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Extraction of aroma compounds by autohydrolysis of brewers' spent grains

Nuno G. T. Meneses, Armando R. M. Sampaio, José A. Teixeira and Solange I. Mussatto*

IBB - Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, University of Minho, Campus de Gualtar, 4710-057, Braga, Portugal
**solange@deb.uminho.pt*

The brewing industry generates large amounts of wastes and by-products that need to be treated, among of which, brewers' spent grains (BSG, the residual solid fraction obtained after wort elaboration) is the most abundant. Finding alternatives for the reuse of this by-product is of great interest for economical and environmental concerns [1]. BSG is a lignocellulosic material rich in polysaccharides and proteins and thus is a substrate of high biotechnological value. Additionally, this material present a characteristic aroma that could be used for other industrial purposes.
Autohydrolysis is a simple and relatively inexpensive technique to hydrolyze lignocellulosic materials. This technique avoids the use of chemical catalyst being a more environmentally friend alternative to the processes that require the use of chemical agents [2]. However, it is necessary to establish the best reaction conditions to obtain a liquid fraction (hydrolysate) containing predominantly the compound of interest. In the present study, BSG was submitted to autohydrolysis reactions under different operational conditions, aiming to extract aroma compounds that will be further used on the elaboration of beverages.

BSG was supplied by Unicer brewery (Portugal). As soon as obtained the material was dried at 60 ºC until approximately 5% moisture content, to be stored. Autohydrolysis reactions were carried out in an autoclave using different solid/liquid ratios (1/10 and 1/30 g BSG/ml water) at 121 ºC, during 10 or 90 min. After hydrolysis the residual solid material was separated by centrifugation followed by filtration and samples of the BSG hydrolysates were analyzed by the DNS and Coomassie Plus (Bradford) methods in order to determine the concentration of total reducing sugars and proteins.
The four different hydrolysate samples were also subjected to sensory analysis, which was performed by 22 untrained panelists in age-group between 20 and 50 years. For comparison, a sample containing distilled water was also submitted to sensory analysis to evaluate the capacity of the panelists in identifying a sample without aroma from the other samples. The panelists received samples of 20 ml (at 20 ºC) in 130-ml dark glasses, which were identified with a letter. After smelling the samples they were required to attribute a value for the intensity of aroma perceived in each one of them. A 4-point scale was suggested, where 0 denoted the absence of aroma; 1, aroma of low intensity; 2, aroma of moderate intensity; and 3, aroma of high intensity. Additionally, the panelists selected the sample that considered having the most pleasant aroma.

BSG is reported to contain significant amounts of sugars and proteins (45.2% and 15.25% w/w, respectively) [3]. Table 1 shows the concentration of total reducing sugars and protein in the BSG hydrolysates. As can be noted, none of the evaluated autohydrolysis conditions were able to promote efficient extraction of these compounds from BSG structure. Such behavior was in fact expected since the temperature has a strong influence on sugars extraction by autohydrolysis of lignocellulosic materials. Efficient sugars extraction has been reported when using temperatures near to 180 ºC [4,5], which is much higher than the value used in the present study.

Table 1. Concentration of total reducing sugars and proteins in BSG hydrolysate obtained under different autohydrolysis conditions.

Hydrolysis conditions	Time (min)	10		90	
	BSG/water ratio (g/ml)	1/10	1/30	1/10	1/30
Concentration in the hydrolysate	Total reducing sugars (g/l)	2.14	0.51	1.44	0.56
	Proteins (g/l)	0.82	0.60	0.98	0.75

Sensory analysis results revealed that the time used for autohydrolysis did not have significant influence on the aroma of the BSG hydrolysate. On the other hand, significant influence of the solid/liquid ratio on the aroma of the hydrolysate was observed. As can be noted in Table 2, the hydrolysates obtained using the highest solid/liquid ratio (1/30 g/ml) were considered to have the weakest aroma, and were chosen by 31% of the panelists as having the most pleasant aroma; whereas the samples obtained using the lowest solid/liquid ratio (1/10 g/ml) were considered to have the strongest aroma, and were selected by 69% of the panelists as having the most pleasant aroma. It was then concluded that samples with strongest aroma were the most enjoyable.

Table 2. Sensory analysis results for the BSG hydrolysates obtained under different autohydrolysis conditions.

Hydrolysate sample	Intensity of aroma[a]				Sample with the most pleasant aroma (%)[b]
	0	1	2	3	
1/10 g/ml – 10 min	0	4	8	10	37
1/30 g/ml – 10 min	1	11	8	2	26
1/10 g/ml – 90 min	0	2	12	8	32
1/30 g/ml – 90 min	0	10	10	2	5
Distilled water	19	3	0	0	0

[a] number of panelists that attributed the respective intensity values for each sample. Scale: 0 - absence of aroma; 1 - aroma of low intensity; 2 - aroma of moderate intensity; and 3 - aroma of high intensity.
[b] Percentage of panelists that chosen the sample as having the most pleasant aroma.

This study revealed that aroma compounds can be extracted by autohydrolysis of BSG. Hydrolysate with the most pleasant aroma was obtained when using 1 g BSG/ 10 ml water. This result is of great interest since the extracted aroma compounds could be reused in other industrial activities for the production of food or beverages, for example.

References

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