Fast chemical treatments for ligno-cellulosic yeast carriers' production from Brewers´ Spent Grains

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Caustic (NaOH) and acid-caustic (HCl + NaOH) treatments have both been previously proposed to prepare ligno-cellulosic yeast carriers from Brewers´ Spent Grains (BSG) [1]. However, these treatments are time consuming (more than 24 h). Base-treated carriers are more hydrophobic if compared to acid-base treated, enhancing adhesion in one hand, but more floatable and easily washed out from the reactor in the other hand [2]. Thus, a balance between hydrophilic (cellulose) and hydrophobic (lignin) composition in carriers obtained from BSG must be idealized. The aim of this study was to idealize a fast and simple treatment on ligno-cellulosic substrate from BSG.

Two types of BSG have been used in this work: dried BSG settle as pellets for animal nutrition and fresh BSG, directly from the beer industry. Both pelleted and fresh BSG were subjected to a series of proposed chemical treatments, as well as to treatments suggested in the literature [1] (Table 1 summarizes the conditions used). Carriers were assessed for cellulose content through high performance liquid chromatography (HPLC) (Varian, Metacarb 67H Column 300 x 6.5 mm). Briefly, approximately 0.5 g of each dried carrier was digested with sulfuric acid. The digested material was settled in glass flasks with water, autoclaved and filtered. Then, the solids were held separately for lignin content determination, while the liquid was settled in vials for sugars assessment.

Table 1 - Chemical treatments applied on Brewers´ Spent Grains (BSG) for Ligno-cellulosic yeast carrier (LCYC) preparation and bulk yield of the chemical treatments

Treatment	Description	Yield* (%)	
		Pellets	Fresh
Caustic (Brányik et al., 2001)	NaOH 2 %; 120rpm; 30 °C; 24 h	10.0	29.6
Acid and Caustic (Brányik et al., 2001)	(HCl 3 %; 60 °C; 2.5 h) + (NaOH 2 %; 120 rpm; 30 °C; 24 h)	8.7	15.1
Fast Caustic	NaOH 3 %; 70 °C; 20 min	9.1	30.0
Double Caustic 3% & 6%	(NaOH 3 %; 70 °C; 20 min) + (NaOH 6 %; 90 °C; 20 min)	5.9	20.1
Double Caustic 3% & 3%	(NaOH 3 %; 70 °C; 20 min) + (NaOH 3 %; 90 °C; 20 min)	6.8	22.7
Double Caustic 3% & 1%	(NaOH 3 %; 70 °C; 20 min) + (NaOH 1 %; 90 °C; 20 min)	8.0	25.2
Double Caustic 0.5%	(NaOH 0.5 %; 70 °C; 20 min) + (NaOH 0.5 %; 90 °C; 20 min)	15.9	36.4
Fast Caustic and Acid	(NaOH 1 %; 70 °C; 20 min) + (HCl 1 %; 70 °C; 20 min)	8.7	30.6

* Weight of carrier obtained from 100 g of BSG.

The bulk yields for the chemical treatments are displayed on Table 1. Treatments applied on fresh BSGs were significantly ($p < 0.05$) more efficient if compared to pelleted ones. Considering the materials separately, all treatments showed different ($p < 0.05$) profiles of cellulose and lignin content for both pelleted and fresh BSG (Figures 1 and 2). The coefficients of variance for cellulose (1.96 % for pellet and 3.63 % for fresh) and for lignin (4.69 % for pellet and 6 % for fresh) assure the reliability between the three repetitions for each treatment.

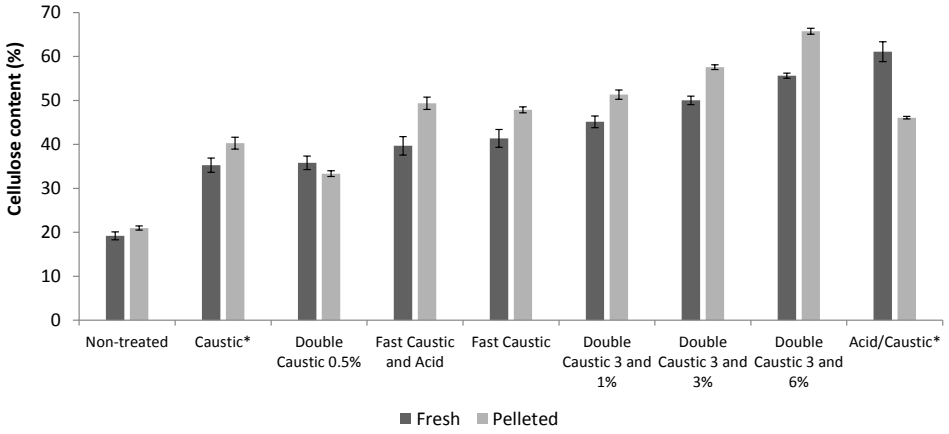

Figure 1 – Cellulose composition of 100 g dried carrier for each treatment. * Methods performed according to Bránik et al. (2001).

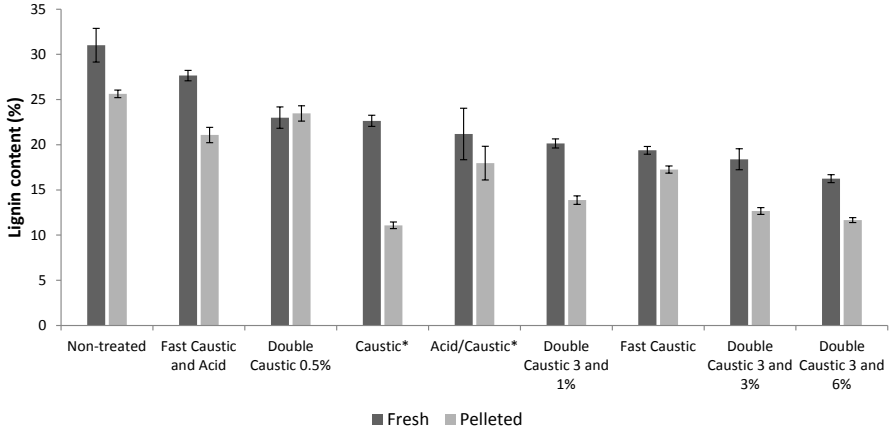

Figure 2 – Lignin composition of 100 g dried carrier for each treatment. * Methods performed according to Bránik et al. (2001).

Heat associated with caustic treatments can greatly reduce the reaction time for lignin removal from BSG, thus creating more cellulose rich carriers. The average bulk yield for treatments applied on fresh BSG was higher compared to pelleted ones. Yeast immobilization experiments can be further held on ligno-cellulosic carriers obtained from these treatments and the ideal treatment can be chosen.

References

[1] T. Branyik, A. A. Vicente, J. M. Machado Cruz, J. A. Teixeira, Spent grains - a new support for brewing yeast immobilisation. Biotechnology Letters 23 (2001) 1073-1078.

[2] T. Branyik, A. A. Vicente, R. Oliveira, J. Teixeira, Physicochemical surface properties of brewing yeast influencing their immobilization onto spent grains in a continuous reactor. Biotechnology and Bioengineering 88 (2004) 84-93.