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Comparative storage stability of shrimp (*Metapenaeus* spp.) pickle at room temperature and refrigerated temperature

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ABSTRACT

One of the determinants of consumer demand for any value added product especially that of a perishable item like fish/ shrimp is its shelf life. Pickling has long since been one of the effective ways to preserve perishable foods for the lean season. The present study was designed to assess the biochemical and microbiological quality of shrimp pickle stored at room temperature and refrigerated temperature (4°C). The recipe for preparation of the product was decided based on the consumer preference of the region. The pH, which is considered as the most important criterion determining the shelf life in pickle, remained below 5 in both the treatments throughout the storage period of six months ($p=0.053$). All the biochemical parameters except total volatile nitrogen (TVN), remained with in the acceptable limit throughout the storage period in both the treatments, although the values were low for pickle stored at refrigerated temperature. There was no significant difference in TVBN value of pickle stored at refrigerated and room temperature at the end of six months ($p=0.072$). The TVN value did not correlate with organoleptic evaluation of the pickles stored at both room temperature and refrigerated condition. As per the organoleptic evaluation, the pickles were in acceptable level even after six months of storage and the sensory quality was not significantly different between the two treatments ($p=0.225$). Consumers perceived taste, price, appearance and health factor as the most important attributes that would determine the acceptability of a product.

Keywords: Consumer perception, Food preservation, Seafood, Value added product

Introduction

Pickle making is an age old form of food preservation. It is the process of preserving food by either anaerobic fermentation in brine or immersion in vinegar or addition of citric acid. It preserves the food and also helps to retain its wholesomeness and nutritive value for a long time. Pickles made of fruits or vegetables have been in use through ages by Indians. But there has been an increasing demand for non-vegetarian pickles like fish and shrimp with the growing awareness on health benefits of seafood. Seafood pickles are particularly better source of protein and minerals in comparison to fruit or vegetable pickles (Ansari *et al.,* 1981). Studies on pickle production from marine fishes, molluscs and crustaceans have been reported earlier (Muraledharan *et al.,* 1982; Vijayan *et al.,* 1982; 1989; Abraham *et al.,* 1996; Renitta and Patterson, 2013: Tinku *et al.,* 2022). The recipe used for pickle preparation varies from region to region depending upon the consumer preference.

The availability of value added seafood products is mostly limited to southern coastal states mainly because of the higher consumption of fish in these states. In order to capture the market, customised preparation of value added fish products to suit the demands of the customers of the region is necessary. The production of value added seafood products become viable only when there is consistent supply of good quality raw material. Shrimp is one such seafood which is available year round irrespective of the coast. Consumer demand will also depend upon the shelf life of a product. Hence, the present study was aimed at preparation of shrimp pickle according to the preference of consumers of the east coast of India and studying the quality characteristics when stored at ambient and refrigerated (4°C) conditions.

Materials and methods

Shrimp (*Metapenaeus* spp.) was procured from the local market in Bhubaneswar, Odisha, brought to the laboratory in iced condition and washed properly with potable water to make it free from sand and any other extraneous material. Washed shrimps were then peeled and deveined hygienically and weighed. Ingredients used for preparation are shown in Table 1. The recipe was standardised by taking into consideration the culinary preferences of the consumers of the region.

Table 1. Ingredients for preparation of shrimp pickle

Ingredients	Quantity
Shrimps	1000 g
Turmeric powder	11 g
Red chilli powder	15 g
Coriander powder	10 g
Salt	30 g
Ginger	150 g
Garlic	100 g
Red chilli paste	50 g
Curry leaves	4 sprigs
Mustard seeds	3 g
Fenugreek seeds	2 g
Asafoetida	1 g
Vinegar	500 ml
Mustard oil	700 ml
Sodium benzoate	4 g

The cleaned shrimps were marinated with turmeric powder, red chilli powder and half the salt for 1 h and shallow fried to remove the excess moisture. The fried shrimps were then removed from the pan and allowed to cool down completely. In the same pan, oil was added, then spluttered mustard and fenugreek seeds, added curry leaves followed by ginger garlic paste and sauteed until the cooked paste released oil. The flame was then simmered and the fried shrimps, red chilli paste, coriander powder, turmeric powder, chilli powder and salt were added and the the mixture was sauteed for 5 min. To this mixture vinegar was added and mixed well. Just when the mixture began to boil flame was switched off. After allowing to cool down completely, 4 g sodium benzoate was added per 1 kg of pickle for better preservation. The pickle thus prepared was packed in previously washed and dried glass containers having acid proof lid. Care was taken to ensure that a layer of oil remained on top of the pickle in the bottle. The pickle was then analysed for proximate and mineral composition. Moisture, ash, crude protein and crude fat were determined by AOAC (2000) method. Minerals like Calcium, Potassium, Phosphorus, Magnesium, Iron, Copper, Zinc and Manganese were determined quantitatively using Atomic Absorption Spectrophotometer (PerkinElmer AAnalyst 400). The pickle was also subjected to a large scale consumer acceptance trial involving 150 consumers from the peri-urban areas of Bhubaneswar, Odisha. Consumer perceptions were analysed as most important, important and least important on the different attributes of the product.

Pickle was divided into two lots and one of the lots was stored in refrigerated condition (4^{o}C) (T1) and the other at ambient conditions (T2). Samples were drawn from each lot during the 6 months of storage period, for biochemical quality estimation. Total volatile nitrogen (TVN) was estimated by Conway diffusion method (Conway, 1950). Free fatty acid (FFA) content of the pickle oil was determined following AOAC (2000). Peroxide value (PV) of the samples was estimated by the titrimetric method (Yildiz *et al*., 2003) and pH as per AOAC (2000). Total bacterial count (TBC) was determined by the standard spread plate method using Nutrient Agar (NA) medium, incubating the plates at 37°C for 48 h (Surendran *et al.,* 2003).

Sensory quality evaluation was carried using the hedonic scale (Lin and Morrissey, 1994). The sensory qualities were judged for attributes such as appearance, colour, texture, odour and overall acceptability. Each sensory attribute was evaluated based on a 1-9 point hedonic scale (9-like extremely, 8-like very much, 7-like moderately, 6-like slightly, 5-neither like nor dislike, 4-dislike slightly, 3-dislike moderately, 2-dislike very much, 1-disike extremely) and the mean of the scores given by the panelists.

Statistical analysis

The data were subjected to statistical analysis using PC-SAS programme for Windows, release v6.12 (SAS Institute, Cary, NC, USA) and Duncan's multiple range test was used to compare the value of parameters among the treatments at 5% level of significance.

Results and discussion

Proximate composition of pickle

In pickles made from meat and fish, vinegar is used as preservative as it brings down the pH. Due the use of vinegar and Sodium benzoate, the amount of salt added in the shrimp pickle was reduced to 3% while a traditional fruit pickle needs a minimum of 18-20% salt for good preservation (Kumar and Basu, 2001). This will satisfy the needs of the present day consumers, who prefer to abstain from hypertensive foods due to the increased awareness about the negative effects of high levels of salt intake. The proximate and mineral composition of shrimp pickle prepared is given in Table 2. The reported average protein content in fresh shrimp flesh ranges from 17-22% (Gopakumar, 1997). Patil *et al.* (2014) have reported a protein content of 14.38% in pickle prepared from *Pangasianodon hypophthalmus* meat. The high protein content (19.65%) in the shrimp pickle will help to boost its acceptance among consumers (Table 2). Dhar and Karthikeyan (2014) have reported a similar composition of protein, fat and ash in pickle prepared from freshwater prawn *Macrobrachium dayanum*. But the moisture content reported was much higher (51$\pm$2%). Kumar and Basu (2001) have reported an ash content of 1.45% in pickle made from *Parapenaeopsis stylifera* whereas an ash

Table 2. Proximate and mineral composition of shrimp pickle

Components	Concentration
Moisture (%)	38.23
Crude protein (%)	19.65
Crude fat (%)	25.6
Ash (%)	2.43
Ca (%)	0.26
Mg (%)	0.12
P (%)	0.8
K (%)	0.39
Mn (mg kg^{-1})	29.23
Zn (mg kg^{-1})	42.07
Fe (mg kg^{-1})	214.5
Cu (mg kg^{-1})	287.77

content of around 7% has been reported in pickle made from *Litopenaeus vannamei* (Tinku *et al*., 2022). The low moisture content in the pickle prepared from shrimp may be because of the appropriate frying of shrimps done before pickling. The high fat content in the pickle is due to the oil content in the pickle. Oil is added in pickle mainly to cut off contact with air which will otherwise promote oxidation and bacterial spoilage. Mineral components such as sodium, potassium, magnesium, calcium, iron, phosphorus and sulphur are important for human nutrition (Erkan and Ozden, 2008). Mineral content in the pickle was much higher than that reported by Dincer and Aydin (2014) in the whole *Metapenaeus affinis* shrimps. The higher mineral content could be attributed to the spices added in the pickle.

Change in pH

Maintaining pH below 5 is considered critical for storage stability of pickled meat products (Dziezak, 1986). Martinez and Gildberg (1988) reported that the rate of degradation by proteolytic enzymes was reduced when fish was kept at 0°C and a pH of 5. In refrigerated pickle (T1), the pH decreased from 4.78 to 4.38 at the end of 6 months of storage and the reduction was significant till the 4th month of storage ($p<0.05$) (Fig. 1a). The reduction in pH was lesser in pickles stored at room temperature (T2) and a significant decrease in pH at room temperature was noted after two months of storage. The decrease in pH may be because of the acid absorption by the meat. Similar decreasing trend in pH during storage of pickle was reported by Tamilselvi *et al.* (2010) and Dhanapal *et al.* (1994). Collins *et al.* (1989) had an opinion that if the pH of the vinegar added in pickled seafood product was 4.5 or less, there was no need for further precaution against bacterial pathogens. At the end of 6 months of storage, no significant difference ($p=0.053$) was observed in pH of pickles stored at refrigerated and ambient temperatures.

Change in total volatile nitrogen (TVN)

TVN value ranged from 10.07 to 50.03 mg% in T1 and 10.07 to 54.37 in T2 (Fig. 1b). The TVBN values were around the acceptable limits set for fish products (30 mg 100 g^{-1}) till the 4th month of storage in both the treatments. Gradual increase in TVN values from 9.80 to 32.20 mg 100 g^{-1} and 0 to 22.4 mg 100 g^{-1} in pickle of *Nemipterus japonicus* and carp, respectively was reported by Chandreshekaran *et al*. (2014) and Waghmare *et al.* (2015). TVBN value did not correlate with organoleptic evaluation of the pickles stored at both room temperature and refrigerated condition. The non-correlation of TVBN with the organoleptic acceptance of fish has been reported earlier also (Kumar and Basu, 2001). With respect to the TVBN content, no significant difference ($p=0.072$) was noticed between the two treatments.

Change in peroxide value and free fatty acid

Pickle is a high fat product (25.6%) and lipid oxidation is catalysed by the presence of mineral like iron which is most active under acidic conditions (Osborn and Akoh, 2003). But there was no significant increase in the peroxide value (PV) in both the treatments up to 3 months of storage even though the pH in pickle was low (Fig. 1c). Dhar and Karthikeyan (2014) have reported a steady increase of PV in *M. dayanum* throughout the 6 months of storage. Oxidation of the unsaturated oil used (mustard oil) would have added to the PV in the pickle. Mustard oil accounts for 18% of Indian edible oil consumption and has characteristic pungent taste. Mustard oil for pickle preparation was chosen based on the consumer demand. The PV value in T2 was higher than that of T1 and it became significantly higher ($p<0.05$) from the 5th month onwards. This might be because of the fact that temperature is one of the most influential factor in enhancing oxidation and breakdown of hydroperoxide with increasing temperature (Erkan *et al.,* 2009). Takeungwongtrakul and Benjakul (2016) also reported an increased oxidation of Pacific white shrimp oil at enhanced temperature. The PV remained within the stipulated limits throughout the storage period in both the treatments. Shiriskar *et al.* (2010) found an increase in lipid quality parameters *viz.,* PV and FFA accompanied by decrease in flavour as well as odour scores of anchovy pickle under storage. But in the present study the increase in PV did not have a marked effect on the acceptability of the product. The reason could be attributed to the flavour of spices and vinegar in the product.

Lipid hydrolysis results in the formation of free fatty acids (FFA). The high unsaturation level of mustard oil could have contributed to the increase in FFA content in the pickles. The FFA values remained low with gradual

increase till the 3rd month of storage in both the treatments (Fig. 1d). Yellappa and Chandrasekar (1989) have reported similar increase in FFA values during storage of clam pickle. By the end of the storage period, pickle stored at ambient temperature had a significantly higher FFA value ($p = 0.035$).

Change in total viable count (TVC)

Chandrashekhar (1979) reported total viable count (TVC) in shrimp pickle in the range of 10^3 to 10^5 g^{-1}. But Erichson (1967) reported that pickled fish, unless spoiled, normally carry low level of bacteria in the range of 10^1 to 10^3 g^{-1}. In the present study, the TVC did not go beyond 10^3 g^{-1} in both the treatments (Fig. 2). The layer of oil and the low pH inhibited the growth of microorganisms in pickle. Mustard oil besides imparting a pleasant pungent flavour to meat (McGorrin, 2011), also contains an active principle, allylisothiocyanate which is reported as an antibacterial compound (Luciano *et al*., 2008; Dias *et al*., 2014). At refrigerated temperatures, the final bacterial load was only to the tune of 10^2 g^{-1}. This could be attributed to the lower temperature of storage which is yet another factor deterring the growth of microorganisms. In T1, TVC decreased significantly till the 4th month of storage. Vijayan *et al*. (1982) observed decreasing trend of TVC in clam meat pickle from 6.2×10^3 to 3.20×10^2 cfu g^{-1} throughout the storage study. Dhanapal *et al*. (1994) reported decrease in TVC from 3.1×10^3 to 1.2×10^1 cfu g^{-1} in chank meat pickle. The subsequent increase in TVC is in line with the increase in TVBN from the 5th month of storage in both the treatments. On the contrary, Kumar and Basu (2001) reported a steady increase in TVC with time of storage. Abraham *et al*. (1996) studied microbiological characteristics of shrimp pickle stored at ambient temperature and the product did not show any visible signs of spoilage for a period of 270 days.

The overall acceptability of the pickle increased steadily with comparatively more acceptability of the pickle stored at ambient temperature. This could be due to

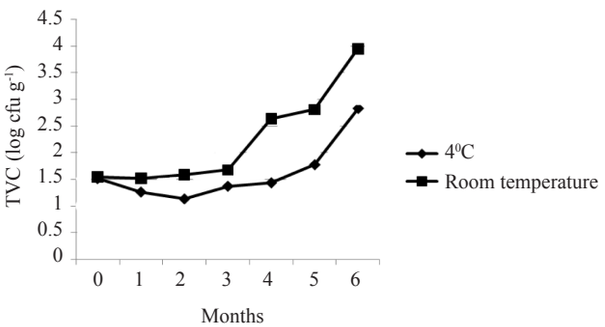

Fig. 2. Change in TVC of shrimp pickle stored at refrigerated temperature (4°C) and ambient temparature

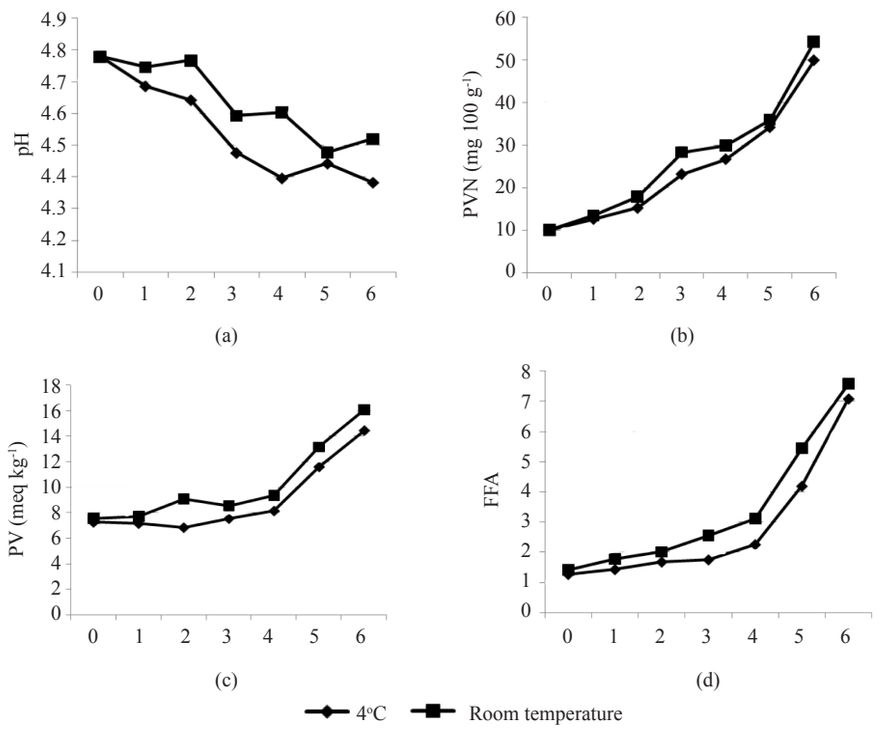

Fig. 1. Change in (a) pH, (b) TVN; (c) PV and (d) FFA of shrimp pickle stored at refrigerated temperature (4°C) and ambient temparature

the improvement in flavour of the product on maturation (Kumar and Basu, 2001) helped by the higher temperature. But the sensory score was not significantly different ($p>0.05$) between both the treatments throughout the 6 months of storage ($p = 0.225$), although the acceptability started decreasing from the 4th and 3rd month for T1 and T2 respectively (Fig. 3). Waghmare *et al.* (2015) and Abraham *et al*. (1996) have reported similar trends in the storage studies of carp pickle and shrimp pickle, respectively. Even at the end of 6 months of storage, the pickles remained acceptable for the panelists. As per the consumer preference study, taste followed by price, appearance and health factor were the most important attributes determining the consumer acceptability of shrimp pickle (Table 3). Attractive packaging of the product was considered to be the least important attribute by the consumer. Geethalekshmi *et al*. (2013) arrived at the conclusion that quality of the product is the most important attribute influencing consumer behaviour in Kerala and they exhibited positive willingness to pay for products of good quality. As per Feng *et al.* (2009), Chinese consumers were willing to pay premium price for safe, traceable fish products over the price of non-traced products of uncertain safety. In a consumer survey study reported by Mugaonkar *et al*. (2011), the consumers ranked shrimp pickle as very good based on sensory evaluation. According to Kumar and Basu (2001), there is large scale acceptance of shrimp pickle among Indian consumers.

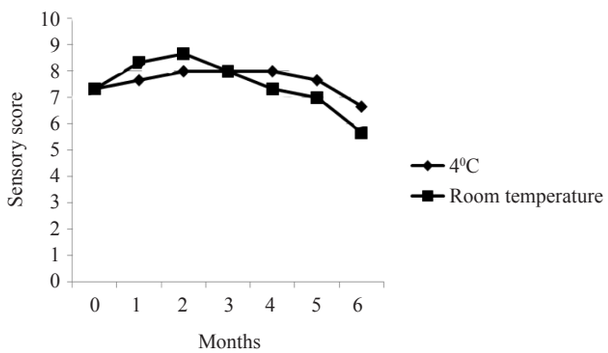

Fig. 3. Sensory score of shrimp pickle stored at refrigerated temperature (4^0C) and ambient temparature

It is evident from the present study that shrimp pickle made in mustard oil could be stored for a minimum of six months without degradation of quality both at refrigerated and ambient temperature. Although the biochemical and microbiological quality indices did show a faster increase in pickle stored at ambient temperature, it did not have a significant effect on the sensory quality of the product. The consumer survey suggests that shrimp pickle prepared by ensuring the taste and nutritional quality will be acceptable if available to them at a reasonable price. This opens avenues for small scale entrepreneurs especially women who could take up the shrimp pickle production as an enterprise taking into account the consumer demand and the longer shelf life.

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References

Abraham, J. J., Rathnakumar, K. and Jeyachandran, P. 1996. Microbiological characteristics of prawn pickle. *Fish. Technol*., 33: 111-115.

Ansari, Z. A., Parulekhar, A. H. and Natondkhar, S. G. P. 1981. Nutritional studies of fishes. *Indian J. Mar. Sci*., 10: 128-136.

AOAC 2000. *Official methods of analysis*, 17th edn. Association of Official Analytical Chemists, Washington DC, USA.

Chandrasekar, T. C. 1979. Quality of seafood by products. *Seaf. Export J*., 6: 15-19.

Collins, C. H., Lyne, P. M. and Grange, J. M. 1989. *Microbiological methods*, 6th edn. Butterworth's, London, UK, 211 pp.

Table 3. Consumer perception about shrimp pickle (n=150)

Attributes	Important (%)	Slightly important (%)	Not important (%)
Price	90	10	--
Appearance	90	5	5
Attractive packing	70	10	20
Taste	93.3	6.67	--
Availability	60	30	10
Ease of availability of ingredients and ease of preparation	50	46.67	3.33
Variety	60	30	10
Health factor	90	10	--
Nutrition information on the pack	80	10	10
Ease of availability	50	50	--

Conway, E. J. 1950. *Microdiffusion analysis and volumetric error,* 3rd edn. Lockwood and Son Ltd., Crosby, London, UK.

Dhanapal, K., Rathnakumar, K., Jasmine, G. I. and Jeyachandran, P. 1994. Processing chank meat *Xancus pyrum* into pickles. *Fish. Technol.,* 31(2): 188-190.

Dhar, B. and Karthikeyan. M. 2014. Functional relationship between storage time and quality parameters of prawn pickle from *Macrobrachium dayanum* (Henderson, 1893). *Indian J. Fish.,* 61(4): 112-117.

Dias, C., Aires, A. and Saavedra, M. J. 2014. Antimicrobial activity of isothiocyanates from cruciferous plants against methicillin-resistant *Staphylococcus aureus* (MRSA). *Int. J. Mol. Sci.*, 15: 19552-19561. https://doi.org/10.3390/ijms 151119552.

Dincer, M. T. and Aydin, I. 2014. Proximate composition and mineral and fatty acid profiles of male and female jinga shrimps (*Metapenaeus affinis*, H. Milne Edwards, 1837). *Turk. J. Vet. Anim. Sci*., 38: 445-451. doi:10.3906/vet-1301-15.

Dziezak, J. D. 1986. Antioxidants and antimicrobial agents. *Food Technol*., 40: 94-111.

Erichson, I. 1967. Bacteriology of pickled fish. *J. Microbiol*., 33: 107-111.

Erkan, N. and Ozden. O. 2008. Quality assessment of whole and gutted sardines (*Sardina pilchardus*) stored in ice. *Food Sci. Technol*., 43(9): 1549-1559. https://doi.org/10.1111/ j.1365-2621.2007.01579.x.

Erkan, N., Ayranci, G. and Ayranci, E. 2009. A kinetic study of oxidation development in sunflower oil under microwave heating: Effect of natural antioxidants. *Food. Res. Int*., 42: 1171-1177. https://doi.org/10.1016/j.foodres.2009.06.003.

Feng, W., Jian, Z., Weisong, M. and Zetial, F. 2009. Consumers' perception toward quality and safety of fishery products, Beijing, China. *Food Control*, 20(10): 918-922.

Geethalakshmi, V., Ashaletha, S., Nasser, M. and Raj, F. 2013. Consumer preference and willingness to pay for value added fish products in Palakkad, Kerala. *Indian J. Fish*., 60(3): 67-71.

Gopakumar, K. 1997. *Tropical fishery products*. Oxford and IBH Publishing Co., New Delhi, India, 190 pp.

Kumar, S. and Basu. S. 2001. Preparation of prawn pickle and its storage characteristics. *J. Indian Fish. Ass*., 28: 105-111.

Lin, D. and Morrissey, M. T. 1994. Iced storage characteristics of Northern squawfish (*Ptychocheilus oregonensis*), *J. Aquat. Food Prod. Technol*., 3(2): 25-43. https://doi.org/10.1300/ J030v03n02_04.

Luciano, F. B., Hosseinian, F. S., Beta, T. and Holley, R. A. 2008. Effect of free-SH containing compounds on allyl isothiocyanate antimicrobial activity against *Escherichia coli* O157:H7. *J. Food Sci.,* 73(5): 14-20. https://doi. org/10.1111/j.1750-3841.2008.00762.x.

Martinez, A. and Gildberg, A. 1988. Autolytic degradation of belly tissue in anchovy (*Engraulis encrasicholus*). *Food Sci. Technol*., 23(2): 185-194. https://doi.org/10. 1111/j.1365-2621.1988.tb00566.x.

McGorrin, R. J. 2011. The significance of volatile sulfur compounds in food flavors an overview. In: Qian, M., Xuetong, F. and Mahattanatawee, K. (Eds.), *Volatile sulfur compounds in food (ACS Symposium Series)*. American Chemical Society, Washington, DC, USA, 355 pp.

Mugaonkar, P. H., Anantha, P. S., Samal, S. S. and Debnath, B. 2011. A study on consumer behaviour at organised fish retail outlet. *Agric. Econ. Res. Rev*., 24: 133-140.

Muraledharan, V., Joseph, K. G. and Devadasan, K. 1982. Pickled products from green mussel. *Fish. Technol.,* 19: 41-43.

Osborn, H. T. and Akoh, C. C. 2003. Effects of natural antioxidants on iron-catalyzed lipid oxidation of structured lipid-based emulsions. *J. Am. Oil. Chem. Soc*., 80: 847-852.

Patil, S. S., Pagarkar A. U., Chaudhary, K. J., Desai A. S. and Shaikh, S. M. 2014. Organoleptic and biochemical quality changes in fish pickle prepared from freshwater catfish Pangasius (*Pangasianodon hypothalamus*). *Indian Vet. J*., 91(7): 12-14.

Renitta, E. R. and Patterson, J. P. 2013. Quality and shelf-life assessment of underutilized marine gastropod pickle. *J. Food Process. Preserv.,* 3 (5): 589-595.

Shiriskar, D. A., Khedkar, G. D. and Sudhakara, N. S. 2010. Preparation of pickled product from anchovies (*Stolephorus* sp.) and studies on quality changes during storage. *J. Food Process. Preserv*., 34(1): 176-190. https:// doi.org/10.1111/j.1745-4549.2008.00332.x.

Surendran P. K., Nirmala, T., Nambiar, V. N. and Lalitha, K. V. 2003. *Laboratory manual on microbiological examination of seafood*. Central Institute of Fisheries Technology, Kochi, India, 170 pp.

Takeungwongtrakul, S. and Benjakul, S. 2016. Astaxanthin degradation and lipid oxidation of Pacific white shrimp oil: Kinetics study and stability as affected by storage conditions. *Int J. Aquat. Res.,* 8: 15-27

Tamilselvi, M., Sivakumar, V., Ali, H. A. J. and Thilaga, R. D. 2010. Preparation of pickle from *Herdmania pallid* simple ascidian. *World J. Dairy Food Sci.,* 5(1): 88-92.

Tinku, D. M. A., Nayak, B. B., Xavier, K. A. M., HariKrishna, V., Krishnaand, G. and Balange, A. K. 2022. Comparative changes in the quality of pickles prepared from pacific white shrimps (*Litopenaeus vannamei*) grown in inland saline water and in brackishwater during storage. *Fish. Technol.,* 59: 106-113.

Vijayan, P. K., Perigreen, P. A., Surendran, P. K. and Balachandran, K. K. 1982. Processing clam meat into pickles, *Fish. Technol.,* 19: 25-28.

Vijayan, P. K., Balachandran, K. K. and Surendran, P. K. 1989. Preparation of pickle from low cost fish. *Recent trends in processing low cost fish*. Society of Fisheries Technologists (India), Kochi, India, p. 140-144.

Waghmare, K. M. 1., Devkate, A. D., Golandaj, A. A. and Surnar, S. R. 2015. Standardising smoking treatments for improved organoleptic quality and storage stability of carp pickle. *Res. J. Recent Sci*., 4: 222-227.

Yellappa, N. and Chandrasekhar, T. C. 1989. Preparation of clam pickle using organic acids. *Recent trends in processing low cost fish.* Society of Fisheries Technologists (India), Kochi, India, p. 130-133.

Yildiz, G., Wehling, R. and Cuppett, S. L. 2003. Comparison of four analytical methods for the determination of peroxide value in oxidized soybean oils. *J. Am. Oil Chem. Soc.*, 80: 103-107.

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