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MEAT RESEARCH LABORATORY

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TENDERISING MEAT USING ENZYMES

Some markets allow the use of proteolytic enzymes to tenderise meat. Although the end result is much the same as in ageing, the action of the added enzyme is believed to be slightly different.

Regulations concerning the use of enzymes differ from country to country and intending users are advised to check the market requirements. In many instances clients specify their own formula.

United States authorities have approved a number of enzymes for use in tenderising meat providing they do not result in a gain of more than 3% above the weight of the untreated product. In Australia, the Food Standards Committee of the National Health and Medical Research Council are currently considering standards.

TYPES:

Commercially used enzymes can be divided into three groups:-

(i) Those derived from either bacteria or fungi. These act primarily on the muscle fibre proteins and only have slight action on connective tissue proteins.

(ii) Those derived from tropical plants. Papain from paw paw, bromelin from pineapple and ficin from fig. These act primarily on the connective tissue fibre proteins although they also attack the muscle fibre proteins to a varying degree. For this reason these enzymes would be thought to be better for cuts containing large proportions of connective tissue, e.g. chuck, blades, silversides.

(iii) Those derived from animals, e.g. Trypsin from pancreas gland.

The tenderising action of enzymes takes place mainly over the cooking temperature range. There is practically no activity at refrigeration temperatures of storage so that enzyme treated meat can be kept below 45°F before or after cooking.

Optimum temperature of activity varies from enzyme to enzyme. Bromelin is most active at about 125°F and is inactivated at over 160°F.

Papain is most active at about 135°F and is still active after the final cooking temperature (over 170°F) has been reached. For this reason, meat tenderised with papain will continue tenderising if the product is kept warm, or reheated or recooked after processing. If any of these conditions are to apply, the enzyme strength must be adjusted. On the other hand, very little tenderising occurs during lower handling temperatures (under 80°F), and this relative safety of papain makes it suitable for some uses.

The microbial proteases have the advantage of rapidly and completely losing their activity at temperatures above 140°F. However, prior to cooking, they are relatively active at temperatures above 70°F.

Because of the different methods of action, a combination of plant, bacterial and fungal enzymes might function more efficiently in a tenderising formula than a single enzyme.

CONCENTRATIONS:

Enzymes are readily available from chemical firms servicing the meat industry.

For frying or grilling steaks, the following maximal concentrations of some commercially available enzymes were found to be satisfactory:

(i)	HT Proteolytic conc.	0.04% solution
	Protease M60	0.06%
	HT Proteolytic 200	0.10%
(ii)	Papain	0.02%
	Bromelin	0.035%

The level of enzyme to give desirable uniform tenderness differs from cut to cut and from grade to grade depending on the initial level of tenderness.

Cooking time and temperature also determines the concentration to be used. A roast that is going to take five times longer than a grill to cook, will need about one fifth of the concentration of the same enzyme to achieve a similar degree of tenderisation. Tenderised cuts require less cooking time than non-tenderised meat and there is less cooking weight loss.

Salts have a tenderising action on meat and 1½ - 2% of sodium chloride can be added to an enzyme solution with beneficial results.

STANDARDISATION:

The optimum level of an enzyme preparation to be used is determined by taste evaluation of the treated steaks. As a quality control measure, this desirable level of the particular enzyme preparation is standardised on an activity basis from one batch to another.

Standardisation involves an accurate assessment of the proteolytic activity of the enzyme on a standard protein at a fixed temperature for a fixed period of time by one or more of the available methods. Cost per unit of activity is an important factor when deciding which enzyme to use.

The proteolytic enzymes used for tenderising meat all show very good stability in the dry state though their activity may decrease after long periods of storage. In solution however, some of them lose their activity fairly rapidly. The use of solutions made up daily and kept under refrigeration is therefore recommended.

INJECTION METHODS:

There are problems of effectively introducing enzymes into raw meat to get uniform distribution of the correct amount of the enzyme.

A number of methods have been devised:

(i) Enzymes were first used as dips. As such they were unsatisfactory since they overtenderised the surface, producing a mushy texture.

Sufficient penetration and diffusion can be achieved in an individual steak by forking it (or pressing it against a plate supporting numerous small needles) while immersed in an enzyme solution and soaking for about 20 minutes. This method is suitable for housewives wishing to tenderise steaks.

(ii) A patented technique whereby the enzyme solution is injected into the animal prior to slaughter. The animal's own circulatory system distributes the enzyme throughout the carcase. The muscles in the carcase contain about the same concentration of enzyme (although there is some suggestion that the more active muscles get more) and the meat is therefore suitable for only one method of cooking. There is also an accumulation of enzyme in certain organs, e.g., liver, kidney, tongue, making them disintegrate on cooking.

(iii) Post-mortem pre-rigor pumping of dressed carcases. This may be done either by intravenous injection (where a solution retention of about 10% is necessary to get even penetration, or by intra-muscular injection using a series of needles where distribution is by diffusion through the muscle.

(iv) Conventional needle injection of cuts using single or multi-needle pumps. The larger the injection volume the faster the distribution in the meat.

(v) A patented method of supplementing the needle injection with controlled gas diffusion which permits proper penetration and diffusion of the enzyme solution.

A set of needles descends into the meat. On the downstroke nitrogen is emitted from the hollow needles and this opens the meat tissue. Then, on the upstroke, the enzyme solution atomised by the gas, enters the meat and is uniformly distributed.

A large proportion of the above has been derived from an unpublished report by P.E. Bouton, of this Laboratory.

JOTTINGS:

The Australian Meat Board held its August Meeting in the Laboratory's Conference Room.

Spray Washing of Carcases:

Some works still have difficulty with keeping quality of carcases washed with water.

It is generally accepted within Industry that spray temperature should be at least blood heat (100°F) to remove visual contamination. In the range of temperatures acceptable to continual handling, there is no advantage, from a keeping quality point of view, in choosing a higher temperature.

Although high wash pressures are useful in removing visual dirt, the higher the pressure the more likely that water will be imbedded in tissues; this may make it difficult to remove during chilling.

The problem of keeping quality of washed carcases against that of unwashed or wiped carcases is basically one of ensuring that refrigeration is adequate both to chill the carcase and remove excess surface water early in the chilling stage. Bacteria grow on wet surfaces, therefore it is necessary to suffer some weight loss to give keeping quality.

(i) Ensure that carcases are well spaced (not touching).

(ii) Apply cold temperatures with high air velocities as early as possible in the chilling stage.

(iii) Reduce running of hot carcases in with cold carcases to a minimum. Keep doors closed when not in use.

(iv) Ensure that the refrigeration design is adequate to cope with the removal of the excess water vapour.

NEXT ISSUE will be Salmonellae.