J. Meat Sci. 2020, 15(2): 67-71 **Research paper**

Effect of Ginger Extract as a Natural Tenderizer in Spent Hen Meat

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ABSTRACT

Aqueous extract of ginger (*Zingiber officinale*) was investigated for its effect as a natural tenderizing agent in thigh meat obtained from spent hens of commercial layer stock. The thigh portion obtained after slaughter and dressing of spent hens were treated with five treatment solutions viz. 0.2% papain as positive control (T_1), naive control without any treatment (T_2); 2% Ginger Extract (T_3); 4% Ginger Extract (T_4); and 6% Ginger Extract (T_5). The samples were kept for 24 hours at 4°C and then divided into two groups. One group of samples was analyzed for various physico-chemical, tenderizing and sensory parameters to ascertain the effect of the Ginger Extract. The results revealed that with increasing Ginger Extract level, there was an increase in pH, moisture content and water holding capacity while as decrease in hydroxyproline content and collagen content, thereby decreasing the toughness and thus desirably improving the tenderness of spent hen meat. Ginger Extract also improved sensory parameters like appearance, flavor, tenderness, juiciness and overall acceptability scores. The other group of samples was cooked for 35 minutes in 1.5 % salt solution. Ginger Extract increased the product yield, pH and moisture content and decreased the shear force value in cooked samples. Ginger Extract also imparted better appearance, color and tenderness scores in cooked samples. Although all levels of Ginger Extract improved the quality of meat, however, the best results were found for 6% Ginger Extract. It was concluded that ginger is a potential natural tenderizer and can thus be explored for its role in the meat processing industry to improve the overall quality of otherwise less valued tougher spent hen meat.

Keywords: Collagen, Hydroxyproline, Ginger, Papain, Spent hen, Tenderness

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INTRODUCTION

In recent years, consumption of poultry and its products has increased rapidly throughout the globe.Worldwide, the rapid development of poultry layer industry resulting in manifold increase in the production of culled and spent hens, which need to be disposed of to avoid potential environmental pollution (Roberts *et* ., 2019). These otherwise culled birds can be harvested for a high protein meat source if processing conditions are favoured to render this tougher meat in to a better quality tender meat. Research has also shown that a functional chicken sausage with better yield can be prepared from spent hen added with plant ingredients like Irish moss (Biswas *et al*., 2020).

Meat from spent layers is not commonly consumed because it is dry, tough and less valued due to its high amount of connective tissue containing higher number of collagen cross linkages (Awosanya and Faseyi, 2001). The more amounts of intramuscular connective tissue, increased muscle fibre length and altered activity of endogenous proteolytic enzymes increases the toughness of meat (Chen *et al*., 2006; Kemp and Parr, 2012). This toughness of meat can be overcome by various tenderization methods using physical, chemical or enzymatic methods. Now-a-days, methods using natural ingredients are preferred by the health conscious consumer to avoid the ill effects associated with chemicals.

Ginger (*Zingiber officinale*) is a typical flavoring agent widely used in the meat industry for its various benefits. Its proteolytic activity on collagen has been found to be many folds greater than acyomyosin and the combined effect on connective tissue proteins and myofibrillar proteins such as myosin, troponin T, and α-actinin has been found to be highly effective in increasing the tenderness of meat. In addition, ginger has been shown to inhibit lipid oxidation, thus enhancing the keeping quality of meat (Tsai *et al*., 2012). The present study was thus designed to evaluate the effect of Ginger Extract as a natural tenderizing agent in thigh portion of spent hens from commercial layer stock.

MATERIAL AND METHODS

Spent hens of commercial layer stock of more than 72 weeks of age were procured from local poultry breeder. Papain enzyme was procured from Himedia firm. For the preparation of Ginger Extract (GE), fresh ginger rhizome was peeled, sliced and blended with an equal quantity of chilled distilled water in a blender (Make: Ploytron PT 2100) for 1 to 2 min. The homogenate was squeezed through 4 layers of muslin cloth and preserved for future use (Naveena and Mendiratta, 2010).

The birds were slaughtered and dressed hygienically in the semi-automatic poultry processing plant at the Division of Livestock Products Technology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir. Birds were scalded in hot water of 59 to 64°C for 45 to 90 seconds followed by defeathering, evisceration and washing. The thigh pieces were separated from the carcass, packed in LDPE bags and kept under refrigeration temperature till future use.

Solutions of five treatments viz; positive control of 0.2% papain (T1); naive control without any treatment (T2); 2% Ginger Extract (T3); 4% Ginger Extract (T4); and 6 % Ginger Extract (T5) were prepared. About 100g of thigh meat samples were immersed in each treatment solution in a food grade plastic container and kept at 4 ± 1 ^{0}C for 24 hours. The samples were divided in to two groups. One group of samples was evaluated for various parameters

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viz., pH, moisture content, water holding capacity, hydroxyproline content, collagen content and sensory evaluation. The other group of the samples was cooked for 35 minutes in 1.5% salt solution. The cooked samples were assessed for product yield, pH, moisture content, shear force value and sensory quality. Each experiment was repeated thrice.

Analytical Procedures

pH: The pH of samples was determined following the method of Trout *et al.* (1992) by using digital pH meter (Model CP 901, Century Instrument Ltd. India).

Moisture Content: The moisture content of the samples was determined following the method as specified by AOAC (1995).

WHC: The water holding capacity was determined following the method of Wardlaw *et al.* (1973). Approximately 10 g samples of meat were stirred for 1 min with 15 ml of 0.6 M NaCl solution in a 50 ml centrifuge tube. The tubes were held at 4° C for 15 min, stirred again for 1 min followed by centrifugation in a refrigerated centrifuge (Make: Eppendorf Model 5804 R) at 10,000 rpm. After centrifugation, the volume of the supernatant was measured and the results were reported as the proportion the fluid retained by the sample according to the following equation:

WHC (%) = (Initial volume - volume of supernatant)/Initial volume) x 100

Hydroxyproline content: Hydroxyproline content was quantitated calorimetrically using chloramines T method as described by Lee *et al.* (2005) with slight modifications. 50 mg sample was weighed in Eppendrof tubes and hydrolyzed in 0.5 ml of 6 N HCl at 100°C for 24 hrs. The hydrolysate was then cooled, neutralized with 0.5 ml of 6 N NaOH followed by centrifugation at 8000 rpm for 10 min. 200 ul of the supernatant was added to 0.125 ml of chloramines T solution and incubated at room temperature for 10 min. To this, 0.75 ml of Ehrlich's solution was added. The final mixture was incubated at 60°C for 35 min followed by room temperature for 10 min. The absorbance was determined at 560 nm. Standard solutions containing 0, 20, 40, 60, 80 and 100 µg/ml of authentic hydroxyproline was treated like wise. The value of hydroxyproline content was expressed as µg/g wet tissue.

Collagen content: The collagen content was estimated by following the method specified by Koolmees and Bijker (1985). The collagen content was calculated by the following formula:

Collagen= Hydroxyproline x 8/ nitrogen x 6.25) x 100%.

Cooking yield: It was estimated by using the following formula;

$$\text{Cooking yield (\%)} = \frac{\text{Weight of cooked samples}}{\text{Weight of uncooked samples}} \times 100$$

Shear Force value: Textural quality of the sample in terms of shear force value was estimated by using TA-XT2i Texture analyzer (MAKE STABLE MICROSYSTEMS, United Kingdom). The compression probe (HDP/ BSK- Blade set with knife) was applied to measure compression force required for sample breakage which indicates hardness.

Sensory evaluation: The raw and cooked samples were presented to semi-trained experienced taste panel members consisting of scientists and post-graduate students (both males and females in the age group of 25 to 60) of Faculty of Veterinary Sciences and Animal Husbandry, Shuhama, SKUAST-K for evaluation. For cooked samples attributes viz. appearance, flavour, tenderness, juiciness, mouth coating and overall acceptability; for uncooked samples attributes viz. appearance, tenderness and colour as described by Wierbicki (1985) were analyzed. The above quality attributes were scored using the following rating scale: 9=Excellent, 8=Very good, 7= Good, 6= Below Good-above fair, 5= Fair, 4= Below fair-above poor, 3=Poor, 2=Very poor and 1=Extremely poor.

Statistical Analysis: The data generated was analyzed statistically following the method of Snedecor and Cochran (1994) using SPSS version 20 software package. Analysis of variance by one way was computed and significance of means was tested at 5% level of significance.

RESULTS AND DISCUSSION

The results of different quality parameters pertaining to raw and cooked spent thigh muscles are depicted in Table 1. In raw/uncooked samples, the pH increased significantly (P≤0.05) with Ginger Extract treatment. In cooked samples, mean pH values of naive control was significantly (P≤0.05) lower than positive control and ginger extract treatment groups. The higher pH values for GE treated samples compared to control might be due to higher pH (6.5) of ginger (Naveena *et al.*, 2004). The moisture content of raw spent hen thigh ranged from 71.13% to 75.50% with values being significantly (P≤0.05) lower for naive control and 2% GE treated samples compared to positive control, 4% and 6% GE samples. Increase in the moisture with increasing concentration of GE indicated improvement in hydrophilic properties by the GE and papain treatment. In cooked samples, moisture content of naive control was significantly (P≤0.05) lower than 6% GE and non-significantly (P>0.05) lower than positive control, 2% GE and 4% GE treated samples. Naveena *et al.* (2004) has reported that the moisture content of GE marinated buffalo meat does not differ significantly than the control samples. Similarly, Abdeldaiem and Hoda (2013) observed no difference between the moisture content of raw GE marinated and control camel meat. According to Yusop *et al.* (2010),there was no difference in moisture content of chicken breast marinated in citric acid; however, Ke *et al.* (2009) reported that citric acid injected beef muscle has higher moisture content than the control. The WHC of naive control was significantly (P<0.05) lower than that of positive control, 4% and 6%

GE treated samples but non-significantly (P>0.05) lower than 2% GE treated sample. The improved WHC in GE treated samples might be due to better moisture retention ability shown by the treated samples when compared with control. The WHC of thigh and breast muscle increased significantly after their ageing for 6 days (Kiran *et al.*, 2020).The hydroxylproline content of positive control was significantly (P<0.05) lower than of naive control, 2% and 4% GE and non-significantly (P>0.05) higher than 6% GE. Naveena and Menditratta (2010) reported the hydroxyproline of GE marinated spent hen meat is not significantly different from the control samples. The collagen content of positive control was significantly (P<0.05) lower than of naive control, 2% GE and 4% GE and was non-significantly (P>0.05) higher than 6% GE. The decreased hydroxyproline and collagen content in GE and papain treated samples might be due to the proteolytic activity of proteases released by the treatment solutions on the collagen protein. These arguments are supported by Thompson *et al.* (1973) who reported that the proteolytic activity of ginger protease on collagen was many times greater than that on actomyosin and the combined proteolysis of these two muscle proteins resulted in significantly more tender meat. Product yield values of 6% GE was significantly (P≤0.05) higher than naive control and 2% GE samples and non-significantly (P>0.05) higher than positive control and 4% GE samples. Overall improvement in the yield in all GE treated samples indicated that treatment with GE had some beneficial effect on yield, probably because of better WHC and subsequent moisture retention. This is in agreement with Labell (1987) who reported a reduction in shrinkage of microwave cooked meat and poultry by 5 to 20% after treatment with ginger powder. The shear force value decreased significantly (P≤0.05) with increasing ginger extract concentration, favorably attributing the role of GE as a tenderizer. Lee *et al.* (1986) found a linear decrease in shear force values with increasing amount of GE in beefsteaks. Similar observations were made by Naveena and Mendiratta (2010) in spent hen meat treated with different concentrations of ginger extract. Thompson *et al.* (1973) also reported a decrease in shear force values from 4.27 Kg to 2.8 Kg per cm^2 by ginger treatment in ovine *B. femoris* muscle. All these observations especially the decrease in connective tissue, shear force value and improved water holding capacity are a confirmation that ginger is a very goodsource of tenderizing agents and can be safely used to improve the quality of less valued and tougher spent hen meat.

Table 1: Quality parameters of spent thigh muscle treated with various levels of ginger extract (Mean ± S.E).

Parameters	Raw Spent thigh				
	T_1 (Positive control)	T_2 (Naive control)	T_3 (2% GE)	T_4 (4% GE)	T_5 (6% GE)
pH	5.98± 0.43^{a}	5.97± 0.54^{a}	6.08± 0.24^{b}	6.07± 0.26^{b}	6.14± 0.01^{b}
Moisture content	75.48± 0.55^{b}	71.13± 0.36^{a}	71.82± 0.20^{a}	74.48± 0.56^{b}	75.50± 0.56^{b}
WHC	40.64± 0.49^{b}	38.11± 1.26^{a}	40.42± 0.81^{ab}	41.82± 0.51^{b}	42.46± 0.60^{b}
Hydroxyproline content	0.10± 0.00^{a}	0.13± 0.01^{b}	0.13± 0.00^{b}	0.11± 0.00^{b}	0.09± 0.00^{a}
Collagen Content	3.67± 0.00^{a}	5.47± 0.36^{c}	4.94± 0.23^{b}	4.67± 0.13^{b}	3.21± 0.29^{a}
			Cooked Spent thigh		
Product Yield	73.66± 0.87^{c}	69.89± 0.33^{a}	70.73± 0.37^{ab}	72.70± 1.03^{bc}	75.15± 0.97^{c}
pH	6.51± 0.02^{bc}	6.30± 0.16^{a}	6.42± 0.00^{b}	6.50± 0.05^{bc}	6.53± 0.04^{c}
Moisture content	62.21± 0.82^{ab}	61.12± 0.59^{a}	62.20± 1.26^{ab}	63.41± 0.94^{ab}	65.03± 1.48^{b}
SFV	18.90± 0.44^{a}	25.54± 1.77^{b}	21.41± 0.71^{a}	19.75± 0.46^{a}	18.72± 0.23^{a}

Row-wise group means with different superscript differ significantly (P<0.05)
For product yield, N = 3 and for other parameters, N=6

The results of different sensory parameters pertaining to raw and cooked spent thigh muscles are depicted in Table 2. The results of sensory evaluation revealed that the ginger extract treatment has led to improvement in all the sensory attributes including the overall acceptability in raw as well as cooked GE treated samples when compared to non-treated samples. These findings are in agreement with those of Thompson (1973)' Lee *et al*. (1986), Labell (1987) and Syed Ziauddin *et al*. (1995) who also reported improvement in appearance, flavor, tenderness, juiciness and overall acceptability of GE treated samples than control.

Table 2: Sensory attributes of spent thigh muscle treated with various levels of ginger extract (Mean ± S.E)

Sensory attributes	Raw Spent thigh				
	T_1 (Naive control)	T_2 (Positive control)	T_3 (2% GE)	T_4 (4% GE)	T_5 (6% GE)
Appearance	6.86± 0.15[b]	5.80± 0.13[a]	6.80± 0.22[b]	6.85± 0.22[b]	7.06± 0.15[b]
Colour	6.46± 0.13[a]	6.20± 0.36[a]	6.69± 0.19[a]	6.76± 0.15[a]	6.76± 0.19[a]
Tenderness	5.73± 0.21[a]	6.86± 0.27[b]	6.20± 0.14[a]	6.29± 0.14[a]	7.33± 0.1b[b]
	Cooked Spent thigh				
Appearance	7.00± 0.09[a]	6.86± 0.16[a]	6.73± 0.11[a]	6.93± 0.15[a]	7.06± 0.11[a]
Flavour	6.73± 0.22[a]	6.80± 0.14[a]	6.60± 0.15[a]	6.73± 0.28[a]	7.00± 0.19[a]
Tenderness	5.53± 0.25[a]	6.93± 0.26[b]	6.06± 0.22[a]	6.26± 0.35[a]	7.06± 0.26[b]
Juiciness	5.80± 0.29[a]	6.00± 0.25[a]	6.06± 0.20[a]	6.26± 0.33[ab]	6.93± 0.20[b]
Overall acceptability	5.93± 0.27[a]	6.13± 0.24[a]	6.13± 0.21[a]	6.53± 0.35[a]	7.00± 0.13[b]

Row-wise group means with different superscript differ significantly (P<0.05)
* 8-point descriptive scale (8 = extremely desirable, 1 = extremely undesirable)
**N = 21

CONCLUSIONS

The study revealed that the quality of spent hen meat changed desirably with an improvement in tenderness and sensory parameters. It was further observed that the best quality product was obtained when the sample was treated with 6% ginger rhizome extract. Therefore, a technology for utilization of easily and cheaply available ginger can be exploited at the industrial or household level for tenderization of less palatable spent hen meat from commercial layer stock and thus a protein rich meat can be made available to masses from otherwise layer industry waste.

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CONFLICT OF INTEREST

The authors have no conflict of interest associated with the material presented in this paper.

ETHICS STATEMENT

Not Applicable

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