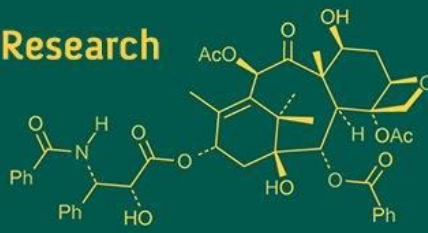


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Effect of chilled storage on quality characteristics of battered and breaded shrimp fingers prepared from kiddi shrimp (*Parapenaeopsis styliifera*) (H. Milne Edwards, 1837)

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Abstract

This study was performed to determine quality changes of battered and breaded pre-fried shrimp fingers developed from kiddi shrimp (*Parapenaeopsis styliifera*) stored at chilled temperature (0 °C to 4 °C). Quality changes were assessed based on biochemical, microbiological and sensory quality evaluation at one day interval for a period of 20 days. Results of biochemical analysis showed increase in Total Volatile Base-Nitrogen (TVB-N) values from initial value of 2.43 to 32.42 mg/100 g, TMA value increased from 8.81 to 10.41 mg/100 g and pH increased from 6.51 to 6.89 during 20 days chilled storage. In microbiological quality evaluation total plate count (Log. Values) increased from 2.43 to 4.51, while *Escherichia coli*, *Staphylococcus aureus* and *Salmonella* were absent during storage period. Results of sensory analysis reported a negative correlation with storage period concluding the shelf life of battered and breaded shrimp fingers to be 14 days at chilled storage conditions.

Keywords: Shrimp fingers, *P. styliifera* (Tiny shrimp), shelf life, quality changes, battered and breaded product, chilled storage

Introduction

Consumption of fish provides quality protein and a range of other nutrients, such as essential fats, minerals and vitamins. Fish accounts for about 17% of the global consumptions of animal protein. This share, even be more than 50% in some countries. At present seafood assist in reducing the food crisis in several developing countries like India by providing valuable nutritious supplement to diet. Also, the demand of seafood for direct consumption increased as evidenced by gradual rise in the seafood consumption throughout the world. In India, millions of people suffer from malnutrition. Protein deficiency can be minimized to some extent by making inexpensive seafood accessible to local communities.

People rarely have time to cook in the modern world, resulting in the demand for "ready to cook" or "ready to serve" foods. Fishery products also have a significant impact on meat consumers in this category. To meet the evolving requirements of the urban population, fisheries products are now processed hygienically and attractively packaged as convenience foods, in contrast to earlier times. Fishery goods that are ready to cook or serve are well-liked by consumers both in the international and Indian markets. If it is prepared using catch and discards, it will further boost the nation's and the producers' economic growth.

One of the important penaeid shrimp species widely distributed in Indian waters is *Parapenaeopsis styliifera* also known as kiddi shrimp or marine shrimp harvested in large quantities from shallow waters, abundantly in the south-west coast from May to September and the peak season of catch is especially in the monsoon season. This species is one of the most commercially exploited Indian shrimp species. It is a small-sized shrimp hardly found growing beyond 135 mm in total length (Suseelan *et al.* 1989; Gopan *et al.* 2020) [18, 10]. Because of the increasing realization of valuable foreign exchange, value addition is the most frequently used term in food processing, especially in the export-oriented fish processing industry.

Fish and fisheries goods can be given more value based on the demands of the various markets. These goods include everything from live fish and shellfish to convenience foods that are ready to eat. Value addition, in general, refers to any additional actions that, in some way or another, alter the nature of the product and increase its value at the point of sale. Value addition is one strategy that might be used to increase profitability in the fish processing sector because it is becoming more and more expensive and highly competitive. (Datta, 2015) [6]

Therefore, to increase the profitability and development of value-added ready-to-cook products from shrimp (kiddi shrimp) is an urgent need for utilization for human consumption. However, there are almost no studies on shrimp-based value-added products from kiddi shrimp. The aim of this study was to prepare battered and breaded shrimp fingers from kiddi shrimp and to evaluate storage characteristics viz., biochemical (pH, TMA and TVB-N), microbial (TPC, *E. coli*, *S. aureus* and salmonella sp.) and sensory quality changes during its storage in refrigerated unit (0 °C to 4 °C).

Materials and Method

Sample preparation: Fresh Kiddi shrimp (*P. stylifera*) procured from a local fish market and brought to the processing hall under iced condition. The shrimp were washed thoroughly with potable water, dressed, washed again with potable water, blanched in boiling water for 15 minutes, and cooked, then stored in a deep freezer at a temperature of -14 °C until further use. As and when required, blanched shrimp was taken out and thawed before use. Using standardized recipe shrimp fingers were prepared. The shrimp fingers included cooked shrimp meat (27%), table salt (0.74%), oil (2.95%), green chili, coriander leaves, ginger and garlic (1.76%), onion (4.5%), potato (22.5%), pepper and clove powder (0.08%), cinnamon and turmeric powder (0.02) and breadcrumbs (5.98%). The standardized batter mix (Pagarkar *et al.* 2012) was prepared using 22.87% refined wheat flour, 2.5% corn flour, 2.95% Bengal gram flour, 0.35% salt, 0.14% turmeric powder, 0.28% carboxy methyl cellulose (CMC) which were mixed with water in the ratio of 1:2 and was blended to homogeneity. After the batter coating, the meat base was covered with bread crumbs, they were flash fried at 180 °C for 30 sec. The shrimp fingers were packed in trays covered with LDPE polythene bags, sealed, and kept at a chilled temperature (0 to 4 °C).

Analysis

Proximate composition viz., moisture, crude protein, crude lipid, carbohydrate and ash of raw shrimp and shrimp fingers on the initial day of production and at the end of the storage were analyzed. Chemical quality analysis was performed in triplicate. Chemical, microbiological and sensory quality was assessed during the storage study. Proximate composition in terms of moisture, crude protein, fat, ash and carbohydrate content was determined according to AOAC standard methods (AOAC, 2005) [2]. Microbiological analysis Total plate count, *Escherichia coli*, *Staphylococcus aureus* and *Salmonella* sp. were done according to standard methods (USFDA, 2001) [22]. Chemical quality pH was determined from the homogenized mixture of shrimp fingers sample and distilled water (1:10, w: v) and then filtered using filter paper and the pH of the

filtrate was recorded using a pH meter (AOAC, 2005) [2]. TMA and TVB-N contents of shrimp fingers were determined by the procedure given by (Beatty and Gibbons, 1938) [3] using Conway micro-diffusion units and results were expressed in terms of nitrogen mg/100 g. Sensory quality of shrimp fingers was assessed by 5 trained panelists. The cutlet was deep-fried in sunflower oil until they were cooked to golden brown colour before being presented to the panelists. Panelists scored for appearance, colour, taste, texture, odour and overall acceptability using a nine-point hedonic scale (1-very poor to 9-Excellent) for product acceptability. Statistical analysis data were analyzed to test significant difference by applying the analysis of variances (ANOVA) tool available in MS-Excel 2007. The significant differences were tested by a 5% level of significance and are mentioned.

Results and Discussion

The sample was drawn randomly on one-day intervals up to 20 days of refrigerated storage to analyze proximate, sensory, microbiological and biochemical parameters. Microbial analysis was first carried out aseptically and afterward, the product was brought to room temperature for carrying out the proximate, biochemical and sensory analysis. The first analyses were carried out on the 0th day of preparation of the product and all the parameters were analyzed in triplicate. Mean sensory numerical scores were obtained based on the assessment carried out by five panelists.

The moisture, crude protein, fat, carbohydrate and ash contents in fresh shrimp meat (*P. stylifera*) were 72.80%, 18.22%, 6.40%, 1.03% and 0.90%, respectively on a wet weight basis. Similarly with slight variation reported by Gopan *et al.* (2020) [10] the values of moisture, protein, lipid, carbohydrate and total ash were found as 73.03%, 18.24%, 6.51%, 1.02 and 1.02%, respectively in *P. stylifera*.

The percentage of moisture was found to be 59.6%, crude protein 18.4%, crude fat 13.45%, carbohydrate 6.3% and ash 2.25% in battered and breaded shrimp fingers. The battered and breaded shrimp fingers, which were placed in a refrigerated display unit (0 °C to 4 °C), exhibited a slight decline in their moisture (59.6 to 58.98), protein (18.4 to 14.28), and carbohydrate (6.3 to 5.08) levels over the duration of the storage study. In contrast, the same sample showed an increase in its fat (13.45 to 17.8) and ash (2.25 to 3.85) content.

The increase in fat and reduction in moisture content in shrimp fingers is due to deep frying as well as dehydration during chilled storage (Ninan *et al.* 2008 and Rathod *et al.* 2014) [13, 17]. The reduction of protein is due to the denaturation of fish muscle during chilled and frozen storage (Gopakumar, 2002 and Rathod *et al.* 2014) [9, 17]. The reduction in protein content can be attributed to the leaching out of the water-soluble nitrogenous components, during storage along with moisture. Cooking can be a possible reason for the reduction in protein content. The increase in fat can be attributed to the decrease in moisture content as they are inversely proportional. An increase in fat content may also be attributed to cooking of the product in oil (Tokur *et al.* 2006) [121]. The higher amount of carbohydrates in the products might be derived from coating materials that contain carbohydrate-rich ingredients such as bread crumbs (Praneetha *et al.* 2015) [14].

Praneetha *et al.* (2015) ^[14] reported the moisture and protein content of fish fingers prepared from rohu during refrigerated storage kept for 11 days decreased significantly from 64.90% to 57.36% and 18.5% to 16.29% ($p < 0.01$) respectively while fat and ash content were increased significantly from 8.68% to 15.33% and 2.5% to 3.43% ($p < 0.01$) respectively.

Chemical quality parameters during storage:

The slight increase in pH value may be a result of volatile compounds liberated as the effect of enzymatic and microbial decay as reported by (Chaijan *et al.* 2005) ^[4]. Changes in pH can be used as an indicator of the degradation of muscle components, e.g., proteins and nucleotides during storage (Hassan *et al.* 2012) ^[11]. In the present study, battered and breaded shrimp fingers showed a slight increase in pH from 6.51 to 6.89 when stored in a refrigerated display unit (0 °C to 4 °C). Pawar *et al.* (2019) ^[16] reported the initial pH of cutlets prepared from Catla was 6.5 ± 0.02 which increased slightly to 6.79 ± 0.01 during 18 days of storage in chilled storage conditions (0 to -4 °C). Hassan *et al.* (2012) ^[11] reported that battered and breaded oyster product showed a slightly increased pH from 6.77 to 8.33 in chilled storage.

Trimethylamine (TMA) is produced by the decomposition of trimethylamine N-oxidase caused by bacteria spoilage and enzymatic activity. The acceptable TMA value for fish is stated as 5-10 mg/100 g. Hassan *et al.* (2012) ^[11] reported that battered and breaded oyster product showed an increase in TMA values from 1.38 to 14.07 in chilled storage. Kolade, (2015) ^[12] reported the TMA values of fish roll samples stored in refrigerated storage increased with time but remained within acceptable limits. TMA values for the fish products ranged between 6.41-7.85(FR1), 6.57-7.05(FR2), 6.4-7.54(FR3), 4.56-7.87(FR4), 6.02-9.15(FR5) and 6.7-8.63(FR6). In the present study, shrimp fingers showed increasing value of TMA from 8.81 to 10.41 during 20 days of chilled storage.

TVB-N (Total volatile base-nitrogen) is a commonly used chemical method to determine spoilage of fish. (Tokur *et al.* 2004) ^[20]. Total volatile base nitrogen is known as a product of bacterial spoilage and endogenous enzyme action and its content is often used as an index to assess the quality and shelf life of products (EEC, 1995) ^[8]. Chomnawang *et al.* (2007) ^[5] stated that the increasing TVBN value during storage is related to bacterial spoilage, activity of endogenous enzymes and degradation of tissue proteins. According to Adebona (1978) ^[1] increase in TVBN with length of storage is mainly attributed to the production of ammonia. TVB-N value of shrimp fingers was increased

from 2.43 to 32.42 mg/100 g during refrigerated storage. Similar results were found by Rathod *et al.* 2014 ^[17] in fish cutlets made from pangasius fish during refrigerated storage the TVB-N values increased from 2.52 to 22.4 mg/100 g. Hassan *et al.* (2012) ^[11] reported the changes in TVB-N values of oyster product in ready-to-fry form during refrigerated storage was 7.35 to 36.16 during 14 days of storage.

Microbial changes

The Total Plate Count (TPC) of the shrimp fingers in chilled storage was increased from 2.7×10^2 to 3.3×10^4 cfu/g and other pathogenic bacteria viz. *Staphylococcus aureus*, *Salmonella* sp. and *Escherichia coli* were absent during the storage study. Rathod *et al.* (2014) ^[17] showed similar results the total plate count (TPC) of the cutlet made from pangasius in storage was increased from 1.4×10^2 to 2.2×10^4 cfu/g during 18 days of chilled storage and other pathogenic bacteria viz. *Staphylococcus aureus*, *Salmonella* sp. and *Escherichia coli* were not detected during the storage study. Praneetha *et al.*, (2015) ^[14] reported the TPC count of chilled stored fish fingers was 5.68×10^2 cfu/g to 1.72×10^5 cfu/g.

Sensory quality

The result of the organoleptic evaluation of shrimp fingers kept in storage (0 °C to 4 °C) showed a slight decrease in overall acceptability when the storage period increased from 0 to 20 days. The shrimp fingers kept in chilled storage were not in acceptable condition after 14 days. An increase in metabolic activity during storage may render a product undesirable. (Pawar *et al.* 2019) ^[16].

Praneetha *et al.* (2015) ^[14] reported the ideal shelf life for storing the fish finger in refrigerated condition was found to be 9 days. The overall mean acceptability scores declined significantly. Duman *et al.* (2018) ^[7] prepared nuggets from fresh and smoked rainbow trout during chilled storage. Sensory quality scores of smoked nuggets were significantly higher than fresh nuggets. The shelf life of fish nuggets was found to be 24 days for fresh nuggets and 27 days for smoked nugget samples according to sensory assessment results. Hassan *et al.* (2012) ^[11] chill store battered and breaded oyster product named oyster pablano pepper fritter in pre-fried and fried form. Sensory quality attributes of products decreased on storage and under chilled storage, ready-to-fry samples got spoiled on the 10th day and ready-to-eat products on the 14th day as indicated by sensory scores.

Biochemical characteristics of shrimp fingers during chilled storage

Storage period (Days)	pH	TMA	TVB-N
0	6.51 ± 0.11^p	8.81 ± 0.01^p	2.43 ± 0.01^p
2	6.56 ± 0.11^{pq}	8.87 ± 0.01^p	4.34 ± 0.01^q
4	6.58 ± 0.11^{qr}	9.01 ± 0.01^q	5.31 ± 0.02^r
6	6.63 ± 0.11^{rs}	9.00 ± 0.02^q	8.19 ± 0.02^s
8	6.67 ± 0.11^{st}	9.06 ± 0.01^{qr}	12.2 ± 0.02^t
10	6.69 ± 0.01^t	9.13 ± 0.02^r	16.80 ± 0.02^u
12	6.72 ± 0.11^{tu}	9.36 ± 0.02^s	19.35 ± 0.02^v
14	6.76 ± 0.11^{uv}	9.53 ± 0.01^t	22.47 ± 0.02^w
16	6.81 ± 0.01^{vw}	9.78 ± 0.01^u	25.60 ± 0.02^x
18	6.84 ± 0.11^{wx}	10.02 ± 0.03^v	28.77 ± 0.02^y
20	6.89 ± 0.11^x	10.41 ± 0.01^w	32.42 ± 0.02^z

Each value is represented as the Mean $\pm$ SD of n = 3.

Microbial changes in shrimp fingers during chilled storage

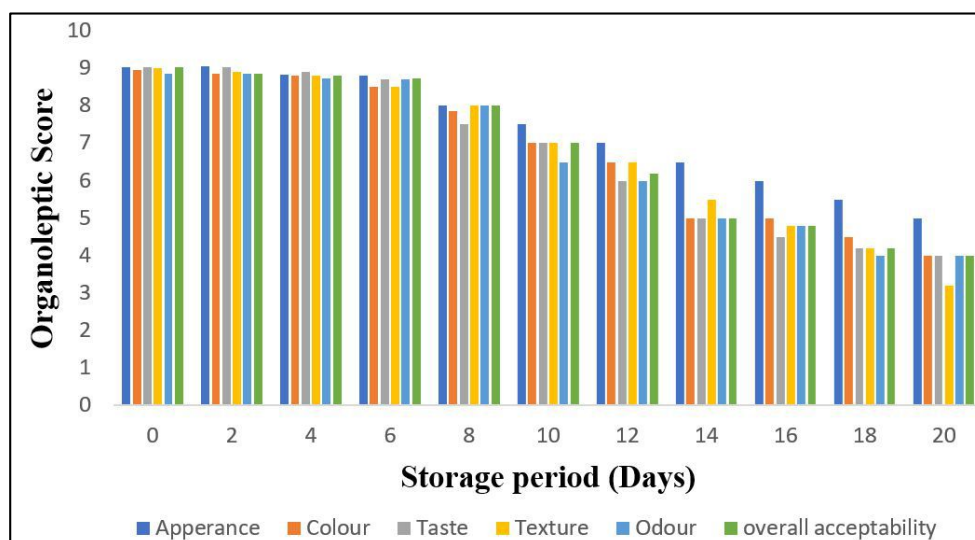
Storage days	Total plate count (cfu/g)	<i>Staphylococcus aureus</i> (cfu/g)	<i>Salmonella</i> (cfu/g)	<i>Escherichia coli</i> (cfu/g)
0	2.7×10 ² (2.43)	ND	ND	ND
2	3.1×10 ³ (3.49)	ND	ND	ND
4	3.8×10 ³ (3.57)	ND	ND	ND
6	4.3×10 ³ (3.63)	ND	ND	ND
8	5.2×10 ³ (3.71)	ND	ND	ND
10	7.8×10 ³ (3.89)	ND	ND	ND
12	8.6×10 ³ (3.93)	ND	ND	ND
14	2.1×10 ⁴ (4.32)	ND	ND	ND
16	2.9×10 ⁴ (4.46)	ND	ND	ND
18	3.1×10 ⁴ (4.49)	ND	ND	ND
20	3.3×10 ⁴ (4.51)	ND	ND	ND

*Each value is represented as the mean of three estimates

Organoleptic evaluation of shrimp fingers during chilled storage

Storage period (Days)	Appearance	Colour	Taste	Texture	Odour	Overall acceptability
0	9±0.08	8.96±0.08	9±0.08	9±0.05	8.86±0.08	9±0.08
2	9±0.12	8.86±0.08	9±0.08	8.9±0.05	8.86±0.08	8.86±0.14
4	8.83±0.08	8.8±0.11	8.9±0.11	8.8±0.11	8.73±0.14	8.8±0.11
6	8.8±0.11	8.5±0.11	8.7±0.11	8.5±0.11	8.7±0.11	8.73±0.14
8	8±0.11	7.86±0.11	7.5±0.11	8±0.11	8±0.04	8±0.06
10	7.5±0.02	7±0.05	7±0.02	7±0.11	6.5±0.09	7±0.08
12	7±0.11	6.5±0.11	6±0.11	6.5±0.12	6±0.11	6.2±0.17
14	6.5±0.11	5±0.08	5±0.05	5.5±0.11	5±0.11	5±0.11
16	6±0.17	5±0.08	4.5±0.11	4.8±0.17	4.8±0.11	4.8±0.11
18	5.5±0.08	4.5±0.11	4.2±0.11	4.2±0.11	4±0.17	4.2±0.11
20	5±0.08	4±0.11	4±0.11	3.2±0.14	4±0.02	4±0.11

Organoleptic scores are written as means±SD of nine-point hedonic ratings given by the organoleptic panel (n = 5).



Conclusion

Chilled storage significantly impacted the sensory attributes, with a gradual decline in texture, flavor, and overall acceptability over the storage period. Chilled storage helps to maintain the natural freshness of shrimp fingers. Additionally, moisture content increased, while lipid

oxidation levels and microbial counts also showed a noticeable increase but they are in acceptable limits. The results suggest that for optimal quality, battered and breaded shrimp fingers prepared from Kiddi shrimp should be consumed shortly after preparation, as prolonged chilled storage of up to 14 days may affect their sensory quality.

Keeping shrimp fingers chilled minimizes the risk of bacterial contamination, ensuring that consumers can safely enjoy this seafood product without concerns about foodborne illnesses. Consumers can conveniently access a delicious and protein-rich option for their meals, whether it's a simple appetizer, a stir-fry, or a more elaborate seafood dish. Chilled storage of shrimp fingers not only improves their quality and safety but also enhances their convenience, versatility, and availability. This practice can greatly increase their popularity among consumers who seek high-quality and reliable seafood options. Chilled storage of shrimp fingers can significantly enhance the quality and appeal of this seafood product, making it a preferred choice for consumers.

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References

- Adebona MB. Evaluation of the keeping quality of smoked fish. Proc Indo-Pac Fish Comm. 1978;18:465-467.
- AOAC. Official methods of analysis of the Association of Official Analytical Chemists. 18th ed. USA: AOAC; 2005.
- Beatty SA, Gibbons NE. The measurement of spoilage in fish. J Biol Board Can. 1937;3(1):77-91.
- Chaijan M, Benjakul S, Visessanguan W, Faustman C. Changes of pigments and color in sardine (*Sardinella gibbosa*) and mackerel (*Rastrelliger kanagurta*) muscle during iced storage. Food Chem. 2005;93(4):607-617.
- Chomnawang C, Nantachai K, Yongsawatdigul J, Thawornchinsombut S, Tungkawachara S. Chemical and biochemical changes of hybrid catfish fillet stored at 4 °C and its gel properties. Food Chem. 2007;103(2):420-427.
- Datta S. Prospects of value-added products and its future in Indian market. 2015.
- Duman M, Karaton Kuzgun N. Quality changes of nugget prepared from fresh and smoked rainbow trout during chilled storage. Br Food J. 2018;120(9):2080-2087.
- EEC. Commission Decision 95/149/EC. Total volatile basic nitrogen (TVBN) limit values for certain categories of fishery products and specifying the analysis methods to be used. Off J Eur Communities. 1995;L97:84-87.
- Gopakumar K. Textbook of fish processing technology. New Delhi: ICAR; 2002.
- Gopan A, Anandan R, Maiti MK, Lalappan S, Devanand TN, Varghese T. Nutritional profiling of kiddi shrimp (*Parapenaeopsis stylifera*) collected from southwest coast of India. J Exp Zool India. 2020;23(2):1-5.
- Hassan F, Joshy CG, Mathew S. Quality evaluation of a battered and breaded seafood product under chilled storage. 2012.
- Kolade OY. Evaluation of quality loss in a fish-based ready-to-eat food (fish roll) during refrigerated storage. 2015.
- Ninan G, Bindu J, Joseph J. Frozen storage studies of mince-based products developed from Tilapia (*Oreochromis mossambicus*). 2008.
- Praneetha SS, Dhanapal K, Reddy GVS, Balasubramanian A. Development of fish finger from rohu (*Labeo rohita*) and its quality evaluation during refrigerated storage condition. Int J Sci Environ Technol. 2015;4:1457-1468.
- Praneetha SS, et al. Studies on the quality of fish cutlet prepared from rohu (*Labeo rohita*) during refrigerated storage. Int J Curr Microbiol Appl Sci. 2017;6(12):3262-3271.
- Pawar PP, Pagarkar AU, Rathod NB. Effect of chilled storage on quality characteristics of battered and breaded snack product from large sized catla (*Catla catla*). J Food Sci Technol. 2020;57(1):52-59.
- Rathod N, Pagarkar A, Phadke G, Pujari KH, Chandra MV. Chemical, microbial and sensory quality changes of fish cutlets made from Pangasius (*Pangasianodon hypophthalmus*) during refrigerated storage (-15 to -18 °C). 2014.
- Suseelan C, Rajan KN. Stock assessment of the kiddi shrimp (*Parapenaeopsis stylifera*) off Cochin, India. 1989.
- Taşkaya L, Kışla ŞÇD, Kılınç B. Quality changes of fish burger from rainbow trout during refrigerated storage. Ege J Fish Aquat Sci. 2003;20(1):1-5.
- Tokur B, Polat A, Beklevik G, Özkütük S. Changes in the quality of fish burger produced from Tilapia (*Oreochromis niloticus*) during frozen storage (-18 °C). Eur Food Res Technol. 2004;218:420-423.
- Tokur B, Özkütük S, Atici E, Ozyurt G, Ozyurt CE. Chemical and sensory quality changes of fish fingers made from mirror carp (*Cyprinus carpio*) during frozen storage (-18 °C). Food Chem. 2006;99(2):335-341.
- USFDA. Bacteriological Analytical Manual (BAM). 2022. Available from: <https://www.fda.gov/food/laboratory-methods-food/bacteriological-analytical-manual-bam>