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EFFECT OF CHICKEN SKIN, SOY PROTEIN AND OLIVE OIL ON QUALITY CHARACTERISTICS OF CHICKEN NUGGETS

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Abstract: The effect of Chicken skin, soy protein (CSSP) and olive oil added as meat and fat replacer on the quality characteristics of chicken nugget was observed. Based on the results it is concluded that, addition of 35% CSSP and 5% olive oil has no adverse effect on physico-chemical, microbial quality and sensory qualities of cooked chicken nuggets. There was a gradual decrease in pH, whereas TBA values of test product and control increased significantly throughout the storage period up to 60 days. The nugget sample containing 35% CSSP and 5% olive oil had 70% less fat and showed less cooking loss than those of the control ($p < 0.05$). The oxidative stability of nuggets has improved significantly ($p< 0.05$) because of addition of olive oil and effect the lightness and yellowness of nuggets. The product with (CSSP) and olive oil were preferred more by panelist than the control. Sensory results indicated that some quality attributes of nuggets such as juiciness and firmness can be improved by the addition of CSSP and olive oil. The chicken nuggets with 35% CSSP and 5% Olive oil be stored safely at (4±1ºC) for 10 days and at (-18±1ºC) for 60 days.

Keywords: Chicken sausage, chicken skin, soy protein, olive oil and fat replacer.

INTRODUCTION

Increasing consumer demand for quality meat products results in the development of meat products by incorporating health enhancing ingredients. Consumer demand healthier meat products that are low in fat, salt, cholesterol, nitrates and calories in general and contain in addition health-promoting bioactive components such as carotenoids, unsaturated fatty acids, sterols and fibres. At the same time competition is forcing the meat processing industry to use the increasingly expensive raw material i.e. meat more efficiently and produce products at lower costs [1]. Soy proteins are commonly used in processed meat products for their fuctional properties and low cost compared to lean meat [2]. The addition of soy protein as non-meat ingredients in processed meat products may be the possible solution to the recent

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consumer demands for low fat and low cholesterol meat products [3]. Soy protein has been incorporated in processed meat products for improving the water binding capacity and fat binding ability, enhancement of the emulsion stability and increasing yield [4].

Chicken skin, a by-product of the chicken meat, production process, is a potential water binder and texture modifying agent for use in reduced-fat meat products. The increasing addition of chicken fat skin in the chicken sausage results in decrease in emulsion stability and emulsion capacity, while extract release volume and cooking loss were increased [5].

Cardiovascular diseases and Cancer, both these diseases are related to excess fat intake and imbalance lipid profile on the diet. In this regard, olive oil has been associated with a decrease in overall and cardiovascular mortality. Evidence suggests that olive oil may have a profound influence on health, specially on cardiovascular risk factors [6]. The addition of chicken skin, soy protein (CSSP) and olive oil increased the moisture and protein content in the nugget because of the water binding capacity in soy protein and protein content in chicken skin. Olive oil is known to have antioxidant and antimicrobial property. High CSSP and olive content resulted in more stable meat emulsions and increased hardness, cohesiveness, gumminess, and chewiness.

The quality of nugget significantly affected by processing, raw material and ingredient factors either from nutritional value or overall acceptability by consumers. Only those nuggets with high nutritional value, low cholesterol, good textural properties, nice flavor and taste profile will become the favorite choice of consumers as flavour and texture, particularly juiciness and tenderness, have a clear relationship to meat palatability [7, 8]

A study was conducted in order to incorporate chicken skin, soy protein and olive oil in chicken nuggets and therefore study their quality and shelf life during refrigeration (4±1ºC) and frozen (-18±1ºC) storage

MATERIALS AND METHODS

Boneless chicken, non-meat ingredients such as salt, sugar, phosphates, nitrite and water were used as per the formulation presented in table 1.

Table 1: Composition of chicken nuggets

Meat	100%
Salt	2%
Sugar	1%
Nitrate	150 ppm
Water	10%
spice/meat masala	5%
maida	60%

eggs	30%
garlic paste	5%

All subcutaneous and intramuscular fat were manually trimmed off. The chicken meat and chicken skin was minced separately using a commercial meat mincer (8 mm plate). The minced meat samples were divided into two equal proportions. The 35% of minced chicken skin, soy protein and 5% of olive oil were mixed to one part of the minced meat samples and treated as test sample and the other sample without CSSP and olive oil as control. Each portion was mixed by gently blending in a bowl chopper for about 5 min to obtain a homogenous mix. The mixtures were filled into boxes (20 × 10 cm) (raw nuggets) and were cooked for 20 min to an inner temperature of 75 °C The boxes were turned over at 10 min intervals to ensure uniform cooking. After cooking the cooked material were cut into pieces to obtain chicken nuggets.

The chicken nuggets containing 35% CSSP and 5% olive oil and chicken nuggets without any CSSP and olive oil (control) were packed in low-density polyethylene (LDPE) bags of 200 gauge and stored under refrigeration (4±1°C) and frozen (-18±1°C) conditions. Samples were evaluated for their quality at 5 days interval for a period of 15 days (0, 5, 10 and15 days) in refrigeration storage and at 20 days interval for a period of 60 days (0, 20, 40 and 60 days) in frozen storage. Different quality parameters like pH, TBARS number, tyrosine value, microbiological and sensory quality were studied.

Colour: Internal colour of cooked sausages was determined by using a Hunterlab colourimeter (Model D25M), Values for L* (lightness), a* (redness) and b* (yellowness) were recorded for 3 samples per batch using a 25 mm aperture.

pH: First, a 5 g sample of the prepared chicken nugget was ground and homogenized with distilled water (20 ml) for 1 min and the pH wad measured using a pH meter. All determinations were performed in triplicate, and the results are expressed as the mean and standard deviation.

Cooking yield - The weight of each sausage was measured before and after cooking to determine cooking yield, which was defined as the cooked weight divided by the uncooked weight then multipied by 100% [9].

Texture analysis: Cut resistance of the nuggets was determined by a texture analyzer (type TA-XT2, Stable Micro Systems Ltd.). Force resistance of the cooked sausage against the razor blade was recorded during lowering the blade. Maximum force during the cutting

process was registered as a parameter for description of cooked nugget cut resistance. The measurements were performed three times per batch.

Sensory evaluation: Twelve panelists were selected basic taste identification tests. Each chicken nugget was evaluated in terms of color, flavor, juiciness, tenderness, and overall acceptability. The samples were served to 12 experienced panel members. The panelists were presented with randomly coded samples.

Microbiological analysis: The sample kept at 4 ± 1^0C were analyzed after every 5 days interval and the sample kept at -18 ± 1^0C were analyzed after every 20 days interval according to procedures outlined in Rehberger et al. [10].

Lipid peroxidation (2-thiobarbituric acid reactive substances/TBARS)

For measuring lipid peroxidation, 3 g of samples were homogenized with 12 mL of distilled water and 50 µL 7.2% butylated hydroxyanisole (BHA) according to the method by Jung *et al.* [20]. The homogenized mixture (5 ml) was transferred to a test tube with 5 ml of TBA/TCA solution (20 mM thiobarbituric acid in 15% trichloroacetic acid). The mixture was heated in a water bath for 15 min at 90°C. After cooling to 20°C, the mixture was centrifuged (3,000 rpm) for 15 min. Absorbance of the supernatant obtained after the centrifugation, was determined by spectrophotometer at 532 nm. Quantification was done based on a standard curve.

Tyrosine estimation: 2.5 ml of TCA extract is diluted with equal quantity of distilled water in a test tube. To this 10 ml of 0.5 N sodium hydroxide is added followed by 3 ml of diluted folin ciocalteu phenol reagent. After mixing and keeping it for 15 min at room temperature. The developed blue colour is measured as absorbance value at 660 nm in a spectrophotometer using a blank (5 ml of 5% TCA) for comparison. With reference to the standard graph, the tyrosine value is calculated and expressed as mg of tyrosine/ 100 gm of meat sample.

Statistical analysis: Data were subjected to analysis of variance (ANOVA) using statistical SPSS to evaluate the statistical significance among the samples.

Total Psychrophilic Count (TPSC) and Yeast and Mould Count (YMC) were determined by the methods described by American Public Health Association (APHA) [11].

Results and discussion

At first both the control and test product kept at refrigerated condition (4 ± 1^0C) were evaluated for their physicochemical, microbiological and organoleptic quality at 5 days interval (0, 5, 10 and 15 days). The results of physicochemical and microbiological quality are presented in table 2 and sensory evaluation in table 3.

Table 2: Physiochemical and microbial quality of chicken nuggets with 35% CSSP and 5% Olive oil during storage at (4±1˚C)

	Storage period (days)			
Treatment/ parameter	0	5	10	15
pH				
C	6.45 ± 0.04^{A}	6.44 ± 0.03^{A}	6.43 ± 0.03^{A}	6.39 ± 0.03^{A}
T	6.55 ± 0.02^{B}	6.54 ± 0.02^{B}	6.54 ± 0.03^{B}	6.49 ± 0.04^{B}
TBA (mg malonaldehyde/kg sample)				
C	0.20 ± 0.02^{Aa}	0.34 ± 0.01^{b}	0.50 ± 0.05^{Ac}	0.77 ± 0.01^{Ad}
T	0.29 ± 0.01^{Ba}	0.37 ± 0.01^{b}	0.63 ± 0.02^{Bc}	0.96 ± 0.01^{Bd}
Tyrosine value (mg/100g)				
C	19.93 ± 0.18^{Aa}	22.35 ± 0.12^{b}	24.57 ± 0.41^{c}	26.13 ± 0.24^{Ad}
T	20.54 ± 0.10^{Ba}	22.38 ± 0.12^{b}	24.35 ± 0.28^{c}	26.46 ± 0.21^{Bd}
SPC ($\log_{10}$ CFU/g)				
C	2.44 ± 0.04^{a}	3.38 ± 0.09^{b}	3.56 ± 0.03^{c}	4.39 ± 0.09^{d}
T	2.46 ± 0.03^{a}	3.22 ± 0.09^{b}	3.67 ± 0.04^{c}	4.43 ± 0.05^{d}
Psychrophiles ($\log_{10}$ CFU/g)				
C	1.36 ± 0.03^{Aa}	2.47 ± 0.10^{Ab}	3.15 ± 0.02^{Ac}	3.93 ± 0.09^{Ad}
T	1.45 ± 0.03^{Ba}	2.85 ± 0.04^{Bb}	3.27 ± 0.02^{Bc}	3.79 ± 0.07^{Bd}

C: Control; T: Test product

*Means with different superscripts (capital letters in same column and small letters in the same row) differ significantly ($P<0.01$)

Table 3: Sensory quality of chicken nuggets with 35% CSSP and 5% Olive oil during storage at (4±1˚C)

	Storage period (days)			
Parameters	0	5	10	15
Appearance and colour				
C	6.03 ± 0.13^{Aa}	5.66 ± 0.12^{Ab}	5.33 ± 0.12^{Ac}	5.20 ± 0.12^{Ad}

T	7.13±0.10^{Ba}	6.70±0.09^{Bb}	6.30±0.08^{Bc}	6.10±0.07^{Bd}
Flavour				
C	5.96±0.14^{Aa}	6.03±0.13^{Aa}	4.86±0.09^{Ab}	4.65±0.7^{Ab}
T	7.03± 0.11^{Ba}	6.90±0.11^{Ba}	6.13±0.11^{Bb}	6.10±0.10^{Bb}
Juiciness				
C	5.76±0.13^{A}	5.80±0.12^{A}	5.93±0.10^{A}	5.99±0.12^{A}
T	6.86±0.09^{B}	7.03±0.08^{B}	6.93±0.10^{B}	6.95±0.13^{B}
Texture				
C	6.26±0.15^{Aa}	6.13±0.13^{Aa}	5.86±0.13^{Ab}	5.51±0.10^{Ab}
T	7.00±0.11^{Ba}	6.96±0.11^{Ba}	6.73±0.13^{Bb}	6.56±0.12^{Bb}
Overall Acceptability				
C	6.26±0.13^{Aa}	5.93±0.11^{Ab}	5.20±0.12^{Ac}	5.10±0.10^{Ad}
T	7.20±0.11^{Ba}	7.03±0.10^{Ba}	6.20±0.11^{Bb}	6.10±0.10^{Bb}

C- Control; T-Test product
*Means with different superscripts (capital letters in same column and small letters in the same row) differ significantly (P<0.05)

Then again both the products i.e control and test kept at frozen condition were evaluated at 20 days interval which were packed in LDPE bags (200 gauge) stored at frozen storage (-18±1^{0}C) for a period of 60 days. The results of physicochemical and microbiological quality were presented in table 4 and sensory evaluation in table 5.

Table 4: Physiochemical and microbial quality of chicken nuggets with 35% CSSP and 5% Olive oil during storage at (-18±1°C).

	Storage period (days)			
Treatment/ parameter	0	20	40	60
PH				
C	6.47±0.03^{Aa}	6.38±0.01^{Ab}	6.39±0.005^{Ab}	6.33±0.01^{b}
T	6.54±0.06^{Ba}	6.51±0.02^{Ba}	6.45±0.01^{Bb}	6.37±0.01^{c}

TBA (mg malonaldehyde/kg sample)				
C	0.20±0.02^{Aa}	0.23±0.03^{Ab}	0.31±0.02^{Ac}	0.56±0.02^{Ad}
T	0.29± 0.01^{Ba}	0.32±0.01^{Bb}	0.37±0.03^{Bc}	0.72±0.05^{Bd}
Tyrosine value (mg/100g)				
C	19.93±0.18^{a}	23.88±0.36^{Ab}	28.24±0.23^{Ac}	31.06±0.27^{Ad}
T	20.54±0.10^{a}	22.07±0.40^{Bb}	26.56±0.14^{Bc}	29.42±0.31^{Bd}
SPC (log_{10} CFU/g)				
C	2.44±0.04^{a}	2.97±0.04^{b}	3.21±0.07^{Ac}	4.19±0.04^{d}
T	2.46±0.03^{a}	3.07±0.10^{b}	3.45±0.06^{Bc}	4.17±0.07^{d}
Psychrophiles (log_{10} CFU/g)				
C	1.36±0.03^{Aa}	2.61±0.06^{b}	2.76±0.04^{Ac}	3.50±0.06^{d}
T	1.45±0.03^{Ba}	2.69±0.07^{b}	3.04±0.05^{Bc}	3.56±0.08^{d}

C: Control; T: test product
*Means with different superscripts (capital letters in same column and small letters in the same row) differ significantly (P<0.01)

Table 5: Sensory quality of chicken nuggets with 35% CSSP and 5% Olive oil during storage at (-18±1˚C)

	Storage period (days)			
Parameters	0	20	40	60
Appearance and Colour				
C	6.03±0.13^{Aa}	6.40±0.11^{Ab}	5.93±0.13^{Ac}	5.50±0.09^{Ac}
T	7.13±0.32^{Ba}	7.20±0.10^{Ba}	7.30±0.09^{Ba}	6.26±0.08^{Bb}
Cooking yield (%)				
C	88.3 ± 0.35Aa	86.4±0.02Ab	84.2±0.01Ac	83.1±0.01Ac
T	88.0 ± 0.28^{Ba}	88.0±0.24Ba	87.8±0.20Ba	86.4±0.10Ba
Flavour				
C	5.96±0.14^{A}	6.06±0.14^{A}	5.83±0.10^{A}	5.63±0.11^{A}

T	7.03± 0.11^{Ba}	7.03±0.12^{Ba}	6.76±0.11^{Bb}	6.76±0.11^{Bb}
Juiciness				
C	5.76±0.13^{Aa}	6.10±0.12^{Ab}	5.93±0.10^{Ab}	5.03±0.12^{Ac}
T	6.86±0.09^{Ba}	7.26±0.09^{Bb}	7.03±0.11^{Bb}	6.23±0.11^{Bc}
Texture				
C	6.26±0.15^{Aa}	5.20±0.12^{Ab}	5.33±0.12^{Ab}	5.23±0.11^{Ab}
T	7.00±0.11^{Ba}	6.33±0.09^{Bb}	6.93±0.10^{Bc}	6.60±0.10^{Bd}
Overall Acceptability				
C	6.76±0.13^{Aa}	6.46±0.14^{Ab}	6.26±0.06^{Ab}	6.00±0.11^{Ac}
T	7.20±0.11^{Ba}	7.23±0.10^{Ba}	6.96±0.07^{Bb}	6.36±0.09^{Bc}

C- Control; T-test product
*Means with different superscripts (capital letters in same column and small letters in the same row) differ significantly (P<0.05).

The product was evaluated for its quality *viz.,* physicochemical properties like pH, TBA value, tyrosine value and microbiological parameters like standard plate count, psychrophilic count, coliform count and yeast and mould count and sensory quality.

pH: There was a gradual decrease in pH of test product and control as the storage period progressed up to 60 days, which might be due to desiccation and accumulation of cell constituents. Similarly, Nath *et al.* [12] and Pandey *et al.* [10] reported a decrease in pH values during frozen storage in chicken patties and low fat egg patties throughout the storage period of 60 days. Das *et al.* [13] described addition of soy protein did not make significant effect on shelf life of goat meat nuggets in frozen storage, while pH, moisture, fat percentage, protein content and water holding capacity were significantly ($p<0.05$) lower in nuggets with 15% soy protein. The pH decreased as the storage progressed up to 15 days which could be due to accumulation of metabolites due to increase in microbial counts. The results of the present study were in agreement with results reported by Nath *et al.* [12], Naveena *et al.* [14], Mandal *et al.* [15], Grover *et al.* [16], Anna Anand *et al.* [17] in chicken patties, smoked spent hen meat treated with ginger, restructured cured chicken, tenderized chicken gizzard pickle and tenderized buffalo tripe rolls during refrigeration storage.

Lipid oxidation (TBARS): In the present study the TBA values of test product as well as control increased significantly throughout the storage period up to 60 days indicating an increase in the lipid oxidation by the prooxidant effect of haem iron. However, the values were far below the threshold value of 1-2 mg/kg for spoilage. The results reported on TBA values of chicken nuggets in the present study were in agreement with the findings of Nath *et al.* [12] and Bhoyar *et al.* [18] who reported an increase in the TBA values as the storage period progressed up to 60 days in chicken patties and restructured chicken steaks. The addition of olive oil makes the test sample resistant to oxidation due to the presence of antioxidants such as β-carotene and phenolic compounds. The percentage of saturated fatty acids is lower in test as compared to control. Increase in lipid oxidation by its reaction with TBA reagent in muscle foods with storage time has been reported [19]. The reports of the present study were in conformity with the findings of different workers in the different chicken products [12-18].

Tyrosine value: The degree of autolysis and bacterial proteolysis in meat can be measured as tyrosine value which actually determines the quantity of amino acids, i.e. tyrosine and tryptophan present in an extract of meat. The tyrosine value of the test product and control increased significantly throughout the storage period which might be attributed to increased microbial proteolytic activity as evident from increased microbial counts on 15^{th} day and 60^{th} day of storage. Similar to the findings of present study Mandal *et al.* [15] reported significant increase in tyrosine values of restructured cured chicken during refrigerated storage. Naveena *et al.* [14] and Anna Anand *et al.* [17] reported a significant increase in tyrosine values in smoked spent hen meat treated with ginger and tenderized buffalo tripe rolls respectively during refrigeration storage up to 15 days. Similarly, Muthulakshmi [20] reported a significant increase in the tyrosine values of buffalo meat sausages incorporated with offal meats during frozen storage.

Microbial evaluation: The microbial counts of the test product and control in the present study increased significantly throughout the storage period. Similarly, an increase in SPC and psychrophilic counts throughout the storage period up to 60 days in chicken patties was reported by Nath *et al.* [12]. Contrary to the findings of present study Bhoyar *et al.* [18] and Pandey *et al.,* [10] reported a decrease in aerobic and psychrophilic counts throughout the storage period of 60-90 days in restructured chicken steaks and low fat egg patties. Coliforms as well as yeast and mould counts were not detected in both test product and control

throughout the storage period, which were in conformity with the findings of Nath *et al.* [12] in chicken patties.

Sensory characteristics: The sensory scores of the test product and control decreased significantly throughout the storage period up to 10 days and the product was spoiled on 15th day due to oxidative changes. Similarly, Bhoyar *et al.* [18], Pandey *et al.* [10], Mandal *et al.* [15] and Anna Anand *et al.* [17] reported a decrease in the sensory scores of restructured chicken steaks, low fat egg patties, cured restructured chicken and tenderized buffalo tripe rolls throughout the storage period of 15 days. The hardness of the control was lower than that of the test samples. Test sample displayed a higher cooking yield than the control. Similar trends in cooking yield were observed in studies involving the addition of dietary fibers or gelatin to meat products such as jerky [21] acceptability score of the chicken nugget (test) were higher than control.

From the present study it was concluded that CSSP could be incorporated up to a maximum of 35% replacing high cost lean, without much loss in quality and nutritional characteristics and sensory attributes. Olive oil can be incorporated up to 5% in chicken meat keep the product under the category of low fat meat product. The chicken nuggets incorporated with 35% CSSP and 5% Olive oil in lean meat could be stored safely at refrigerated temperature (4±1ºC) for 10 days and at frozen temperature (-18±1ºC) for 60 days without any deterioration in quality.

CONCLUSION

The chicken skin, soy protein and olive oil are added in meat products to improve the quality attributes and functional properties. It was concluded based on literature that the addition of above said ingredients reduced the cost, improved the quality attributes and consumer acceptability of meat products. The CSSP has a greater water holding capacity. Therefore, the incorporation of CSSP and olive oil improved cooking yield and texture profile and decreased fat contents of chicken nugget. Thus, CSSP and olive oil can replace the chicken meat and replacer in the chicken nugget industry.

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