Enhancing Sustainability: Brewer's Spent Grain-based Biochar as a Renewable Energy Source and Agriculture Substrate

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1. **Equations for BSG biochar characterization**

$Carbon retention \left(\%\right)=\frac{C\_{biochar}}{C\_{biomass}} x BY$ (A.1)

$Water holding capacity \left(WHC\right)=\frac{Water retained weight}{Initial weight of the dry sample} x 100$ (A.2)

$Stable C mass fraction=1.00-2.24 x O/C$ (A.3)

$Aromaticity factor \left(fa\right)= \frac{1200}{1240} x \frac{\left(100\%-VM\left(daf\right)\right)}{C(daf)}=0.967 x \frac{FC (daf)}{C (daf)}$ (A.4)

$Recalcitrance potential \left(R50\right)=\frac{0.170 (0.474xVM+0.963xFC+0.067xASH)}{\left(100-ASH\right)+0.00479} $ (A.5)

$CS=BC yield x C\_{BC} x \frac{R\_{50}}{C\_{F}}$ (A.6)

Where BY was yield, daf was dry and ash-free, CBC and CF were the mass fractions of carbon in the biochar (BC) and feedstock (F), respectively.

1. **Equations used in Bioenergy Indices**

$LHV=HHV-2.454∙\left(\frac{Moisture \left(\%\right)+9H}{100}\right)$ (B.1)

$BD=LHV∙ρ$ (B.2)

$FVI=\frac{LHV∙ρ}{Ash(\%)}=\frac{BD}{Ash(\%)}$ (B.3)

$FFEV=\frac{BD\_{biomass}}{BD\_{fossil fuel}}∙1000$ (B.4)

$PCOR=EF∙FFEV$ (B.5)

$Energy densification \left(Ed\right)= \frac{HHV\_{biochar}}{HHV\_{dry biomass}}$ (B.6)

$Energy yield \left(Ey\right)= ED x η(\%)$ (B.7)

Where $η$ were yield.