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Estimating bioenergy potentials of common African agricultural residues

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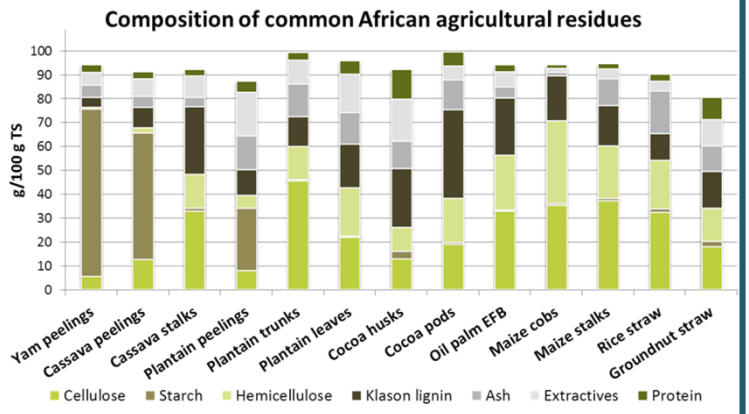
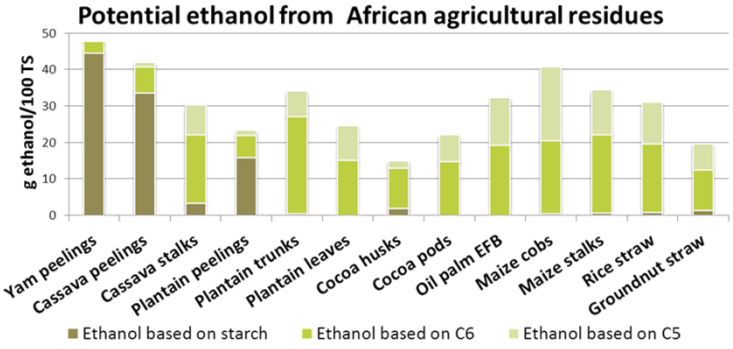
Introduction

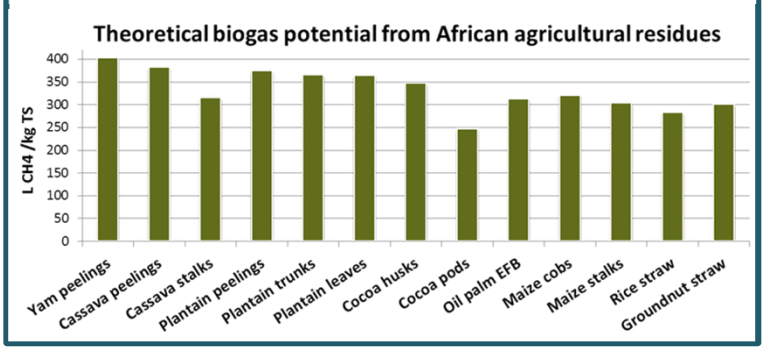
Asking a bioenergy researcher about the composition of wheat straw, he would know it by heart. But if enquiring about typical African biomasses – it would be another case. Until now, biomasses common to African countries have not received the same scientific attention as biomasses from Europe, North America or Brazil. For that reason, it is difficult to estimate bioenergy potentials in the African region.

As a part of an on-going research collaboration investigating production of 2g biofuels in Ghana, this study have analysed 13 common African agricultural residues: yam peelings, cassava peelings, cassava stalks, plantain peelings, plantain trunks, plantain leaves, cocoa husks, cocoa pods, maize cobs, maize stalks, rice straw, groundnut straw and oil palm empty fruit bunches (EFB). This was done to establish detailed compositional mass balances, enabling estimations of accurate bioenergy potentials for bioethanol and biogas. Furthermore, biomasses high in specific biomass constituents, such as hemicellulose or lignin, have been identified for future biorefinery applications.

Results







Discussion

The composition of the residues shows significant differences. **Yam-, cassava-, and plantain peelings have very high bioenergy potentials** of up to 41 g bioethanol (100 g TS)$^{-1}$ and 439 L methane (kg TS)$^{-1}$ due to a high starch content. **Plantain trunks have the highest amount of cellulose**, 46 g (100 g TS)$^{-1}$, which can hold potentials in relation to biomaterials as well as bioenergy.

Cocoa pods are unusual rich in lignin, thus poor in carbohydrates and will therefore not be optimal for fermentative processes such as in biogas and bioethanol production. However, this residue might be favorable for biorefinery purposes where a phenol rich starting material is desired.

Cocoa husks and groundnut straw are among the residues with least carbohydrates and therefore they hold low ethanol potentials, however these residues are relatively **high in protein** which makes them more attractive as livestock feed.

The bioenergy potentials are strictly theoretically based on the composition of the residues, thus **biomass recalcitrance are not taking into account**. This might have resulted in over-estimations in the presented results. As part of future studies, laboratory pretreatment and fermentation test of the most attractive residues should be done.

The findings in this study will be linked to results from project partners who have assessed availability of the agricultural residues, possible low tech pretreatment technologies, and sustainability of the agricultural systems.

Acknowledgement

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If interested visit www.2gbionrg.dk.
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Presented pictures from www. old.iita.org

Methodology

Raw material analysis was done according to standard methods (NREL 2012). Ethanol potentials were estimated stoichiometrically, while the theoretical biogas potentials were estimated using Buswell's formula:

$$C_nH_aO_b + (n - a/4 - b/2)\ H_2O \rightarrow (n/2 + a/8 - b/4)\ CH_4 + (n/2 - a/8 + b/4)\ CO_2$$

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