Kerr Center for
Sustainable Agriculture
P.O. Box 588
Poteau, OK 74953
Phone: 918.647.9123
Fax: 918.647.8712
mailbox@kerrcenter.com
www.kerrcenter.com

Feedstock Guide for a Two-Barrel Nested Biochar Retort

by Jonathan Pollnow, Student Intern 2013
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Introduction

Kerr Center's 2013 investigations of biochar relied on a simple two-barrel nested retort. Details on this retort are available at www.kerrcenter.com/publications/biochar_retort.pdf ; a step-by-step procedural is located at www.kerrcenter.com/publications/biochar_sm.pdf

During 2013, we looked at various on-site waste materials as possible feedstocks for making biochar, with the expectation that some would perform better than others. Composition is one important factor in performance. Better feedstocks are generally those that are high in lignin, which produce higher yields of char (Lehmann and Joseph 2009; Orfao et al. 1999). Feedstocks higher in cellulose do not do as well. We understand this to be a matter of time, temperature, and heat.

Our retort only heats the feedstock to about 350° C (662° F). Cellulose does not start to degrade until temperatures reach 300° F to 315° F, depending on the nutrient content of the feedstock. Feedstocks like okra stalks, with high cellulose content (>60%) do not char very well because the retort only exposes the feedstock to high temperatures for a relatively brief amount of time. Okra stalks may need more heating time because cellulose is a natural insulator. With a two-barrel nested retort, longer heat exposure would mean conducting a burn twice, and this is impractical.

The accompanying table lists possible biochar feedstocks found in Oklahoma and their proportions of cellulose, hemicellulose, and lignin. Ideal feedstocks for use with a two-nested barrel retort are highlighted [1].

The "moderate suitability" feedstocks will probably produce biochar of middling quality. The "high suitability" materials will probably produce excellent quality biochar in good, satisfying quantities. The "low suitability" feedstocks should probably be avoided because of their high cellulose content. Newspaper may or may not produce decent biochar, as its lignin and cellulose content can vary widely from publisher to publisher.

The final choice of feed stocks is not dependent on composition alone. Manure, for example, is packed with nutrients and beneficial organisms. It would be better composted and applied as such to the soil [2]. Another issue might be handling and transportation. Woody materials are more dense than crop residues, which would make them more efficient to transport. Also, crop residues are very directly important in soil protection and the cycling of organic matter and nutrients. Removing them from the field to make biochar may be counterproductive, an inefficient use of resources, and a potential contributor to soil erosion due lack of groundcover.

Notes

1. Information on many other feedstocks can be found at http://www.ecn.nl/phyllis2/Browse/Standard/ECN-Phyllis.

2. Burning manure is prohibited for certified organic production under the current National Organic Standard.

References

Lehmann, J. and Joseph, S. (eds.) 2009. *Biochar for environmental management: science and technology*. Earthscan, London.

Orfao, J.J.M, Antunes, F.J.A, and Figueiredo, J.L. 1999. Pyrolysis kinetics of lignocellulosic materials: three independent reactions model. *Fuel* 78:349-358.

Phyllis2, database for biomass and waste. http://www.ecn.nl/phyllis2. Energy research Centre of the Netherlands.

FEEDSTOCK	SUITABILITY	CELLULOSE %	HEMICELLULOSE %	LIGNIN %
okra stalks	low	67.5	15.4	7.1
sunflower stalks	moderate	40.3	31.6	15.5
sweet potato vines	leave in field	19.8	14.6	7.7
peanut vines	leave in field	45.0	18.2	11.8
rye straw	leave in field	37.6	22.5	9.7
sorghum straw	leave in field	41.5	26.1	8.4
cottonseed hulls	high	49.0	17.0	24.0
cotton straw	moderate	42.0	12.0	15.0
wheat straw	moderate	37.4	26.9	18.4
soybean straw	moderate	38.0	16.0	16.0
ryegrass straw	leave in field	37.0	27.0	5.0
corn stalk	moderate	40.4	24.6	14.3
bermudagrass	moderate	32.4	24.8	20.3
horse manure	moderate	37.8	32.4	19.6
cow manure	moderate	32.6	23.8	26.8
peanut hulls	moderate	42.0	9.0	23.0
pecan shells	high	5.6	3.8	70.0
walnut shell	high	23.3	20.5	42.5
oak leaves	moderate	30.4	28.8	24.1
pine bark	high	23.7	24.9	50.0
pine needles	high	42.6	22.3	37.7
loblolly pine slash	high	40.4	29.4	34.5
hardwood sticks	high	47.5	26.4	23.0
elm	high	43.0	22.0	27.0
spruce	high	44.5	20.6	27.8
shredded office paper	low	81.7	9.6	2.0
newspaper*	moderate	57.6	23.4	22