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APPLICATION OF NATURAL TENDERIZERS IN MEAT- A REVIEW

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ABSTRACT

Most of the research works related to tenderness of meat are concerned with the use of different chemical tenderizers. But certain limitations of these chemical tenderizers have been reported on one or the other sensory attributes of meat and have limitations for exploitation at restaurant or household level and thus are only partially successful in tenderizing tough meat. So to combat these undesirable effects of chemicals, some natural tenderizers could be used. Natural tenderizers refer to those fruits and vegetables, which contain proteolytic enzymes, responsible for tenderization of tough meat. Therefore the studies for utilization of unused tough meat with natural tenderizers like papaya *(Carica· papaya)*, ginger *(Zingiber officinale roscoe)*, *kachri (Cucumis trigonus Roxb)* and fig *(Ficus carica)* heve been reviewed here.

Of all the eating quality attributes, the average consumer presently rates tenderness of meat as one of the most important factors. No palatability factor has received more research study than tenderness. The overall impression of tenderness to the palate involves three aspects: firstly, the initial ease of penetration of the meat by the teeth, secondly, the ease with which the meat breaks into fragments; and thirdly, the amount of residue remaining after chewing (Weir, 1960). The degree of tenderness can be related to those of connective tissue, myofibrils and sarcoplasmic proteins (Lawrie, 1991). Singh and Panda (1984) reported that in meat obtained from young animals, myofibrillar components contributed the toughness known as actomyosin toughness or myofibrillar toughness, whilst from old animals the toughness of meat was caused by connective tissue and known as background toughness.

Tenderness and its measurements:

Physical and chemical methods have been developed for assessing the tenderness of meat. Physical methods include measuring of force for shearing, penetrating, biting, mincing, stretching and compressing (Lawrie, 1991). Chemical methods have involved determination of connective tissue, its solubility (Mahendrakar *et al.,* 1989) and enzymatic digestion (Lawrie, 1991).-

Warner Bratzler shear force instrument, as the name indicates, measures the force needed to shear muscle fibers. The more force needed, the tougher the meat is. Different workers used this instrument for assessing the tenderness of meat. Its unit of measurement is kilogram of force needed to shear a one cubic centimeter muscle sample.

According to Morgan *et al.* (1991), tenderness was measured by a sensory panel test, where trained panelists as well as ordinary people consumed the meat and recorded their perception of its tenderness. Besides, many sophisticated techniques have been used to assess the tenderness of meat, such as enzyme activity estimation (Koohmaraie *et al., 1988),* myofibrillar fragmentation index (Olson and Parrish, 1977), hydroxyproline measurement (Ashie *et al.,* 2002), conductivity measurement (Stumpe *et al.,* 1990) and scanning electron microscopic studies (Grover *et al.,* 2004).

Factors affecting tenderness:

Tenderness of meat is affected by both pre slaughter and post slaughter factors. Pre slaughter factors include species, breed, age, sex, feeding and management, genetic influence and stress conditions.

Among the commonly discussed pre slaughter factors, species is the most important factor affecting tenderness (Lawrie, 1991). Wheeler *et al.* (1990) reported that Brahman

breed tend to be tougher than Hereford breed in cattle. Ricard and Touraille (1988) observed that the breast muscle tenderness in chicken was better in female than male. Rapid growth in young animals would be expected to foster a higher proportion of less cross-linked collagen and thus increased tenderness (Bailey and Light, 1989). Morgan *et al.* (1991) reported that when cattle were fed grains and other supplements, they laid down extra fat within the muscle (marbling) that could be considered as an indication of tenderness. Stress, prior to slaughter influences the ultimate tenderness and it has been observed that minimum stress during transport, yarding, handling and slaughter, the meat was consistently at the tender end of the scale, regardless of breed (Morgan *et al., 2002).*

Post slaughter factors that influence meat tenderness include, postmortem glycolysis, postmortem shortening, conditioning, processing and cooking methods (Sahoo and Panda (1984a, b). The lowering of pH in muscle due to accumulation lactic acid is one of the most significant postmortem changes that occur due to postmortem glycolysis. Several researchers have reported that the rate of postmortem glycolysis is an important determinant of meat tenderness (White *et al.,* 2006; O'Halloran *et al.,* 1997). Devine *et al.* (2006) stated that low ultimate pH was necessary to obtain optimum tenderness. Postmortem shortening due to permanent actomyosin bond formation during the development of rigormortis contributes to the muscle stiffening (Forrest *et al.,* 1975). The meat obtained from such stiff muscle is considered as tough meat. It has long been recognized that the tenderness of meat increases when it is conditioned and for this purpose venison is regularly aged (Lawrie, 1991).

Subsequent processing of meat after slaughtering may alter meat tenderness. Locker (1960) reported that rapid chilling of meat resulted in tough meat due to muscle contraction. This phenomenon is known as cold shortening (Dransfield, 1994). Coleby *et al.* (1961) observed that ionizing radiation at sterilizing doses (about 5 Mrad) or above, caused changes in the meat proteins, which resulted in increased tenderness. Cooking causes an increase or a decrease in tenderness depending on a variety of factors including the temperature to which the meat is cooked, the time of heating and the particular meat muscle being considered (Lawrie, 1991).

Weir (1960) reported that prolonged cooking time at relatively low temperature converted collagen to gelatin resulting in more tenderness of meat, whereas, Lawrie (1991) reported that cooking coagulated the proteins of myofibrils resulting in toughness. McCrae and Paul (1974) stated that microwave cooking preferentially increased the solubilization of collagen.

Significant reduction in toughness of gizzard musculature on cooking has been reported by many researchers. Arafa (1977) reported that the shear force value of raw gizzard decreased considerably after cooking. Charoenpong and Chen (1980) revealed that tenderness of gizzard was affected by the length of cooking time in boiling water due to enhanced collagen hydrolysis. Improved tenderness of gizzard due to pressure cooking was also reported by Sharma *et al.* (1986) and Sachdev *et al.* (1994). Grover *et al.* (2005) stated that cooking significantly reduced the shear force value of gizzard from 15.75 to 4.51 kg/cm^3

Natural tenderizers:

In order to improve the tenderness of meat, a number of tenderizing methods have been tried as antemortem or postmortem treatments. Antemortem treatments include feeding of electrolytes, use of enzymes etc., whereas postmortem treatments include

marination, electrical stimulation, pressure cooking and aging (Mendiratta, 1992). However, most of these treatments have negative effects (Naveena and Mendiratta, 2001) such as experimental data of Young and Lyon (1986) did not show desirable tenderizing effect due to sodium tripolyphosphate. Papain treated meat received high tenderness but high score for bitterness, too (Gerelt *et al.,* 2000). Abnormal flavour and bitter taste due to calcium chloride had been reported by Perez *et al.* (1998). There are numerous fruits, vegetables or plant products which contain naturally occurring proteolytic enzymes. These have potential for improving tenderness of tough meat with desirable sensory attributes.

Natural tenderizers are defined as those· natural products such as different fruit and vegetables that contain proteolytic enzymes. To achieve efficient utilization of tough meat, these proteolytic enzymes obtained from natural products may be used. Among these plant proteolytic enzymes most commonly discussed are papain, zingibain, cucumin, ficin etc. Kang and Warner (1974) reported that tenderization of meat by papaya latex preparation is achieved due to presence of papain enzyme in raw papaya. Cucumin present in *kachri* enzyme system possessed a strong meat tenderizing property (Hujjatullah and Baloch, 1970). Recent investigations have shown that zingibain in ginger rhizome has proved to be an effective tenderizing agent for meat and meat products (Naveena and Mendiratta, 2001). Cormier *et al.* (1989) reported that the protease enzyme ficin present in fig could be used as meat tenderizer.

Tenderizing effect of papaya:

Papaya is a natural source of proteolytic enzymes (Skelton, 1969). Kang and Warner (1974) reported that tenderization of meat by papaya was achieved by combined action of papain, chymopapain and papaya peptidase--A. Among them chymopapain was the primary contributor for tenderization as it had more favourable action at neutral pH. Tenderization of meat can be improved by application of this papain which acts on the structural component of muscle (Gracey, 1985). Papain is a proteolytic enzyme extracted from *Carica papaya* (Poulter and Caygill, 1985). They reported that fully grown but totally green fruit of papaya were tapped to a maximum depth of two mm and the latex collected in a container was dried bellow 70°C to form powder. It was solubilized in water which showed greater enzymatic activity.

Kang and Rice (1970) concluded that papain showed higher activity for myofibrillar fraction with stronger solubilizing activity on connective tissue. Mendiratta (1992) reported that papain and pressure treatment had synergistic effect on improving tenderness with higher collagen solubility. Khanna (1995) suggested that papain infusion plus forking technology was more suitable for tenderizing spent hen meat cuts than injection method. Grover *et al.* (2005) also showed the synergistic effect of papain and sodium tripolyphosphate in increasing the tenderness of chicken gizzard.

Tenderizing effect of *kachri:*

The fruit.of *kachri,* a melon variety fruit is available throughout the drier upland tracts of India, West Pakistan, Afghanistan and Persia. Among the widely used plant proteolytic enzymes, cucumin which is obtained from *kachri* has been reported to have proteolytic activity and coarsely ground dried fruits of *kachri* are traditionally used as a food tenderizing agent (Hajjatullah and Baloch, 1970). They also suggested that dried *kachri* powder could be spread over the piece of meat at room temperature for meat tenderization. Kumar and Berwal (1998) reported that *kachri* could be used successfully to improve the tenderness of spent hen meat. Mendiratta *et al.* (2003) reported that tough sheep meat was effectively tenderized with in 4 hours at room

temperature (25°C) by treatment with 5 per cent extract of cucumis fruits. Naveena *et al.* (2004) concluded that cucumis could be used as better alternative to papain for tenderization of tough buffalo meat.

Tenderizing effect of ginger:

Ginger rhizomes were investigated as a new source of plant proteolytic enzyme called zingibain by Thompson *et al.* (1973). They reported that the proteolytic activity of ginger protease on collagen was manifold greater than on actomyosin. The combined proteolysis of these two muscle proteins resulted in significantly more tender meat. They also reported that when sheep meat was cooked with fresh ginger slice, shear force value decreased from 4.27 to 2.8 kg/cm^3. Ginger rhizome has been shown to have a powerful proteolytic enzyme, which can be used as tenderizing agent for tough meat (Lee *et al.,* 1986; Mansour and Khalil, 2000). Lee *et al.* (1986) explained that higher concentration of ginger extract extensively degraded the myofibrils and the degradation appeared to begin at I band of each sarcomere and progressed towards the M line. Naveena *et al.* (2004) reported that cheaper and easily available ginger rhizome could effectively be used for tenderization of tough meat. Zingibain obtained from ginger rhizome, a natural spice, has an advantage over other tenderizing agent that it has a greater proteolytic activity in heated condition, which is desirable (Naveena and Mendiratta, 2001).

Tenderizing effect of fig:

Ficin obtained from fig was reported as a natural meat tenderizing agent (Wang et aI., 1957). They further explained that its maximum action was on breakdown of elastin fibre and a sufficient proteolytic activity was recorded on actomyosin complex and collagen. Cormier *et al*. (1989) conducted an experiment on cell culture of fig and evaluated the cell culture as a source of protease enzyme that could be used successfully as meat tenderizer. Ramezani *et al.* (2003) investigated the water holding capacity of ficin tenderized meat and evaluated the effect of ficin on meat protein by gel electrophoresis and concluded that solubility of meat protein increased when ficin was used as meat tenderizer.

It is concluded from this review that unused tough meat can be successfully utilized as well-accepted one with application of natural tenderizers like papaya, ginger, *kachri* and fig.

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