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Quality attributes of low sodium chevon nuggets substituted with fish meat

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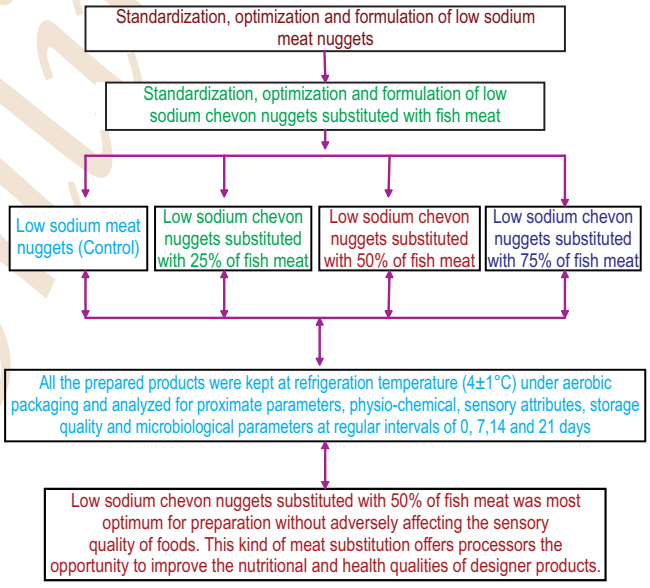
Abstract

Aim: The present study was carried out to utilize the chevon and fish meat quality together nutritionally by substituting chevon meat with fish meat in chevon nuggets along with low sodium to produce designer low sodium chevon nuggets.

Methodology: The low sodium nuggets were optimized to be prepared by incorporating of 7% refined vegetable oil, 5% refined wheat flour and 1.50% sodium chloride (sucrose-0.50g, potassium chloride-0.70g and citric acid-0.30g). The prepared products were optimized to be cooked at an internal temperature of 94±2 ºC in designer low sodium chevon nuggets. The different variants of the products were prepared and were aerobically packaged in low density polyethylene pouches separately and were assessed for various storage quality parameters under refrigerated (4±1ºC) condition till 21 days of storage. The products were assessed for various physico-chemical, microbiological and sensory parameters at regular intervals of 0th, 7th ,14th and 21st day of storage.

Results: Chevon nuggets substituted with fifty percent fish meat were found to be most optimum for preparation of fish substituted low sodium chevon nuggets. Substitution of chevon meat with fish meat resulted in significantly (P<0.05) lower fat percent, however significantly (P<0.05) higher in emulsion stability, cooking yield and protein content. The low sodium chevon nuggets substituted with fish meat, acceptable till 14th days of refrigenation, were regarded safe for human consumption.

Interpretation: The developed products were found suitable and safe for human consumption till 14th day of refrigeration storage (4±1°C), without adversely affecting the sensory quality. This kind of meat substitution offers meat food processors the opportunity to improve the nutritional and health qualities of designer products.



Introduction

Nuggets are one of the most acceptable value added comminuted emulsion based products that is either baked, steamed cooked or consumed after frying (Bansil, 2003). Meat is almost rich in all nutrients required for human nutrition. Most fish and sea foods give rise to products of great economic importance in our country, as it is surrounded by ocean from three sides. The demand for such health beneficial products has been progressively increasing. Fish and its products are known to provide significant amount of indispensable dietary macromolecules such as essential amino acids, lipid soluble vitamins, microelements (iodine, fluorine, calcium, copper, zinc, iron) and poly unsaturated fatty acids. The lipid fraction has unique characteristics due to high content of ω-3 polyunsaturated fatty acids, docosahexaenoic acid, eicosapentaenoic acid and alpha-linolenic acid which has health beneficial role, which reduces the risk of heart disease and strengthens immune mechanism (Paramasivam *et al*., 2007). Fish meat contains high ratio of unsaturated fatty acid, calcium and phosphorus and also consist of lesser amount of cholesterol and sodium. Moreover no religious taboo is attached with it, there by increasing its acceptance. Anihouvi *et al*. (2012) reported that chevon meat consist of high myoglobin content which provides bioavailable iron. It comes in the category of red meat and contains saturated fat, high calories and cholesterol. Dhanda *et al*. (2003) quoted that goat meat has high amount of iron, potassium and thiamine together with less sodium than traditional meat.

There is no doubt that fish proteins suits human nutrition better than any other red meat including chevon meat proteins. Some people don't like fish due to its fishy smell and spines present in fish flesh (Nwabueze and Nwabueze, 2010; Panpipat and Yongsawatdigul, 2008). But, the cost of these products are comparatively lower as compared to red meat affordable enough to all the sects of society. Thus, its economic formulation, keeping the sensory attributes to an acceptable limit, is a challenge and as such there is a requirement of some low cost compatible meat and lean meat replacers (Nowsad and Hoque, 2009). Mixing of different animal meat having different nutritive features in such a way that suits human nutrition better is a noble idea of designing healthy meat food. Making nuggets by substituting fish meat in other popular meat products viz. chevon, nuggets has created a new hope of contribution to the production of healthy meat based product. Therefore, the objectives of the present investigation were to analyze the efficacy of different levels of incorporation of fish meat on the physico-chemical, microbiological and sensory attributes of low-sodium chevon nuggets and to evaluate the storage parameters of the best developed nuggets at refrigeration temperature.

Materials and Methods

Source of material: Fish (*Pangasius pangasius* or Pangash belonging to catfish of Pangasidae family) were bought. The skin was removed, followed by beheading and evisceration. Deboning of dressed fish was done manually hygienically. The lean meat was packed in low density polythene bags (100 gauge) and kept under frozen condition at -18±2 ºC until use. The chevon meat from 1.5 to 2 years of male Bhakerwali species of goat was purchased from the local market of R.S. Pura, Jammu. The lean meat was kept frozen at -18±2ºC in a low density polythene bags until use. Condiments used in the product formulation were onion, garlic and ginger weighed in a ratio of 3:2:1 in fine paste form. The spices were dried in an oven at 50ºC for 24 hrs and then grounded to powder form. All the chemicals used in the designer products were of food grade and others used in quality analysis were of analytical grade. Low-density polyethylene films (100 gauge) were used for aerobic packaging during storage parameters analysis.

Methodology of preparation of nuggets from meat of chevon substituted with fish meat : All the ingredients, as per formulation for the designer product is as follows Fish meat-29.850 g, Chevon meat-29.850 g, ice flakes-10.0g, condiment mixture-5.0g, vegetable oil-9.0g, refined wheat flour-10.0g, spice mixture-2.50g, sodium chloride+ potassium chloride + citric acid+sucrose-1.00+0.50+0.25+0.25g (low sodium standardized salt combination), sodium tripolyphosphate-0.30g, monosodium glutamate-0.50g and egg white-1.0 g. Meat emulsion for nuggets was prepared in Sirman mincer followed by Sirman Bowl Chopper. Chevon nuggets were molded in rectangular stainless steel boxes (20 cm x 10 cm). The emulsion of weighed quantity was stuffed in steel box mould with parchment paper smeared with oil to avoid sticking. Mould was tightly covered with lid and was subjected to steam cooking for 30±2 min in a pressure cooker. The steel boxes moulds were allowed to cool at room temperature after removal from pressure cooker. The brick shaped chevon nugget so obtained were sliced uniformly to obtain nuggets.

Analytical techniques : The pH of designer chevon nuggets was determined as per Keller *et al.* (1974).The weight of the designer nuggets were recorded before and after steam cooking. The cooking yield percentage was calculated by the following formula : Weight of cooked nugget block/weight of raw emulsion block x 100. Emulsion stability was determined following the method of Townsend *et al.* (1968). The proximate parameters viz. moisture, fat, ash and protein were determined by standard methods of AOAC (2000). Thiobarbituric acid content in designer nuggets during storage was determined by the method of Witte *et al.* (1970). Free Fatty Acid (FFA) was determined as per Koniecko (1979). Microbiological Profile was as per APHA (2015). Sensory evaluation was executed using trained experienced sensory panel who evaluated the sensory attributes using 8 point descriptive scale as described by Seman *et al.* (1987). The results were analyzed statistically for analysis of variance (ANOVA) and least significant ($P<0.05$) difference (LSD) as per Snedecor and Cochran (1997).

Experimental design: The formulation for low sodium designer meat nuggets was standardized and optimized for its preparation. The low sodium meat nuggets were prepared by substituting fish meat @ 25%, 50% and 75% in chevon meat to prepare optimized designer products. The product was evaluated for quality and acceptability on the basis of physiochemical, proximate and sensory attributes. The storage quality and shelf life of optimized products at refrigeration temperature was assessed on microbiological quality, TBA, FFA and sensory attributes. The statistical analysis was done with statistical package of SPSS version 20.0.

Results and Discussion

The nutritive value of fish meat showed significant consumer acceptability, being rich source of mono and poly unsaturated fatty acids. Red meat is also a major source of saturated fatty acids and cholesterol, however its consumption can be related to cardiovascular diseases, hypertension, obesity and diabetes (Valsta *et al*.,2005). Therefore, various strategies and procedures have been adopted to produce functional meat and meat products (Jimenez-Colmenero *et al*., 2006).

The standardization for preparation of low sodium nuggets is depicted in Table 1. As per the sensory parameters, the score of 7% refined vegetable oil level, the overall acceptability scores were significantly (P<0.05) higher than both 6% and 8% level. The overall acceptability scores were higher (P<0.05) for 5% than 3% and 7 % level of incorporation of refined wheat flour. The overall acceptability was significantly (P<0.05) higher for designer products. The temperature-time combination of 100±2ºC for 30 min had more sensory scores than temperature of 95±2ºC for 30 min and 105±2ºC for 30 min, respectively. For preparing low-sodium nuggets, sodium salt was replaced by potassium salt, citric acid and sucrose at three different levels, however using 1.5 g sodium chloride gave better sensory scores than sodium salt at 1g and 2g levels.

As the level of substitution of fish meat in low-sodium cooked chevon nuggets increased, a gradual significant (P<0.05) decrease in pH was observed (Table 2). The pH showed a significant difference (P<0.05) between control and treated products and was found to be lower in low sodium designer meat products. A reduction in pH of meat emulsion system was observed by Saricoban *et al*. (2008). A possible reason for decrease in emulsion stability could be attributed to low pH of fish meat than red meat, which is in concordance with the previous study of Jones and Jew (2007) who observed improvement and significant variation in meat emulsion systems including pH by incorporating different levels of various species of meat. The emulsion stability firstly increased gradually till fifty percent fish meat substitution and then decreased significantly (P<0.05). Moisture content and cooking yield study revealed that it increased with increase in substitution level of fish meat in designer products. Similarly, Parkouda *et al*. (2009) reported sausages prepared from fish meat in different combinations showed higher moisture content than control. Incorporation of fish in mixed-meat sausages resulted in a superior water-holding capacity with low-fat product, better textural and nutritional properties (Gadiyaram, 2004). The protein content in designer product increased significantly (P<0.05) with the increased level of fish meat substitution. Similar results were also reported by Kindossi *et al*. (2012), who studied extensively on quality attributes of Lanhouin, a fish-based condiment from West Africa. The main components of meat, excluding water, are proteins and lipids. Fish meat is a lean meat rich in proteins of high biological value and is characterized by high levels of essential amino acids as compared to vegetable food products (Dalle Zotte, 2004). So, this increase in protein content of designer nuggets may be attributed to the high content of protein in fish meat than chevon. This increase in protein content is also coherent with the study of Sangtam *et al*. (2006) who also reported an increase in protein content with the increase in fish meat substitution in chevon nuggets. A gradual but significant (P<0.05) decrease in fat was recorded at all the substituted levels as compared to control, this is in agreement with the study of Yılmaz (2004) who observed that 20% addition of rye bran significant by (P<0.05) reduced the fat content of meatballs. The amount of linolenic acid was remarkably abundant in fish meat (3%) (Hernandez and Gondret, 2006) compared to other meats. Ash percentage was significantly (P<0.05) lower at various incorporation levels of fish meat, but @ 50% and 75% level it did not vary significantly (P>0.05). This is in concordance with the findings of Parkouda *et al*. (2009) and Erple (2008), who analyzed the factors affecting flesh quality in farmed fish and various other fish and meat products.

Influence on sensory characteristics of designer meat products is shown in Table 3. Appearance and flavour score showed significant (P<0.05) increase at 50% level compared control. Anihouvi *et al.* (2012) reported similar results in frankfurters for flavour, appearance and colour. The juiciness score showed increasing trend as compared to control, but at 75% and 50% level, it was comparable. The texture score was best at 50% level and least at 25% level of fish meat substitution. Overall acceptability of product was assessed based on all the parameters and with 50% level of fish substitution it had provided the best scores. The variation in sensory scores was obvious and in agreement with the findings of Parkouda *et al*. (2009) in fish sausage.

Studies on the storage quality and shelf life of developed designer meat nuggets at refrigeration temperature is presented in Table 4. The designer products were evaluated for different physico-chemical, proximate, microbiological and sensory properties parameters at 0^{th} , 7^{th} , 14^{th} and 21^{st} storage days, following standard procedures during refrigerated storage at 4±1ºC. A significant decrease (P<0.05) in the pH values was noted in all the treated samples at successive storage intervals. A

Table 1 : Standardization of level of added refined vegetable oil, refined wheat flour, time-temperature combination and sodium chloride level for preparation of low sodium nuggets

Sensory attributes	Added refined vegetable oil level (%)		
	6	7	8
Appearance	7.05^{a} ± 0.10	7.43^{b} ± 0.08	7.12^{ab} ± 0.08
Flavour	6.61^{a}±0.12	7.09^{b}±0.12	7.07^{b}±0.11
Juiciness	7.24±0.17	7.21±0.17	7.06±0.09
Texture	6.90±0.14	7.11±0.20	7.11±0.16
Overall acceptability	7.03^{a}±0.13	7.30^{b}±0.09	7.07^{a}±0.11
Sensory attributes	**Incorporation levels of refined wheat flour (%)**		
	3	**5**	**7**
Appearance	7.07±0.17	7.24±0.11	7.03±0.11
Flavour	7.21^{b}±0.11	7.15^{b}±0.10	6.92^{a}±0.12
Juiciness	6.82±0.12	6.97±0.15	6.79±0.11
Texture	6.88±0.10	6.93±0.11	6.76±0.13
Overall acceptability	6.96^{ab}±0.08	7.06^{b}±0.12	6.86^{a}±0.12
Sensory attributes	**Internal end point temperature-time levels (low sodium chevon nuggets)**		
	95±2ºC for 30 min	**100±2ºC for 30 min**	**105±2ºC for 30 min**
Appearance	6.87^{a} ±0.08	6.96^{ab}±0.09	6.93^{a}±0.10
Flavour	6.83^{a}±0.16	7.17^{ab}±0.13	6.94^{a}±0.13
Juiciness	6.95^{a}±0.09	6.96^{ab}±0.10	6.93^{a}±0.15
Texture	7.11±0.18	7.21±0.12	7.01±0.14
Overall acceptability	6.90^{a}±0.17	7.34^{b}±0.11	6.94^{a}±0.13
Sensory attributes	**Internal end point temperature (low sodium fish nuggets)**		
	92±2ºC	**94±2ºC**	**96±2ºC**
Appearance	6.86^{a} ±0.10	6.97^{ab}±0.09	6.92^{a}±0.11
Flavour	6.82^{a}±0.14	7.18^{ab}±0.10	6.90^{a}±0.14
Juiciness	6.93^{a}±0.11	6.97^{ab}±0.08	6.91^{a}±0.11
Texture	7.11±0.15	7.22±0.06	7.01±0.12
Overall acceptability	6.92^{a}±0.17	7.34^{b}±0.07	6.94^{a}±0.11
Sensory attributes	**Incorporation levels of common salt (%)**		
	Nacl-1.0 g, Sucrose-0.6g KCl-1.0 g, Citric acid-0.4g	**Nacl-1.5 g, Sucrose-0.6g KCl-1.0 g, Citric acid-0.4g**	**Nacl-2.0 g, Sucrose-0.6 g KCl-1.0 g, Citric acid-0.4 g**
Appearance	7.20^{a}±0.07	7.22^{a}±0.12	7.19^{a}±0.04
Flavour	7.05^{a}±0.11	7.07^{a}±0.11	7.05^{a}±0.11
Juiciness	7.02^{a}±0.09	7.02^{a}±0.13	7.04^{a}±0.06
Texture	7.05^{a}±0.10	7.05^{a}±0.12	7.08^{a}±0.11
Overall acceptability	7.16^{a}±0.09	7.19^{a}±0.11	7.19^{a}±0.10

Mean± SE with different superscripts in a row differs significantly (P<0.05). Mean values are scores on 8 point descriptive scale, where 1 : extremely poor and 8: extremely desirable; n = 21 for all treatments

decrease in pH is usually attributed to lactic acid production due to metabolic activity of bacteria. A decrease in pH value of meat products was also due to easily fermentable carbohydrates present in it. Free fatty acids indicate enzymatic or microbial degradation of lipids and its estimation reveals information about the stability of fots in meat products during storage. FFA followed a significant (P<0.05) linear increasing trend on successive storage days. The designer products had comparable FFA values on 7th and 14thday of storage period, but differed significantly (P<0.05) on 21st day of storage. These results are in confirmation with the reports of Marco *et al*. (2006) in dry fermented sausages. San Giovanni and Chew (2005) while working on the role of mono

Table 2 : Effect of fish meat substitution on pH, emulsion stability and proximate composition of low-sodium chevon nuggets

Parameters	Levels of fish meat (%)			
	0	25	50	75
pH	6.27^{b}±0.07	6.22^{a}±0.05	6.18^{a}±0.03	6.15^{a}±0.05
Emulsion stability (%)	82.42^{a}±4.44	82.28^{a}±4.23	92.96^{b}±2.21	91.06^{ab}±1.95
Cooking yield (%)	84.35^{a}±3.44	85.27^{a}±3.12	90.95^{b}±2.05	91.05^{bc}±1.35
Moisture (%)	60.35^{a}±0.42	62.28^{ab}±0.91	63.21^{b}±0.50	64.82^{c}±0.33
Protein (%)	17.69^{a}±0.53	17.93^{a}±0.37	18.13^{b}±0.46	19.75^{c}±0.30
Fat (%)	9.89^{c}±0.21	9.54^{b}±0.27	9.48^{b}±0.14	8.88^{a}±0.18
Ash (%)	1.55^{a}±0.11	2.01^{b}±0.05	2.01^{b}±0.04	2.15^{b}±0.09

Mean ±SE with different superscripts in a row differs significantly (P<0.05); n = 6 for all treatments

Table 3 : Effect of fish meat substitution on sensory attributes of chevon nuggets substituted with fish meat

Sensory attributes	Levels of fish meat (%)			
	0	25	50	75
Flavour	7.45^{ab} ±0.12	7.19^{ab} ±0.18	7.48^{b} ±0.12	7.10^{a}±0.15
Juiciness	7.47^{ab}±0.12	7.17^{ab}±0.14	7.49^{b}±0.13	7.09^{a}±0.16
Texture	7.38^{ab}±0.07	7.19^{ab}±0.13	7.50^{b}±0.15	7.18^{ab}±0.18
Overall acceptability	7.43^{ab}±0.09	7.15^{a}± 0.11	7.57^{b}±0.16	7.21^{a} ±0.17

Mean± SE with different superscripts in a row differs significantly (P<0.05). Mean values are scores on 8 point descriptive scale, where 1: extremely poor and 8: extremely desirable; n = 21 for all treatments

and polyunsaturated fatty acids in health and disease reported the possibility of development of low sodium meat products and its positive impact on consumer's health. Similarly, Oehlenschlager and Rehbein (2009) reported an increase in free fatty acids during storage while assessing quality fishery products. A significant (P<0.05) linear increasing trend from through out storage period was observed for TBA content. The increase in TBA values on storage might be attributed to oxygen permeability of low density polythene packaging material that results in lipid oxidation. Dushyanthan *et al*. (2000) and Kumar *et al*. (2007) reported an increase in TBA content with increasing storage period**.** The moisture content significant by (P<0.05) decreased with increasing storage days. The protein, ash and fats content increased with increasing storage days. The mean protein, ash and fats values showed significant difference (P<0.05) among different types of developed designer low sodium nuggets, which might attributed to decrease in the moisture content of nuggets which led to increase in protein, fat and ash content of designed meat nuggets with advancement of storage days. Similarly, Oehlenschlager and Rehbein (2009) reported an increase in proximate values, as well as in storage parameters viz. TBARS, FFA during storage while evaluating various quality various fishery products.

The microbial profile of control and designed nuggets is depicted in Table 4. Total plate count of fish meat substituted chevon nuggets increased with significant difference (P<0.05) from day 0 to 21 in treated products and control. The TPC significantly (P<0.05) differed with increase in storage period. The increase in TPC with increase in storage period was also reported by Azokpota *et al*. (2006) while studying on microbiological and chemical changes during the fermentation of African locust bean *Parkia biglobosa* to produce traditional products. Anihouvi *et al.* (2012), quoted similar results who worked on fermented fish sausage and other fisheries products. Psychrotrophic counts were not detected till 7 days, but, it was observed on day 14 and successive storage days in all types of designer products. A detectable count on day 14 and onwards in designer meat products might be due to lag phase of bacterial growth before active multiplication. A gradual increase in psychrotrophs in Momoni, a Ghanaian fermented fish condiment during storage of chevon products. Sanni *et al*. (2002). The coliforms were not detected from during entire period of storage in any product. It could be due to adoption of strict hygiene procedure and microbial destruction during steam cooking at high temperatures. Kumar (2007) also reported no coliform count for meat product cooked at high temperature during refrigerated storage study. Yeast and mould counts were observed on day 14 of storage in all types of products and significantly increased on day 21. Similar results were also quoted by Anihouvi *et al.* (2012), worked on fermented fish sausage. The increase in yeast and mould counts with increase in storage period was also reported in traditional fish and meat products by Azokpota *et al*. (2006) and Visnuvinayagam *et al*. (2015).

Table 4 : Effect of refrigerated storage on physico-chemical, proximate and microbiological characteristics of aerobically packaged low-sodium chevon and chevon nuggets substituted with fish meat

Treatments	Storage period (Days)			
	0	7	14	21
		pH		
Control	6.44^{aA}±0.29	6.17^{aA}±0.18	6.63^{aA}±0.22	6.65^{aA}±0.25
Designer nuggets	6.92^{aB}±0.22	7.08^{aB}±0.27	6.70^{aA}±0.25	6.75^{aA}±0.25
		FFA(% oleic acid)		
Control	0.094^{aA}±0.02	0.097^{aA}±0.01	0.12^{aA}±0.02	0.12^{bA}±0.02
Designer nuggets	0.091^{aB}±0.01	0.11^{aB}±0.02	0.11^{aA}±0.01	0.14^{aA}±0.01
		TBARS (mg malonaldehyde kg^{-1})		
Control	0.22^{aA}±0.02	0.54^{bA}±0.01	0.77^{cA}±0.02	0.85^{cA}±0.01
Designer nuggets	0.25^{aB}±0.01	0.57^{bB}±0.02	0.85^{cB}±0.01	0.95^{dB}±0.02
		Moisture (%)		
Control	63.68^{aB}±2.54	62.28±2.11	62.53^{aA}±1.91	61.72^{aA}±1.76
Designer nuggets	63.39^{aB}±2.12	63.63^{aA}±1.43	63.32^{aA}±1.92	61.70^{aA}±1.68
		Protein (%)		
Control	20.63^{aA}±0.79	22.61^{aB}±0.62	23.43^{bA}±0.50	23.57^{bB}±0.85
Designer nuggets	21.59^{aA}±1.41	21.16^{aA}±1.14	23.15^{aB}±0.52	23.17^{aB}±0.82
		Fat (%)		
Control	10.75^{aA}±0.40	10.84^{aA}±0.44	11.46^{bB}±0.22	11.84^{aB}±0.23
Designer nuggets	10.54^{aA}±0.47	10.75^{aA}±0.68	11.19^{aB}±0.23	11.45^{aB}±0.31
		Ash (%)		
Control	2.02^{aA}±0.04	2.16^{aB}±0.10	2.87^{cB}±0.09	2.98^{bB}±0.19
Designer nuggets	2.03^{aA}±0.15	2.10^{aA}±0.11	2.51^{bA}±0.18	2.82^{bA}±0.08
		Total plate counts(log_{10} cfu g^{-1})		
Control	2.57^{aA}±0.26	3.35^{bB}±0.24	4.05^{abBC}±0.27	4.57^{bC}±0.29
Designer nuggets	2.54^{aA}±0.24	3.07^{aB}±0.21	4.09^{bBC} ±0.12	4.64^{bC}±0.35
		Psychrotrophic counts (log_{10} cfu g^{-1})		
Control	ND	ND	2.14^{aA}±0.25	2.68^{bB}±0.20
Designer nuggets	ND	ND	2.30^{aA}±0.23	3.30^{bB}±0.18
		Coliform counts (log_{10} cfu g^{-1})		
Control	ND	ND	ND	ND
Designer nuggets	ND	ND	ND	ND
		Yeast and mould counts (log_{10} cfu g^{-1})		
Control	ND	ND	ND	1.92^{aA}±0.14
Designer nuggets	ND	ND	ND	2.05^{bA}0.11

*Mean ±SE with different superscripts in a row wise (upper case alphabet) and column wise (lower case alphabet) differ significantly (P<0.05). n=6 for all treatments

The mean sensory scores of aerobically packaged designed fish-chevon nuggets during storage at 4±1ºC is depicted in Table 5. It was observed that substitution of fish meat at different levels significantly (P<0.05) affected the sensory attributes. All the sensory parameters showed significant decrease on all successive storage days. Though some of these attributes were comparable throughout the storage period but the overall acceptability decreased with successive storage study periods. The non-enzymatic browning of meat products decreased the appearance scores. Lipid peroxidation decreased the flavour of meat products. A decrease in flavour scores of meat products during storage was also reported by Thomas *et al*. (2006) in buffalo meat nuggets. Juiciness score followed a decreasing trend in designed meat products during storage period due to moisture loss from the designer products during storage. The lowered textural scores found in control and treated products might be due to lipolysis and proteolysis, which resulted in decreased water binding capacity. These findings were similar to those of Anihouvi *et al*. (2012) and Visnuvinayagam *et al*. (2015) observed in various fish and meat products. A significant (P<0.05) decrease in scores might reflect a decline in scores of flavour, juiciness and texture attributes. Similar pattern of results during storage period were quoted by Kopermusub and Yunchalard (2010), who worked on traditional fish products from Thailand. They also reported that both extrinsic as well as intrinsic factors in perspective of meat products were responsible for lipolysis and proteolysis and lead to quick destruction of meat foods.

Table 5 : Effect of refrigerated storage on sensory attributes of aerobically packaged control and chevon nuggets substituted with fish meat

Treatments	Storage period (Days)			
	0	7	14	21
		Appearance		
Control	6.95^{dA}±0.21	6.57^{bcB}±0.18	6.10^{abA}±0.22	5.79^{aA}±0.28
Designer Nuggets	7.18^{bcA}±0.13	6.88^{bA}±0.21	6.26^{abA}±0.13	5.96^{aA}±0.25
		Flavour		
Control	7.08^{bA}±0.26	6.92^{bA}±0.21	6.22^{aA}±0.25	5.89^{aA}±0.23
Designer Nuggets	7.06^{bcA}±0.18	6.74^{bcA}±0.20	6.28^{aA}±0.20	6.06^{aA}±0.22
		Texture		
Control	7.14^{bcA}±0.17	7.02^{bA}±0.25	6.81^{bA}±0.25	6.02^{aA}±0.22
Designer Nuggets	7.07^{cA}±0.14	6.36^{bA}±0.18	6.11^{abA}±0.16	5.75^{aA}±0.21
		Juiciness		
Control	6.85^{abA}±0.21	6.77^{abA}±0.21	6.09^{aA}±0.18	5.82^{aA}±0.22
Designer Nuggets	7.00^{cA}±0.18	6.85^{abA}±0.20	6.79^{aA}±0.20	6.03^{aA}±0.20
		Overall acceptability		
Control	6.96^{cA}±0.17	6.56^{bA}±0.26	6.30^{abA}±0.15	5.82^{aA}±0.23
Designer Nuggets	6.98^{cA}±0.22	6.19^{abA}±0.17	6.24^{abA}±0.17	5.90^{aA}±0.29

Mean± SE with different superscripts in a row differs (lower case) column differs (upper case) significantly ($p<0.05$). Mean values are scores on 8 point descriptive scale where, 1: extremely poor and 8: extremely desirable; n = 21 for each treatment

In conclusion, Chevon nuggets substituted with 50 % of fish meat were found to be the most optimum sensorily. Substitution of chevon meat with fish meat in designer meat product resulted in lower fat percent, however higher in emulsion stability, cooking yield, protein and moisture content. During refrigerated storage, the designer low sodium fish substituted chevon meat products were found acceptable up to 14 days. The use of fish meat in meat products provides an opportunity to improve the qualities and made the meat product functional and healthy. This substitution would permit functionality to our designer product without affecting the sensory attributes.

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