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### RESEARCH ARTICLE

#### QUALITY CHARACTERISTICS OF RESTRUCTURED CHICKEN CUBES INCORPORATING SPENT CHICKEN MEAT.

Chetan S Khanapur<sup>1</sup>, Renuka Nayar<sup>2</sup>, Neethu Divakar<sup>1</sup>, Kavitha Rajagopal<sup>2</sup>, Sunanda C<sup>3</sup> and Magna Thomas<sup>4</sup>.

1. MVSc Scholar, Department of Livestock Products Technology, College of Veterinary and Animal sciences, Pookode, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad- 673 576, Kerala, India.
2. Assistant Professor, Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Poolode, Wayanad- 673 576, Kerala, India.
3. Assistant Professor, Department of Biostatistics, College of Veterinary and Animal Sciences, Pookode, Wayanad-673 576, Kerala, India.
4. Assistant Professor, Department of Dairy Science, College of Veterinary and Animal Sciences, Pookode, Wayanad- 673 576, Kerala, India.

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#### Abstract

Tough meat from spent chicken can be economically utilized for preparing various convenience meat products which are nutritious and tasty. Ready-to-cook restructured chicken meat cubes were developed by incorporating spent chicken meat (SCM) into broiler chicken meat (BCM) at different ratios (T1, T2 and T3) and compared with broiler breast muscle cubes (C). Physico-chemical properties such as pH, TBARS numbers and tyrosine values showed significant ( $p < 0.01$ ) difference between C and treatments. Significantly ( $p < 0.01$ ) higher L and b values and lower a values were observed in C than treatments. Except for hardness, all texture parameters were significantly ( $p < 0.01$ ) lower for C. T2 and T3 showed significantly ( $p < 0.01$ ) higher aerobic plate count and T2 had higher yeast and mould count compared to others. C had significantly ( $p < 0.01$ ) lower protein, fat and ash contents than treatments. Overall acceptability scores were highest for T1 and then for C and T2. Spent hen meat can be incorporated up to 50 per cent level to prepare convenient, ready-to-cook restructured meat cubes.

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#### Introduction:-

Present day consumers are concerned about their health and are careful in selecting their diet. A good diet is necessary to lead a healthy life and it can reduce the risk of diseases which would help in maintaining better health status and moreover a secure life. In recent days, there is a trend among consumers to include in their diet, meat products with less salt and fat content to minimize the adverse health effects.

Restructuring involves disassembling the carcass and reassembling it into same or different form which, gives a texture similar to the steaks, chops and roasts. The main objective of producing restructured meat products is to utilize the low value carcass trimmings or cuts from spent or aged animals to develop more palatable products which

**Corresponding Author:-Chetan S Khanapur.**

Address:-MVSc Scholar, Department of Livestock Products Technology, College of Veterinary and Animal sciences, Pookode, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad- 673 576, Kerala, India.

are marketed at higher cost. Poultry meat is most suitable for processing into various products due to the reasonable price, wide acceptance and mild flavour. Spent hen meat obtained as a byproduct from egg industry has higher fat and cholesterol content and also has poor sensory characteristics due to its tougher and less juicy nature and hence marketed at lower prices (Kumar *et al.*, 2015). The binding of meat pieces during restructuring can be achieved by adding non-meat proteins like vegetable proteins, milk proteins, egg albumen, microbial transglutaminase etc. which improve the physico-chemical and functional properties and sensory attributes of the product. The extraction of myofibrillar proteins is usually enhanced by adding salt to the meat pieces and by subjecting to techniques like massaging, vacuum tumbling etc. which facilitates proper mixing of all added ingredients along with meat and also improves the raw binding ability of small meat pieces. Ready to eat or ready-to-cook restructured meat products have advantages of convenience in preparation and at the same time with added benefits of nutrients/ingredients which are incorporated during the formulation process. In this study, restructured chicken meat cubes were developed with incorporation of spent hen meat at different levels and compared with broiler breast meat cubes.

### **Materials And Methods:-**

Broiler and spent chickens were procured from the local markets in Vythiri, Wayanad district and were brought to the Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Pookode. The birds were provided *ad libitum* water and proper rest. They were slaughtered, dressed under hygienic conditions and the carcasses were washed and chilled overnight ( $4\pm 1^{\circ}\text{C}$ ). On the next day chilled carcasses were deboned and restructured chicken cubes were prepared and stored for further studies.

### **Preparation of restructured chicken meat cubes:-**

The spent and broiler chicken carcasses were deboned separately. Deboned meat from spent chicken (SCM) and from broiler chicken (BCM) was used for the study. Three treatments of restructured meat were prepared incorporating SCM and BCM in proportions as shown in the Table 1.

In all the treatments seventy percent of the total meat was manually chunked into pieces of size  $1.5\text{ cm}^3$  and thirty percent of the meat was coarse minced in a mincer. Both chunked and minced meat was mixed with salt as well as whipped egg albumen (1% each) and subjected to vacuum tumbling (five minutes tumbling done twice with an interval of five minutes in between). Later the mixture was stuffed into suitable moulds of size  $2\text{ X }2\text{ X }1.5\text{ cm}^3$  and kept for freezing at  $-18\pm 1^{\circ}\text{C}$ . On the next day, the formed cubes were removed from moulds and subjected to analyses.

### **Physico-chemical characteristics:-**

pH of the samples was measured by using a digital pH meter as per AOAC (2012). Thiobarbituric acid reactive substances (TBARS) numbers were determined as per Witte *et al.* (1970) with modifications and the absorbance values measured at 530 nm were expressed as TBARS number of sample. Tyrosine values of the control and treatment samples were estimated as per the method described by Pearson (1968). The absorbance was measured at 660 nm in a spectrophotometer. By referring to the standard graph of tyrosine, tyrosine values of samples were calculated and expressed as mg of tyrosine/100g of sample.

Texture profile analysis was conducted as per Bourne (1978) using a Universal Testing Machine (TRAPEZIUM EZ-SX, Shimadzu, Japan). A crosshead speed of 10mm/min was used, applying 500 N load cell and texture parameters like hardness, springiness, cohesiveness and adhesiveness were estimated. Colour of the samples was determined objectively as per Page *et al.* (2001) using Hunter Lab Mini Scan XE Plus Spectrophotometer (Hunter Lab, Virginia, USA) with diffuse illumination. The colour coordinates L (lightness), a (redness) and b (yellowness) of the samples were measured thrice and mean values were taken.

The samples were also analysed for proximate principles like moisture, fat, protein and ash as per AOAC (2012) and carbohydrate and energy values were calculated.

### **Microbiological parameters:-**

Aerobic plate count (APC) was evaluated as per the procedure of Morton (2001). Psychrotrophic count was expressed as per the procedure of Cousin *et al.* (2001). Yeast and mould count was expressed as per the procedure of Beuchat and Cousin (2001). The number of colonies was multiplied by the dilution factor and expressed as  $\log_{10}\text{cfu/g}$ .

**Sensory attributes:-**

Sensory evaluation of control and treatment cubes was conducted by a semi-trained panel consisting of seven panellists from the Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Pookode using a nine-point Hedonic scale as per (Badr *et al.*, 2004). Cost involved in the product preparation was also estimated and statistical analysis was done for all the parameters as per the procedures of Snedecor and Cochran, (1994) using SPSS version 21.

**Result And Discussion:-****Physico-chemical characteristics:-**

pH values, TBARS numbers and tyrosine values of control and treatment cubes are presented in Table 2.

Significantly ( $p < 0.01$ ) lower pH values were recorded for C when compared to treatments. This might be because of the fact that C consisted of breast muscle which was white meat with more glycolytic metabolism and the higher pH in treatments might also be due to incorporation of egg albumen with alkaline pH during restructuring. Swatland (2008) observed lower pH values in pale breast muscle ( $5.91 \pm 0.12$ ) in comparison to dark breast muscle ( $6.36 \pm 0.25$ ) in commercial broiler chicken. Gupta *et al.* (2017) stated that increase in pH of functional restructured spent hen meat blocks could be due to replacement of meat with different binders and extenders having slightly higher pH than meat.

TBARS number was significantly ( $p < 0.01$ ) higher for T3 and lower for C and T1. The higher TBARS number for T3 might be due to the incorporation of spent chicken meat, which is rich in fat that might have undergone oxidation due to the various processes involved in the preparation of cubes. Biswas *et al.* (2006) also reported higher TBA values in duck patties due to higher fat content in comparison to spent hen and broiler meat patties and opined that higher fat percent was responsible for increased fat oxidation in patties. The present findings were in agreement with the results of Singh *et al.* (2011) who noted higher TBA values for chicken snack developed from mixture of spent chicken meat, rice flour, sodium caseinate and spice mix when compared to control. Chueachuaychoo *et al.* (2011) observed that spent hen meat had high fat percent and polyunsaturated fatty acid content due to which it was more prone to lipid oxidation.

Tyrosine values for T2 and T3 were significantly ( $p < 0.05$ ) higher when compared to control and T1. Sudheer *et al.* (2011) recorded higher tyrosine values for chicken blocks incorporated with gizzard when compared to control chicken blocks without gizzard.

The values obtained on instrumental texture and colour of control and treatment cubes are presented in Table 3. On instrumental texture profile analysis, C showed significantly ( $p < 0.01$ ) lower cohesiveness, springiness and adhesiveness values when compared to T1, T2 and T3. No significant difference was observed in the case of hardness among control and treatment cubes. Similar hardness values for control and treatment cubes on instrumental analysis might be due to the comminution of spent hen meat that might have reduced the effect of toughness. Similar findings were reported by Reddy *et al.* (2015) in restructured mutton products prepared with smaller particle size which had lower hardness values and it could be due to more retention of moisture in samples with smaller particle size. However, on sensory analysis, significantly higher toughness was noticed in T2 and T3 than C and T1.

Talukder *et al.* (2014) noticed significantly ( $p < 0.05$ ) higher hardness and adhesiveness values for restructured chicken meat blocks treated with hydrated lotus (*Nelumbonucifera*) root powder than control blocks and stated that it could be due to binding and gelling property of the vegetable extenders.

Hunter 'L' value was significantly ( $p < 0.05$ ) higher for C than T1, T2 and T3 and might be due to that breast meat is white muscle and is lighter in colour. Ali *et al.* (2007) recorded lower lightness ( $L^*$ ) values and higher ( $a^*$ ) values in duck breast meat when compared to chicken breast which was due to more red muscle fibers in duck breast. Apart from that, lower pH of control cubes from breast portion might have resulted in lighter colour scores as reported by Fletcher (2002).

C had significantly ( $p < 0.01$ ) lower 'a' value and significantly ( $p < 0.01$ ) higher 'b' value when compared to treatment cubes and might be due to the comparatively lower proportion of red muscle fibres in breast muscle. Nowsad *et al.* (2000) noticed that unwashed spent hen mince had shown decreased lighter ( $L^*$ ) and increased redness ( $a^*$ ) values in comparison to unwashed broiler mince.

Results of proximate analysis are presented in Table 4. On proximate analysis, similar moisture levels were observed in all the samples, however fat and ash contents were significantly ( $p < 0.05$ ) lower for C than T1, T2 and T3. Fat percentage was the highest for T3. Higher fat and ash contents of treatments could be due to the incorporation of spent hen meat which is higher in these proximate principles. The protein content of T3 was significantly higher in comparison to C, T1 and T2. Reddy *et al.* (2016) reported different range of values for protein (21.25 to 23.46), fat (1.62 to 2.78), ash (1.22 to 1.29) and moisture content (71.05 to 73.15) in spent meat and the values were closer to the values obtained in the present study. Lakshani *et al.* (2016) recorded significantly ( $p < 0.05$ ) higher protein content in spent hen breast muscle than commercial broiler meat.

#### Microbiological parameters:-

Aerobic plate count and yeast and mould count obtained for control and treatment cubes are given in Table 5. Aerobic plate count and yeast and mould count were significantly ( $p < 0.01$ ) lower for control when compared to treatment cubes. This might be due to the greater handling of meat and different steps involved in the processing of restructured chicken meat cubes. Luckose *et al.* (2015) opined that restructuring involved repeated handling of meat during product preparation which was highly prone for contamination and this could be avoided by proper storage.

#### Sensory attributes:-

In the raw cubes, appearance score was significantly lower for T2 and T3 when compared to C and might be due to the darker colour of the cubes due to more percentage of spent hen meat. Raw meat bind score was similar to all restructured meat cubes and all had high scores. In the case of cooked samples, significantly ( $p < 0.01$ ) lower value for appearance was noticed in T2 and T3 and might be due to the dark colour of cubes due to more incorporation of spent hen meat. Although flavour scores were similar for all, juiciness score was significantly ( $p < 0.01$ ) lower for T3. Tenderness score was significantly ( $p < 0.01$ ) lower for T2 and T3 when compared to C even though on instrumental analysis it was not significant. Lower tenderness scores in T2 and T3 might be due to the higher percentage of incorporation of spent hen meat. Guan *et al.* (2013) reported higher muscle fibre diameter in spent layer birds which was directly related to meat toughness and also opined that spent hen meat had lower sensory scores than other birds due to its more toughness. Score for overall acceptability was the highest for T1 and lowest for T3, with C and T2 having scores in between. Kalaikanan *et al.* (2007) reported that egg albumen had good emulsifying and binding properties in meat products and retained fat and moisture of products which attributed to increased juiciness of the end products.

#### Cost of production:-

The cost of production was found to be lowest for treatment samples when compared to control (boneless breast muscle cubes). The cost of C, T1, T2 and T3 were Rs. 270, Rs.238, Rs.243 and Rs.249 respectively, for one kg sample.

#### Conclusion:-

Restructured chicken meat cubes developed by incorporating spent chicken meat (SCM) and broiler chicken meat (BCM) showed acceptable physico-chemical, microbiological and sensory quality characteristics. Hence we can conclude that T 1 had superior scores in all sensory attributes and lower cost of production than others and also showed lesser proteolysis and lipid oxidation in comparison to T 2 and T 3 samples. T 3 had the lowest sensory scores and was least accepted due to increased toughness. Spent chicken meat (SCM) can be incorporated upto 50 per cent level for economic production of restructured chicken cubes with good sensory attributes and can be conveniently used as a ready-to-cook meat product suitable for curries, fries, *biriyanis* etc.

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**Table.1:-**Preparation of treatment and control cubes.

Treatments	Percentage of SCM	Percentage of BCM
Treatment 1 (T1)	25	75
Treatment 2 (T2)	50	50
Treatment 3 (T3)	75	25

Control	Broiler breast muscle cubes
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**Table 2:-**Physico-chemical characteristics of control and treatment cubes.

Sample	pH	TBARS number	Tyrosine value(mg of tyrosine /100g sample)
C	5.76±0.012 <sup>b</sup>	0.015±0.002 <sup>c</sup>	0.075±0.011 <sup>bc</sup>
T1	5.85±0.012 <sup>a</sup>	0.017±0.002 <sup>c</sup>	0.058±0.008 <sup>c</sup>
T2	5.82±0.022 <sup>a</sup>	0.030±0 <sup>b</sup>	0.125±0.011 <sup>a</sup>
T3	5.75±0.007 <sup>b</sup>	0.038±0.002 <sup>a</sup>	0.100±0.013 <sup>ab</sup>
F-value	7.858 <sup>**</sup>	40.606 <sup>**</sup>	7.000 <sup>*</sup>
P-value	0.001	<0.001	0.002

**Note:**\*\*-significant at 1% level, \*- significant at 5% level, ns-non significant; Means having different alphabets as superscripts are significantly different within a column.

**Table 3:-**Texture profile parameters and Hunter L, a, b values of control and treatment cubes.

Sample	Hardness	Springiness	Cohesiveness	Adhesiveness	L value	a value	b value
C	50.80±3.288	0.392±0.003 <sup>c</sup>	0.382±0.004 <sup>c</sup>	0.093±0.004 <sup>c</sup>	41.62 ± 0.082 <sup>a</sup>	6.58± 0.137 <sup>c</sup>	14.47± 0.115 <sup>a</sup>
T1	54.36±0.964	0.593±0.018 <sup>b</sup>	0.410±0.009 <sup>b</sup>	0.124±0.009 <sup>b</sup>	37.20± 0.243 <sup>b</sup>	8.75± 0.165 <sup>a</sup>	12.25± 0.139 <sup>b</sup>
T2	48.19±1.449	0.660±0.008 <sup>a</sup>	0.386±0.006 <sup>c</sup>	0.154±0.011 <sup>a</sup>	36.49± 0.236 <sup>b</sup>	9.18± 0.157 <sup>a</sup>	10.69± 0.045 <sup>c</sup>
T3	54.02±1.721	0.634±0.005 <sup>a</sup>	0.432±0.007 <sup>a</sup>	0.147±0.006 <sup>ab</sup>	36.42± 0.622 <sup>b</sup>	7.64± 0.196 <sup>b</sup>	10.35± 0.100 <sup>d</sup>
F-value	2.020 <sup>ns</sup>	137.092 <sup>**</sup>	11.303 <sup>**</sup>	12.037 <sup>**</sup>	48.471 <sup>**</sup>	49.912 <sup>**</sup>	316.528 <sup>**</sup>
P-value	0.144	<0.001	<0.001	(<0.001)	<0.001	<0.001	<0.001

**Note:**\*\*-significant at 1% level, \*- significant at 5% level, ns-non significant; Means having different alphabets as superscripts are significantly different within a column.

**Table 4:-**Proximate principles of control and treatment cubes.

Proximates	C	T 1	T 2	T 3	F-value (p-value)
Moisture	74.40±0.402	74.98±0.135	74.43±0.138	75.22±0.191	2.779 <sup>ns</sup> (0.068)
Fat	0.74±0.072 <sup>c</sup>	2.07±0.185 <sup>b</sup>	2.25±0.178 <sup>b</sup>	2.99±0.330 <sup>a</sup>	19.558 <sup>**</sup> (<0.001)
Protein	20.25±0.196 <sup>b</sup>	19.64±0.090 <sup>b</sup>	19.86±0.323 <sup>b</sup>	21.70±0.213 <sup>a</sup>	17.602 <sup>**</sup> (<0.001)
Ash	2.08±0.252 <sup>b</sup>	3.16±0.145 <sup>a</sup>	2.80±0.166 <sup>a</sup>	2.82±0.180 <sup>a</sup>	5.732 <sup>**</sup> (0.005)
Carbohydrate	2.54±0.514 <sup>a</sup>	0.67±0.085 <sup>b</sup>	0.85±0.151 <sup>b</sup>	0.30±0.147 <sup>b</sup>	12.461 <sup>**</sup> (<0.001)
Energy	97.78±1.45 <sup>b</sup>	99.51±1.68 <sup>b</sup>	102.32±0.920 <sup>ab</sup>	106.68±1.81 <sup>a</sup>	6.694 <sup>**</sup> (0.003)

**Note:**\*\*-significant at 1% level, \*- significant at 5% level, ns-non significant; Means having different alphabets as superscripts are significantly different within a column.

**Table 5:-**Microbiological parameters of control and treatment cubes.

Sample	Aerobic plate count	Yeast and mould count
C	3.73±0.630 <sup>c</sup>	2.84±0.024 <sup>d</sup>
T1	4.15±0.015 <sup>b</sup>	3.14±0.036 <sup>b</sup>
T2	4.40±0.021 <sup>a</sup>	3.39±0.036 <sup>a</sup>
T3	4.36±0.017 <sup>a</sup>	3.04±0.023 <sup>c</sup>
F-value	77.679 <sup>**</sup>	57.313 <sup>**</sup>

P-value	(<0.001)	(<0.001)
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**Note:**\*\* -significant at 1% level, \* - significant at 5% level, ns-non significant; Means having different alphabets as superscripts are significantly different within a column.

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