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Investigation of an Effective Acid Pre-Treatment Method for the Valorisation of Canola Fine Agricultural Residues

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BACKGROUND

Canola fines are agro-processing residues that may be exploited as lignocellulosic feedstocks to produce substrates for bio-conversion into valuable products such as bioplastics, biofuels (ethanol) and other organic chemicals(Svärd et al., 2015; Xu et al., 2021). This can be achieved by systematically pre-treating the canola fines to extract soluble sugars(Brahim et al., 2017). This paper focusses on a statistical approach for enzyme assisted acid pretreatment of canola fines to maximize sugar release. EXPERIMENTAL A batch of Canola fines was collected from an edible oil processing facility in South Africa. The material consisted of all the matter that was removed via sieving prior to pressing of the oilseeds. The size of the fines was physically reduced via cutting and grinding in order to enhance the effective surface area. Optimisation studies on the pre-treatment and enzyme hydrolysis of the prepared fines was carried out using CCD (Central Composite Design) using Design Expert software, version 13. A total of three factors were selected for the study: (i) chemical (acid) concentration (0 to 2% vol./vol.), (ii) temperature (25 to 55ºC), and (iii) biomass loading (5 to 10% wt./vol.). Twenty experimental runs were included in the CCD, and the results were analysed in terms of the types and quantities of sugars in the hydrolysates as outputs (responses). Response to each experiment was noted in terms of qualitative and quantitative analysis of extracted total sugar using HPLC Table 1. Design of experiment with three factors studied at three level and the response received in terms of Total sugar (TS) release after acid and acid assisted enzyme treatment

MAJOR FINDINGS

Analysis of variance (ANOVA) for acid assisted post enzymatic hydrolysis of canola fines for proposed quadratic model is statistically reported to be significant with the predicted R^2 of 0, 7350 in reasonable agreement with the adjusted R^2 of 0, 9147 i.e. the difference is less than 0.2. The maximum release of sugars after pre-treatment was found at the highest acid concentration (2% vol./vol.) and biomass loading of 8% (wt./vol.), with temperature having no significant effect on extraction efficiency. However, at the highest acid concentration and biomass load, a notable increase in the sugar concentration (10.79 to 22.62 g/L) occurred at the optimal temperature for the enzymes employed (55°C). Overall, the study showed that both acid pre-treatment and enzyme hydrolysis are required to release sufficient sugar substrates (glucose, xylose, arabinose) from canola fines.

TABLE 1: ANOVA for Quadratic model for acid assisted enzyme hydrolysis of canola fines

Source	*Sum of Squares*	*df*	*Mean Square*	*F-value*	*p-value*	
Model	**29,32**	**9**	**3,26**	**23,64**	**< 0.0001**	**Significant**
A-Temp	0,0713	1	0,0713	0,5172	0,4885	Not significant
B-Conc	10,59	1	10,59	76,87	< 0.0001	Significant
C-Loading	7,92	1	7,92	57,50	< 0.0001	Significant
AB	0,2350	1	0,2350	1,71	0,2208	
AC	0,3185	1	0,3185	2,31	0,1594	
BC	3,03	1	3,03	21,99	0,0009	
A^2	0,1970	1	0,1970	1,43	0,2594	
B^2	2,28	1	2,28	16,57	0,0022	
C^2	0,9835	1	0,9835	7,14	0,0234	
Residual	1,38	10	0,1378			
Lack of Fit	1,17	5	0,2342	**5,66**	0,0401	**Significant**

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