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ORIGINAL ARTICLE

Effect of mung bean and sprouted mung bean (*Vigna radiata*) powder on chicken breast meat tenderness, microbial and sensory characteristics

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Abstract Effect of mung bean and sprouted mung bean (*Vigna radiata*) was investigated on meat tenderness, microbial and sensory characteristics. Results showed that treatment of aqueous extract obtained from sprouted mung powder and mung powder have beneficial effect ($P<0.05$) on tenderness of chicken breast meat. These extracts also showed ($P<0.05$) antibacterial activity for meat bacteria; values of TPC and PPC (log cfu/gm) at 24 h of marination were also lower than initial values in SMP and MP groups thus SMP and MP may contain some antibacterial substances which have beneficial effect on meat bacterial count. There was better ($P<0.05$) cooking and sensory scores observed for marinated meat samples than control groups.

Keywords *Vigna radiata* · Sprouted · Meat · Tenderness · Microbial · Sensory

Introduction

Consumers consider meat tenderness the most important palatability trait of meat quality (Gonzalez et al. 2001) and its variability is an area of major concern in the meat industry (Koohmaraie 1996.). Tenderness is the major factor affecting consumer satisfaction and eating quality (Narsaiah et al. 2011). It is a real challenge for the scientific community and for the meat industry to achieve products with standardized and guaranteed tenderness.

It is well known that meat tenderness increases gradually during postmortem storage, and it is generally accepted that degradation of myofibrillar proteins and structure disruption by endogenous proteases are responsible for this postmortem tenderness improvement (Ouali 1990; Koohmaraie 1992; Koohmaraie 1994). During postmortem storage of carcasses, numerous changes occur in skeletal muscle, some of which result in the loss of tissue integrity that translates into improved meat tenderness. Proteolysis is the principal reason for meat tenderization during postmortem storage (Whipple et al. 1990; Shackelford et al. 1991).

Meat has been marinated to improve flavor, improve tenderness, and increase product shelf life. An important aspect of marination is the increase of yield of the raw meat, which can provide benefits to the producer and the consumer. Infusion or perfusion of compounds to change the rate of glycolysis, rate and state of contraction, and rate of proteolysis appear to be feasible methods of manipulating the postmortem tenderization process in meat (Lee et al. 2000; Koohmaraie et al. 1990; Morgan et al. 1991; Wheeler et al. 1991).

There are many reports of plant protease activities in the literature. Most reports are on legumes (Citharel and Garreau 1987; Couton et al. 1991; Collier and Murray 1977; Crump and Murray 1979; Yu and Greenwood 1994). Aspartic proteinase and some amino peptidase activities are present in ungerminated seeds. Amino peptidases are expressed in sprouts of sweet potato (Lin and Chan 1990). During germination and early growth, storage proteins are degraded by proteolysis.

Many reports also deal with mung bean (*Vigna radiata*), especially with cotyledons of mungbean. Results have

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suggested that the appearance of a sulfhydryl-type endopeptidase activity is a necessary prerequisite for the rapid metabolism of the reserve proteins which accompanies the germination of mung bean (Chrispeels and Boulter 1975). Vicilin peptidohydrolase, the major endopeptidase in the cotyledons, has been purified and characterized (Baumgartner and Chrispeels 1977). *V. radiata also* has a potential antibacterial activity on clinically isolated bacteria (Hussein S. AL-Janabi 2010) and there is no difference in antibacterial ability of aqueous or alcoholic extract of mung bean plant parts.

Therefore in view of the presence of many proteolytic enzymes, antimicrobials, minerals and vitamins in mung bean and sprouted mung beans the main objective of this study is to determine the marination effect of aqueous extract of mung bean and sprouted mung bean powder on meat tenderness, pH, cooking loss, microbial quality and sensory characteristics of chicken breast meat.

Materials & methods

Preparation of aqueous solution of different powders and marination of chicken breast meat

Different ingredients like mung bean and chicken breast meat (6 week of age, 2 h post slaughter) obtained from local market. To sprout the beans, mung bean were soaked overnight and then allowed to sprout for a couple of days after that they were dried in tray driers at 45 °C. Sprouted moong powder (SMP) and moong powder (MP) was made in heavy duty kitchen grinder; care was taken that temperature did not rise above 45 °C because at higher temperature enzyme activity might be destroyed. These grinded powders then sieved through 0.6 mm mesh size sieve. About 100 g of different dried powders were mixed with 1 l warm sterilized distilled water (45 °C) and left for 2 h. The extracts obtained after filtration with sterilized gauze were used to marinate chicken breast meat. During marination chicken breast meat kept at 4 °C in refrigerator. Two controls were also kept, in control 1 chicken breast meat was marinated in sterile distilled water and in control 2 chicken breast meat kept as such at 4 °C.

Estimation of pH & cooking loss

The pH of meat or meat products was determined by blending 10 g sample with 50 ml distilled water for 60 s. in a homogenizer. The pH values were measured using a standardized electrode attached to a digital pH meter (Eutech instruments cyberscan pH tutor, India).

For estimation of cooking loss 20 g meat sample was sealed in a plastic bag and cooked in a water bath at 100° c for 20 min. each piece was cooled, removed from the bag and then weighed. The weights of samples were recorded before and after cooking and the cook loss was expressed as a percentage.

Shear force measurement (tenderness value)

For shear force measurement, samples were vacuum packaged and cooked at 70 °C for 40 min in water bath. Samples were cooled and three core samples (3X1X1 cm) were taken from the chicken breast meat in the longitudinal direction of muscle fibres. Each core sample was cut at a speed of 120 mm/min at 20 N force with a Warner-Bratzler blade (width 5 cm) attached to a TA.XT2 Texture Analyzer (Texture Technologies Group, Scarsdale, New York). The shear force value was the mean of the maximum forces required to shear each set of core samples.

Microbiological examination

Microbiological examination was done for fresh meat (before marination) and after 24 h of marination. One gram of each sample was weighed into a mortar (that had been previously sterilized) and ground with a sterile pestle until it became smooth and 9 ml of sterile distilled water was poured into the mortar. This was transferred to a test-tube followed by serial dilution up to 10^{-7} dilution. To determine aerobic plate counts (APC), 1 ml of each of dilutions were used in triplicates. Pour plate method was used in present investigation. Pschrophyllic plate counts (PPC) were also done for all samples in triplicate at 7 °C±1 °C for 10 days. In the case of APC of bacteria, the samples were incubated at 37 °C±1 °C for 48 h.

Sensory analysis for fresh meat

Subjective odour, taste and tenderness evaluations were conducted by six member experienced panel. Odour and taste scores were determined after cooking and recording the score. Scores of 1 to 5 were used according to the following description: 1= fresh chicken odour/taste; 2= no off odour/taste; 3= slight off odour/taste development but still acceptable; 4= definite off odour/taste; 5= very strong off odour/taste. Likewise tenderness scores were determined after cooking as 1= most tender; 2= more tender; 3= medium tender; 4= less tender; 5= least tender.

Statistical analysis

All experiments were done in triplicate unless otherwise mentioned. Results obtained were subjected to analysis of variance (ANOVA) and to Duncan's multiple range

procedure to determine the significant differences among treatments.

Results & discussion

pH & cooking loss

The average pH value of aqueous extracts of SMP and MP were 5.28±0.006 and 6.59±0.006 respectively; hence slightly acidic medium which can fasten the marination process. The average values of chicken breast meat pH are shown in Table 1. Results showed that pH value after 6, 9 and 24 h differed significantly ($P<0.05$) and initially the rate of fall in pH was more in SMP group, while in MP group after 6 h there was a short rise in pH due to unknown reason. In SMP group after 24 h of marination the pH of meat again increased which might be due chemical influence of SMP proteolytic enzymes on meat proteins. Cooking losses (Fig. 1) were similar in all groups initially but at later stage it differed significantly ($P<0.05$). At all observed stages of marination cooking losses were less in SMP and MP group than control groups ($P<0.05$).

Shear force measurement (tenderness value)

To present the data regarding shear force or tenderness value we are more emphasizing on reduction in shear force value because shear force value at initial stage itself differed significantly ($P<0.05$) due to unknown reasons. In present investigation reduction in shear force was higher in SMP and MP groups at all observed stage. After 3 h it is more in SMP group followed by MP group and least reduction is observed in control 1, while instead of reduction slightly increased values were obtained in control 2 which was due to dehydration or post-mortem rigor development. After 6 h reduction in shear force was higher ($P<0.05$) in MP group followed by SMP group. At later stages at 9 h and 24 h reduction in shear force value was more in MP groups ($P<0.05$) followed by SMP group than the two controls; at these stages reduction in shear force value also observed for both control which might be due to post mortem ageing and proteolysis.

During post mortem ageing some endogenous proteolytic enzymes present in meat can lyse the protein component of meat fibres and enhance meat tenderness. These endogenous proteolytic enzymes or proteases are very meagre in meat to cause sufficient tenderness. In environment of increased exogenous proteases activity these proteolytic process may increase upto a certain level to achieve more tender meat. Maiti and Ahlawat (2011) did experiments on tenderizing

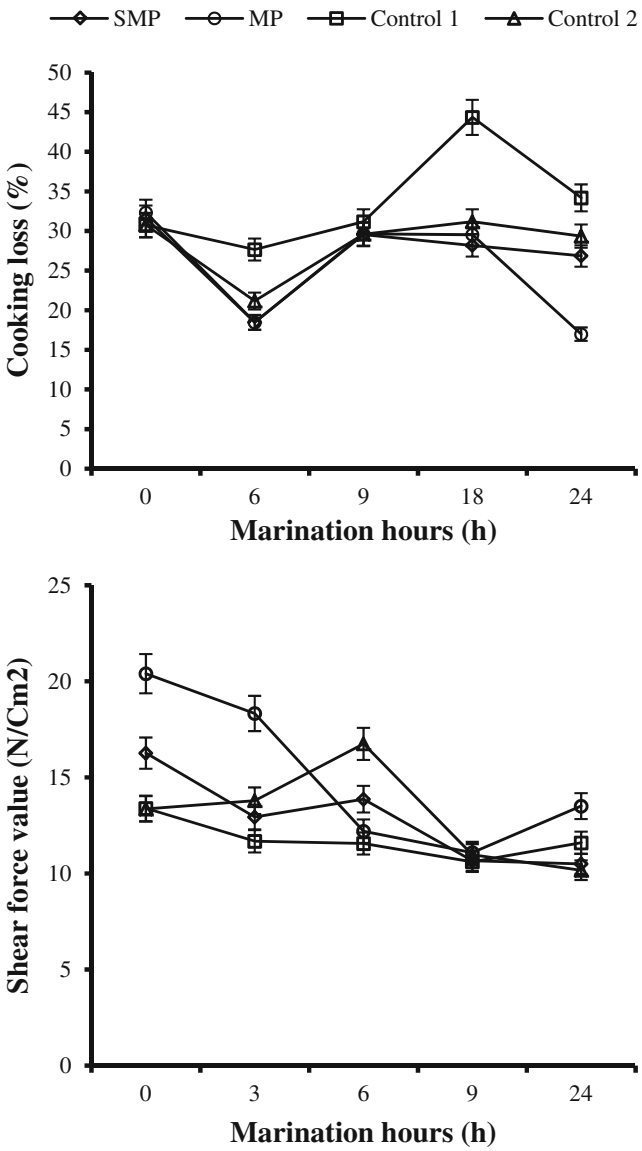

Fig. 1 Physical changes in raw chicken meat during marination ($n=9$). All values are expressed as mean ± standard deviation of triplicate experiments with 3 determinations in each replication. SMP-sprouted mung powder; MP-mung powder; Control 1-water; control 2- no marination

Table 1 pH values at initial stage, at 6 h; 9 h; 24 h of marination

Treatment	Initial	After 6 h.	After 9 h	After 24 h.
SMP	6.1 ± 0.01^{c}	5.8 ± 0.03^{c}	6.1 ± 0.02^{b}	6.2 ± 0.02^{a}
MP	6.1 ± 0.02^{b}	6.2 ± 0.02^{a}	6.1 ± 0.01^{a}	5.9 ± 0.03^{b}
Control 1	6.2 ± 0.01^{a}	5.8 ± 0.04^{bc}	5.6 ± 0.02^{c}	5.9 ± 0.04^{b}
Control 2	6.1 ± 0.02^{c}	5.9 ± 0.06^{b}	6.1 ± 0.03^{b}	5.9 ± 0.04^{b}

All values are expressed as mean ± standard deviation of triplicate determinations with 3 determinations in each

Values bearing different superscript in a column differ significantly ($P<0.05$)

SMP sprouted mung powder; *MP* mung powder; Control 1-water; control 2- no marination

effect of kachri (*Cucumis trigonus*) and ginger (*Zingiber officinale*) and found that these food pastes/marinades significantly reduced the shear press value of marinated chicken parts. Thompson et al. (1973) also indicated that proteolytic activity of ginger proteases on collagen and actomyosin protein complex resulted in more tender meat. A serine protease (M) was also identified in mice that could bind to myofibrils and cause degradation (Sangorrín et al. 2002). In present investigation extract of SMP and MP showed tenderizing effects on chicken breast meat which may be due to presence of proteases; these proteases called as exogenous proteases for meat, may synergize the endogenous proteases of meat or may have proteolytic activity for proteolysis of meat fibres like collagen cross linking. Thus results obtained in this investigation are in close agreement that SMP and MP may possess proteases that further may cause meat tenderization process faster. Pawar et al. (2003) observed similar trend for chevon tenderized by papain. Narsaiah et al. (2011) did same experiment with pomegranate seed powder and pomegranate rind powder and observed tenderness scores were significantly higher in treated samples than control. Mendiratta et al. (2000) found reduction in shear force values with ginger extract treatment in sheep meat. Syed-Ziauddin et al. (1995) reported same effect for buffalo meat.

Microbiological examination

APC and PPC data presented in Table 2, after 24 h of marination APC and PPC vales were lower ($P<0.05$) in SMP and MP group than two controls. The values at 24 h of marination were also lower than initial values in SMP and MP groups thus SMP and MP may contain some antibacterial substances which have beneficial effect on meat bacterial count. Results shown in table are gaining support from earlier studies that SMP and MP have antibacterial activities but no earlier studies have been done on fresh meat to confirm antibacterial activity of SMP and MP. According to Hussein S. AL-Janabi dried extracts of *V. radiata* parts showed more effective action on clinically isolated bacteria than fresh extracts. Furthermore in their study no differences were noted between ethanolic and aqueous extracts on both of gram positive and negative bacteria with no differences in the susceptibility of each group of bacteria to any part of plant. In present investigation MP showed better antibacterial activity than SMP which might be due to consumption of antibacterial substances during germination of mung bean hence reduction of antibacterial activity of SMP.

Table 2 Microbiological characteristics (APC and PPC) of chicken breast meat before marination and after 24 h of marination

Treatment	APC (log cfu/g)		PPC (log cfu/g)	
	at 0 h.	at 24 h.	at 0 h.	at 24 h.
SMP	6.2±0.01	6.1±0.02^{c}	5.6±0.01	5.5±0.01^{c}
MP	6.2±0.02	5.7±0.06^{d}	5.7±0.01	5.0±0.02^{d}
Control 1	6.2±0.02	6.3±0.02^{a}	5.6±0.01	5.8±0.01^{a}
Control 2	6.2±0.02	6.3±0.02^{b}	5.7±0.01	5.7±0.03^{b}

All values are expressed as mean ± standard deviation of triplicate experiment with duplicate determination ($n=6$)

APC aerobic plate count; *PPC* psychrophilic plate count

Values bearing different superscript in a column differ significantly ($P<0.05$)

SMP sprouted mung powder; *MP* mung powder; Control 1-water; control 2- no marination

Sensory analysis

SMP and MP group showed better sensory scores than control groups (Table 3). Significant ($P<0.05$) results were observed for tenderness scores, scores were higher in SMP and MP groups than two controls. Both instrumental and sensory evaluation of cooked meat samples showed increased tenderness of SMP and MP group than control groups. Similar results observed when goat meat was marinating with pomegranate seed extract which affected the physicochemical and sensory attributes of raw goat meat (Narsaiah et al. 2011).

Table 3 Sensory evaluation scores at 3 h; 6 h; 9 h; 24 h of marination

Treatment	Marination hrs.			
	after 3 h.	after 6 h.	after 9 h	after 24 h.
Odour				
SMP	1.1±0.20	1.4±0.49	1.5±0.63	1.3±0.58
MP	1.5±0.55	1.6±0.67	1.4±0.49	1.3±0.42
Control 1	1.7±0.52	1.7±0.52	1.5±0.55	1.7±0.52
Control 2	1.5±0.55	1.4±0.49	1.6±0.66	1.8±0.68
Taste				
SMP	1.2±0.26	1.6±0.58	1.5±0.63	1.5±0.45
MP	1.4±0.49	1.3±0.41	1.4±0.49	1.5±0.63
Control 1	1.5±0.45	1.9±0.49	1.5±0.55	1.7±0.52
Control 2	1.5±0.55	1.4±0.49	1.7±0.61	1.8±0.69
Tenderness				
SMP	2.8±0.75^{b}	3.2±0.75^{ab}	2.3±0.52^{b}	1.5±0.55^{b}
MP	2.8±0.41^{b}	2.3±0.52^{b}	1.8±0.75^{b}	1.7±0.75^{b}
Control 1	4.0±0.89^{a}	3.7±0.52^{a}	3.3±0.52^{a}	3.2±0.75^{a}
Control 2	4.5±0.84^{a}	3.7±0.82^{a}	3.7±0.82^{a}	3.3±0.52^{a}

All values are expressed as mean ± standard deviation of triplicate experiments with six determinations. ($n=18$)

Values bearing different superscript in a column differ significantly ($P<0.05$)

SMP sprouted mung powder; *MP* mung powder; Control 1-water; control 2- no marination

Conclusion

The results indicated that marination in aqueous extract obtained from sprouted mung powder and mung powder have beneficial effect on tenderness of chicken breast meat. These extract also showed antibacterial activity for meat bacteria and there was better cooking and sensory scores observed for marinated meat samples than control groups. Thus isolation of particular tenderizing agent and antibacterial compounds will be needed in search of a GRAS compounds to increase meat quality and shelf life of fresh meat.

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