Enhancing energy yield through saccharification of sorghum bagasse and second generation bio-ethanol production

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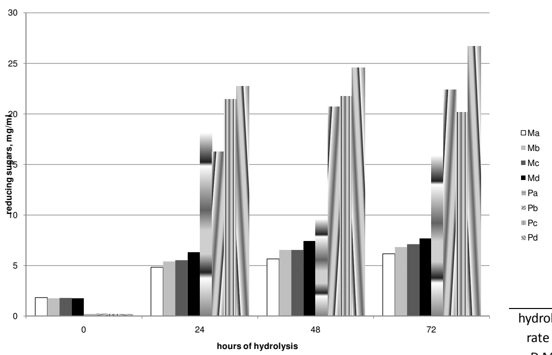
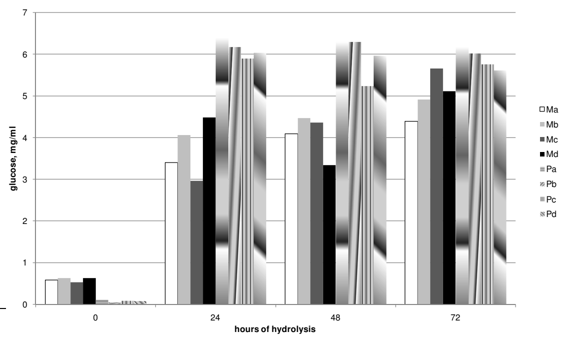
Sorghum bagasse resulted after sweet juice extraction was processed to obtain more energy as lignocellulosic ethanol. In our study, we used six commercial products consisting of biomass degrading enzymes to hydrolyze cellulose from pretreated sorghum bagasse and obtain fermentable sugars.
Tests containing combinations of steam-alkaline, mechanical pretreated bagasse (50 mg D.M.·ml^{-1}) and different enzymes cocktails were conducted.

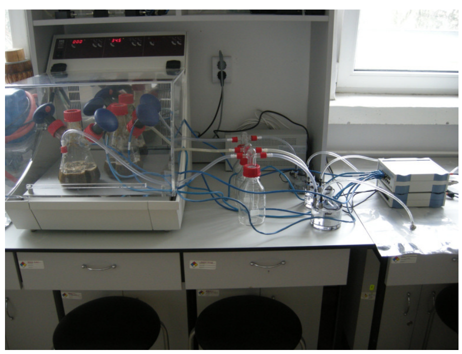


	Ma	Mb	Mc	Md	Pa	Pb	Pc	Pd
hydrolysis rate (% D.M.)	7,39	8,23	9,17	7,47	68,21	54,58	65,69	54,63



Legend: M = mechanical pretreated; P = physical-chemical pretreated (NaOH+steam); enzymes cocktails: a = NS22086; b = NS22086+NS22118+NS22119+NS+22035; c = NS22086+NS22083+NS22002; d = NS22086+NS22083+NS22002+NS22118+NS22119+NS22035

The results indicated the combination of steam-alkaline pretreatment and NS22086 cellulase complex (*Novozymes*), a mixture of cellulase and xylanase (endo -1,4-) releasing the highest yield of glucose. Regarding yield of total sugars, the cocktail formed of NS22086, NS22083, NS22002, NS22118, NS22119 and NS22035 (*Novozymes*) is the most efficient.



Next, the optimal pretreatment and hydrolysis conditions were applied to hydrolyze three types of *Sorghum bicolor* bagasse (*Sugar Graze, Jumbo and Fundulea FT132*). The hydrolysis rates obtained in the three sorghum types are between 32% and 40%. The conversion process continued with fermentation of hydrolyzates by *S. cerevisiae* in 500 ml fermenters equipped with NIR sensors (*BlueSens*) to evaluate in real time the ethanol concentration.

Sorghum type	Concentration of sugars after hydrolysis (mg/ml)	Concentration of glucose after hydrolysis (mg/ml)	Etanol, g%	Ethanol yield mg·g^{-1}
SG	11,01	3,70	1,96	392
JU	12,76	4,10	1,65	330
FT	13,56	4,54	1,74	348

From 1 kg sorghum fresh mater 460 ml juice is extracted and 143 g D.M. of bagasse is generated. The sugar concentration in juice is up to 95 g/L and the ethanol yield is 0,43 g/g sugar. According to these data, production of ethanol as energy carrier from sweet sorghum is:

	Ethanol produced, g kg^{-1} sorghum (F.M.)	Energy from ethanol*, kJ kg^{-1} sorghum (F.M.)	Lignocellulosic ethanol produced, g kg^{-1} sorghum (F.M.)	Energy from lignocellulosic ethanol*, kJ kg^{-1} sorghum (F.M.)	Total energy produced, J kg^{-1} sorghum (F.M.)
Ethanol from sweet juice	**18.8**	**501.96**	**0**	**0**	**501.96**
Ethanol from sweet juice and lignocellulosic ethanol	**18.8**	**501.96**	**49.76**	**1328.59**	**1830.55**

*calculated for an energy content of 26.7 kJ/g ethanol

Applying biotechnology developed in this study in combination with current sugar extraction method applied in sorghum, the overall ethanol production efficiency and energy yield would increase.

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