# X-ray spectroscopy as a tool for process control in biorefineries

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**Abstract**

Solid biomass as a biorefinery feedstock is physically and chemically heterogeneous which stress the need for rapid and accurate methods for characterization and classification. This is especially the case when considering the inorganic content of potential biomass materials suitable for the biorefinery process. It would be desirable to identify, and potentially classify, the incoming biomaterial to obtain tailored fractions of raw material supply streams for downstream manufacturing of high added-value products. Furthermore, information of the biomaterials ash related properties can be important in thermal conversion processes into heat and power. Several types of biomass material, including softwoods, hardwoods and agricultural waste, were used to acquire energy-dispersed (ED) XRF spectra in order to explore their usefulness for characterization and classification purposes. Subsequent multivariate modelling detected large variations in organic contents among the different biomass types. Several cases of separation of biomass materials were obtained by principal component analysis (PCA), classifying the materials with regard to their inorganic composition, thus providing a fingerprinting tool for biomaterial identification. Furthermore, individual inorganic compounds related to ash problems, such as silica, phosphor and potassium was classified and their content could be accurately predicted by multivariate calibration modelling using partial least square regression (PLS). One potential valuable aspect of the multivariate calibration approach is that non-detectable, by the ED-XRF instrument used in this study, compounds could be accurately predicted by utilising co-variation between individual inorganic compounds. One example, from a calibration model (PLS) consisting of wood and several types of agricultural waste, was that the alumina content could be accurately predicted primarily based on the iron content of the ingoing biomass materials. Attempts were made to predict more complex variables, such as total ash content and melting behaviour of the biomaterials ash, with varying success. This study illustrates the possibility of combining ED-XRF spectral data with multivariate statistics to classify and predict chemical properties in biomass materials and show great potential for on-line, or at least at-line, applications in a biorefinery.