EFFECTS OF BROMELIN ON BEEF TENDERNESS

Daniela Istrati
"Dunarea de Jos" University of Galati, Faculty of Food Science and Engineering,
111 Domneasca Street, Building F
cucoanesd@yahoo.com

Abstract

Artificial meat tenderization is used only for beef meat because pork, mutton and chicken meat are enough tende. From all types of treatments used to improve meat tenderness (mechanical, chemical, enzymatic tenderization), has been studied the enzymatic tenderization with bromelin a tropical plant enzyme derived from pineapple. In this research has been evaluated bromelin effects on mature beef tenderness. Proteolytic enzyme was added in different concentrations in injection brine and subsequently the beef cuts were injected with a specific percent of brine (10%). Beef tenderness was evaluated based on rigidity index measurement. Experimental data indicate that bromelin weaken beef meat structure produced improvement of tenderness. Samples injected with bromelin were tenderer than control.

***Keywords**: tenderness, beef meat, bromelin*

Introduction

Meeting consumer expectation for product quality and consistency has been identified as high priority by the beef industry. Five main factors contribute to the overall eating quality of meat taste, tenderness, juiciness, appearance and odour. Among these factors tenderness is considered the most important by the average consumer (Sims & Bailey, 1998). Tenderness of meat is the total sum of the mechanical strength of skeletal muscle tissue and it is weakening during post-mortem ageing of meat (Takahashi, 1996). The former depends on species, breed, age, sex and individual skeletal muscle tissue of animal. Meat tenderness originates in structural and biochemical properties of skeletal muscle fibers, especially myofibrils and intermediate filaments, and in the intramuscular connective tissue, the endomysium and perimysium, which are composed of collagen fibrils and fibers. The mechanical stability of collagen fibrils increase with chronological age of the animal. Meat produced from old animal is tough and has a lower eating quality. Improvement of meat tenderness of aged

cattle is necessary to increase palatability and value of the meat (Shiba, 2004). To obtain a meat of a high quality, animal should be slaughtered and post-mortem aged at 4°C for a specific period. Ageing periods are usually more than 10 days, 5-6 days and 0.5-1 day for beef, pork and chicken, respectively. To reduce time of ageing and to improve tenderness of meat exist many type of treatments electrical stimulation, chemical tenderization, mechanical tenderization and enzymatic tenderization. Enzymatic tenderization is the addition of meat tenderizing enzymes which affect the structure of meat. This method is used to improve both tenderness and flavor of meat. The two most often used meat tenderizing enzymes are Papain and Bromelin which are derived from tropical plant papaya fruit and pineapple plant. Ficin is another plant enzyme derived from fig tree latex that is used to improve meat tenderness.

Often, the enzyme is added as part of a marinade which include various spices and flavor enhancers. For this method, the marinade can be applied through the mechanical process called "forking", allowing the enzyme to penetrate the meat cut. Then, by cooking immediately is produced a tenderized and palatable product. Since these enzymes are deactivated by heat (Papain at 77-85°C and Bromelin at 71°C), they will continue to tenderize the meat until the meat is cooked. The heat will deactivate the enzyme. Meat tenderized using this method should be cooked and not stored. If the meat is stored for a long time and is not cooked right away a mushy unpalatable texture will be present.

Experimental

The study employed adult beef thigh post rigor (24 hours after slaughter), purchased from the commercial distribution in refrigerated form. Salt was of food-suitable purity, being a largely used additive in meat industry Papain Chilko P (Lay Condiments, Bucharest).

Chemical Analyses. The chemical composition of beef was determining by:

- ***the water content*** according to the AOAC- 1995 method, by hot drying for 24 hours at 100°C;
- ***the total nitrogen content*** and calculating the content of global proteins by multiplying the percentual content of total nitrogen by the proteic factor 6,25 was achieved according to the SR ISO 9037:2007 method;

- ***the fat content*** consisted in extraction of the free fat substances from the sample to be analysed with ethilic ether according to the AOAC method (1984);
- ***the pH*** has been measure according to the AOAC method (1984), by preparing an extract (10 g ground sample and 90 ml distilled water) which was homogenised for 2 minutes, the meat suspension was filtered, and the pH determined with a Hanna digital pH-meter.

Tenderness degree. The degree of tenderness for the papain-tenderized beef was assessed by determining the rigidity index, according to the method described by Ionescu, and al, 1992. the rigidity index was calculated by means of the formula:

$$\mathbf{I_r = a/g\ [cm^2/g]},$$

where:

a = surface occupied by pressed meat by applying a weight of 1 kilo, for 10 minutes, cm^2;

g = mass of the meat submitted to pressure, in g.

Sensorial analysis. The sensorial analysis of papain-tenderised meats was done by a samplers team, made up of 5 specialists, using a 5-point scale (1-I dislike it; 2- I do not like or dislike it ; 3- I like it; 4-I like it moderately; 5- I like it very much).

Sample preparation. The adult beef thigh separated from the gross conjunctive tissue and fat was cut into pieces of the same size in length and thickness, weighing approximately 130 g, cut along the muscular fibers. The meat pieces were divided into four groups and were used for a certain treatment. They were injected with brine made up of: salt 2 g and water 98 g to which various amounts of papain were added. For each treatment series were constituted, consisting of:

- **Control sample (M),** the pieces of meat were injected with 10% brine without papain addition;
- **Sample A** – the brine was completed with papain to a concentration of 0.002 mg/100g meat. The injection was 10%;
- **Sample B** – the brine was completed with papain to a concentration of 0.004 mg/100g meat. The injection was 10%;
- **Sample C** – the brine was completed with papain to a concentration of 0.006 mg/100g meat. The injection was 10%.

The injection was performed manually by means of a single-needle injector, so that the entire brine quantity could be uniformly pumped into the whole muscular mass. The eliminated brine was reinjected. The injected meats were wrapped with a polyethilene film and stored at 4°C for 24-48

hours aiming to achieving an uniform that diffusion of brine in the muscular tissue with or without papain addition and to deploying the activity of exogenous proteolitic enzymes.

After maturation, the meats were boiled in hermetically sealed test tubes on a water bath with gradual heating (about 1°C/minute) up to reaching the thermal centre of the temperature of 83°C, which was maintained for 10 minute. After boiling, the samples were immediately cooled on a water bath cooled by means of ice, followed by storage at refrigeration temperature over night. The boiled meats, brought to room temperature were carefully removed from the test tubes and were weighed after being tapped with filter paper. The juice expressed at boiling was collected, weighed and used for various analyses. Percent of expressed juice at thermal treatment was calculated with the formula:

% Expressed juice = [Mass of meat after injection and maturation – Mass of boiled and cooled meat] x 100 / Mass of meat after injection and maturation

Results and Discussions

The study used adult beef thigh post rigor (24 hours after slaughter), purchased from specialized stores in refrigerated state. Initially the chemical composition of the purchase meat was determined. The data obtained (Table 1.) showed a relatively lean meat (5.82% ± 1.4% fat), with an average protein content (17.2% ± 1.08%) and water content (75.8% ± 1.03), the average values and errors being calculated with the statistic program Sigma plot 2001 for five different lots of beef.

Table 1: Chemical components of beef

Chemical components	Content	
	g%	g% s.u.
Moisture	76,8	-
Dry substance	24	-
Total nitrogen	2,85	11,87
Total proteins	17,81	71,07
Fats	5,62	24,04
Non-protein nitrogen	0,202	0,84
Aminic nitrogen	0,066	0,272
Ammonia	0,019	-
pH	6,02	-

The evolution of tenderness degree of the mature beef tenderized with bromelin was determined by rigidity index measurement (rigidity index is a measure of the resistance opposed by meat to compression). Experimental data shows a significant increase of rigidity index both in thermally treated samples by boiling and in raw samples tenderized with bromelin. Rigidity index was higher for the samples tenderized with bromelin as compared to the control (injected only with brine without bromelin addition). The increase of the level of bromelin added in brine and the increase of the duration of enzyme action cause a significant increase of weakening of the mature beef structure and the increase of index rigidity values (fig.1, fig.2).

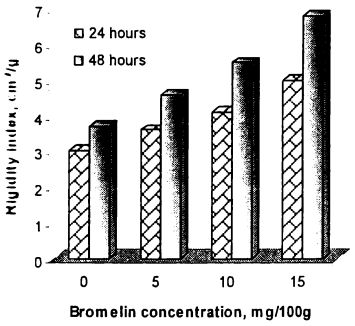

Fig. 1: Influence of the bromelin level on the rigidity index of thermally treated beef by boiling

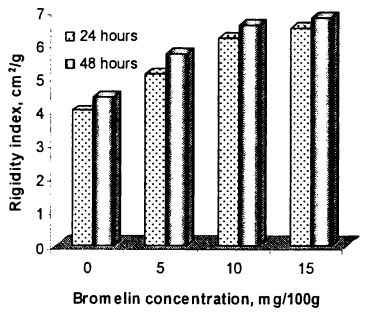

Fig. 2: Influence of papain on the rigidity index of raw beef

The increase of bromelin concentration in brine solution determined a slow increase of cooking losses, the minimal losses being displayed by the control samples. Cooking losses decrease with the increase of duration of the enzyme action both in the control samples and in the samples tenderized with bromelin (fig.3).

The sensorial evaluation of the samples high texture that with the increase of the level of bromelin added and with the increase of the duration of the enzymatic tenderization from 24 to 48 hours, a considerable fragmentation of muscular fibers was seen, part of the meat treated with bromelin, became soft after thermal treatement, with very low resistence to mastication. The tenderization with bromelin determined a increase of beef tenderness with a slowly decrease of the juiciness and the flavor. If we

utilize condiments in process of enzymatic tenderization with bromelin, the intensity of cooked beef flavor will increase.

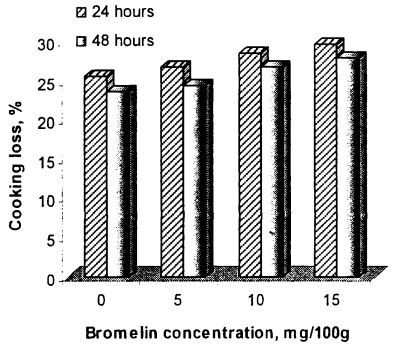

Fig.3: Influence of papain enzymatic tenderisation on cooking losses during thermal treatment

Conclusions

Bromelin is a proteolytic enzyme which affects the texture of the beef meat causing the improvement of tenderness. A significant increase in tenderness was observed when the samples were injected with high concentration of bromelin and when the enzymatic tenderization increased up to 24 hours. Injection of beef roasts with bromelin improved tenderness with a mild depression of juiciness and cooked beef flavor intensity.

Application of this technology assists beef producers and processors in their efforts to meet consumer expectations for product quality and consistency.

Aknoledgement

The presented studies were made under the scientific coordination of Professor Dr.Eng. Banu C[tin], corresponding member of ASAS.

References

AOAC, 1984. Official Methods of Analysis. 11th ed. Association of Official Analytical Chemists, Washington, DC.

AOAC, 1990. Association of Official Analytical Chemists. Methods of Analysis 15 th Edition Washington D.C.

AOAC, 1995. Official Methods of Analysis. 15th ed. Association of Official Analytical Chemists. Washington, DC.
Banu C., Ionescu A., Bahrim G., Dorin S.S., Vizireanu C., 2006, Biochimia, microbiologia si parazitologia carnii, Ed. Agir, Bucuresti.
Cross. H.R., Carpenter, Z.L., and Smith, G.C., 1973. Effects of intramuscular collagen and elastin on bovine muscle tenderness. J. Food Sci., 38, 998-1003.
Fregeding, E. A., and D. K. Larick. 1986. Tenderization of beef with bacterial collagenase. Meat Sci., 18, 201–210.
Lanz J.A.M., Pietrasik Z., Aalhus J.L., Shand P.j., 2005, The effects of enzyme and phosphate injections on the quality of beef semitendinosus, Canadian Journal of Animal Science, p. 327-334.
King. D. A., M. E. Dikeman, T. L. Wheeler, C. L. Kastner, and M. Koohmaraie, 2003, Chilling and cooking rate effects on some myofibrillar determinants of tenderness of beef. J. Anim. Sci. 81:1473–1481.
Kang. C. K., and E. E. Rice. 1970. Degradation of various meat fractions by tenderizing enzymes. J. Food Sci., 35, 563–577.
Miller. M.F., Hover, L.C.; Cook, K.D., Guerra, A.L., Huffman, K.L., Tinney, K.S., Ramsey, J.B., Brittin, H.C., Huffman, L.M., 1995. Consumer acceptability of beef steak tenderness in the home and restaurant. Journal of Food Science, 60, 963-965.
Pleidori P., F. Fantuz, 2003, Use of Ionic Compounds Infusion to Improve Meat Tenderness, International Journal of Applied Research in Veterinary Medicine.
Ramrie. N.W. and Regenstein, J.M., 2000. Action of crude papain on actin and myosin heavy chains isolated from chicken breast muscle. Journal of Food Science 42, 5, 1159–1163.
Santos H.C., Brandelli A., Zachia Ayub M.A., 2004, Influnence of post-mortem aging in tenderness of chiken breast fillets, Ciencia Rural, Santa Maria, Vol.34, Nr.3, p:905-910, ISSN 0103-8479.
Semeia L., 2005, Meat characteristics and acceptability of chevon from South African indigenous goats, Faculty of Natural & Environment, Vol. 3(1):87-90.
Stă. C., Muscă. L., Segal. R.,2000 – Îndrumar de lucrări practice pentru biochimia produselor alimentare.
STAS - SR ISO 9037:2007 – Carne şi preparate de carne. Determinarea conţinutului de azot