

## STUDIES ON THE EFFECT OF IMPURITIES ON THE PENETRATION OF SALT IN THE CURING OF FISH

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### INTRODUCTION

Among the factors governing the quality of cured fish, purity of salt used for curing plays an important part. Tressler reported in 1920 that impurities such as Calcium, Magnesium and sulphate hinder salt penetration and may thereby cause spoilage during the curing process before optimum salt concentration is built up. Although subsequent workers have dealt with the effect of such impurities on organoleptic properties of the cured products (Boury 1932) and rate of microbial spoilage (Hess 1942), critical studies\*\* on the penetration of chloride as such were lacking. A detailed investigation by the present authors has however failed to reveal any delay in salt uptake by the presence of the above impurities in the salt. Results of these findings which run counter to the commonly held opinion are presented in this account.

### EXPERIMENTAL PROCEDURE

Medium sized fish like mackerel has been chosen for the study and freshly landed fish after evisceration and washing were divided into four groups of 25 each. Dry salting was adopted for the study since it forms the most common commercial practice in India. The temperature during the period of experiment was in the range of 28 to 29°C. Control group was salted with pure sodium chloride and for the other three groups Calcium Chloride was incorporated in the salt to yield 0.25% to 0.75% of  $\text{Ca}^{++}$ . Salt ratio employed was 1:6. Samples of three fish from each group were removed (always from the middle layer) at 4, 8, 16 and 24 hours of salting for analysis. Samples of self brine formed were also taken for analysis at these stages. In order to avoid any possible sampling error the experiment was repeated to include more rigorous sampling. Ten fish were picked out from each group and average of five observations on samples of two fish in each case, was employed for comparison.

The experiments on similar lines were conducted to test the effect of Magnesium and sulphate as impurities in the salt on the efficiency of curing.

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\*\*Sen and Aitkins (1965, *J. Food. Sci.* 30 (2), 256) have recently presented some evidence that the presence of small quantities of Magnesium (1 to 1.5% as Magnesium chloride) has no effect on salt penetration.

In these experiments Magnesium chloride and Sodium sulphate were used. For the sulphate experiment the fish employed were medium sized Sciaenids.

#### METHODS OF ESTIMATIONS

*Moisture.*—2 to 5 gms. of sample was weighed in a silica crucible. Dried in air oven at 105-106°C for 4 to 6 hours to constant weight. Cooled in a desiccator and weighed.

*Salt.*—Weighed quantity of sample was ashed and the ash extracted with hot water. Filtered and filtrate made up to a definite volume and a known volume was titrated with 0.1 N. Silver Nitrate after addition of a few drops of 10% Potassium chromate solution.

*T.V.N.*—Convay Microdiffusion method was used. 1 ml. of N/100 standard sulphuric acid and 1 ml. of alcoholic extract were taken in the inner and outer compartments respectively and 1 ml. of saturated potassium carbonate was added to the outer compartment with partial covering of the dish. The dish after complete covering was rotated to ensure thorough mixing of extract and potassium carbonate and kept over night at room temperature. The excess standard acid in the inner compartment was titrated with standard N/100 sodium hydroxide using Tashiro's indicator.

#### RESULTS AND DISCUSSION

It may be observed from the Table I that the rate of penetration of salt bears no relationship to the Calcium content of the salt even at 0.75% (Ca.) level. From Table III it may be seen that the ultimate salt content of the fish is not lowered by the presence of Calcium in the salt. Analysis of self brine for Total Volatile Nitrogen (TVN) (Table II) which is not subject to individual variations, does not show any spoilage due to the presence of Calcium during the salting period. Volume of self brine formed in each group did not differ by more than 2 to 3% and T.V.N. level is almost equal in all cases. Rate of moisture withdrawal from the fish is also not affected as is evident from the moisture level of the fish after curing. During the drying stage however, presence of Calcium appeared to slightly retard the rate of drying (Table VI). Presence of Magnesium and sulphate in the salt does not appear to retard the penetration of salt as seen from the Table IV and V respectively. Taste panel observation did not reveal any significant difference in the case of Calcium or sulphate containing fish. However, it was casually noted that taste panel members expressed a general liking to fish cured with salt containing 0.5% Mg. ion. This might be due to the fact that they were normally accustomed to fish cured with impure salt.

TABLE I

Effect of Calcium as impurity in salt on the curing of Mackerel (Salt content expressed on dry weight basis)

| Period of salting in hours | Pure Na Cl |              | Na cl + 0.25% Ca <sup>++</sup> |              | Na cl + 0.5% Ca <sup>++</sup> |              | Na Cl. + 0.75% Ca <sup>++</sup> |              |       |       |       |       |
|----------------------------|------------|--------------|--------------------------------|--------------|-------------------------------|--------------|---------------------------------|--------------|-------|-------|-------|-------|
|                            | moisture % | T.V.N mgms.% | moisture %                     | T.V.N mgms.% | moisture %                    | T.V.N mgms.% | moisture %                      | T.V.N mgms.% |       |       |       |       |
| 4                          | 68.44      | 6.18         | 34.41                          | 69.88        | 6.61                          | 24.64        | 66.40                           | 10.54        | 46.81 | 66.06 | 9.34  | 29.34 |
| 8                          | 64.98      | 12.53        | 23.18                          | 67.61        | 10.03                         | 32.83        | 64.18                           | 13.35        | 27.40 | 64.65 | 12.16 | 19.30 |
| 16                         | 63.80      | 14.15        | 36.19                          | 63.96        | 15.81                         | 26.60        | 65.50                           | 16.87        | 53.70 | 62.77 | 14.83 | 36.34 |
| 24                         | 65.68      | 21.84        | 26.68                          | 56.22        | 22.89                         | 34.39        | 57.06                           | 20.37        | 24.77 | 57.44 | 21.82 | 36.36 |

TABLE II

*Total Volatile Nitrogen in self brine (mg.%)*

| Period of salting<br>in hrs. | Control<br>(pur Na cl) | Na cl                       | Na cl                      | Na cl                       |
|------------------------------|------------------------|-----------------------------|----------------------------|-----------------------------|
|                              |                        | +<br>0.25% Ca <sup>++</sup> | +<br>0.5% Ca <sup>++</sup> | ×<br>0.75% Ca <sup>++</sup> |
| 4                            | 13.29                  | 13.29                       | 14.00                      | 14.00                       |
| 8                            | 14.00                  | 13.29                       | 16.80                      | 14.00                       |
| 16                           | 18.20                  | 17.50                       | 18.90                      | 18.80                       |
| 24                           | 17.50                  | 18.90                       | 20.30                      | 17.55                       |

TABLE III

*Effect of Calcium on Salt penetration in Mackerel*

| Description                      | Moisture<br>%  |       | Salt content<br>% (dry weight basis) |       |
|----------------------------------|----------------|-------|--------------------------------------|-------|
|                                  | range          | mean  | range                                | mean  |
| Control<br>(pure Na cl)          | 60.94 to 64.51 | 63.42 | 23.43 to 25.82                       | 24.60 |
| Na cl +<br>0.5 Ca <sup>++</sup>  | 60.58 to 63.98 | 62.74 | 24.76 to 26.64                       | 25.79 |
| Na cl +<br>1.0% Ca <sup>++</sup> | 59.80 to 62.92 | 61.52 | 23.46 to 26.76                       | 25.58 |

TABLE IV

Effect of Magnesium as impurity in salt on the curing of Mackerel  
 (Salt content expressed on dry weight basis)

| Period of salting in hours | Pure Na cl |               | Na cl + 0.25% Mg <sup>++</sup> |               | Na cl + 0.5% Mg <sup>++</sup> |               | Na cl + 0.75% Mg <sup>++</sup> |               |       |       |       |       |
|----------------------------|------------|---------------|--------------------------------|---------------|-------------------------------|---------------|--------------------------------|---------------|-------|-------|-------|-------|
|                            | moisture % | T.V.N. mg/100 | moisture %                     | T.V.N. mg/100 | moisture %                    | T.V.N. mg/100 | moisture %                     | T.V.N. mg/100 |       |       |       |       |
| 6                          | 67.14      | 7.07          | 20.96                          | 68.36         | 7.14                          | 18.33         | 68.05                          | 11.51         | 23.29 | 70.00 | 10.24 | 22.89 |
| 16                         | 64.63      | 10.98         | 27.89                          | 67.97         | 9.63                          | 26.34         | 64.36                          | 14.04         | 24.13 | 64.00 | 10.09 | 23.83 |
| 24                         | 64.12      | 17.08         | 27.94                          | 61.37         | 17.02                         | 27.62         | 63.56                          | 17.56         | 23.09 | 61.09 | 17.44 | 18.90 |

TABLE V  
*Effect of sulphate as impurity in salt on the curing of Sciaenids\**

| Group             | Moisture<br>% | Salt<br>% | T.V.N. Mg. % |
|-------------------|---------------|-----------|--------------|
| Pure Na cl        | 36.38         | 18.60     | 9.86         |
| Na cl + 0.5% So.4 | 39.12         | 19.58     | 21.87        |
| Na cl + 1.0% So.4 | 39.90         | 18.32     | 26.25        |
| Na cl + 2.0% So.4 | 39.38         | 21.94     | 30.63        |

\*In this experiment fish was analysed after salting and drying.

TABLE VI

*Loss of moisture during drying (per cent)*

| Period of drying in hrs. | Treated with pure Na cl | Treated with Na cl+10.25% Ca | Treated with Na cl+0.5% Ca <sup>++</sup> | Treated with Na cl+0.75% Ca <sup>++</sup> |
|--------------------------|-------------------------|------------------------------|--|---|
| 11                       | 20.01                   | 20.52                        | 20.81                                    | 20.88                                     |
| 13                       | 25.90                   | 24.80                        | 23.97                                    | 24.51                                     |
| 16                       | 30.15                   | 29.87                        | 28.39                                    | 29.56                                     |
| 20                       | 32.44                   | 31.79                        | 30.66                                    | 31.32                                     |

Results of the present study indicate that at temperature of 28 to 29°C presence of Calcium, Magnesium and sulphate may not have any effect on the rate of penetration of salt. Although Tressler observed a retardation in the uptake of salt at a much higher level of 4.7% Magnesium chloride in salt there is no room for commonly held opinion expressed by Stansby in a recent work on Fish Technology that even a few tenths percent of Magnesium present as impurity retards salt penetration. Levels of Calcium and other salts employed in this study conform to the range ordinarily found to be present in a larger number of Indian commercial salts studied by the authors (1957). Only one out of 51 samples was found to contain the level of Magnesium mentioned by Tressler (*i.e.*, 4.7%).

It may therefore be concluded that the presence of Calcium or other impurities mentioned here have no effect on salt penetration.

Although Sen and Aitkins (*loc cit*) have suggested that species difference may be responsible for the discrepancy observed in their study on cod versus the type of fish (*Cynoscion regalis*) studied by Tressler, the present investigation with mackerel and other types of fish like Scianoids and sardines with which also similar results were observed indicate that no such explanation appears to be possible.

## SUMMARY

The effect of impurities such as Calcium, Magnesium and sulphate in salt on curing mackerel and scianoids was studied. The levels of 0.25 to 0.75% of Calcium and Magnesium and 0.5 to 2.0% of sulphate in pure sodium chloride

were tried and it was found that the rate of penetration of salt had no relationship to the Calcium and Magnesium contents of salt even at a level of 0.75%. There was no evidence of enhanced spoilage due to the presence of Calcium and Magnesium during the process of salting. The presence of Calcium however appeared to slightly retard the rate of drying.

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