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EFFECT OF SAPONIN ON ASPARAGINE-GLUCOSE MAILLARD REACTION

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Abstract

Saponins are molecules commonly found in foods of plant origin (*e.g.* yerba mate and quinoa) or can be added to foods as foaming and emulsifying agents, being capable of interact with proteins. Therefore, its effect on reactions involving proteins and aminoacids is demanded. In this context, the aim of this work was to study the effect of saponin on asparagine-glucose Maillard reaction at pH 7 and 150 °C. The effect of different saponin concentration and time of reaction on the formation of melanoidins and acrylamide was studied by UV-VIS and HPLC, respectively. Results obtained by this work showed that the melanoidins and acrylamide content of asparagine-glucose model system increase linearly in function of saponin concentration. The effect of saponin is more evident after 20 min of reaction. Thus, the addition of saponin and plant extracts rich is these substances may be evaluated when products submitted to heating are developed mainly due to the acrylamide formation that can be carcinogenic.

Introduction

The Maillard reaction (MR) is responsible for color, flavor and aromas development in processed foods and beverages [1]. Furthermore, the reaction has been applied to increase emulsification, gelation, antioxidant, and antimicrobial properties of proteins [2]. However, due to the loss of nutrients and the development of toxic compounds it becomes necessary to control the formation of MR products during food processing [3].

Acrylamide and melanoidins monitoring are important when the effect of an additive is evaluated during MR. Acrylamide is one of the main compounds considered as toxic product of MR. This substance presents potential toxic and carcinogenic effects [4] and can be an endocrine-disrupting chemical [5]. By the other hand, the color formed by MR came from melanoidins that are compounds generated in the late stages of the reaction during food processing and preservation. Food melanoidins have been reported to be anionic and colored compounds with antioxidant and other biological activity [6].

Saponins are widely distributed in marine animals and plants and are known to interact with proteins [7]. There are still no studies on the role of saponins in MR. However, due to its structure being composed of sugar molecules and interaction with proteins, it is possible that this substance participates in the reaction, changing the final products obtained. Therefore, the aim of this work was to study the effect of saponin on asparagine-glucose Maillard reaction at pH 7 and 150 °C.

Material and methods

Material

L-asparagine, saponin and acrylamide were purchased from Sigma-Aldrich and the glucose was purchased from Vetec.

Preparation of reaction mixtures

It was used the preparation methodology described by Knol et al). [8] with some modifications. Equimolar solutions of glucose and asparagine (0.1 M) were prepared in phosphate buffer (0.1 M, pH 7). Samples (2 mL) were heated in hermetically closed screw-capped glass tubes at 150 °C in a Digital Reactor Block 200 (DRB 200, Hach Company, Germany). After 30 min of reaction, samples were taken and immediately cooled in ice bath.

Analysis of Melanoidins

Quantification of melanoidins was performed by measuring the absorbance at 470 nm on a spectrophotometer (UV-1601, Shimadzu, Kyoto, Japan). The concentration of melanoidins was calculated from the Lambert-Beer equation. The extinction coefficient considered for melanoidins formed from glucose and asparagine was considered as 282 L mol^{-1} cm^{-1} [8].

Acrylamide determination by HPLC

A ACE 5 C18 (Batch V13-7473) column (250 x 4.6 mm) was used for the analysis . Samples (20 µL) were eluted isocratically at 25 °C with a solution containing 6% acetonitrile and 94% Millipore water at a flow rate of 0.8 mL/min. Acrylamide (tr = 4.6 min) was detected by its absorbance at 210 nm with a DAD-detector, and quantified by the external standard procedure, using a calibration curve (1-100 µg/mL of acrylamide).

Results

Figure 1 shows melanoidin content as a function of saponin concentration (0-1.5 mg/mL) and reaction time (0-30 min; 1.5 mg/mL saponin). The melanoidins content increased linearly with the rise in the saponin concentration (Figure 1 a) showing that it has a catalytic effect on MR. Figure 1b shows the concentration of melanoidins formed as a function of heating time at 150 °C. The catalytic effect of saponin on MR occurs after 10 min of reaction, and the final content of melanoidins in the sample with saponin was 58% higher than in the control sample.

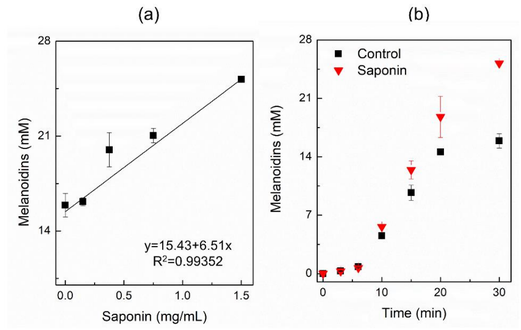

Figure 1: Effect of saponin on the formation of melanoidins by Maillard reaction (150 °C; pH 7) in function of saponin concentration (a) and time of reaction (b). The effect saponin concentration and reaction time was performed at 30 min of reaction and a saponin concentration of 1.5 mg/mL, respectively. The concentration of asparagine and glucose was 0.1 mol/L for all experiments.

Figure 2 shows acrylamide content as a function of saponin content (0-1.5 mg/mL) and reaction time (0-30 min; 1.5 mg/mL saponin). Acrylamide content linearly increased with increasing saponin concentration (Figure 2a). The catalytic effect of saponin on acrylamide content occurs after 20 min of reaction, and the final concentration of acrylamide in the sample with saponin was 44% higher than in the control sample.

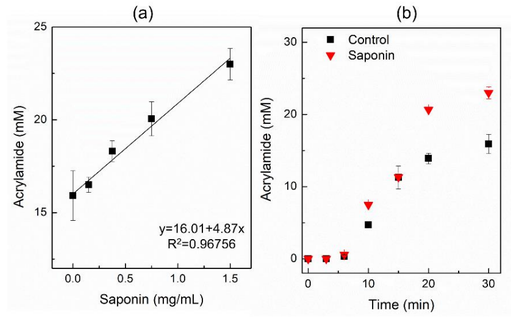

Figure 2: Effect of saponin on the formation of acrylamide by Maillard reaction (150 °C; pH 7) in function of saponin concentration (a) and time of reaction (b). The effect saponin concentration and reaction time was performed at 30 min of reaction and a saponin concentration of 1.5 mg/mL, respectively. The concentration of asparagine and glucose was 0.1 mol/L for all experiments.

A control experiment was carried out containing only acrylamide and saponin which resulted in 0.33 mM of acrylamide. This result shows that saponin, in addition to acting as a catalyst for MR, can react directly with asparagine.

Conclusion

Saponin presents a catalytic effect on asparagine-glucose MR. The melanoidins and acrylamide content increased linearly in function of saponin concentration, and its effect is more evident after 20 min of reaction. The results obtained in this work highlight the need to evaluate the effect of the saponins and plant extracts on products that undergo thermal processing.

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