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Development and Standardization of Tilapia (*Oreochromis niloticus*) Fish Fingers Fortified with Moringa Leaves Powder

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ABSTRACT

The investigation was conducted during the period of November, 2024 to January, 2025 at the Department of Fish Processing Technology and Microbiology, College of Fisheries, Ratnagiri, Maharashtra, India to develop and standardize the recipe for fish fingers fortified with moringa leaves powder. Nile tilapia (*Oreochromis niloticus*) contained protein, vitamins, minerals and essential fatty acids. Tilapia was high in polyunsaturated fatty acids (PUFA), particularly the Omega-3 PUFA namely eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA). These nutrients were all essential for the nutritional stability of humans. Tilapia was odourless and lean fish which made it potentially perfect raw material for making ready-to-eat fish products. The yield of fish mince from whole tilapia was 33.91%. The "drumstick" or "horseradish" tree, Moringa (*Moringa oleifera*), belonged to the Moringaceae family. It was a readily available source of essential nutrients and nutraceuticals that might help to prevent malnutrition. Moringa leaf flour was high in nutrients and contained four times the calcium of milk, 25 times the iron of spinach, six times the zinc of almonds, and twice the protein of yogurt, which might help to combat malnutrition. For the preparation of fish fingers fortified with moringa, various treatments were formulated viz., Fish meat, moringa leaves powder and potato. The fish fingers were prepared with standardized quantity of fish meat (25.36%), moringa leaves powder (0.97%) and potato (24.39%).

KEYWORDS: Fish, fingers, moringa, standardization, tilapia, meat, leaf powder

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1. INTRODUCTION

Fish is the most affordable and excellent source of animal protein and nutrients for people all over the world. (Penarubia et al., 2023). It is a nutritious food, that is high in micronutrients and contains polyunsaturated fatty acids (PUFA), particularly the Omega-3 PUFA eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and high-quality animal proteins. The World Health Organization (WHO) suggested consuming one or two servings of fish each week which will supply the recommended 200–500 mg of omega-3 polyunsaturated fatty acids (Raimi and Salami, 2025). In addition, compared to other forms of animal protein, fish are more readily available and reasonably priced (Mohanty et al. 2019). Fisheries and aquaculture are essential in solving these issues because they support the development of livelihoods, food security and nutrition (Mangale et al., 2024). World food-fish supplies are increasingly derived from aquaculture, which has also raised world food-fish supplies per capita (Beveridge et al. 2013). The Nile tilapia is often called the "aquatic chicken." It can be considered a fish for the people or a staple for those who are poor. (El-Sayed and Fitzsimmons, 2023). The odourless, lean, white-fleshed tilapia makes it a potentially ideal raw material for the production of fish products that are ready to eat (Dhanapal et al., 2016). Due to the strong export potential, Nile tilapia, a lacustrine fish are widely raised in tropical and subtropical regions of the world with an annual growth rate of 11.5%. (Olopade et al., 2017). Due to its inexpensive price, tilapia is in high demand in India. *Moringa oleifera* provides an excellent nutritional balance, including vitamins, minerals, fatty acids, and amino acids. Moringa significantly reduces blood sugar, lowers cholesterol, and boosts antioxidant levels in humans without any negative side effects (Stohs and Hartman, 2015). Butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT), two synthetic antioxidants, are frequently utilized to preserve the meat products. The latest global developments in the agricultural sector have opened up various opportunities for the global business or trading in agricultural commodities, thus WTO agreements in this regard can be viewed as an endorsement (Chaturvedi, 2016). Human intake of synthetic antioxidants has caused concerns. Therefore, in order to increase the shelf life of meat products, investigators are looking for natural alternatives. *Moringa oleifera* leaves have potential as a natural food preservation ingredient (Isra et al., 2024). Moringa leaf flour has twice the protein of yogurt, four times the calcium of milk, 25 times more iron than spinach and six times more zinc than almonds (Haruni et al., 2024). The demand for ready-to-cook or ready to serve seafood products, as well as hygienically prepared and appealing packaged convenience foods is rising in response to the shifting demands of the urban population (Praneetha et al., 2015). Value-added fish products, such as fish fingers promote livelihoods in villages and create jobs contributing to the economic viability (Kyule et al., 2025). Fish fingers are ready-to-cook and have a delightful flavor, making them highly convenient. (Talab et al., 2022). There is a great scope for increasing the fish consumption in India and marketing in variety of value-added products in the form as whole, filleted, steaks, smoked, cured and marinated products. (Pawar et al., 2012). Natural antioxidants have been gaining popularity among consumers since they are thought to be safer than synthetic ones. (Dubeni et al., 2025). The main objective of this study was to standardize the recipe of tilapia fish fingers fortified with moringa leaves powder.

2. MATERIALS AND METHODS

The investigation was conducted during the period of November to January (2024–2025) at Department of Fish Processing Technology and Microbiology, College of Fisheries, Ratnagiri. The main objective of this study was to standardize the recipe of tilapia fish fingers fortified with moringa leaves powder.

2.1. Raw materials

Freshly caught tilapia fish (*Oreochromis niloticus*) were procured from Marine Biological Research Station (MBRS) of Ratnagiri and transported to the processing laboratory of the college, by maintaining a chilled condition with 1:1 (w/w) ice: fish in insulated box. The tilapia fish selected for present research work had an average length of 17.77±1.34 cm and the average weight 361±30.56 g was used. The moringa (*Moringa oleifera*) leaves were freshly plucked from the tree. The raw material was thoroughly washed under running tap water and then sun dried for 5 consecutive days.

The whole tilapia (*Oreochromis niloticus*) was washed with potable water. The scales, fins, gills and gut content was removed. The remaining non-edible material was removed from the fish by carefully washing them after they have been descaled and gutted. Fish meat was prepared as per the method of Gedam et al. (2024) Moringa (*Moringa oleifera*) leaves powder was prepared as per the methodology of Isra et al. (2024). The moringa leaves were plucked freshly from the tree. The leaves were thoroughly washed in tap water and subjected for drying. The leaves were sun dried for five consecutive days and then crushed using mixer grinder.

2.2. Percentage yield of separated fish meat

The initial weight of whole fishes was weighed. After dressing and boiling, fish meat was separated and the weight of separated fish meat was recorded. The percentage yield was calculated by taking the difference of initial and final weight (Bhor et al., 2025).

2.3. Preparation of batter mix

Batter was prepared as per the methodology of Mangale et al. (2024) by adding refined wheat flour (maida), bengal gram flour, corn flour, salt, turmeric powder, and CMC (carboxymethyl cellulose).

2.4. Standardization of fish finger fortified with moringa (FFFM)

2.4.1. Standardization of fish meat for the preparation of fish finger fortified with moringa (FFFM)

Fish fingers were prepared as per the methodology of Mangale et al. (2024) by replacing shrimp meat with tilapia fish meat. Different quantities of tilapia fish meat were added in fish fingers viz. 54, 53, 52, 51 and 50 g as mentioned in Table 1.

2.4.2. Standardization of moringa leaves powder for the preparation of fish finger fortified with moringa (FFFM)

After standardization of fish meat in fish fingers, moringa leaves powder were standardized. Different quantities of moringa leaves powder was added in fish fingers viz. 0, 1, 2, 3 and 4 g (Table 1).

2.4.3. Standardization of potato for the preparation of fish finger fortified with moringa (FFFM)

After standardization of moringa leaves powder in fish fingers, standardization of potato was carried out. Different quantity of potato was added in fish fingers viz. 45, 40, 50, 55 and 60 g (Table 1).

2.7. Organoleptic evaluation

Formulated fish fingers were evaluated for various attributes such as appearance, colour, texture, taste, odour and overall acceptability by a group of panellist using a 0 to 9 hedonic scale.

2.8. Statistical analysis

The data were analyzed statistically by using the appropriate statistical methods of Snedecor and Cochran, 1967.

3. RESULTS AND DISCUSSION

3.1. Percentage yield of separated fish meat

Fresh tilapia fish (*Oreochromis niloticus*) having the average length of 17.77±1.34 cm and the average weight 361±30.56 g were used in the present study. The percentage yield of fresh fish meat was recorded as 33.91±0.29% in the present study. Dhanapal et al. (2016) reported the yield of tilapia fish meat with 33.39%.

Similar result was noted by Ninan et al. (2008) with the tilapia yield of 33.2% from whole tilapia. The percentage yield of fresh fish meat from Tilapia (*Oreochromis niloticus*) was 33.91±0.29%.

3.2. Standardization of fish finger fortified with moringa (FFFM)

Table 1: Different treatments formulated for standardization of recipe for tilapia fish fingers fortified with moringa

Sl. No.	Ingredients	T_1	T_2	T_3	T_4
1.	Fish meat	53	52	51	50
2.	Moringa leaves powder	1	2	3	4
3.	Cooked potato	45	40	50	55
4.	Table salt	1.48	1.48	1.48	1.48
5.	Oil	5.9	5.9	5.9	5.9
6.	Green chilly	3.52	3.52	3.52	3.52
7.	Coriander leaves	3.52	3.52	3.52	3.52
8.	Ginger	3.52	3.52	3.52	3.52
9.	Garlic	3.52	3.52	3.52	3.52
10.	Onion	9	9	9	9
11.	Pepper powder	0.16	0.16	0.16	0.16
12.	Clove powder	0.16	0.16	0.16	0.16
13.	Cinnamon powder	0.04	0.04	0.04	0.04
14.	Turmeric powder	0.04	0.04	0.04	0.04
15.	Breadcrumbs	11.96	11.96	11.96	11.96
Batter mix					
16.	Refined wheat flour (maida)	45.74	45.74	45.74	45.74
17.	Corn flour	5	5	5	5
18.	Bengal gram flour	5.9	5.9	5.9	5.9
19.	Salt	0.7	0.7	0.7	0.7
20.	Turmeric powder	0.04	0.04	0.04	0.04
21.	Carboxymethyl cellulose (CMC)	0.56	0.56	0.56	0.56

3.2.1. Standardization of different level of fish meat for the preparation of fish finger fortified with moringa

Battered and breaded fish finger fortified with moringa leaves powder were prepared with control (54 g) and four different treatments such as T_1 (53 g), T_2 (52 g), T_3 (51 g) and T_4 (50 g) of fish meat by replacing the shrimp meat. Based on the organoleptic evaluation, the fish meat concentration of 52 g (T_2) was more acceptable as compared to other four treatments with overall acceptability score of 8.9 (Figure 1). The statistical analysis confirmed that fish fingers prepared with varying levels of fish meat exhibited significant differences (p<0.05). Further validation through

Table 2: Percentage yield of tilapia fish mince

Particulars of dressing	Yield (%)
Whole raw fish	100
Separated fish meat	33.91±0.29

Tukey's test indicated that the battered and breaded fish fingers prepared with 52 g of fish meat (T_2) were superior in sensory quality compared to other treatments. Consequently, the T_2 formulation was selected for preparation of fish fingers fortified with moringa leaves powder. The finalized quantities of ingredients used in the preparation of moringa-fortified fish fingers were presented in Table 3. The final standardised quantity of fish meat in % was 25.36%.

These results were agreed with the Mangale et al. (2024) where the different level of shrimp meat was standardized by maintaining the same quantities of other ingredients, among all the treatments 27% shrimp meat was found more acceptable and shrimp fingers was prepared.

Table 3: Organoleptic score for standardization of fish meat

Attributes	Control	T_1	T_2	T_3	T_4
Appearance	7.80±0.78^{ab}	7.60±0.69^{a}	8.60±0.51^{b}	7.50±0.70^{a}	7.50±0.84^{a}
Odour	7.80±0.78^{a}	7.50±0.70^{a}	8.80±0.42^{b}	7.40±0.69^{a}	7.60±0.51^{a}
Colour	8.00±0.66^{ab}	8.20±0.63^{ab}	8.50±0.52^{b}	7.80±0.63^{ab}	7.60±0.84^{a}
Texture	7.60±0.51^{a}	7.30±0.48^{a}	7.30±0.48^{a}	7.70±0.82^{a}	7.40±1.07^{a}
Taste	7.90±0.56^{a}	7.60±0.69^{a}	8.80±0.42^{b}	7.80±0.78^{a}	7.50±0.84^{a}
Overall acceptability	8.00±0.47^{a}	7.60±0.69^{a}	8.90±0.31^{b}	7.40±0.69^{a}	7.40±0.51^{a}

3.2.2. Standardization of different level of moringa leaves powder for the preparation of fish finger fortified with moringa

After standardization of fish meat in fish fingers, moringa leaves powder were standardized. Different quantities of moringa leaves powder was added in fish fingers viz. control (0 g), T_1 (1 g), T_2 (2 g), T_3 (3 g) and T_4 (4 g). The moringa leaves powder concentration of 2 g (T_2) was more acceptable with overall acceptability score of 8.4 (Table 4). Statistical analysis confirmed that fish fingers prepared with varying levels of moringa leaf powder showed significant differences (p<0.05). Tukey's test further validated that the MLP2 formulation was superior in sensory quality compared to the other treatments. Therefore, the T_2 treatment was selected for subsequent studies. The final concentration of moringa leaves powder used to prepare standardised fish finger fortified with moringa leaves powder was 0.97%.

Similarly, Isra et al. (2024) prepared pangasius fish balls incorporated with moringa leaves powder with different level of moringa leaves powder, among all the treatments 1% was more superior.

3.2.3. Standardization of different level of potato for the preparation of fish finger fortified with moringa

After standardization of moringa leaves powder in fish fingers, standardization of potato was carried out. Different quantity of potato was added in fish fingers viz. control (45 g), T_1 (40 g), T_2 (50 g), T_3 (55 g) and T_4 (60 g). The potato concentration of 50 g (T_2) was more acceptable with overall acceptability score of 8.6 (Table 5). Among these, the T_2 treatment containing 50 g of potato received the highest overall acceptability score of 8.6. Statistical analysis confirmed that fish fingers prepared with varying levels of potato showed significant differences (p<0.05) Tukey's test further validated that the T_2 formulation was superior in sensory quality compared to the other treatments. Therefore, the T_2 treatment was selected for further study.

Based on the different level, the potato was standardized by Mangale et al. (2024) while maintaining the same quantities of other ingredients, among all the treatments 22.5% was more superior.

3.2.4. Standardized recipe of different ingredients used for the preparation of fish finger fortified with moringa

For the preparation of fish fingers fortified with moringa, three ingredients were standardized viz. fish meat, moringa leaves powder and potato. These standardized quantities were obtained from organoleptic evaluation by panellist after forming various treatments. By applying Tukey test to

Table 4: Organoleptic score for standardization of moringa leaves powder

Attributes	Control	T_1	T_2	T_3	T_4
Appearance	7.90±0.73^{ab}	7.40±0.69^{a}	8.70±0.48^{b}	7.80±0.63^{a}	7.50±0.70^{a}
Colour	7.80±0.63^{a}	7.60±0.51^{a}	8.80±0.42^{b}	7.60±0.51^{a}	8.80±0.4^{2a}
Odour	7.60±0.69^{a}	7.50±0.52^{a}	8.70±0.48^{b}	7.10±0.99^{a}	6.90±1.10^{a}
Texture	7.50±0.84^{a}	7.60±0.84^{a}	8.70±0.48^{b}	7.30±0.82^{a}	7.40±0.84^{a}
Taste	7.60±0.84^{a}	7.50±0.52^{a}	8.70±0.48^{b}	7.20±0.63^{a}	6.90±0.73^{a}
Overall acceptability	8.00±0.47^{bc}	7.50±0.52^{ab}	8.40±0.84^{c}	7.30±0.67^{ab}	7.10±0.56^{a}

Table 5: Organoleptic score for standardization of potato

Attributes	Control	T_1	T_2	T_3	T_4
Appearance	7.60±0.51[a]	7.80±0.78[a]	8.40±0.51[a]	7.60±0.69[a]	7.60±0.96[a]
Colour	7.90±0.56[ab]	7.50±0.70[a]	8.40±0.51[b]	7.20±0.63[a]	7.30±0.82[a]
Odour	7.80±0.42[ab]	7.80±0.63[ab]	8.50±0.52[b]	7.80±0.78[ab]	7.40±0.84[a]
Texture	7.60±0.51[a]	7.20±0.42[a]	8.70±0.48[b]	7.20±0.63[a]	7.30±0.48[a]
Taste	7.80±0.63[ab]	7.20±0.42[a]	8.50±0.52[b]	7.40±0.69[a]	7.10±0.8[7a]
Overall acceptability	7.90±0.31[ab]	7.30±0.48[a]	8.60±0.51[b]	7.40±0.69[a]	7.30±0.94[a]

the obtained organoleptic score given by panellist, the final standardized quantity of selected ingredients was obtained in gram and then converted into percentage as fish meat 25.36% (52 g), Moringa 0.97% (1 g) and potato 24.39% (50 g) (Table 6).

Table 6: Percentage composition of standardized ingredients along with other ingredients used for the preparation of fish finger fortified with moringa

Sl. No.	Ingredients	Quantity (%)
1.	Fish meat	25.36
2.	Moringa leaves powder	0.97
3.	Cooked potato	24.39
4.	Table salt	0.72
5.	Oil	2.87
6.	Green chilly	1.71
7.	Coriander leaves	1.71
8.	Ginger	1.71
9.	Garlic	1.71
10.	Onion	4.39
11.	Pepper powder	0.07
12.	Clove powder	0.07
13.	Cinnamon powder	0.02
14.	Turmeric powder	0.02
15.	Breadcrumbs	5.83
Batter mix		
16.	Refined wheat flour (maida)	22.31
17.	Corn flour	2.43
18.	Bengal gram flour	2.87
19.	Salt	0.34
20.	Turmeric powder	0.13
21.	Carboxymethyl cellulose (CMC)	0.27
Total		99.90%

4. CONCLUSION

Battered and breaded fish fingers fortified with moringa prepared using a standardized recipe were excellent in taste, texture, colour, odour, and good overall. Therefore, fish fingers fortified with moringa present a promising value-added convenience food and meets the consumer demand for tasty, ready-to-cook products.

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