STUDIES ON REPLACEMENT OF SODIUM CHLORIDE WITH POTASSIUM CHLORIDE IN LEMON (CITRUS LIMON) PICKLES

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ABSTRACT

High consumption of sodium salts may lead to hypertension and the their continued consumption reported to cause heart attacks and death. Pickling technology is based on the extensive use of sodium chloride. The objectives of this study were to identify how replacement of sodium chloride with potassium chloride would affect the physiochemical, microbiological and organoleptic qualities of pickles during storage. Substituting sodium chloride with potassium chloride did not affect the quality of lemon pickles during 90 days storage. It was possible to manufacture low sodium lemon pickle by substituting 50% and 75% NaCl by KCl.

Keywords: Lemon pickle, Potassium chloride, Sodium chloride, Salt substitution.

INTRODUCTION

India is the largest producer of pickles with a volume estimated at 65000 tons valued at Rs 5 billion (MOFPI, 2011). Pickles based on mango, lime, amla, karonda, gongura, mixed vegetables, etc, are also exported mainly to meet the needs of immigrant populations of Indian origin.

Pickles contain salt at about 15-20% levels making it one of the high salt containing foods. Sodium is a vital element required in small amounts by the human body, as it helps to control homeostasis and nerve impulses (Starr and McMillan, 2006). Sodium chloride is essential in food as it improves the preservative, technological and sensory quality of food (Brady, 2002). However, over consumption of salt leads to an excess amount of sodium linked to hypertension. Approximately one quarter of the world’s population suffers from this condition (WHO, 2011).

One of the drawbacks with pickles is the inevitable presence of high concentration of sodium chloride which may lead to adverse effects on food bussness because of the aggressive anti salt campaigns in many countries.

The national and international bodies have set targets for a reduction in sodium in the diets. The partial substitution of NaCl by KCl seems to provide an alternative for reducing sodium content. Increased potassium intake is reported to protect stroke, high blood pressure, heart rhythm problems, kidney failure, and even osteoporosis (Hall, 2003). The additional use of KCl to partially replace NaCl (Gillette, 1985) could be helpful in reducing sodium content, However, the use of KCl is mainly limited by its bitter and astringent taste (Reddy and Marth, 1991).

The present work was undertaken to investigate the possibility of replacing sodium by potassium and develop low sodium lemon pickle without affecting its physiochemical, microbiological and sensory quality.

MATERIALS AND METHODS

Tata brand sodium chloride and Cargill potassium chloride were procured from Delhi market. Chemicals of laboratory grade were procured from Sd. Fine chemicals, Mumbai. Fresh lemon fruits were procured from Azadpur vegetable market. Turmeric powder, chilly powder and other spices of AGMARK grade were purchased from the local supermarket. Acetic acid of edible grade (Tops brand) was used. All the equipments used like chopping board, stainless steel plate were cleaned and sanitized with water heated at 90C before use. Lacquered metal containers used for packaging were pre-sterilized in a hot air steriliser.
**Preparation of lemon pickle:** Lemons were thoroughly washed under running water to remove traces of dirt, dust and to reduce microbiological load. Lemons were cut into four pieces using sanitized knife. Lemons were subjected to brining by addition of sodium chloride/kalium chloride, acetic acid and turmeric powder for one week (Fig. 1). Lemon pieces were mixed with other spices, packed in metal containers and stored at room temperature (25 ± 2°C).

**Analysis:** The pickle samples were analysed for physicochemical, microbiological and sensory parameters at 30 days interval for three months. Titratable acidity was determined by AOAC (1997) method. Hot air oven method given by BIS: 1009-1979 was used for determination of moisture. Water activity was found out using Aqua lab 4 te duo, decagon device.

Total plate count was estimated using IS: 5402 (2002) and yeast and mold count with the help of IS: 5403 (1999) methods.

Sensory evaluation was carried out by a panel of 10 semi trained judges for appearance, colour, flavour, texture, taste and overall acceptability using a 9-point Hedonic scale. (Peryam and Pilgrims; 1957). Sensory scores were subjected to statistical analysis by ANOVA using SPSS 15.0 to ascertain whether differences were significant at p< 0.05.

**RESULTS AND DISCUSSION**

**Physicochemical analysis:** The increase in titratable acidity is shown in (Fig. 2). Acidity registered a consistent increase during the storage period. This increase was more pronounced in high potassium pickle after 60 days storage. The increased acidity during storage could be attributed to the activity of microbial population as evident in (Fig. 5). A non significant increase in moisture content during storage may be attributed to the hydrolysis of proteins and natural sugars by the action of bacteria. Water activity is affected by moisture content in the product. As the moisture present increased in pickle during storage, $a_w$ also registered an increase (Fig. 4).

**Microbiological analysis:** The total viable counts in pickle samples increased throughout the storage period. The growth was not more than 5.4 log cfu/g after 3 months storage. This was due to the multiplication of acid tolerant bacteria. This is below the maximum recommended bacterial counts (5.7 log cfu/g) for good quality products (ICMSF 1986). Yeast and mold growth was not visible during the storage period of 3 months.

**Sensory analysis:** Storage had a significant effect on color, texture and overall acceptability, but the flavor was not affected significantly. The sensory scores increased during the storage period. This might be due to the softened texture and increased acidity during storage. The overall acceptability of pickled samples prepared with 50% and 75% substitution was found within acceptable limits (Table.1).

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**FIG. 1:** Flowchart for preparation of lemon pickle

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**FIG. 2:** Flowchart for preparation of lemon pickle
Cost of production of lemon pickle: The cost of production of 1 kg lemon pickle without replacement of NaCl was estimated to Rs 89 (Table 2) 50% replacement of NaCl with KCl increased the cost of production to 104 Rs/kg and that for 75% replacement to Rs. 112. This increase in cost was primarily because of the increased price of KCl. However, keeping in view the significance of health of human beings and resulting benefits in life span, this increased cost should be considered permissible and acceptable to consumers excepted. This study is to promote the sale of potassium chloride pickles in India.

<table>
<thead>
<tr>
<th>Storage Days</th>
<th>NaCl/KCl; 100/0 (control)</th>
<th>NaCl/KCl; 50/50</th>
<th>NaCl/KCl; 25/75</th>
<th>NaCl/KCl; 0/100</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7.5 ± 0.52</td>
<td>7.3 ± 0.40</td>
<td>6.14 ± 0.36*</td>
<td>4.5 ± 0.44*</td>
</tr>
<tr>
<td>30</td>
<td>7.7 ± 0.53</td>
<td>7.5 ± 0.45</td>
<td>6.05 ± 0.25*</td>
<td>4.35 ± 0.26*</td>
</tr>
<tr>
<td>60</td>
<td>7.95 ± 0.54</td>
<td>7.8 ± 0.40</td>
<td>6.35 ± 0.30*</td>
<td>4.15 ± 0.41*</td>
</tr>
<tr>
<td>90</td>
<td>8.0 ± 0.57</td>
<td>7.95 ± 0.46</td>
<td>6.05 ± 0.35*</td>
<td>4.0 ± 0.42*</td>
</tr>
</tbody>
</table>

*Significantly different (p<0.05) from 0 day
TABLE 2: Cost of pickle samples prepared at different levels of substitution

<table>
<thead>
<tr>
<th>S.no</th>
<th>Raw material</th>
<th>Cost/kg raw material(Rs.)</th>
<th>Amount used / kg of product(g)</th>
<th>Cost/ kg of product(Rs.)</th>
<th>Replacement of NaCl with KCl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>1.</td>
<td>Lemon</td>
<td>85</td>
<td>762</td>
<td>64.77</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>NaCl</td>
<td>10</td>
<td>174.35</td>
<td>1.74</td>
<td>0.87</td>
</tr>
<tr>
<td>3.</td>
<td>KCl</td>
<td>180</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Acetic acid</td>
<td>200</td>
<td>2.36</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Turmeric powder</td>
<td>180</td>
<td>21.51</td>
<td>3.87</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Chilli powder</td>
<td>180</td>
<td>27.52</td>
<td>4.95</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Methi powder</td>
<td>200</td>
<td>1.28</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Mustard powder</td>
<td>200</td>
<td>10.94</td>
<td>2.18</td>
<td></td>
</tr>
</tbody>
</table>

Cost of raw material: 78.26 | 93.08 | 100.5
Cost of processing: 1.0 | 1.0 | 1.0
Cost of packaging: 10.0 | 10.0 | 10.0
Total Cost of the product/kg: 89.26 | 104.08 | 111.5

FIG 6: Sensory scores of lemon pickle at 0 day

FIG 7: Sensory scores of lemon pickle at 90 days

CONCLUSION

Sodium substitution by potassium was successfully achieved in the preparation of lemon pickle. Replacement of NaCl by 50% and 75% KCl was found with in acceptable sensory characteristics during 3 months of storage. However, beyond these substitution levels, there exists a challenge for manufacturers to produce pickle with low bitterness and texturally, as pickle made with higher concentrations of sodium.

REFERENCES