HIGH PRESSURE ON COOKED HAM: A WAY TO INCREASE SHELF-LIFE WHILE MAINTAINING HIGH STANDARD QUALITY

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Abstract: This study investigated the effect of high pressure processing on technological properties (water holding capacity and texture), oxidative stability and protein denaturation of “French top quality cooked ham” (pork meat, salt 1.76%, lactose 0.22%, nitrite 25 ppm, sucrose 0.07%), vacuum-packed and pressure-treated (500 MPa, 20° C, 5 min) throughout 21 days of chilled storage. The results show that pressure has no significant effect on the level of proteins oxidation whatever the chilled storage duration. Similarly, high pressure treatment does not promote protein denaturation. Thus, high pressure processing would extend the shelf life of cooked ham without adding preservatives and without changing the characteristics of the product.
Key words: high pressure, cooked ham, protein

I- INTRODUCTION

Cooked ham is a high quality processed meat product and one of the most consumed (30 % of the 712000 t of pork delicatessen production in France) [1]. Manufacturers aim to produce cooked ham with high sensory quality (flavour, juiciness, colour, texture) and a reasonable shelf life. However, the high pH and water activity of cooked ham make this a highly perishable product. Furthermore, handling, cutting, slicing and final packaging operations can recontaminate the product with emerging pathogens and spoilage organisms from the external sources. In order to eliminate the risks, HPP has been promoted as a decontamination processing technology for ready-to-eat cooked and cured ham [2]. Indeed, HPP as a novel non-thermal method has shown great potential in destruction of microbial population while maintaining the sensory and nutritional properties of the food items and allows a substantial increase in shelf-life. However, HPP can also lead to some unfavorable effects on foods, such as acceleration of food protein oxidation and protein denaturation, leading to deterioration of meat related-quality (texture, color) [3]. The aim of this study was to determine the effects of high pressure treatment on “French top quality cooked ham”.

II- MATERIAL AND METHODS

Sample preparation

Cooked ham was prepared from pork muscle according to Thomas *et al.* (2013) [4]. Preparation was inspired by the industrial process. The brine formula based on finished product was composed of NaCl (1.76% w/w), lactose (0.22% w/w), sucrose (0.07% w/w) and nitrite (25 mg/kg). The brine was added at a concentration of 10% of final muscle weight. After curing, the meat was tumbled for 17 h with alternant tumbling (15 min at 7.5 rpm) and resting time of 15 min to ensure diffusion of the brine in the meat. Afterwards, the meat was filled into molds and packed into plastic bags under vacuum conditions. The ham was steam-cooked up to a core temperature of 65 °C: The temperature increased step-by-step to 40 °C (60 min), 50 °C (60 min) and 65 °C (150 min). After cooking, the cooked ham was cooled to 18 °C during 20 min and then let equilibrate to 4 °C during 3 days.

Pressure treatment

Before treatment, the cooked ham is diced (1.5 cm side) and vacuum packaged at 80 mbar in polyamide/polyethylene bags (La Bovida, Paris, France). Samples were pressure-treated at 500 MPa for 5 min at 20 °C according to Villamonte *et al*. (2013) [5]. The samples are then stored at 4 ° C for 21 days.

Water holding capacity (WHC)

The WHC was evaluated by centrifugation (5000 g at 20 °C for 20 min). The exuded water was then removed. WHC was determined by calculating the ratio between the weight of the sample before and after centrifugation.

Texture analysis

The texture was evaluated using a texturometer (TAXT-Plus). Each diced cooked ham was compressed axially in two consecutive cycles of 30% compression with an aluminium cylinder probe of 75 mm diameter. Force–time deformation curves were obtained with a 50 kg load cell applied at a cross-head speed of 1 mm/s. Hardness were calculated from the force–time deformation curve as proposed by Bourne in 1978 [6].

Differential scanning calorimetry (DSC)

Samples were analyzed using a Micro DSC III (Setaram, Caluire et Cuire, France) according to Villamonte (2013) [5]. The total enthalpy (J/g) was calculated by the area under the transition curve from 40 °C to 85 °C and the temperature of denaturation (Td) was estimated from the peak temperature of the thermal transition.

Protein oxidation

Protein oxidation was determined by assaying the protein carbonyl content reacting with DNPH (2,4-dinitrophenyl hydrazine) [7]. The carbonyl concentration is expressed as µmol per gram of protein.

III- RESULTS AND DISCUSSION

Microbial count on Plate Count Agar showed that application of treatment of 500 MPa for 5 min significantly decreased the level of total bacterial count. Color measurement of the cooked ham using a colorimeter showed that HPP did not impact the CIE L*a*b* values during storage (Data not shown).

Table 1 shows the main results of technological and physico-chemical properties of control (0.1 MPa) or pressurized (500 MPa) cooked ham. The results show that the pressure has no significant effect on the WHC of cooked ham. However, for control sample, the WHC is higher on D1 and decreases on D21. Because WHC is intimately linked to the juiciness of meat products, it can be concluded that control cooked ham loses its juiciness during storage. Further, texture analysis demonstrated that hardness was no significantly affected by pressure. However, storage time has a significant effect on the hardness of cooked ham. Indeed, the hardness of the control cooked ham at D1 of storage is lower than the hardness of the control cooked ham at D21 of storage. This increase in hardness could be explained by the decrease of the WHC on the 21st day of storage.

HPP has no significant effect on the oxidation of proteins. The content of carbonyl compounds is almost identical at D1 and D21. As ham is cooked, the effect of the pressure would be less important than on the raw meat because the proteins are already denatured during the cooking step.

Table 1: Results of WHC, texture analysis and protein oxidation of cooked ham according to pressure level and storage duration

Storage	Pressure (MPa)	WHC (%)	Hardness (N)	DNPH (µmol of carbonyl compounds/g of protein)
Day 1	0,1	48,19 ± 1,43^a	36,46 ± 8,11^a	1.15 ± 0.10^a
	500	42,88 ± 0,96^b	37,20 ± 10,37^a	1.37 ± 0.40^a
Day 21	0,1	39,37 ± 0,98^b	55,43 ± 23,48^b	1.08 ± 0.10^a
	500	38,82 ± 0,43^b	38,88 ± 12,42^a	1.04 ± 0.17^a

Mean ± standard deviation. Different letters in the same column indicate a significant difference ($p<0.05$)

The DSC results show that neither the pressure nor the storage duration has significant effect on the cooked ham. Also, the total denaturation enthalpy is very low (about 0.349 J/g at D1). Indeed, the product is cooked and then pressurized so proteins are already highly denatured, which explains the low enthalpy value.

Otherwise, the low enthalpy value makes the identification of peak transition difficult. The thermograms of control and pressurized cooked ham presented two main thermal transitions, the first at about 60 °C and the second at about 71 °C. The endotherm peak at 60 °C can be reported as collagen and sarcoplasmic proteins and the thermal transition at 71 °C as actin [5].

IV- CONCLUSION

The results show that high pressure processing would keep the technological and organoleptic qualities (WHC, hardness, color) of the cooked ham as close as possible to the traditional product while ensuring its safety.

One of HPP advantages is to extend the products shelf life by reducing the undesirable microbial flora. It would therefore be interesting to extend the study beyond 21 days in order to evaluate the evolution of the previously studied technological and chemical parameters over a longer storage period.

Furthermore, changes in protein conformation induced by HPP could have an effect on muscle protein breakdown during digestion. Future works will focus on understanding the relationships between HPP of cooked ham and the resultant effects on quality, structure and protein digestion kinetics.

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