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Quality characteristics and stability of chicken cutlet fortified with Fish Protein Hydrolysate (FPH)

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Abstract

Fish Protein Hydrolysate (FPH) was incorporated in chicken cutlet to study its effect on quality aspects and storage stability. FPH was added at four different concentrations *viz.,* 0, 5, 10 and 15%. It was observed that 15% FPH in chicken cutlet gave a better cooking yield of 63.64 ± 0 .08% and a lower cooking loss of 36.55± 0.53%. Hence 15% FPH among the treatment groups was used for the formulation of chicken cutlet with various proportions of chicken and binder (60% chicken and 40% potato, 70% chicken and 30% potato, 80% chicken and 20% potato) for optimization. The combination of 70% chicken and 30% binder exhibited low oil uptake, minimum shrinkage, optimum pH, and overall acceptability during sensory evaluation (OA). Finally, the optimised combination of 70:30 was used to prepare the chicken cutlet and analysed for the storage stability by MAP and Normal Packaging. It was observed that the oxidative parameters such as PV, TBARS and TPC were lower for the samples which were given MAP. OA was highest for the samples with MAP. It could be concluded that FPH imparts a positive impact on storage stability and quality parameters of chicken cutlet.

Keywords: Fish Protein Hydrolysate (FPH), chicken cutlet, Modified Atmospheric Packaging, Normal Packaging

Introduction

Demand and production of fish globally shows an increasing trend which significantly improves the fishery trade. As part of fishery trade huge quantities of fishes are processed and exported. Processing of fish leads to generation of fish wastes which contain significant quantity of protein. Various byproducts can be developed from these wastes and FPH is a viable alternative in this direction. FPH having its potential application in food industry due its functional properties. It is known for its effect for reducing the oxidative changes in food stored under various storage conditions. The hydrolysate which is having the broken down peptides and peptones exhibits various functional properties which inturn can be applied in various food products (He et al., 2013). These hydrolysates exhibit better functional properties (anti oxidative, anti microbial, anti hypertensive etc) when compared to parent protein. Protein hydrolysates are believed to have valuable dietary properties and high nutritional value (Korhonen et al., 1998). Fish protein hydrolysates are reported to have significant antioxidant properties, ability to reduce oil uptake and shrinkage in fried products and have good water holding capacity which can considerably increase the cooking yield of meat (He et al., 2013). It was reported that chicken meat had abundant PUFA in their body because of the diets supplied to them for their fast growth (Milicevic et al., 2014; Asghar et al., 1990; Rhee et al., 1996). Hence the chances of lipid oxidation is more in products prepared from poultry products. Thus it is significant to use dietary antioxidants in these meat products to enhance the shelf life of these food products. MAP is a packaging technique to reduce microbial growth and enzymatic deterioration in food products and to enhance their stability and durability. Chicken cutlet is a deep fat fried product comprising of cooked chicken and binder as major ingredients. The shelf life of this product is limited to 4 days under refrigerated conditions. The product yield and characteristics depend upon processing steps and ingredient composition used. Not much

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work has been reported on the quality characteristics of cooked chicken and deep fat fried cutlets incorporating FPH as a functional ingredient.

Materials and Method

Fresh deboned 500g chicken meat was purchased and divided into four groups which includes a control group (C), and three treatment groups F1, F2, and F3 respectively. The treatment groups are differentiated based on the treatment of FPH in which F1 group was treated with 5% FPH, F2 group with 10% FPH and F3 group with 15% FPH and was subjected to cooking in order to analyse the cooking yield and cooking loss and expressed as %.

Cooking yield = Cooked weight of the chicken meat / Raw weight of the chicken meat x 100

Cooking loss = Raw weight of the chicken – Cooked weight of the chicken x 100 / Raw weight of the chicken

Optimization of the blend for chicken cutlet with varying levels of binder was done for the standardization of binder composition with chicken. The whole group was divided into 6 subgroups with 3 different chicken composition. The groups are C1 with 60% chicken without FPH and 40% binder, C2with 70% chicken without FPH and 30% binder, C3 with 80% chicken without FPH and 20% binder and also E1 with 60% chicken with FPH and 40% binder, E2 with 70% chicken with FPH and 30% binder, E3 with 80% chicken without FPH and 20% binder.

$$\text{Oil uptake (\%)} = W_1 - W_2 / W_3$$

where,

W_1= Weight of oil in the frying pan before frying

W_2= Weight of oil in the frying pan after frying

W_3= Weight of the raw battered chicken cutlet

$$\text{Shrinkage (\%)} = RD - CD / RD$$

where,

RD= diameter of raw cutlet

CD= diameter of cooked cutlet

pH of the sample was analyzed using pH meter in the temperature range of 27°C – 29°C (APHA, 1998).

To find optimal combination of components or ingredients to produce a desired property in the product, mixture design was used. It is not the literal amounts that matter but the proportion of the whole made up by each component.

Different concentrations mixture design (3 factors at 3 levels) comprising of 6 experimental runs was used with varying levels of chicken (51-80%), FPH (0-12%) and Potato (20-40%). Experimental design is shown in Table 2. The responses studied were oil uptake, shrinkage and overall acceptability. Regression models were fitted and constants were obtained using SYSTAT 13. Optimization of the composition was done keeping the goals of minimizing the oil uptake, shrinkage and maximizing overall acceptability.

Table 1: Different concentrations of FPH incorporated

Chicken	FPH	Potato
80.0	0.0	20.0
68.0	12.0	20.0
59.5	10.5	30.0
60.0	0.0	40.0
51.0	9.0	40.0

Fresh deboned 2.5 kg chicken meat was purchased from local market, cleaned and weighed. Cleaned chicken was marinated with red chilly, turmeric and salt and kept it aside for 20 mins. The marinated chicken was weighed and separated into respective groups and mixed with FPH as per requirement. About 1.25 kg of potato was cleaned and cooked in hot water for 30 min. Ginger, onion, green chillies were chopped finely and sauted in hot oil till it turned soft. To this group required amount of garam masala, pepper powder and salt were mixed thoroughly. The cooked mixture was then allowed for cooling. The cooked potato was then mashed after cooling, weighed and separated. To the weighed potato the cooked chicken along with masala were mixed thoroughly to reach the proper consistency. The mixture was then shaped round dipped in beaten eggs and then coated with bread crumbs individually. It was then fried in hot oil in low flame until it turns golden brown and was then subjected to further analysis. The quantity of ingredients used in cutlet preparation are shown in Table 1.

Table 2: Ingredients required to prepare chicken cutlet

Ingredient	Quantity
Chicken	500 g
Potato	250 g (boiled and mashed)
Finely chopped Onion	125 g
Ginger	10 gm
Green chilly	2-3no
Turmeric powder	5 gm
Red chilly powder	8 gm
Pepper powder	5-7 gm
Garam masala	8 gm
Bread crumbs	1 cup
Beaten eggs	2
Salt	As per requirement
Oil	For frying

The final optimized chicken and binder composition was then taken to storage studies. Here the samples are divided into four groups. CM-the sample which contain no FPH and given modified atmospheric packaging (75% CO_2 and 25% N_2), CN-the sample which contain no FPH and given normal packaging, RM- the sample which contain FPH and given modified atmospheric packaging and RN-the sample which contain FPH and given normal packaging. The parameters analyzed were: Peroxide Value (AOAC 2005), TBARS (AOAC 1995), TPC (APHA 1992).

Sensory characteristics were evaluated for chicken cutlet using 9 point hedonic scale for the product evaluation prescribed by Meilgaard et al., 1999. The overall impression of the product on the assessor was estimated by overall acceptability, by adding scores of all the attributes.

All the experiments were conducted in triplicate and results are expressed as mean±sd. The differences between treatments were analysed using one way ANOVA and pairwise comparison was done using Tukey's test.

Results and Discussion

The effect of FPH on the cooking yield (%) of chicken meat was analyzed by adding FPH in three different levels. One group was the control (C) with 0% FPH followed by three treatment groups -F1 with 5% level of FPH, F2 with 10% level of FPH and F3 with 15% level of FPH in chicken meat. The sample F3 (15% FPH) showed the highest cooking yield of 64% when compared to control and other treatment groups . There is significant difference between control, FPH 10% and FPH 15% ($p<0.001$). When FPH is added at higher levels (10% and 15%), there was significant increase in cooking yield of chicken. The cooking loss of the samples were compared and concluded that F3 (15% FPH) showed reduction in cooking loss (36.5%) when compared to control (C) and treatment groups. Salem et al. (2014) has reported am improvement in cooking yield and decrease in cooking loss due to the addition of soy protein hydrolysate in beef burger which was then frozen stored.

Here the control samples (C1, C2, C3) were prepared using Chicken without FPH (C) with varying levels of binders (20%, 30%, 40%). Experimental samples were prepared using Chicken containing 15% FPH (CF) with varying levels of binders- B (20%, 30%, 40%). Control and experimental samples were compared for oil uptake, shrinkage and sensory quality to study the effect of FPH in different formulations. The least oil uptake was observed in the group (E2) which showed a value of 4.5±0.268 when compared to other samples. He et al. (2015) also demonstrated the ability of FPH in reduced oil uptake when added to deep fried product. He also reported that this capacity is affected by MW distribution of the FPH (He et al., 2015).

The shrinkage value varied from 2.4-8.2 among the samples. The sample E2 demonstrated a lower shrinkage value 2.42±0.225 when compared to other treatment and control samples. He et al. (2014) also demonstrated a lower shrinkage values when FPH was added to beef burger and followed by subsequent frozen storage. The value of the pH ranged from 5.6-6.5 within in the samples. The lowest pH was observed in C1 (C: B- 60:40) and the highest was observed in E2 (C: B- 60:40). Dhanapal and others 2012 indicated that increase in pH of the sample may be due to breakage of hydrogen bonds and electrostatic interaction.

Different attributes of the chicken cutlet with varying chicken and binder composition was subjected to sensory analysis. It showed a highest value of overall acceptability (OAA) of 8.5 in the sample E2 and the lowest OAA of 7.3 in the sample C3. FPH is playing a major role in softening the texture, improving the flavor, juiciness of the product which resulted in better sensory score.

Optimization of the composition Chicken, FPH and Binder

Table 3: Regression coefficient obtained for responses

Factor Factor	Oil uptake	Coefficient Shrinkage	OAA
A (chicken)	0.341	-3.090	0.447
B (FPH)	-0.861	-0.704	-0.042
A*A	0.798	2.641	0.868
B*B	1.535	10.186	2.623
R^2	0.840	0.640	0.676

It was observed that the binder doesn't have a significant effect on any of the responses studied and hence the Quadratic model contains only A, B, A^2 and B^2 terms. It is clear from Table 3 that when FPH increases there is a considerable decrease in oil uptake and shrinkage. It is also clear that there was not much role played by the binder in improving these attributes. It was demonstrated that as the proportion of chicken increased there showed an increase in oil uptake where as a decrease in shrinkage and improvement in OAA. The responses plotted as function of independent factors are shown in Fig:1.

As per the numerical optimization the chicken cutlet, formulation containing 64.59% chicken, 7.33% FPH and 36.18% potato is optimum combination with Desirability =1. Using Response surface

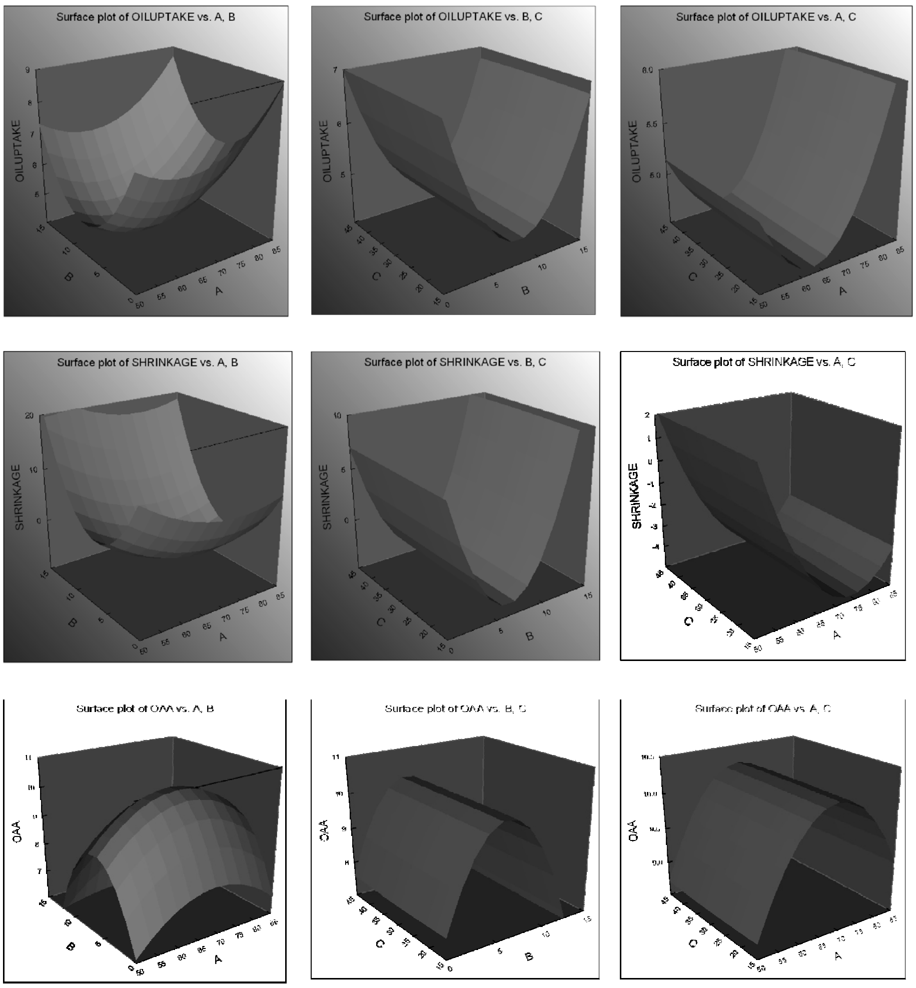

Fig. 1: Response surface graphs for oil uptake, shrinkage and OAA (Overall acceptability as function of chicken (A), FPH (B) and Binder (C)

methodology, three responses were analysed separately and the optimum combination was obtained by keeping goals for each response. The predicted combination was then experimentally validated by preparing a cutlet sample using 65% chicken, 7% FPH and 36% potato. The obtained responses for oil uptake, shrinkage and OAA were in good agreement with the predicted responses.

Control (chicken 70% and binder 30%) and optimised chicken cutlet (chicken 60%, FPH10% and Binder 30%) were then subjected to the storage stability studies and quality analysis using normal packaging (PFP) and MAP (in MP), CN (control with normal packaging), CM (control with MAP), RN (sample with normal packaging), RM (sample with MAP).

The prepared samples were stored under refrigerated conditions and the storage stability was analysed. The parameters analysed include Peroxide Value, TBARS, TPC and Sensory Analysis. Results are summarised in following subsections.

The samples were analysed intermittently to for checking the oxidative deterioration on storage in different packaging conditions. The samples were stored in refrigerated condition after providing suitable packaging systems. Among the samples, RM showed lowest PV value during the storage period and CN showed highest PV value (Fig. 2)

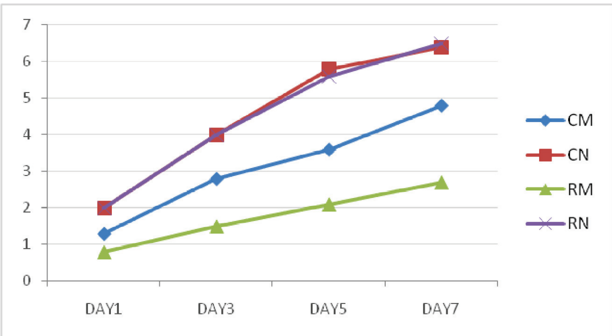

Fig. 2. Changes in PV during storage of control and optimum samples in normal and MAP packaging

The samples were stored in refrigerated condition after providing suitable packaging systems. Among the samples, RM showed lowest TBARS value during the storage period and CN showed highest TBARS value (Fig. 3).

Kittiphattanabawon et al. (2012) have demonstrated a lower PV and TBARS value in cooked comminuted pork meat was added with gelatin hydrolysate of black tip shark during storage. Similar results was also reported by Nasri et al. (2013) when Goby fish protein hydrolysate was added to cooked turkey meat during the storage period. The peptide present in the FPH exhibited it ability to lower the antioxidant properties on the product during storage. Tanwar et al. (2016) studied the effect of Bacopa monnieri extract on storage and microbial quality of vaccum packaged chicken nuggets observed that nuggets prepared with incorporation of 2% of Bacopa monnieri L. showed the best among the rest of the treatment group (1% and 3%). Pena-Ramos et al. (2003) have compared soy protein and whey protein hydrolysate antioxidant properties by incorporating it in cooked pork patties which exhibited more improved antioxidant property in soy protein hydrolysate than whey protein hydrolysate. Wu et al. (2003) studied on the antioxidant properties of mackerel hydrolysate which proved to possess noticeable antioxidant properties. He also depicted that the peptides of molecular weight 1400Da exhibited considerably more in vitro activity when compared with smaller peptides (900 and 200Da). The study conducted by Ketnawa et al. (2015) on the effect of shrimp hydrolysate in the preparation of fish tofu noted that as greater the incorporation of hydrolysate in fish tofu showed greater inhabitance to lipid oxidation with a lower thiobarbituric acid-reactive substances (TBARS) values along the storage period.

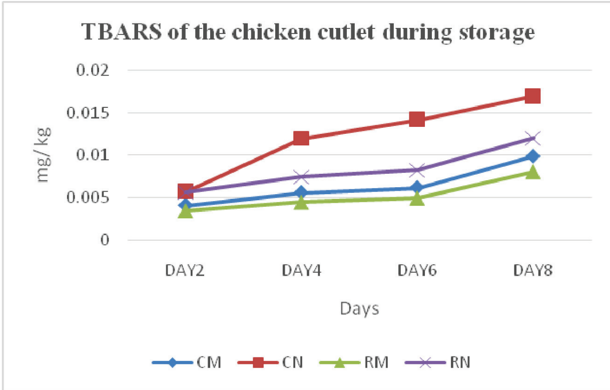

Fig. 3. Changes in TBRAS during storage of control and optimum samples in normal and MAP packaging

The cutlet sample which was given Normal Packaging and Modified Atmospheric Packaging systems were sampled for Total Plate Count (TPC) during the period of storage.

The TPC value of the control and treatment samples stored under refrigerated storage condition with

Table 6: TPC value during the storage days

Type of Packaging	1st day (log_{10})	3rd day (log_{10})	5th day (log_{10})	7th day (log_{10})
CN	2.48±0.06	2.77±0.04	3.21±0.05	4.06±0.03
CM	2.34±0.02	2.53±0.016	2.98±0.04	3.94±0.042
RM	2.05±0.03	2.27±0.05	2.72±0.02	2.99±0.09
RN	2.10±0.02	2.31±0.008	2.94±0.027	3.03±0.01

two different packaging substances exhibited acceptable limit throughout the storage period (Table 6). Tanwar et al. (2016) who studied the shelf life and quality parameters of vaccum packed chicken nuggets found that the product was stable till 45 days under refrigerated conditions. Bhoyer et al. (1997); Mandal et al. (2002) observed a slow rate of increase in TPC of meat products stored under refrigerated condition. Khare et al. (2017) who studied the effect of chitosan and Cinnamon oil edible coating given to the chicken nuggets stored at refrigerated conditions showed an overall increase in the count during the period of storage. But the treatment sample showed less count than control samples. Incorporation of shrimp hydrolysate in fish tofu for the extension of its storage life depicted that lower microbiological count along with lower yeast and molds were exhibited for the fish tofu incorporaterd with 2% hydrolysate when compared to control

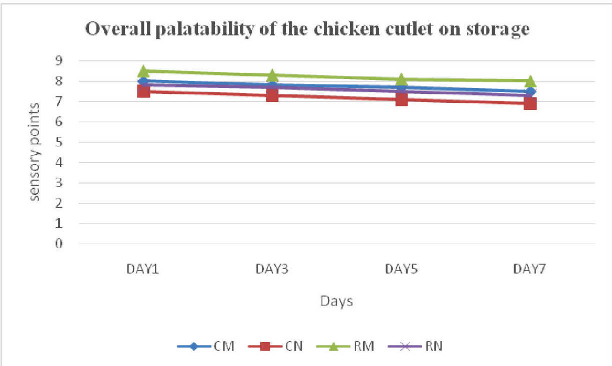

Fig. 4: Changes in Overall palatability during storage of control and optimum samples under normal and MAP conditions

The overall palatability of the chicken cutlet also showed an improved remarks in the sample RM during the storage period and the lowest value was demonstrated by the sample CN during the storage period (Fig. 4). These improved attributes were due to the addition of FPH which is playing a major role in improving storage stability and sensory attributes of the product.

This study evaluated the effect of Fish Protein Hydrolysate on cooking properties of chicken. It was observed that addition of 15% FPH in chicken during cooking significantly reduced the cooking losses and in turn increased the yield of chicken. This formulation was further used in preparation of chicken cutlet with varying binder compositions and was compared with control samples prepared using only chicken and binder. The study revealed that product obtained using 70% chicken (containing 15% FPH) and 30% binder had minimum oil uptake, shrinkage and maximum overall acceptability. Further optimization was carried out using Response Surface Methodology and the numerical solution obtained had: 60% chicken, 10% FPH and 30 % binder. These results were further verified using experimental responses for oil uptake, shrinkage and OAA for the same formulation. It can be concluded that FPH exerts a positive impact on storage stability and quality parameters of chicken cutlet. This study indicates the potential use of FPH as an additive to enhance cooking yield, improve the frying characteristics and oxidative stability of meat based system and deep fat fried products. Further studies are required to establish the nutritional improvement in terms of protein content and amino acid composition of products developed using Fish Protein Hydrolysate.

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