Pakistan J. Zool., pp 1-9, 2024. DOI: https://dx.doi.org/10.17582/journal.pjz/20231127052631

Effect of Marinades on Quality Characteristics of Spent Hen Meat

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Article Information
Received 27 November 2023
Revised 18 January 2024
Accepted 31 January 2024
Available online 07 June 2024 (early access)

Authors' Contribution
AHS, MAJ and TAK conceived and designed the study. RAK performed the experimental work. GBK, GSB and AAM helped in sampling, data analysis and interpretation the data.

Key words
Spent hen, Ginger extract, Tamarind juice, Glycogen, Marinade, Shear force

ABSTRACT

This study investigates the influence of marinades on the quality attributes of spent hen meat. Spent hen meat, while a valuable protein source, often faces challenges related to tenderness and palatability. The study focuses on effect of marination on essential factors such as taste, tenderness, and overall quality. The meat samples were divided into seven groups i.e., control (C), yoghurt (Y), ginger extract (GE), tamarind juice (TJ), honey 20% (H20%), honey 25% (H25%), and honey 30% (H30%). All these groups were analyzed for moisture, protein, fat, ash, glycogen, energy content and shear force at various intervals of storage. Higher moisture content (74.28%) was observed in honey 30% at interval of 72h as compared to other groups, while higher protein content (22.25%) was in honey 20% at interval of 24h. Similarly, fat content was higher in control group i.e., 3.95%. Ash content and glycogen content was higher in control (2.20; 1.65) and honey 20% (2.20; 1.65) group at interval of 24h respectively. Energy content (131.15) and shear force was also higher in control group at zero interval and 72h of storage, respectively. In the chemical properties of spent hen meat, the moisture content and shear force was increased in all treated groups, ash, protein, fat, glycogen, and energy content showed decreasing trend in all groups. Further it was observed that spent hen meat was improved by using honey (20%) followed by yoghurt, ginger extract, tamarind juice, honey 25%, and honey 30%, respectively.

INTRODUCTION

Malnutrition is the public health problem affecting the large population of world, also quite prevalent in Pakistan, the energy requirement is 2735 calories/day while consumption is 2350 calories/day per person that enhance the global acute malnutrition rate at 17.17% leads 177,000 deaths/year (UN-2023). As per standard of WHO, daily requirement of animal protein for a person is 27g while public is consuming only 17g (PPA, 2022). This has happened because of less intake of protein sources. As per standard of WHO daily requirement of animal protein for a person is 27 grams while public is consuming only 17g (Pakistan Poultry Association, 2022). The poultry sector holds a crucial role in Pakistan's livestock industry, contributing significantly to financial and rural development (Aslam *et al*., 2020). Serving as a valuable source of animal protein, poultry meat plays a vital role in maintaining dietary balance and overall health for the population (Shahzad *et al*., 2011).

To fill the gap, alternative animal origin protein sources are required thus spent hen meat is considered as one of them. The commercial value of spent laying hen has been considered negligible. Hens at the end of laying life are considered a by-product of the egg industry, unlike the broilers meat which is a valuable food product. In simpler terms, birds are either composted or merely buried following euthanasia due to their limited market value (Kondaiah and Panda, 1992). After laying eggs for one laying cycle, or about a year, commercial laying hens are traditionally consumed out from the farm, at this point, they are referred to as spent or spent hens. This can be attributed to a decrease in both egg and meat quantity and quality. Although some hens may be allowed to lay into their second or third cycle, billions of spent hens are produced annually worldwide (Jacob *et al*., 2014). However, in the

* Corresponding author: vetdr_atta@sau.edu.pk
0030-9923/2024/0001-0001 $ 9.00/0

western world, spent hen is typically not processed or recognized for food consumption due to a low meat yield and the meat's high collagen content, which makes it too tough and increases the expense and technical difficulty of industrial meat production. Instead of that the majority of hens are killed on farms or in processing facilities, where they are buried, composted, burned, or made into oils and protein meals that are used in animal feed or pet foods (Pirsich *et al.*, 2017; Cheng *et al.*, 2004). Due to their high biological value, meat and egg products present a particular marketing challenge in developing nations in Asia and Africa where protein shortage and malnutrition are two persistent issues (Singh *et al.*, 2008). Traditional meat products no longer meet the preferences of present consumers. Instead, they favor meat products that are convenient to prepare, rich in nutrients, cost-effective, and offer an engaging addition to menus. Additionally, these products should boast an extended shelf life and gain greater consumer acceptance compared to conventional alternatives (Deogade *et al.*, 2008). There is potential for the processed meat industry to grow, particularly in value-added meat products, to meet the demands of the urban population, which consumes 70–75 percent meat products (Singh, 2004). Marination technology, also known as value addition, allows for the better development of products into valuable goods. The three main methods of marination are still marination, injection, and tumbling. Still marination takes more time and space than other technique while requires a much smaller initial investment than tumbling or injection, as both require expensive equipment. By reducing tenderizing and enhancing succulence, flavor, and shelf life, the term "marinade" is used to meet consumer demand (Lemos *et al.*, 1999; Björkroth, 2005). This research seeks to explore the effects of using marinades on the quality features of spent hen meat. It specifically concentrates on examining how marination influences crucial aspects like taste, tenderness, and overall quality. This study aimed to assess how yogurt, herbal extracts, and honey impact the quality characteristics of spent hen meat, with the goal of enhancing consumer perceptions of meat.

MATERIALS AND METHODS

The spent hen was sourced from the Hyderabad market, slaughtered by hall method. Meat samples were brought to the laboratory of Animal Products Technology, within the Faculty of Animal Husbandry and Veterinary Sciences at Sindh Agriculture University, Tandojam, for further analysis.

To examine the influence of marinades on the quality characteristics of spent hen meat, the meat samples were categorized into seven groups: Group-A (raw/control group), Group-B (marinade with yoghurt), Group-C (marinade with ginger extract), Group D (marinade with tamarind juice), Group-E (marinade with 20% honey), Group F (25% honey), and Group G (30% honey). The marinades were fixed at a ratio of 1:2 Meat: Marinade.

Marination process

Marinades were prepared in the lab by purchasing milk for yogurt, ginger, tamarind, and honey from the local market. Yoghurt was made by fermentation process, while ginger extract (GE) was prepared by blending fresh ginger with chilled distilled water. Tamarind juice was made by dissolving compressed tamarind in water, and honey solutions of 20%, 25%, and 30% were created by mixing honey with distilled water.

Analysis of quality characteristics

The moisture content, protein content, total fat content and ash content of spent hen meat samples were determined following the AOAC (2000) method. The glycogen content in spent hen meat samples was determined following Kemp *et al.* (1954). The calorific values of meat samples was determined according to James (1995).

Shear force value

Steaks were cooked, cooled overnight at 0-2^{o}C, and then cut into 1cm^{3} meat strips with a scalpel handle, ensuring the fibers were parallel (Moczkowska *et al.*, 2017; Lagerstedt *et al.*, 2011). Warner-Bratzler shear force values in N/cm2 were measured using a V-Slot blade and the TA.XTplus texture analyzer (Stable Micro System Ltd., Godalming, UK). Each sample underwent a minimum of three shear force measurements, and the results were averaged for statistical analysis (Jaspal *et al.*, 2022).

Statistical analysis

The study used statistical analysis, employing ANOVA to compare means across multiple groups. A post-hoc LSD test was then applied to identify significant differences between individual group pairs.

RESULTS

Moisture content (%)

Table I shows the composition of various marinades used in this study, whereas Table II shows effect of these marinades on moisture, protein, fat, ash, glycogen and total energy content of spent hen meat. In the control group, the moisture content increased from 69.95 (00h) to 75.19 (72h). Notably, the moisture content increased in all marinades as marination duration extended. Specifically, in yoghurt,

Table I. Composition of various marinades.

S. No.	Marinade	Color	pH	Moisture %	Protein %	Fat %	Ash %	Crude fiber	Carbohy-drate %	Energy (kcal/100g)
1	Yoghurt	Whitish	4.4	83.66	4.57	1.78	0.9	-	9.1	70.7
2	Ginger extract	Pale yellow	5.3	79.55	7.3	3.85	3.1	1.1	8.11	443.45
3	Tamarind juice	Dark black	5.7	51.14	6.7	3.31	1.9	2.7	34.25	319.59
4	Honey	Dark brown	4.6	21.01	3.43	3.12	0.4	-	72.04	329.96

Table II. Effect of different marinades on moisture, protein, fat, ash, glycogen and energy contents of spent hen meat at three different time intervals.

	Fresh value	24 H	48 H	72 H	P value	SE value
Moisture (%)						
C	69.95 ^{cd}	71.92 $^{a-d}$	73.78 $^{a-c}$	75.19 ^{a}		
Y		72.46 $^{a-d}$	72.94 $^{a-d}$	73.63 $^{a-d}$		
GE		71.49 $^{a-c}$	72.30 $^{a-c}$	74.13 ^{ab}		
TJ		70.92 $^{b-d}$	71.86 $^{a-d}$	72.93 $^{a-d}$	0.0002	1.9554
H 20 %		69.77 ^{d}	71.17 $^{b-d}$	72.38 $^{a-d}$		
H 25 %		73.04 $^{a-d}$	73.65 $^{a-d}$	74.62 ^{ab}		
H 30 %		72.47 $^{a-d}$	73.92 ^{ab}	74.28 ^{ab}		
Protein (%)						
C	22.25 ^{ab}	20.70 $^{a-f}$	19.50 $^{d-f}$	18.84 ^{f}		
Y		20.25 $^{b-f}$	20.00 $^{c-f}$	19.52 $^{d-f}$		
GE		21.15 $^{a-e}$	20.80 $^{a-f}$	19.35 $^{d-f}$		
TJ		22.00 $^{a-c}$	21.50 $^{a-d}$	20.15 $^{b-f}$	0.0003	1.0771
H 20 %		22.25 ^{a}	21.50 $^{a-d}$	20.50 $^{a-f}$		
H 25 %		20.50 $^{a-f}$	20.25 $^{b-f}$	19.25 ^{ef}		
H 30 %		20.15 $^{b-e}$	19.52 $^{d-f}$	19.35 $^{d-f}$		
Fat (%)						
C	3.95 ^{a}	3.78 ^{d}	3.57 ^{ij}	3.39 ^{l}		
Y		3.70 ^{ef}	3.68 ^{fg}	3.62 ^{h}		
GE		3.83 ^{c}	3.65 ^{gh}	3.37 ^{lm}		
TJ		3.82 ^{c}	3.50 ^{k}	3.38 ^{lm}	0.0001	0.0188
H 20 %		3.88 ^{b}	3.73 ^{e}	3.69 ^{f}		
H 25 %		3.57 ^{i}	3.39 ^{l}	3.36 ^{lm}		
H 30 %		3.54 ^{j}	3.37 ^{lm}	3.35 ^{m}		
Ash (%)						
C	2.20 ^{a}	2.05 ^{b}	1.70 ^{h}	1.25 ^{m}		
Y		1.98 ^{cd}	1.80 ^{f}	1.69 ^{hi}		
GE		1.95 ^{de}	1.75 ^{g}	1.70 ^{h}		
TJ		1.82 ^{f}	1.73 ^{gh}	1.65 ^{i}	0.0002	0.2721
H 20 %		2.20 ^{a}	2.00 ^{c}	1.91 ^{e}		
H 25 %		1.44 ^{j}	1.35 ^{k}	1.32 ^{kl}		
H 30 %		1.32 ^{k}	1.27 ^{lm}	1.25 ^{m}		
Glycogen (mg/100g)						
C	1.65 ^{a}	1.55 $^{b-d}$	1.45 $^{e-f}$	1.35 ^{i}		
Y		1.61 ^{ab}	1.58 ^{bc}	1.55 $^{b-d}$		
GE		1.59 ^{ab}	1.50 ^{de}	1.45 ^{ef}		
TJ		1.43 ^{fg}	1.41 $^{f-h}$	1.40 $^{f-i}$	0.0004	0.311
H 20 %		1.65 ^{a}	1.61 ^{ab}	1.52 ^{cd}		
H 25 %		1.45 ^{ef}	1.40 $^{f-i}$	1.35 ^{hi}		
H 30 %		1.40 $^{f-i}$	1.38 $^{g-i}$	1.36 ^{hi}		
Energy (kcal/100g)						
C	131.15 ^{a}	123.52 $^{d-f}$	115.93 ^{kl}	111.19 ^{n}		
Y		120.74 $^{g-h}$	119.16 $^{h-j}$	116.82 ^{jk}		
GE		125.43 ^{de}	122.05 $^{f-h}$	113.53 $^{l-n}$		
TJ		128.21 $^{b-c}$	123.14 $^{e-g}$	116.58 ^{k}	0.0007	1.2893
H 20 %		130.52 ^{ab}	125.99 ^{cd}	121.31 $^{f-h}$		
H 25 %		120.02 ^{hi}	117.11 ^{jk}	112.64 ^{mn}		
H 30 %		118.06 $^{i-k}$	113.91 ^{lm}	112.97 $^{l-n}$		

Table continued on next column.............

The different superscripts between rows and columns are showing significant differences. C, control; Y, Yoghurt; GE, Ginger Extract; TJ, Tamarind juice; H, Honey.

the values were 72.46, 72.94, and 73.63; in ginger extract, 71.49, 72.30, and 74.13; in tamarind juice, 70.92, 71.86, and 72.38; in honey 20%, 69.77, 71.17, and 72.38; honey 25%, 73.04, 73.65, and 74.62; and honey 30%, 72.47, 73.92, and 74.28, at 24, 48, and 72 h, respectively. Significant differences ($P \leq 0.05$) were observed in fresh meat results compared to ginger extract, honey 20%, and honey 30%, except for tamarind juice and yoghurt results at 72 h. However, non-significant differences ($P \geq 0.05$) were found with 24- and 48-h storage periods across all treated groups.

Protein content (%)

The protein content in the control group decreased from 22.25 (00 h) to 18.84 (72 h). In yoghurt, ginger extract, tamarind juice, honey 20%, 25%, and 30%, the protein content at 24 h was 20.25, 21.15, 22.00, 22.25, 20.50, and 20.15, respectively. At 48 h, it was 20.00, 20.80, 21.50, 21.50, 20.25, and 19.52, respectively, and at 72 h, it was 19.52, 19.35, 20.15, 20.50, 19.25, and 19.35, respectively. The control group exhibited non-significant differences (P≥0.05) among all groups at the 24-h marination interval but showed significant differences (P≤0.05) at 48 h in control, yoghurt, and honey 30%, and at 72 h with all treated groups except honey 20%. A decreasing trend in protein content was observed in the control group and various marinated group.

Fat (%)

In the control group, the fat content decreased from 3.95 (00 h) to 3.39 (72 h). Contrastingly, in yoghurt, ginger extract, tamarind juice, honey 20%, 25%, and 30%, fat content at 24 h was 3.70, 3.83, 3.82, 3.88, 3.57, and 3.54, respectively. At 48h, it was 3.68, 3.65, 3.50, 3.73, 3.39, and 3.37, respectively, and at 72 h, it was 3.62, 3.37, 3.38, 3.69, 3.36, and 3.35, respectively. Significant differences (P≤0.05) were observed in the fresh (C) value compared to all marinades at various marination periods. Notably, a decreasing trend in fat content was observed in both the control group and all marinades.

Ash content (%)

The ash content of the control meat group was 2.20, decreasing to 2.05, 1.70, and 1.25 at 24, 48, and 72 h, respectively. In yoghurt, ginger extract, tamarind juice, honey 20%, 25%, and 30% marinades, the ash content at 24 h was 1.98, 1.95, 1.82, 2.20, 1.44, and 1.32, respectively. At 48 h, it was 1.80, 1.75, 1.73, 2.00, 1.35, and 1.27, and at 72 h, the results were 1.69, 1.70, 1.65, 1.91, 1.32, and 1.25, respectively. The ash content in fresh meat showed significant differences (P≤0.05) with all marinades except honey 20% at the 24-h marination interval. All treated groups exhibited significant differences (P≤0.05) compared to the control and among the various marinades. A decreasing trend in ash content was observed in both the control and all marinades.

Glycogen (meq/g)

The glycogen content in the control group was 1.65, 1.55, 1.45, and 1.35 at various intervals of 00, 24, 48, and 72 h. For yoghurt, ginger extract, tamarind juice, honey 20%, 25%, and 30%, the glycogen content at 24 h was 1.61, 1.59, 1.43, 1.65, 1.45, and 1.40, respectively. At 48 and 72 h, the values were 1.58, 1.50, 1.41, 1.61, 1.40, 1.38, and 1.55, 1.45, 1.40, 1.52, 1.35, 1.36, respectively. The numerically highest glycogen content was observed in honey 20% marination, followed by yoghurt, ginger extract, tamarind juice, honey 25%, and honey 30%, respectively. The fresh meat value showed significant differences (P≤0.05) at 24 h with tamarind juice, honey 25%, and honey 30%, and at 48 and 72 h in all treated groups except honey 20% at 48 h.

Energy (Kcal/100g)

In the control group, significant differences (P≤0.05) were observed with all treated groups at various intervals. The energy content in the control group decreased from 131.15 (00 h) to 111.19 (72 h). For yoghurt, ginger extract, tamarind juice, honey 20%, 25%, and 30%, the energy content at 24, 48, and 72 h was as follows: 120.74, 125.43, 128.21, 130.52, 120.02, and 118.06; 119.16, 122.05, 123.14, 125.99, 117.11, and 113.91; 116.82, 113.53, 116.58, 121.31, 112.64, and 112.97, respectively. A decreasing trend in energy content was observed in the respective treated groups over the storage period.

Shear force value

Table III shows effect of different marinades on texture profile of spent hen meat. In the control group, shear force values were 3.83 (Fresh), 3.93, 4.05, and 4.52 at 00, 24, 48, and 72 h, respectively. For the marinades, at 24, 48, and 72 h, the values were 3.65, 3.80, and 3.92 in yoghurt, 3.70, 3.88, and 4.00 in ginger extract, and 3.70, 3.88, and 4.02 in tamarind juice. In honey 20%, it was 3.64, 3.68, and 3.90, in honey 25%, the values were 3.85, 4.20, and 4.33, and in honey 30%, the result was 4.05, 4.22, and 4.38, respectively. The fresh meat value showed significant differences (P≤0.05) with all marinades except honey 25% at 24 h, respectively. An increasing trend was observed in both the control and treated groups.

Table III. Effect of different marinades on shear force value of spent hen meat at three different time intervals.

Parameters	Fresh value	24 H	48 H	72 H	P value	SE value
Shear force value						
C	3.83^{jk}	3.93^{g}	4.05^{e}	4.52^{a}		
Y		3.65^{m}	3.80^{k}	3.92^{gh}		
GE		3.70^{l}	3.88^{hi}	4.00^{f}		
TJ		3.89^{g-i}	3.93^{g}	4.02^{ef}	0.0013	0.0224
H 20 %		3.64^{m}	3.68^{lm}	3.90^{gh}		
H 25 %		3.85^{ij}	4.20^{d}	4.33^{c}		
H 30 %		4.05^{e}	4.22^{d}	4.38^{b}		

See Table II for statistical details and abbreviations.

DISCUSSION

Moisture content is pivotal for meat quality, impacting taste, juiciness, appearance, and safe cooking. Marination enhances this through acidity and moisture absorption (Yusop *et al*., 2010). Pre-cooking marination improves flavor, juiciness, and tenderness, contributing to overall palatability with diverse ingredients. Natural sources like yogurt, ginger extract, tamarind juice, and honey enhance spent hen meat quality. Over time, moisture content increases during storage, peaking at 72 h, notably in samples with 25% and 30% honey, surpassing the control. Marinated samples exhibit significantly higher moisture content ($p < 0.05$), indicating enhanced water retention by meat proteins (Koeipudsa *et al*., 2019). Increased water retention is linked to myofibrillar protein swelling. Marinated results, influenced by yoghurt (lactic acid), ginger extract, tamarind juice (acetic acids), and honey (hygroscopic nature), retain moisture content through physicochemical mechanisms, including decreased pH and elevated ionic strength (Bertram *et al*., 2004). Comparisons with literature findings support the results. Anandh *et al*. (2020) and Sarkar *et al*. (2020) reported moisture content values within treated groups, aligning with this study. Discrepancies with Koeipudsa *et al*. (2019) may stem from bird breed and age differences. Kumar *et al*. (2017) reported ginger extract marination results, correlating closely with observed moisture content values at different time intervals.

Protein content is a vital quality parameter in spent chicken meat, supporting various physiological functions in the human body. Its significance lies in muscle development, immune function, metabolic processes, and overall health. The protein-rich nature of chicken makes it an essential component of a balanced diet, contributing to overall nutrition and well-being. Significant variations in protein content were observed at 72 h in all groups except honey 20% and tamarind juice, and at 48 h in control, yoghurt, honey 25%, and 30%. Non-significant changes occurred at 24 h across all groups. The decrease in protein with storage is attributed to proteolysis, where enzymatic activity, even at low temperatures, contributes to the degradation of meat protein quality. Marinades play a protective role against protein degradation during storage due to their acidic nature and enzyme inactivation. Extended storage prevents further degradation, thanks to the presence of phenolic compounds and organic acids in ginger, tamarind juice, lactic acid in yoghurt, and flavonoids in honey. Comparable findings by Homade *et al*. (2010) and Suriani *et al*. (2014) support the impact of various treatments on protein content, highlighting the effectiveness of marinades in mitigating protein loss. Proteolytic enzyme in ginger extract, contributes to protein breakdown, affecting its water retention ability. The results align with studies of Nardin *et al*. (2023), Pawar *et al*. (2007) and Ali *et al*. (2022), which provide comprehensive validation of the protein content changes observed in this study.

The fat content in spent hen meat plays a crucial role in meat quality, showing a significant decrease with storage at 24, 48, and 72 h, respectively. The numerically highest content was observed in fresh meat compared to all other marinades. This might be due to a longer laying cycle (72-78 weeks), less exercise in the cage system in Pakistan, and factors related to feeding and genetics, leading to higher fat storage (intracellular or extracellular fat) observed during bird slaughtering. Meat fat primarily consists of monounsaturated and saturated fatty acids, including oleic (C18:1), palmitic (C16:0), and stearic acid (C18:0). Lakshani *et al*. (2016) reported crude fat values of 4.37 and 3.80 in broiler and spent hen meat, respectively, which align with the treated groups at various storage intervals. The change in fat content in spent hen meat could be attributed to factors such as age, breed, and nutrition (Suriani *et al*., 2014). Chuaynukool *et al*. (2007) found similar fat contents in breast meat from commercial broilers and spent hens, supporting the findings in treated groups. Khalifa *et al*. (2016) also noted a fat content of 3.80% in quail, which correlated with both the control and marinade findings.

Ash content serves as an indicator of meat quality and purity, with higher values suggesting increased mineral concentration influenced by animal diet and environment. Fresh ash values were significant at 24, 48, and 72 h, except for honey 20% at the 24-h marination interval. A decreasing trend was observed in all treated groups, probably due to fat, protein, and water hydrolysis. Animal diet, feed additives, and supplements can influence meat ash content. Examining ash content provides insights into mineral origins, crucial in prolonged laying and egg production. Considering marinades' abundance in inorganic elements, there may be an impact on spent hen fillet ash content during storage. The 72-h ash value correlates with Chueachuaychoo *et al*. (2011) pectoral muscle findings and Lakshani *et al*. (2016) results (0.98). Kim *et al*. (2015) documented an ash content of 2.04, aligning with fresh samples and the 24-h control. This alignment was observed in samples treated with 20% honey at 24- and 48-h marination intervals. Honey, with its high mineral content, demonstrated elevated ash content, consistent with Ali *et al*. (2022) findings (3.59). Ali *et al*. (2022) reported ash content in sausages from broiler breast meat and spent hen, noting values of 2.23 and 2.44, respectively. Including 2% and 4% bee honey in spent hen breast meat sausage resulted in ash content of 2.39 and 2.42, closely corresponding to values observed in fresh and 20% honey-treated groups.

Meat quality is closely tied to glycogen levels, crucial for enhancing traits like tenderness. A decrease in glycogen, notably at 48 and 72 h in marination (except for honey 20% at 48 h), indicates significance. Honey 20%, yogurt, and ginger extract showed no significant differences at 24 h, but overall storage significance may stem from saccharides in marinades. Lower fiber diameter in broilers, noted by Berri *et al*. (2004), correlates with decreased muscle glycogen and glycolytic potential. Glycogen synthase (GS) influences glycogen levels, with dephosphorylation causing reduction (Jensen and Lai, 2009). Control group glycogen (1.65–1.35) aligns with Ayoob *et al*. (2022), while honey concentrates at 10%, 20%, and 30% (1.06, 1.39, 1.69) agree with storage trends.

Storage-induced glycogen degradation may explain group result discrepancies. Pre-slaughter stress reduces muscle glycogen, impacting meat pH through lactic acid production in the anaerobic glycolytic pathway (Addis, 2015). These factors link to observed results during storage.

Meat quality relies on its energy content from protein, fat, and carbohydrates. Notably, all groups showed a significant correlation in fresh meat values, except the 20% honey group after 24 h of marination. This suggests higher energy content in the 20% honey marinade across different storage periods. Discrepancies in nutritional value may stem from feed quality and post-slaughter storage techniques. Observations suggest that marinades enhance the quality and nutrition of spent hen breast meat, with variations due to macronutrient preservation methods. The nutritional value of meat is intricately linked to both macro- and micronutrients, including minerals, proteins, polyunsaturated fats, B-complex vitamins, and essential amino acids (Ossipova, 2013). Sial *et al*. (2021) found that the energy values for buffen, venison, and chevon were 122.75, 122.03, and 106.00, respectively, closely aligning with the outcomes observed in marinades at 24 and 72 h of storage. Khalifa *et al*. (2016) determined the caloric value of spent quail meat to be 134.28 kcal/100g of breast meat, comparable to fresh meat. Similarly, Ioniţă *et al*. (2011) noted that the energy content of quail meat was 192 kcal/100g, exceeding the values of other groups, potentially attributed to breed variations.

Shear force measurements, assessing meat tenderness and the impact of marinades, showed enhancement compared to the control. Notably, elevated shear force levels were observed in honey 30% after 24 h, and in the control, honey 25%, and honey 30% after 48 h. The same trend continued with the control, ginger extract, tamarind juice, honey 25%, and honey 30% after 72 h, displaying higher values than other treated groups across various storage intervals. This phenomenon may be attributed to meat toughness, particularly when the pH value is close to the isoelectric point (pI) of meat (Wongwiwat, 2009). The softening effect of acid marinades is attributed to muscle fiber and connective tissue swelling, reducing the load-resisting material and maximizing tenderness (Burke and Monahan, 2003). Calcium in dairy products like kefir activates calpain enzymes, potentially lowering shear force (Maróstica and Pastore, 2010). Natural marinades with acidic attributes, including lactic acid (in yogurt), organic acids (in ginger extract and tamarind juice), and viscosity (in honey), positively influence meat tenderness. The shear force values of fresh spent hen fillet, reported as 3.41 by Lee *et al*. (2012), exhibited a strong correlation with the control and other groups, showing statistical significance with treated groups. Baéza *et al*. (2012) noted an increase in shear force with the age of spent hen fillets and hypertrophied fiber cross-sectional area. Naveena *et al*. (2001) reported shear force findings of 2.27 and 2.13 with 1% and 3% ginger extracts, differing from the results, possibly due to variations in bird age and marination technique. The elevated shear force, likely linked to meat toughness and a pH close to the isoelectric point (pI) of meat, aligns with observations in the marinated groups.

CONCLUSION

In conclusion, this study investigated the impact of various marinades on different quality attributes of spent hen meat. The results revealed significant changes in moisture, protein, fat, ash, glycogen, energy content, and shear force values over different time intervals and with different marinades. Notably, the marinades influenced the texture profile, with changes observed in shear force values.

Notably, marinades demonstrated a remarkable enhancement in both the qualitative and quantitative aspects of spent hen meat. The most substantial improvements were observed in honey (20%), succeeded by yoghurt, ginger extract, tamarind juice, honey (25%), and honey (30%). In light of these findings, future initiatives should focus on refining and innovating marination strategies to further elevate the overall quality and market potential of spent hen meat.

DECLARATIONS

Acknowledgments

I would like to praise Allah almighty who provide me gratitude to proceed successfully. I would extend my gratitude to the Animal Product Technology Department who provide opportunity for research and will remain grateful to provide such a wonderful excremental station.

Funding

The study received no external funding.

Ethical statement

Approved by the Sindh Agriculture University Tandojam Ethical Committee.

Statement of conflict of interest

The authors have declared no conflict of interest.

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