COMBINED TREATMENT OF PORCINE PLASMA WITH MICROBIAL TRANSGLUTAMINASE AND CYSTEINE-EFFECTS ON THE FOAMING AND EMULSIFYING PROPERTIES

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Introduction

Different studies focused on the improvements of heat-induced gel properties of plasma proteins at acidic pH using microbial transglutaminase (*MTGase*) have carried out, the most recent one that combining the enzymatic treatment with cysteine (Fort *el al.*, 2006). The results of this work indicate that cysteine does not enhance the enzyme activity, but both improve gel texture separately. However, the effects of these treatments on other functional properties of plasma proteins have been not elucidated. Plasma is frequently used in comminuted meat products for its emulsifying properties and it is also being considered a possible alternative to egg proteins as foaming agent. So, the aim of this study is to determine how the treatment with *MTGase* and/or cysteine modifies the surface properties of plasma.

Materials and Methods

Three porcine plasma samples came from an industrial abattoir. Cysteine (1.02838) was purchased from Merck & Co., Inc. (New Jersey, USA), and *MTGase* commercial preparation (ACTIVA®, Ajinomoto Co. Inc., Japan) was supplied as a mixture containing 99 % maltodextrin and 1% *MTGase*. The enzyme concentration is reported as the commercial product concentration and referred as % MTG.

Experimental design: Each sample was separated in 5 aliquots, each one being submitted to one of the next treatments: a) native solution (control); b) *MTGase* (MTG) treatment; c) cysteine (Cys) treatment; d) simultaneous *MTGase* and cysteine (MTG+Cys) treatment; and e) *MTGase* first and adding cysteine afterwards (MTG//Cys) treatment. The enzymatic treatment was carried out with 3 % MTG (w/v) for 3 h at 30 ºC and pH 7, and the cysteine concentration applied was in every case 0.25 % (w/v).

Foaming properties: A 200-mL sample of 0.25 % (w/v) plasma protein solution adjusted to pH 5.5 was blended in a double beater Multimix M700 (Braun, Kronberg, Germany) for 10 min. The foaming capacity (FC) was determined as foam volume recorded 2 min after blending. To measure foam stability (FS), a discontinuous gravimetric method was used placing a known foam quantity in a dry stainless sieve and monitoring the percentage of remaining foam as a function of time after. The relative foam stability (RFS) was calculated as time (min) taken for 50 % foam weight loss by fitting data to an exponential function.

Emulsifying properties: A 150 mL sample of 0.35 % (w/v) plasma protein solution adjusted to pH 5.5 was mixed with 50 mL of corn oil and homogenized in a HC-5000 Microfluidizer homogenizer (Microfluidics, Newton, MA, USA). Immediately, 20 mL of the emulsion were diluted with 50 mL of 0.1 % SDS solution. The absorbance of this solution was measured at 500 nm. EAI ($m^2 \cdot g^{-1}$ of protein) was calculated as follows: $EAI=(2T/\phi C)\cdot$dilution factor, where T= turbidity, ϕ= oil volume fraction, C= weight of protein per volume unit in the aqueous fraction before emulsification, and the dilution factor= 2500. To determine the emulsion stability index (ESI), a new sample of diluted emulsion was taken 10 min after emulsification.

Statistical Analysis: Data were subjected to Proc GLM by considering sampling days as blocks in a randomized complete block design. The Tukey test was used to compare means. The significance level for all tests was α= 0.05.

Results and Discussion

A significant ($P<0.05$) reduction in foaming capacity (FC) of the control samples was observed when the plasma was treated only with *MTGase* (Table 1). This was in all probability due to a reduction in protein flexibility as a result of an increase in the degree of protein cross-linking, although contradictory results have been reported with respect to foaming properties (Babiker, 2000). The presence of cysteine seemed to partially diminish the foaming effect. The tested treatments did not significantly ($P>0.05$) affect the relative foam stability (RFS), although in *MTGase* treatments (both with and without cysteine) the mean values tended to be lower.

Table 1. Foaming properties of porcine plasma; effect of treatment with *MTGase* (MTG) and/or cysteine (Cys). Mean ± sd (n=3). Different letters indicate significantly differences between treatments.

Treatment	FC (mL)	RFS (min)
Control	785 ± 14 a	32 ± 12
MTG	708 ± 2 b	26 ± 3
Cys	742 ± 34 ab	34 ± 12
MTG + Cys	728 ± 28 ab	26 ± 4
MTG // Cys	732 ± 30 ab	22 ± 5

These results indicate that the viscoelastic properties of film surrounding the gas bubbles were not greatly affected by the applied treatments. In addition, the majority of foam was lost during the first forty minutes post foaming (Figure 1).

A significant ($P<0.05$) decrease in the emulsifying activity index (EAI) of plasma proteins was detected post treatment with *MTGase* and/or cysteine (Figure 2), thus indicating that their efficiency as emulsifiers was always reduced. For treatments with *MTGase* only, similar results have been reported by other authors working on different proteins, which have been attributed to a decrease in protein solubility (Siu *et al.*, 2002). However, emulsions were stable (no change in absorbance values) for 10 min.

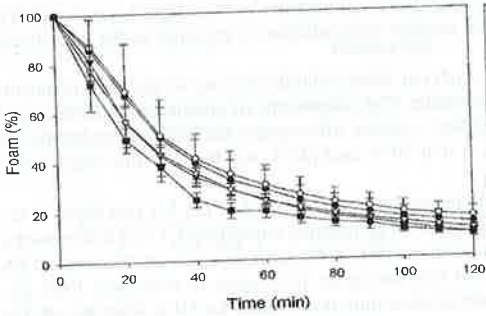

Figure 1: Foam stability of porcine plasma. Effect of different treatments: control (●), MTG (▼), Cys(○), MTG+Cys(▽), and MTG//Cys (■). Mean ± sd (n=3).

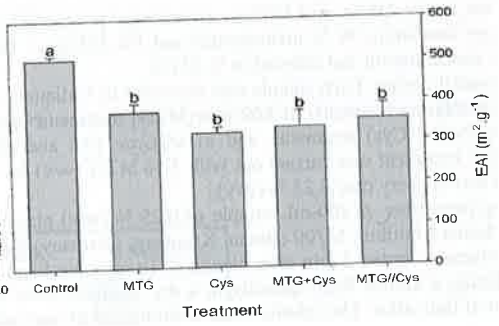

Figure 2: Emulsifying activity index (EAI) of porcine plasma; effect of treatment with cysteine (Cys) and/or *MTGase* (MTG). Mean ± sd (n=3). Different letters indicate significantly differences between treatments

The results indicate that the treatment of plasma proteins with *MTGase* alone or in combination with cysteine supposes an important reduction in their surface properties.

References

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