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EFFECT OF PYROLYSIS DURATION ON BIOCHAR YIELD FROM WHEAT STRAW

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Abstract. This study investigates the effect of pyrolysis duration on biochar yield from wheat straw. According to the study's conclusion, high-quality biochar was obtained by pyrolyzing wheat straw at 400 °C for 30 minutes. The results section reports biochar yields of 39%, 35%, and 33% after 15, 30, and 45 minutes, respectively.

Keywords: biochar, pyrolysis, wheat straw, temperature, pyrolysis duration, yield.

Introduction

Biochar is a carbon-rich material used as a soil amendment to increase the amount of organic matter in soil. It is produced by heating biomass—such as corn husks or stalks, rice straw, or wheat straw—in an oxygen-limited environment through a process known as pyrolysis. Its composition includes ash and carbon [1].

Biochar can help improve soil aeration, reduce greenhouse-gas emissions from soil, decrease nutrient leaching and soil acidity [2, 3], and reduce the need for irrigation and fertilizers [5]. It may also increase water-holding capacity in soils with a light texture [4]. In addition, biochar can play a role in stimulating soil microbial activity [6].

Biochar may increase the yield of crops that require potassium and a relatively high-pH environment [7, 8]. It can also improve plant resistance to fungal diseases [9].

Biochar can be particularly important for improving the fertility of degraded soils in tropical and subtropical regions, although its benefits may be less pronounced in temperate regions [10].

The selection of feedstock and the determination of suitable pyrolysis temperature and duration are important for obtaining a high yield of high-quality biochar.

Materials and Methods

Wheat straw was selected as the feedstock because it is inexpensive, widely available on farms, and available in substantial quantities. The straw was first chopped into pieces measuring 10–20 mm and 20–30 mm, then dried for two hours at 105 °C in a Memmert UN 200 drying oven until a constant mass was reached. The masses of the dried feedstock and the resulting biochar were measured using a VLTE-1100 technical balance. Pyrolysis was carried out in a THERMNEVO EVO mini muffle furnace. The study examined the effect of pyrolysis duration (15, 30, and 45 minutes) on biochar yield at a temperature of 400 °C.

Results and Discussion

Interest in the potential role of biochar in mitigating global climate change is increasing [11]. Pyrolysis efficiency depends on process conditions such as temperature, heating rate, and pyrolysis duration [12]. These parameters can be adjusted to increase biochar production [13]. For example, temperatures of 400–500 °C can produce more biochar, whereas temperatures above 700 °C reduce biochar yield. However, pyrolysis at high temperatures can take minutes rather than hours [14].

Taking into account the effect of pyrolysis conditions, the suitable duration for obtaining high-quality biochar from the tested feedstock sizes was assessed (Table 1).

The results indicate that pyrolysis was incomplete after 15 minutes for both feedstock size ranges. High-quality biochar was obtained when pyrolysis lasted 30 and 45 minutes.

Table 1. Suitable pyrolysis duration for obtaining high-quality biochar

Feedstock size (mm)	15 minutes	30 minutes	45 minutes
10–20	–	+	+

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20–30	–	+	+

Note: – insufficient; + sufficient.

The study also examined the effect of pyrolysis duration on biochar yield from the feedstock. At a pyrolysis duration of 15 minutes, biochar yield was 39% of the initial feedstock mass. When the duration was doubled to 30 minutes, the yield was 35%; when it was tripled to 45 minutes, the yield was 33% (Figure 1).

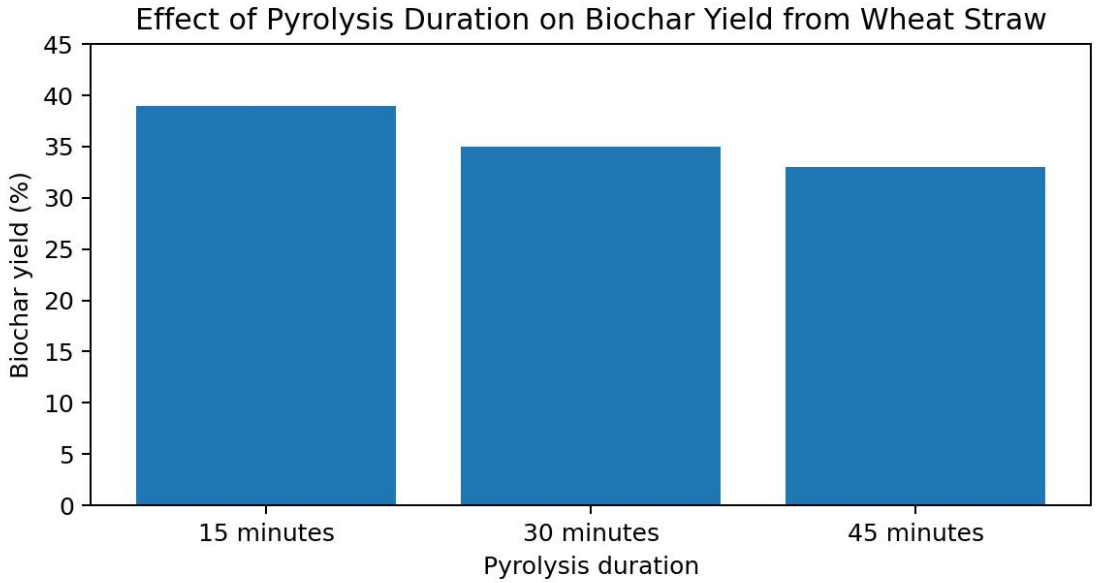


Figure 1. Effect of pyrolysis duration on biochar yield from wheat straw.

Conclusion

Biochar yield from the feedstock depends on pyrolysis duration, and the yield decreases as the duration increases. Biochar yield also depends on the type of feedstock and its composition. The article recommends pyrolyzing wheat straw at 400 °C for 30 minutes to obtain high-quality biochar. It should be noted that the reported yield values in the results section are 39% at 15 minutes, 35% at 30 minutes, and 33% at 45 minutes.

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