DESIGN OF A BIO-COAL FROM WATER HYACINTH

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ABSTRACT

Madagascar was covered by a large natural forest which occupied more than 20% of Malagasy territory, or more than 13 million hectares. Unfortunately, about 85% of this area is destroyed today. On average, 200 to 300,000 hectares of forest disappear each year. Deforestation in Madagascar is caused mainly by the practice of slash-and-burn, logging and the production of fuel including charcoal for domestic use. Indeed, 92% of the daily energy of Malagasy people comes from charcoal and more than 85% of households use it mainly for the preparation of the meal. Now, the use of charcoal contributes strongly to the consequent deforestation of Madagascar. To meet the need for charcoal throughout Madagascar, it takes at least more than 410 000 tonnes per year, or the equivalent of 115 000 hectares of forests destroyed per year. The objective of this study is to design an environmentally friendly fuel called bio-Coal as a sustainable solution to curb deforestation caused by the use of charcoal. Thus, the water hyacinth will be used as a source of energy. So, this bio-Coal is made from very dry water hyacinth, mixed with some additives after being carbonized and then packaged to make a fuel that will be both economical and ecological with a calorific value of about 5 594 kcal.kg^{-1}. This alternative bio-coal to charcoal will contribute to reducing forest destruction in Madagascar.

Keywords: *bio-Coal, combustible, deforestation, ecological, hyacinth.*

1. INTRODUCTION

Water hyacinth is an invasive aquatic plant with a high amount of carbon [5]. It has become a real scourge in the waters of the whole world. Madagascar contains a large amount of water hyacinth in several regions.

During the last ten years, its spread has caused ecological and hydro-agricultural crises. It also slows down river transport, obstructs the water intakes of hydroelectric dams and the circulation of water evacuation channels in the city which causes the pollution and flooding [1].

Deforestation in Madagascar is caused mainly by the practice of slash-and-burn, logging and the production of fuel including charcoal for domestic use.

Harnessing water hyacinths for a new source of energy is a lasting solution to these problems and also decreases the consumption of charcoal.

The water hyacinth or camalote (Eichornia crassipes) is a species of monocotyledon plant of the Pontedereaceae family, native to South America (figure 1). They are aquatic plants found in rivers, canals and lakes in tropical regions [1] .

This plant can be propagated either by the seeds that the hyacinth emits abundantly or in ways by dividing the sucker, more precisely by the growth of a stolon detached from the mother plant [3]. The body of water for its cultivation should be just a few feet deep enough for the development of its root. Growing water hyacinth only takes a few days and requires only good natural conditions like light and a good water temperature which should not be too cold. Madagascar is one of the countries that contains water hyacinth in the African continent.

Fig-1: water hyacinth

Chemical composition

The Table 1 shows the major elements in water hyacinth [4].

Table-1: Major elements in water hyacinth

Elements	Chemical formula	Concentration in mg/kg
Hydrogen	H	60000
Carbon	C	450000
Oxygen	O	450000
Nitrogen	N	15000

2. METHODOLOGY

2.1. Bio-coal design

-Pickup

There are several places in Madagascar that can provide us with water hyacinth. A bag of water hyacinth costs around 1000 Ar. To start the work we need to collect or buy bags of water hyacinth and store them in a dry environment.

-Drying

After collecting, let's move on to the next step, which is drying the collected water hyacinths. The drying temperature should not exceed 50 ° C and the drying time is about a week.

-Carbonization

This process takes place in a carbonizer, here carried out in a metallic barrel. The dry hyacinth is introduced into the barrel; it is then ignited in order to gradually reach a temperature of 400-500 ° C.

Dry Hyacinth ⟹ **Pyrolysis** ⟹ **Carbonized**

+400 °C without O2

-Grinding

We have to use a grinder to make the charred water hyacinth into a powder.

-Adding the additive

We need to use the potato starch as an additive. The potato starch ensures the bonding between the mixture of the charred powder because of its high viscosity quality. If the amount of charred powder is 80%, we need 20% potato starch while adding water until the mixture becomes viscous.

-Molding

After mixing, we obtained an ecological charcoal paw. The molding consists of putting the viscous paws in the molds.

-Drying and Packaging

After molding, put the racks in the sun for 5 to 7 days while the briquettes dry. Pack briquettes for storage and sale. Protect products well in the event of rain. In the end we get ready-to-use ecological combustible.

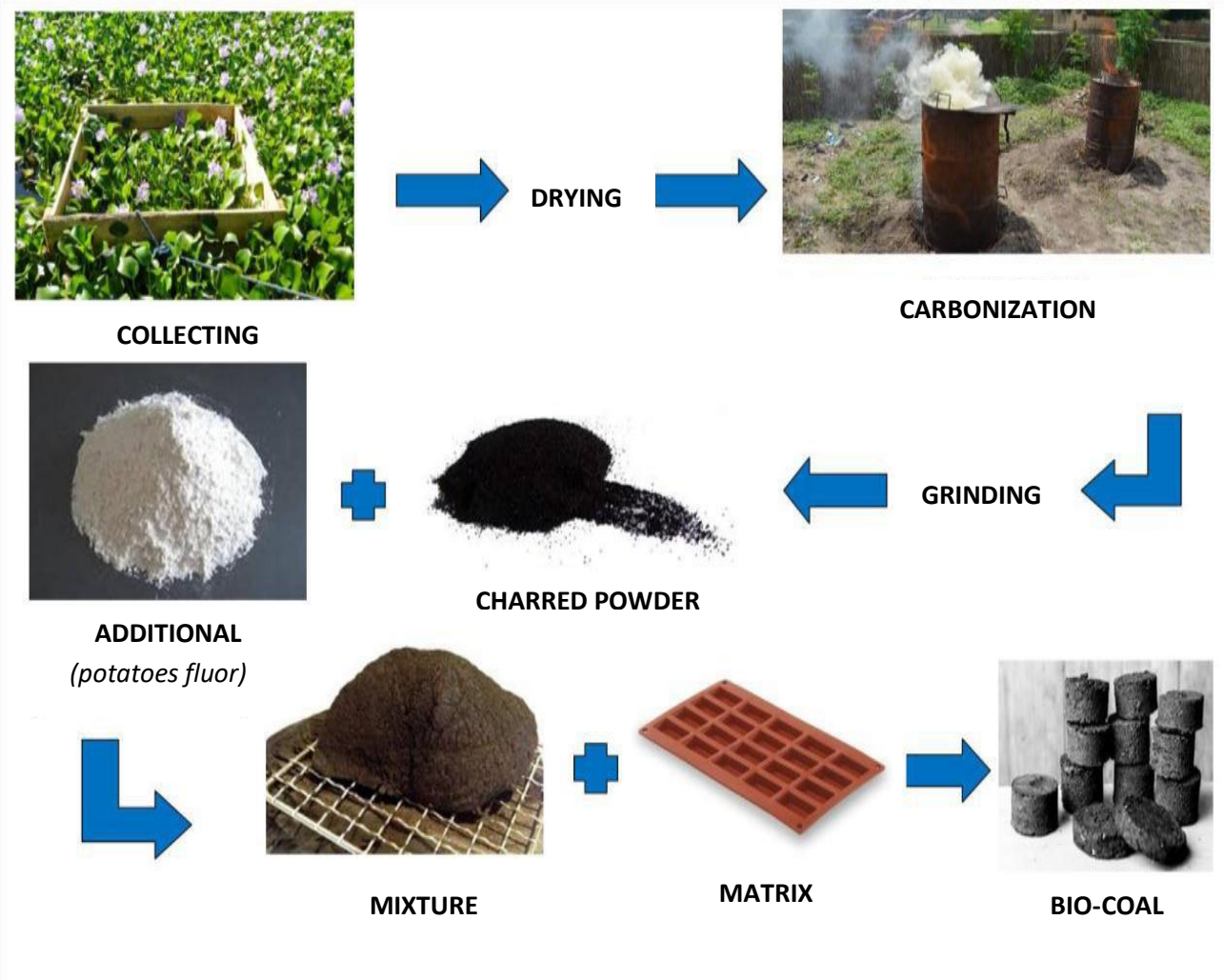

Fig-2: Simplified diagram of the stages in the production of bio-coal.

2.2. Bio-coal analysis methods

After production, quality control analyzes were carried out in the laboratories according to the coal analysis protocols [6, 7, 8, 9, 10, 11] in order to ensure the effectiveness of the product.

Different analysis steps are used for the quality control of the bio-coal.

-Analysis to determine humidity, ash content, volatile matter content as well as fixed carbon.

-The determination of the calorific value of bio-coal by an adiabatic isoperbol calorimeter bomb.

3. RESULTS AND INTERPRETATIONS

An ecological biofuel product was obtained which after laboratory analyzes gives a calorific value of 5 594 kCal . kg^{-1}. It is a combustible that will be both economical and environmentally friendly.

Table-1: Analysis results of bio-coal

	Humidity (%)	Volatil Matter (%)	Ash (%)	Fixed Carbon (%)	Calorific Value (kCal)
Bio-coal (1 kg)	6,95	23,34	25,68	43,98	5594

Comparison with charcoal

The table shows the comparison of this bio-coal versus charcoal in order to compare the quality.

Table-2: Comparison results

	Humidity (%)	Volatil Matter (%)	Ash (%)	Fixed Carbon (%)	Calorific Value (kCal)
Charcoal (1 kg)	6,02	18,92	48,97	31,07	3566
Bio-coal (1 kg)	6,95	23,34	25,68	43,98	5594

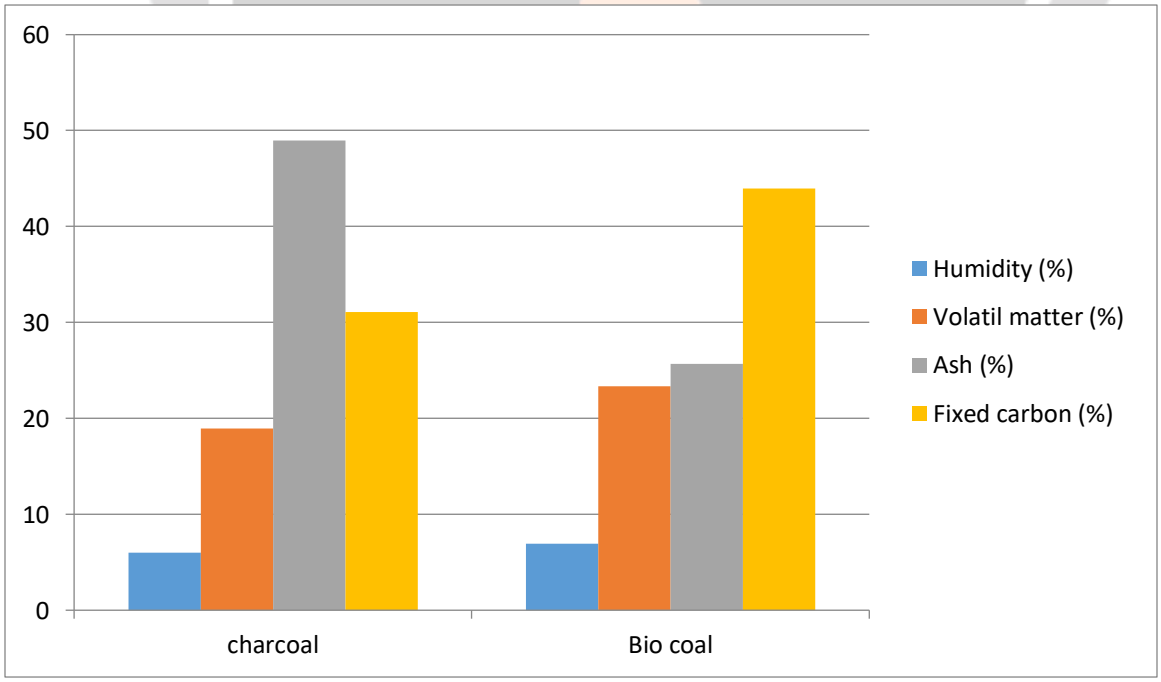

Chart-1: approximate analysis comparison

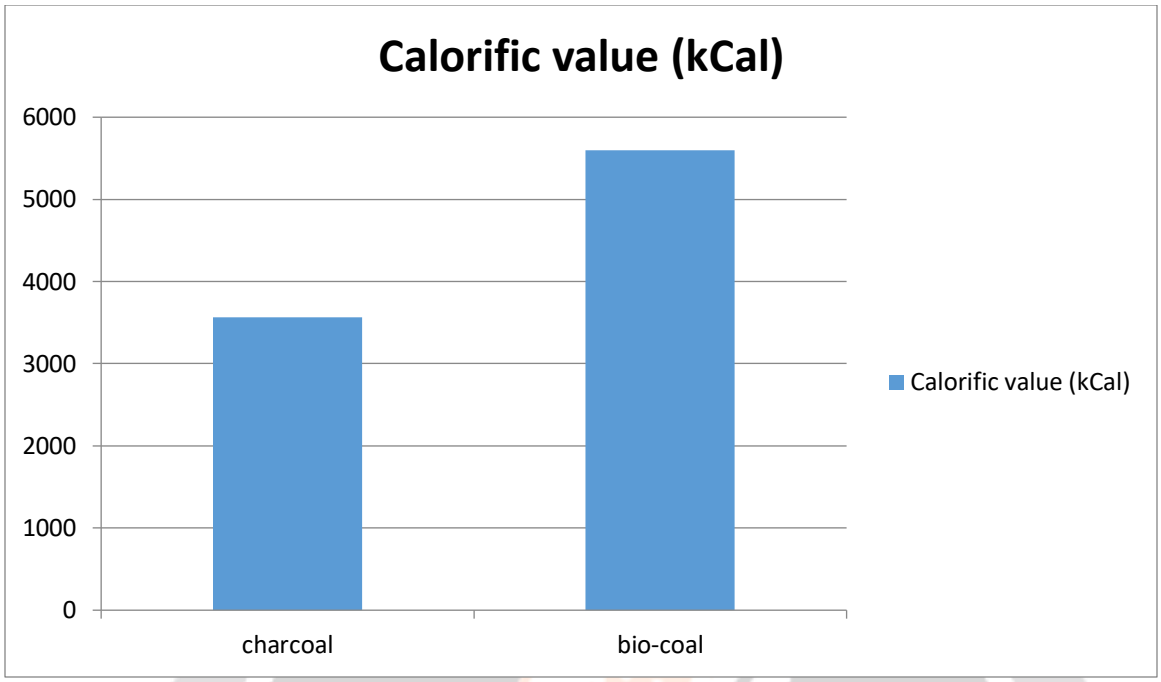

Chart-2: Calorific value comparison

The calorific value of bio-coal is almost double that of charcoal, which means that bio-coal ignites and produces twice as much energy as charcoal. As for the ash content of bio-coal, it gives off half as much ash as charcoal, therefore beneficial for health and the environment. We can clearly see that ecological fuel is very beneficial for everyone. We can also deduce that for 1 kg of charcoal is equivalent to only 0.5 kg of ecological fuel. The need is halved with this new fuel.

4. CONCLUSION

Deforestation in Madagascar is caused mainly by the practice of slash-and-burn, logging and the production of fuel including charcoal for domestic use. Indeed, 92% of the daily energy of Malagasy people comes from charcoal and more than 85% of households use it mainly for the preparation of the meal.

Water hyacinth is an invasive aquatic plant with a high amount of carbon and during the last ten years, its spread has caused ecological and hydro-agricultural crises. It also slows down river transport, obstructs the water intakes of hydroelectric dams and the circulation of water evacuation channels in the city which causes the pollution and flooding.

The design of bio-coal from water hyacinth begins with collecting, then drying through carbonization. Once crushed, additive is added to it. In order to have the desired shape, the use of a mold is necessary and finally we dry in the sun before packaging.

Thus, we obtain an ecological fuel with a calorific value of the order of 5594 $kCal.kg^{-1}$, which is approximately twice that of charcoal and the ash content of bio-coal is half the content of ash from charcoal, therefore beneficial for health and the environment.

5. REFERENCES

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