CLEAN FRACTIONATION OF BIOMASS - STEAM EXPLOSION AND EXTRACTION

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(ABSTRACT)

The fractionation of two biomass resources, red oak *(Quercus rubra)* chips and oil palm *(Elaeis guineensis)* trunk solids, into constitutive chemical components, cellulose, hemicelluloses (called "other carbohydrates") and non-carbohydrates (includes lignin, tannins, etc.), was studied quantitatively in terms of relative cleanness. Red oak chips were steam exploded using a batch reactor at five different treatment severities, R_o 5,000, 10,000, 15,000, 20,000 and 35,000. Steam exploded fibers (SEF) of each severity were extracted with water and alkali.

Mass fractionation and summative analysis data of all solid biomass fractions were determined. These data were interpreted in term of a unifying clean fractionation concept designed to evaluate the effectiveness of the fractionation processes. Within a series of severities applied to a single biomass resource, the quantitative clean fractionation can be used to choose an optimum severity for the isolation of any particular component fraction.

The red oak results revealed that 25 % (on average) of biomass solids were lost during steam explosion. Cellulose remained almost unaffected (retained in fibers form) by water and alkali extraction. About 35-55 % of the hemicelluloses can be recovered in the water extracted liquor fraction (WEL). The remaining non-cellulosic carbohydrates were lost during steam explosion, especially at high severity. At R_o 10,000 and above, alkali extracted fibers (AEF) consists almost entirely of cellulose and non-carbohydrates. The majority of the non-carbohydrates component (> 50 %) can be isolated by alkali extraction. The non-carbohydrate component harvested increased with severity to 67 % at R_o 35,000

The optimum severity to recover the other carbohydrates component in the WEL solids and to obtain the highest yield of the AEF solids free of hemicelluloses was somewhere between at R_o 10,000 to 15,000. The best severity to recover non-carbohydrates from WEF was at R_o 35,000.

Oil palm trunk solids were fractionated in a likewise manner. However, since oil palm biomass contains significant quantities of starch, the fractionation protocol was complicated by analytical uncertainties. It appeared that other carbohydrates required severities above R_o 2,000 to be released into the aqueous extract. A significant portion (> 50 %) of the non-carbohydrates component becomes alkali soluble when severity is above R_o 8,000.

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ABBREVIATIONS

AcEF	Acetic acid extracted fibers
AcEL	Acetic acid extracted liquor
AEF	Alkali extracted fibers
AEL	Alkali extracted liquor
AH	Acid hydrolysis
AIL	Acid insoluble lignin/tannins
ASL	Acid soluble lignin/tannins
CC	Chemical composition
EtEF	Ethanol extracted fibers
EtEL	Ethanol extracted liquor
2-F	2-furaldehyde
HMF	5-(hydroxymethyl)-2-furaldehyde
HPLC	High performance liquid chromatography
MF	Mass fraction
OPT	Oil palm trunk solids
SEF	Steam exploded fibers
SM	Starting material
WEF	Water extracted fibers
WEL	Water extracted liquor