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# Utilization of fish mince in formulation and development of pasta products

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**Abstract**

Pasta Products were developed using refined wheat flour (*Triticum aestivum*), semolina (*Triticum durum*), green gram (*Pharsalus aureus Roxb*), black gram (*Phaseolus mungo Roxb*), cheese flavor and fish mince (*Katla Katla*) with a lab scale extruder. Acceptability studies on the pasta products were conducted initially, and at the end of the storage period, that is, 2 months at laboratory level by panel of judges using a 5-point hedonic scale. Cooking quality and proximate principles were assessed. The results of the study showed that acceptable pasta products of good quality can be developed by extrusion cooking utilizing refined wheat flour, rice, fish mince, cheese flavour and other pulses. Among the different blends studied, the most acceptable pasta was the product made with combination of refined wheat flour + semolina + black gram dhal + cheese flavour + fish (*RWF + S + Blgd +CF + F*) in the ratio of 32.5:32.5:10:5:20. The results of present study indicate that fish mince can be utilized for the development of well accepted pasta products, thereby improving the nutrient content of the product developed.



## Introduction

In modern days there is an ever increasing awareness about health foods and fish is gaining more acceptance because of its special nutritional and functional properties. Fish is an excellent source of high nutritional value protein and an excellent source of lipid that contains omega-3 fatty acids, especially, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (Kris-Etherton *et al*., 2000; Kris-Etherton *et al*., 2002). Omega-3 fatty acids are essential for normal growth and development and may prevent or moderate coronary artery disease, hypertension, diabetes, arthritis, others inflammatory and autoimmune disorders as well as cancer (Simopoulos, 2000). Interestingly, fish is also a good source of various vitamins (A, D, $B_6$, $B_{12}$, etc) and minerals (Iron, Zinc, Iodine, Selenium, Potassium, Sodium etc).

Using fish mince as raw material, many varieties of products can be made by extrusion. It is ready material for preparation of many highly acceptable ready to serve fish products like frozen surimi, frozen mince block, extruded product, imitated products etc. A few studies have reported successful incorporation of fish flesh or fish powder into starch-based materials by extrusion processes to produce nutritious extruded products that were acceptable by consumers (Gogoi *et al*., 1996; Suknark *et al*., 2001; Shaviklo *et al*., 2011). However, the data available on pasta products with incorporation of fish mince is limited. Hence, the present study has been designed to incorporate fish mince with the aim of developing acceptable extruded products utilizing fish, and to determine the retention of nutrients and omega-3 fatty acid content of the products.

## Materials and Methods

*Development of extrudates*

*Raw materials*

The raw materials used for product development were refined wheat flour (*Triticum aestivum*), semolina (*Triticum durum*), green gram (*Pharsalus aureus* Roxb), black gram (*Phaseolus mungo* Roxb), cheese flavor and fish mince (*Katla Katla*). All the raw materials were procured from local markets.

*Preparation of fish mince*

Fish (*Katla Katla*) was selected for the project

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due to its low cost and abundant availability in the local market. Fresh fish purchased from the local market was prepared by discarding the head, fins, tail, viscera and washing with clean water. Soft pieces were deboned manually and flesh was separated. The flesh was simmered at low flame for proper cooking and to obtain mince. The fish mince was dried in a cabinet drier at 60$^0$C for 24 h and ground in a domestic grinder to obtain the fish powder. The fish powder was sieved, passing through 44 mm mesh sieve and was packed in plastic container and stored in refrigerator until further use.

*Formulations used*

Different formulations with refined wheat flour (*Triticum aestivum*), semolina (*Triticum durum*), green gram (*Pharsalus aureus* Roxb), black gram (*Phaseolus mungo* Roxb), cheese flavor and fish mince (*Katla Katla*) were used to prepare the pasta products (Table 1). Black gram dhal and green gram dhal were roasted at low flame till a pleasant aroma developed, and ground into powder.

*The extruder*

Pasta was produced at Department of Foods and Nutrition, Post Graduate and Research Centre, Acharya N.G.Ranga Agricultural University, Hyderabad using a lab model mini pasta extruder (Dolly mini P3) which has a hopper capacity of 2.5 kg and production rate of approximately 6 kg/hr with a power specification of 110v/220v which runs on a 1Hp motor.

*Extrusion conditions*

To optimize the process variables of extrusion cooking for preparation of the pasta products of maximum possible expansion ratio with desirable internal and apparent texture, the blended samples were tempered by adding a measured quantity of luke warm water by spraying and blended in a mixing chamber thoroughly to adjust the feed moisture content to 31%.

*Drying*

The developed pasta was dried at high temperature (80ºC) for 4 hours to ensure the quality of the product.

*Packaging*

The dried pasta products were packed in Metallized Poly Ethylene (MPET) sachets, which provided moisture proof protection for the product.

*Cooking time and cooking quality*

Pasta quality was influenced by a range of characteristics, physical, chemical and nutritional. Cooking quality of pasta was the most important aspect from the consumer's point of view, including optimal cooking time, swelling or water uptake during cooking, texture of the cooked product, stickiness, aroma and taste. These cooking factors of pasta were related to the gelatinization rates and chemical composition of the pasta used. Cooking time, cooking quality and water absorption were studied as per the methods described by AAmerican Association of Cereal Chemists (AOAC, 2000). Tests for assessing bulkiness, firmness and stickiness of the products were also carried out and again repeated at the end of the storage period i.e. 2 months, through sensory evaluation

*Sensory evaluation*

Basic pasta recipe was prepared using vegetables and spices for sensory evaluation. Sensory evaluation was carried out by semi-trained judges using a 5-point Hedonic rating scale (Amerine *et al*., 1965) for sensory attributes like colour, appearance, flavour, taste, texture and overall acceptability initially and repeated again at the end of the storage period i.e. 2 months.

*Proximate composition*

The moisture content of the samples was determined by AOAC (1990) method. Carbohydrate content was estimated by the difference. The energy values of the extruded samples were determined by computation and expressed in kilocalories. The crude protein content of the samples was estimated using Microkjeldhal method AOAC (1990) procedure and calculated as the product of percent nitrogen and a multiplication factor. The amount of fat in the food mixes was determined using soxhlet method AOAC (1990). The ash and crude fibre content of the sample was estimated by AOAC (1990) method. The calcium, phosphorus and iron content in the samples were calculated based on the nutritive value of Indian foods (Gopalan *et al*., 2004). Omega 3 fatty acids were estimated by gas chromatography (Chrisite, 2003).

*Storage studies*

The developed pasta products were packed in metalized polyester terphalalene and stored at room temperature for 2 months

*Statistical analysis*

The results were subjected to statistical analysis with the window stat programme. Mean and standard deviation for ten replicates were calculated. Completely Randomized Design (CRD) Analysis of variance (ANOVA) was used to know the significant differences for the different treatment combinations and to find the best treatment combination. Significance was accepted at probability $P < 0.05$.

## Results and Discussion

*Cooking time*

Cooking time of all the pasta was determined to evaluate the hydration properties of different formulations. Cooking times ranged from 5.12 to 6.9 minutes and the highest cooking time was for T6 (Table 1). An increase in cooking time was observed for experimental samples compared to control samples. Studies on wheat based composite flour for pasta products by Shanti *et al*., (2005) on development of high quality pasta products with optimum conditions showed that cooking time of pasta products ranged from 8.13 to 9.27 min. Higher cooking time was recorded for blends of ragi (20%), soy flour (10%) whole wheat and refined wheat flour. This could be attributed to the hydration levels, which are more for wheat and millet based than semolina and refined wheat pasta.

*Water absorption*

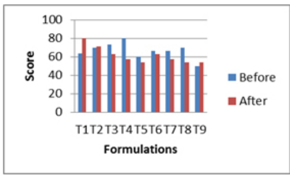
Water absorption of the pasta samples ranged from 42.46 to 53.57 and the highest water absorption index was recorded for T4 pasta (Table 1). The water absorption index of control pasta was lower than all the experimental pasta products. This could be due to the higher capacity to absorb and retain water within a very well developed protein network. This was also evident from the studies conducted by Fardet *et al*. (1998) who analyzed the textural images of pasta protein networks to determine the influence of technological processes. The findings showed that there were significant differences in protein network structure of pasta which had protein enrichment of 20% and these results were obtained from the confocal laser scanner microscopy which allows the visualization of three dimensional organization of macromolecules in food network.

*Stickiness*

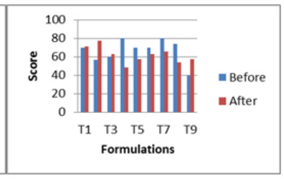
The stickiness of pasta products ranged from 60 to 80 (Figure 1). The stickiness of control samples was significantly higher ($p<0.05$) than experimental pasta products. Among control products stickiness was higher in sample number T3, and among experimental pasta products, stickiness was higher in sample number T4. After 60 days of storage, a similar trend of highest stickiness was observed for control pasta products compared to experimental samples

Table 1. Formulations used for development of pasta products

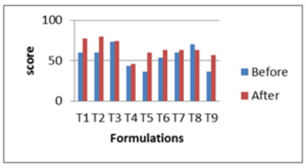
| S.no | Raw Material | Formulations |
|---|---|---|
| 1 | Refined Wheat Flour + Semolina + Cheese Flavour *(RWF+S+CF)* | 47.5:47.5:5 |
| 2 | Refined Wheat Flour+ Semolina + Green gram dhal + Cheese Flavour *(RWF+S+Ggd+CF)* | 35:35:25:5 |
| 3 | Refined Wheat Flour+Semolina+Black gram dhal + Cheese Flavour *(RWF+S+Blgd+CF)* | 35:35:25:5 |
| 4 | Refined Wheat Flour + Semolina + Green gram dhal + Cheese Flavour +Fish *(RWF +S+ Ggd +CF+F)* | 35:35:10:5:15 |
| 5 | Refined Wheat Flour + Semolina + Green gram dhal + Cheese Flavour + Fish *(RWF +S+ Ggd +CF+F)* | 32.5:32.5:10:5:20 |
| 6 | Refined Wheat Flour + Semolina + Black gram dhal + Cheese Flavour +Fish *(RWF +S+ Blgd +CF+F)* | 35:35:10:5:15 |
| 7 | Refined Wheat Flour + Semolina + Black gram dhal + Cheese Flavour + Fish *(RWF +S+ Blgd +CF+F)* | 32.5:32.5:10:5:20 |
| 8 | Refined Wheat Flour + Semolina + Cheese Flavour + Fish *(RWF +S +CF+ F)* | 37.5:37.5:5:20 |
| 9 | Refined Wheat Flour + Semolina + Cheese Flavour + Fish *(RWF +S +CF+ F)* | 32.5:32.5:5:30 |




**Stickiness**




**Firmness**




**Bulkiness**

Figure 1. Cooking quality of pasta before and after 2 months storage period

(Table 3). However, this difference was not found to be significant.

*Bulkiness*

The bulkiness of pasta products ranged from 56.66 to 80 (Figure 1). Bulkiness in control samples was significantly higher ($p<0.05$) in experimental than in control pasta products. Among control products T1 bulkiness was higher and among experimental pasta products T4 and T7 bulkiness was higher. This could be due to the higher protein levels. After 60 days of storage, a similar trend of significantly ($p<0.05$) highest bulkiness was observed for experimental than control pasta products (Table 3).

Table 2. Cooking quality of different pasta formulations

| Treatments | Cooking time (min) | Water Absorption Index |
|---|---|---|
| T1 | 5.12±0.01 | 42.46±0 |
| T 2 | 5.34±0.02 | 42.60± 0.02 |
| T 3 | 5.63±0.01 | 43.14±0.05 |
| T 4 | 6.4±0.56 | 53.57±0.09 |
| T 5 | 6.01±0.01 | 51.89±0.04 |
| T 6 | 6.94±0.02 | 46.39±0.04 |
| T 7 | 6.78±0.05 | 47.37±0.02 |
| T 8 | 6.73±0.04 | 46.0±0 |
| T 9 | 6.82±0.02 | 46.43±0.01 |

Values are expressed as mean ± standard deviation of three determinations

Table 3. Nutritive value of pasta products (per 100 g)

| Nutrients | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 |
|---|---|---|---|---|---|---|---|---|---|
| Moisture (g) | 1.18 ± 0.02 | 1.58 ± 0.02 | 1.13 ± 0.01 | 1.95 ± 0.04 | 1.74 ± 0.05 | 1.4 ± 0.28 | 2.01 ± 0.01 | 1.57 ± 0.04 | 1.67 ± 0.02 |
| Ash(g) | 1.35 ± 0.02 | 1.20 ± 0.02 | 1.08 ± 0.02 | 1.63 ± 0.02 | 1.48 ± 0.1 | 1.5 ± 0 | 1.56 ± 0.04 | 1.37 ± 0.02 | 1.20 ± 0.02 |
| Fibre(g) | 0.29 ± 0.02 | 0.36± 0.01 | 0.36 ± 0.01 | 0.26 ± 0.02 | 0.23 ± 0.01 | 0.27 ± 0.02 | 0.2 ± 0.02 | 0.26 ± 0.02 | 0.23 ± 0 |
| Energy (k.cal) | 341.11 ± 1.55 | 303.3± 1.83 | 303.0± 0 | 306.0± 1.41 | 292.4± 1.13 | 304.7± 2.82 | 292.3± 2.96 | 293.4± 0.28 | 266.7± 1.41 |
| CHO(g) | 70.94 ± 1.39 | 58.3 ± 2.54 | 59.7 ± 0.98 | 58.4 ± 0.56 | 54.7 ± 0.56 | 58.4 ± 0.28 | 54.7 ± 0.28 | 56.2 ± 0.28 | 48.8 ± 0.56 |
| Protein(g) | 11.30 ± 0.28 | 13.8 ± 0.56 | 13.5 ± 0.28 | 14.0 ± 0 | 14.5 ± 0.14 | 13.5 ± 0.14 | 14.5 ± 0.14 | 13.1 ± 0.28 | 14.0 ± 0 |
| Fat(g) | 1.35 ± 0.02 | 1.20 ± 0 | 1.13 ± 0.02 | 1.80 ± 0.28 | 1.7 ± 0.28 | 1.9 ± 0 | 1.7 ± 0.28 | 1.8 ± 0 | 1.7 ± 0.28 |
| Calcium (mg) | 49.0 ± 0.70 | 60.65 ± 0.02 | 90.05 ± 0.70 | 140.15 ± 0.07 | 165.67 ± 0.02 | 148.05 ± 0.07 | 173.57 ± 0.04 | 160.12 ± 0.02 | 210.57 ± 0.09 |
| Phosphorus (mg) | 131.80 ± 0.49 | 144.55 ± 0.70 | 190.1 ± 0.14 | 179.75 ± 0.28 | 185.88 ± 0.56 | 177.75 ± 1.06 | 183.80 ± 0.98 | 156.48 ± 0.56 | 168.85 ± 0.91 |
| Iron(mg) | 1.14 ± 0.02 | 1.08 ± 0.01 | 1.41 ± 0.02 | 1.21 ± 0.01 | 1.26 ± 0 | 1.20 ± 0.01 | 1.25 ± 0.01 | 1.60 ± 0.01 | 1.90 ± 0.01 |
| Zinc(mg) | 0.28 ± 0.01 | 0.32 ± 0.01 | 0.38 ± 0.01 | 0.49 ± 0.01 | 0.47 ± 0.02 | 0.51 ± 0.02 | 0.49 ± 0.02 | 0.41 ± 0.02 | 0.43 ± 0.01 |
| EPA (%) | - | - | - | 0.4 ± 0.01 | 0.5 ± 0.01 | 0.4 ± 0 | 0.5 ± 0.01 | 0.5 ± 0 | 0.6 ± 0.01 |
| DHA (%) | - | - | - | 1.05 ± 0.01 | 1.08 ± 0.02 | 0.98 ± 0.01 | 1.01 ± 0.01 | 1.03 ± 0.02 | 1.15 ± 0.01 |

Values are expressed as mean ± standard deviation of three determinations

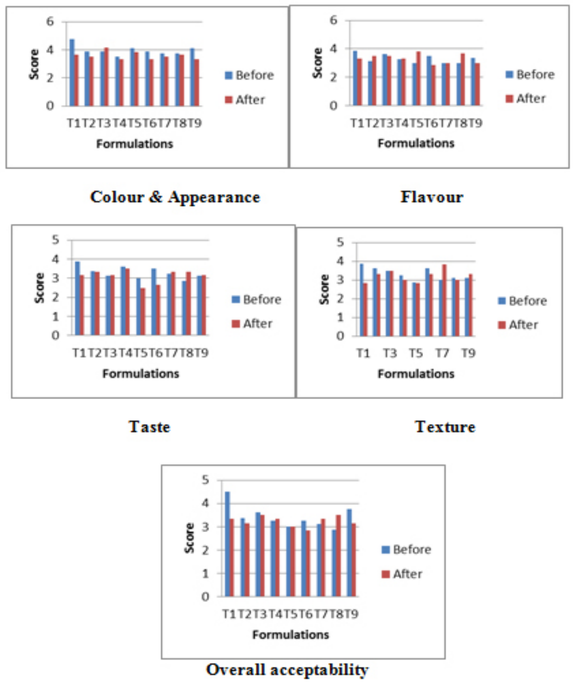
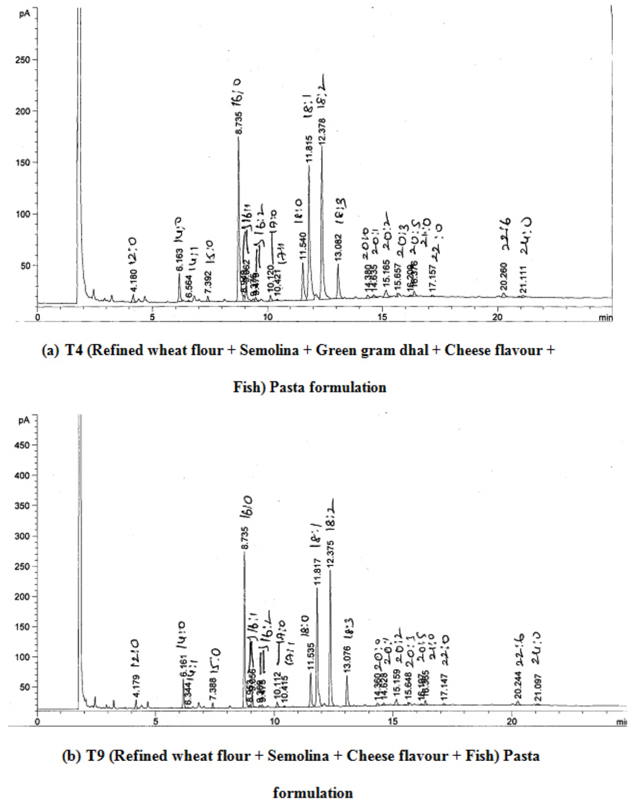


Figure 2. Sensory evaluation of pasta before and after two months storage period



Figures 3. Gas Chromatography analysis of pasta formulations

*Firmness*

The firmness of pasta products ranged from 36.66 to 73.33. Firmness in control samples was higher than in experimental pasta products. Among control products, firmness was higher in T3 and T4, and among experimental pasta products T8 firmness was higher (Figure 1). After 60 days of storage, a similar trend of highest firmness was observed for control pasta products than experimental samples (Table.3).

*Nutrient analysis*

The results of nutrient analysis are tabulated in Table 2.The moisture content of the samples ranged from 1.13 to 2.01g. The moisture content was higher in T7 and lower in T3. The carbohydrate content of experimental products was lower than the control pasta products. Among the products CHO content of T1 content was higher and CHO content of T9 content was lower. The protein and fat content was highest in experimental products than the control products.

The energy value of the products ranged from 266.78 to 341.11 Kcal. The energy content of control samples was higher than experimental products. The crude fibre of the extrudates ranged from 0.2 to 0.36 g. The products made from fish were observed to have high ash and lower crude fibre content.

Among fish incorporated samples omega 3 fatty acid content was higher in fish (incorporated at 20% and 30%) levels, respectively, and lower in 15% fish incorporated products (Figure 3). Since omega 3 fatty acids are present in high amounts in fish, this is reflected in higher omega 3 fatty acid content of these samples. The eicosapentaenoic acid (EPA) content of fish mince was 2.4%, and docosahexaenoic acid (DHA) was 3.2% and after extrusion, the EPA content was reduced to 0.4 to 0.64 % and DHA content reduced to 0.98 to 1.15% (Table 3). From these results, it is evident that there is a huge loss of omega 3 fatty acids during extrusion.

The calcium and phosphorus content was higher in fish incorporated products than control products. This could be due to the higher calcium and phosphorus content in fish. The iron and zinc content was higher in products made from fish incorporated products than control products. Among the experimental samples, the products which had highest iron content were T8 (1.6mg) and T9 (1.9mg). Among the experimental samples the zinc content was higher in products T6 (0.51mg) and T4 (0.49 mg).

*Sensory evaluation*

Acceptability of pasta products was evaluated by a trained panel of judges. The products made from refined wheat flour, Semolina, cheese flavor, green gram dhal and black gram dhal alone were served as control and refined wheat flour, Semolina, cheese flavor, green gram dhal, black gram dhal and fish incorporated products as experimental samples.

All the products scored well for colour and appearance (Figure 2). The refined wheat flour, Semolina and cheese flavor incorporated samples scored higher than the other samples. Among the experimental samples T5 scored the highest for colour, both at initial period, and also after the storage period of 60 days. After 60 days of storage, T3 scored higher than the other samples.

With respect to flavor, products made from fish scored the least and products made from T1 obtained highest scores. This could be due to the mild fish flavor which was present in the products. After storage, interestingly, products made from T5 and T8 scored higher than the control samples. The texture of control samples was found to be better in control samples than fish incorporated products. Among the samples, T1 scored highest and T5 scored the least for texture. After 60 days of storage, the textural properties of fish incorporated products were found to be better than control samples. Among the products, T1 scored the least and T3, the highest .

The taste of all the extrudated products was found to be good. Among the products, T1 scored the highest and T8 the least, for taste. After storage, T4 scored the highest and T5 scored the least for taste. The mean scores for overall acceptability of the products made from control samples was significantly ($p<0.05$) higher than experimental samples. Among experimental samples T9 scored the highest and T5 scored the least for overall acceptability. After storage for 60 days, the overall acceptability was higher for T3 and T8 products.

## Conclusion

Extruded products like pasta products are popularly used as snack products. Usually, pasta products are prepared using cereals like wheat, which are limiting in some essential amino acids. In order to increase the nutritive value of such products, the supplementation with protein rich fish mince is an alternative. Development of pasta products using cereals and fish mince, without compromising on the quality of the final product, would help improve the nutritional quality apart from adding a distinct falvor and taste. The well accepted pasta products that were developed in the study can be scaled up for potential commercialization and marketing. The underutilized fish also can be utilized for development of products which will improve the nutritional value and reduce the cost of the product.

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