MEAT TENDERIZATION BY CALCIUM CHLORIDE AFTER OSMOTIC DEHYDRATION

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Key words: meat tenderization, calcium chloride, osmotic dehydration, myofibril

Background and objectives:

The treatment of $CaCl_2$ is one of the popular methods for meat tenderization. In this case, it is very important how to penetrate the $CaCl_2$ into meat. There are two methods to penetrate $CaCl_2$ into meat cuts, such as dipping in a $CaCl_2$ solution and injection of Ca^{2+} into meat cuts. In our previous report (Gerelt, Ikeuchi & Suzuki, 1999), it was proved that the penetration of proteolytic enzyme after the osmotic-contact dehydration was effective to tenderize tough meat.

This paper describes meat tenderization by dipping meat cuts in a $CaCl_2$ solution after the osmotic dehydration (Nomamota & Kasai, 1983).

Materials and methods:

Lean meat from culled cow was excised from the shoulder part of a beef carcass 2 days after slaughter and stored at –25℃. As required, it was tempered overnight in a cold room (3 - 4℃) and cut into small pieces (30×30×20 mm).

Osmotic dehydration

Pichit, a contact-dehydrating sheet consists of a high osmotic pressure substance, a polymeric water absorbent and a hydrophilic alcohol, which are integrally covered with a semipermeable membrane allowing selective permeation of water. Each piece of meat covered with a cellophane sheet was placed between contact-dehydrating sheet and stored for 18 hr in cold room. After the dehydration, samples were dipped in a two volume (w/w) of 150mM $CaCl_2$ solution for 3 hr. The meat cuts used in this experiment were as follows: 1) control, meat cuts without any treatment; 2) meat cuts dipped in a $CaCl_2$ solution without dehydration; 3) meat cuts dipped in a $CaCl_2$ solution after the osmotic dehydration. The all samples were stored for 24, 48 and 168 hr in cold room.

Texture measurement

Hardness of meat cuts was measured by Rheometer with a conical plunger. Five places of each sample were measured.

Concentration of Ca^{2+} of outer and inner layers

Concentration of Ca^{2+} was measured by Polarized Zeeman Atomic Absorption Spectrophotometer, Z-8200 HITACHI. Outer and inner mean the outer one-third of the meat cut and the middle of the meat cut, respectively.

Fragmentation

Myofibrils were made from each muscle by the method of Busch *et al.* (1972). After adjusting the protein concentration to 0.5 mg/ml of 100mM KCl, turbidity at 540 nm of the solution was measured as fragmentation index (Moller *et al.*, 1973).

Transmission electronmicroscope(TEM) studies on ultrastructure of myofibril

Specimens for TEM were prepared by the procedure of Suzuki, Saito, and Nonami (1978) and examined using a TEM (Philips Electron Optics, Netherlands) with an accelerating voltage of 80kv.

Results and discussion:

Dehydration and absorption of $CaCl_2$ solution

The absorption ratio of $CaCl_2$ solution [absorption of $CaCl_2$ solution(ml) / dehydration of water(ml)×100] was about 80% of the water dehydrated. The penetration efficiency of $CaCl_2$ after the contact-osmotic dehydration of meat seems to be sufficient.

Texture measurement

The changes in the relative hardness of meat cuts as expressed as a percentage of the untreated meat immediately after thawing are shown in Fig 1. Decreases of relative hardness were observed in the $CaCl_2$ treated meats during storage as compared to the control. Apparently, the relative hardness of the dehydrated meat cut was lower than that of the nondehydrated.

Concentration of Ca^{2+} of outer and inner layer

Concentration of Ca^{2+} of outer and inner layers is shown in Fig 2. Immediately after the dipping in $CaCl_2$ solution, the Ca^{2+} concentration both in outer and inner parts of the meat cuts remarkably increased. Higher concentration of Ca^{2+} appeared in

dehydrated meats than that of nondehydrated, and the Ca^{2+} concentration in the outer is higher than that of the inner. Howover the gradual decrease and increase of the concentration were observed in outer and inner parts, respectively, during storage, which will come to equilibrium.

Fragmentation of myofibrils

The changes in the relative fragmentation of myofibrils prepared from meat cuts as expressed as a percentage of that of the untreated meat immediately after thawing are shown in Fig 3. The gradual increases of the relative fragmentation were observed in $CaCl_2$ treated meats at any stage of storage compared to the controls. Especially, the fragmentation ratio of myofibrils from $CaCl_2$ treated meats reached about 200% at 168hr storage.

Transmission electronmicrographs(TEM) of ultrastructure of myofibril

TEM of the ultrastructure of myofibril in the meat cuts treated with $CaCl_2$ are shown in Fig 4. Disappearance of M lines and broadening of I bands were observed in $CaCl_2$ treated meats compared to the controls. Especially, the severely disordered Z line were observed in the dehydrated meat cuts stored for 168 hr.

Conclusion:

From the results, it was proved that the contact-osmotic dehydration was effective method to penetrated Ca^{2+} into meat cut, and $CaCl_2$ was useful to tenderize tough meat.

Pertinent literature:

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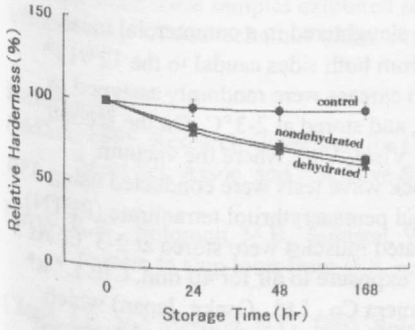

Fig.1. Changes of Hardness of $CaCl_2$ Treated Meats

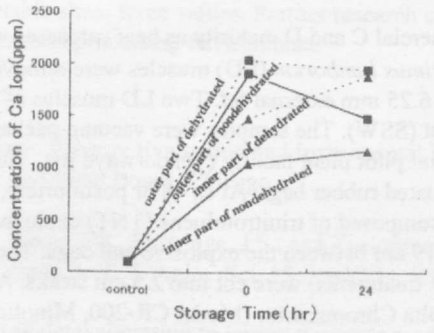

Fig.2. Concentration of Ca^{2+} of $CaCl_2$ Treated Meats

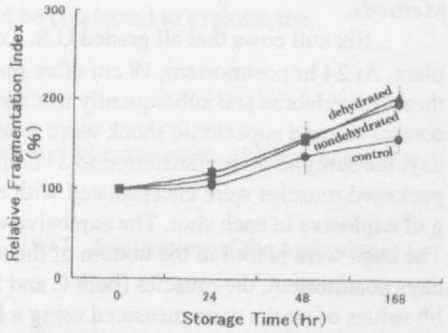

Fig.3. Changes in Fragmentation of Myofibrils from $CaCl_2$ Treated Meats

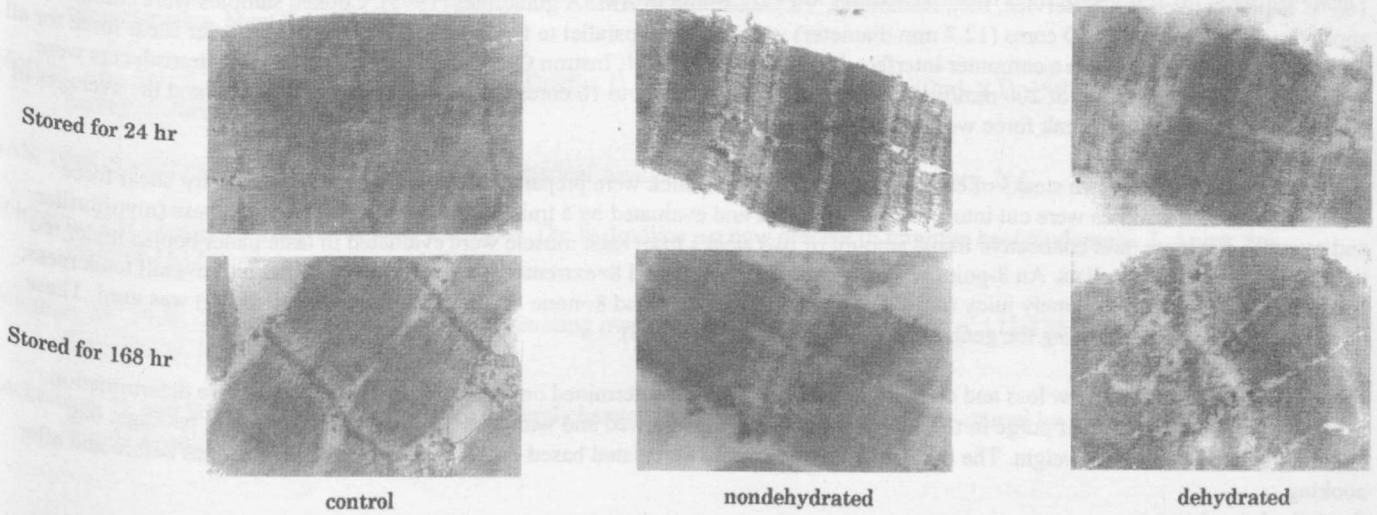

Fig.4. Ultrastructure of Myofibrils from $CaCl_2$ Treated Meats