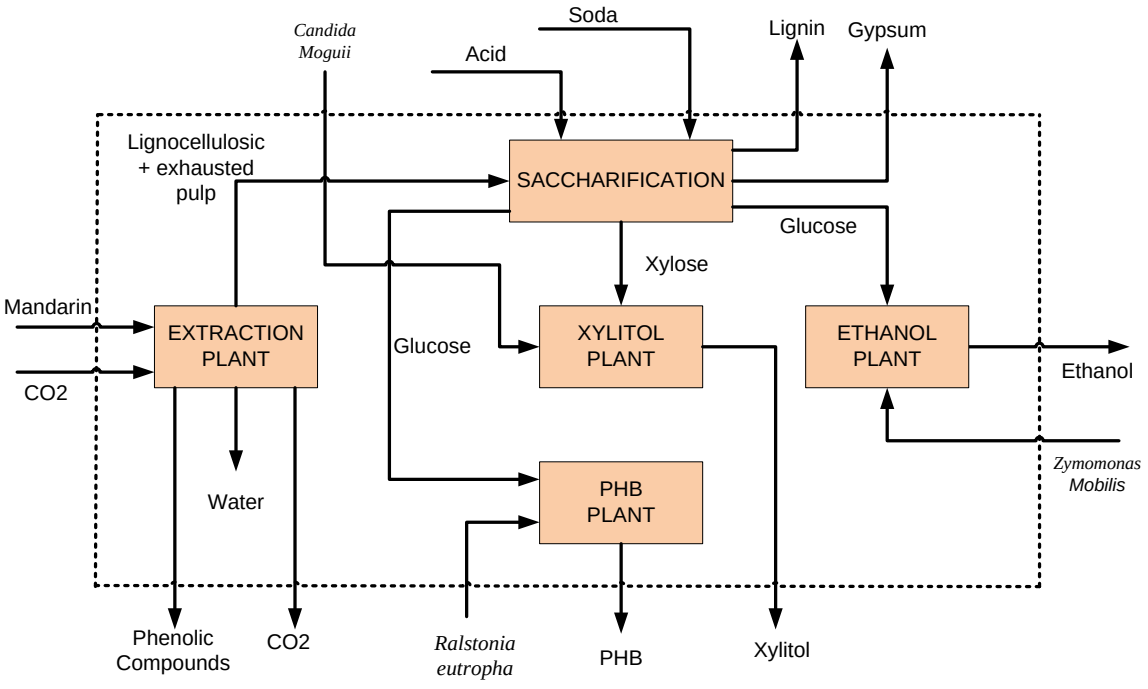
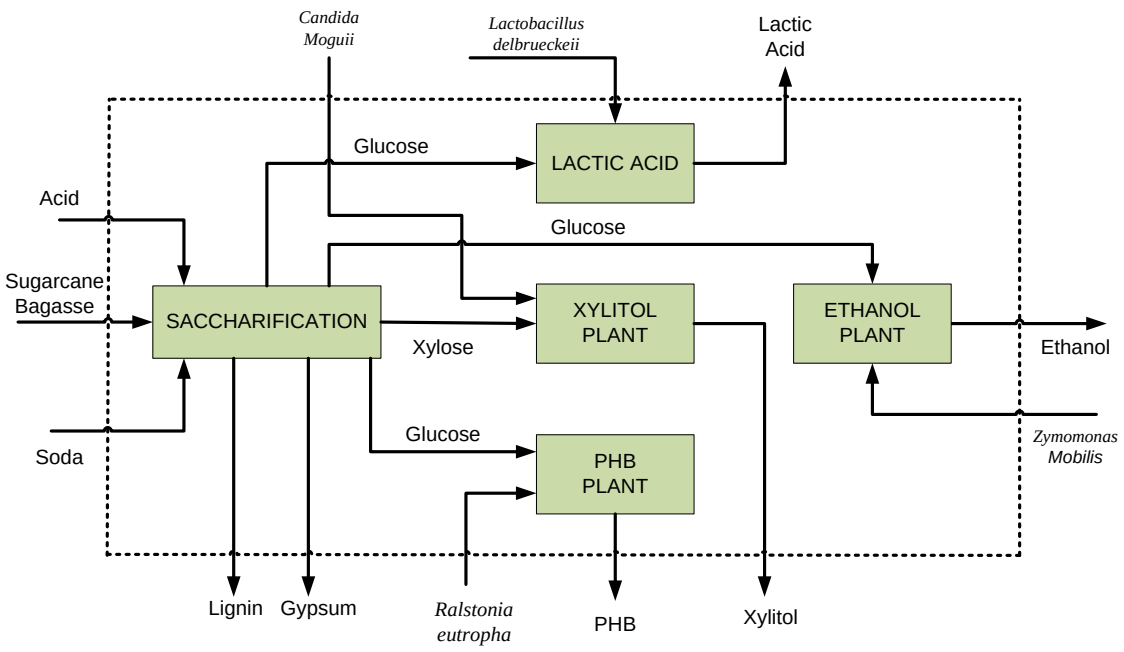
Analogous to the refinery concept in a biorefinery a wide range of bioproductos (food, biochemicals, biomolecules, biomaterials, etc.) are obtained from sustainable raw material processing. The beneficial biomass resources to be used into a biorefinery as feedstock can be classified into three main categories: First, second and third generation feedstocks. The first generation feedstocks include edible crops such as sugarcane, oil palm, maize and fruits, among others. On the other hand, non – edible energy crops, e.g. Jatropha, as well as crop residues, sustainably-harvested wood and forest residues, and clean municipal and industrial wastes are considered as second generation feedstocks. Finally, microalgae are considered as three generation feedstock [1] [2]. The small-scale biorefineries are the new trend design because these operations sometimes are unfeasible in large scale due to its production cost. Small-scale biorefineries are affected by external factors such as governmental policies, environmental considerations and market conditions [3]. These considerations have a direct influence on the supply chain decisions, technologies selections and integration forms levels [4]. The supply chains involve biomass production, biomass transportation and distribution cost. The technologies used in these processes should be carefully selected since high value-added compounds are extracted and operating costs are regularly raised because non-conventional technologies are used. This generates an increase in capital cost of the project that will be compensated with the obtained products. Levels of integration discussed in the small-scale biorefineries are fundamental because when non-conventional technologies are used the energetic costs are high [5].



Small- Scale Biorefinery



Large - Scale Biorefinery

This work presents the design and analysis of two biorefineries based on the type of scale. The first biorefinery is based on mandarin fruit to produce ethanol, poly-3-hydroxybutyrate (PHB), xylitol and phenolic compounds. On the other hand, a biorefinery based on sugarcane bagasse to produce ethanol, poly-3-hydroxybutyrate (PHB), xylitol and lactic acid was also proposed. Sugarcane bagasse was characterized by measuring moisture content (AOAC 928.09 method), klason lignin content (TAPPI 222 om-83 method), acid-soluble lignin content (TAPPI 250UM-85 method) holocellulose content (ASTM Standard D1104 method), cellulose content (TAPPI 203 os-74 method) and ash content (TAPPI Standard T211 om-93 method). In the same way, the acid pretreatment has been experimentally assessed as well as the ethanol production from the resulting sugar-rich (C6-C5) liquor using *Zymomonas mobilis* obtaining yields higher than 60% for ethanol. All the experimental stages have been developed in the Biotechnological and Agroindustrial laboratory of Universidad Nacional de Colombia Sede Manizales.

The aim of this work was to carry out a pre-feasibility analysis of the proposed biorefineries. Economic and Environmental assessment were evaluated in order to determine the most promising scenario. Two different scenarios were evaluated according to two levels of energy integration: i) biorefinery without energy integration (scenario 1) and ii) biorefinery with energy integration (scenario 2). On the other hand, eight environmental categories are evaluated using the waste reduction algorithm developed by the Environmental Protection Agency (EPA). Also was performed an analysis of sensitivity where it was evaluated the production cost and the potential environmental impact (PEI) vs. the scale of the biorefinery for determining the optimal operation point. As a result, scenario 2 was the most attractive alternative due to its integration level for both biorefineries. It was found that small-scale biorefineries have a promising future when

using non-conventional technologies that provide low contamination and different energy integration levels to obtain value-added products.

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