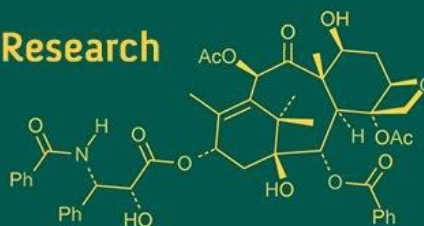


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Quality changes in battered and breaded cutlets prepared from *Acetes (Acetes indicus)* as a function of chilled storage

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Abstract

Effect of chilled storage on the quality and shelf life of enrobed *Acetes* cutlet have been evaluated. The values of pH, peroxide value (PV), free fatty acid (FFA), total volatile base nitrogen (TVB-N), trimethylamine (TMA) increased as a function of progressive chilled storage period and were within permissible levels. In microbiological quality assessment, total plate count (TPC) values increased, while *Escherichia coli*, *Staphylococcus aureus* and *Salmonella* were not detected. Sensory evaluation of product showed a declining trend and estimated product shelf life of the product to be 10 days suggesting development of battered and breaded *Acetes* cutlet as avenue for value addition and effective utilization.

Keywords: *Acetes*, fish cutlet, biochemical quality changes, sensory evaluation, shelf life estimation

Introduction

Consumption of fish based value added products has been increasing due to urbanization, awareness about their health benefits and high nutritional value (Sriket and La-ongnual, 2018) [35]. Prominent amongst these group is battered and breaded products which are highly valued due to their favourable sensory attributes such as crispy/crunchy outer side and juicy inside with attractive golden brown colour (Pagarkar *et al.*, 2011 & 2012a; Xavier *et al.*, 2018; Fiszman and Salvador 2003; Mah and Brannan, 2009) [25, 26, 27, 41, 10, 19].

Acetes (Acetes indicus) is a small sized shrimp, locally called as “Kolim or Javala” in India is a low cost, small sized, delicate bodied, bycatch of great fishery importance and contributing to 16.8% of total marine landing (Sonanvane *et al.*, 2016) [33] and more than 50% of total non-penaeid landing (183, 405 t) along the Indian coast, with high nutritional value containing 12.7 % protein (Deshmukh, 1991; Dhanabalan *et al.*, 2017) [6, 7]. *Acetes (Acetes indicus)* is very highly perishable nature and smaller size limits its cleaning (meat separation) and improper storage is leading to deterioration of this wealthy resource. Hence consumed in dried form or used as raw material for production of fish meal, fish manure and powder due to non-availability of spaces for drying, leading to loss in their functional properties of proteins upon drying (Zynudheen *et al.*, 2004; Balange *et al.*, 2017) [43, 3].

Finding ways for better utilization of low valued bycatch during the bulk availability season by developing value added batter and breaded product would provide better return to the community on economic as well as nutritional grounds (Deshmukh, 1991; Govindan, 1971) [6, 11]. No studies have been reported for utilization of fresh *Acetes (Acetes indicus)* for value added battered and breaded product as well. Considering all these factors, present study had been undertaken to utilise *Acetes (Acetes indicus)* in the development of value added batter and breaded product and evaluation of its quality as a function of chilled storage period.

Materials and Methods

Materials

Fresh *Acetes (Acetes indicus)* of 3.0 to 4.0 mm size were procured from landing centre in Alibaug in Maharashtra State (India) and transferred to laboratory under iced condition. Meat was prepared according to the method of Sonavane *et al.*, (2016) [33] and all other material

required were of food grade, procured from local market. All chemicals used were of analytical grade.

Method for making battered and breaded Acetes cutlet

The standardised cutlet recipe included 38% Acetes meat, 1% salt, 4.17% oil, 2.3% green chillies, 2.1% coriander leaves, 2.3% ginger, 2.1% garlic, 8.3% onions, 31.33% cooked potatoes, 0.12% pepper powder, 0.12% clove powder, 0.08% cinnamon powder, 0.08% turmeric powder and 8% bread powder as standardised by Kudale *et al.* (2018). The cutlets were coated in standardized batter mix (Pagarkar *et al.* 2012b) [27] containing 77.5% refined wheat flour, 9.7% corn flour, 9.7% Bengal gram flour, 1.20% salt, 0.47% sodium tri polyphosphate (STPP), 0.47% turmeric powder, 0.96% carboxy methyl cellulose (CMC) which were mixed with water in the ratio of 1:2 and was blended to homogeneity. After the batter coating, it was covered with bread crumbs, they were flash fried at 180°C for 30 s later air packed in polypropylene pouches having 100 g capacity and chilled stored with analysis every alternate days for 12 days.

Biochemical analysis

The proximate composition viz., moisture, protein, fat and ash were analysed using AOAC standard methods (AOAC, 2005) [2]. Total volatile basic nitrogen (TVB-N) and trimethylamine (TMA) contents of Acetes cutlet was determined by the micro-diffusion method as described by Beatty and Gibbons. (1936) [4] using Conway micro-diffusion units and results are expressed in terms of nitrogen mg/100g. Free fatty acid (FFA) value, expressed as percentage (%) of oleic acid, and peroxide value expressed as milli equivalent of O₂/kg fat were evaluated using standard AOAC method (AOAC, 2005). The pH was measured as per the method of AOAC (AOAC, 2005) [2] by using a pH meter. Carbohydrate content was estimated by subtracting the sum of moisture, ash, fat, and protein from 100.

Sensory analysis

Sensory quality of Acetes cutlets were evaluated directly by semi-trained panellists, using a nine point hedonic scale (1-dislike extremely to 9-like extremely) for product acceptability, with 5 being border line for acceptability (Lawless and Heymann, 1998) [17]. The samples were deep-fried in sunflower oil until cooked before being presented to the panellists. Panellists scored for appearance, colour, taste, texture, odour and overall acceptability. During the evaluation sessions, the samples were coded by a letter and presented in random order.

Microbiological analysis

Samples were analyzed for total plate count (TPC), *Staphylococcus aureus*, *Salmonella*, *Escherichia coli* and spore counts as per USFDA (2001) [39].

Statistical analysis

Data were analyzed to test significant difference by applying analysis of variances (ANOVA) tool available in MS-Excel 2003. The significant differences were tested by 5% level of significances and are mentioned as $p < 0.05$ for significances difference using Least significant difference method (LSD).

Results and Discussion

Storage characteristics of battered and breaded Acetes cutlet

Effect of chilled storage on proximate composition changes of battered and breaded Acetes cutlet

The proximate composition of fresh Acetes mince and battered and breaded cutlets on the 0 day and 12th day of storage is presented in Table 1. Acetes usually referred as bycatch, having desirable protein content (11.64%), moisture (84.90%), fat (0.92%) and ash (2.54%) which can be utilised for value addition, similar results in line were also reported by Dhanabalan *et al.*, (2017) [7], Zyundheen *et al.*, (2004) [43] and Heu *et al.*, (2003) [13].

The moisture and protein content in batter and breaded Acetes cutlet decreased from 57.34 to 56.9% and 9.78 to 8.32% respectively, conversely fat and ash content increased from 3.34 to 5.73% and 3.33 to 3.71% respectively during storage. The decrease in moisture and increase in fat can be due to leaching out of the water soluble components and absorption of oil during flash frying (Ninan *et al.*, 2008; Vanitha *et al.*, 2015; Izci, 2010) [21, 40, 18]. The reduction in protein content can be attributed to cooking at elevated temperatures leading to denaturation of proteins (Sehgal *et al.*, 2010) [31].

Storage characteristics of battered and breaded Acetes cutlet

Total volatile basic nitrogen (TVB-N) and Trimethylamine (TMA)

TVB-N and TMA are products of bacterial metabolism and endogenous enzymatic action evolving from non-protein nitrogenous compound, indicating protein degradation often used to assess the keeping quality, freshness and shelf life of products. The maximum permissible limit of TVB-N is 30 mg/100g and TMA is 10 mg/100g in fish products (EEC 1995; Yerlikaya *et al.*, 2005; Rupsankar, 2010) [8, 42, 29]. TVB-N and TMA values of battered and breaded Acetes cutlet were measured and presented in Fig.1 (A and B). TVB-N and TMA contents increased from initial 2.43 and 1.36 mg/100g with storage time up to 7.16 and 5.64 mg/100g respectively during storage. Values of TVB-N and TMA were within prescribed limits, indicating low microbial activity/growth and enzymatic activity due to high temperature processing and inclusion of spices. The regression equation for TVB-N was $y = 0.38x + 2.45$ with r^2 value of 0.97 and TMA was $y = 0.34x + 0.91$ with r^2 value of 0.93 which was significant. Similar findings were also reported by Emir Coban, (2013) [9], Izci, L., (2010) [18], Dabade *et al.*, (2015) [5], Tsironi *et al.*, (2009) [37].

Free fatty acid (FFA)

Changes in FFA contents during storage is depicted in Fig.1 (C) the FFA value changed significantly from 1.41 to 4.16 % oleic acid during storage period. FFA formation has been linked to enzymatic decomposition of lipids and lipid hydrolysis leading to off flavour formation (Tokur *et al.*, 2004; Ozyurt *et al.*, 2011) [36, 24]. The lower rise in FFA value indicates lower rate of lipid hydrolysis and inactivation of enzymes by heat application during product preparation (Srikar *et al.* 1993; Ninan *et al.*, 2011) [34, 22]. The increase in FFA content showed a significant increase with reference to regression equation $y = 0.22x + 1.18$ with r^2 value of 0.95 during the storage.

Peroxide value (PV)

The main reason for oil deterioration is rancidity caused due to oxidation imparting off odours and flavours nutritional quality, usually influenced by heat treatment (Yerlikaya, *et al.*, 2005; Özyurt *et al.*, 2011) [42, 24]. Hydroperoxides are primary product of lipid oxidation often used as measure to assess shelf life of products, measured as PV (Praneetha *et al.*, 2015) [28]. The PV of battered and breaded Acetes cutlet increased significantly ($p < 0.05$) from 2.40 to 4.66 meq of O_2/kg during 12 days refrigerated storage period Fig.1 (D) showing a positive correlation with time, corresponding regression equation is $y = 0.19x + 2.70$ and r^2 value of 0.88. The lower level of PV during storage may be due to antioxidant properties of spices added in the cutlet. A similar trend for PV was observed in enrobed product prepared from anchovy during storage but well within acceptable limits of 8 meq O_2/kg (Xavier *et al.* 2018) [48].

pH

The pH value of battered and breaded Acetes cutlet increased during storage from 6.28 to 7.46 Fig.1 (E) the pH of the fish muscle is around neutral Mazorra- Manzano *et al.* (2000) [20], also a good indicator of fish quality Abbas *et al.*, (2008) [1]. The pH value increased significantly in accordance to regression equation $y = 0.11x + 6.31$ with r^2 value of 0.98. The increase in pH value can be due to biochemical reactions, enzymatic actions and microbial action as well. Similar values were also reported by (Ocaño-

Higuera *et al.* 2011; Emir Coban, 2013) [23, 9].

Microbial analysis of battered and breaded Acetes cutlet

The microbiological quality changes of battered and breaded Acetes cutlet is depicted in (Fig. 2) Initial total plate count (TPC) of Acetes cutlet was found to be 2.24 log. Cf/g which significantly increased to 5.31 log. Cf/g during 12 day storage period in relation to equation $y = 0.22x + 2.63$ with r^2 value of 0.93, within maximum limits prescribed by ICMSF (1978) [14]. Similar observations were reported by Turhan *et al.*, (2001) [38] for anchovy patties, Kilinc *et al.*, (2007) [15] observed increased in total counts in anchovies fish patties, Sehgal *et al.*, (2011) [30] reported similar findings in fish patties from Carp (*Cyprinus carpio* Linn.). *Escherichia coli*, *Staphylococcus aureus* and *Salmonella* were not detected in the battered and breaded Acetes cutlet during 12 days storage.

Sensory analysis of battered and breaded Acetes cutlet

Sensory scores of battered and breaded Acetes cutlet decreased through storage period Table 2. The sensory scores showed a declining trend through the storage. The results also indicated that battered and breaded Acetes cutlet could be stored for 10 days retaining good quality characteristics. Gupta *et al.*, (2015) [12] reported shelf life of cutlet made from *Wallago attu* to be 10 days. Praneetha *et al.*, (2015) [28] reported shelf life of fish finger made from rohu to be 9 days based on sensory evaluation.

Table 1: Proximate composition of fresh Acetes meat, par fried battered and breaded Acetes cutlet on the day of production and on 12th day

Parameters (%)	Acetes	Initial Cutlets (0 days)	Final Cutlets (12 days)
Moisture	84.90±0.50 ^a	57.34±0.38 ^b	56.9±0.26 ^c
Crude Protein	11.64±0.29 ^a	9.78±0.28 ^b	8.32±0.15 ^c
Fat	0.92±0.07 ^a	3.34±0.19 ^b	5.73±0.16 ^c
Ash	2.54±0.17 ^a	3.33±0.15 ^b	3.71±0.27 ^c

¹ Data are expressed as means±standard deviation ($n = 7$).

² Means within the same rows with different superscripts are significantly different at $p < 0.05$.

Table 2: Changes in sensory quality of battered and breaded Acetes cutlet during storage^{1,2}

Storage Period Days	Appearance	Colour	Taste	Texture	Odour	Overall Acceptability
0	8.95±0.10 ^a	8.72±0.15 ^a	8.64±0.13 ^a	8.75±0.15 ^a	8.61±0.21 ^a	8.70±0.20 ^a
2	8.24±0.17 ^b	8.01±0.37 ^b	8.50±0.25 ^b	8.00±0.35 ^b	8.42±0.20 ^b	8.22±0.22 ^b
4	8.14±0.14 ^b	7.85±0.13 ^c	7.96±0.23 ^c	7.84±0.15 ^b	7.74±0.16 ^c	7.86±0.18 ^c
6	7.94±0.13 ^b	7.74±0.19 ^c	7.74±0.28 ^c	7.80±0.16 ^b	7.20±0.16 ^d	7.66±0.17 ^c
8	6.48±0.19 ^c	6.24±0.23 ^d	6.18±0.18 ^d	6.11±0.19 ^c	6.12±0.16 ^c	6.18±0.28 ^d
10	5.34±0.20 ^d	5.20±0.21 ^e	5.14±0.18 ^e	5.47±0.24 ^d	5.60±0.15 ^f	5.26±0.25 ^e
12	4.10±0.30 ^e	4.54±0.36 ^f	4.00±0.17 ^f	3.98±0.25 ^e	4.58±0.29 ^g	4.10±0.20 ^f

¹ Data are expressed as means±standard deviation ($n = 10$).

² Means within the same rows with different superscripts are significantly different at $p < 0.05$.

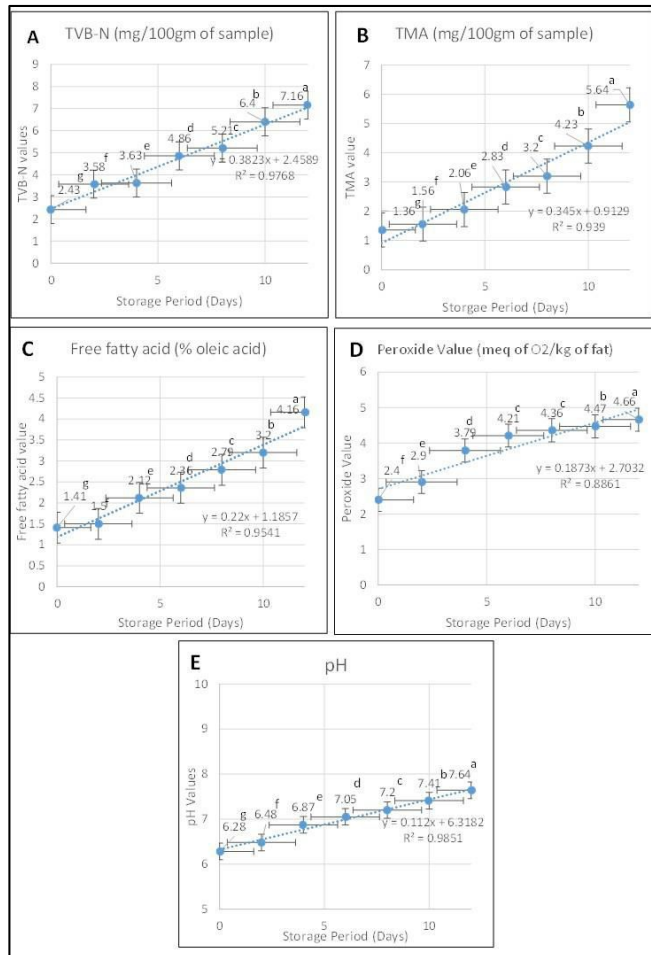


Fig 1: Biochemical changes in battered and breaded Acetes cutlet during refrigerated storage. Plot of linear regression with time*

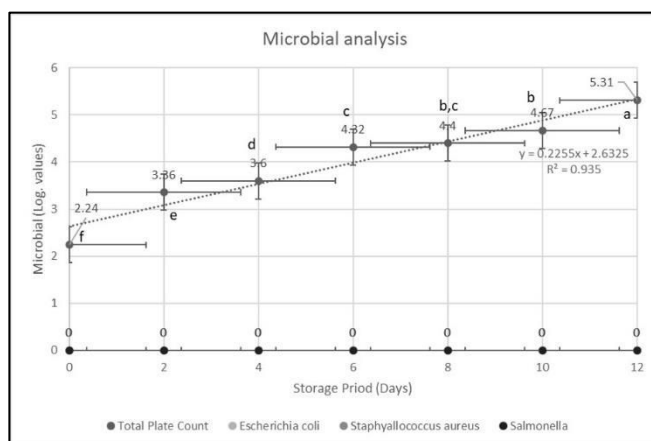


Fig 2: Regression equation of storage period on microbial quality of battered and breaded Acetes cutlet during refrigerated storage. Plot of linear regression with time.

Conclusion

The results conclude that fresh Acetes can be efficiently utilised for development of battered and breaded product. Upon storage life estimation during refrigerated storage for 12 days the samples were found fit for consumption till 10 days with intention for utilization of fresh Acetes for reducing losses. The results of biochemical, microbial and sensory evaluation indicated the shelf life of product to be 10 days with respect to sensory parameters, while biochemical and microbial parameters were within the

limits. Hence fresh Acetes can be effectively utilized for producing nutritious battered and breaded product.

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