International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 1943-1950

Received: 17-01-2019
Accepted: 22-02-2019

Prabir Debbarma
College of Fisheries, Central Agricultural University, Lembucherra, Tripura, India

Apurba Saha
College of Fisheries, Central Agricultural University, Lembucherra, Tripura, India

Correspondence
Prabir Debbarma
College of Fisheries, Central Agricultural University, Lembucherra, Tripura, India

Biochemical changes of dried *Hilsa toli* (Valenciennes, 1847) in different packaging during self-life under ambient condition

Prabir Debbarma and Apurba Saha

Abstract
A study was conducted to evaluation of the changes in the biochemical composition of dried Chandana (*Hilsa toli*) during storage under ambient temperature in three different packaging conditions namely transparent (TP), opaque (OP) and vacuum (VP). During storage the TVBN was found increased from 32.2 to 51.86, 40.17, 42.09 and 43.4 mg% in control, TP, OP and VP respectively. The salt content decreased in control while increased non-significantly in other packaging during storage. The TBA content was increased from 1.64 to 3.32, 3.19, 2.16 and 2.43 mg malonaldehyde per kg fish in control, TP, OP and VP respectively. The microbial count was found to increase in control whereas no significant difference was observed in other packaged. Rehydration capacity decreased with the storage period. Self life of *H. toli* in TP, OP and VP was found to be 120, 150 and more than 210 days respectively.

Keywords: Dried fish, *Hilsa toli*, packaging, storage period

1. Introduction

Drying is regarded as a traditional and primitive method of preservation of fish. Dried fish products have been considered as one of the safest food groups for human because their manufacture involves hurdles to microbial survival and growth (Calicioglu *et al*., 2002) [12]. Sun drying of fishes is a simple and the oldest known method of fish preservation. Drying method is considered as the least expensive method of fish preservation (Balachandran, 2001) [8]. This traditional method is followed for the preservation of fish especially in rural areas (Chakrabarti and Varma, 1999) [13]. Traditional drying is often rudimentary and good hygiene is rarely practiced. The cured fishery products have good potential for internal market and exported to various South and South East Asian countries such as Sri Lanka, Hong Kong and Singapore. During the past few years, there has been a decline in the export of Indian cured fishery products (Sugumar *et al*., 1995) [40] mainly because of their poor quality and suggested that the quality of dry fish available in the country requires much improvement. The deterioration of quality in dried fish products is due to improper packaging during storage and transportation.

Packaging technology has undergone significant changes and these technologies offer new, alternative ways of protecting meat products from discolouration, off-flavour, off-odour, nutrient loss and texture changes. The main purpose of food packaging is to protect the product from the surroundings and to maintain the quality of the food throughout the product's shelf-life. Furthermore, packaging must address communication, legal, and commercial demands. The type of packaging depends upon the species of fish, the type of the product and the distance to the retail market. The special functions required of a suitable dried fish/product package are inertness, leak proofness, impermeability to oxygen and moisture and translucent. Resistance to mechanical abrasion and puncture is another desired quality. Above all the packaging must be as inexpensive as possible to reduce the escalation of the price of fish. One fifth of India's fish catch is salted and dried for internal consumption. The packaging employed is highly unsatisfactory leaving much to be desired from the scientific and hygienic points of view.

The North Eastern region of India comprising eight states namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim, Fish is the major source of diet for the peoples of Tripura where about 95% people consume fish. The per capita consumption of fish in Tripura is 13 kg which is much higher than all over India (9 kg)

(Anonymous, 2008) [3]. In Tripura fish is consumed in fresh, dry and fermented form. In Tripura dried fishes are a delicacy which are consumed in the form of chutneys or mixed with vegetables. Among the dry fishes available cured Chandana (Hilsa toli) are very popular dried fishes in the Northeast India and have more commercial importance.

Tenualosa toli, also known as Sarawak Terubok, Chinese Herring or Toli Shad is a shad of the Clupeidae family, available in western Indian Ocean and the Bay of Bengal to the Java Sea and the South China Sea and it is mostly consumed in salted and dried form.

But the quality of the dried *Hilsa toli* varies in different seasons and with different traders. Moreover, sales of dry fish are still restricted in the dry fish markets only. Dry fish markets are very unhygienic and lack sanitation; this resulted in lack of consumer acceptance of dried products. Proper packaging of dry fishes will not only increase the shelf life of the product but also attracts the consumers in the retail outlets. Based on the above factors, an attempt has been done to collect the good quality Chandana from the dry fish markets of Agartala and further shelf stability studies of the products during storage was studied under different packaging conditions or with different packaging methods i.e., normal packaging, opaque packaging and vacuum packaging.

2. Materials and Methods

Material

The study was carried out in three laboratories including Microbiology Lab, Biochemistry Lab and Product Development Lab of Department of Fish Processing Technology, College of Fisheries, Central Agricultural University, Lembucherra, Tripura West 79910, India. Salted-dried Chandana (*Hilsa toli*) was collected from Jagi Road Dry Fish Market (one of the largest dry fish market of Southeast Asia) of Assam through local agent. As reported the post-dried age of the products till the experiment started was about 3-4 weeks. Usually the dry fish are transported from the place of production to Jagi Road market in gunny bags. The dry fish were first cleaned of extraneous matter like pieces of gunny bags, broken pieces of dry fish etc. Dry fish were sorted and only whole fish (without any damage) used for this study.

For transparent packaging polypropylene pouches were used whereas for opaque packaging black coloured polybags were used. Polypropylene pouches were also used for vacuum packaging. Number of sample dry fish per pack for salted-dried Hilsa was four and one respectively. Dry fish packed in transparent and vacuum packs were stored in open place whereas black polybags were stored in closed cartoon. Dry fish without packaging were kept in open place. To study changes in biochemical, microbiological and organoleptic characteristics of dry fish packed in different packaging was done periodically at 30 days interval.

Method

Proximate analysis of dried fish

The proximate composition analysis (moisture, crude protein, fat and ash content) of experimental dried fish samples was carried out using standard methods (AOAC, 2010) [5].

Estimation of salt content

Excess silver nitrate is added to the salt solution prepared from the dried fish and the silver nitrate left behind after precipitation is determined by titrating against ammonium thiocyanate using ferric alum as indicator. (AOAC, 2000) [5].

Estimation of Non-Protein Nitrogen

Non protein nitrogen (NPN) content was determined by the method as described by Velankar and Govindan (1958) [44]. About 10 g of sample was taken and macerated with 10 ml of 15% TCA for 3 min. using pestle and mortar. The slurry was allowed to settle at refrigerated temperature for 30 min. The slurry was filtered and made up to 50 ml with distilled water and 20 ml aliquot was taken for nitrogen estimation by Kjeldahl method. The NPN content was expressed as mg N/ 100 g meat.

Estimation of Total Volatile Basic Nitrogen

Total Volatile Base Nitrogen (TVBN) content of dry fish samples was determined by Conway micro diffusion method Beatty and Gibbon (1937) [11]. 10 g of the dry fish sample was macerated with 20% tri-choloro acetic acid (TCA) solution using pestle and mortar. The slurry was filtered with coarse filter paper and made up to 100 ml with distilled water. 2 ml of boric acid containing mixed indicator (0.066% methyl red and 0.066% bromo cresol green solution in alcohol in ratio of 1:1) was added into the inner chamber and 1 ml of sample into outer chamber of Conway micro diffusion unit followed by addition of potassium carbonate in the same chamber. Grease was applied on the covering glass of unit to make it air tight. The solution was incubated at 37 ºC for 90 min. After incubation, inner chamber content was titrated against 0.02N sulphuric acid. A blank was run using 2% TCA solution instead of sample. TVBN was calculated and expressed in mg%.

Estimation of Peroxide Value

The Peroxide Value content was determined by the method as described by Jacob (1958) [22]. 10 g dry fish was macerated with 15 g anhydrous sodium sulphate transferred to an iodine flask. After that, 80-100ml chloroform was added followed by shaking vigorously for 2-3 min and kept in dark overnight. The slurry was filtered using Whatman No. 1 filter paper. Exactly 10ml of chloroform extract was taken in a dried and weighed Petri dish which was placed over a hot plate to evaporate chloroform and weight of the oil was determined from the difference of weight. 5-10 ml of chloroform extract was taken in a 250ml iodine flask and 25ml of solvent (2 parts by volume of glacial acetic acid and 1 part by volume of chloroform) was added to this followed by 1g potassium iodide salt. The content was shaken well for one minute and allowed to stand in dark for 30 min. Then about 35ml of distilled water was added by washing the stopper and sides of the flask. The content in the flask was titrated against 0.01N sodium thiosulphate solution using starch as indicator with vigorous shaking till complete disappearance of blue colour.

Rehydration capacity

Reconstitution property of the dried fish was assessed as percentages of water imbibed by 5g of the dried fish sample soaked in 50ml of cold water (1: 10 ratio) for a period of 3.5 hour. Then the soaked sample with water was transferred into test tube and subjected to centrifuge for 10 minutes at 2000 rpm. After completion of centrifugation the water was drained out by keeping the test tube in inverted position and final weight of sample was taken. The results was expressed as, ml of water absorbed per 100g of dried samples. (Valsan, 1975) [43].

Microbiological analysis of dried fish
Total plate count
The total plate count was determined by the method as described by APHA (1995) [6]. For enumerating total bacteria or Total plate count (TPC), 10 g each samples of dried fish were macerated with 90 ml of sterile physiological saline (0.85% Nacl). Tenfold serial dilution of the samples was made and 0.1ml from each dilution was placed on duplicate plates of nutrient agar following spread plate technique. The plates were incubated in aerobic condition for 24 hrs. Colony counted and expressed in log cfu (colony forming units) per gram of samples. The TPC was calculated using following formula

Count per gram = Number of colonies counted X reciprocal of dilution from which the colonies counted X reciprocal of aliquot plated

Total Fungal Count
The total fungal count was determined by the method as described by APHA (1976) [7]. 10g of sample was introduced aseptically in a sterile stomach bag (Seward stomach BA6141CPG standard bags) and macerated for 2 min. with 90ml of sterile diluents of 0.1% peptone using a stomacher (Seward stomach 400 circulator, England). A serial decimal dilution of 10^{-2} was prepared using 9ml sterile 0.1% peptone and 1ml homogenize sample and it was well mixed in cyclomixer. Then pipette 0.1ml of inoculums was spread plated on PDA plates using a sterile glass spreader. The plates were incubated at 28-30^{0}C for 48 hrs. The plates containing 10-150 colonies were counted. The TFC was calculated using following formula

Count per gram = Number of colonies counted x reciprocal of dilution from which the colonies counted x reciprocal of aliquot plate.

Sensory evaluation of dried fish
Sensory characteristics and overall acceptability of sundried fish was assessed by a panel of six members on the basis of 5 point scale suggested by Ninan *et al*. (2008) [32]. The score were given in the decreasing order scale with 5for excellent, 4 for very good, 3 for good, 2 for poor and 1 for unacceptable. The mean of the score given by the panel represented the overall sensory quality. A score of below 3 was considered as unacceptable.

3. Result and Discussion
Changes in proximate composition
Changes in proximate composition such as moisture, ash, protein, lipid, NPN and salt contain of dried *H. toli* is presented in table 1. The dried *H. toli* where moisture content was observe in significantly ($p<0.05$) increased to 31.42±1.91% from the initial (Day-1) value of 24.70±0.9%. This may be due to storing of the product exposed to the air (since product not packaged) which accelerated re-absorption of moisture from the atmosphere. However, re-absorption of moisture by the dried fish depends upon the relative humidity of the surrounding air of the place where it is stored. Since the study has been conducted from the month of August onwards, this period falls in the summer in the Northeast with high RH of the air (more than 85%). Moisture, being an important factor in respect of dried fish products, initiates deteriorative activities mainly microbial proliferation in the product.

The dried *H. toli* when packaged showed slight decrease of moisture contents during the period up to 120 days (HT-TP), 150 days (HT-OP), and 210 days (HT-VP). The decrease of moisture was about 8% in the cases and not significant except between Day-1 and Day-120. Such slight decrease of moisture content while packaged in poly pouch may be due to dehydration particularly in the winter months when the RH of the air remains low and moreover, the poly pouches used in this study were not 100% moisture impermeable. Another reason for declining moisture content may be due to utilisation of moisture by microbes for their metabolism under control condition. Traditionally, dried fish products are packed in gunny bags during storing at warehouse which allows re-absorption of moisture. Mohamed *et al*. (2011) [31] reported a declining trend of moisture content during a storage period of 6 months. They had studied on dried tilapia fillets and found that moisture content reduced in all treatments under vacuum packaging condition. Similar observation also reported by Zaki *et al*. (1976) [47] and Rowland *et al*. (2009) [33].

No significant change was noticed in the ash contents of dried fish products during storage study under different packaged conditions. Ash content decreased (p>0.05) in CON condition of dried fish may be due to increase in moisture content. However, it increased (p>0.05) under all packaging conditions which may be due to decrease in moisture content. Protein content reduced significantly in control condition in case of the products. There was 8% reduction of crude protein content in HT-CON respectively. This may be due to increase of moisture content under control condition of the products and utilisation of protein by microbes for their nutrition. The changes of protein content under different packaging conditions (TP, OP and VP) for the dried fish showed slight changes which may be due to lesser degradation or breakdown of protein under packaging condition and it was also correlated with less formation of NPN. Similar observations were also recorded for lipid and NPN contents. Except the control (CON) the reduction of lipid content was very less for all the packaging conditions (TP, OP and VP), which may be due to less oxidation of lipid under packaging conditions. Due to the increase of moisture the lipid content decreased in CON condition. The changes were least in VP which might be due to anaerobic condition. No significant change was observed in packaged products in respect of any proximal parameters studied. But NPN content was found to increase in all the packaged products during storage and this may be explained as synthesis of low molecular weight nitrogenous compounds due to microbial activity during storage. Salt content of dried *H. toli* (chandana sutki) was analyzed since the raw fish is treated with salt before drying. Average salt content was found as 13.14% (range, 11.59 – 14.62%) and this level is considered optimum from the view point of microbial safety and consumers‟ acceptability. To achieve water activity (aw) of 0.90, which inhibits most bacteria, a salt solution of approx 15.5% is required (Davidson, 1997) [15]. In general, food borne pathogenic bacteria are inhibited by aw of 0.92 or less that is equivalent to NaCl concentration of 13% (w/v) (Eyo, 1991) [17]. Salt content of dry salted mackerel and pink perch stored at ambient temperature were reported as 17.5% and >21.0% respectively (Srikar, 1993) [38]. A considerable quantity of salt is lost during precooking washing of dried *H. toli*. The preservative action of sodium chloride has been discussed by number of authors (Tressler, D. K. and Lemon. J, 1951; Shelef, L. A. and Seiter, J. A, 1993; Stansby, 1963; Koizumi *et al*, 1985; Fabian, 1951; Majumdar, R. K. and Basu S., 2010; Barbut *et al*, 1986; Luck, E. and Jager, 1997 and Daun, H., 1975) [41, 36, 39, 27, 18, 30, 9, 29, 14]. According to them, the preservative action of salt lies in the reduction of water activity (aw) of a system thus renders a condition less favourable for the microbial life.

Changes in biochemical quality

Changes of total volatile base nitrogen (TVBN)

There was significant increase in TVB-N contents of all the treatments whether packaged or not. However, rate of increase was higher in non-packaged products. In case of dried *H. toli*, the treatment (HT-CON) showed a 61% increase of TVB-N content from the initial value (32.20 mg/100g) after 60 days, (Table 2). The reason for such higher increase in TVB-N content under control condition may be due to keeping the dried products in open condition without packaging which made it susceptible for bacterial proliferation and as a result bacteria produced volatile compound (TVB-N) increased rapidly. In case of packaged products, the increase of TVB-N content was 25% (on Day-120) and 31% (on Day-150) in respect of treatments HT-TP and HT-OP respectively. Similarly, the treatments such as HT-VP showed 35% increase of TVB-N value from the initial value during storage period of 210 days. The initial TVB-N value was high in the products and this may be due to post dried handling and transportation. The rate of increase in TVB-N content was higher in transparent package followed by opaque and vacuum condition. The increment rate was least in vacuum condition which may be due to storage of product in absence of oxygen. The activity of microbes and enzymes were reduced under vacuum condition which results in less formation of protein degraded volatile compound TVB-N. Due to presence of air or oxygen in transparent and opaque packages the volatile formation was more compared to the former one for both the dry fishes. Compared to TP the formation of TVB-N was less in OP condition for the species which may be due to the dark condition in opaque packages which suppressed the proliferation of bacteria and leads to lesser volatile compounds formation. Mohamed *et al.* (2011) [31] reported that the TVBN of dried tilapia fillets increased slightly for all the different treatments towards the end of 180 days storage study period under vacuum packaging condition.

Changes of peroxide value (PV)

Rancidity development was measured by means of primary (PV) and secondary (TBA) lipid oxidation compound formation. Peroxide value registered a significant ($p < 0.05$) increase in all the treatments. In case of dried *H. toli*, the initial value (27.12 m moles per O^2/kg fat) increased to 93, 71, 42 and 47% after 60 days (HT-CON), 120 days (HT-TP), 150 days (HT-OP) and 210 days (HT-VP) of storage respectively. Having high initial fat content, dried *H. toli* showed 93% increase in PV under non-packaging condition (HT-CON) which may be due to direct contact with atmospheric oxygen. Transparent package (HT-TP) showed comparatively more rise in PV content than the opaque (HT-OP) which may be due to presence of air inside the pouch. The least increment was observed in vacuum packaging condition (HT-VP) which may be due to absence of air as well as prevention of entry of light inside the pouch. The higher PV of dried fish products might be attributed to the oxidation of lipids during the drying process (Aitken, A. and Connell, J. J., 1979) [2]. The PV is not related to actual sensory quality of products, which may indicate a potential for a later formation of objectionable compounds. The oxidation of fat during drying may lead to rancid flavour (Tsuchiya, T., 1961) [42].

Changes of thiobarbituric acid value (TBA)

The TBA value is widely used as an indicator of the degree of secondary lipid oxidation. The increase in TBA indicates formation of secondary lipid oxidation products such as aldehydes and other volatile compounds (Kolakowska, A., 2002) [28]. TBA value increased significantly in all the treatments during the period of storage. The TBA value of dried *H. toli*, was found in the initial value (1.64 mg malonaldehyde/kg meat) increased to 102, 94, 32 and 48% after 60 days (HT-CON), 120 days (HT-TP), 150 days (HT-OP) and 210 days (HT-VP) of storage respectively (Table. 6). The reason for high increase of TBA contents for the dried fish in CON, TP, OP and VP conditions respectively may be due to the same reason as explained for PV. In this study, the control of dried *H. toli* showed higher TBA which may be due to more inherent lipid content of the former.

The extent of increase in lipid oxidation is a general phenomenon of aerobically stored, dehydrated fishery products (Horner, 1992; Jeevanandam *et al*., 2001) [20, 23]. The product was made by traditional sun drying method, where there is likelihood of more lipid peroxidation during drying. Kezban, S. A. and Nuray, K. (2003) [26] also reported that sun-drying induced more lipid alteration than smoke-drying. Gok *et al.* (2008) [19] reported that TBARS value increased throughout 120 days storage period from 0.90 to 2.80 mg malonaldehyde / kg under aerobic packaging condition for Pastirma which is a dry cured beef product of Turkey. For the same product they also reported a slow but steady increasing trend of TBARS packaged under vacuum condition. Yagli and Ertas (1998) [46] also reported a similar trend of TBARS for the same product. Increase in TBA value during storage period of dried tilapia fillets was also reported by Mohamed *et al*. (2011) [31].

Changes of rehydration capacity (RC)

The reconstitution (rehydration) property of the meat gives an index of protein quality and its ability to retain moisture. The rehydration capacity of dried *H. toli* was found 43.89% (range, 41.28 – 46.83) respectively. Different values of rehydration capacity were due to samples collected from different shops and probably due to different age of the products. The rehydration capacities of freshly prepared solar dried non-tenderised and tenderized Rohu steaks were recorded as 39.8% and 55.8% respectively (Smruti *et al.*, 2003) [37]. Whereas, the values were 42% and 61.7% respectively, when dried in tunnel dryer. Rehydration is the replacement of water in dehydrated foods, but not all products reconstitute to 100% of their original state because of inherent differences in their chemical composition (Vonloesecke, 1955) [45]. The difference in rehydration capacities of different products could be attributed to the degree of protein denaturation taking place during drying and damage to cellular structure (Horner, 1992) [20]. DebNath K. and Majumdar R. K. (2013) [16] reported almost similar rehydration ratio in case of market samples and solar tent dried products of *Puntius sophore* and *Mystus gulio*.

Changes of microbiological quality

The total plate count of dried *H. toli* was found in the range of 3.75 – 5.36 log cfu/g (mean value, 4.49). The dried products had a microbial load of around 5 log cfu g^{-1}. ICMSF (1986)

[21] suggested acceptable limit of bacterial load in dry fish as < 5 log cfu g^{-1}. Abraham *et al*. (1993) [1] and Basu *et al*. (1989) [10] reported microbial load of around 5 log cfu g^{-1} in dried marine fishes. Therefore, the average value of microbial load in the dried fish products from the market did not exceed the acceptable limit suggested by different authors. According to report of Kalaimani *et al*. (1988) [24], the APC of 10^3 cfu/g is normal in salted and dried fishery products. However, Shakila *et al*. (2002) [35] have reported that the APC in the salted fish ranged from 10^4 to 10^5 cfu g^{-1}, while dried fish product contained about 104 cfu g^{-1}. The total fungal counts was found in the range of 3.55 – 4.26 (mean value, 4.00) in dried *H. toli*. Dried fish products are very prone to fungal infection and it increases with the increase of moisture contents. Dried fishes are displayed in open condition in retail market which makes them susceptible for visible insect and fungal attack due to re-absorption of moisture from the atmosphere. Sarojnalini and Suchitra (2009) [34] reported TPC and TFC values of 4.77 and 3.25 log $cfug^{-1}$ respectively for sundried Setipinna sp. Higher values of TPC and TFC may be due to drying and keeping the raw materials in open space for longer time and unhygienic handling. DebNath and Majumdar (2013) [16] reported 4.14 and 3.20 log cfu/g total fungal count in market sample of *P. sophore* and *M. gulio*.

Changes in organoleptic quality

All the sensory indices, viz. general appearance, colour, odour and texture showed lower scores with increasing days of storage period under the packaging conditions (Table 3). Based on the sensory scores, the quality shelf life of dried *Hilsa toli* was considered to be 150 days and 210 days respectively when packed and stored in transparent poly pouches and opaque poly pouches. But the quality shelf life of vacuum packed dried *H. toli* was considered to be more than 210 days. Karthikeyan *et al.* (2007) [25] observed sensory score in the range of 5.7-7.3 (on 10-Point hedonic scale) of dried fish collected from the markets of Tripura. The dried fish gradually lose their sensory attributes upon storage; however, good packaging can slow down the rate of deterioration with resultant increase of shelf-life.

Table 1: Changes of proximate composition during storage of dried Chandana (*Hilsa toli*) under different packaged conditions

Parameters	Treatments*	Day-1	Day-30	Day-60	Day-90	Day-120	Day-150	Day-180	Day- 210
Moisture (%)	HT-CON	$24.70^{a} \pm 0.9$	$29.72^{b} \pm 1.66$	$31.42^{b} \pm 1.91$					
	HT-TP	$24.70^{a} \pm 0.9$	$24.53^{a} \pm 0.99$	$23.81^{a} \pm 0.94$	$23.62^{a} \pm 0.94$	$22.97^{a} \pm 1.45$			
	HT-OP	$24.70^{a} \pm 0.9$	$24.43^{ab} \pm 1.12$	$24.12^{ab} \pm 0.63$	$23.77^{ab} \pm 0.25$	$23.36^{bc} \pm 0.44$	$22.81^{c} \pm 0.16$		
	HT-VP	$24.70^{a} \pm 0.9$	$24.62^{a} \pm 1.12$	$24.32^{ab} \pm 0.53$	$24.17^{ab} \pm 0.28$	$23.93^{ab} \pm 0.67$	$23.35^{b} \pm 0.19$	$23.07^{b} \pm 0.16$	$21.81^{c} \pm 0.71$
Ash (%)	HT-CON	$17.24^{a} \pm 0.8$	$16.54^{a} \pm 0.63$	$15.42^{b} \pm 0.61$					
	HT-TP	$17.24^{a} \pm 0.8$	$17.17^{a} \pm 0.68$	$17.57^{a} \pm 0.37$	$17.79^{a} \pm 0.17$	$17.85^{a} \pm 0.23$			
	HT-OP	$17.24^{a} \pm 0.8$	$17.37^{a} \pm 0.27$	$17.5^{a} \pm 0.48$	$17.66^{a} \pm 0.21$	$17.73^{a} \pm 0.42$	$17.75^{a} \pm 0.1$		
	HT-VP	$17.24^{a} \pm 0.8$	$17.28^{a} \pm 0.27$	$17.35^{a} \pm 0.17$	$17.4^{a} \pm 0.24$	$17.37^{a} \pm 0.26$	$17.47^{a} \pm 0.12$	$17.45^{a} \pm 0.18$	$17.51^{a} \pm 0.29$
Protein (%)	HT-CON	$42.87^{a} \pm 1.08$	$41.38^{a} \pm 0.92$	$39.45^{b} \pm 0.99$					
	HT-TP	$42.87^{a} \pm 1.08$	$42.44^{a} \pm 0.60$	$41.97^{ab} \pm 0.86$	$40.67^{b} \pm 0.46$	$40.59^{b} \pm 1.06$			
	HT-OP	$42.87^{a} \pm 1.08$	$42.46^{a} \pm 0.68$	$42.23^{a} \pm 0.87$	$41.98^{a} \pm 0.10$	$41.81^{a} \pm 0.46$	$42.76^{a} \pm 0.52$		
	HT-VP	$42.87^{a} \pm 1.08$	$42.71^{a} \pm 0.99$	$42.64^{a} \pm 0.83$	$42.46^{a} \pm 0.97$	$42.35^{a} \pm 0.93$	$41.88^{a} \pm 0.31$	$42.02^{a} \pm 0.27$	$42.69^{a} \pm 1.02$
Lipid (%)	HT-CON	$13.74^{a} \pm 0.43$	$13.48^{a} \pm 0.96$	$11.28^{b} \pm 0.53$					
	HT-TP	$13.74^{a} \pm 0.43$	$13.82^{a} \pm 0.1$	$13.96^{ab} \pm 0.26$	$13.06^{ab} \pm 0.29$	$13.09^{a} \pm 0.34$			
	HT-OP	$13.74^{abc} \pm 0.43$	$13.8^{abc} \pm 0.13$	$13.84^{bc} \pm 0.41$	$13.95^{c} \pm 0.38$	$13.03^{a} \pm 0.66$	$13.11^{ab} \pm 0.26$		
	HT-VP	$13.74^{a} \pm 0.43$	$13.77^{a} \pm 0.21$	$13.82^{a} \pm 0.19$	$13.86^{a} \pm 0.22$	$13.93^{a} \pm 0.2$	$13.78^{a} \pm 0.11$	$13.72^{a} \pm 0.17$	$13.69^{a} \pm 0.3$
NPN (%)	HT-CON	$1.1^{a} \pm 0.04$	$1.17^{a} \pm 0.04$	$1.22^{b} \pm 0.06$					
	HT-TP	$1.1^{a} \pm 0.04$	$1.17^{a} \pm 0.06$	$1.3^{b} \pm 0.08$	$1.33^{bc} \pm 0.05$	$1.41^{c} \pm 0.04$			
	HT-OP	$1.1^{a} \pm 0.04$	$1.16^{a} \pm 0.06$	$1.21^{bc} \pm 0.05$	$1.29^{cd} \pm 0.07$	$1.36^{d} \pm 0.05$	$1.52^{e} \pm 0.03$		
	HT-VP	1.1 ± 0.04	1.12 ± 0.05	$1.18^{ab} \pm 0.05$	$1.25^{b} \pm 0.07$	$1.27^{b} \pm 0.06$	$1.23^{b} \pm 0.03$	$1.25^{b} \pm 0.03$	$1.37^{c} \pm 0.07$
Salt(%)	HT-CON	$13.07^{a} \pm 1.65$	$11.31^{a} \pm 0.52$	$11.11^{a} \pm 0.13$					
	HT-TP	$13.07^{a} \pm 1.65$	$12.33^{a} \pm 1.17$	$12.45^{a} \pm 0.63$	$13.11^{a} \pm 0.69$	$13.27^{a} \pm 0.85$			
	HT-OP	$13.07^{a} \pm 1.65$	$13.15^{a} \pm 0.48$	$12.92^{a} \pm 0.73$	$13.19^{a} \pm 0.12$	$13.23^{a} \pm 0.16$	$13.31^{a} \pm 0.03$		
	HT-VP	$13.07^{a} \pm 1.65$	$13.11^{a} \pm 0.37$	$13.14^{a} \pm 0.79$	$13.18^{a} \pm 0.17$	$13.21^{a} \pm 0.18$	$13.18^{a} \pm 0.26$	$13.09^{a} \pm 0.13$	$13.12^{a} \pm 0.23$

Values of means ± S. D. Mean values bearing different superscripts (a, b, c, etc.) in a row are significantly different with respect to period of storage.
* HT-CON=Dried *H. toli* without any packaging, HT-TP= Transparent packaged dried *H. toli*, HT-OP= Opaque packaged dried *H. toli*, HT-VP= Vacuum packaged dried *H. toli*.

Table 2: Biochemical and microbiological changes during storage of dried Chandana (*Hilsa toli*) under different packaged conditions

Parameters	Treatment*	Day-1	Day-30	Day-60	Day-90	Day-120	Day-150	Day-180	Day- 210
TVBN (mg%)	CON	$32.2^{a} \pm 0.1$	$44.93^{b} \pm 1.76$	$51.86^{c} \pm 1.55$					
	HT-TP	$32.2^{a} \pm 0.1$	$34.86^{b} \pm 0.48$	$37.75^{c} \pm 0.65$	$38.92^{d} \pm 0.27$	$40.17^{e} \pm 0.45$			
	HT-OP	$32.2^{a} \pm 0.1$	$34.16^{b} \pm 0.3$	$36.28^{c} \pm 0.46$	$38.22^{d} \pm 0.47$	$39.75^{e} \pm 0.34$	$42.09^{f} \pm 1.37$		
	HT-VP	$32.2^{a} \pm 0.1$	$33.59^{b} \pm 0.33$	$33.98^{b} \pm 0.13$	$34.31^{bc} \pm 0.11$	$35.25^{c} \pm 0.25$	$37.24^{d} \pm 0.89$	$41.06^{e} \pm 1.17$	$43.4^{f} \pm 1.16$
PV (milliequivalent O_2 /kg fat)	CON	$27.12^{a} \pm 0.11$	$47.15^{b} \pm 0.45$	$52.36^{c} \pm 0.89$					
	HT-TP	$27.12^{a} \pm 0.11$	$39.43^{b} \pm 0.18$	$42.75^{c} \pm 0.36$	$44.13^{d} \pm 0.56$	$46.29^{e} \pm 0.59$			
	HT-OP	$27.12^{a} \pm 0.11$	$28.96^{b} \pm 0.72$	$32.07^{c} \pm 0.42$	$33.9^{d} \pm 0.51$	$35.46^{e} \pm 0.67$	$38.44^{f} \pm 0.79$		
	HT-VP	$27.12^{a} \pm 0.11$	$28.21^{ab} \pm 0.17$	$28.72^{bc} \pm 0.31$	$29.53^{cd} \pm 0.27$	$28.19^{cd} \pm 0.34$	$31.43^{de} \pm 0.67$	$36.12^{e} \pm 1.65$	$39.78^{f} \pm 0.64$
TBA (mg malonaldehyde /kg fish)	CON	$1.64^{a} \pm 0.05$	$2.04^{b} \pm 0.2$	$3.32^{c} \pm 0.16$					
	HT-TP	$1.64^{a} \pm 0.05$	$1.83^{a} \pm 0.05$	$2.12^{b} \pm 0.27$	$2.93^{c} \pm 0.18$	$3.19^{c} \pm 0.06$			
	HT-OP	$1.64^{a} \pm 0.05$	$1.76^{b} \pm 0.04$	$1.89^{c} \pm 0.05$	$1.97^{d} \pm 0.08$	$2.06^{e} \pm 0.07$	$2.16^{f} \pm 0.01$		
	HT-VP	$1.64^{a} \pm 0.05$	$1.73^{ab} \pm 0.04$	$1.85^{bc} \pm 0.07$	$1.91^{cd} \pm 0.06$	$1.98^{cd} \pm 0.06$	$2.08^{de} \pm 0.04$	$2.2^{e} \pm 0.12$	$2.43^{f} \pm 0.21$
Rehydration capacity (%)	CON	$42.32^{a} \pm 1.28$	$35.21^{b} \pm 1.68$	$31.66^{c} \pm 1.09$					
	HT-TP	$42.32^{a} \pm 1.28$	$41.69^{b} \pm 0.38$	$36.51^{c} \pm 0.72$	$32.81^{d} \pm 0.77$	$29.65^{d} \pm 0.51$			
	HT-OP	$42.32^{a} \pm 1.28$	$42.25^{a} \pm 0.7$	$41.89^{a} \pm 0.77$	$38.65^{b} \pm 0.17$	$35.93^{c} \pm 0.42$	$33.64^{d} \pm 0.55$		
	HT-VP	$42.32^{a} \pm 1.28$	$42.21^{b} \pm 0.71$	$41.67^{c} \pm 0.55$	$39.62^{d} \pm 0.13$	$36.18^{e} \pm 0.76$	$34.28^{f} \pm 0.53$	$32.22^{f} \pm 0.81$	$29.91^{f} \pm 1.27$

TPC (logcfu/g)	CON	$3.83^{a} \pm 0.08$	$4.42^{b} \pm 0.36$	$5.34^{c} \pm 0.11$					
	HT-TP	$3.83^{a} \pm 0.08$	$3.86^{a} \pm 0.09$	$3.61^{b} \pm 0.06$	$4.74^{c} \pm 0.05$	$4.65^{c} \pm 0.05$			
	HT-OP	$3.83^{b} \pm 0.08$	$3.76^{ab} \pm 0.03$	$3.58^{a} \pm 0.04$	$3.74^{ab} \pm 0.05$	$4.65^{e} \pm 0.1$	$4.4^{c} \pm 0.23$		
	HT-VP	$3.83^{a} \pm 0.08$	$3.76^{a} \pm 0.05$	$3.2^{b} \pm 0.15$	$3.59^{ab} \pm 0.07$	$3.17^{bc} \pm 0.12$	$3.18^{bc} \pm 0.39$	$3.08^{c} \pm 0.32$	$2.98^{c} \pm 0.36$
TFC (logcfu/g)	CON	$3.95^{a} \pm 0.09$	$4.11^{a} \pm 0.23$	$5.22^{b} \pm 0.39$					
	HT-TP	$3.95^{a} \pm 0.09$	$4.14^{ab} \pm 0.11$	$4.21^{b} \pm 0.1$	$4.17^{b} \pm 0.14$	$4.12^{ab} \pm 0.09$			
	HT-OP	$3.95^{a} \pm 0.09$	$4.17^{ab} \pm 0.1$	$4.09^{ab} \pm 0.13$	$4.01^{a} \pm 4.01$	$4.22^{ab} \pm 0.1$	$4.39^{b} \pm 0.21$		
	HT-VP	$3.95^{a} \pm 0.09$	$3.88^{a} \pm 0.26$	$3.15^{a} \pm 0.1$	$4.08^{a} \pm 0.13$	$4.05^{a} \pm 0.09$	$3.98^{a} \pm 0.21$	$4.05^{a} \pm 0.09$	$3.92^{a} \pm 0.19$

Values of means ± S. D. Mean values bearing different superscripts (a, b, c, etc.) in a row are significantly different with respect to period of storage.
*HT-CON= Dried *H. toli* without any packaging, HT-TP= Transparent packaged dried *H. toli*, HT-OP= Opaque packaged dried *H. Toil*, HT-VP= Vacuum packaged dried *H. toli*.

Table 3: Organoleptic changes during storage study of dried Chandana (*Hilsa toli*) under different packaged conditions

Parameters	Treatments*	Day-1	Day-30	Day-60	Day-90	Day-120	Day-150	Day- 180	Day-210
Appearance	HT-CON	$4.85^{c} \pm 0.22$	$3.7^{b} \pm 0.27$	$3.3^{a} \pm 0.27$	$3.1^{a} \pm 0.22$				
	HT-TP	$4.85^{d} \pm 0.22$	$4.5^{cd} \pm 0.35$	$4.3^{c} \pm 0.27$	$4.35^{c} \pm 0.49$	$3.55^{b} \pm 0.37$	$2.9^{a} \pm 0.22$		
	HT-OP	$4.85^{c} \pm 0.22$	$4.5^{c} \pm 0.35$	$4.3^{c} \pm 0.45$	$4.4^{bc} \pm 0.22$	$3.85^{b} \pm 0.65$	$3.25^{a} \pm 0.35$	3 ± 0.35	
	HT-VP	$4.85^{f} \pm 0.22$	$4.7^{ef} \pm 0.27$	$4.5^{ef} \pm 0.35$	$4.3^{de} \pm 0.27$	$4^{cd} \pm 0.35$	$3.8^{bc} \pm 0.35$	$3.4^{ab} \pm 0.27$	$3.2^{a} \pm 0.27$
Colour	HT-CON	$4.9^{c} \pm 0.22$	$3.6^{b} \pm 0.42$	$3.2^{b} \pm 0.27$	$2.7^{a} \pm 0.27$				
	HT-TP	$4.9^{d} \pm 0.22$	$4.75^{d} \pm 0.31$	$4.55^{d} \pm 0.27$	$3.95^{c} \pm 0.11$	$3.25^{b} \pm 0.35$	$2.8^{a} \pm 0.27$		
	HT-OP	$4.9^{e} \pm 0.22$	$4.75^{e} \pm 0.35$	$4.6^{de} \pm 0.42$	$4.2^{cd} \pm 0.27$	$3.75^{bc} \pm 0.25$	$3.4^{b} \pm 0.42$	$2.7^{a} \pm 0.45$	
	HT-VP	$4.9^{e} \pm 0.22$	$4.7^{de} \pm 0.45$	$4.3^{cd} \pm 0.45$	$4.25^{cd} \pm 0.35$	$4.1^{c} \pm 0.22$	$3.6^{b} \pm 0.42$	$3.3^{ab} \pm 0.45$	$3^{a} \pm 0.35$
Odour	HT-CON	$4.8^{c} \pm 0.27$	$4.3^{c} \pm 0.27$	$3.4^{b} \pm 0.55$	$2.5^{a} \pm 0.5$				
	HT-TP	$4.8^{e} \pm 0.27$	$4.3^{d} \pm 0.27$	$3.9^{cd} \pm 0.22$	$3.65^{c} \pm 0.42$	$3.2^{b} \pm 0.27$	$2.3^{a} \pm 0.45$		
	HT-OP	$4.8^{d} \pm 0.27$	$4.4^{cd} \pm 0.42$	$4.2^{c} \pm 0.27$	$4.1^{c} \pm 0.28$	$3.6^{b} \pm 0.42$	$3.2^{b} \pm 0.27$	$2.5^{a} \pm 0.5$	
	HT-VP	$4.8^{f} \pm 0.27$	$4.5^{ef} \pm 0.5$	$4.4^{def} \pm 0.42$	$4.1^{cde} \pm 0.22$	$3.85^{bcd} \pm 0.65$	$3.7^{abc} \pm 0.57$	$3.4^{ab} \pm 0.55$	$3.2^{a} \pm 0.27$
Texture	HT-CON	$4.65^{d} \pm 0.49$	$3.9^{c} \pm 0.42$	$3.3^{b} \pm 0.45$	$2.5^{a} \pm 0.35$				
	HT-TP	$4.65^{d} \pm 0.49$	$4.35^{d} \pm 0.42$	$4.15^{cd} \pm 0.22$	$3.7^{c} \pm 0.57$	$3.1^{b} \pm 0.22$	$2.1^{a} \pm 0.22$		
	HT-OP	$4.65^{d} \pm 0.49$	$4.6^{d} \pm 0.55$	$4.1^{cd} \pm 0.22$	$4^{c} \pm 0.35$	$3.7^{bc} \pm 0.57$	$3.2^{ab} \pm 0.27$	$2.7^{a} \pm 0.45$	
	HT-VP	$4.65^{e} \pm 0.49$	$4.5^{de} \pm 0.5$	$4.3^{de} \pm 0.45$	$4^{cd} \pm 0.35$	$3.95^{bcd} \pm 0.37$	$3.55^{abc} \pm 0.51$	$3.4^{ab} \pm 0.42$	$3.12^{a} \pm 0.25$

Values of means ± S. D. Mean values bearing different superscripts (a, b, c, etc.) in a row are significantly different with respect to period of storage.
* HT-CON=Dried *H. toli* without any packaging, HT-TP= Transparent packaged dried *H. toli*, HT-OP= Opaque packaged dried *H. toli*, HT-VP= Vacuum packaged dried *H. toli*

Fig 1: Opaque packaging

Fig 2: Normal transparent packaging

Fig 3: Vacuum packaging

4. Conclusion

In this study the highest shelf-life was observed in vacuum packaging condition compared to other two conditions. The result of the study could be adopted by the dry fish traders for commercial application on trial basis.

5. Acknowledgments

The authors would like to thank Dr. R. K. Majumdar, HOD, department of fish processing technology and Engineering, College of Fisheries, Central Agricultural University, Lembucherra, Tripura, India, for providing facility and support to conduct the research work. The assistance rendered by the technical staffs of the Department of Fish Processing Technology, College of Fisheries, CAU is sincerely acknowledged.

6. References

1. Abraham TJ, Sukumar D, Shamugam SA, Jeyachandran P. Microbial stability of certain fishery products. Fishery Technology, 1993; 30:28-31.
2. Aitken A, Connell JJ. Fish. In: Effects of heating on foodstuffs. Pristley RJ (ed), Applied Science Publication, London. 1979; pp.219-254.
3. Anonymous. March Towards Self Sufficiency in Production of Fish: Performance of the Fisheries Department (April 2007 March 2008). Department of Fisheries, Fishery technology, 2008; 36(1):24-7.
4. AOAC. Official method of analysis of AOAC International. Vol II, Edn 18, Association of Official and Analytical Chemist International. Virginia, 2010, 39.
5. AOAC. Official methods of analysis. In: Horwitz, W. (ed). Association of Official Analytical Chemists International. 17th edition, section 13.32 and 13.33. Gaithersburg, Maryland, USA, 2000.
6. APHA. Compendium of methods for microbiological examination of Foods. American Public Health Association. Yanderzant C, Splittstoesser, D.F. (ed), Washington, DC, USA, 1995.
7. APHA. Compendium of Methods for Microbiological Examination of Foods, ed., M.L. Speak, American Public Health Assn., Washington, 1976; 701.
8. Balachandran KK. Onboard handling and preservation. In Post harvest technology of fish and fishery products. Daya publishing house, New Delhi, India, 2001; pp. 57-76.
9. Barbut S, Tanaka N, Maurer AJ. Effects of varying levels of chloride salt on *Clostridium botulinum* toxin production in Turkey Frankfurters. J Food Sci. 1986; 51(5):1129-1131.
10. Basu S, Imam KD, Gupta SS, Panduranga Rao CC. Quality of dry fish from markets in Andhra Pradesh. Fishery Technology, 1989; 26:114-118.
11. Beatty SA, Gibbons NE. The measurement of Spoilage of fish. J Biol Bd Canada. 1937; 3:77-91.
12. Calicioglu M, Sofos JN, Samelis J, Kendall PA, Smith GC. Destruction of acid-and non-adapted *Listeria monocytogenes* during drying and storage of beef jerky. Food Microbiol. 2002; 19:545-559.
13. Chakraborti R, Verma PRG. Halotolarent fungi in salted and dried fish at lower Visakhapatnam coast. Fishery Technology, 1999; 36(1):28-31.
14. Daun H. Effect of processing by additives on nutrients I. In: Nutritional Evaluation of Food processing. Westport, Connecticut, 1975; 355-381.
15. Davidson PM. Chemical preservatives and natural antimicrobial compounds, In: *Food Microbiology Fundamentals and Frontiers,* edited by Doyle MP, Beuchat LR & Montville TJ, (ASM Press, Washington DC), 1997.
16. DebNath K, Majumdar RK. Quality evaluation of solar tent dried *Puntius sophore and Mystus gulio* of North East India, *Fishery Technology,* 2013; 50:146-153.
17. Eyo AA. Studies on the preparation of fermented fish products from *Alestes nurse*, In: FAO Expert Consultation on Fish Technology in Africa, 1991.
18. Fabian FW. Food preservation by use of microorganisms, In: The Chemistry and Technology of Food and Food Products, Vol 3, edited by Jacobs M. B., (Interscience Publishers Inc, New York), 1951.
19. Gok V, Obuz E, Akkaya L. Effects of packaging method and storage time on the chemical, microbiological, and sensory properties of Turkish pastirma – A dry cured beef product. Meat Science, 2008; 80:335-344.
20. Horner WFA. Preservation of fish by curing (drying, salting and smoking). In Fish Processing Technology, Blackie Academic and Professional, London, 1992; pp. 31-72.
21. ICMSF. Microorganisms in foods. Sampling for microbiological analysis: principles and specifications. International Commission of Microbiological Specification for Foods, University of Toronto Press, Toronto, 1986.
22. Jacob MB. The Chemical Analysis of Foods and Food products. Kreiger Publishing Co. Inc. New York, USA, 1958, 393-394.
23. Jeevanandam K, Venugopal V, Doke SN, Rao BYK, Bongirwar DR. Preparation and storage characteristics of ribbon fish laminates. Journal Aquatic Food Product Technology. 2001; 10:77-86.
24. Kalaimani N, Gopakumar K, Nair TSU. Quality characteristics of cured fish of commerce. Fisheries Technology, 1988; 25(1):54-57.
25. Karthikeyan M, Dhar B, Kakati B. Quality of dried freshwater fish products of commerce in Tripura. Journal of Food Science and Technology. 2007; 44(2):161-164.
26. Kezban SA, Nuray K. Storage stability of beef low-fat frankfurters formulated with carrageenan or carrageenan with pectin. Meat Science, 2003; 64:207-214.
27. Koizumi C, Oshima T, Wada S. Preservative effect of sodium chloride in salted and dried fish products. Bulletin of the Japanese Society for the Science of Fish. 1985; 51(1):87-90.
28. Kolakowska A. Lipid oxidation in food systems. In Z. Sikorski & A. Kolakowska (Eds.), Chemical and functional properties of food lipids, London, UK: CRC Press, 2002; pp.133-165.
29. Luck E, Jager M. *Antimicrobial Food Additives*, (Springer, New York), 1997.
30. Majumdar RK, Basu S. Characterization of the traditional fermented fish product *Lona ilish* of Northeast India. Indian Journal of Traditional Knowledge. 2010; 9(3):453-458.
31. Mohamed Gamal F, Eman M Hegazy, Abdellatef M. Physicochemical Properties and Mycotoxins Contents of Tilapia Fish Fillets after Solar Drying and Storage, Global Veterinaria, 2011; 7(2):138-148.
32. Ninan G, Bindu J, Joseph J. Frozen Storage studies of Minced Based Products developed from Tilapia (*Oreochromis mossambicus*, Peters 1852). Fishery Technology, 2008; 45(1):35-42.
33. Rowland S, Bower CK, Patil KN, DeWitt CA. Updraft gasification of salmon processin waste. J. Food Sci. 2009; 74(8):426-431.
34. Sarojnalini C, Suchitra T. Microbial and Nutritional Evaluation of fermented Setipinna species. Fishery Technology, 2009; 46(2):165-170.
35. Shakila RJ, Lakshmanan R, Jeyasekaran G. Incidence of amine forming bacteria in the commercial fish samples of Tuticorin region. Indian Journal of Microbiology. 2002; 42:147-150.
36. Shelef LA, Seiter JA. Indirect antimicrobials, In: Antimicrobials in Foods, edited by Davidson, P. M. and Branen, A., (Marcel Dekker Inc, New York), 1993.
37. Smruti K, Rai S, Yardi V, Warrier SB, Venugopal V. Tenderised, dehydrated steaks of freshwater fish, rahu:

Preparation and storage characteristics. Fishery Technology, 2003; 40(1):43-49.

38. Srikar LN, Khuntia BK, Reddy GVS, Srinivas BR. Influence of storage temperature on quality of salted Mackerel (*Rastrelliger kanagurta*) and pink perch (*Nemipterus japonicus)*. J Sci Food Agric. 1993; 63:319-322.
39. Stansby ME. Cured fishery products In: Industrial fishery technology. Stansby M. E., Robert E (eds), Krieger Publication Co., New York, 1963; p.415.
40. Sugumar G, Abraham TJ, Jayachandran P. Sanitation in fish curing yards of Tuticorin, Tamil Nadu. Fishery Technology, 1995; 32:136-138.
41. Tressler DK, Lemon J. Marine products and Commerce, 361-152 pp, Reinhold Pub. New York, 1951.
42. Tsuchiya T. Biochemistry of fish oils. In: Fish as food. Borgstrom, G. (ed). Academic Press, New York, 1961; pp. 211-258.
43. Valsan AP. A comparative yield and biochemical evaluation of the existing fish curing methods in India, pp. 77-79. *In*: Proc. Symp. Fish. Processing Industry in India, Assn. of Food Scientists and Technologists (India) and Central Food Technological Research Institute, Mysore, 1975.
44. Velankar NK, Govindan TK. A preliminary study of the distribution of non-protein nitrogen in some marine fishes and invertebrates. In Proceedings of the Indian Academy of Sciences-Section B. Springer India. 1958; 47(4):202-209.
45. Vonloesecke HW. Drying and dehydration of foods. Reinhold publishing corporation. New York, London, 1955; 164.
46. Yagli (Gur) H, Ertas AH. Effect of sodium ascorbate on some quality characteristics of Turkish pastirma. Turkish Journal of Agriculture and Forrestry. 1998; 22:515-520.
47. Zaki MS, Hassan YM, Rahma EH. Technolgocial studies on the dehydration of the Nile bolti fish (*Tilopia nilotica*). Nahrung, 1976a; 20(5):467-474.