to the laboratory.



**Figure 1:** *Typha domingensis* gathering in the suburb of Dakar, Senegal

### 2.1.2. Cattle rumen

contents harvest samples of cattle rumen content that serves starter is made to slaughterhouses of SOGERAS (Animal Resources Management Company of Senegal) DAKAR next morning after the night slaughter. A jar is used for the collection of the raw material (Figure 2). This biomass is then stored in a thermostated cooler and fed to the laboratory [6]



**Figure 2:** Rumen contents of cattle to slaughterhouses collecting Dakar

## 2.2. Methods

### 2.2.1 Sampling Methods

The sample of fresh material *Typha domingensis* is ground to reduce the size of the raw materials in order to obtain good homogenization of the mixture in the digesters.

### 2.2.2. Preparation of substrates for the production of biogas

Different samples of *Typha domingensis* crushed were inoculated with rumen contents of cattle. With proper experimental design, we followed quantitatively and qualitatively, the daily production of biogas mixture *Typha*

and cattle rumen contents.

### 3. Experimental and operating conditions.

#### 3.1 Experimental setup

The apparatus comprises a digester (1000ml vial) type "batch" closed using a cap with an orifice through which a flexible pipe for conveying the biogas produced to specimens capacity 1000 ml, returned and suspended in a container filled about one-third by brine (NaCl). The digester is connected to a column of water in the tubes for the visual measurement of the volume of biogas produced daily. The measurement of the specimen guard liquid is a saturated solution (NaCl) in order to minimize the dissolution of CO<sub>2</sub>. The digester and its contents are immersed in a thermostatically controlled water bath at 37 ° C. A regular addition of water is carried out in the bath to replenish losses due to evaporation. The water temperature of the water bath is monitored using a digital thermometer to check the temperature differences (Figure 3).



Figure 3: Measuring temperature digesters

The scheme of the experimental setup is shown in (Figure 4).

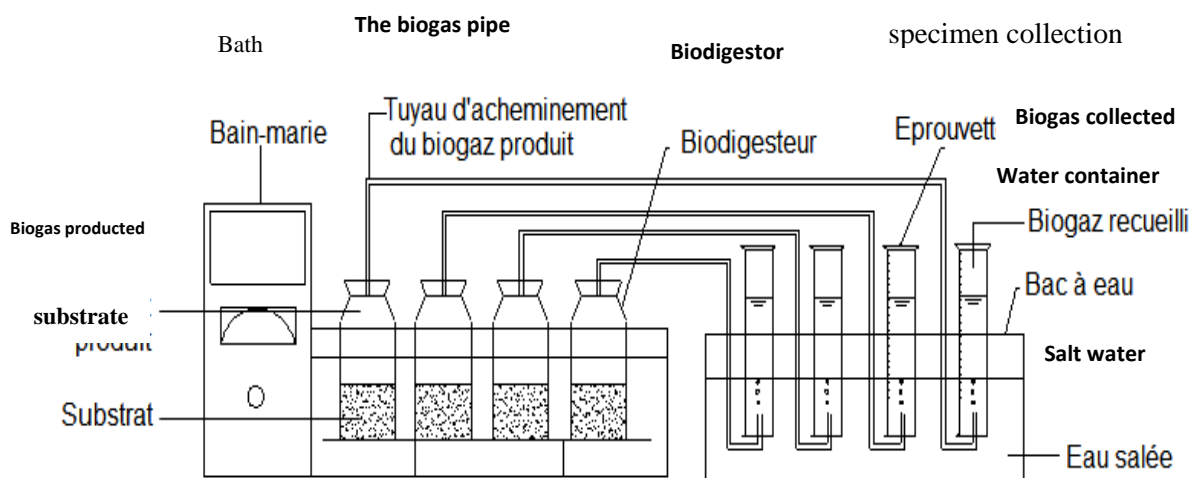


Figure 4 : Schematic of the experimental setup

### 3.2 Operating Conditions

The methane fermentation is made discontinuous. The bioreactor is charged and discharged at the end of the anaerobic process. Fermenters are subjected to a 37-day incubation period. Sealing tests are carried out to prevent the intakes may disrupt the process. A monitoring anaerobic digestion is carried out in mesophilic regime at the temperature of 37 ° C. The pH measurement is carried out spaced in order to reduce the risk of disturbance of the process by the air inlet in the fermenters (Figure 5).



**Figure 5:** PH meters digesters

The sampling substrate for the pH measurement is done at a lateral opening fermentors using an embedded electrode in the biogas analyzer. This opening is closed with a folded and pinched fitting to prevent entry of air. The probe of the pH meter is dipped into the reactor containing the substrate that is previously well homogenized. The results are displayed on the analyzer's screen. Agitation digesters is manually performed once each day before the reading of produced gas volumes. It aims to release the gas trapped in the substrate and to homogenize the contents of each digester to prevent crusting and allow the settling dense particles [6].

### 3.3 Commissioning

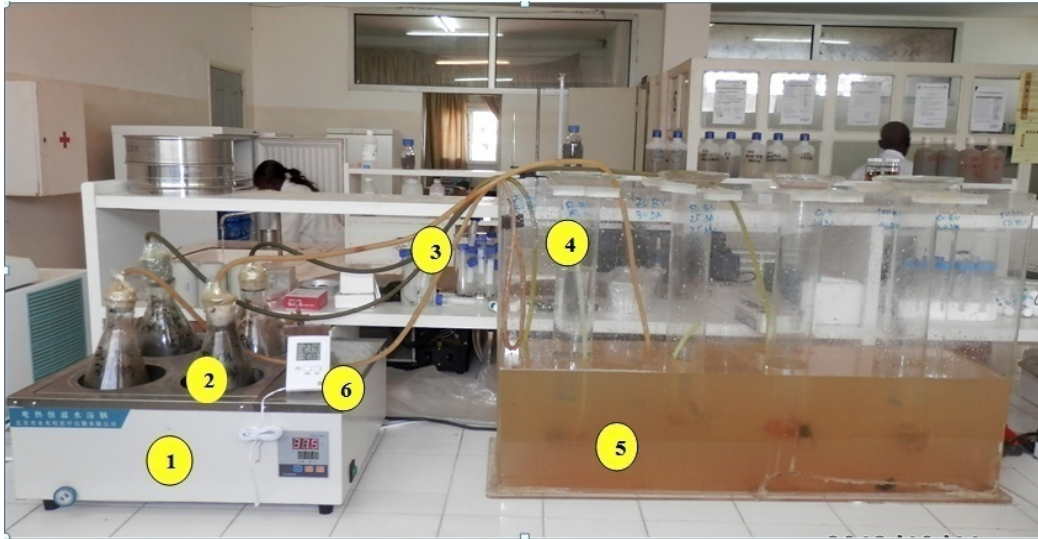
#### **3.3.1 experimental work. Biogas or BMP test The test potential of biogas, or potential test methanogenic or BMP (Biochemical Methane Potential)**

Determines under anaerobic conditions the maximum biogas production of 150 g of biomass sample. During this test, the biogas production is measured as the methane composition. (Figure 6).

The idea is to load the fermenters Typha. The daily and cumulative gas production in the preset incubation conditions followed [6]. The choice of mesophilic regime is explained by optimal bacterial activity at this temperature. Biodigestion tests are done in "batch" system for 37 days. Racking digestate is made therefore to the 37th day. The BPM value corresponds to the cumulative amount of gas after 37 days of incubation.

#### **3.3.2. Monitoring the production of biogas and analysis during testing of methanogenic potential**

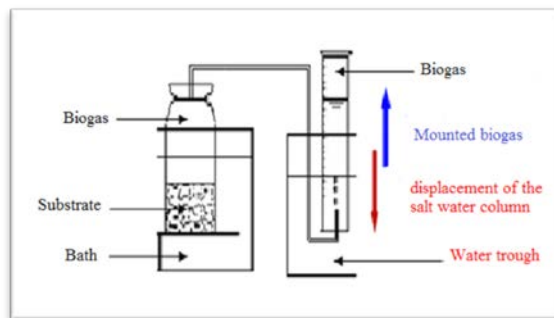
The volume of biogas produced is measured daily. A visual reading of gas in the production of the digester is made by means of the graduations of the specimen. Biogas creates additional pressure and the pressure gradient gives rise to a displacement of the gas produced in the reactor to the sample collection. The volume of water displaced corresponds to the volume of biogas produced.



**Figure 6:** Experimental design of the BMP test

- (1) Water bath; (2) digesters, (3) conveying the biogas pipe, (4) biogas collection test tubes; (5) water tray, (6) Thermometer

The displacement of the guard allows a measurement of liquid volume of biogas produced (Figure 7).



**Figure 7:** Movement of water and gas flows in the cylinder during the fermentation

Thus, when a volume of gas in the cylinder rises, the water column moves proportionally down to the submerged portion of the specimen in the water tray. An analysis of the composition of the collected biogas is carried out using a biogas analyzer. According to the following process: - agitation to allow biogas to rise; - Reading of the level of the gas column; - Purge the biogas analyzer to remove residual methane until the zero display on the analyzer's screen; - Connecting the analyzer to the pipe of up to the gas column; -

Verification of the closure and sealing of the circuit - trigger pump of the analyzer and vacuum pump until the gas column; - Reading of the maximum percentage displayed methane gas analyzer The biogas is connected to an Erlenmeyer flask for hydraulic primer to prevent water ingress into the biogas analyzer. Thus, the water pumped during the measurement of the biogas is collected in the Erlenmeyer flask to be emptied when it reaches a critical volume (Figure 8).



**Figure 8:** An analysis of biogas

## **4. Results and Discussion**

### ***4.1. pH Change***

The pH is an important parameter in the methanation process [2]. In fact, the methane requires a neutral environment with pH values between 6.5 and 8.5. Our results show that during the biogas *Typha domingensis* the pH stabilized at 7.2. During the test period, *Typha domingensis* is not acidified during biodegradation unlike *Euphorbia tirucalli* [7].

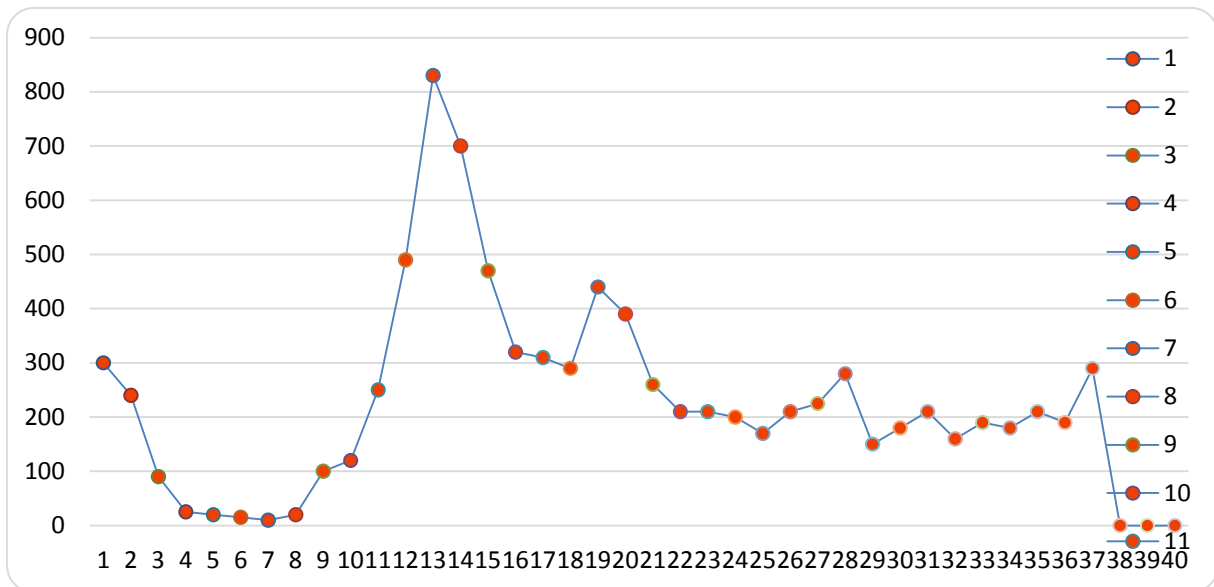
### ***4.2. Quantitative and qualitative assessment of the biogas productivity***

#### ***4.2.1. Biogas produced Quantification***

The daily production of biogas ground *Typha* are shown in Figure 9.

Daily production registered biogas peaked between the 11th and the 14th day digestion (830ml). Combined output constitutes a volume of 8955ml or 59,70ml / g biomass. The biogas kinetic runs in three [3] main phases: a) a lag phase which starts the closing of the digester. It corresponds to the liquefaction stage where the hydrolysis take place, the acetogenesis and acetogenesis [8]. A very low production, however, was recorded in this phase. This phase lasted eight days. b) bottom phase during which the optimal fermentation conditions are achieved which allows to collect substantial amounts of biogas. This phase took place from 8th to 19th day.

Anaerobic digestion of *Typha domingensis* gave a production up to 830ml on the thirteenth day, 5,53ml / g biomass or 34,6ml / g ms. c) a third phase in which there is a bearing. During this phase, the production of biogas is slowed, which is probably due to the depletion of digested substrate. This phase lasts from the 19th day to 37 days. Biogas production is a function of the nature of the substrate (plant material, animal waste, human waste) and fermentation conditions (anaerobic, temperature, pH, agitation, etc.). [9]. Indeed, *Typha domingensis* contains easily biodegradable items such as cellulosic fibers, but the addition of inoculum (bovine rumen content) probably favored biogas plant by its intake adapted flora. The biogas that biomass has given a total volume of biogas is 8955ml 59.70 ml / g biomass or 0,24l / l j. Compared to the dry matter (ms), *Typha* biogas production is 373ml / g ms or 373l / kg ms. 4.2.2. Results of the qualitative monitoring of the productivity of biogas The biogas quality is evaluated by the percentage of methane (CH<sub>4</sub>) it contains. A biogas is even better than the percentage of methane is high [3]. In this experiment, biogas produced from *Typha* as an average 40.04% methane (Figure 10).

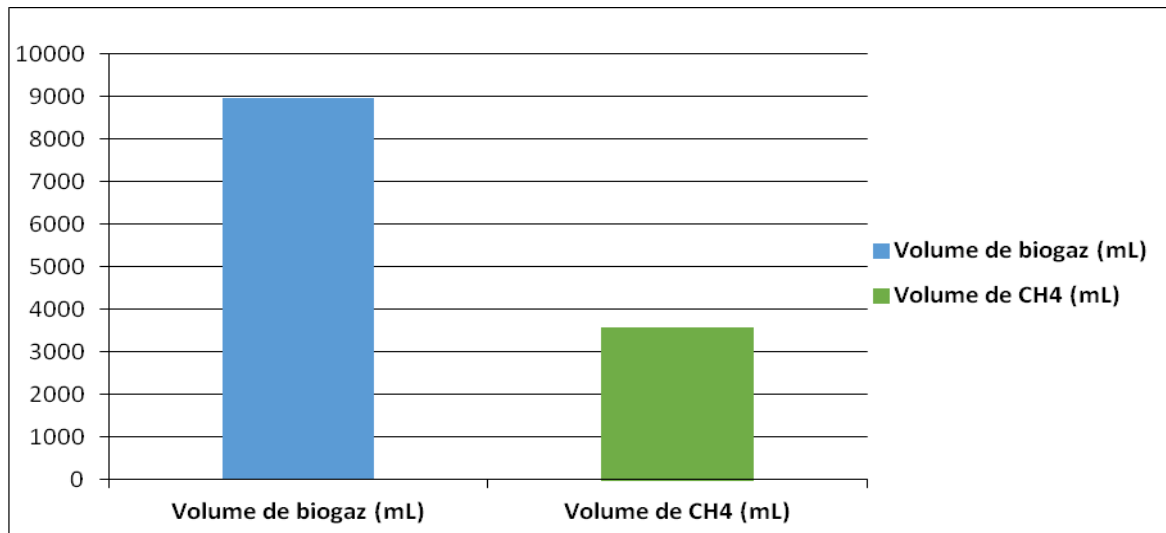


**Figure 9:** Evolution of the daily production of biogas

Thus, after 37 days of fermentation, the production of methane from this biomass is 3585,6ml or 23,90ml / g biomass or 0,097l / l j. Relative to the dry matter, methane production is 149,37ml / g ms. *Typha domingensis* its composition (Table 1) rich in carbohydrates and protein that are nutrient fermentative bacteria is potentially biofermentescible.

These components give it a fermentable power that results in significant production of biogas (12, 13). Comparée other biomasses biodigérées in Senegal for the production of biogas, *Typha domingensis* could be a good substrate for methane fermentation (Table 2) .





**Figure 10** : Diagram of the production of biogas and methane composition

**Table 1** : Chemistry of *Typha domingensis* : reference from [4]

Désignation	Teneur en pourcentage
<i>Matière Sèche</i>	16-24%
<i>Hydrates de carbone</i>	38-48%
<i>Protéines brutes</i>	7-12%
<i>Lipides</i>	1,5-3,5%
<i>Fibres brutes</i>	30-39%

**Table 2**: Production of biogas compared to digested biomass to Senegal : reference from [5, 6, 7,9]

Fermented biomass	<i>Typha domingensis</i>	<i>Euphorbia tirucalli</i>	Sludge emptying	stomachs of cattle
Senegal				
<i>Duration in days</i>	37	35	25	10
<i>Volume 1 liter digester</i>	1	1,5	1	1,5
<i>Biogas</i>	0,24	0,24	0,11	0,65
<i>% méthane</i>	40	65	29	55

Except rumen of cattle that quantitatively and qualitatively give the best biogas *Typha* is a better substrate for the methane fermentation in Senegal [9, 11,12].

### 5. Conclusion

The results of this study on the anaerobic digestion of *Typha domingensis* show that this plant is fermentable.

Biogas *Typha* is identical to that of *Euphorbia tirucalli* (0, 24l / l) Concerning the methane content of the biogas produced, *Typha domingensis* is better than *Euphorbia tirucalli* (0,096l / l) against 0,045l / l) [9]. Several fermenters fly *Euphorbia tirucalli*, financed by France, were satisfactory in different farms in the distant suburb of Dakar. The production of biogas from the *Typha* anaerobic digestion could be an effective way of valuing this abundant biomass renewable and invasive. *Typha domingensis* could no longer be seen as a constraint but as a richness. biogas Tests with *Typha* will be pursued by combining it with other substrates to improve the quantity and quality of its biogas .

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