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Original Article

Bio-Oil Production from Ficus Trees Trimming Biowaste with Simple Method

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Abstract *- Bio-oil was produced by partially incarnation processes for any biowastes using a simple, low-cost kiln designed inside the cylindrical chamber with a total size of 0.272 m3 made up the kiln. The study was made on five residence times (2, 2.5, 3, 4, and 5 hours) to determine the impact of temperature on the Bio-oil's quality and quantity. Temperature and retention duration have a big impact. According to the results, a low pyrolysis temperature of 400 °C and a retention period of 1 hour can provide a bio-oil with a basic pH of 4.27, a lower water content (36%) and a greater calorific value (37.1 MJ/kg) as well as a bigger fraction of important aromatics. Therefore, the study shows that it is feasible to produce bio-oil from Ficus trees trimming biowaste under controllable circumstances. The bio-oil produced by this pyrolysis methodology shows higher results than previous studies, with better quality for use as fertilizer and soil improvement material for irrigation and soil reclamation in dry lands.*

Keywords *- Bio-oil, Pyrolysis, Ficus trees trimming, Low-cost, Bio-waste.*

1. Introduction

Bio-oil can improve soil bioactivity and water retention capacity even in drylands with little soil fertility. Recycling trash instead of throwing it away, the old-fashioned method, promotes resource sustainability and benefits the environment. Consequently, using the waste from Ficus trees as soil conditioners is an innovative method to encourage the development of drylands and increase their productivity. Adopting this simple resource reuse approach can have a significant positive impact on the ecosystem and agriculture in arid regions.

Investigating the reuse of biowaste, particularly concerning cutting Ficus trees, requires a solid understanding of the corpus of research on organic amendments and waste bioconversion. In the first reviewed publication, Galic and Bogunovic (2018) provide a comprehensive agrochemical assessment of solid residues and by-products from the wine and olive industries. Their findings demonstrate the agronomic benefits of composted agricultural wastes, particularly with regard to enhancing soil quality and crop yield.

The study found that the long-term application of composted olive mill pomace to olive orchards significantly improves soil properties and promotes the production of higher-quality fruit and oil. When considering similar applications for biowaste from the trimming of Ficus trees, this insight offers a basic understanding of how organic additions may enhance soil qualities [1]. Explores the possibility of using woody biomass and municipal solid waste as feedstocks to manufacture bio-oil, thus expanding on the issue of waste use. According to this study, some waste materials can produce bio-oil with compositions similar to those of conventional sources, offering the advantages of waste reduction and renewable energy production. The results highlight the need for a methodical comprehension of feedstock properties, essential for streamlining the procedures involved in producing biofuel [2].

Bio-oil production from agricultural waste is emphasized in a more recent evaluation, along with its potential for effective waste management and environmental advantages. By concentrating on sustainable feedstocks that do not compete with food production, the authors note a growing drive in the bio-oil research community to identify alternative sources that support sustainability objectives.

In addition to addressing environmental concerns, this initiative advances understanding of the many waste materials that may be recycled for energy production and dryland soil enhancement. [3].

Lastly, a thorough review of microbial inoculants in the bioconversion of waste biomass into bio-organic fertilizers is given by Michelin Kiruba N. and Saeid (2022). The growing interest in waste valorization and bioconversion techniques like anaerobic digestion and vermicomposting is highlighted by their systematic review. Although they also recognize the difficulties related to pathogen presence and nutrient content, the authors emphasize the potential of these techniques to improve the quality of composted organic wastes. [4].

By presenting a variety of approaches for using biowaste in soil improvement and biofuel generation, these articles illustrate the critical intersection of waste management, agricultural sustainability, and renewable energy. With 16 million Ficus trees, Egypt's agricultural sector generates about 7.3 million tons of dry matter yearly [5]. Under typical growth circumstances, a date Ficus tree produces 12–15 new leaves on average; as a result, it is reasonable to anticipate that the same number of leaves will need to be removed for upkeep [6].

In order to lessen dependency on non-renewable energy sources, biomass offers a low-cost, renewable, and ecologically friendly way to generate bioenergy in the form of bio-oil or bio-crude. Bio-oil, or bio-crude, is the term commonly used to describe the liquid product obtained from the thermochemical conversion of biomass. In order to prevent misunderstandings, this review will make significant use of the term "bio-oil." Bio-oil is a liquid fuel that may be used as a practical substitute for fossil fuels to reduce pollution-causing greenhouse gas emissions, geopolitical instability in supply regions, and volatile fuel prices [7].

The resulting bio-oil can be used in boilers, burners, turbines, furnaces, and engines. Bio-oil-derived compounds can be utilized as fertilizers, adhesives, agrochemicals, and resins. They can also be used to flavor food. After appropriate upgrading, bio-oil may be converted into a range of alternative fuels for transportation, such as biodiesel for cars, bio-gasoline, and bio-jet fuel [8].

Bio-oil emits approximately 50% less nitrogen oxide than diesel oil, making it a greener fuel than fossil fuels due to its low percentage of CO2 production. However, before bio-oil can be utilized as chemicals and motor fuel, it has to be upgraded. Numerous techniques, such as hydrogenation, solvent addition, and catalytic cracking, are being investigated in the literature to improve bio-oil [9].

2. Problem Formulation

Many agricultural, animal, and human wastes are wasted, damaging the environment. The residues of crops fed with sulfur and nitrogen-rich fertilizers are frequently burned in field fires, which are sluggish, smoky smoulders.

2.1. Soil Degradation

Intensive agricultural practices lead to increased crop yields, erosion, and fertility loss. The organic compounds in bio-oil, produced by pyrolyzing biomass, can improve soil quality. When added to soil, bio-oil increases microbial activity, increases nutrient accessibility, and helps retain moisture, all of which contribute to improved soil health.

2.2. Pest and Weed Management

Chemical pesticides and herbicides pose a major threat to human health and the environment. These pesticides may cause weeds and pests to become resistant, which might lead to a cycle of further treatments. The phytotoxic properties of bio-oil have demonstrated potential as a natural pesticide. When applied correctly, it can deter some pests and prevent the growth of weeds.

2.3. Economic Viability

Farmers frequently deal with shifting market prices and growing input expenses. Bio-oil can offer economic resilience as an affordable alternative to energy and input needs. Farmers may lessen their dependency on external energy sources and increase their revenue from value-added products by turning locally produced biomass into bio-oil.

3. Materials and Methods

This research was done at Sanitary laboratory field pilots, Faculty of Engineering, Ain Shams University, Cairo, Egypt. The design was made using a suitable size for one community. Unit sizing according to design was as follows:

- Inner part steel tank (40*68) cm at a height of 20 cm.
- Outer part steel tank (60*88) cm.
- Two copper valves (2) in.
- One copper valve (3/4) in.
- Quench steel tank (30*30) cm, surrounded by cooling pipes (1/8) inch.
- Bio-oil steel tank (30*30) cm.
- Water tank (30*30) cm. with the pump to complete the quench system.
- Using 4 m of Galvanized Steel pipes with diameter 2 inch.

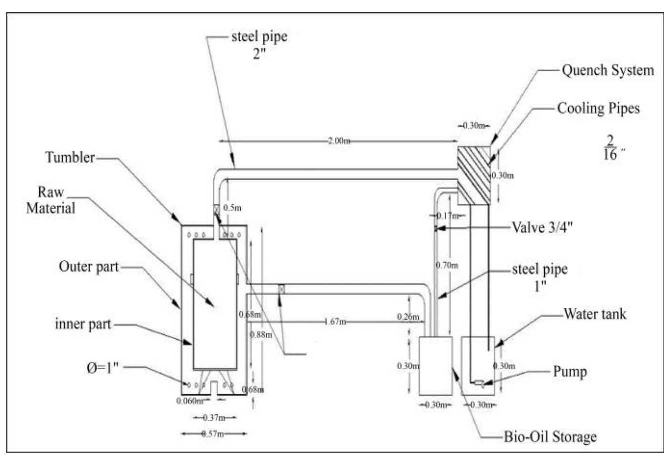

Fig. 1 Dimensions and engineering drawing of bio-oil production unit

The pilot was being operated throughout a number of runs with varying operation times ranging from 2 to 5 hours at intervals of 0.5 to 1.0 hours and a set preparation time of 15 minutes utilizing raw biowaste Ficus tree pruning.

The smaller compartment is filled with the waste from Ficus trees and shut firmly. After that, a bigger chamber is placed within this smaller one. To heat the Ficus tree waste in an oxygen-free atmosphere, a tiny amount of wood or any other waste material is used to start a fire surrounding the bigger chamber. Bio-oil is created when the gases produced by this process condense in a condensation chamber. To aid in the burning process, the combustible gas that leaves the condensation chamber is sent to the primary combustion chamber. Samples of bio-oil were taken and analyzed for their characteristics. The following measurements were made for each sample at the Dry Land Institute, ASU, Cairo, Egypt laboratory.

- Burning Time (hr.)
- Weight of Raw (kg)
- Bio-oil Weight (kg)
- Bio-oil yield (%)
- O.M %
- O.C %
- Total Nitrogen %
- Total phosphorus %
- Total Potassium %

4. Results

The duration of each run was four weeks. The analysis of every sample gathered during the pilot study's initial run is shown in Table 1. The analysis of every sample gathered during the second pilot research run is displayed in Figures 2 through 6.

Table 1. Resulted Bio-oil analysis

Resulted Bio-oil analysis					
Burning Time (hr.)	2 (hr.)	2.5 (hr.)	3 (hr.)	4 (hr.)	5 (hr.)
Weight of Raw (kg)	3	3	3	3	3
Bio-oil Weight (kg)	0.257	0.357	0.455	0.585	0.70
Bio-oil yield (%)	8.57	11.90	15.17	19.5	23.33
PH (value)	4.31	4.25	4.01	3.27	3.21
O.M %	9.49	11.42	13.07	11.84	11.28
O.C %	4.30	6.60	7.60	6.88	6.56
Total Nitrogen %	0.39	0.45	0.38	0.22	0.36
Total phosphorus %	N/A	N/A	N/A	N/A	N/A
Total Potassium %	12.68	25.02	29.63	11.02	16.70

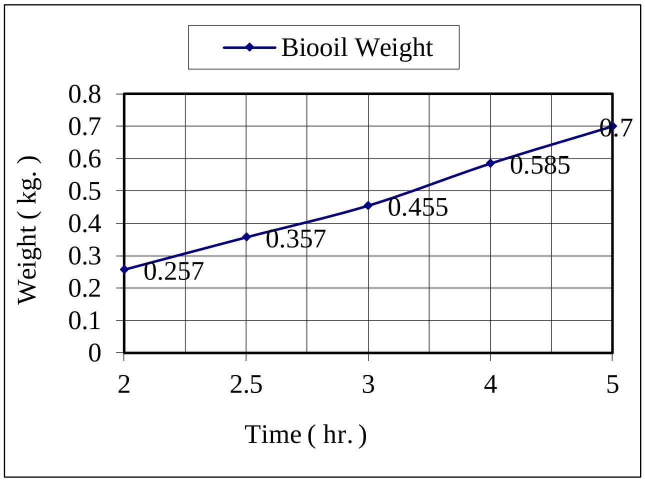

Fig. 2 Relation between burning time and weights (Bio-oil)

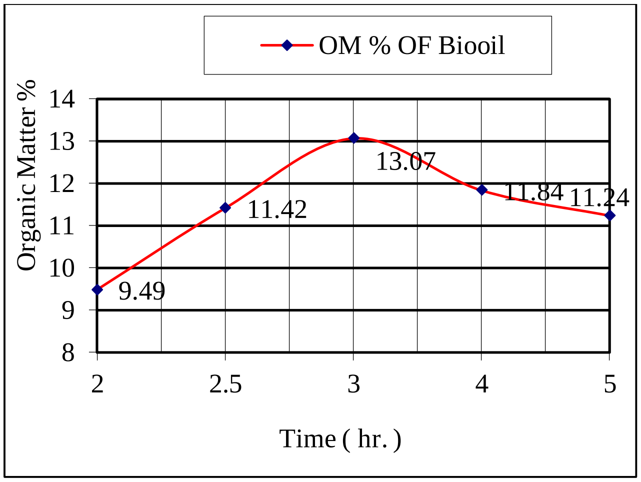

Fig. 3 Relation between burning time and Organic Matter (Bio-oil)

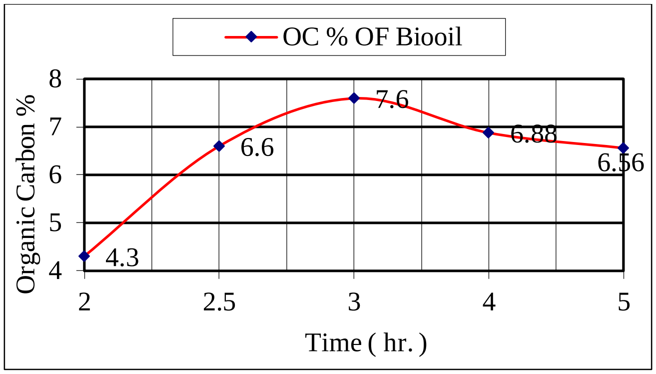

Fig. 4 Relation between burning time and Organic Carbon (Bio-oil)

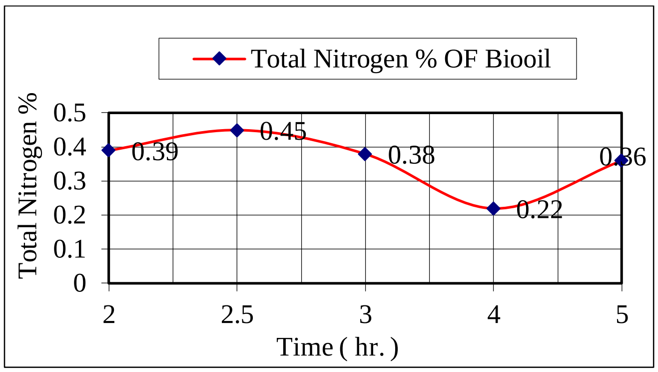

Fig. 5 Relation between burning time and total nitrogen (Bio-oil)

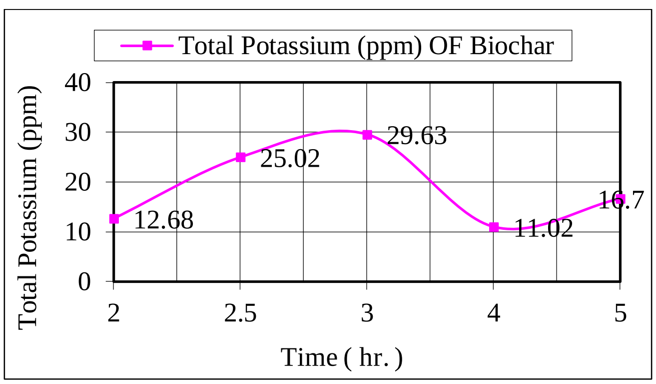

Fig. 6 Relation between burning time and total potassium (Bio-oil)

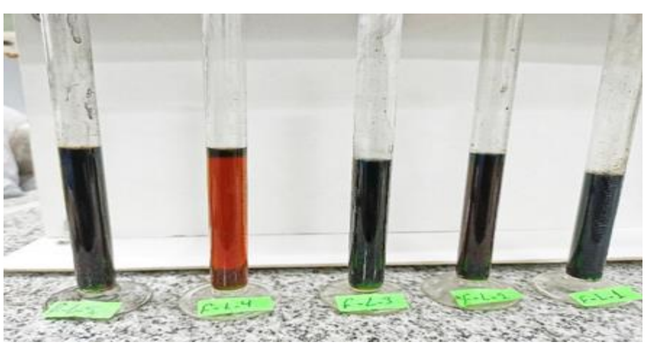

Fig. 7 Bio-oil of (Ficus Trees trimming) shape after burning

F: Ficus Trees Trimming
L: Liquid
Number: The number of samples arranged ascending.

5. Discussion

Bio-oil yields increase with longer burning times, ranging from 8.57% for two hours to 23.33% for five hours. This implies that higher carbon retention and char formation are produced by extended pyrolysis, which is most likely brought on by the thermal breakdown of organic components that results in more stable carbon structures.

As the burning time increases, the pH measurements substantially drop. The pH decreased from 4.31 after two hours to 3.21 after five, suggesting that the bio-oil becomes more acidic as the pyrolysis process is prolonged. Since lower pH levels may prevent plant development if applied excessively, this can significantly affect the soil's chemistry. The percentage of organic matter fluctuated initially, peaking at 13.07% over three hours before dropping to 11.28% after five. As pyrolysis continues, the organic matter decomposes, and its content falls, although the initial increase indicates that more organic material is being kept [10].

The organic carbon content also rises initially, peaking at 7.60% after three hours and then declining slightly to 6.56% at five hours. This pattern shows how bio-oil may retain carbon in the form of stable structures, which is in line with the behavior of organic matter.

After peaking at 0.45% for 2.5 hours, the percentage of total nitrogen drops precipitously to 0.22% after 4 hours. This trend suggests that as burning times rise, the amount of nitrogen decreases, most likely due to the loss of nitrogenous molecules caused by pyrolysis [10, 11].

Variability: values increased to 29.63 ppm three hours later before dropping again. The fluctuating potassium levels might result from potassium salts leaching or altering during burning. The absence of total phosphorus data (N/A) is noteworthy as it is a crucial factor in determining the availability of nutrients.

The acquired data exhibited a strong trend in agreement with the data produced [12, 13]. Showing how highly condensed components become at higher temperatures. According to [14], however, bio-oil from Ficus trees trimmed at the same temperature and residence duration yielded higher values under the same production circumstances. Possible causes of the discrepancy in results include different pyrolysis methods and the peak of the curve at five hours, as well as the optimal state at three hours and fifteen minutes.

Increasing in Percent Nitrogen: The bio-oil's volatile constituents, including light hydrocarbons, water, and gasses, continue to evaporate as the pyrolysis process continues. Over time, this causes the total mass of bio-oil to decrease. As the volatile mass diminishes, the nitrogen concentration in the leftover bio-oil increases. This explains why, even when the total amount of nitrogen stays mostly the same or slightly rises, the proportion of nitrogen in the bio-oil gradually increases.

Creation of Stable Potassium Compounds: Potassium can also react with organic acids or other substances in the bio-oil to create compounds that include potassium, such as potassium phenolate or potassium acetate. Because they are less likely to volatilize, these stable chemicals help to raise the potassium concentration in the bio-oil after four hours.

Table 2. Comparison between this study and previous studies for bio-oil

Properties	This study	Literature data	Reference
Bio-oil yield (%)	**6.67-14.47**	5-15	15
PH (value)	**2.51-4.23**	2-4.64	16
Total Nitrogen %	**0.015-0.046**	0.001-0.048	17
Total phosphorus %	**0.07-0.08**	0-0.09	18
Total Potassium %	**5.7-19**	10-30	17

6. Conclusion

The efficient use of the pyrolysis process has transformed the production of outstanding bio-oil, which is ideal for enriching soil with essential nutrients. This innovative technique significantly improves conditions in dry areas while increasing the soil's capacity for agricultural production. Bio-oil produced from pyrolysis may effectively boost plant growth and size, resulting in more robust crops. The pyrolysis process involves the thermal decomposition of organic molecules without oxygen, producing bio-oil rich in nutrients. This bio-oil acts as a natural fertilizer by providing plants with the macronutrients and micronutrients they require for wholesome growth. When farmers use this nutrient-dense bio-oil in their soil management practices, they observe noticeable improvements in soil fertility, structure, and water retention.

Furthermore, it is impossible to overestimate the potential of bio-oil produced from pyrolysis to improve dryland conditions. This technique promotes sustainable farming techniques that foster robust crops that can flourish in harsh situations by enhancing the health and nutrient content of the soil. Crops show greater vigor and production potential, demonstrating the beneficial effect on plant development and size. The pyrolysis process has produced high-quality bio-oil that enhances agricultural productivity, particularly in dry areas and enriches soil with vital nutrients. This development is a step on the right path toward sustainable farming practices that enhance plant growth and boost food security.

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