Chapter VII

BIOCHEMICAL ANALYSIS OF COMMON SALTS

VII.1 Introduction

Many minerals are required for the normal functioning of the body. Feeds of animal origin usually contain relatively high concentrations of sodium. The chief source of sodium is common salt. The commercially available common salt in addition to providing sodium chloride to body is associated with a number of other elements present in traces. Thus common salt is a good source of several elements which are essential to human body.

Chronic intake of high levels of salt have been reported to raise the blood pressure in some people\textsuperscript{407} and low sodium, high potassium diets are often recommended for hypertensive patients.\textsuperscript{408} The preferential concentration of K\textsuperscript{+} ion over Na\textsuperscript{+} ion by a cell and the greater activation of certain enzymes by K\textsuperscript{+} ion over Na\textsuperscript{+} ion, indicate the need of a potassium-rich diet. These two minerals are antagonistic in nature. To reduce the sodium levels and enhance the potassium levels in the body, rock salt (Halite, Malayalam: Induppu) is recommended as a substitute for common salt in indigenous systems of medicine. It is commonly believed that rock salt
contains more potassium and less sodium than common salt and hence is more suitable to hypertensive patients.

In the present chapter, a detailed chemical analysis of three different forms of common salt, that is, the crude marine form, the rock form and the commercially available refined form, has been carried out.

**VII.2 Materials and Methods**

The test samples, common salt (Marine form), rock salt (Halite, Malayalam: Induppu) and commercially available refined salt (Powdered iodized salt, Brand name: Sprinkle) were procured from the local dealers.

Test samples such as common salt, rock salt and refined salt were prepared by weighing a known quantity and dissolved in double distilled water.

**A. Determination of sodium, potassium and lithium**

To prepare 1000 ppm standard stock solution of sodium and potassium, 2.542 g. of NaCl and 1.9067 g. of KCl were weighed and dissolved in 1000 ml. of distilled water. 1000 ppm standard stock solution of lithium was prepared by weighing 5.3228 g. of Li₂CO₃ and dissolved in dilute HCl and made up to 1000 ml. with distilled water.

Diluted the sodium/potassium standard solutions so as to get a range of standards, 1 ppm, 2 ppm, 3 ppm, 4 ppm and 5 ppm. To prepare the lithium working standards, diluted the lithium stock solution to 2-10 ppm range.

The readings of standard solutions of Na⁺, K⁺ and Li⁺ in a flame photometer were measured using the filter for the concerned element.
Calibration curves were prepared for the elements by plotting the readings in the flame photometer against the concentrations of the working standard solutions. The concentration of elements (ppm) in the samples was determined by intrapolation.

B. Determination of calcium

Estimation of calcium was done as follows. Pipetted 20 ml. of the sample solution into a 250 ml. beaker. Added a drop of methyl orange and NH₄OH was added dropwise till the solution changed to yellow. Added 5 ml. of dilute HCl, diluted to 150 ml., covered with a watch glass and boiled. To the boiling solution, added 10 ml. of hot freshly prepared 2% solution of ammonium oxalate with constant stirring. NH₄OH was then added dropwise stirring continuously till the solution smells strongly of ammonia. Boiled for a few minutes more. Allowed to settle for an hour. Made sure that precipitation was completed by adding few drops of ammonium oxalate to the supernatant liquid along the sides of the beaker. If precipitation was incomplete, turbidity was seen in the supernatant liquid. Then added more ammonium oxalate. The contents of the beaker was then filtered through a quantitative filter paper. Washed the precipitate with water containing little ammonia till the washings gave no precipitate with HNO₃ and AgNO₃. Transferred the precipitate into the beaker in which precipitation was done. Added 25 ml. of dilute H₂SO₄ into the filter taking special care to ensure that the acid came into contact with every part of the filter paper. Washed the filter thoroughly with hot water and the sides of the beaker with dilute H₂SO₄. The liquid in the beaker containing oxalic acid was heated to 70°C. It was then titrated with standard KMnO₄ solution. The experiment was repeated to get concordant values.
The above experiment was used to determine the concentration of calcium in the three samples of salts.

KMnO₄ was standardised by the following method. About 0.315 g. of H₂C₂O₄ 2H₂O was weighed accurately. Made up to 250 ml. 20 ml. of the standard oxalic acid was pipetted out into a clean conical flask. Added 10-15 ml. of 2N H₂SO₄. Heated to 75-80°C. (Boiling was avoided as H₂C₂O₄ decomposes on boiling.) It was then titrated against KMnO₄ solution run from the burette. From the volumes of KMnO₄ used and the normality of H₂C₂O₄ solution, the normality of KMnO₄ was calculated.

C. Determination of sulphate

Sulphate in the three different forms of salts was determined as follows. Pipetted out 25 ml. of the sample solution into a beaker. Added 0.3-0.6 ml. of conc. HCl and diluted to 225 ml. Heated to boil. Added dropwise 10-12 ml. of warm 5% BaCl₂ solution (5 g. of BaCl₂ 2H₂O in 100 ml. of water). Stirred constantly during addition. Boiled for 2 or 3 minutes further. Allowed the precipitate to settle for a minute. Tested the supernatant liquid for complete precipitation using BaCl₂ solution. Kept the covered solution hot, not boiling, for an hour, filtered and the filtrate was tested for complete precipitation. The precipitate was then washed with hot water. (8 or 10 washings are necessary.) The moist paper was folded and placed in a weighed crucible. It was then ignited to redness. Cooled and weighed the crucible with contents. The experiment was repeated to get constant weight.

The above experiment was repeated using the three different forms of the salts.
D. Determination of moisture

For determining the moisture content, five g. each of the common salt, rock salt and iodized salt were weighed in pre-weighed china dishes. They were placed in an air oven at 70°C and kept over night. Then the weights of samples with china dishes were taken. The samples were again placed in the oven for 30 minutes and weighed. The same process was repeated to get concordant values.

After taking wet and dry weights of the samples, the moisture content of the salts was calculated using the formula,

\[
MC = \frac{WW - DW}{WW} \times 100
\]

Where MC = Moisture content in percentage
WW = Wet weight of the sample in grams
DW = Dry weight of the sample in grams

VII.3 Results and Discussion

Results are presented in the Tables VII.1a and VII.1b. Among the salts, the content of sodium in rock salt (375 ± 12.19 mg./g.) is higher than that in the other two salts. Of the three forms of salts analysed, common salt contains the least amount of sodium (299.6 ± 13.33 mg./g.). Iodized salt contains 363.8 ± 8.55 mg./g. of sodium. The potassium content of common salt and rock salt are 0.6212 ± 0.0261 mg./g. and 0.6791 ± 0.0231 mg./g. respectively. This showed that there is no significant difference in the potassium content of common salt and rock salt. Iodized salt contains significantly less amount of potassium (0.1125 ± 0.0026 mg./g.) than that contained in the other two salts.
Table VII.1a. **Results of chemical analysis of three different forms of common salt (marine form, rock form and the commercially available refined form)**

(Values are the mean of 10 different experiments in each case \( \pm \) S.E.M.)

<table>
<thead>
<tr>
<th>Item</th>
<th>Salt samples</th>
<th>Concentration of Na(^+) (mg./g. of salt)</th>
<th>Concentration of K(^+) (mg./g. of salt)</th>
<th>Concentration of Li(^+) (mg./g. of salt)</th>
<th>Concentration of Ca(^{2+}) (mg./g. of salt)</th>
<th>Concentration of SO(_4^{2-}) (mg./g. of salt)</th>
<th>Moisture content in per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Crude crystals of common salt (Marine form)</td>
<td>299.6 ( \pm ) 13.33</td>
<td>0.6212 ( \pm ) 0.0261</td>
<td>0.2190 ( \pm ) 0.0092</td>
<td>18.95 ( \pm ) 1.0423</td>
<td>11.950 ( \pm ) 0.6931</td>
<td>1.0228 ( \pm ) 0.0430</td>
</tr>
<tr>
<td>II</td>
<td>Rock salt</td>
<td>375.0 ( \pm ) 12.19 ( a )</td>
<td>0.6791 ( \pm ) 0.0231</td>
<td>0.1970 ( \pm ) 0.0066</td>
<td>16.88 ( \pm ) 0.6583</td>
<td>29.360 ( \pm ) 1.4386 ( a )</td>
<td>0.1600 ( \pm ) 0.0037 ( a )</td>
</tr>
<tr>
<td>III</td>
<td>Iodized salt (Commercially available refined form)</td>
<td>363.8 ( \pm ) 8.55 ( a )</td>
<td>0.1125 ( \pm ) 0.0026 ( a )</td>
<td>0.1965 ( \pm ) 0.0044</td>
<td>19.95 ( \pm ) 0.9776</td>
<td>4.736 ( \pm ) 0.1847 ( a )</td>
<td>0.0832 ( \pm ) 0.0027 ( a )</td>
</tr>
</tbody>
</table>

\( a = P < 0.01 \)

\( b = 0.01 < P < 0.05 \)

no symbol = not significant

Table VII.1b. **t-values**

<table>
<thead>
<tr>
<th>Items compared</th>
<th>Na(^+)</th>
<th>K(^+)</th>
<th>Li(^+)</th>
<th>Ca(^{2+})</th>
<th>SO(_4^{2-})</th>
<th>Moisture content</th>
</tr>
</thead>
<tbody>
<tr>
<td>I and II</td>
<td>3.96</td>
<td>1.5760</td>
<td>1.8433</td>
<td>1.5930</td>
<td>10.3432</td>
<td>18.9654</td>
</tr>
<tr>
<td>I and III</td>
<td>3.85</td>
<td>18.3992</td>
<td>2.0931</td>
<td>0.6639</td>
<td>9.5412</td>
<td>20.6891</td>
</tr>
</tbody>
</table>
In the indigenous system of medicine, there is a general practice of prescribing rock salt (Malayalam: Induppu) as a safer substitute for common salt for hypertensive patients. This is based on the assumption that rock salt contains more potassium and less sodium than common salt. Many other medicinal properties have been ascribed to rock salt in indigenous system of medicine. There is another mineral with an appearance resembling rock salt (Halite), called sylvite which is mostly potassium chloride. Sylvite contains high amount of potassium and less amount of sodium. It was not available with the local medical suppliers. The rock salt (Malayalam: Induppu) available here has now been shown to contain a higher amount of sodium and an approximately equal amount of potassium as in common salt. So rock salt is more harmful than common salt for hypertensive patients. So its consumption as a safer substitute for common salt is hazardous. The safety and efficiency of application of this rock salt (Induppu) in hypertensive patients for other therapeutic action needs further investigation.

Iodized salt contains significantly higher amount of sodium and significantly lower amount of potassium than that contained in common salt. Hence it cannot be considered to be a safer substitute for common salt especially for hypertensive patients. However, it is nutritionally significant as a source of iodine. Purification of salt is thus found to decrease the content of potassium significantly.

Lithium is used in the therapy of manic depression. Here the three salts have comparable lithium contents which are very low. They are $0.2190 \pm 0.0092 \text{ mg./g.}$, $0.1970 \pm 0.0066 \text{ mg./g.}$ and $0.1965 \pm 0.0044 \text{ mg./g.}$ respectively for common salt, rock salt and iodized salt. Hence the possible
therapeutic role of dietary salt as a source of lithium for pharmacological action is ruled out.

The calcium content of common salt, rock salt and iodized salt are $18.95 \pm 1.0423$ mg./g., $16.88 \pm 0.6583$ mg./g. and $19.95 \pm 0.9776$ mg./g. respectively. There is no significant difference in the amount of calcium in all the three types of salts analysed. So the substitution of any of the three salts will not cause any effect in the availability of calcium. But sulphate content is significantly higher in rock salt ($29.360 \pm 1.4386$ mg./g.). Iodized salt contains significantly less amount of sulphate ($4.736 \pm 0.1847$ mg./g.). Sulphate content of common salt is $11.950 \pm 0.6931$ mg./g.

Regarding moisture content, common salt contains more moisture with value of $1.0228 \pm 0.0430\%$. Rock salt sample contains $0.1600 \pm 0.0037\%$ of moisture. Iodized salt has got less amount of moisture with value of $0.0832 \pm 0.0027\%$. 