Agroindustry activities generate different types and quantities of by-products. Their valorization is a challenge for industries and has a great importance in circular economy. Rice processing by-products have a great potential for valorization.

This work intended to study and optimize the enzymatic hydrolysis of two rice by-products (bran and broken rice) for the development of rice-based beverages. Two commercial enzymes were used for starch hydrolysis alone or in combination. For broken rice, using TERMAMYL 120L the reducing sugars profile was similar to the one found where both enzymes were applied. In the case of rice bran, due to its small amount of starch, it was observed an absence of enzymes activity. Under the tested conditions, broken rice proved to be a viable solution for the development of rice-based beverages without sugars addition, in contrast with rice bran. Besides that, the exclusive application of TERMAMYL 120L simplifies the production process and reduces costs.

Introduction

Rice is a cereal consisting essentially of starch (90%) appreciated and consumed all over the world [1]. About 600 Mton are produced annually worldwide, being Asian region the largest producer [2]. In Portugal, rice is the second most cultivated cereal (169 289 ton) only exceeded by corn crop (710 634 ton) [3].

Rice by-products, like broken rice and rice bran are generated during the industrial rice processing, accounting of 14% and 8%, respectively [4]. Nowadays their most common destination is animal feed [2]. However, their recognized high nutritional properties comparing with polished rice [2] give them a high potential for valorization, especially for vegetable-based drinks development for human consumption.

The increasing concerns about health, allergies and intolerances has stimulated the demand of these type of drinks, that compete directly with the dairy market [5]. The sweet taste of “rice milk” can be obtained using enzymatic hydrolysis. The starch breaks down into simple sugars making the sugar/sweeteners addition unnecessary [6].

Methods

Bran and broken rice, supplied by Cooperativa Agrícola Montemor-o-Velho (Portugal), were first characterized and ground to be used in the form of flour for the development of the rice beverages. Thereafter a 1:10 dilution with water was made to each flour. During the enzymatic hydrolysis two commercial enzymes supplied by Novozymes (Denmark) were used: AMG 300L and TERMAMYL 120L. Trials were performed in order to study the combined activity of both enzymes (in rice bran and broken rice flours) and their individual activity (only in broken rice flour). The performance of both enzymes in the starch hydrolysis was conducted sequentially according to their optimum reaction temperature [7]. Namely the mixture was first heated to 90 °C, TERMAMYL 120L was added and allowed to react for 45 minutes under stirring. AMG 300L was then introduced, after cooling down the mixture to 60 °C, and the reaction takes place for more 180 minutes. In the case that the enzymes were tested separately, the optimum reaction temperature of each enzyme was maintained constant for 120 minutes.

The starch hydrolysis and enzymes activity were monitored by UV-vis spectroscopy (Hach, XION 500 - LPG385, Germany). The soluble reducing sugars were evaluated, in duplicate, by dinitrosalicylic (DNS) colorimetric assay and by refractometry (° Brix). Weende scheme was used to determine moisture, protein, fiber, fat and ash contents in rice by-products. Starch content was determined according to [8].

Results

According to Table 1, broken rice consists essentially of starch and protein, while rice bran is characterized by high content of fiber, fat and ash.

<table>
<thead>
<tr>
<th>Composition (%)</th>
<th>Rice bran</th>
<th>Broken rice</th>
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<tbody>
<tr>
<td>Moisture</td>
<td>3.46 ± 0.01</td>
<td>6.37 ± 0.01</td>
</tr>
<tr>
<td>Dry extract</td>
<td>96.54 ± 0.01</td>
<td>93.63 ± 0.01</td>
</tr>
<tr>
<td>Protein</td>
<td>22.32 ± 0.26</td>
<td>10.90 ± 0.35</td>
</tr>
<tr>
<td>Fiber</td>
<td>12.24 ± 0.10</td>
<td>0.37 ± 0.08</td>
</tr>
<tr>
<td>Fat</td>
<td>19.84 ± 0.12</td>
<td>0.50 ± 0.11</td>
</tr>
<tr>
<td>Ash</td>
<td>9.32 ± 0.01</td>
<td>0.60 ± 0.03</td>
</tr>
<tr>
<td>Starch</td>
<td>12.36 ± 0.77</td>
<td>60.50 ± 2.76</td>
</tr>
</tbody>
</table>

This composition is somehow expected because it is intrinsically related with the part of the rice grain from where it was extracted.

Figure 1 shows the combined enzyme activities for rice by-products hydrolysis. In the case of broken rice, it was observed that the reducing sugars concentration doubles over the reaction. However, after AMG 300L addition the hydrolysis slows down maybe due to the reaction temperature decrease (60 °C). In the case of the rice bran, the reducing sugars concentration practically did not change over time. This result can be explained by the low quantity of starch present in this by-product (Table 1). It was also possible to inferred that the
commercial enzymes used in this study were not appropriated for the rice bran starch hydrolysis. For that reason, only the broken rice was used to test the enzymes individually (Fig 2).

Figure 1. Combined enzymes activity in broken rice and rice bran.

Using only TERMAMYL 120L the reducing sugars profile was similar to the one found where both enzymes were applied, indicating that this enzyme was the main responsible for the hydrolysis. This behavior was confirmed by refractometry (data not shown). In the case of AMG 300L there was no variation in reducing sugars over the reaction time. These results confirm the lack of activity of this enzyme under the tested conditions (time and temperature) and by-products.

Figure 2. Reducing sugars concentration during the hydrolysis of broken rice using AMG 300 L or TERMAMYL 120L.

Conclusion
This study allowed to conclude that TERMAMYL 120L is appropriated for the production of broken rice-based beverages leading to higher reducing sugar concentrations. Refractometry is a simple and expeditious method to monitor the starch hydrolysis. It was also found that AMG 300L can be disposed in this case allowing to a processing costs reduction. The smaller amount of starch in rice bran and the absence of enzymes activity in this by-product demonstrated that it is not appropriate for the production of rice-derived beverages.

Acknowledgements
Authors would like to thanks to Cooperativa Agrícola Montemor-o-Velho for supplied the broken rice and rice bran and also the financial support to FEDER, through the partnership agreement Portugal2020 - CENTRO2020, under the project CENTRO- 01-0145-FEDER-023631 SoSValor.

References