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Evaluation of Moisture Content and Sensory Properties of Colored and Non-Colored Fish (Silver Carp, *Hypophthalmichthys molitrix*) Noodles during Storage

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Authors' contributions

This work was carried out in collaboration among all authors. Author FHS was involved in planning and designing the experiment. Author SNS performed the experiment, involving in the activities of product preparation, sensory and chemical analysis of the products. Authors FHS, MIH, MMH and NTB contributed with the technical support. Authors FHS and MIH provided valuable suggestions regarding conducting the experiments. Authors SNS and MPJ collected, analyzed, and interpreted the data. Author MPJ prepared the manuscript. Authors FHS and MPJ critically reviewed and edited the manuscript. Author MPJ produced the final version of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The study was done to evaluate moisture content and sensory properties of colored and non-colored noodles incorporated with different amount of fish (Silver carp, *Hypophthalmichthys molitrix*) mince during storage at room temperature (30-35°C) in two types of packaging conditions (sealed polyethylene packet and vacuum sealed packet). In addition, proximate composition, cooking time, and water absorption capacity were also investigated at initial stage. Boiled fish mince was incorporated with wheat flour and spices to prepare eight different samples namely CN (without fish mince, colorless), CC (without fish mince, colored), S1N (25% fish mince, colorless), S1C (25% fish mince, colored) S2N (30% fish mince, colorless), S2C (30% fish mince, colored) and S3N (35% fish mince, colorless) and S3C (35% fish mince, colored). No significant change in the moisture content of colored and non-colored fish noodles was found but moisture, protein, and fat content rose significantly with the increment of added amount of fish mince in the noodles. A significant decreasing trend was observed in the moisture content of the samples stored in sealed polyethylene packets during the 305 days of storage period whereas the moisture content of all the samples packed in vacuum sealed packets witnessed a non-significant change for the storage of 360 days. The color, flavor and texture of the products were acceptable up to 305 days in sealed polyethylene packets and 360 days in vacuum sealed packets. Food color had no remarkable effect on proximate composition, cooking time, water absorption capacity, and sensory characteristics of prepared noodles. Colorless noodles containing 35% fish mince was preferred by the panelists. So, both colored and non-colored fish noodles prepared with fish mince (up to 35%) can be stored at room temperature (30-35°C) in both sealed polyethylene packets and vacuum sealed packets for at least 10 months with acceptable moisture content and sensory properties. Vacuum sealed packaging provided the products with better protection against moisture loss throughout the storage period.

Keywords: Silver carp; colored fish noodles; fish mince; sensory properties; packaging.

1. INTRODUCTION

Noodles are being consumed for thousands of years and remain an important part in the diet of many Asians. Asian noodles are popular foods around the world, where in Asia nearly 50% of all wheat is consumed in noodle form [1]. There is a wide variety of noodles in Asia with many local variations as a result of differences in culture, climate region and a host of other factors. Noodles can be made from different flour like wheat, rice, buckwheat, starches derived from potato, and from pulses. At present noodles are prepared from wheat flour, water and salt [2].

The inadequacy of cereal proteins particularly that of wheat protein in meeting nutritional need for humans is well established. All the essential amino acids are not found in instant noodles which mainly consist of wheat flour. Noodles and other pasta types are rich in carbohydrate but they are deficient in terms of protein quantity and amino acid balance [3]. Therefore, there is a need of addition of protein which will increase the protein content and thereby improving nutritional value of noodles. For this purpose, fish can be used as animal protein source for enhancing the protein content in the noodles.

Extruded products like noodles, wafers, flakes, etc. from vegetable sources are well established in the consumer market. Fish based extruded products have very good marketing potential but are yet to gain recognition. Formulation of appropriate types of products using different fish mince, starches and attractive packaging, market studies are needed for the popularization of such value added products. Fish products are comparable to meat and dairy products in nutritional quality depending on the methods used in preservation and preparation. The protein content of most fish averages from 15 to 20 percent [4]. Fish also contains significant amount of all essential amino acids, particularly lysine, which are relatively poor in cereals [5]. So, fish protein can be utilized to complement the amino acid pattern and boost the overall protein quality of a mixed diet. On top of that, sensory properties of an otherwise bland diet can be

improved through fish incorporated products which will facilitate and contribute to greater consumption.

In recent year's value addition have received a wider attention because of increased urbanization. There is a growing demand for value-added products due to social and cultural changes [6]. Accordingly, development of value added products from low cost fish could be a new era for both to produce quality food products for human consumption and to increase profitability in Bangladesh.

There are a wide variety of fish available in Bangladesh. Among them carp species are the most crucial and inland ponds account for more than 50 percent of aquaculture production. The most farmed carp species are Rohu (*Labeo rohita*), Catla (*Gibelion catla*) and Silver carp (*Hypophthalmichthys molitrix*) which contribute to 10.55, 6.46 and 6.79% of the total annual fish production of inland water bodies respectively [7]. Among the three species Silver carp is the cheapest fish in the market. In addition, nine essential amino acids beneficial for human health are found in this species. It also contains other essential amino acids and essential fatty acids mainly EPA and DHA [8]. The development and standardization of techniques for the production of value added products from silver carp flesh would expand the utilization of this cheap fish. Higher return would ensure development of sustainable aquaculture practice of the species and will elevate income of the poor farmers. For these reasons silver carp fish (*Hypophthalmichthys molitrix*) mince was chosen to develop colored and non-colored fish noodles and to observe the changes in their moisture content and sensory properties during storage at room temperature (30-35ºC) under different packaging conditions.

2. MATERIALS AND METHODS

2.1 Design of Experiment

The experiment was done in the Fish Processing and quality control laboratory of the Department of Fisheries Technology, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. Fresh Silver Carp fish mince was used as main raw material. Other ingredients used were wheat flour, salt, oil, spices (black pepper) and food color. Eight experimental samples were prepared for this experiment namely CN (without fish mince, colorless), CC (without fish mince, colored), S1N (incorporated with 25% fish mince, colorless), S1C (incorporated with 25% fish mince, colored) S2N (incorporated with 30% fish mince, colorless), S2C (incorporated with 30% fish mince, colored) and S3N (incorporated with 35% fish mince, colorless), and S3C (incorporated with 35% fish mince, colored). Sensory properties and proximate composition of all the samples were analyzed. Half of the each sample was sealed in polyethylene packets and another half was packed in vacuum sealed packets. They were stored at room temperature (30-35ºC). All the samples packed in polyethylene packets were analyzed at 15 days of interval for initial 1.5 months, at 30 days of interval for next 4.5 months and 60 days of interval for last 6 months. The samples sealed in vacuum packets were analyzed at 30 days of interval for initial 3 months, 60 days of interval for next 6 months and 90 days of interval for last part of the experimental months. During storage period, the changes in moisture content, texture, color, flavor and mold growth were investigated.

2.2 Preparation of Fish Noodles

Fresh fish collected from local market were washed with potable water and dressed properly. Then the fish were boiled in clean water with salt and white pepper for 15-20 minutes. After boiling fish were deboned and minced manually using hand. Water content was removed as much as possible.

All the ingredients were weighed as shown in Table 1. The ingredients were mixed to prepare dough. Then the dough was kneaded and kept in rest for 20 minutes to form gluten network. The dough was transferred to a vertical noodles making machine and longer type of noodles were made. The prepared noodles were then oven dried at 65ºC for 4-6 hours. The cooled and dried noodles were divided into two part. One-part was sealed in polyethylene packets and another part was packed in vacuum sealed packets. Then all the packets were stored in cool and dry place at room temperature (30-35ºC) until further use.

2.3 Proximate Composition

The wheat flour, fresh Silver Carp fish, its mince and the prepared noodles were analyzed for moisture, protein, ash, fat content by AOAC [9]. The total carbohydrates were calculated by approximation i.e. by subtracting the measured protein, moisture, fat, and ash from 100 [10].

Table 1. Basic formulation of eight experimental fish noodles samples with flour, silver carp mince and other ingredients

Ingredients	Samples							
	CN	CC	S1N	S1C	S2N	S2C	S3N	S3C
Wheat flour (g)	100	100	75	75	70	70	65	65
Silver carp mince (g)	0	0	25	25	30	30	35	35
Water (ml)	40	40	40	40	40	40	40	40
Oil (ml)	5	5	5	5	5	5	5	5
Salt (g)	2	2	2	2	2	2	2	2
Spices (g)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Food Color (drops)	0	3	0	3	0	3	0	3

** CN (without fish mince, colorless), CC (without fish mince, colored), S1N (incorporated with 25% fish mince, colorless), S1C (incorporated with 25% fish mince, colored) S2N (incorporated with 30% fish mince, colorless), S2C (incorporated with 30% fish mince, colored) and S3N (incorporated with 35% fish mince, colorless) and S3C (incorporated with 35% fish mince, colored)*

2.4 Water Absorption Capacity of Fish Noodles

100g of prepared noodles were cut into 4 cm length and were added to a beaker containing about 225 ml of boiling distilled water on a hot plate and was cooked at 100ºC for required time and stirred slightly with a glass rod. Then, the samples were weighed. The difference in weight between the boiled sample and the dry sample is water absorption during cooking [11].

2.5 Sensory Analysis of Fish Noodles

The consumer's acceptability of developed noodles was evaluated by a testing panel. The hedonic rating test was used to determine the acceptability. It is also called the 9-point hedonic test. The panelists were chosen from different social status. The panelists rated their acceptability of the product on a 01-09 point hedonic scale [12].

The scale was arranged such that

> 9= like extremely, 8= like very much, 7= like moderately, 6= like slightly, 5= neither like nor dislike, 4= dislike slightly, 2= dislike very much and 1= dislike extremely.

2.6 Storage of Fish Noodles

Samples packed in polyethylene packets and vacuum sealed packets were stored at room temperature (30ºC to 35ºC). During storage period, changes in the moisture content and overall acceptability of the products were observed and analyzed.

2.6.1 Changes in the moisture content

Changes in the moisture content of the fish noodles were determined according to AOAC (9).

2.6.2 Overall acceptability

Changes in overall acceptability were observed during the whole storage period. Three randomly selected person tested the fish noodles after cooking at the specified interval of time described in the section 2.1.

2.7 Statistical Analysis

Statistical analysis was done by using one way ANOVA test to compare the data obtained from products' proximate composition, overall acceptability score, water absorption capacity, and changes in the moisture content throughout the storage time at 0.05 significance level. Post Hoc test and Duncan test were performed. All the tests were carried out by SPSS version 25. Tables and Graphs of the data were prepared by MS Excel (version: 2110).

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

3.1.1 Proximate composition of silver carp fish, silver carp mince, wheat flour, and food color

Silver carp fish is highly rich in protein. Table 2 represents the data of proximate composition of silver carp fish, wheat flour, silver carp mince and food color.

The moisture content (%) in silver carp fish was found 76.91±0.05% which coincides with the findings of Nabi and Hossain [13], Salam et al. [14] and Marias and Erasmus [15]. Protein content (%) in the Silver carp fish in present study was 17.63±0.10% which is more or less similar with the findings of Mazumder et al. [16]. The fat content (%) in silver carp fish in this study was found 2.19±0.11%. Usually moisture and lipid contents in fish fillets are inversely related and their sum is approximately 80% [17].

The ash content (%) in silver carp fish was found 1.30±0.08% which was nearer to the result of Abimbola [18] and Devadsan et al. [19]. The proximate composition of silver carp mince of this study are quite similar to the experimental findings of Hakimeh et al [20]. During mincing moisture content was reduced a little bit that's why protein, lipid and ash content were increased than that of the whole fish. Proximate composition of wheat flour is nearer to the results found by Ocheme et al. [21].

3.1.2 Proximate composition of prepared noodles

After drying in the hot air oven, eight experimental noodles samples (CN, CC, S1N, S1C, S2N, S2C, S3N, and S3C) were analyzed for proximate composition, and total carbohydrate. The results are presented in Table 3.

The moisture content of the different noodles samples prepared with different levels of wheat flour and silver carp mince ranged from 6.30±0.15 to 8.57±0.27%. The lowest value was found for sample CN and the highest value was for sample S3C (Table 3). Similarly, CN was in the lowest (8.23±0.59%) and S3N was in the highest (25.16±1.61%) in case of protein content. It is statistically supported that the percentage of protein varies discernibly among control (CN & CC), S1 (S1N & S1C), S2 (S2N & S2C) and S3 (S3N &S3C) treatments. Next, the lipid content of

Table 2. Proximate composition of silver carp fish, silver carp mince, wheat flour and food color

Components	Silver carp fish	Silver carp mince	Wheat flour	Food color
Moisture (%)	76.91±0.05	76.05±0.09	12.91±0.17	0.00
Protein (%)	17.63±0.10	20.12±0.19	10.00±0.15	0.00
Lipid (%)	2.19±0.11	1.63±0.18	0.85±0.29	0.00
Ash (%)	1.30±0.08	1.21±0.10	0.66±0.28	0.00
Total carbohydrate (%)	1.97±0.25	0.99±0.22	75.58±0.31	0.00
Sodium (%)	0.00	0.00	0.00	0.2±0.01
Salt Equivalent (%)	0.00	0.00	0.00	0.5±0.04

Table 3. Proximate composition of prepared noodles

Sample	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Total carbohydrates (%)
CN	6.30±0.15^{a}	8.23±0.59^{a}	7.05±0.27^{a}	2.66±0.15^{ab}	74.12±1.02^{a}
CC	6.35±0.30^{a}	9.0±0.36^{a}	7.00±0.23^{a}	2.78±0.22^{ab}	73.67±0.58^{a}
S1N	7.15±0.15^{b}	19.30±0.65^{b}	8.32±0.34^{b}	2.17±0.29^{a}	60.20±1.08^{b}
S1C	7.23±0.20^{bc}	19.55±0.43^{b}	8.19±0.38^{b}	2.26±0.28^{ab}	60.14±1.10^{b}
S2N	7.77±0.23^{bcd}	22.69±0.55^{c}	8.51±0.53^{b}	2.46±0.46^{ab}	56.03±0.88^{c}
S2C	8.01±0.21^{cd}	22.29±1.17^{c}	8.61±0.53^{b}	2.35±0.46^{ab}	56.26±1.00^{c}
S3N	8.33±0.29^{d}	25.16±1.61^{d}	8.39±0.73^{b}	2.88±0.35^{b}	53.13±1.02^{d}
S3C	8.57±0.27^{d}	24.68±0.60^{d}	8.61±0.52^{b}	2.88±0.35^{b}	53.29±0.97^{d}

** The values are expressed as mean ± SEM in each treatment (n = 3). Means with the same superscripts within the same column are statistically non-significant among the groups (P>0.05).*

** CN (without fish mince, colorless), CC (without fish mince, colored), S1N (incorporated with 25% fish mince, colorless), S1C (incorporated with 25% fish mince, colored) S2N (incorporated with 30% fish mince, colorless), S2C (incorporated with 30% fish mince, colored) and S3N (incorporated with 35% fish mince, colorless) and S3C (incorporated with 35% fish mince, colored)*

the processed noodles was between 7.00±0.23 to 8.61±0.53% (Table 3). The minimum value was obtained for CC and maximum value was for sample S2C, and S3C (Table 3). Fish noodles (S1, S2, and S3) showed significantly high lipid content compared to control samples. Regarding ash content, the minor value was 2.17±0.29% in sample S1N and the major value was found 2.88±0.35% in sample S3N, and S3C.

From the statistical analysis, it was evident that the moisture content significantly increased after addition of fish mince compared to control sample. Nawaz *et al.*]22] reported 7.23% moisture content for 25% fish mince incorporated noodles and 7.45% moisture content for 30% fish mince incorporated noodles which are nearer to the results found in this study. The obtained high moisture content here, may be due to the protein contained of fish muscle which has the ability to bind water [23].

Highly significant ($p<0.001$) rise in protein content was observed in the samples with the increased amount of fish mince. Since Silver carp fish mince has 20.12±0.19% protein so the addition of fish mince caused increased protein content in the noodles. Ejembi *et. al*. [24] reported that the protein content of prepared noodles was 12.69% but in the present study protein content of the noodles prepared with fish mince was higher than the mentioned value. Protein content of fish noodles observed in this study was similar to the findings of the dried noodles prepared from motan fish meal which revealed higher content of protein in noodles with lower moisture content [25]. Mishra and Bhatt [26] found 1.14% fat content in pasta. But, the fat content found in this study is higher than the reported value and this is might be due to the inclusion of 5 ml soybean oil and different amount of silver carp muscle in the noodles. There was no noticeable change in ash content of fish noodles compared to control sample. Ash content found in this study was close to the results reported by Mishra and Bhatt [26].

The range of carbohydrate content of observed treatments was 53.13±1.02 to 74.12±1.02% (Table 3). It was also evidenced that the carbohydrate content decreased significantly with rising amount of silver carp mince. Observation of Belitz and Grosch [27] in case of carbohydrate content of noodles is more or less similar with the results of the present study.

From the table it was ascertained that there was no statistical difference in the proximate composition of colored and non-colored fish noodles. So the food color has no apparent effect on the proximate composition of the fish noodles.

3.2 Water Absorption Capacity of Cooked Noodles

Eight different cooked noodles samples were analyzed for water absorption capacity. The results are presented in Table 4.

Noodles having increasing amount of fish mince had shown significant decreasing trend in case of water absorption capacity and increasing pattern in case of cooking time. Fish meat is mainly protein so with the addition of fish meat, the starch content in the noodles was decreased, thus decreased the water absorption rate. Moreover, starch has higher water absorption rate than protein [28]. It has been stated that water absorption capacity (%) of noodles

Table 4. Water absorption capacity test of prepared noodles

Samples	Cooking time (min)	Water absorption (%)
CN	2.16±0.14^{a}	90.00±1.0^{a}
CC	2.37±0.29^{ab}	89.23±1.25^{a}
S1N	2.59±0.30^{ab}	81.33±1.53^{b}
S1C	3.01±0.21^{bc}	80.57±0.81^{b}
S2N	3.56±0.51^{cd}	76.17±0.97^{c}
S2C	3.78±0.25^{de}	77.33±1.30^{c}
S3N	4.36±0.48^{ef}	74.21±1.08^{d}
S3C	4.44±0.46^{f}	73.11±0.94^{d}

** The values are expressed as mean ± SEM in each treatment (n = 3). Means with the same superscripts within the same column are statistically non-significant among the groups (P>0.05)*

** CN (without fish mince, colorless), CC (without fish mince, colored), S1N (incorporated with 25% fish mince, colorless), S1C (incorporated with 25% fish mince, colored) S2N (incorporated with 30% fish mince, colorless), S2C (incorporated with 30% fish mince, colored) and S3N (incorporated with 35% fish mince, colorless) and S3C (incorporated with 35% fish mince, colored)*

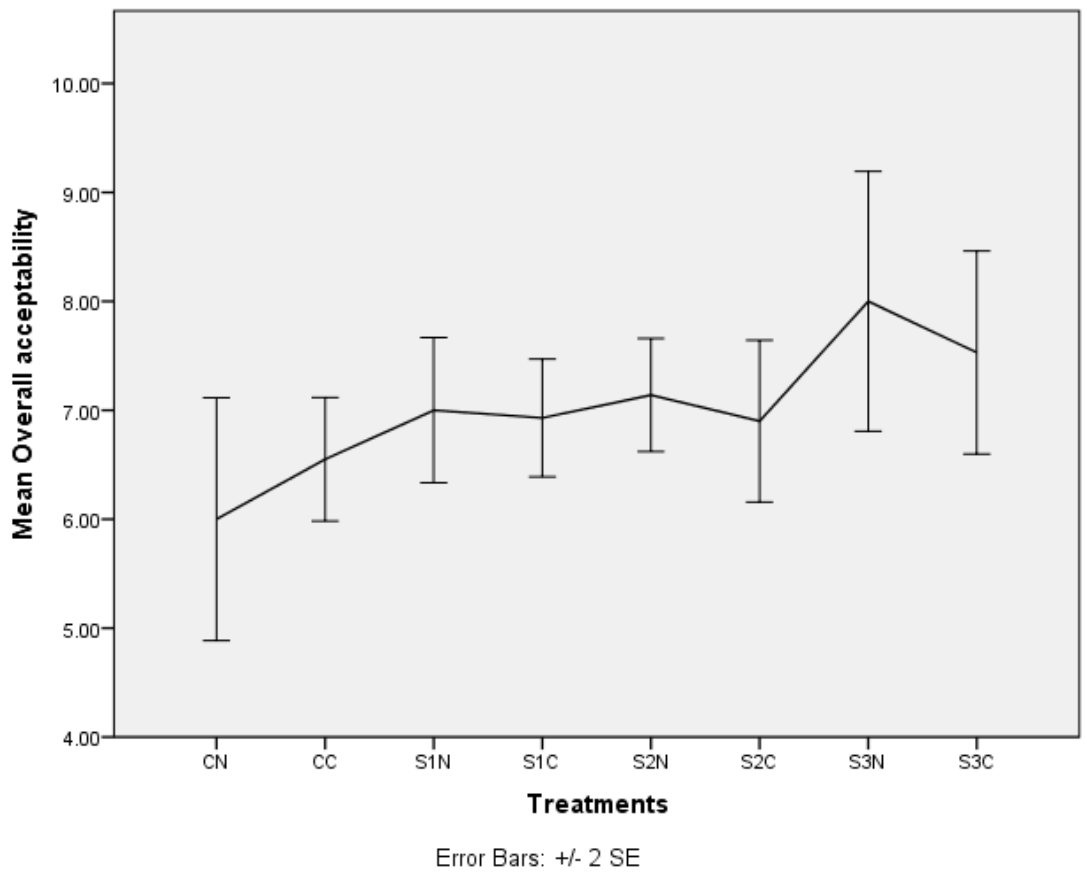

Fig. 1. The rating score for sensory parameters of the noodles given by panel members

***** *CN (without fish mince, colorless), CC (without fish mince, colored), S1N (incorporated with 25% fish mince, colorless), S1C (incorporated with 25% fish mince, colored) S2N (incorporated with 30% fish mince, colorless), S2C (incorporated with 30% fish mince, colored) and S3N (incorporated with 35% fish mince, colorless) and S3C (incorporated with 35% fish mince, colored)*

Table 5. The changes in moisture content of different types of noodles in sealed polyethylene packets

	Moisture content (%) of treatments							
Storage period (Days)	**CN**	**CC**	**S1N**	**S1C**	**S2N**	**S2C**	**S3N**	**S3C**
0	6.30±0.15^{a}	6.35±0.30^{a}	7.15±0.15^{a}	7.23±0.20^{a}	7.77±0.23^{b}	8.01±0.21^{ab}	8.33±0.29^{ab}	8.57±0.27^{a}
15	6.37±0.19^{a}	6.34±0.23^{a}	7.06±0.21^{ab}	7.23±0.20^{a}	7.88±0.11^{ab}	8.05±0.13^{ab}	8.49±0.27^{a}	8.38±0.14^{ab}
30	6.63±0.23^{a}	6.25±0.25^{ab}	6.98±0.09^{ab}	6.83±0.15^{b}	8.17±0.29^{a}	8.13±0.11^{a}	8.23±0.15^{ab}	8.47±0.37^{a}
45	6.50±0.26^{a}	6.32±0.18^{ab}	6.87±0.15^{abc}	6.60±0.31^{bc}	7.88±0.12^{ab}	7.87±0.33^{ab}	8.03±0.21^{ab}	8.46±0.47^{a}
75	6.63±0.32^{a}	6.36±0.74^{a}	6.83±0.15^{abc}	6.84±0.05^{b}	7.86±0.05^{ab}	7.79±0.20^{bc}	8.04±0.05^{ab}	8.23±0.25^{abc}
105	6.63±0.40^{a}	6.49±0.44^{a}	6.72±0.20^{bc}	6.49±0.43^{bcd}	7.68±0.25^{b}	7.88±0.11^{ab}	8.24±0.25^{ab}	7.95±0.39^{abc}
135	6.55±0.42^{a}	6.27±0.20^{ab}	6.58±0.16^{c}	6.70±0.10^{bc}	7.60±0.10^{b}	7.50±0.17^{cd}	7.88±0.42^{ab}	7.73±0.47^{bcd}
190	6.36±0.48^{a}	6.18±0.10^{ab}	6.56±0.11^{c}	6.60±0.11^{bc}	7.29±0.08^{c}	7.41±0.10^{de}	8.33±0.58^{ab}	8.27±0.52^{abc}
245	6.50±0.51^{a}	5.87±0.25^{b}	6.15±0.13^{d}	6.32±0.12^{d}	7.14±0.13^{c}	7.16±0.08^{ef}	7.69±0.16^{b}	7.62±0.14^{cd}
305	6.60±0.53^{a}	5.88±0.09^{b}	5.61±0.43^{e}	6.16±0.05^{d}	7.02±0.15^{c}	6.99±0.07^{f}	6.67±0.84^{c}	7.16±0.49^{d}

** The values are expressed as mean ± SEM in each treatment (n = 3). Means with the same superscripts within the same column are statistically non-significant among the groups (P>0.05)*

***** *CN (without fish mince, colorless), CC (without fish mince, colored), S1N (incorporated with 25% fish mince, colorless), S1C (incorporated with 25% fish mince, colored) S2N (incorporated with 30% fish mince, colorless), S2C (incorporated with 30% fish mince, colored) and S3N (incorporated with 35% fish mince, colorless) and S3C (incorporated with 35% fish mince, colored)*

Table 6. The changes in moisture content of different types of noodles in vacuum sealed packets

	Moisture content (%) of treatments							
Storage period (Days)	**CN**	**CC**	**S1N**	**S1C**	**S2N**	**S2C**	**S3N**	**S3C**
0	6.30±0.15^{a}	6.35±0.30^{a}	7.15±0.15^{abc}	7.23±0.20^{abc}	7.77±0.23^{a}	8.01±0.21^{a}	8.33±0.29^{a}	8.57±0.27^{ab}
30	6.10±0.15^{a}	6.17±0.12^{a}	7.15±0.09^{abc}	7.09±0.09^{abc}	7.70±0.15^{a}	7.68±0.34^{a}	8.16±0.12^{a}	8.10±0.12^{ab}
60	6.31±0.12^{a}	6.36±0.17^{a}	7.26±0.12^{ab}	7.29±0.20^{ab}	7.48±0.22^{a}	7.54±0.28^{a}	8.18±0.09^{a}	8.23±0.17^{a}
90	6.50±0.12^{a}	6.31±0.17^{a}	7.51±0.28^{a}	7.62±0.27^{a}	7.80±0.42^{a}	7.67±0.28^{a}	8.31±0.13^{a}	8.06±0.07^{ab}
150	6.31±0.20^{a}	6.27±0.27^{a}	7.18±0.19^{abc}	7.22±0.29^{abc}	7.56±0.28^{a}	7.59±0.27^{a}	8.36±0.23^{a}	8.12±0.18^{ab}
210	6.33±0.29^{a}	5.88±0.11^{a}	6.51±0.28^{c}	6.88±0.10^{bc}	7.00±0.34^{a}	7.07±0.38^{a}	7.91±0.31^{ab}	7.61±0.30^{ab}
270	6.34±0.29^{a}	6.34±0.27^{a}	6.80±0.20^{bc}	6.76±0.14^{bc}	7.42±0.38^{a}	7.29±0.66^{a}	7.10±0.25^{c}	7.42±0.38^{b}
360	6.02±0.80^{a}	5.99±0.29^{a}	6.75±0.22^{bc}	6.56±0.29^{c}	7.45±0.12^{a}	7.39±0.20^{a}	7.55±0.29^{bc}	7.62±0.26^{ab}

** The values are expressed as mean ± SEM in each treatment (n = 3). Means with the same superscripts within the same column are statistically non-significant among the groups (P>0.05)*

***** *CN (without fish mince, colorless), CC (without fish mince, colored), S1N (incorporated with 25% fish mince, colorless), S1C (incorporated with 25% fish mince, colored) S2N (incorporated with 30% fish mince, colorless), S2C (incorporated with 30% fish mince, colored) and S3N (incorporated with 35% fish mince, colorless) and S3C (incorporated with 35% fish mince, colored)*

supplemented with tilapia bone flour (addition of 5, 10, 15% flour by weight) were 104.25, 95.74, 92.35, 89.85, and cooking time (sec.) were 115, 110, 110, 120 respectively for the experimental samples [29]. The results obtained from this research are more or less in agreement with the present study. Finally, there was no statistically evident effect of color on cooking time and water absorption capacity of the noodles.

3.3 Sensory Evaluation of the Noodles

After cooking, the color, flavor, texture, taste and overall acceptability of 8 samples of noodles were evaluated by panel members. The result of sensory evaluation is presented in Fig.1.

The colorless noodles containing 35% fish mince (S3N) was preferred most by the panel members with mean rating score 8.00±0.60. CN was the least preferred samples by the panelists with the score of 6±0.56. The overall acceptability of fish mince based colored and non-colored noodles was significantly higher than those of control samples. The results found in this study was close to the results reported by Pascual [30].

3.4 Changes in Moisture Content during Storage

Samples of each type of noodles packed in sealed polyethylene packets and vacuum sealed packets were examined to measure the moisture content at different storage time mentioned above. The result of changes occurred in moisture content of different types of noodles in both packaging condition during storage is shown in Table 5 and Table 6.

Moisture content being an important quality parameters of dry noodles affects the shelf life of the noodles. Dried noodles having higher moisture content than the standard limit will have a shorter shelf life [31]. In case of samples packed in sealed polyethylene packets, S1N showed the lowest value (5.61±0.43%) and S3C showed the highest amount (8.57±0.27%) of moisture content. Apart from CN and CC, moisture content of all other treatments decreased significantly during the storage period. It may be due to surrounding environment and low permeability of the polyethylene packets. Among the treatments, moisture content remained significantly higher in fish incorporated noodles compared to the control samples (CN and CC) during the storage time of 305 days.

The moisture content of the samples packed in vacuum sealed bag was in the range of 5.88±0.11 (CC) to 8.57±0.27% (S3C) during 360 days of storage. All the samples have manifested non-significant changes in the moisture content during the experimental period which indicates that vacuum sealed bag provides good protection against moisture loss compared to sealed plastic bag. It's because vacuum packaging involves the use of a low O_2 permeable package and sealing after air evacuation [32].

It has been observed that the moisture concentration of the pasta is lowered from approximately 30% to less than 12.5% after drying [33]. Moreover, it is suggested that pasta and noodles should not have more than 13% moisture to prevent the growth of pathogens and spoilage micro-organism [34]. Ranges of moisture content of all the samples throughout the storage time remained much lower than 12.5% which indicates that products were in good condition.

Besides, results found from the changes in moisture content in both cases of the samples packed in sealed polyethylene packets and vacuum sealed packets were nearer to the results obtained by Shikha *et. al.* [35].

3.5 Evaluation of Sensory Properties During Storage

No remarkable changes of color, flavor and texture for the experimental noodles were found while packed in sealed polyethene packets. The color and flavor was acceptable and the texture was also crispy after 305 days of storage. No mold growth was observed in the samples during this storage period. Almost similar result was obtained for products stored at vacuum sealed samples. This result coincides with the results obtained by Shikha et. al. [35].

4. CONCLUSION

From the present study it can be inferred that the increasing quantity of fish mince was accountable for an increased amount of moisture, protein, fat, and decreased amount of carbohydrate in prepared noodles. The inclusion of fish mince also reduced water absorption capacity and enhanced the cooking time of the noodles. Colorless noodles with 35% fish mince was liked most by the panelist. Food color had no marked effect on the proximate composition, storage period, cooking time, water absorption

capacity and sensory properties of noodles prepared with fish mince. Both colored and non-colored fish noodles can be stored in both sealed polyethylene packets and vacuum sealed packets at room temperature (30-35ºC) for at least 10 months with acceptable moisture content and sensory properties. Vacuum packaging is recommended to store the products as it has the potential to keep the products in good condition for longer period of time without any significant change when compared with sealed polyethylene packets. Further studies should be conducted to determine the changes in protein and lipid content together with microbial load of fish noodles during storage to understand the nutritional benefits and safety of stored products.

ETHICAL STATEMENT

All the participants were informed about the panel test and permission was taken.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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