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UTLIZATION OF SPENT HEN MEAT FOR VALUE ADDED CHICKEN PATTIES

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Abstract

Background: *Spent hens are usually discarded after egg production, but their meat can be used to make useful food products. Converting spent hen meat into chicken patties increases its value and reduces waste.*

Objective: *This study was conducted to manufacture chicken patties with broiler meat and find out the cost effective substitute of broiler meat.*

Methodology: *For this purpose, five formulations were prepared for the manufacturing of chicken patties including, control containing 100% broiler meat and four different levels of replacement with layer (spent hen) meat at 25% spent hen meat + 75% broiler meat (T25), 50% spent hen meat + 50% broiler meat (T50), 75% spent hen meat + 25% broiler meat (T75) and 100% spent hen meat (T100).*

Results: *It is revealed that the average pH value was considerably (P<0.05) higher in 100% broiler (control group) than 75% spent hen meat and 100% spent hen meat. Control groups have significantly higher (P<0.05) WHC as compared to 100% spent hen meat. Spent hen meat (T100) patties have remarkably higher (P<0.05) cooking loss than all other treatments. Moisture content of 100% broiler meat (control group) was remarkably (P<0.05) higher followed by T50, T75 and T100. Fat content showed that except T100 group, all other treatment groups were non-significant (P>0.05) for fat percentage. Obtained data for protein and ash content were further subjected to ANOVA and results showed that there is no significant (P>0.05) difference in protein and ash content among cooked chicken*

patties of different formulations. Among various sensory characteristics, no significant differences among all treatments were observed in terms of appearance score. While statistical data indicates that flavour score of 100% broiler was statistically higher (P<0.05) compared to the 100% spent hen meat patties and all three other groups including both meat of broiler and spent hen at varying levels were statistically non-significant (P>0.05). Panelist score for texture & juiciness revealed that T100 group received considerably lower score as compared to the control group, while control group has no significant (P>0.05) difference as compared to the T25, T50 and T75. For the overall acceptability panel of judges rated first three groups (control, T25 and T50) significantly (P<0.05) higher than T75 and T100.

Conclusion: *Overall, it is concluded that replacement up to 50% of broiler meat with layer after laying period (spent hen meat) did not impair the overall sensory acceptability as per rating of the panelist and it is suggested that spent hen is cheaper source of protein and 50% substitution of broiler chicken meat with spent hen meat can be utilized for the manufacturing of different value added meat products to enhance the socioeconomic status of the farmers.*

INTRODUCTION

Pakistan's livestock business heavily relies on the production of chicken, which is rated 11th in the world. There are presently 45 million domestic chickens and 68 million commercial laying hens in Pakistan (PES, 2021-2022). Due to its low cholesterol and fat percentage, as well as its affordability, poultry meat is very popular around the globe (Farrell et al., 2013). Likewise, eating poultry meat is not prohibited by any cultural or religious norms (Barbut et al., 2001). Among chicken meat, layers are commonly used for egg purposes and broilers to produce meat (Charlton et al., 2008). Large farms frequently concentrate on raising more broilers when the demand for chicken meat rises, especially on the commercial broiler reached the market within 6 weeks and generates greater profits (Jayasena et al., 2013). Broiler meat is highly nutritious, flavorful, aromatic, and has a tender texture, while being relatively economical (Suriani et al., 2014). On the other hand, a lot of factors which plays the vital role in the success of poultry meat production, including: i) the widespread belief that poultry products are healthy, nutritious and high protein level, lower cholesterol, lower fat percentage and availability of functional ingredients; ii) their ease of processing, which enables meat producers to introduce products that are more appealing and convenient; iii) less expensive than red meats; iv) There are no ritual and cultural restraint on consumption (Schonfeldt et al., 2013).

Female birds that have finished laying eggs are known as spent chickens. Their meat has additional nutritional benefits and is a good source of protein (Lee et al., 2003). In commercial layer farming, millions of birds must be killed every year after they have finished their productive cycle. These spent hens are either sold at a reduced price for human consumption or are commonly utilized in the preparation of concentrated stock and animal feed (Ajuyah et al., 1992). However, the poultry industry faces a significant economic and environmental challenge when it comes to disposing of spent hens due to the volume of biological matter, labor requirements, and transportation costs (Lyons et al., 2001).

Traditionally, spent laying hens have been regarded as of little commercial value in Pakistan. Many are killed and turned into protein meal for feeding animals or used to make pet food. Spent hens are usually considered as a by-product of the egg industry in contrast to broilers, which are raised for meat and are valued as a food product. These hens have completed their laying cycles and produce billions of eggs annually around the world. Some Asian nations, including Thailand, China, Korea, Pakistan and India consume spent hens as processed meat products. Attitudes toward spent hens as a food source vary by country. Spent hens, on the other hand, are typically utilized as pet food, animal feed, composting (as fertilizers), burial, rendering and incineration in Western societies, which have little value on the market

and raise concerns about animal welfare and the environment. Despite being considered a waste product, these birds are good source of animal origin protein & can be used to develop value-added products (Fan et al., 2022). Cooking techniques and using fish meat can enhance the nutritional profile and sensory properties of chicken meat (Fateh et al., 2025; Zafar et al., 2025).

Chicken patties are a common food product that many people like because of good taste. (Kondaiah & Panda et al., 1992), on the other hand, there are reported difficulties in the production of patties, sausages, and chicken nuggets from spent hen meat. As a meat product, patties require a controlled manufacturing process, a carefully planned structure, and the right combination of ingredients in the right proportion. The quality of the raw materials used and the production method used determine the final product's quality (Bonoli et al., 2008).

The number of spent chickens is rising along with the poultry production industry's continued rapid expansion (Sarkar et al., 2020). Because spent layers are inexpensive, they can be used to make beef products with increased value (Kim & Ahn et al., 1997). These goods, including patties, sausages, nuggets, kababs, and samosas, have a lot of promise in both Western and Eastern countries, according to Patnaik et al. (1993).Therefore, the utilization of spent hen meat in the manufacturing of highly nutritional meat products has the potential to be extremely profitable for producers as well as consumers (Abdelrahman et al., 2023) and present study was conceived to utilize the spent hen meat for the manufacturing of chicken patties and compare the physical, chemical & sensory properties of patties made from broiler meat and various levels of spent hen meat.

METHODS AND MATERIALS

Raw material and experiment design

All the birds (broiler and spent laying hen) were procured from local market of Hyderabad and brought to the Department of Animal Products Technology, Sindh Agriculture University, Tandojam. After slaughtering, five formulations were prepared for the manufacturing of chicken patties including, control containing 100% broiler chicken meat and 4 levels of replacement with spent hen meat at 25% spent hen meat + 75% broiler meat (T25), 50% spent hen meat + 50% broiler meat (T50), 75% spent hen meat + 25% broiler meat (T75) and 100% spent hen meat (T100).

Preparation of chicken patties

Chicken patties of different formulation were manufactured by the method reported by Nardoia et al., 2018 with minor modification. The minced chicken meat was mixed with different spices and salt. The patties formulas were homogenized in the mixer and then shaped into the chicken patties. All samples were fried in soybean oil, after cooking the patties were allowed to cool at room temperature.

Analysis of physiochemical properties

pH value

The value of pH of spent hen meat was observed as described by Ockerman (1985). In brief, 10 g of samples mixed with distilled water (90 mL) and transferred to beaker. Then, an electrode along with temperature probe was inserted into the sample. The pH value of spent hen meat was recorded by noting and recording the constant reading displayed on the pH meter's base.

Water holding capacity (WHC)

This technique described by Wardlaw et al., (1973) was used to measure the WHC of samples of spent hen meat. Briefly, eight grams of samples remained positioned in centrifuge tube collected with 0.6 molar NaCl solution (12 ml), for fifteen minutes of time. The tube was centrifuged (4 degree C) at ten thousand rpm then the liquid of upper portion was poured out and examined. The volume difference among the (NaCl 0.6 M) used and obtained supernatant was noted as water holding capacity of spent hen meat samples.

$$\text{WHC (\%)} = \frac{\text{Actual weight} - \text{supernatant volume}}{} \times 100$$

Actual weight

Cooking loss

The technique is described by Kondaiah et al., (1985) was used to measure cooking loss of spent hen meat. In Brief, the 20 grams of meat sample were taken in polyethylene bag. Sample was put in the water bath for one hour having a temperature of 72-80 degrees after one hour sample was removed from water bath with the help of pair of tongs and removed all cooked fluid from bag and dry the sample with the help of filter paper and weigh the sample. Cooking loss was determined by using following formula,

$$\text{Cooking loss (\%)} = \frac{\text{Mass before cooking} - \text{Mass after cooking}}{\text{Mass before cooking}} \times 100$$

Moisture content

Spent hen meat moisture content was calculated by the process as reported by (AOAC, 2000) First, weigh an empty crucible dish. After that, put 2 grammes of the sample in the dish and place it in a hot air oven at 100°C for four hours. The sample was moved to a desiccator for an hour after drying. Then, the dish was weighed and the formula used to get the moisture percentage was:

$$\text{Moisture (\%)} = \frac{W2 - W1}{W2 - W3} \times 100$$

Here,
W1 = Empty weight of aluminum dish.
W2 = Aluminum dish + sample weight.
W3 =Aluminum dish + dried sample weight.

Total Protein content

The following procedures were conducted for the determination of total protein content of spent hen meat as reported by Association of Official Analysis Chemist (AOAC, 2000). By using Micro-Kjeldhal digestion unit 2 grams meat sample was digested in the presence of copper sulphate (0.35) and potassium sulphate (7 grams) and Sulphuric acid (30 ml). 250 milliliters of distilled water added to dilute the samples. Then diluted samples 5 milliliters was extracted with the 40 percent sodium hydro oxide solution using micro–Kjeldahl distillation unit and steam was extracted about two percent of Boric acid 5 milliliters containing a bromocresol green indicator for 3 minutes. Lastly, the process of titration with 0.1 N HCL ammonia was determined, and following formula was used to determine the protein content in spent hen meat.

$$\text{Nitrogen \%} = \frac{1.4\,(V1-V2) \times \text{normality of HCl}}{\text{Weight of meat sample} \times \text{volume of diluted sample}} \times 250$$

Where,
V1 = The value of titrated
V2 = Blank samples values
The protein percent was calculated through using conversion factors and converting the obtained nitrogen into protein (Conversion factor) that is 6.25.
Protein percent = Nitrogen % × (CF) factor of conversion

Total Fat content

Total fat content of spent hen meat sample was extracted in Soxhlet Extraction Unit (Lablin Melrose park, ILL) as described by AOAC (2000) 2g of meat sample was collected in a thimble and put in the Soxhlet extraction machine in a condenser. However, the distillation flask was fixed through the Soxhlet Extractor due to dryness and pre-weighing. About 150 milliliters of petroleum ether are taken in a distillation flask. The solvent was boiled after the condenser, and an electronic heater were connected.

The solution was extracted after six hours, let to cool and dry in an oven, and then weighed. The formula was used to determine the percentage of total fat content.

$$\text{Fat (\%)} = \frac{W2\text{-}W1}{W3} \times 100$$

Now,
W1 = weight of empty flask.
W2 = Distillation flask weighted +fat
W3 =Sample weight.

The Ash content

The Gravimetric method as described by (AOAC 2000) was used for determination of ash content of spent hen meat sample. 2 g of sample of spent hen meat transferred in to the muffle furnaces (Neverherm Mod; L9/11/8KM, Germany) for 5 hours at 550 ^{0}C to ignite sample. Thereafter, ashed sample was shifted to desiccators for 1 hour and weight of dish was again measured. To calculate the ash content, following formula was used,

$$\text{Ash \%} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where,
W_1 = empty weight of Crucible
W_2 = Crucible weight + Sample
W_3 = crucible +Ashed sample weight

Sensory evaluation

Sensory characteristics were assessed on the first day of manufacturing chicken patties. All the samples were subjected to sensory analysis by panelist at Sindh Agriculture University, Tandojam. Selection of judges in the panel was done as per the procedure described by Wheeler et al., (1997). The sensory questionnaires were measured by intensity on a 9-point hedonic scale (1 = extremely dislike, 2 = very much dislike, 3 = moderately dislike, 4 = slightly dislike, 5 = neither like nor dislike, 6 = slightly like, 7 = moderately like, 8 = very much like, 9 = extremely like) for the attributes such as appearance, flavor, juiciness, texture and overall acceptability. Sensory evaluations were performed under controlled conditions of temperature, humidity and light.

STATISTICAL ANALYSIS

The data were analyzed using statistical software (Student edition of Statistix, USA, version 8.1). The data was tabulated and presented as mean±SD. For the statistical analysis, One-way ANOVA and least significant difference test was performed to check the differences among various treatment groups.

RESULTS

pH

Results of the pH value of patties prepared from the broiler and replacement with spent laying hen meat at graded levels are mentioned in Figure 1. Data indicates that pH of patties ranged between 5.7 to 6.06 in all treatment groups. Mean pH value was significantly ($P<0.05$) higher (6.06) in 100% broiler control group than 75% spent hen meat replacement (5.82) and 100% spent hen meat (5.70). Furthermore, statistical analysis of the obtained data indicates that there is non-significant ($P>0.05$) difference in pH value of patties among various treatment groups including, 75% broiler (5.90), 50% broiler (5.88) and 25% broiler (5.82).

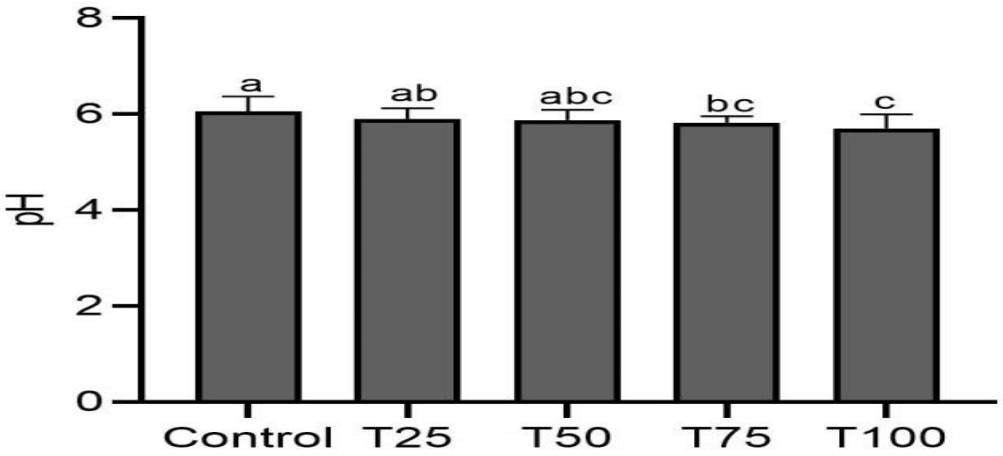


Figure 1: pH value of different treatment groups of chicken patties. Different superscripts indicated significant differences. (Control = 100% broiler meat, T25 = 75% broiler meat and 25% spent hen meat, T50 = 50% broiler meat and 50% spent hen meat, T75 = 25% broiler meat and 75% spent hen meat and T100 = 100% spent hen meat).

Water holding capacity (WHC)

The results for the water holding capacity of chicken patties manufactured from various levels of broiler meat and spent hen meat is depicted in Figure 2. WHC was 51.16, 53.66, 50.33, 49.33 and 45.0% in control, T25, T50, T75 and T100 treatment group, respectively. Furthermore, range of WHC chicken patties among all groups was between 45.00 to 51.16. Statistical analysis showed that 100% broiler (control group) has significantly ($P<0.05$) higher WHC as compared to 100% spent hen meat. Moreover, spent hen meat was statistically ($P<0.05$) lower in WHC among all groups.

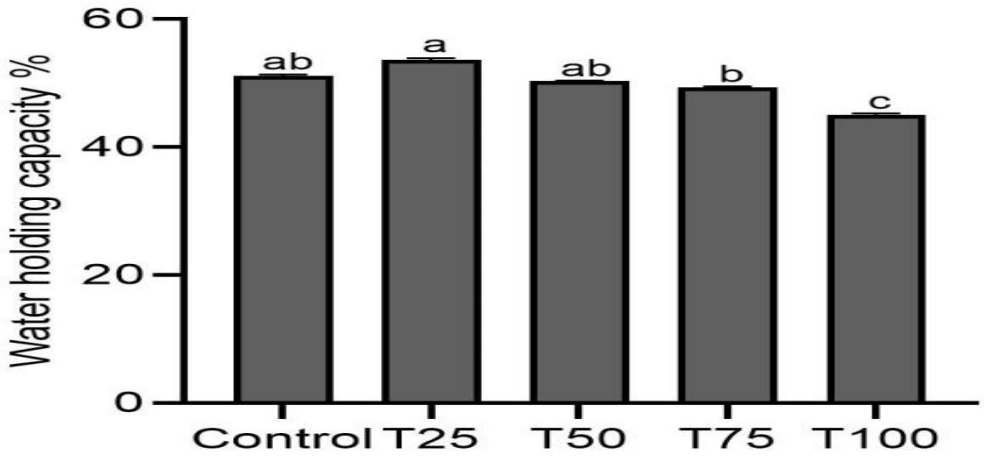


Figure 2: Water holding capacity % of different treatment groups of chicken Pattie.

Cooking loss (%)

In the present study cooking loss of different groups was analyzed and data is presented in Figure 3. Result indicates that cooking loss of patties was ranged between 22.33 to 35.00% in different treatments. Mean cooking loss was 35.00% in 100% spent hen meat (T100 groups), 30.00% in T75 treatment, 29.33% in T50 group, 26.66% in T25 formulation and 22.33 in control group. ANOVA results showed that there is significant difference ($P<0.05$) among different groups. 100% spent hen meat patties have remarkably ($P<0.05$) higher cooking loss than all other treatments and 100% broiler meat patties have significantly

(P<0.05) lower in cooking loss. While T25, T50 and T100 groups were non-significant (P>0.05) with each other.

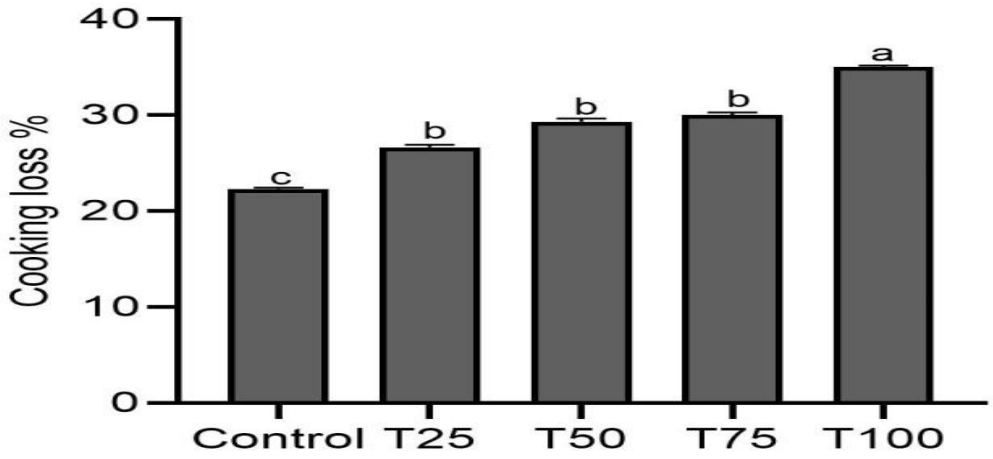


Figure 3: Cooking loss % of different treatment groups of chicken patties.

Moisture content (%)

In the current study, the moisture percentage of chicken patties made from different formulations of meat from broiler and spent hen was evaluated and the results are provided in Figure 4. Result showed that moisture percentage in control groups, T25, T50, T75 and T100 was 71.16, 70.0, 69.33, 6.33 and 66.0%, respectively. Data further indicates that moisture content of patties in all groups varied between 66.00 to 71.16%. Statistical analysis showed that moisture percentage of control group was significantly higher, followed by T50, T75 and T100. While moisture percentage of chicken patties from 100% spent meat was significantly (P<0.05) lower among all formulation.

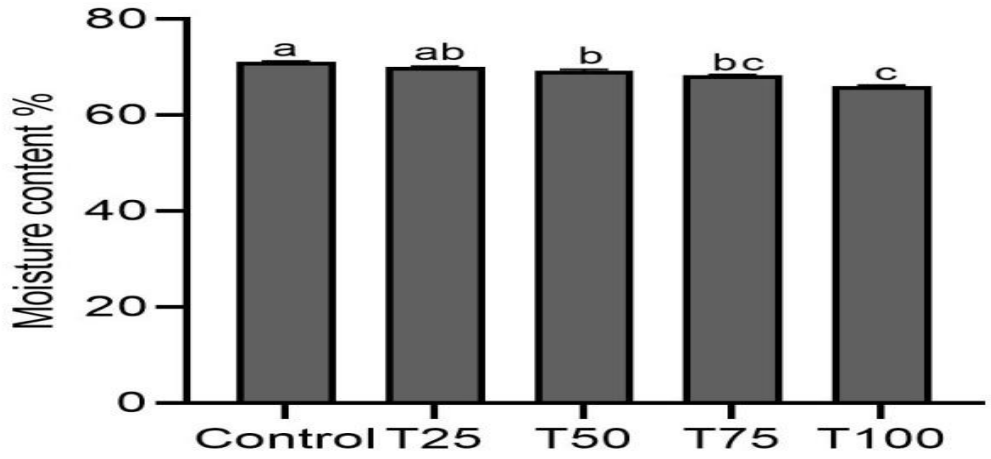


Figure 4: Moisture content % of different treatment groups of chicken patties.

Fat content

Fat content of chicken patties prepared by broiler meat replacement with spent laying hen was evaluated and mentioned in Figure 5. Findings of present study indicate that fat percentage of chicken patties of various formulations ranging from 9.00 to 13.00%. Mean fat content was 10.33, 10.0, 12.0, 11.33 and 12.66% in the control, T25, T50, T75 and T100 treatment groups, respectively. Moreover, statistically data showed that only T100 group was significantly (P<0.05) higher when compared to all other groups. Except for the T100 group, all other treatment groups were non-significant (P>0.05) for fat percentage.

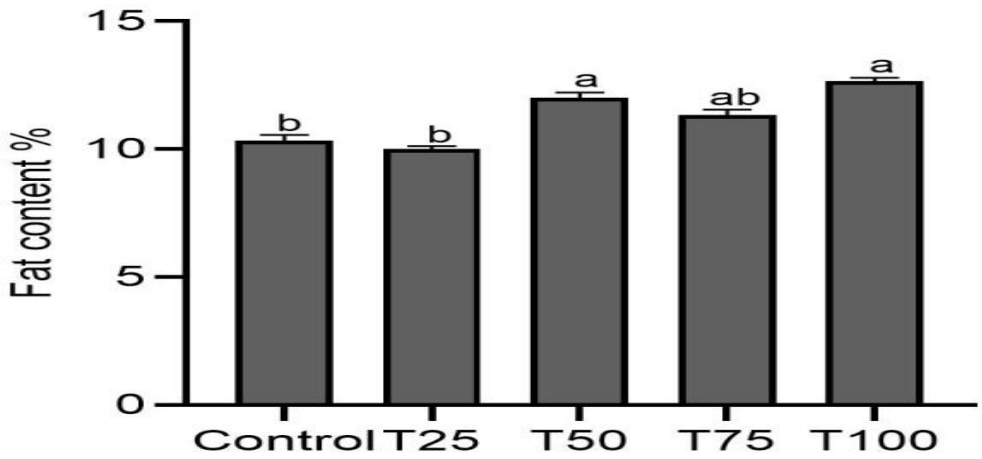


Figure 5: Fat content % of different treatment groups of chicken patties.

Protein content

Present study analyzed the protein percentage of chicken patties manufactured from varying levels of broiler and spent hen meat. Protein percentage was between 14.33 to 15.66 among various formulations as shown in Figure 6. Protein content in control groups was 14.33%, T25 (15.0%), T50 (14.33%), T75 (15.33) and T100 (15.66). Obtained data were further subjected to ANOVA and results showed that there is no significant (P>0.05) difference in protein content among chicken patties of different treatment groups.

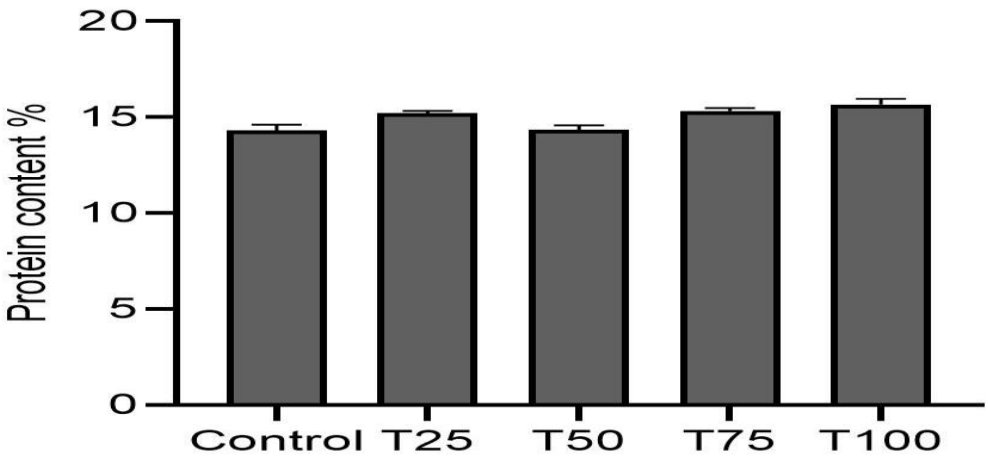


Figure 6: Protein content % of different treatment groups of chicken patties.

Ash content (%)

Results for the ash content of chicken patties prepared from broiler meat replacement with spent hen meat is mentioned in Figure 7. Findings of current research showed that ash content was 1.63% (control), 2.02% (T25), 2.08% (T50), 1.76% (T75) and 2.10% (T100). Moreover, no significant differences (P>0.05) were observed in the chicken patties manufactured with different formulation using broiler and spent hen meat when data was subjected for statistical analysis.

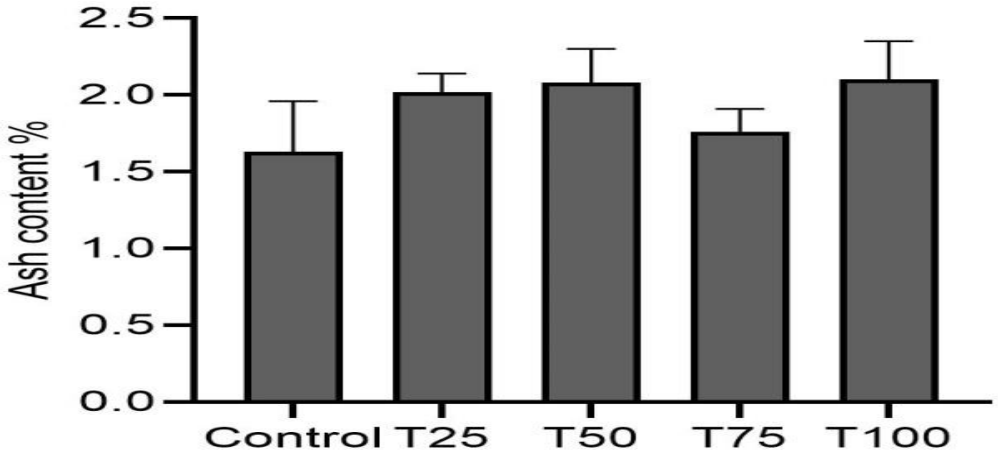


Figure 7: Ash content % of different treatment groups of chicken patties.

Appearance score

In the present research, after various analysis including physico-chemical properties of the cooked chicken patties made from different formulations of broiler and spent hen meat, all the groups were further evaluated for sensory analysis. Results of the appearance score of patties are presented in Table 1 and Figure 8. Data of appearance score indicates that mean score of the panelist is between 7 to 7.88 in all groups for appearance. Mean appearance score was 7.88, 7.33, 7.66, 7.11 and 7.0 in control, T25, T50, T75 and T100 group. Furthermore, data was treated for analysis of variance and results showed that there is no significant difference (P>0.05) among all treatments in term of appearance score.

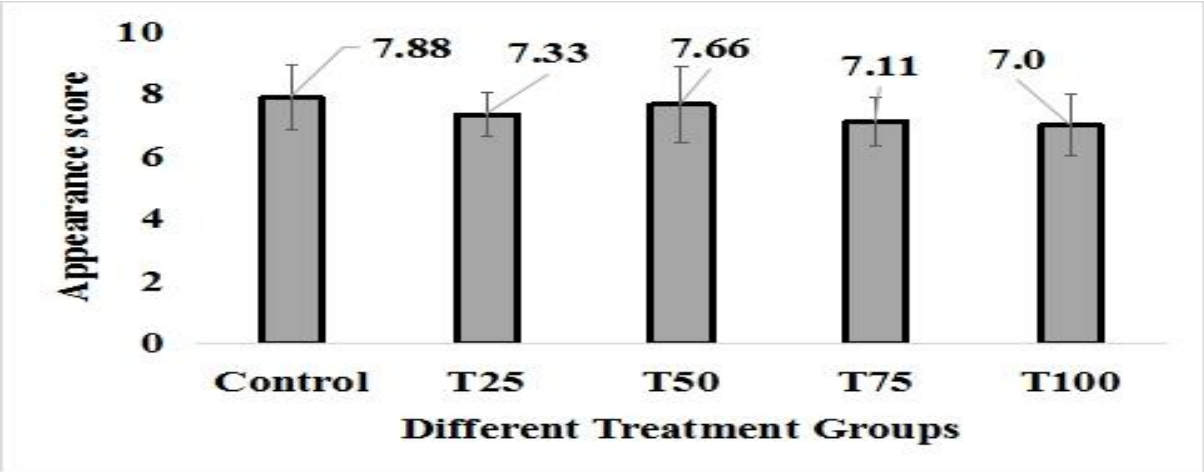


Figure 4: Appearance score of different treatment groups of chicken patties.

Flavor

In the current study chicken patties of different treatments were assessed for flavor and panel of judges scored the cooked chicken patties and mean score is depicted in Figure 9; appendix Table 1. Obtained data was tabulated and it was observed that mean flavor score of all formulation was between 6.11 to 7.11. Results further showed that the average flavor score was 7.11, 6.88, 6.55, 6.44 and 6.11 in control group, 75% broiler, 50% broiler, 25% broiler and 0% broiler (100% spent hen meat), respectively. Furthermore, statistical data indicates that flavor score of 100% broiler was remarkably (P<0.05) higher as compared to the 100% spent hen meat patties. While all three other groups, including both meat of broiler and spent hen at varying levels were statistically non-significant (P>0.05).

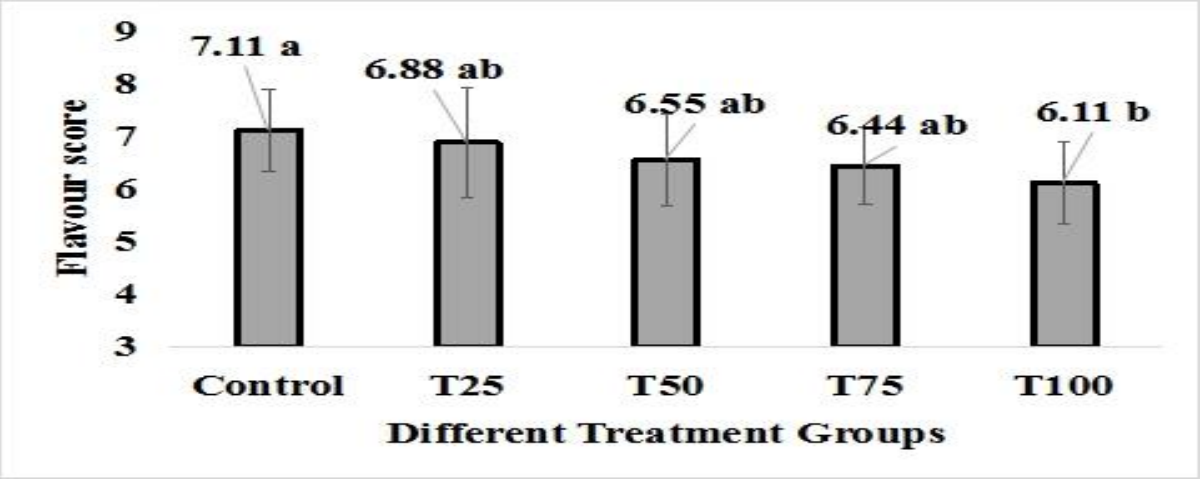


Figure 9: Flavor of different treatment groups of chicken patties

Texture

In this study, chicken patties of different types of meat were evaluated for the texture score by the panel of judges using 9-point hedonic scale and obtained results were mentioned in Table 1 and Figure 10. Sensory analysis results for mean texture scores range from 5.66 to 6.77. Among various formulations, control group received higher scores (6.77), followed by T25 (6.55), T50 (6.44), T75 (6.11) and T100 (5.66). ANOVA test results show that there is significant ($p<0.05$) difference among different groups. Therefore, data was further treated for LSD analysis, and it was observed that T100 group received considerably ($P<0.05$) lower score as compared to the control group, while control group was statistically non-significant ($P>0.05$) as compared to the T25, T50 and T75.

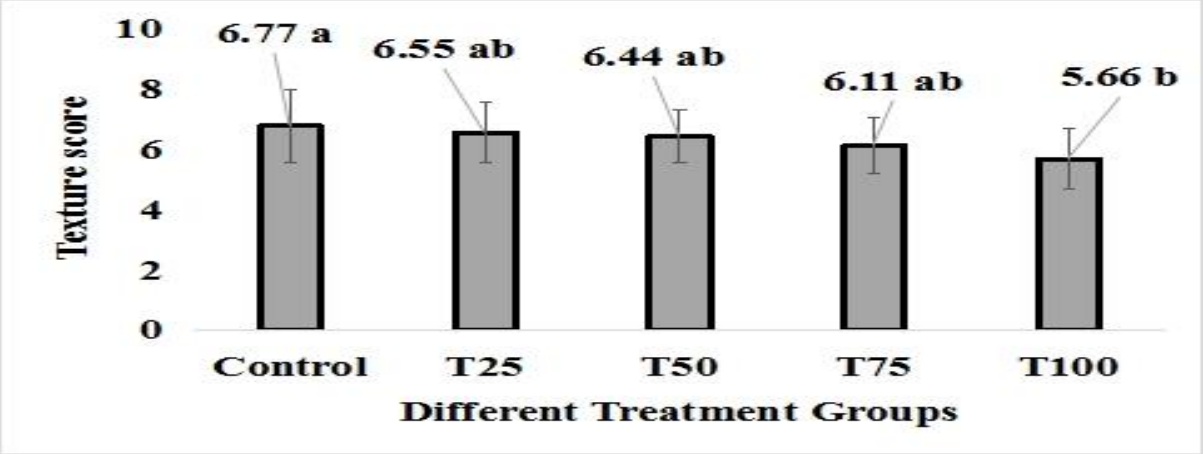


Figure 10: Texture of different treatment groups of chicken patties

Juiciness score

Among various sensory analysis, chicken patties of various formulations were further assessed for juiciness score, and the mean score is presented in Table 1 and Figure 11. Panel of judges score the patties of different groups and mean score ranged between 5.44 to 7.22 for all groups. Furthermore, data shows that juiciness scores were 7.22, 7.0, 6.22, 6.55 and 5.44 in control, T25, T50, T7meanly. Statistical analysis shows that T100 group was significantly different among all other groups. One the other hand, control groups was statistically similar ($P>0.05$) as compared to the T25, T50 and T75.

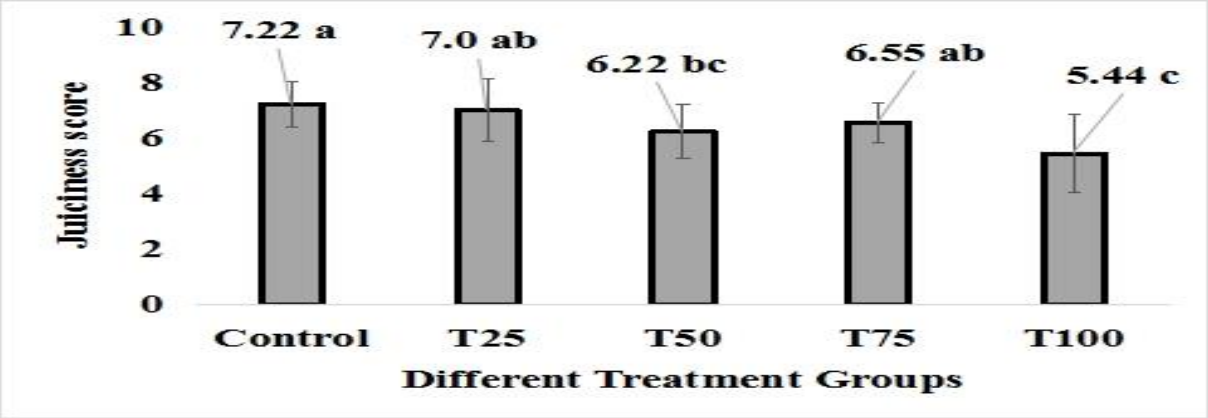


Figure 11: Juiciness score of different treatment groups of chicken patties

Overall acceptability

In the current study, finally all formulations of cooked patties were analyzed for overall acceptability, and results are depicted in Table 1 and Figure 12. Data indicates that panelist rated the chicken patties between 5.11 to 7.11. Among various treatments, control, T25, T50, T75 and T100 received 7.44, 6.77, 6.66, 5.55 and 5.11 overall acceptability scores. ANOVA results show that there is significant difference ($P<0.05$) among various groups. Least significance test (LSD) results show that first three groups (control, T25 and T50) were significantly ($P<0.05$) higher in overall acceptability score than T75 and T100.

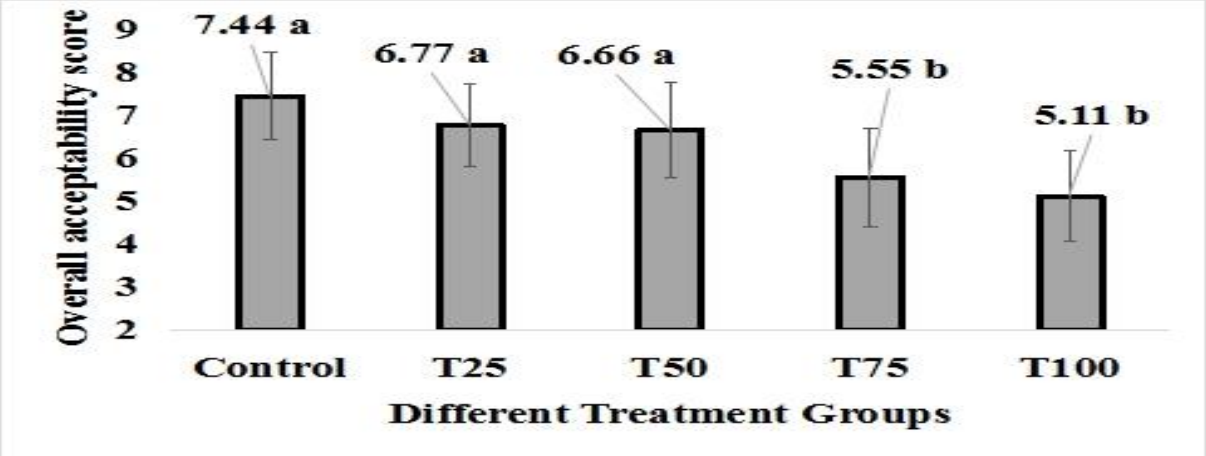


Figure 12: Overall Acceptability of different treatment groups of chicken patties

Table 1: Analysis of sensory attributes of chicken patties prepared from different formulations of broiler and spent hen meat (mean ± s.e.m)

Sensory parameters	Control	T25	T50	T75	T100
Appearance	7.88 ± 0.21	7.33 ± 0.22	7.66 ± 0.22	7.11 ± 0.3	7 ± 04
Flavor	7.11 ± 0.11^{a}	6.88 ± 0.34^{ab}	6.55 ± 0.1^{ab}	6.44 ± 0.32^{ab}	6.11 ± 0.32^{b}
Texture	6.77 ± 0.3^{a}	6.55 ± 0.13^{ab}	6.44 ± 0.12^{ab}	6.11 ± 0.28^{ab}	5.66 ± 0.24^{b}
Juiciness	7.22 ± 0.22^{a}	7 ± 0.4^{ab}	6.22 ± 0.2^{bc}	6.55 ± 0.1^{ab}	5.44 ± 0.29^{c}
Overall acceptability	7.44 ± 0.15^{a}	6.77 ± 0.22^{a}	6.66 ± 0.13^{a}	5.55 ± 0.2^{b}	5.11 ± 0.32^{b}

Different superscripts indicated significant differences. (Control = 100% broiler meat, T25 = 75% broiler meat and 25% spent hen meat, T50 = 50% broiler meat and 50% spent hen meat, T75 = 25% broiler meat and 75% spent hen meat and T100 = 100% spent hen meat).

DISCUSSION

In the current investigation, broiler meat was used to make chicken patties, and the meat of spent hens was substituted for varying amounts of broiler meat. In our study, pH of chicken patties significantly ($P<0.05$) decreased with the increased percentage of spent hen meat and ranged between 5.7 to 6.06% in all groups. These findings of the current study agree with the results of Biswas et al., (2006), who observed that spent hen meat patties were higher in the pH value and could be due to differences in the quality & quantity of the glycolytic enzymes and glycogen reserves (Brahma et al., 1984). Furthermore, Jin et al., (2007) reported that the values of pH ranged between 5.90 and 6.25 in the sausage containing surimi made from spent hen meat (20%, 40% and 60%) & the levels of pH increased as the more surimi was incorporated in the treatment groups.

Patties' cooking loss varied from 22.33 to 35.0% depending on the formulation. Adding spent hen meat to chicken meat patties enhanced their cooking loss. In the literature, it was noticed that influence of chicken meat replaced by spent hen meat on cooking loss of sausage showed that the control group (100% chicken meat) had lowest cooking loss and increased with spent hen meat inclusion in the other treatment groups (Polizer Rocha et al., (2019) and these findings are in line with the current study. These findings may be explained by the fact that old age animals or birds generally have higher levels of collagen (Abe et al., 1996; Tarte et al., 2009). Moreover, during cooking, the myofibrillar proteins denature, incurring water loss and change in the collagen fiber, whereby its triple helix structure starts to denature into a simple chain, shrink and dissolve, causing the gel breakdown in meat products that forms during cooling. When the collagen shrinks, the muscle proteins actuate against it resulting in a compression with the denatured myofibrils. It can result in an instability of the mass, causing an extra loss of liquid. leading to a decrease of water retention and increase in the cooking loss (Tarte et al, 2009) and these findings agree with the report of Biwas et al., (2006) who reported higher cooking loss in cooked patties manufactured from spent laying hen meat when compared with chicken meat.

The moisture level of the patties in this study varied between 66.0 and 71.16% among the various groups. When comparing the patties made from spent hen meat to those made from broiler meat, the mean moisture content was significantly ($P<0.05$) lower. In a study, the patties were prepared from spent hen, duck and broiler and were analyzed for the moisture percentage. Their findings revealed that cooked patties differed significantly in moisture content (Biswas et al. 2006). The moisture content of cooked patties manufactured from the meat of broiler was higher as compared to the duck meat and spent hen because moisture percentage of muscle decreases with increasing age (Lawrie et al., 1998). These findings are also in line with as reported by Polizer Rocha et al., (2019). Furthermore, there was also reduction in the moisture percentage of the cooked patties during cooking because loss of moisture due to the coagulation of sarcoplasmic and myofibrillar protein of muscle fiber (Warris et al., 2000).

In this study, mean protein content of patties ranged between 15.66 to 14.33% in various formulations. This range of protein percentage were acceptable in meat products as per Bureau of Indian Standards (BIS, 1992). Furthermore, protein percentage of different groups were also acceptable as per standards of Technical Regulations of Quality and Identity of Sausages (Brasil et al., 2000). They recommended that the minimum protein percentage of such products should be 12 percent. Moreover, in the current study, statistical analysis shows that there is no significant difference ($P>0.05$) in terms of protein content of chicken patties among all groups and these findings agree with the conclusions of Polizer Rocha et al., (2019) and Biswas et al., (2006).

Fat content of chicken patties formulated with different types of meat (broiler and spent hen meat) ranged between 10.33 to 12.66%. Findings of this study shows that fat content was increase with the addition of spent hen meat and this finding is matching with the literature as suggested by Biswas et al., (2006), who found that cooked patties manufactured from the meat of broiler showed lower fat percentage when compared with the spent hen meat due to higher fat in the spent laying hen meat (Sharma, 1999). One the other hand, Polizer Rocha et al. (2019) found that there is no significant difference among fat content in the meat products prepared from the broiler and spent hen. In the literature, it is also well documented that cooking increased the fat content of patties as reported by Lingiah and Reddy (2001), Singh and Verma (2000) and Warris (2000). They also concluded that cooking causes reduction in moisture percentage, thereby content of fat is increased in the cooked meat product.

Overall, result regarding sensory analysis showed that the 100% broilers were highly attractive than others in the average appearance, flavor, juiciness, texture and overall acceptability. Furthermore, findings of current study regarding sensory analysis are in line with the Polizer Rocha et al., (2019). However, small variations may be due to processing and handling of meat products in the laboratory. Sensory analysis panelist rated higher score to the control group and decreasing trend was observed with the increase level of spent hen meat in overall acceptability. However, statistically in first three groups control, T25 and T50, there is no significant difference, which shows that spent hen meat can be used for the manufacturing of value-added meat products and 50% replacement is acceptable. While T75 and T100 received significantly ($P<0.05$) lower score in overall acceptability than control, T25 and T50 group. This might be due to addition of high level of spent hen meat and consumers' behavior towards old age bird meat as compared to the broiler.

CONCLUSION

The current study's findings indicate that the protein and ash content of chicken patties made with various formulas remained unchanged. The moisture content, WHC, juiciness, and flavor score all decreased when spent laying hen meat was added. As the amount of spent hen meat grew, cooking loss in the broiler meat decreased. Overall sensory acceptability remained same when spent laying hen meat was substituted with broiler meat up to 50%.

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Author Contributions

MI is researcher and author of manuscript. MAJ and AHS supervised study conducted. ZAL guided to conduct research in laboratory. MY, WUD, NUM and SA helped in formal analysis. IU, JK and MJ helped in manuscript writing review and editing.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this research.

Data Availability

The original data of study is available.

Ethical Statement:

The current study, which was authorized by the Institutional Review Board (IRB)/Bioethics Committee under license number IRB-APT-102, was conducted at the Department of Animal Products Technology, Sindh Agriculture University, Tandojam, Pakistan.

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