Chapter 5

PHYSICAL AND ORGANOLEPTIC CHANGES IN DRIED FISH PRODUCTS
5.1 Introduction

The physical changes and organoleptic qualities are the important characteristics concerned directly with marketing of dried fish and cured fish. The appearance is one of the most important factors that attract consumers towards the product. The customers will not prefer poor appearance and other organoleptic characteristics in products. This leads to loss to the seller as well as the producer. So the study on physical changes is equally important with the chemical changes of the fish and fishery products (Prabhu & Kandoran, 1991).

Salting is reported to change the structural and mechanical feature of muscle tissue (Anon., 1982; Stansby, 1963 & Voskresensky, 1965). Due to the contraction of tissue and the electrostatic force of terminal end of protein molecule determining the structural lattices of proteins about 15 to 25% bound water is reverted to free state (Voskresensky, 1965). This leads to the shrinkage and structural variations in protein molecules. Drying is the removal of water. The products become hard, brittle and reduce in size (Anon., 1981; 1982). The salted fish reabsorbs moisture during storage period and causes damage to the fish. As the fish contain nutrients necessary to support the growth of microorganisms, water content in the fish increase the growth of mould. These are called as "dun", and cause objectionable flavour and texture. The pink discolouration on cured fish and dried fish cause proteolytic attack to soften and break up the flesh and produce off-flavours (Anon., 1982).

5.1.2 Storage temperature

Like any other product, proper storage is an important factor in case of dry fish too. The dried fishes are usually stored at room temperature 28°C (Antony, 1990). Further, the stored dried fish absorbs moisture from the surrounding atmosphere or it may lose moisture due to dry atmosphere. This is because the moisture content of the atmosphere has greater influence on the relative humidity and temperature. Keeping fish
at the low temperature of $10^\circ$C check the growth of red halophiles (Anon., 1982; 1981). Syme (1966) reported that the dry fish be stored at $41^\circ$ F ($5^\circ$C) so that the red halophiles do not grow. The maximum growth occurs during the storage at $77^\circ$ F ($25^\circ$C). Klaveren & Legendre (1965) suggested that the proteolytic action of the meat at $25^\circ$C helps the growth of red halophiles. FAO. (1957) suggested that the salted dry fish stored at low temperature did not encourage the growth of red halophiles. Rubbi et al. (1983) reported that the fish stored at $13^\circ$C was of superior quality in all cases than the fish stored at room temperature. Camu et al. (1983) suggested that the dried mackerel stored at $18^\circ$C is acceptable for 12 week. Tressler & Lemon (1951) recommended low temperature for fatty fishes.

5.1.3. Fish spoilage

5.1.3.1. Microbiological spoilage

In cured / dried fish the salt loving bacteria or other bacteria or yeast help the spoilage (Anon., 1982). The dominating bacteria are gram positive, halophilic or halotolerant micrococci, yeasts, spore formers, lactic acid, bacteria and moulds. A number of specific spoilage organisms have been reported (Anon., 1981, 1982). Some are extremely halophilic, anaerobic gram-negative rods and halophilic yeasts as causing off odour and flavours (sulphidy, fruity) in wet salted herring and cause ‘pink’. The bacteria (Halococcus and Halobacterium) also cause pink discolouration of salt, brine and salted fish as well as off odours and off flavours normally associated with spoilage (hydrogen sulphide and indole). Some halophilic moulds cause spoilage, not produce off odours but reduce the value of the product.

5.1.3.2. Chemical spoilage

The most important chemical spoilage process was the changes taking place in lipid fraction of the fish. Oxidative process, autoxidation, is a reaction involving only oxygen and unsaturated lipid. The first step leads to formation of hydroperoxide, a
a tasteless compound but causes brown and yellow discoloration to the fish tissue. The degradation of hydroperoxide give rise to formation of aldehydes and ketones. These compounds have a strong rancid flavour. Oxidation are initiated and accelerated by heat, light and several organic, inorganic substances. The signs of spoilage include detention of off-odours and off-flavours, gas production, discolouration and changes in texture. These changes are due to the combined effect of microbiological, chemical and autolytic phenomena (Anon., 1981, 1982).

5.1.3.3. Autolytic spoilage

The autolytic changes are responsible for early quality loss in fresh fish and contribute to the spoilage of chilled fish and fish products. Rapid development of off odour and discoloration are due the action of gut enzyme in ungutted fish.

According to Sikorski et al. (1995) the sensory characteristics of salted fish is resulting from enzymatic changes in protein, lipids and carbohydrates and undergoes various partial proteolysis and depends on temperature. So the salted fish should be stored at low temperature. The product needs good colour and appearance for effective selling. If the product is accepted, the consumer will always tend to buy the product even at a higher rate. The freshly prepared dried fish will always have a good colour subject to good handling of fish. Colour, appearance, flavour and textural changes are the important physical and organoleptic observations and are normally made on the point to check the quality of dried fish. Colour is an important factor to attract the customer to buy the product than quality. All are interconnected factors while the texture of fresh salted fish is always good, hard with less moisture content.

Anon. (1956) reported organoleptic changes of dehydrated fish. Firmness of fish increases (Anon., 1982, 1981) and textural change is due to the extraction of the moisture content from the fish flesh during salting. The appearance of the fish product is an added quality for a customer. Really the appearance and colour attracts the increase
of the price of product and also the customer will eagerly spent more money for the same. The packets also need good appearance. The dried fish always have the fishy odour due to its nature and the oxidative nature of the fish oils contained in flesh. The organoleptic qualities of dry fish were studied by (Antony et al., 1988) in bulk packing and market samples by Joseph et al. (1983; 1986; 1988a). Since, the unsaturated fatty oil content of fish reacts with oxygen in the surrounding air in presence of the salt, the fishy odour is unavoidable. Sodium chloride accelerates the reaction and affects the appearance of the products.

5.2. Aim

This study was aimed at,

- Organoleptic and physical changes of fresh fish during salting that affect the quality of dried products.
- Physical and organoleptic changes during different intervals of salting that affect the quality of dried products.
- To observe, physical and organoleptic changes during different intervals of storage at different conditions that has different effect on the quality of dried products.

5.3. Materials and Methods

For storage studies, the fishes used were mackerel, ribbonfish and shark. The observations were made during salting and storage to study the physical and organoleptic changes of the products from initial to final storage periods by following the materials and methods described in Chapter 4 and flow sheet tables 1, 2 and 3 in order to find out the limitations of storage period at different temperature and storage conditions. Only general observations were made during salting. Rating method was used to assess the quality, as 1- Very good, 2. Good, 3. Fair, 4. Bad, and 5. Very bad
(Ramachandran & Solanki, 1991) in different products. The parameters were tabulated and compared.

5.4. Results

5.4.1. General observations

The fish were salted at fresh condition after cleaning. The fish became firm in dry and wet salted fish and water came out only in dry salted fish. The colour and appearance were good during the course of salting and drying.

5.4.2. Initial Quality of Salted Fish

Dry salted mackerel. The selected lot was good in colour and appearance, with firm texture and fishy odour. In wet salted mackerel the selected lot was good in appearance, semi-firm texture, fishy odour and lightly oily yellowish colour. In dry salted ribbonfish the selected lot was having good appearance, colour, hard texture and fishy odour. In wet salted ribbonfish the selected lot was good in appearance, colour, semi-firm texture and slightly yellowish at belly portions. In dry salted shark the selected lot was good in appearance, colour, firm texture and ammonia odour. In wet salted shark the selected lot was good in appearance, semi-hard texture, ammonia odour and very light yellowish colour. No wet salted fish from *T. Indicus* had dark colour as noted in the products from gorukha puli (Rao et al., 1958; Balachandran & Muraleedharan, 1975) but was palatable and semi-firm.

5.4.3. Products

5.4.3.1. Unpacked Sample stored in open air

The dry salted mackerel after 10 days showed that the oily yellow colour and hard texture increased and with good appearance but fishy odour decreased. After 20 days, it had less appearance with dark yellowish colour, hard texture and less fishy odour. After 30 days, it had increased harder texture and brittle, yellowish colour with salt crystal and moderate appearance and less fishy odour (Figure – 5.1). The wet salted
as after 10 days showed yellowish colour increased at the belly portion, firm and fishy
odor with good appearance. After 20 days the yellowish colour increased further with
less fishy odour and hardened texture and moderate appearance. After 30 days the fish
tail hardened and the tail side portion broken with less fishy odour with moderate
appearance and yellowish colour as observed by Nair & Gopakumar (1986) with salt
crystals on surface and brittle (Figure – 5.2). The dry and wet salted fish were
acceptable up to 20 days only.

The dry salted ribbonfish had good appearance, colour, fishy odour and firm
texture initially. After 10 days, fishy odour slightly decreased with little hard and good
appearance and colour. After 20 days, they were yellowish or grey colour at belly with
moderate appearance, less fishy odour and little hard texture. After 30 days they were
yellowish colour and the colour was dense at belly portion, fair appearance, hard texture,
and brittle and very less fishy odour (Figure – 5.3). The wet salted ribbonfish had soft
texture which increased to hard, fishy odour decreased with good appearance and
colour after 10 days. The colour of the fish turned to whitish yellow with moderate
appearance, hard texture and fishy odour decreased after 20 days. After 30 days, colour
changed to yellowish with fair appearance and very hard texture with no fishy odour and
brittle (Figure – 5.4). The dry and wet salted samples were acceptable only for 10 days.

The dry salted shark was good in appearance, colour with ammonia odour and
hardness increased in texture after 10 days. After 20 days, there was no change in
appearance and colour but hardness in texture increased with ammonia odour. After 30
days, ammonia odour decreased and colour and appearance were dim with harder and
brittle texture with salt crystals (Figure – 5.5). The wet salted shark, after 10 days
showed that colour and appearance are decreasing with ammonia odour and hardness
sightly increased. After 20 days, colour, ammonia odour and appearance are further
decreased with increase of hardness in texture. After 30 days the appearance and
colour got faded with very less ammonia smell with hard texture and brittle (Figure – 5.6). The products seemed to be good and acceptable for 20 days.

5.4.3.2. Packed and Stored sample in open air

The Dry salted mackerel had good appearance, colour and fishy odour and hard texture after 10 days. But after 20 days, the appearance and colour decreased with decrease of hardness in texture and fishy odour. After 30 days, the samples had fouling smell and were almost spoiled (Figure – 5.1). The wet salted samples were with fade appearance, colour, less fishy odour and with softened texture after 10 days. After 20 days, the samples had pale yellow colour and appearance was dim, with semi-hard texture and less fishy odour. After 30 days, the samples were with colour fadedness and appearance with spoiled smell and lousy texture (Figure – 5.2). The former product seems to be good for 20 days and latter only for 10 days.

The dry salted ribbonfish after 10 days storage was good in appearance, whitish grey in colour with fishy odour and hard texture. After 20 days, colour and appearance are faded with texture and fishy odour decreased. After 30 days, the colour turned to grey with faded appearance, soft texture and little fishy odour (Figure – 5.3. The wet salted samples were good in appearance, colour fishy odour and hard texture after 10 days storage. After 20 days, colour turned to pale with loss of good appearance, less fishy odour and light soft texture. After 30 days, the colour turned to grey with further loss of good appearance and soft texture with very little fishy odour (Figure – 5.4). The dry salted fish was better than wet salted fish and the former was acceptable for 20 days and the latter for 10 days.

The dry salted shark after 10 days, were good in appearance, colour, with firm texture and ammonia odour. After 20 days, the ammonia odour increased with less colour, texture and appearance. After 30 days the samples showed very fair appearance and colour, soft texture with strong ammonia odour (Figure – 5.5). The wet salted
samples showed good appearance, texture and colour with ammonia odour after 10 days. After 20 days the samples showed high ammoniacal odour, mild soft texture with an appearance and yellowish colour. After 30 days the samples were with inferior appearance, colour and odour with soft texture with strong ammonia smell with indication of spoilage (Figure - 5.6). The dry products were acceptable for 20 days and wet salted for 10 days.

1.4.3.3. Refrigerator Stored Sample

Dry salted mackerel samples had no identifiable organoleptic change even after one month storage. During the second month also not much change was noticed except the change in colour to light yellow. In the 3rd month there was no change in appearance but the yellowish colour increased with decrease of hardness and fishy odour. In 4th month the sample had only a slight change in appearance but the colour and texture were decreased (Figure - 5.1). The wet salted samples showed not much change in 1st month. In the 2nd month the samples showed moderate change in appearance, fishy odour and yellowish colour with hard texture. In the 3rd month, colour turns to yellow and with reduction in the initial appearance with soft texture with less fishy odour. In the 4th month the appearance was further decreased, yellow colour turn to dark with soft texture and with very less fishy odour (Figure - 5.2). The dry salted fish is better than the wet salted fish. The yellowish colour formation is fast in wet salted fish than dry salted fish even during storage. Dry salted fish is acceptable for four months and wet salted fish for three months.

The dry salted ribbonfish samples showed no organoleptic changes in the 1st and 2nd months. In the 3rd month, the samples had slightly yellowish colour with fair appearance, soft and fishy odour. In the 4th month, the samples had yellowish colour and appearance was dim with soft texture and fishy odour decreased (Figure - 5.3). The wet salted samples showed no difference in the 1st and 2nd month except the starting of
yellowish colour. In the 3rd month the colour and appearance decreased slightly with soft texture and lightly fishy odour. In 4th month, the appearance and colour further decreased with soft texture and less fishy odour (Figure – 5.4). The dry salted fish was better than the wet salted fish and the acceptance was four months and three months respectively.

The dry and wet salted shark had no changes in the 1st month. In the 2nd month the appearance and colour were good with slight change in texture and ammonia odour. In the 3rd month, samples had high ammonia odour with less appearance and colour with soft texture. The meat was white in colour and without any discolouration (Figure – 5.5). The wet salted samples had same characters as fresh dried fish in the 1st and 2nd month except in high ammonia odour. In the 3rd month the appearance was less and the colour turned to brownish and softness of texture increased with more ammonia odour. The meat was pink or reddish colour and this may be due to the oxidized body oil (Figure – 5.6). The dry salted shark was better than wet salted fish in all quality parameters. The dry and wet salted shark was acceptable up to three months.

5.4.3.4. Packed Sample stored in cold storage

The dry salted mackerel samples showed no changes in the 1st month. In the 2nd month the samples had slight yellow colour with out any change in texture, odour and appearance. In the 3rd month the samples showed hard texture and the yellowish colour withed to other places with fishy odour. In the 4th month, it was noticed that appearance was fair with less fishy odour and less hardness with yellowish colour (Figure – 5.1). The wet salted samples had no difference from that of freshly salted fish product up to 2nd month except that slight change in colour. In 3rd month, sample had light yellowish colour, lightly hard with less fishy odour with less appearance. In 4th month the appearance was dim with yellowish colour, soft texture with slight fishy odour (Figure –
The dry salted fish was better than wet salted and the dry salted fish was acceptable for three months and wet salted less than three months.

The dry salted ribbonfish samples had no change for the 1st and 2nd months. The samples in 3rd month, had slight yellow colour at white meat with less appearance, soft texture and fishy odour. In 4th month, the colour was yellowish, the appearance increased with slight soft texture and fishy odour (Figure – 5.3). The wet salted samples had no significant change in first month. In the 2nd month, only slight change in sour was noticed. In the 3rd month, colour changed to yellowish with slightly soft texture and fishy odour and slight loss of appearance. In the 4th month, the appearance and colour were dim and soft texture increased with less fishy odour (Figure – 5.4). The dry salted fish was better than the wet salted fish and the dry salted fish was acceptable for three months and the wet salted between two to three months.

The dry salted shark samples had no specific change in the 1st month. In the 2nd month it had slight change in appearance with ammonia odour and hard texture without any colour change. In the 3rd month, the appearance and colour were reduced, and soft texture increased with ammonia odour. The meat was white in colour and without any discoloration (Figure – 5.5). The wet salted samples had no specific change in the 1st month. In the 2nd month, the samples had less appearance and colour, hard texture with ammoniacal odour. In the 3rd month, the samples had less appearance and colour, softness of the texture increased with strong ammonia odour. The meat was pink or reddish may be due to the oxidized body oil (Figure – 5.6). The dry salted fish was better than wet salted shark and the dry salted shark was acceptable for three months and the wet salted shark for two months.

5.3. Discussion

As fresh fish was used for the present study, quality of the raw fish was good and only minor changes were noted. The firmness of the meat increased as observed by
Ilanki et al. (1970). The shrinkage and deformations were more in dry salted fish than salted. The pressure on the fish was less due to less quantity used for salting purpose. Sikorski et al. (1995) reported that the quality depends on the property of the material and the condition at the time of packaging.

Unpacked stored lots had almost same condition that they decreased the softness and moisture and increased hardness and become brittle and agrees as reported by Anon (1981), Zain and Yusof (1983). The dried fishes are usually stored at room temperature 28°C (Antony, 1990). Nair et al. (1994) reported the yellowish colouration on dried stored fish but no red or dun formation was observed during 30 days of storage in this experiment as sterilized salt was used. Prasad & Rao (1994) reported that the discolouration is due to the increase in moisture from initial to final stage. This may be due to wet humidity condition. Prabhu & Kandoran (1991) reported the organoleptic changes of dried anchovies and studied the colour changes as pale yellow, browning and rancid. This may be due to dry humidity condition. Since the samples were stored in room condition the possibility of dust fall on samples were less. As the lots lose moisture due to dry atmospheric temperature and relative humidity Figure - 9.1), the texture become hard and brittle. The yellowish colour on the fishes showed the oxidation of fatty acids of the fish body. The yellowish colour was more on the wet salted lots than the dry salted lots. So it is assessed that the dry salted lots are good for 20 days on the basis of appearance. This is the same in ribbonfish and shark. Dried shark has unpleasant ammonia odour as reported by (Anon., 1956).

The packed open air stored lot showed the fish was useful only for 20 days as observed by Ramachandran et al. (1990) in storage of semi-dried dhoma. The fish was totally firm for 10 days then the moisture accumulated in the sealed cover might have been reabsorbed in the flesh and cause the spoilage of fish. The moisture content was not affected in any lots and spoilage was easy as reported by Hanumanthappa &
Candrasekhar (1987) in hot smoked mackerel. Anon (1956) reported the same variation on packed and stored fish which loss fishy odour in fatty fish which cause pleasant bitter product. Klaveren & Legendre (1965) suggested that the meat at 25°C was the proteolytic action.

The lot stored in refrigerator showed that fish can be used for two to three months and there is not much textural and colour change. But further storage gradually reduces the organoleptic qualities of the products. FAO. (1957) suggested that the salted dry fish be stored at low temperature. Rubbi et al. (1983) reported that the fish stored at 13°C was of superior quality in all cases than the fish stored at room temperature. Camu et al. (1983) suggested that the dried mackerel stored at 18°C is acceptable for 12 weeks. This observation agrees with above report. Cold storage stored lot showed that there is no much change in colour and texture for three months and this also can be used for more than three months. Only little dryness was observed during storage period. Anon., (1981; 1982) suggested to keep the dry fish at low temperature of 10°C and Syme (1966) reported that the dry fish be stored at 41°F (5°C). Tressler & Lemon (1951) recommended low temperature for fatty fish. This study shows that the cured or dried fish can be stored in the refrigerator or in cold storage to increase shelf life substantially. This can also avoid the easy spoilage of dry or wet salted fish at ordinary condition.
Figure 5.1. Organoleptic changes on dry salted Mackerel
Figure 5.2. Organoleptic changes on wet salted Mackerel
Figure – 5.3. Organoleptic changes on dry salted Ribbonfish
Figure – 5.4. Organoleptic changes on wet salted Ribbonfish.
Figure 5.5. Organoleptic changes on dry salted Shark.
Figure - 5.6. Organoleptic changes on wet salted Shark