# Application of Meat Tenderizer

## precooking holding periods for beef treated with tenderizers using papain as the activating agent found to be unnecessary

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**Physical** incorporation of tenderizers into meat is an important factor influencing their effectiveness.

Papain—a plant enzyme obtained from the papaya—is the active ingredient in most commercial tenderizers. The proteolytic action of the enzyme cleaves or breaks apart the muscle fiber proteins and connective tissue of meat by hydrolysis—in a manner similar to that of digestion—which makes food more absorbable.

Because the use of meat tenderizers containing papain has grown to large proportions studies were conducted on the effect of time of papain application prior to cooking and the effect of temperature on protein hydrolysis by papain.

For penetration studies, it was assumed that relatively small dye molecules would readily diffuse in meat to any depth to which the large papain molecules could penetrate so a fluorescent compound, quinine sulfate, and the dye, bromerosol green—neither compound inhibits papain activity—were incorporated into solutions of papain. Small cubes of the semitendinosus muscle—inner thigh—from U.S.D.A. Choice grade beef were cut approximately one centimeter square and immersed in the solutions to a depth of one millimeter at temperatures ranging from 73°F to 131°F. Periodically, cubes were removed and the penetration of the enzyme was determined. Controls containing no papain were used for comparison.

The maximum penetration of the dye to about two millimeters clearly indicates that effective distribution of papain within the meat can not be accomplished by natural diffusion or by papain's hydrolytic activity.

To study the effects of precooking holding time samples of the semitendinosus muscle were cut lengthwise into 3″ thick sections. From each section two rectangular samples measuring 1″ × 3″ × 3″ were cut so that the muscle fibers ran parallel to the 3″ length. One sample was treated with papain and the other used as the control. Papain treatment consisted of placing the sample in 20 milliliters of 1% aqueous papain and forking thoroughly so that tine marks were approximately ⅜″ apart. The control sample was treated in the same manner, using water instead of papain solution. Both samples were allowed to incubate at room temperature for intervals of 0, 1, or 5 hours.

The samples were cooked in a pressure cooker at 10 pounds per square inch for 15 minutes, cooled to room temperature and then sliced on one face to give a plane surface. A cylindrical sample 2″ in diameter was cut out and sliced at a thickness of approximately ¾″. The texture of each sample was measured by shearing in a mechanical texturemeter. This experiment was done five times.

The data obtained in these studies show that papain treatment gave definite tenderization but that the holding periods of one and five hours before cooking had no significant effect. Therefore, the significant tenderization must have occurred during the cooking period.

For microscopic studies of enzyme action the meat was cut into ⅝″ thick slices by parallel cuts along the length of the muscle fibers. Consecutive disks, 1″ in diameter, were sliced from the samples. Some disks were left raw, some untreated and with others, coated on the upper flat surface with powdered papain, were cooked in a pressure cooker for 20 minutes at 10 pounds per square inch.

Several additional pieces of meat were cut so as to expose the ends of the muscle fibers and the exposed surface was covered with papain powder. Samples were taken immediately, after three hours at room temperature, after ½ hour at room temperature, and after 10 minutes of broiling.

After three hours of exposure to a thick layer of papain powder, no evidence of enzymatic activity was observed by microscopic examination. Below the superficial layer of enzyme powder, all the muscle fibers were intact, with few noticeable disturbances in the striation pattern. Similarly, no changes were evident in the collagenous—connective—or elastic fibers when the treated meat was compared with the untreated controls. A slight coalescence of muscle fibers at the outermost surface of both the treated and untreated samples may perhaps be related to a slight drying of this surface on standing.

When meat coated with enzyme powder was placed in a broiler or in a pressure cooker, definite changes occurred, distinct from those due to heating alone.

In a cross section of the raw meat—with collagenous and elastic fibers among the muscle fibers—nuclei were readily noticeable at the periphery in the muscle fiber cells. A control sample, where no enzyme preparation was used, cooked in a pressure cooker showed a layer of coagulated material over the surface of the meat, and some of the muscle fibers near the surface were beginning to separate from each other. The nuclei of the muscle fiber were still quite apparent throughout the section but the collagenous fibers had lost much of the structure. Elastic fibers appeared unaffected by the heat treatment.

After application of the enzyme powder and cooking, marked changes were found in the meat tissues. Not only was the sarcolemma—transparent sheath enclosing muscle fiber—destroyed at the surface of the sample, leading to marked separation of muscle fibers, but in some cases the fibers had coalesced. Only much deeper in the meat were indications of the sarcolemma found. Likewise, the nuclei of the muscle fibers were apparent only at a considerable distance from the treated surface of the meat. Subsequent stages in hydrolysis involved the appearance of small open areas in the muscle fibers.

A longitudinal section showed breakdown of the muscle fibers when the papain powder was applied to the exposed ends before broiling. Collagenous fibers at the surface had disappeared but the elastic fibers were still intact.

The microscopic study of beef cooked with papain also showed that papain does not affect sarcolemma, nuclei, or muscle fibers to depths greater than 0.5 millimeter.

Collectively, the studies of papain action, the effect of temperature on papain activity, the hydrolysis of beef proteins, and the effect of precooking holding periods on beef tenderization indicate that precooking holding periods are unnecessary.

The studies further indicate that the incorporation of papain into meat to be tenderized is a most important problem. Physical means of incorporation should be used and—perhaps—the technique of thoroughly forking papain into the meat may be a solution to this problem.

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accepted in the United States that the additional outlays for food are in the vicinity of 20% to 25% of an income increase.

With the population growth and income rise that are in prospect, the demand for food by 1975 may be 50% higher than in 1950. This expectation results from an estimated population growth of 36% between 1950 and 1975, accompanied by a 10% increase in per-capita food demand, which is based on the expectation of higher incomes.

In the spring of 1948, the Department of Agriculture made a nationwide survey of the food consumption of urban families. It was found that fruit took 8¢ of the consumer's food dollar and 5¢ of the 8¢ were spent on noncitrus fruits. Of the total expenditure for fruits other than citrus, about 62% was spent on fresh fruit, 26% on canned fruit, 5% on canned juices, and the remainder on frozen and dried products. Urban families with annual incomes between $1,000 and $2,000 spent $17 a week for food compared with $31 by the group with incomes between $5,000 and $7,500.

Among the food commodities to which consumers respond most readily—if they have adequate incomes—are frozen and fresh fruits. The 1948 survey indicated that the quantity of these items consumed in the home can increase as much as 3% with 10% higher incomes.

American families do not have rigid and fixed consumption habits and patterns, which—perhaps—is one of the most outstanding and significant features of the national economy. The great changes that have occurred in the American manner of living within recent decades have had their impact on every phase of economic life. The changes in food needs and preferences are certainly not the least important of these impacts. Formerly the American working force in many industries and occupations was engaged in energy-consuming physical labor now performed by machines. However, Americans continue to consume about the same total poundage of foodstuffs per capita as they did half a century ago. The adjustment has been to substitute foods that have appetite appeal and nutritional components other than carbohydrates for part of the previous energy-rich diets.

The shifting in the average diet is a gradual process likely to continue for many years to come. In addition, a further influence is the growing proportion of people in the older age categories. In coming years, it is expected that the number of persons aged 65 and over will increase almost twice as rapidly as the total population. This is in consequence of improvements in medical science.

Decreased need of energy-rich diets by older people and by a population that has less arduous physical work to do is a matter that should have far-reaching significance for the fruit industries. Fruits are a very satisfactory substitute for foods that are high in carbohydrate. The role which could be played by lemon-juice products, particularly frozen concentrated lemonade, in this changing pattern of food consumption depends in large part on the manner in which the lemon products industry takes advantage of the situation; the potential will exist.

Making projection of consumption rates for a new product—such as frozen concentrated lemonade—and particularly one which apparently caught public favor is a different problem from one of making projections for an old long-time established product. For the new product the early growth factor is significant. In relative terms, the new product can be expected to reflect a strong initial growth factor due to market penetration and extension during the early years. Then a leveling out often prevails as the product becomes established, which may be expected of frozen concentrated lemonade.

To some observers the projections set forth in the table on page 2 may seem unnecessarily conservative, and to others the rates may seem grossly overoptimistic. But the projections are not predictions; they are indicators of potential developments in light of historical experience and considered likelihood as to the future of the United States economy.

The market projections are based—in addition to the population and income levels shown in the tabulation—on the premises that national productivity and employment generally reflect current peacetime conditions and that no marked changes occur in consumers preference structure. Therefore, they may be suggestive of the longer term market potential for lemon juice products.

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*The fourth article in this series will appear in the November issue.*

## TENDERIZERS

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These studies give some insight into the mechanism of papain tenderization of beef. Probably the most important tenderization mechanism is the hydrolysis of muscle-fiber protein, which accounts for three-fourths of the edible portion of beef. Papain hydrolyzes the sarcolemma and the muscle cell nuclei before there is any apparent digestion of the muscle fibers themselves. As measured by the transformation of soluble protein to amino acids, papain hydrolysis reaches a maximum at temperatures of 140°F to 176°F. It is probable that the heat-labile muscle proteins denature before the relatively heat-stable papain and papain hydrolizes these denatured proteins with maximum effect.

Tenderization by papain can not be ascribed to one specific reaction but rather to a general hydrolysis of all of the structural components of beef muscle.

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## ALFALFA APHID

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aphid skin. The *Trioxys*-produced mummy is smooth, rounded, and grayish-brown in appearance but the mummy produced by *Aphelinus* is oblong in shape and black in color.

Several days after the mummy is formed, the parasite pupa changes to the adult which chews a hole in the aphid skin and emerges through it to continue the attack on the aphid. The adults of all three parasites are very small wasps, those of the largest species, *Praon palitans*, being no longer than one-eighth inch. Except for their lethal attack on spotted alfalfa aphid, these wasps are completely harmless, probably gaining their food from nectars and honeydews.

At present it is impossible to speculate as to the role these wasps will play in the biological control of spotted alfalfa aphid. Even after becoming established they must demonstrate the ability to spread from the release plots into adjacent commercial alfalfa fields and there survive and multiply in the face of the disruptive conditions of the alfalfa growing cycle.

Some of the factors which may tend to inhibit maximum parasite activity are: widespread insecticide applications; the mowing and baling processes; winter pasturing or dormancy of alfalfa; and periodic scarcity of aphids resulting from ladybird beetle attack or adverse climatic conditions. However, if—despite these factors—the parasites can reach the status which they have attained in a number of areas in the Mediterranean region and Middle East, their collective role should be of considerable importance in the biological control of spotted alfalfa aphid in California.

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