APPLICATION OF HIGH HYDROSTATIC PRESSURE ON PORCINE BLOOD PLASMA

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INTRODUCTION

One way of upgrading porcine blood generated in industrial abattoirs consists in making use of the functional and nutritional properties of the protein fraction of this by-product (Tybor et al., 1975; Wismer-Pedersen, 1979). The blood, or its fractions, can be used as functional ingredients in the preparation of foods as its functional properties are comparable to those of some commercial products, for example egg albumen (Raeker and Johnson, 1995).

Nevertheless, microbial contamination is still a serious problem even if blood is collected hygienically and it needs to be solved before plasma be used as an ingredient in human food.

The interest in maintaining functional properties supposes a limitation in the use of conventional systems to improve hygienical standards. The application of high hydrostatic pressure is a new technique, which may be used to disactivate spoilage microorganisms in certain foods and food ingredients. High hydrostatic pressure induces a number of changes in the morphology, biochemical reactions, genetic mechanisms, and cell membrane and wall of microorganisms (Hoover et al., 1989). As compared to classical heat treatments high pressure seems not to disrupt covalent bonds and acts without dependence on product size and geometry. As a consequence, high pressure may produce food products which have the necessary microbial stability and which retain the original nutritional and organoleptic qualities (Van Camp, 1996).

OBJECTIVES

The aim of this study was to apply high hydrostatic pressure to plasma obtained from the blood of slaughtered pigs in order to improve its microbiological quality and in such a way that the main functional properties of the plasma are not affected. The effect of treatment on some functional properties of plasma was also studied.

MATERIAL & METHODS

Blood was collected from pigs in an industrial abattoir. Sodium citrate (0.4% w/v) was added as an anticoagulant and blood was immediately refrigerated at 5-7 °C. The plasma fraction was obtained by centrifugation of the blood for 15 min at 2520 x g (Sorvall RC 5C Plus, DuPont Co., Newtown, U.S.A.) at a temperature of 4-5°C and was later separated by decanting. High pressure treatment was applied to each sample in the 24 hours after collection.

High pressure experiments were performed on a cold isostatic press of ACB Gec Alsthom (Nantes, France).

Flexible polyvinylidene chloride bags were filled with 250 mL of plasma and sealed. Water was used to apply pressure arround the bag inside the pressure vessel. Operating pressures of 450 MPa were applied during total compression times of 15 min. The temperature of the samples before and during high-pressure processing was maintained at 40ºC. Control (non-pressurized plasma) was maintained at the same temperature.

Microbial counts were determined by pour plating on Blood Agar Base (Oxoid, Unipath Ltd., Basingstoke, Hampshire, U.K.) and incubating for 24 hours at 37ºC.

The denaturation level of plasma proteins was studied by Differential Scanning Calorimetry using a Mettler DSC30 (Mettler-Toledo, S.A.E., Switzerland) differential scanning calorimeter as described in Parés et al. (1998). Aliquots of samples measuring 100 µL were weighed into aluminum pans and hermetically sealed, water was used as the reference material. The temperature was raised from 30 to 100°C at a heating rate of 3°C/min.

To determine water holding capacity (WHC) of the gels a technique was used which combines filtration and centrifugation based on that proposed by Kocher and Foegeding (1993) although with slight modifications as described in Carretero et al. (1998).

Hardness of protein gels was analyzed using a TA XT2 (Stable Micro Systems, Surrey, U.K.) texturometer. A penetration test was undertaken with an ebonite cylindrical probe 10 mm diameter at 0.1 mm s^{-1}. The work of penetration and the force on the probe at 4 mm from the gel surface were measured.

The method of Morr (1985) was used to determine protein solubility. 10 mL of plasma were mixed with 40 mL of distilled water. The pH was adjusted to 4.5 or 7.0 and it was stirred for 1 hour. Then the dispersion was centrifuged for 30 min at 20000 x g. The protein content of the supernatant was determined by Biuret method.

RESULTS AND DISCUSSION

Our previous experiences on HHP application to blood and plasma in different operation conditions showed that the effect of treatment is heavily dependent on temperature. Treatments at 5ºC had little effect on microorganism inactivation, but treatments over 25ºC produced great reduction in the microbiological counts. Figure 1 shows the growth curves of bacterial populations from untreated and pressurized samples at different temperatures. The treatment at 40ºC was found to be the most effective, with a reduction of 99.97 (±0.02) % in bacterial counts.

Table 1 reports the results of calorimetric parameters, Td and ΔH, WHC, force and work of penetration of both treated and untreated plasma. Although the calorimetric parameters demonstrated that the proteins were slightly denatured by the HHP treatment, lower values of ΔH and greater values of Td, statistical analysis shows that there are not significant differences between control and treated samples in the main functional properties. This fact confirms that HHP treatment is a good system to improve the microbiological quality of blood plasma without noticeable losses in its functionality. When the sample was submitted to high pressure there was only a reduction in the solubility of plasma proteins. The loss in solubility is more important at low pH (Table 2), at pH 7.0 the solubility of plasma proteins remains higher than 90%. The HHP treatment promotes the structural modification of proteins, as was observed in the calorimetric parameters, which can alter the solubility of plasma but which do not affect the water holding capacity nor the force of the gels obtained from it.

CONCLUSIONS

High hydrostatic pressure at 450 MPa, during 15 min at 40ºC is an effective method to improve the microbiological quality of plasma, with a reduction of 99.97% in bacterial counts. This treatment does not affect the water holding capacity nor the force of gels obtained from pressurized plasma.

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Table 1. Calorimetric parameters (Td and ΔH) of plasma, water holding capacity, force and work of penetration of gels from untreated and pressurized plasma at 450 MPa at 40ºC.

Property	Untreated plasma	HHP plasma
Td (ºC)	75.74 ± 0.6	79.3 ± 0.2
ΔH (Jg^{-1})	10.1 ± 0.8	6.3 ± 0.7
WHC (% retained water)	46.09 ± 1.99	49.99 ± 0.16
Penetration Force (N)	1.34 ± 0.10	1.48 ± 0.13
Penetration Work (mJ)	2.63 ± 0.18	2.82 ± 0.21

Mean values and confidence interval (α=0.05)

Table 2. Solubility in % (w/w) of proteins of untreated and pressurized plasma (450 MPa /40ºC/15 min), at different pH.

Sample	pH 7.0	pH 4.5
Untreated	99.6	88.8
HHP	96.9	67.3

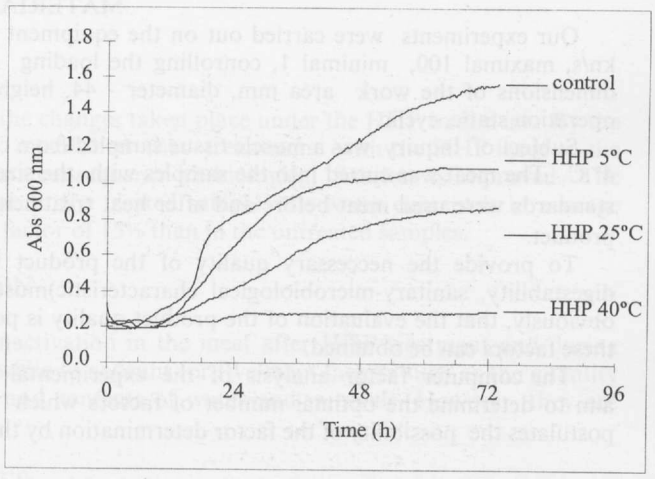

Figure 1. Growth curves of bacterial population from untreated and pressurized plasma at 450 MPa at 5, 25 and 40ºC.