

Xylose Enriched Ethanol Fermentation Stillage from Sweet Sorghum for Xylitol and Astaxanthin Production

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Supplementary Information

ADDITIONAL ETHANOL PRODUCED IN SWEET SORGHUM JUICE (SSJ) COMBINED WITH LMAA-TREATED SWEET SORGHUM BAGASSE (SSB)

Basis: 1 kg total mass at start of the experiment

V_i = Initial liquid volume in L

Final Ethanol Concentration as Determined by HPLC = 69.6 g/L

Ethanol Density = 790 g/L

V_f = Final Liquid Volume

$$69.6 \frac{g}{L} \times V_f = (V_f - 0.9) \times 790$$

Solving for V_f gives a final liquid volume of 0.99 L

Ethanol volume produced:

$$V_f - V_i = 0.99 L - 0.9 L = 0.09 L$$

Mass of ethanol produced:

$$0.9 L \times 790 \frac{g}{L} = 71.1 g \text{ ethanol}$$

Ethanol yield per liter of SSJ:

$$\frac{71.1 \text{ g} \times 1 \text{ L}}{0.9 \text{ L}} = 79.0 \text{ g ethanol}$$

Using the same calculation procedure, the control experiment where only SSJ was used for fermentation the ethanol yield per liter of juice was 66.0 grams.

Additional ethanol produced:

$$79.0 \text{ g ethanol} - 66.0 \text{ g ethanol} = 13.0 \text{ g ethanol per L of juice}$$

ETHANOL EFFICIENCY

Glucan Mass Fraction in LMAA-treated SSB = 0.383 g glucan/g bagasse

Theoretical amount of glucose released assuming complete hydrolysis of LMAA-treated SSB (Basis 100 g):

$$0.383 \frac{\text{g glucan}}{\text{g SSB}} \times 100 \text{ g SSB} \times 1.11 \frac{\text{g glucose}}{\text{g glucan}} = 42.5 \text{ g glucose}$$

The value 1.11 g glucose/g glucan represents the anhydrous correction that converts mass of glucan to mass of glucose.

Theoretical amount of ethanol produced assuming complete hydrolysis of LMAA-treated SSB:

$$42.5 \text{ g glucose} \times 0.51 \frac{\text{g ethanol}}{\text{g glucose}} = 21.7 \text{ g ethanol}$$

The value 0.51 g ethanol/g glucose is the stoichiometric amount of ethanol that can be produced from glucose.

The efficiency of ethanol production is then calculated to be:

$$\left(\frac{13.0 \text{ g ethanol}}{21.7 \text{ g ethanol}} \right) \times 100\% = 60.0\%$$

THEORETICAL XYLOSE YIELD AFTER HYDROLYSIS OF LMAA-TREATED SSB

Basis: 100 g of LMAA-treated SSB

Xylan Mass Fraction in LMAA-treated SSB = 0.224 g xylan/g SSB

Mass of xylose released assuming complete hydrolysis:

$$0.224 \frac{g \text{ xylan}}{g \text{ SSB}} \times 100 g \text{ SSB} \times 1.15 \frac{g \text{ xylose}}{g \text{ xylan}} = 33.6 g \text{ xylose}$$

The value 1.15 g xylose/g xylan represents the anhydrous correction that converts mass of xylan to mass of xylose.

Final Xylose Concentration as Determined by HPLC = 18.1 g/L

$$V_f = 0.99 L$$

Mass of xylose released:

$$18.1 \frac{g \text{ xylose}}{L} \times 0.99 L = 17.9 g \text{ xylose}$$

Calculation of xylose yield:

$$\left(\frac{17.9 g \text{ xylose}}{33.6 g \text{ xylose}} \right) \times 100\% = 53.3\%$$