



Subcritical Water Fractionation of bioactive compounds from Brewer's Spent Grain (BSG)

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Brewer's spent grain (BSG)

- Is the most abundant brewing industry by-products (85 % of the total generated¹)
- Is a lignocellulosic material, source of different biocompounds.



Figure 1. Brewer's spent grain.

BSG composition can vary due to several factors². Biomass characterization has been carried out according to the NRLE protocols³ (Table 1).

Subcritical water fractionation (SWF)

- Semicontinuous bed reactor
- Flow rate of 4 mL/min
- Operating pressure of 50 bar
- Different temperatures.

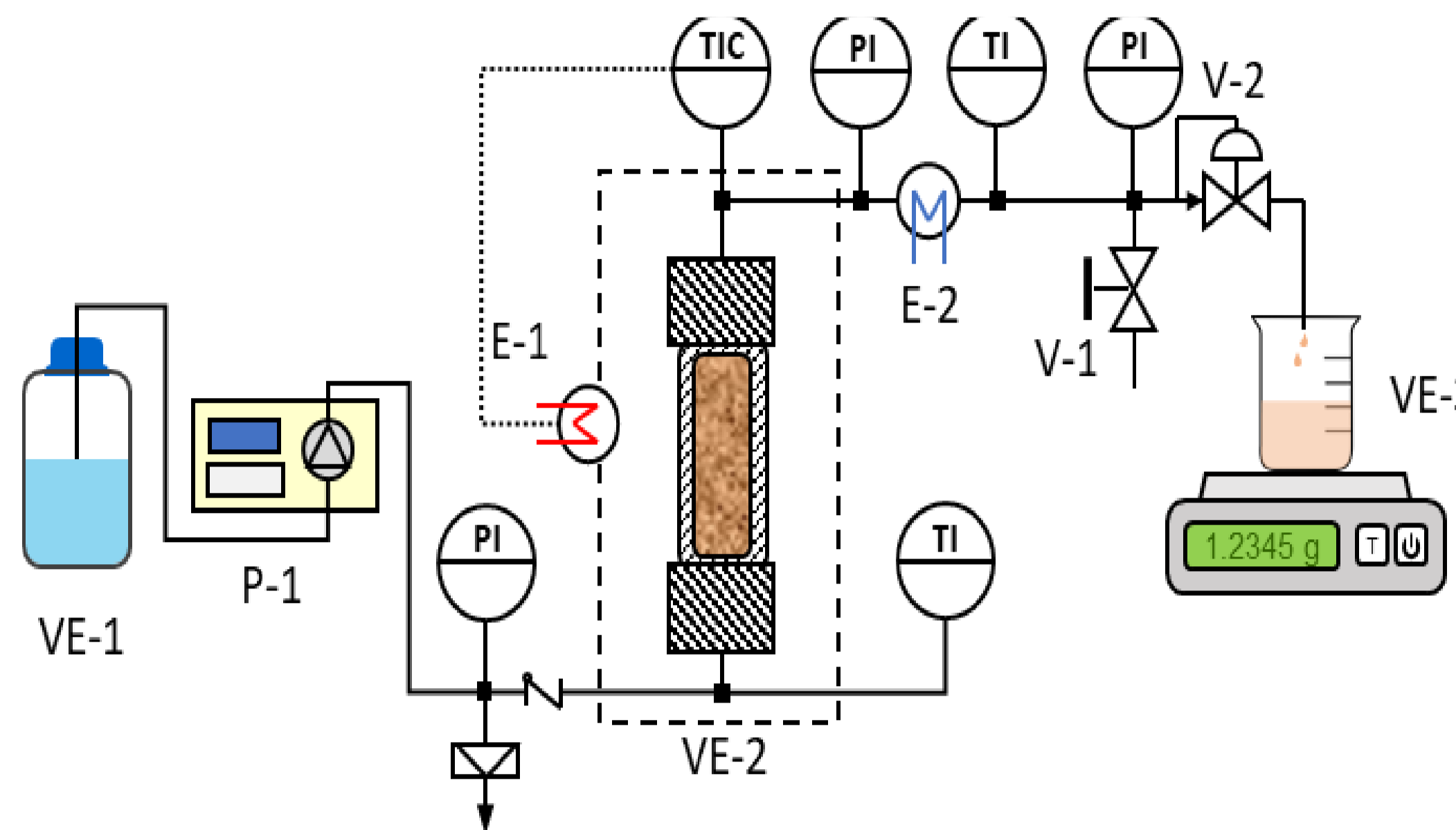


Figure 2. Continuous pressurized liquid extraction.

Effluents were periodically collected and analyzed in terms of:

- Total proteins
- Free amino acids
- Polyphenols

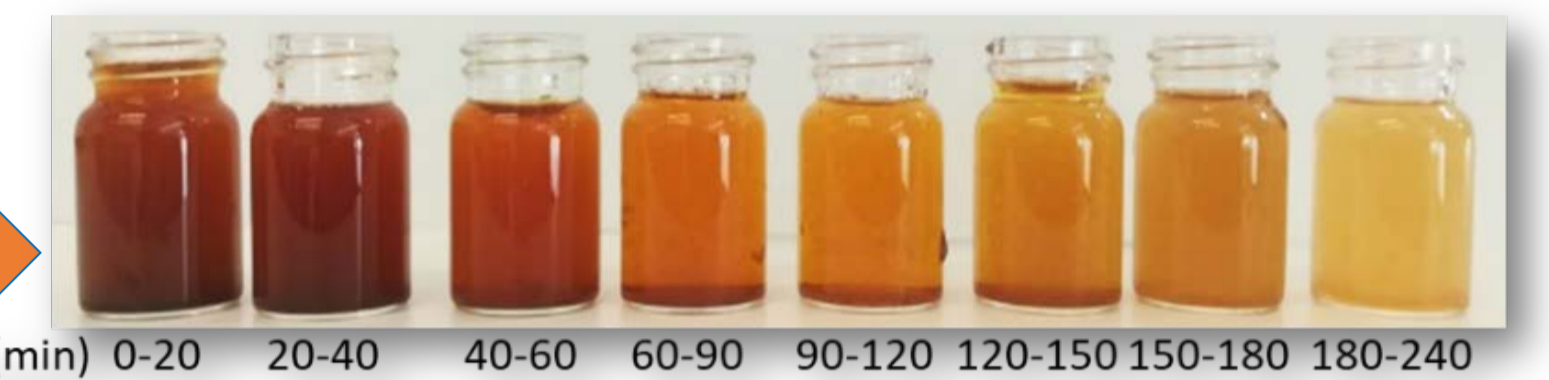


Figure 3. BSG extracts obtained by SWF at 185 °C and different times.

CHARACTERIZATION

Compound	% w/w
AX	22.3
Glucan*	26.7
ASL	5.3
KL	11.5
Ashes	1.4
Protein	17.8
Lipids	5.9
Extractives	15.2
TOC	47.5

Table 1. Chemical composition of BSG. Glucan in BSG is mainly cellulose but residual amounts of starch and β -glucan are also present.

PROTEIN EXTRACTION AND HYDROLYSIS

Charts 1a and 1b show the proteins and amino acid yields at different operating temperatures, in the range from 125 to 185 °C.

A temperature increase led to an increase of the extraction yield. The highest protein and amino acids yield were obtained at 160°C: being a protein content of 11.44% w/w with respect to dried raw material and 16,69 mg amino acid/g BSG accumulated after 240 minutes of extraction, respectively.

These results could be due to an increase of the protein solubility at high temperature, but also to an increase of the ionization constant of water (K_w) with temperature at subcritical water condition. In the presence of hydronium and hydroxide ions, peptide bonds are broken down into smaller molecules of soluble protein or amino acids⁴. In any case, amino acids yield is not high due to stability of the peptide bond. Proteins and amino acids could start to be degraded at temperatures over 160°C., due to the high residence time.

POLYPHENOL EXTRACTION

Chart 2 shows the total polyphenol compounds (TPC) extraction curve in the temperature range from 125 to 185°C. TPC extraction yield increases with increasing temperature, in the experimental range investigated, the highest quantity being found at 185°C. At 160 and 185°C, the TPC obtained in the extract is even higher than the TPC obtained after acid hydrolysis, (18.1 mg /g BSG dry).

Maillard reactions being favored by high temperatures. This can be visually observed in the color of the extracts from BSG since they become darker at higher temperatures with toasty aroma (Figure 3). Additionally, this can be also related to the increase of antioxidant activity with temperature since Maillard-reaction products may reinforce the antioxidant activity of PLE extracts from different raw materials, including BSG⁵.

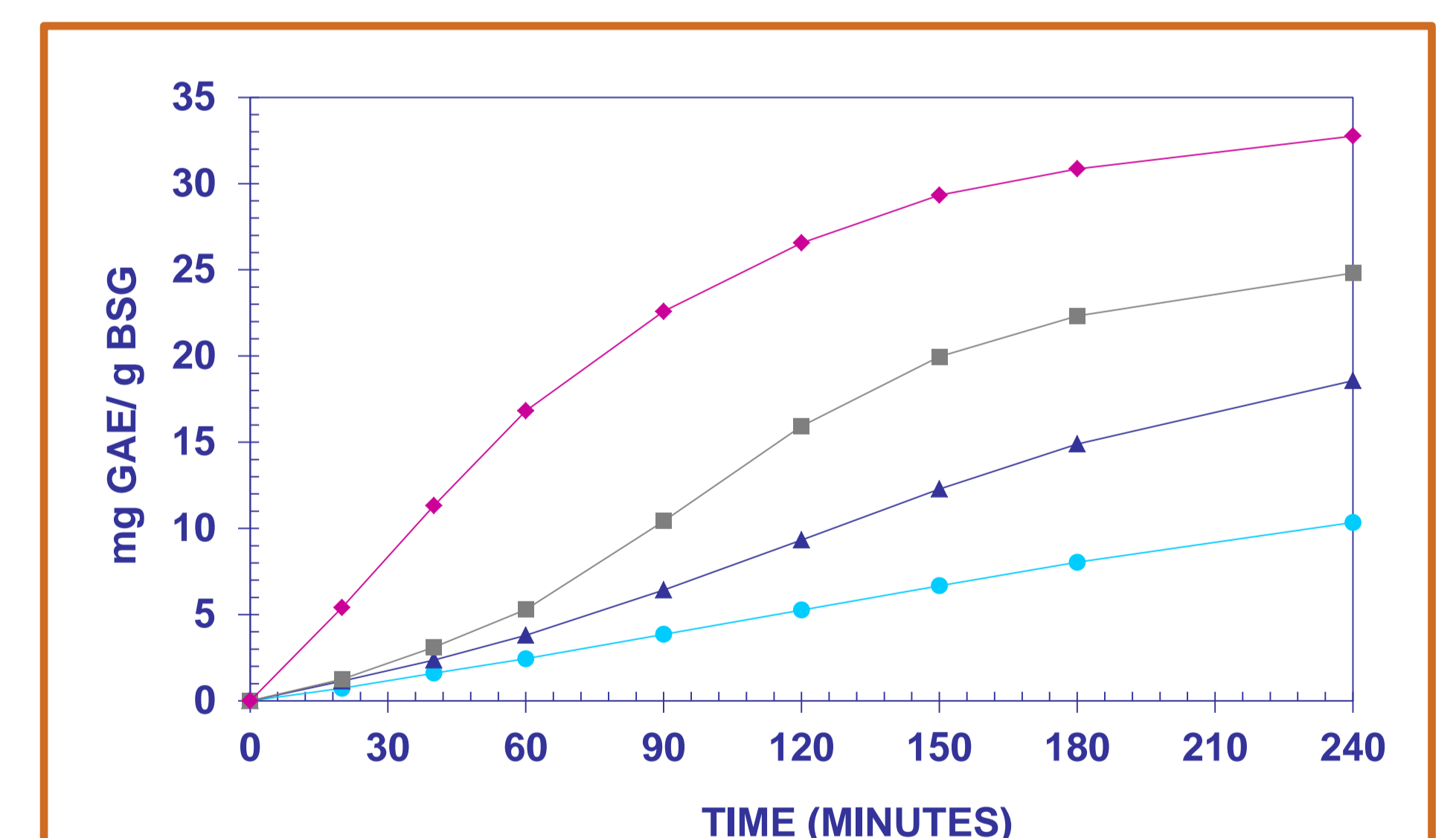
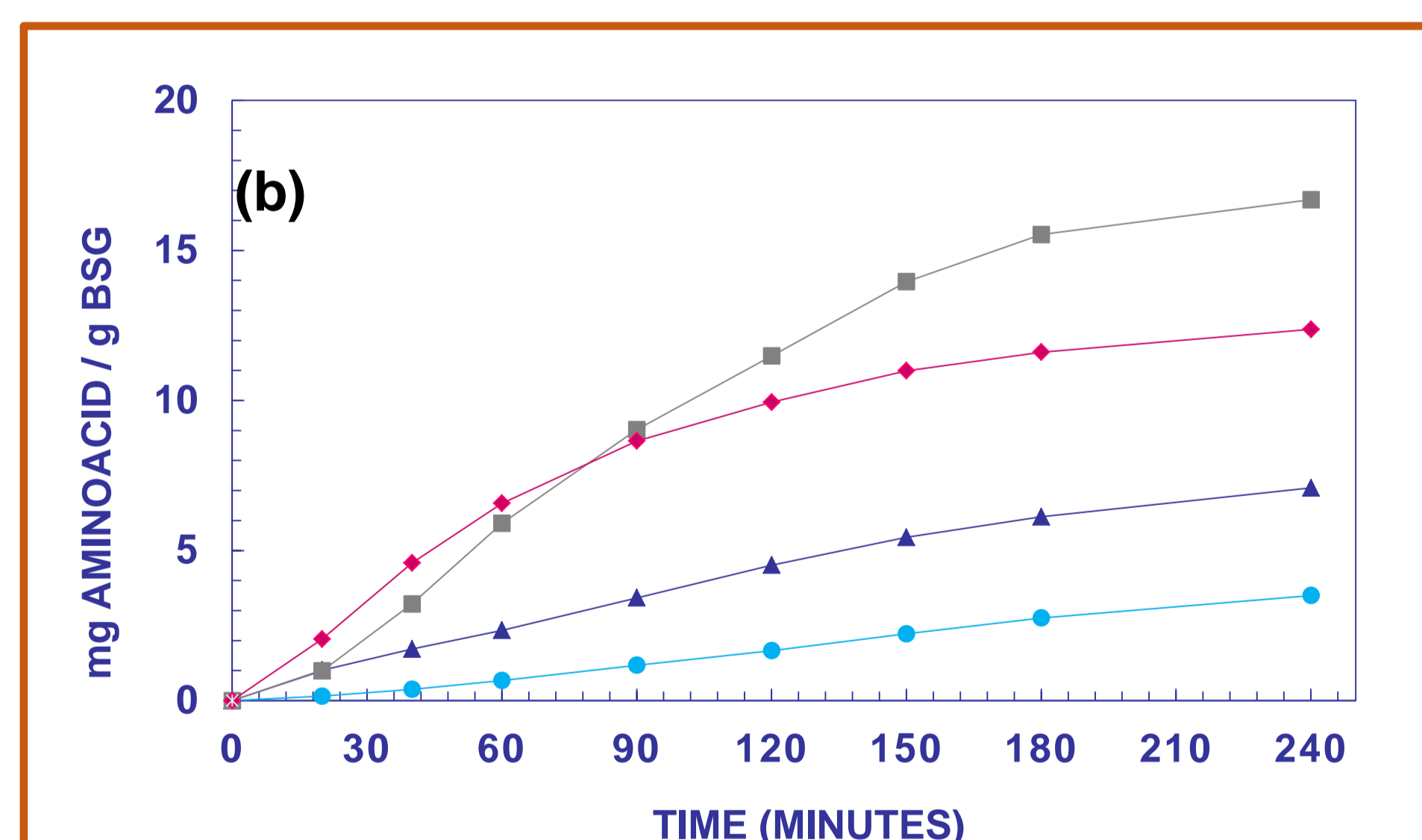
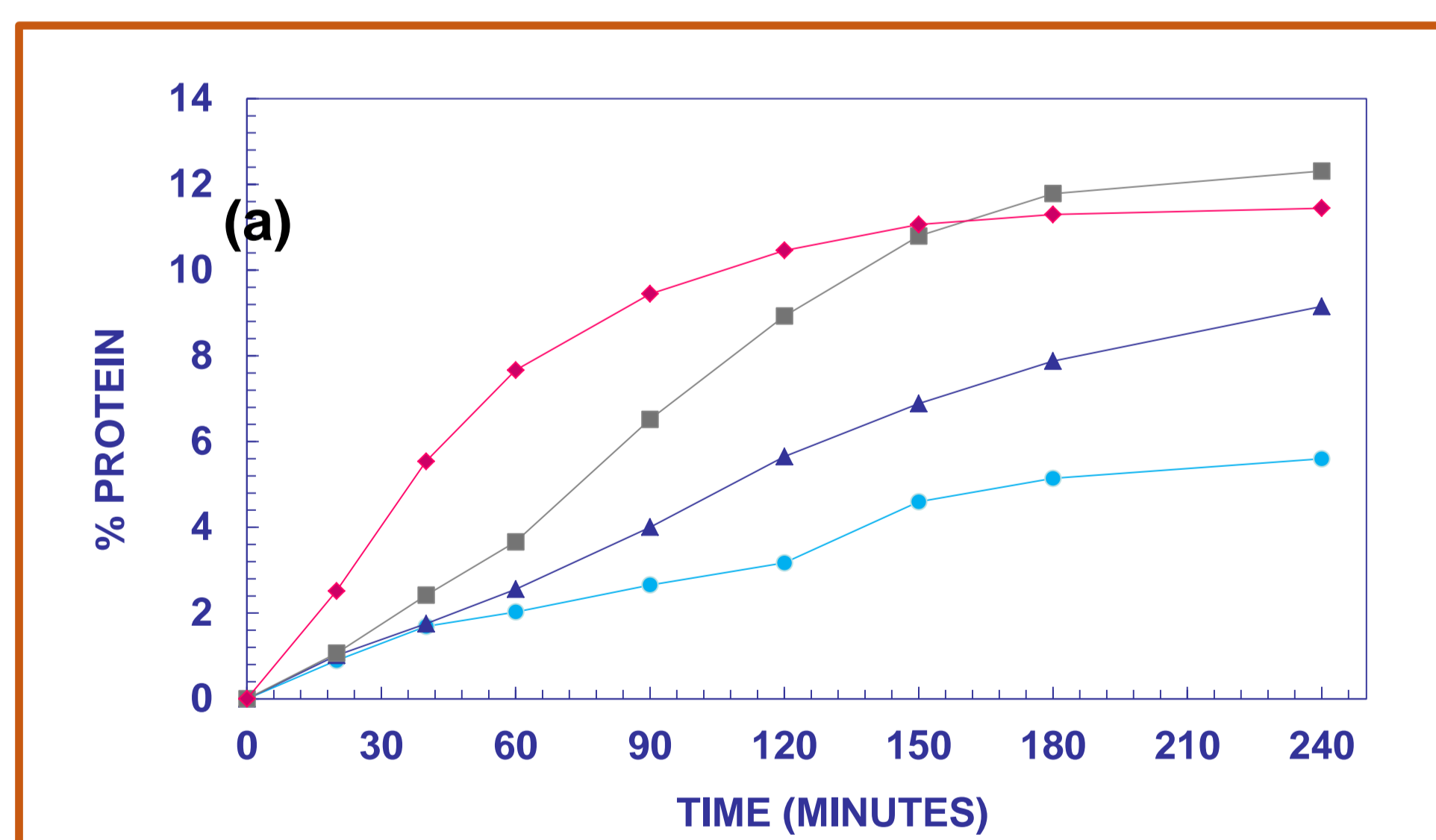


Chart 1. Effect of temperature on (SWF) of BSG at 50 bars and different temperatures (● 125°C, ▲ 145°C, ■ 160 °C and ◆ 185°C). (a) % Protein (b) Free Amino acids as mg amino acid/g BSG.

Chart 2. Total polyphenol compound at 50 bars and different temperatures (● 125°C, ▲ 145°C, ■ 160 °C and ◆ 185°C).

CONCLUSIONS

BSG has a wide range of possible applications as a valuable source of bioactive products as it has been shown in this work. Furthermore, BSG, as lignocellulosic biomass, is also a source for sugars production such as xylose, arabinose and glucose. High protein content of BSG (17.8 %wt.) makes it very interesting for application in the human diet. The results obtained in this work suggest that subcritical water fractionation of BSG is suitable to recover the main protein fraction and the total polyphenol content. The highest temperature in the range investigated, shows the best results related with bioactivity.

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