CHAPTER V

Textural, storage and sensory characteristics of slowly digestible noodles.
5.1 INTRODUCTION

In the developed countries many convenience foods are prepared by extrusion process using forming extruder, as it offers a large number of desired characteristics to be incorporated in the product. Noodles are one of the many convenience foods prepared through this system and have been considered to symbolize long life and good luck in Asian culture. Macaroni products, alimentary pastas and pasta are the most extruded products and are more or less synonymous. They depict a broad category of important products which include spaghetti, macaroni, vermicelli and noodles. These products can be described as hard, brittle pieces, formed into different shapes by extruding, cutting and drying tough dough made of semolina or farina mixed with water. It is the versatility of form, composition and ease of preparation, nutritional content and excellent storage stability as well as increased consumer interest in ethnic foods in the Western world (Cole, 1991). The inherent blandness of the product makes them congenial with many kinds of adjuncts such as sauces, toppings, flavorings, etc, enabling vermicelli noodles to be used as the basis of different dishes with infinite variations (Sowbhagya and Ali, 2001).

Noodles/vermicelli is shelf stable convenience foods consumed not only in India but in many other countries. The present study was aimed at evaluating the effect of prepared noodles by utilizing the health and nutritional benefits of brown rice (pigmented and non-pigmented) along with chick pea and other additives on their storage, textural and sensory characteristics have been studied.
5.2. MATERIALS AND METHODS

5.2.1. Materials

Red-pigmented paddy variety, Jyothi and non-pigmented variety, IR-64 was procured from the Agriculture Produce Market committee (APMC), Bandipalya, Mysore, Karnataka, India. These two paddy varieties were cleaned and stored at 4–6°C until use. Whole chick pea and whole fenugreek seeds were procured from local market. Food grade - xanthan gum and guar gum was procured from Hi-Media, Mumbai. The paddy varieties were de-hulled, the husked (pigmented and non-pigmented) rice, whole Bengal gram and fenugreek seeds were pulverized in a mixer (Johnson Lady Bird plus) and the flour was passed through 60-mesh sieve (250 microns). All chemicals used were of analytical grade.

5.2.2. Selection and barrier properties of packaging material

Poly propylene (PP) of thickness 75 μm and metalized Polyester/Polyethylene (M-PET/PE) of thickness 75 μm were selected for packaging studies and shelf life of the noodles was evaluated.

5.2.3. Packaging and storage studies of noodles

One hundred gram of the noodles were packed in 12 X18 cm of PP and M-PET/PE pouches and stored under 90% RH/38°C (accelerated) and 65% RH/27 °C (ambient) storage conditions. They were withdrawn periodically every 15 days from accelerated and every month from ambient stored conditions and analyzed for free fatty acids (FFA). Noodles were prepared from the respective storage conditions and their sensory studies were carried out.
5.2.4. Percentage of free fatty acids in the stored Noodles

This was analyzed for dry noodles at accelerated and ambient stored products according to the methods of (AACC, 2000). Fat was extracted in petroleum ether (60–80 °C) at room temperature for 5 h/overnight. The extract was filtered through Whatman filter paper No. 1. Filtrate was divided into equal volumes; one part was evaporated in a pre weighed petri dish on water bath and dried at 105 °C for 1 h and another part was titrated against known concentration of alkali using phenolphthalein as indicator with addition of equal volume of warm neutral alcohol. FFA was expressed as Oleic acid (%) and it was determined using the formula:

$$\text{FFA} \% = \frac{mL \times N \times F \times 100}{\text{Sample weight} \times 1000}$$

Where mL = mL of NaoH required.

N = Normality of NaoH

F = equivalent weight of FFA in which results are to be expressed.

FFA is usually expressed as % oleic acid and equivalent weight is 282.

5.2.5. Instrumental colour measurement:

The colour of uncooked/cooked noodles was measured. The values of surface colour (L, a and b) of raw noodles in terms of lightness (L) and colour (+a: red -a: green; +b: yellow -b: blue) and DE were measured using Hunter Lab colour measuring system (Colour measuring Labscan XE system, Hunter Associates Laboratory Inc., Reston, VA). A standard white tile of barium sulfate (100% reflectance) was used as a perfectly white object for calibration of the instrument with the illuminant. Noodles samples were placed in the sample holder and the reflectance was auto-recorded for the wavelength
ranging from 360 to 800 nm. All parameters were carried out in quadruplicate and the mean values were reported.

5.2.6. Texture Profile Analysis (TPA) of noodles:

Textural properties were measured by double compression method using a texture analyzer (LLOYD texture instrument LR 5 K, England) equipped with a 1KN load cell. Dry and cooked noodles (1 cm) length was cut from the noodle strands.

The following parameters were determined. Hardness, cohesiveness, springiness, gumminess, chewiness, adhesiveness, and stiffness were calculated from the texture profile analysis as described by Bourne (1978).

5.2.7. Sensory analysis of cooked noodles:

A trained panel was employed for carrying out sensory evaluation of noodles prepared by following the method of quantitative descriptive analysis (Stone and Sidel 1998). Noodles was prepared from fresh as well as stored samples (for 3 months), and were evaluated for sensory quality attributes at designated intervals of 15 days in the case of accelerated and 30 days in the case of ambient stored conditions. Evaluations were carried out in sensory booths under white fluorescent light, air conditioned at 20±2 °C with RH 50±5%. The samples were served to panelists in porcelain plates coded with 3- digit random numbers to minimize bias. Panel training Descriptors were developed during initial sessions by the panelists. Each member was asked to describe the food sample with as many spontaneous descriptive terms as they found applicable. The common descriptors chosen by at least one-third of the panel were compiled along with some impact descriptors for the preparation of
scorecard. In order to trace the changes that could alter the sensory profile of the samples during storage, specific terminologies such as brown, moist, intactness of strands, firm, chewy, spicy were used in the scorecard for evaluation of these products. Panellists were suitably briefed and oriented about the perception of these notes.

Quantitative descriptive analysis (QDA) method was employed for conducting sensory analysis of the samples. A suitable score card comprising selected sensory attributes (descriptors) was formulated for this purpose. Panelists were asked to mark on a scale of 0-15 cm to indicate the perceived intensity of each attribute listed on the score card. The scale was anchored at 1.25 cm on either end, representing ‘Recognition Threshold’ and ‘Saturation Threshold’ respectively. Scores given for all the attributes for each sample were tabulated. Next, mean value was calculated for each attribute of a sample, representing the panel’s judgment about the sensory quality of the product. These are depicted graphically as ‘Sensory Profiles’.

5.2.8. Statistical analysis

Data were analyzed using Minitab 17 statistical software. Each experiment was performed in triplicate and the results were expressed as the mean values ± standard deviation. Results were analyzed and significance level was calculated using Tukey–Kramer multiple comparison test by means of one way ANOVA. Values with $p< 0.05$ were considered statistically significant.
5.3 RESULTS AND DISCUSSION

5.3.1. Changes in FFA in the stored noodles (PN/NPN)

Even though the mixes had a low fat content (<4%), changes in FFA was monitored to see the correlation with the sensory quality. The initial FFA for PN and NPN was between 5.6 and 5.79%, respectively (Table 14). At accelerated storage the FFA in PN increased from 5.6 to 8.45% for 90 days, in NPN it increased from 5.79 to 9.58%. At ambient storage, the increase in FFA was less than 1% at each withdrawal for every month. Thus the changes were marginal on storing at ambient and accelerated conditions, as the maximum value observed was around ~10% up to 3 months. Similar trend was observed with the packaging materials used.
Table 14. Percentage of free fatty acids in noodles (PN/NPN) while storage for different periods at accelerated and ambient conditions.

<table>
<thead>
<tr>
<th>Storage days</th>
<th>Pigmented noodles (90% RH)</th>
<th>Non-pigmented noodles (65% RH)</th>
<th>Pigmented noodles (90% RH)</th>
<th>Non-pigmented noodles (65% RH)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(PP pouch)</td>
<td>(M-PET/PE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>5.6</td>
<td>5.6</td>
<td>5.79</td>
<td>5.79</td>
</tr>
<tr>
<td>15</td>
<td>5.99</td>
<td>-</td>
<td>6.5</td>
<td>-</td>
</tr>
<tr>
<td>30</td>
<td>6.11</td>
<td>5.76</td>
<td>6.6</td>
<td>6.27</td>
</tr>
<tr>
<td>45</td>
<td>6.69</td>
<td>-</td>
<td>7.46</td>
<td>-</td>
</tr>
<tr>
<td>60</td>
<td>7.11</td>
<td>8.28</td>
<td>8.47</td>
<td>8.10</td>
</tr>
<tr>
<td>75</td>
<td>7.77</td>
<td>-</td>
<td>9.02</td>
<td>-</td>
</tr>
<tr>
<td>90</td>
<td>8.45</td>
<td>8.7</td>
<td>9.58</td>
<td>8.92</td>
</tr>
</tbody>
</table>

For storage in PP pouch conditions (90% RH), the free fatty acid percentages range from 5.6% to 8.7% for pigmented noodles and from 5.6% to 8.92% for non-pigmented noodles. In M-PET/PE conditions (65% RH), the range is slightly higher, with pigmented noodles showing 6.5% to 9.03% and non-pigmented noodles showing 6.27% to 9.33%.

The data suggests that free fatty acid content increases with storage time, with higher RH conditions leading to slightly higher values.
5.3.2. Instrumental colour measurement:

The colour values of noodle samples (uncooked/cooked) are presented in (Table 15). There was decrease in lightness (L*) in both PN uncooked/cooked samples. This may be attributed to the pigments present and thermal breakdown of starch during processing. There was increase in redness (a*) in the NP noodle samples unlike in case of PN. However, b* values which indicate yellowness (+ve) and blueness (-ve) shows a downward trend for PN and more so in case of NPN. Similar pattern was observed for cooked noodles in both types of noodles.
Table 15. Instrumental colour analysis of the noodles.

<table>
<thead>
<tr>
<th>Noodles</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>ΔE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PN (dry)</td>
<td>37.31±0.71&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.67±0.26&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.78±0.43&lt;sup&gt;b&lt;/sup&gt;</td>
<td>60.75±1.24&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>NPN (dry)</td>
<td>40.22±0.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.16±0.13&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.38±0.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>74.50±0.56&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>PN (cooked)</td>
<td>45.33±0.38&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.57±0.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.47±0.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>64.27±0.32&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>NPN (cooked)</td>
<td>47.79±0.34&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.71±0.05&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.57±0.12&lt;sup&gt;a&lt;/sup&gt;</td>
<td>72.21±0.21&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values are mean ± SD of three independent analyses (n=3). Values with different superscript within a column are significantly different (p<0.05).

L* (lightness axis indicate '0' is black and '100' is white.
a* (red-green axis indicates positive values represent red and '0' is neutral and negative values indicate green.
b* (yellow-blue) axis indicate positive values, they are yellow when positive, negative values represent blue and '0' is neutral.
ΔE, magnitude of the total colour differences.
5.3.3. Instrumental texture analysis

Texture and mouth feel of cooked noodles is the most critical characteristic that determines consumer acceptance of the product. Results of the instrumental texture analysis of uncooked noodles are given in (Table 16). The breaking strength is the stress required to break across a noodle strand. High breaking strength is desirable to minimize the breakage during handling and transportation. PN had the highest breaking strength of 1.3 ± 0.09 Newton (p<0.05) followed by NPN (0.94 ± 0.05 Newton).

Similar to the above result of uncooked noodles, PN exhibited significantly higher peak force (10.2 ± 0.2 Newton), compression energy (6.4 ± 0.2 mJ) and firmness (2.3 ±0.1Newton/mm) than NPN.

The textural parameters depicted that PN had a better textural property compared to NPN.
Table 16. Instrumental texture analysis of the noodles.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Breaking strength (Newton)</th>
<th>Peak Force (Newton)</th>
<th>Compression energy (mJ)</th>
<th>Firmness (Newton/mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigmented Noodles</td>
<td>1.3±0.09&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.2±0.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.4±0.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.3±0.1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Non-pigmented Noodles</td>
<td>0.94±0.05&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.9±0.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.2±0.08&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.8±0.05&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values are mean ± SD of five independent analyses (n=5). Values with different superscript within a column are significantly different (p<0.05).
5.3.4. Sensory analysis of cooked noodles (pigmented and non-pigmented)

At the end of 30 days, among samples stored under accelerated conditions, pigmented noodles (PN) had higher intensity of brown colour, higher scores for intactness, firmness and chewiness. This probably resulted in slightly lower scores for overall quality (OQ) in these samples. On the other hand, non-pigmented noodles (NPN) were lighter in colour, had higher moistness (mouth feel), higher spicy aroma (predominantly fenugreek, which was perceived to be desirable) and lower scores for chewiness and firmness. Consequently, these samples had higher OQ scores. This pattern was observed in samples packaged in both PP and PET/PP. Among samples stored under ambient conditions, similar trend was observed.

At the end of 60 days, perceived intensity of spicy (fenugreek) aroma of the samples remained comparable to the initial samples. The trend of low perception of moist mouth feel continued. There was a decreasing trend in the OQ scores of samples stored in PP under accelerated conditions compared to that of samples stored in PET pouches. However, this difference was not seen in samples stored under ambient conditions.

At the end of 90 days, among the samples stored under accelerated conditions, NPN continued to show better intactness (form / appearance) compared to PN. Perceived intensity of spicy aroma continued to be desirably high. Similar trend was observed in case of samples stored under ambient conditions. The OQ scores were relatively low compared to initial samples. Nevertheless, this did not affect the acceptability of the samples. There was no off-note in odour or taste of the samples. The changes in
sensory quality of stored noodle samples were gradual. Samples withdrawn at the end of 15, 45 and 75 days did not differ to a great extent from their counterparts withdrawn at the end of 30, 60 and 90 days. Hence, separate description of the samples withdrawn and evaluated at the end of 15, 45 and 75 days has not been mentioned. Fig [27, 28, 29 & 30 (A & B)] respectively refer to sensory profiles of samples packaged in PP and PET/PP stored under ambient and accelerated conditions for 30, 60 and 90 days, described in the preceding paragraphs describing the sensory quality changes during the storage period.

All the samples stored under ambient and accelerated conditions were acceptable at the end of 90 days of storage. Samples did not have any off-taste or off-odor during the storage period. Major changes in sensory quality during storage were related to textural attributes, in terms of slightly increased perception of firmness. Pigmented noodles retained the intactness (appearance) better until the end of 90 days. Although there was slight decrease in the intactness of non-pigmented noodles, the OQ scores were not affected drastically. Both types of noodles retained spicy aroma (fenugreek) to a desirably high level until the end of the study.
Fig 27 (A & B). Sensory profile of pigmented and non-pigmented noodles stored in PP at Ambient condition.
**Fig 28 (A & B).** Sensory Profile of pigmented and non-pigmented noodles stored in PP at Accelerated condition.
Fig 29 (A & B). Sensory Profile of pigmented and non-pigmented noodles stored in PP/PET at Ambient condition
Fig 30 (A & B). Sensory Profile of pigmented and non-pigmented noodles stored in PP/PET at Accelerated condition.
5.4. CONCLUSIONS

Noodles (PN and NPN) were developed by utilizing the health and nutritional benefits of brown rice (pigmented and non-pigmented) along with chick pea and other additives. These noodles could be stored up to 3 months under both the conditions. Free fatty acids (FFA) developed was similar under both the conditions, varying only in marginal changes. These noodles were highly acceptable. Overall quality of these noodles varied from 8 to 9 based on quantitative descriptive analysis method of intensity scale.