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Drying & Value Addition

Section (A): Salted and Dried mackerel

6.1 (A) Introduction

Mackerel is one of the most common food fishes in India and in other countries it is a potential raw material for canning, drying and smoking considering its abundances and nutritive value. In India, dried fish is acceptable to all income groups and it is considered as staple food item which provide good source of proteins. With a 200 km Exclusive Economic Zone (EEZ) around a coast line of more than 5600 km., India has vast marine fisheries resources. The hilly regions of India, still depends on dry fish sources. Since, a well organized cold chain is yet to be established, the interior regions still depend on cured fishery products for the their supply of fish. Depending on the regional variation in taste and consumer preference, different types of cured products are popular in different parts of the country. The southwest coast had always been the major fish landing areas in India. Sun drying had been a popular method of fish preservation along this coast. Oils sardines, mackerel sole, white bait etc., are traditionally sun dried on the sandy beach. This crude method naturally yielded poor products contaminated with sand and dirt. With the advent of improvised technological investigation, hygienic drying practices were accepted. The use of preservatives (Sodium propioniate) was induced as an effective and cheap method for producing good quality cured fish of longer shelf life. Even though the export of dry fish is very low, over the past decades improved methods for maintaining the quality of a cured product should not be over looked. The present study involves drying incorporated with spice oleoresin extracts as natural preservative on dry fish curing; which aims at deriving a new product that is free of chemical preservatives.

6.2 (A) Review of Literature

The most common method of utilization of fish in India is in fresh and cured (drying, salting and smoking) Prasad and Panduranga, 1994). In India, 20% of fish catch is preserved by curing (Bindu, 2004). The low cost of production, transport and storage give the cured product a substantial market in India as well as in many tropical countries (Yean, 1998).

Salted fish processing started antiquity (Cutting, 1955, 1962; Kruezer, 1994). In Asia where consumption is highest, dried salted fish is also an important source of low-cost dietary protein (Poermomo et al., 1992)
Each country has its own standard as to the amount of salt and moisture desirable in their products (Tapiador & Carroz, 1963; Voskresensky, 1965). In Asian countries where most of the processing and trade in salted dried fish takes place, the problem of incorrect moisture and salt content is widespread and accounts for heavy losses of products (Zain and Yusuf, 1983).

During brining, salt penetrates the fish flesh with accompanying loss of moisture. Under ideal conditions, salt uptake will continue until salt concentration in the aqueous phase of the tissue becomes equal to that in the brine.

6.2.1 (A) Effect of Sodium chloride

Sodium chloride, commonly known as salt, table salt, or rock salt, is a vital part of human life. Salt enhances the flavor of foods and plays a functional role in food processing. For instance, salt controls microbial growth and controls yeast activity; it enhances the texture, ripening, and shelf life extension in cheese; it lowers water activity, strengthens gel structure, and enhances color in processed meats (Ravishankar and Juneja, 2000).

In fish, salting has been one of the oldest methods of preservation. Fish is one of the commodities to which a large amount of salt is sometimes added and if less salt is added, it is usually combined with other methods of preservation. Dipping fish in sodium chloride solution preserves the texture and color combined with modified atmospheric packaging (MAP) and storage (Mitsuda et al., 1980). Hake slices were dipped in sodium chloride (5 min in 5% brine) and MAP stored and these were compared with MAP stored slices of hake without sodium chloride dipping (Pastoriza et al., 1998). In sodium chloride dipped slices, biochemical, microbial, and sensory deterioration changes were inhibited, shelf life was extended, and the total volatile bases and total viable microbial counts were significantly lower than those of non-dipped slices. The postmortem changes (rigor mortis) of Atlantic salmon influenced the salt uptake of the fish muscle (Wang et al., 1988). The equilibrium salt concentration of pre-rigor fillet was much lower (0.53 g/g salt-free solids) than that of in-rigor (0.66 g/g salt-free solids) and post-rigor mortis (0.75 g/g salt-free solids) salmon fillets in 20% (w/v) sodium chloride solution at 10°C.

Dried fish having pH of 6.0-6.9 are considered to be of very good quality. The high drying periods required to achieve low moisture contents to ensure the keeping quality of product increases the tendency of the fat to become rancid (FAO, 1981).
6.2.2 (A) Spoilage Bacteria

Fish spoilage is a complex process involving both nonmicrobiological and microbiological processes. Nonmicrobiological deterioration is caused by endogenous proteolytic enzymes, which are concentrated in the head and viscera and attack these organs and surrounding tissues after death. Enzymatic spoilage is followed by the growth of microorganisms, which invade the fish flesh, causing breakdown of tissues and a general deterioration of the product. During processing of fish (e.g., deheading, eviscerating, cutting), the microorganisms present in the surface slime layer, the gills and the gut can be spread onto the processing equipment, the workers and the flesh of the fillet. Hence, the normal sterile flesh can be contaminated with millions of bacteria (Banwart, 1989; Bonnell, 1994; Garthwaite, 1997; Inglish et al., 1993).

6.3 (A) Materials and methods

6.3.1 (A) Preparation of fish for drying

Fresh mackerel was purchased from Munabam Harbour, Kochi. They were dressed as butterfly fillet with head on, washed thoroughly and soaked in 1:3 brine incorporated with 0.05% concentration of spice oleoresins of rosemary, ginger, pepper and clove and BHA. The duration of soaking was two hours. The soaked fish was arranged in trays and subjected to sun drying. It was cooled and packed in polythene covers (Fig: 6.1). A control was also prepared without incorporating any spice. The dried samples were stored at room temperature (28 ± 2°C) and at 15°C. Sensory, chemical and microbiological test were conducted in the products. The general acceptability score was evaluated. Samples were analysed for a period of eight weeks for the following parameters.
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Figure 6.1 Flow chart showing procedure of mackerel drying

Fresh mackerel

Splitting

Washing

Soaking in 1:3 brine incorporated with spice extract 0.05% concentration 1.5 hrs

Arranging in trays

Sun drying

Cooling

Packing

Figure 6.1 Flow chart showing procedure of mackerel drying
Plate 6.1 Treated dry fish samples
6.3.1.1 (A) Moisture content

Moisture content of the samples were analysed according to AOAC, (1995).

6.3.1.2 (A) Salt content

Weighed out 0.4 g of dried cured material into a 250 ml conical flask added 20 ml of dilute nitric acid (1:4). Heated to boil. Cooled and added 20 ml of silver nitrate (0.1 N), boiled again until all salts except silver chloride dissolved. Cooled and added 20 ml of distilled water and 2 ml of ferric alum indicator and titrated against standard ammonium thiocynate solution. The end point was determined by a permanent pink colour and a blank was also run simultaneously (FAO, 1981).

Calculation:

Percentage of NaCl = \[
\frac{5.85 \times V_1N_1 - V_2N_2}{W}
\]

Where, \( W \) = Weight of sample

\( V_1 \) = Volume of Silver nitrate

\( N_1 \) = Normality of Silver nitrate

\( V_2 \) = Volume of ammonium thiocynate

\( N_2 \) = Normality of ammonium thiocynate

6.3.1.3(A) Peroxide value

Peroxide value was determined as detailed in chapter 3 (3.3.3.3) by the method of AOCS, (1999).

6.3.1.4 Thiobarbituric Acid Reactive Substances (TBARS)

Thiobarbituric acid reactive substances was analysed as given in Chapter 3 (3.3.3.4) by the method of Tarladigs et al., (1960)
6.3.1.5 (A) Microbiological Test

Enumeration of mold in the samples of dried fish was done by the procedure of Pitt et al., (1992).

i) Dichloran Rose Bengal Chloramphenicol (DRBC) agar (M183)

ii) Sample and media preparation

Preparation of DRBC of agar Suspend 15.75 grams in 500 ml distilled water. Heated to boiling to dissolve the medium completely. Sterilized the medium completely. Sterilize by autoclaving at 15 lbs pressure (121° C) for 15 minutes. Cooled to 50° C and aseptically add sterile reconstituted contents of 1 vial of Chloramphenicol Selective Supplement (FD033). Mixed well and pour into sterile petriplates. Media should be prepared no more than 24 hours prior to use. Before plating, held the sample at –20° C for 72 hours to kill mites and insects that might interfere with analysis.

iii) Plating and incubation of sample

From each sample, transferred about 50 g in to a sterile 300 ml beaker. Using 95% ethanol flamed forceps place intact food items on surface of solidified agar. 5-10 item per plate (depending on size of food item), 50 item total per sample. Flame forceps between plating of each item. Use several forceps alternatively to avoid overheating. Aligned 3-5 plates in stacks and identified with sample number plus date of plating. Incubated stacks, undisturbed in the dark at 25°C for 5 days. If there was no growth at 5 days of incubation, re-incubated for another 48 hour to allow heat or chemically – stressed cells and spores enough time to grow.

iv) Reading of plates

Determined the occurrence of mold in percentages. If mold emerged from all 50-food items, moldiness is 100%; if from 32 item, moldiness is 64%. Determined percent occurrence of individual mold on the above basis.
Plate 6.2 Media used for enumeration of mould
(Dichloran base /w rosebengal agar)
Plate 6.3  Petri dishes showing mould growth

(a) Samples stored at 10°C
(b) Samples stored at 26°C
Plate 6.4 Dried samples (3 months)
(a) Control at 26°C  (b) Treated sample (Clove) at 26°C
6.4 (A) Results

6.4.1 (A) Moisture Content

Table 6.1 Moisture content of samples stored at 15°C

<table>
<thead>
<tr>
<th></th>
<th>1 week</th>
<th>2 weeks</th>
<th>3 weeks</th>
<th>4 weeks</th>
<th>5 weeks</th>
<th>6 weeks</th>
</tr>
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<tbody>
<tr>
<td>CNT</td>
<td>31.50</td>
<td>42.33</td>
<td>42.03</td>
<td>42.73</td>
<td>42.18</td>
<td>44.20</td>
</tr>
<tr>
<td>RM</td>
<td>41.77</td>
<td>41.13</td>
<td>41.42</td>
<td>41.97</td>
<td>40.79</td>
<td>42.32</td>
</tr>
<tr>
<td>GIN</td>
<td>42.67</td>
<td>41.36</td>
<td>41.22</td>
<td>42.64</td>
<td>42.35</td>
<td>43.60</td>
</tr>
<tr>
<td>PEP</td>
<td>42.17</td>
<td>44.32</td>
<td>36.33</td>
<td>41.16</td>
<td>40.86</td>
<td>42.50</td>
</tr>
<tr>
<td>CLO</td>
<td>41.33</td>
<td>41.25</td>
<td>40.91</td>
<td>42.99</td>
<td>41.96</td>
<td>42.78</td>
</tr>
<tr>
<td>SYN</td>
<td>40.83</td>
<td>40.89</td>
<td>43.85</td>
<td>41.42</td>
<td>40.51</td>
<td>41.82</td>
</tr>
</tbody>
</table>

Table 6.1 shows the variation in moisture content of dried mackerel stored 15°C for 6 weeks. There is significant difference between storage periods (p<.05). Six weeks stored samples gave significantly high moisture content than 4 weeks samples. There is significant difference between treatments. Control and ginger gave significantly higher values than others. Significantly lower values are obtained by pepper followed by rosemary and clove (Appendix 6.1 A).

In the comparison between control and pepper there is significant difference between storage period (p<.05). The percentage moisture content in 6 weeks is significantly higher than that in 4 weeks storage. [Appendix 6.1 (b)]

Table 6.2 Moisture content of samples stored at room temperature

<table>
<thead>
<tr>
<th></th>
<th>2 weeks</th>
<th>3 weeks</th>
<th>4 weeks</th>
<th>5 weeks</th>
<th>6 weeks</th>
</tr>
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<tbody>
<tr>
<td>CNT</td>
<td>31.22</td>
<td>21.93</td>
<td>13.00</td>
<td>33.11</td>
<td></td>
</tr>
<tr>
<td>RM</td>
<td>31.63</td>
<td>32.92</td>
<td>32.22</td>
<td>42.82</td>
<td></td>
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<tr>
<td>GIN</td>
<td>31.28</td>
<td>31.95</td>
<td>39.22</td>
<td>39.61</td>
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<tr>
<td>PEP</td>
<td>30.60</td>
<td>30.32</td>
<td>32.85</td>
<td>40.53</td>
<td></td>
</tr>
<tr>
<td>CLO</td>
<td>31.32</td>
<td>30.98</td>
<td>40.22</td>
<td>39.22</td>
<td></td>
</tr>
<tr>
<td>SYN</td>
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<td>22.75</td>
<td>24.17</td>
<td>40.19</td>
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Table 6.2 shows the moisture content of the sample stored at room temperature. Moisture content of 6 months storage is significantly higher than that of 4 months (p<.05) [Appendix 6.1 (c)].
6.4.2 (A) Peroxide Value (PV)

Table 6.3 Peroxide value of dried samples stored at 15°C

<table>
<thead>
<tr>
<th></th>
<th>2 weeks</th>
<th>4 weeks</th>
<th>6 weeks</th>
<th>8 weeks</th>
<th>10 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNT</td>
<td>30.14</td>
<td>46.02</td>
<td>50.59</td>
<td>50.51</td>
<td>47.59</td>
</tr>
<tr>
<td>RM</td>
<td>7.68</td>
<td>11.61</td>
<td>24.68</td>
<td>42.59</td>
<td>38.87</td>
</tr>
<tr>
<td>GIN</td>
<td>12.32</td>
<td>13.23</td>
<td>27.53</td>
<td>49.86</td>
<td>32.56</td>
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<tr>
<td>PEP</td>
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<td>28.48</td>
<td>18.02</td>
<td>53.88</td>
<td>33.49</td>
</tr>
<tr>
<td>CLO</td>
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<td>16.79</td>
<td>21.15</td>
<td>41.18</td>
<td>45.11</td>
</tr>
<tr>
<td>SYN</td>
<td>14.60</td>
<td>51.49</td>
<td>28.96</td>
<td>50.18</td>
<td>34.53</td>
</tr>
</tbody>
</table>

Table 6.4 Peroxide values of dried samples stored at Room temperature

<table>
<thead>
<tr>
<th></th>
<th>2 Weeks</th>
<th>4 Weeks</th>
<th>5 Weeks</th>
<th>6 Weeks</th>
<th>8 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNT</td>
<td>28.9</td>
<td>32.96</td>
<td>54.63</td>
<td>68.25</td>
<td>52.46</td>
</tr>
<tr>
<td>RM</td>
<td>23</td>
<td>29</td>
<td>52</td>
<td>60.75</td>
<td>42.13</td>
</tr>
<tr>
<td>GIN</td>
<td>31.6</td>
<td>29.6</td>
<td>45.98</td>
<td>70.17</td>
<td>54.26</td>
</tr>
<tr>
<td>PEP</td>
<td>35</td>
<td>24.7</td>
<td>37.13</td>
<td>64.28</td>
<td>40.62</td>
</tr>
<tr>
<td>CLO</td>
<td>37.3</td>
<td>23.2</td>
<td>32.42</td>
<td>56.75</td>
<td>49.35</td>
</tr>
<tr>
<td>SYN</td>
<td>23</td>
<td>24.7</td>
<td>42.51</td>
<td>45.26</td>
<td>49.35</td>
</tr>
</tbody>
</table>

Table 6.3 gives the peroxide values samples stored at 15°C. The comparison of peroxide value of dried samples stored at 15°C shows significant difference between storage (p<0.01). Ten weeks stored samples gave higher peroxide values [Appendix 6.2 (a)].

Table 6.4 gives the peroxide values samples stored room temperature. In the comparison of peroxide values for samples stored at room temperature there is significant difference between storage periods. 8 weeks stored period significantly higher than 4 weeks, Appendix 6.2(b).
6.4.3. (A) Thiobarbituric Acid Reactive Substances (TBARS)

![Figure 6.1 Variation in TBARS content of dried samples stored at room temperature](image)

![Figure 6.2 Variation in TBARS content of dried samples stored at 15°C](image)
Fig 6.1 shows the variation of TBARS content of treated dried samples kept at room temperature. There is significant difference between storage period (p<.05). TBARS 8 weeks stored samples significantly higher than that of 6 weeks. There is significant difference between treatment (p<.05). Rosemary shows significantly lower values while control shows significantly higher values. (Appendix 6.3 (a))

Fig 6.2 shows the variation in TBARS content of treated dried samples stored at 15°C. There is significant difference between storage periods.

6.5 (A) Discussion

From the result of moisture content of samples stored at 15°C there is no significant difference in samples stored at two different temperatures. Table 6.3 & 6.4 shows the peroxide value of dried samples stored at 15°C. Peroxide values of the control samples kept at 15°C were comparatively lower than that at 30°C. All treated samples had lower value than control. This shows that treatment is effective. The samples treated with rosemary had lower values when compared to control. This again highlights the antioxidative role of the spice in dry products. Salt content of the cured sample stored at room showed a decrease in salt content after a period of 8 weeks. This probably might be due to the absorption of moisture from the atmosphere, resulting in loss of salt content in liquid forms.

Comparison of TBA products of sample stored at room temperature showed that there is an increase in TBARS substances for sample stored at room temperature than those stored at 15°C. This shows that the effect of temperature control reinforces the quality of dried stored fish. A lower temperature of storage yielded a good product.

While comparing the effect of treatment at the sample, clove had recorded a minimum TBA value after storage period for eight weeks. This shows the inhibitory effect of clove as confirmed by many authors (Rajkumar and Berwal, 2003). The active constituent of clove eugenol has proved to be an effective antioxidant in dried fish too. Studies by Prasad and Seenayya (2000) showed that cloves and clove oil were very effective on salt cured fish at 2 and 0.1% (v/v), respectively. Onion, coriander, garlic, asafoetida, mustard and spilanthes showed excellent growth control. Red chillies, turmeric, ginger, cumin seed and fenugreek were very good in inhibiting the growth. In
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the present study rosemary has shown to be a good antioxidant as confirmed by the low values of PV and TBARS. Samples treated with BHA did not show any good values.

Yang et al., (1981) found that the added ascorbic acid had an antioxidative effect for 2 weeks of storage. They concluded that the organoleptic evaluation indicated no significant decrease in flavor until after 4 week of storage and statistical test showed no significant differences for appearance, odour, and texture among salted grayfish and salted cod fillets.

6.6 (A) Conclusion

Peroxide values of the control samples kept at 15°C were comparatively lower than that at 30°C. All treated samples had lower value than control. This shows that treatment is effective. The samples treated with rosemary had lower values when compared to control. This again highlights the antioxidative role of the spice in dry products. While comparing the effect of treatment at the sample, clove had recorded a minimum TBA value after storage period for eight weeks. This shows the inhibitory effect of clove as confirmed by many authors. Comparison of TBA products of sample stored at room temperature showed that there is an increase in TBARS substances for sample stored at room temperature than those stored at 15°C. This shows that the effect of temperature control reinforces the quality of dried stored fish. A lower temperature of storage yielded a good product. Salt content of the cured sample stored at room showed a decrease in salt content after a period of 8 weeks. This probably might be due to the absorption of moisture from the atmosphere, resulting in loss of salt content in liquid forms.

Section (B) Value Added Products

6.1 (B) Introduction

With global rise in interests of fishery products there is need for parallel progress in technology for their processing and value addition in order to satisfy the consumer demand for convenience products and thereby to enhance the marketability (Venugopal, 1995). These products should assume economic viability and fatty fishes like mackerel could be converted to products with good organoleptic qualities and storage stability. In this study attempt is made to formulate some products from Indian mackerel treated with rosemary oleoresin extract. Here, only rosemary is selected for this study taking into consideration the maximum antioxidant and antimicrobial effect
of rosemary compared to other spices as confirmed from the previous chapters. A control sample without spice treatment was also taken for comparison for all the following preparations.

6.2. (B) Recipe and methods of preparation

6.2.1 (B) Fish Cutlets: (Plate 6.5)

**Ingredients:**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooked Fish Meat</td>
<td>1000 g</td>
</tr>
<tr>
<td>Salt</td>
<td>25 g (approx – to taste)</td>
</tr>
<tr>
<td>Oil</td>
<td>125 ml</td>
</tr>
<tr>
<td>Green chilli</td>
<td>15 g</td>
</tr>
<tr>
<td>Ginger</td>
<td>25 g</td>
</tr>
<tr>
<td>Onion</td>
<td>250 g</td>
</tr>
<tr>
<td>Potato (cooked)</td>
<td>500 g</td>
</tr>
<tr>
<td>Pepper (powder)</td>
<td>3 g (to taste)</td>
</tr>
<tr>
<td>Clove (powdered)</td>
<td>3 g</td>
</tr>
<tr>
<td>Cinnamon (powered)</td>
<td>2 g (to taste)</td>
</tr>
<tr>
<td>Turmeric</td>
<td>2 g</td>
</tr>
<tr>
<td>Eggs</td>
<td>4 Nos.</td>
</tr>
<tr>
<td>Bread powder</td>
<td>200 g</td>
</tr>
</tbody>
</table>

**Method of preparation:**

- Cook fish mince in boiling water for 20 min.
- Drain off the water. (In case of whole fish, dress the fish and cook for 30 min. and drain)
- Remove skin, scales and bones and separate the meat.
- Add salt and turmeric to the cooked meat and mix well.
- Fry chopped onions in oil till brown. Fry chilli and ginger. Mix these with the cooked meat.
Plate 6.5 Fish Cutlet

(b) Fried Cutlet

(a) Battered and Breaded Cutlet
Add mashed potato and spices and mix well with the meat.

Shape 40 g each of this in oval or round form, dip in beaten eggs, roll in bread powder and store in deep freezer.

Thaw and fry in oil before use.

6.2.2 (B) Fish Pickle: (Plate 6.6)

Ingredients:

1. Fish
   (Dressed and cut into small pieces) 1 Kg
2. Mustard 10 g
3. Green Chilli (Cut into pieces) 50 g
4. Garlic (peeled) 200 g
5. Ginger (peeled and chopped) 150 g
6. Chilli powder 50 g
7. Turmeric powder 2 g
8. Gingelly oil 200 g
9. Vinegar (Acetic acid 1.5%) 400 ml
10. Salt 60 g
11. Pepper (powdered) 2.5 g
12. Sugar 10 g
13. Cardamom, clove, cinnamon
   (powdered) 1.5 g

Method of preparation:

Mix the fish thoroughly with 3% of its weight of salt and keep for two hours. Light salted and partially dried fish also may be used. Fry the fish in minimum quantity of oil. Set apart the fried fish.
Plate 6.6 Fish Pickle
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Fry the ingredients 2-5 in the remaining quantity of oil and then add chilli powder, pepper powder and turmeric powder and mix well over low flame for a few minutes. Remove from fire, add fried fish and mix well. When cooled, add vinegar, powdered cardamom, clove, cinnamon, sugar and remaining salt and mix thoroughly. Sufficient quantity of boiled and cooled water may be added to over the ingredients well. Transfer to clean, sterile glass bottles and seal with acid proof caps. Take care to see that there is a layer of oil over the contents in the bottle.

Flexible pouches made of 121 polyester lamined with 1181 LD HD co- extruded film can also be used for packing the pickle.

6.2.3 (B) Fish Balls: (Plate 6.7)

Ingredients:

1. Fish Mince (Mackerel) 1 Kg.
2. Turmeric Powder 10 g.
3. Pepper Powder 20 g.
4. Salt 25 g.
5. Cornstarch 50 g.

Method of preparation:

Mixed mince prepared from fish using a mechanical meat bone separator after heading, gutting and washing thoroughly with 1% salt and 5% corn starch. Prepared balls, 2-3 cm in diameter, from the resultant mass and cooked in boiling 1% brine for 5-10 minutes.

Cooled the cooked balls after which they are battered and breaded. Packed the balls preferably in thermoformed trays as such or after flash frying in hot vegetable oil. Preserved by freezing.
6.2.4 (B) FISH CURRY: (Plate 6.8)

Ingredients:

- Dressed fish 1 Kg treated meat
- Chilly Powder 100g
- Turmeric 10 g
- Tamarind 25 g
- Salt 20 g
- Ginger 50 g
- Garlic 20g
- Small onion 5 g
- Curry leaves 5 g
- Oil 5ml
- Water 1 liter
- Coconut ½ table spoon

Method of preparation:

Fish was cleaned and dressed, and cut into piece of desired length and kept aside. In a pan, added oil, and fried all green curry leaves, garlic, small onion, chilly powder, turmeric, salt, and tomato. Added tamarind puree in water and allowed to boil. Added fish pieces and cooked for 20 minutes.

6.3 (B) Results

Sensory analysis of the products was done for the four products by a panelist of six members. In the present study oleoresin rosemary treated sample was used as the base material. The two products (cutlet and fish balls) from the minced sample, pickle and fish curry from whole treated samples were analysed for overall acceptability. Compared to control sample, rosemary treated samples gave a good score of overall acceptability. As these products are meant for human consumption, sensory evaluation of the product is very important. Rosemary treated sample did not have any rancid taste.
Plate 6.7 Fish Balls

Plate 6.9 Fish Curry
Table 6.5 Mean sensory evaluation score for fish cutlet

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Control</th>
<th>Rosemary treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Odour</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Taste</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Texture</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Overall score</td>
<td>5.5</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Mean of 10X3 readings

Table 6.6 Mean sensory evaluation score for Fish Pickle

<table>
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</thead>
<tbody>
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<td>7</td>
</tr>
<tr>
<td>Odour</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Taste</td>
<td>5</td>
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Mean of 10X3 readings

Table 6.7 Mean sensory evaluation score for Fish balls

<table>
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</thead>
<tbody>
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</tr>
<tr>
<td>Odour</td>
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</tr>
<tr>
<td>Taste</td>
<td>6</td>
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<td>Texture</td>
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<td>7</td>
</tr>
<tr>
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</tbody>
</table>

Mean of 10X3 readings

Table 6.8 Mean sensory evaluation score for Fish curry

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<tr>
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Mean of 10X3 readings
6.4. (B) Discussion

Moisture due to dehydration is a common problem in frozen food products. Functionally coating provides a moisture barrier to the product. It also helps in reduction of weight loss during frozen storage and also while reheating before consumption. A good consumer appeal is offered for the product by improving sensory value of the processed items. Coating also provides an opportunity to increase the nutritional value of the product through incorporation of nutrients in the coating. Breading is cereal based coating often as bread crumbs. Fish cutlets are battered and breaded products. To protect food item from oxidation addition of spices like rosemary has to be adopted which can provide a longer shelf life in the frozen stage. This is mainly due to its antioxidant constituents. Breaded and coated products have a strong consumable demands all over the world. The quality control of coated products is important for standardization of the process. With respect of fat oxidation studies from the previous chapters rosemary has proven to possess potent antioxidant property. Currently USA is the country which markets rosemary as a colourless, odourless compound. Taking into consideration health aspects involved by the use of synthetic antioxidant, the qualities of rosemary spice has to be popularized for preparing value added products.

6.5 (B) Conclusion

Of all the spices used in this study rosemary and clove have shown to be the most effective natural antioxidants on salt cured fish. As there is great demand for sea food and seafood based products, large number of diversified and ready to eat products can be prepared from low priced fish like mackerel by incorporating proper additives of natural origin. To popularize the products, this technology can be extended to society for gainful employment of women.