MECHANICAL CHARACTERISTICS OF HAM-LIKE MEAT PRODUCTS IN RELATION TO PLASTICIZATION PROCESSES

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SUMMARY

Experimental studies has been undertaken to recognise the responsibility of two processes: mechanical tenderization and tumbling of meat for the observed shear value and slice-binding value of final product.

The results of the experiments show that both plasticization processes took part in creation of mechanical properties of product. Tenderization caused initial decrease of firmness followed by further fall of shear value during tumbling. Tumbling was a decisive factor for development of slice-binding ability of ham-like product.

Introduction

Plastifying of meat by use of mechanical tenderizers and massagers or tumblers is a physical process to enhance quality attributes, accelerate meat product manufacturing and increase product yield. The increase of production yield and improvement of meat eating quality are mainly due to water uptake during the process of manufacture. Water in meat is primarily bound by the myofibryllar proteins with varying forces of interaction. The immobilization of water is related to the spatial arrangements of the proteins and to the availability of intermolecular spaces (Offer, Knight 1988). Water-holding capacity is enhanced, among others, by addition of salt (Kenney, Hunt 1990) and by cleavage of the Z-lines during ageing of meat, as well as by microstructure damage during plasticization process (Tyszkiewicz, Jakubiec-Puka 1993; Motycka, Bechtel 1983; Katsaras, Budras 1993).

Binding of meat pieces during thermal treatment shows connection with extractability of myofibrillar proteins. The extraction power is intensified by the increase, with some limitations, of salt concentration (Knight, Parsons 1988) and by the enlargement of meat surface exposed to the brine solution.

Generally, binding of meat and creation of quality attributes are complex effect of water-holding capacity changes, microstructure damage, sticky exudate formation and physical and chemical modification of protein molecules during thermal treatment (Katsaras, Budras 1993).

To obtain a protein-rich sticky exudate without severe disruption the normal muscle structure is the goal of the massaging or tumbling process. The process of mechanical tenderization preceding massaging causes more pronounced damage of meat structure (Tyszkiewicz, Jakubiec-Puka 1993) resulting in more effective formation of sticky exudate and decrease of meat firmness.

From this point of view the two physical processes: mechanical tenderization and tumbling can be considered as competitive to each other in formation of structure and mechanical properties of final meat product. To recognize the actual role of the two processes in development of rheological properties of ham-like meat product the experimental studies has been undertaken.

Materials and methods

Pork ham muscles cut off from the carcasses about 48 hours post mortem and well trimmed were mechanically tenderized by being treated with meat activator and meat grinder with a kidney plate. In the meat activator (fig.1A), which is the tubular attachment mounted on the outlet of meat grinder, the muscles were transported by a conveying worm and squeezed out through a narrow slide what caused a sudden expansion of meat, like explosion. In meat grinder equipped with a kidney plate (fig. 1B) the muscles were transported by a conveying worm and coarsely ground. As controls, the untreated muscles cut into 3x3x3cm cubes were used in each run.

Tumbling of tenderized and control muscles was accomplished with a HOFFMANN tumbler model HS-150 (640) operated at 19rpm. 50% (w/w) of brine solution containing 7,9% of salt had been added to meat before the tumbling process started. The intermittent tumbling cycle consisted of 20min. rotation and 10min. rest periods. Whole process lasted 420min. of rotation time what was equivalent to about 16000m of tumbling distance.

In succeeding rest periods the mixture of meat and exudate was sampled continually. The samples were canned and pasteurised to corn temperature 68_C.

Shear force values were determined as previously described (Tyszkiewicz, Olkiewicz 1991) using a 1445 series ZWICK Universal Testing Machine equipped with Warner-Bratzler shear device as a working part. Eight meat cubes (40x40mm of surface area) were penetrated for each run and the maximum force necessary to damage the structure was recorded as shear value.

Slice binding value was determined using the same ZWICK UTM under conditions previously described (Tyszkiewicz, Olkiewicz 1991). Ten slices (3mm thick and 60mm wide) were successively expanded and the force necessary to break the slice was recorded.

Results and discussion

The results presented in fig. 2 show that mechanically tenderized samples at the beginning of tumbling process demonstrated lower shear forces in comparison to untenderized ones. Similar value could be obtained by untenderized sample not before 6880m of tumbling distance. The greatest initial softening of meat was observed as a result of meat grinder application. In the course of tumbling time the shear value of the ground sample decreased slowly and at the end of the process at about 16000m of tumbling distance it reached the minimum value about 59N.

The shear force of activated sample declined faster and its minimal value was achieved at about 3800m of tumbling distance. After that a small increase of shear value occurred, which might be due to so called overtumbling, connected with too far advanced structure damage and water release. Perhaps the new arrangement of protein molecules in exudate was responsible for further drop of shear force after crossing the 11500m of tumbling distance.

Control sample became less firm continually and achieved its lowest shear force at about 9100m of tumbling distance. After that a small increase of shear value occurred, similar to that in the activated sample, followed by further decline of shear value when the tumbling distance was long enough and exceeded 14400m.

Slice binding values for both tenderized samples (fig. 3) increased continuously together with lengthened tumbling distance. Activated sample achieved its maximum binding force at about 12000m of distance. In the whole range of tumbling distances the value for activated samples exceeded by 0,5-0,8N the values for samples tenderized by meat grinder.

Control samples in the conditions of experiment demonstrated no slice-binding ability and tumbling process was ineffective. The only explanation of the phenomenon was that salt concentration in brine was too low to extract proteins from mechanically untreated meat (Theno et al1978). The conclusion might be supported by previously described results of experiments (Tyszkiewicz, Olkiewicz 1991), where 30% (w/w) of brine containing 11,3% of salt was used and where slice-binding value for control sample was very low but increased during tumbling from initial 0,5N to final 1,8N at about 11500m of tumbling distance.

Slice binding ability of the meat seems to be strongly connected with the relationship between the degree of myofibrils fragmentation and myofibrillar protein concentration in exudate (Olkiewicz at all 1994, unpublished data). The experiments aimed at elucidation the phenomenon of slice-binding are being carried on.

Conclusion

Both plasticization processes took part in creation of mechanical properties of meat product. Tenderization caused initial decrease of firmness followed by further fall of shear value during tumbling. Tumbling was a decisive factor for development of slice binding ability of ham-like meat products, unless there were no conditions for protein-rich exudate formation as it might happen in the case of untenderized sample and low salt concentration.

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Fig. 1 Tenderizers
Fig. 2 Changes of the shear value of ham-like product during massaging
Fig. 3 Changes of slice-binding value of ham-like product during massaging