Study on shelf life of QPM incorporated noodles

Vandana and Sarita Srivastava

Abstract
In the present study shelf life of QPM incorporated noodles was studied in terms of moisture content, peroxide value, free fatty acid, microbiological qualities and sensory properties for a period of three months at ambient temperature in two types of packaging material viz. LDPE and aluminium laminated packets. The noodles were formulated by incorporating QPM flour and refined wheat flour at the ratio of 44:44, 12 g gluten, 0.2 g guar gum and 53 ml water used for dough making. Control noodles were prepared from only refined wheat flour. These noodles were dried in hot air oven at 39°C for 6-8 hours. There was seen non-significant increase in moisture content, peroxide value, free fatty acids and microbiological parameters upto three months of storage. The noodles were found to be suitable for consumption upto 90 days of storage at room temperatures in both type of packaging material.

Keywords: QPM, noodles, LDPE, aluminium laminated packets, shelf life

Introduction
Quality Protein Maize (QPM) has recently fetched abundant attention in international market as it contains twice the amount of lysine and tryptophan as compared to normal maize (Ruiz et al., 2008) [1]. QPM is a derivative of opaque-2 maize. It was developed at the International Maize and Wheat Improvement Centre, CIMMYT in Mexico. It can be processed into food products with improved protein quality.

Noodles are widely consumed throughout the world because these are economical, tasty, easy to prepare, shelf stable. These can also be served in different ways. Global consumption of noodles is second after the bread (Pakhare et al., 2016) [2]. Because of the high popularity, these could also be used as a vehicle to improve the nutritive value of the habitual diets (Kumar et al., 2019) [3]. Flour of hard wheat (Triticum aestivum L.) is the primary ingredient used to make noodles which is not only low in fiber and protein contents but also low in essential amino acid such as lysine. Traditional noodles lack essential nutritional components such as vitamins, minerals, dietary fibre and bioactive compounds. Now a days consumer demand food products which are supplemented with vitamins, minerals and free from synthetic additives. So, one of the greatest challenges in today’s world is to develop food products that are inexpensive, nutritionally superior and also highly acceptable that fulfill the need of the consumers.

The consumer preferences have increased for high food quality and accordingly they expect that the food quality will be intact at a high level throughout the period between purchase and consumption. Shelf life is an important feature of all foods, including raw materials, ingredients and manufactured products. “Shelf life is defined as the time during which the food products will remain safe; be certain to retain desired sensory, chemical, physical and microbiological characteristics; comply with any label declaration of nutritional data and be acceptable to the consumer (Earle and Earle, 2008) [4]. So, shelf life study helps to determine the keeping quality of the product. Factors which determine the shelf life of food product are processing, method of preservation, packaging and microbial count (Pakhare et al., 2016) [2].

Packaging plays an important role in preserving the functional and sensory qualities of food. It also helps in providing correct environmental conditions for food and protects it against microbiological, physical or chemical degradation (Komolafe, 2005) [5].

Hence the present investigation was carried out to know the best packaging material which extends the shelf life of QPM noodles while retaining all its properties.

Materials and Methods
Place of study
Present study was carried out in the Department of Foods and Nutrition, College of Home Science, GBPUA&T, Pantnagar, Uttarakhand, India.

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Materials and Methods
Place of study
Present study was carried out in the Department of Foods and Nutrition, College of Home Science, GBPUA&T, Pantnagar, Uttarakhand, India.

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Procurement of the samples
Vivek QPM-9 was procured from Vivekananda Parvatiya Krishi Anusandhan Sansthan VPKAS, Almora, Uttarakhand. Gluten and guar gum were purchased from Honey Confectionary, Rudrapur, Uttarakhand while refined wheat flour was purchased from the local market of Pantnagar, Uttarakhand.

Method for preparation of flour
QPM grains were cleaned manually to remove dust, stones and other impurities. According to Shobha et al. (2011) [6] nixtamalization process of QPM grains was carried out. Five hundred gram of whole grains were soaked in 1% calcium hydroxide solution and then cooked for 30 min at 85°C. The nixtamal was steeped overnight at 32±1°C, followed with washing in excess tap water. The grains were spread on tray and dried in a dryer at 60°C until the moisture percentage reached to 9-10% with constant mixing. After drying the grains were milled in the milling machine and passed through 60 mesh sieve. The prepared flour was stored in airtight containers for further preparation.

Preparation of noodles
Response surface methodology (RSM) was used to optimize the level of QPM: refined wheat flour (RWF), gluten and water used for dough making in the preparation of noodles. Noodles were prepared following the procedure of Dixit and Chaudhary (2017) [7]. The optimized QPM noodles contained 44.0g QPM flour, 44.0g RWF, 12 g gluten, 0.2 g guar gum and 53 ml water used for dough making. The control noodles were prepared from 100% refined wheat flour. Dough was prepared by continuously kneading with the help of hand for 15 minutes, followed by resting for 20 minutes at room temperature. Noodles were then extruded by using hand operated pasta machine. These noodles were dried in hot air oven at 39°C for 6-8 hours to attain moisture content less than 12 percent as per the PFA specifications for noodles.

Storage studies
Optimized QPM noodles were stored along with control samples for three months at ambient conditions (temperature ranged from 28-32°C and relative humidity 70-80 percent) in two types of packaging material viz. aluminum laminated packets and low-density polyethylene (LDPE) of 150 gauge of thickness. The samples were drawn at 0, 30, 60 and 90th days of storage for conducting storage study. Moisture content and free fatty acid content in optimized QPM noodles and refined wheat flour noodles were analyzed as per AOAC (1995) [8], peroxide value was estimated as per American Oil Chemists Society (AOCS,1997) [9] and microbiological quality was determined using standard plate count (SPC) technique as given in the compendium of methods for microbiological examination of foods (APHA,1984) [10].

Sensory quality
Refined wheat flour noodles and optimized QPM noodles were evaluated for sensory characteristics using score card method by 10 semi-trained panel members from the Department of Foods and Nutrition, College of Home Science, GBPUA&T, Pantnagar. Water was provided to rinse the mouth between the samples and noodles were served in paper plate with fork for comfortable testing.

Noodles cooking for assessing sensory quality
Noodles (100g) were cooked in 350 ml of boiling water with occasional stirring till white core disappear.

Statistical analysis
Statistical analysis was carried out using analysis of variance (ANOVA) by taking mean of 10 semi-trained judges for various sensory parameters. Data obtained from each treatment was subjected to one-way analysis of variance (ANOVA) to test the storage parameters in order to measure significant differences.

Results and Discussion

Moisture content
Moisture content greatly affects the physical and chemical properties of food which are related to freshness and stability during storage (Isengard, 2001) [11]. Table 1 represents that packaging material has a non-significant effect on the moisture content of the formulated noodles. The initial moisture content of optimized QPM noodles and refined wheat flour noodles was 7.90 and 7.67 percent, respectively. On 90 days of storage the moisture content of optimized QPM noodles in LDPE was 8.37 percent and in aluminum laminated packets was 8.24 percent, respectively while the moisture content of RWF noodles in LDPE was 7.90 percent and in aluminum laminated packets was 7.85 percent, respectively. Kaur et al. (2017) [12] also reported that moisture content of pasta prepared from wheat flour stored in high density polyethylene (temperature 20-30°C, RH 55-75%) did not show significant changes during storage for 90 days.

Table 1: Moisture content (percent) of optimized QPM noodles and control refined flour noodles during storage

<table>
<thead>
<tr>
<th>Storage period</th>
<th>Optimal QPM noodles</th>
<th>RWF noodles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LDPE</td>
<td>Aluminum laminated packets</td>
</tr>
<tr>
<td>0</td>
<td>7.90±0.66</td>
<td>7.90±0.66</td>
</tr>
<tr>
<td>30</td>
<td>8.13±0.61</td>
<td>8.10±0.53</td>
</tr>
<tr>
<td>60</td>
<td>8.20±0.62</td>
<td>8.13±0.65</td>
</tr>
<tr>
<td>90</td>
<td>8.37±0.35</td>
<td>8.24±0.35</td>
</tr>
<tr>
<td>S.Em.</td>
<td>0.29</td>
<td>0.37</td>
</tr>
<tr>
<td>C. D. @ 5%</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

All results are mean ± standard deviation of three values LDPE= Low Density Polyethylene
QPM: RWF+ gluten+ water used for dough making + guar gum:44:44 + 12 g +53 ml + 0.2 g
S/NS signifies significant and non-significant difference, respectively. S.Em. - standard error of mean, C.D.- critical difference

Peroxide value
Peroxide value is used as an indicator of fat deterioration which takes place due to oxidation of fat. Table 2 revealed that the initial peroxide value of the optimized QPM noodles
was 0.31 m eq/kg fat while the final peroxide value was 0.54 and 0.50 m eq/kg fat, respectively for LDPE and aluminum laminated packets after 90 days of storage. For refined wheat flour noodles, the peroxide values at 0 day was 0.12 m eq/kg fat and after 90 days of storage, the final peroxide value was 0.28 and 0.24 m eq/kg fat, respectively for LDPE and aluminum laminated packets. There has been found non-significant increase in peroxide value in both optimized QPM noodles and refined wheat flour noodles irrespective of packaging materials. Shobha et al. (2015) [13] also reported non-significant increase in peroxide value of normal noodles (0.63-0.64 m eq/kg fat) and QPM noodles (0.61-0.63 m eq/kg fat) up to three months of storage.

### Table 2: Peroxide value (m eq/kg fat) of optimized QPM noodles and control refined wheat flour noodles during storage

<table>
<thead>
<tr>
<th>Storage period</th>
<th>Optimized QPM noodles</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
<th>RWF noodles</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.31±0.11</td>
<td>0.31±0.11</td>
<td>0.12±0.07</td>
<td>0.12±0.07</td>
<td>0.28±0.11</td>
<td>0.28±0.11</td>
<td>0.64±0.08</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>0.40±0.13</td>
<td>0.38±0.15</td>
<td>0.17±0.07</td>
<td>0.14±0.06</td>
<td>0.50±0.09</td>
<td>0.24±0.09</td>
<td>0.59±0.09</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>0.49±0.12</td>
<td>0.45±0.12</td>
<td>0.22±0.09</td>
<td>0.18±0.08</td>
<td>0.50±0.09</td>
<td>0.24±0.09</td>
<td>0.45±0.10</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>0.54±0.19</td>
<td>0.50±0.09</td>
<td>0.28±0.11</td>
<td>0.24±0.09</td>
<td>0.50±0.09</td>
<td>0.24±0.09</td>
<td>0.45±0.10</td>
<td>NS</td>
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<td></td>
</tr>
<tr>
<td>S. Em.</td>
<td>0.08</td>
<td>0.07</td>
<td>0.06</td>
<td>0.05</td>
<td>0.07</td>
<td>0.07</td>
<td>0.08</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>C. D. @ 5%</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

All results are mean ± standard deviation of three values LDPE= Low Density Polyethylene S/NS signifies significant and non-significant difference, respectively. S. Em. - standard error of mean, C.D. - critical difference

### Table 3: Free fatty acid (% oleic acid) of optimized QPM noodles and control refined wheat flour noodles during storage

<table>
<thead>
<tr>
<th>Storage period</th>
<th>Optimized QPM noodles</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
<th>RWF noodles</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.44±0.13</td>
<td>0.44±0.13</td>
<td>0.23±0.12</td>
<td>0.23±0.12</td>
<td>0.07</td>
<td>0.07</td>
<td>0.08</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>0.50±0.14</td>
<td>0.47±0.11</td>
<td>0.30±0.10</td>
<td>0.29±0.08</td>
<td>0.17±0.07</td>
<td>0.17±0.07</td>
<td>0.23±0.12</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>0.59±0.09</td>
<td>0.55±0.09</td>
<td>0.38±0.13</td>
<td>0.35±0.11</td>
<td>0.12±0.07</td>
<td>0.12±0.07</td>
<td>0.23±0.12</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>0.64±0.08</td>
<td>0.60±0.10</td>
<td>0.45±0.10</td>
<td>0.40±0.10</td>
<td>0.12±0.07</td>
<td>0.12±0.07</td>
<td>0.23±0.12</td>
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<td>NS</td>
<td></td>
</tr>
<tr>
<td>S. Em.</td>
<td>0.07</td>
<td>0.07</td>
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<td>0.06</td>
<td>0.07</td>
<td>0.07</td>
<td>0.08</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>C. D. @ 5%</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

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### Sensory quality

Table 4 show non-significant decrease in all the sensory parameters viz. color, flavor, texture, taste and overall acceptability of optimized QPM noodles and control refined wheat flour noodles up to 90 days. The optimized QPM noodles at 0 day had color, flavor, texture, taste and overall acceptability of 7.70, 7.80, 7.90, 7.90 and 7.90 percent, respectively. On 90 day the color, flavor, texture, taste and overall acceptability of optimized QPM noodles in LDPE was reported to be 7.10, 7.10, 7.2, 7.0 and 7.0 percent, respectively while in aluminum laminated packets was 7.20, 7.30, 7.30, 7.30 and 7.10 percent, respectively. The RWF noodles at 0 day showed color, flavor, texture, taste and overall acceptability of 7.9, 8.0, 7.90, 7.70 and 7.60 percent, respectively while the color, flavor, texture, taste and overall acceptability in LDPE was 7.20, 7.30, 7.20, 7.10 and 7.0 percent, respectively while in aluminum laminated packets was 7.40, 7.30, 7.40, 7.40 and 7.40 percent, respectively after 90 days of storage.

### Table 4: Sensory quality of optimized QPM noodles and control refined wheat flour noodles during storage

<table>
<thead>
<tr>
<th>Storage period</th>
<th>Optimized QPM noodles</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
<th>RWF noodles</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
<th>LDPE</th>
<th>Aluminum laminated packets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>7.7±0.67</td>
<td>7.7±0.67</td>
<td>7.9±0.94</td>
<td>7.9±0.94</td>
<td>0.20</td>
<td>0.19</td>
<td>0.30</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>7.4±1.51</td>
<td>7.4±0.84</td>
<td>7.6±1.17</td>
<td>7.8±0.79</td>
<td>0.20</td>
<td>0.19</td>
<td>0.30</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>7.2±1.42</td>
<td>7.2±0.84</td>
<td>7.4±0.84</td>
<td>7.4±0.48</td>
<td>0.20</td>
<td>0.19</td>
<td>0.30</td>
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<tr>
<td>90</td>
<td>7.1±0.88</td>
<td>7.2±0.42</td>
<td>7.2±1.14</td>
<td>7.4±0.52</td>
<td>0.20</td>
<td>0.19</td>
<td>0.30</td>
<td>NS</td>
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</tr>
<tr>
<td>S. Em.</td>
<td>0.20</td>
<td>0.19</td>
<td>0.30</td>
<td>0.20</td>
<td>0.20</td>
<td>0.19</td>
<td>0.30</td>
<td>NS</td>
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<tr>
<td>C. D. @ 5%</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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<td>NS</td>
<td>NS</td>
<td>NS</td>
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</tr>
</tbody>
</table>

Flavour

~ 24 ~

Free fatty acid (FFA)

Table 3 reveals that there was a non-significant increase in the FFA with storage days. FFA value at 0 day was 0.44 (% oleic acid) for optimized QPM noodles and the final FFA value after 90 days of storage, was 0.64 and 0.60 (% oleic acid), respectively for LDPE and aluminum laminated packets. While in case of RWF noodles, initially FFA was 0.23 (% oleic acid) and after 90 days of storage, the final FFA value was 0.45 and 0.40 (% oleic acid), respectively for LDPE and aluminum laminated packets.

Table 3: Free fatty acid (% oleic acid) of optimized QPM noodles and control refined wheat flour noodles during storage
Shobha et al. (2015) [13] reported that QPM noodles and control noodles showed maximum overall acceptability score up to three months of storage.

**Microbiological quality**

The microbial study was conducted by taking total viable count of optimized QPM noodles and RWF noodles at every 30 days for three months of storage period (Table 5). The total viable count of QPM incorporated noodles in LDPE was $12.0 \times 10^2$ cfu/g and in aluminum laminated packets was $9.0 \times 10^2$ cfu/g during three months of storage period which was initially found to be $5.0 \times 10^2$ cfu/g. In refined wheat flour noodles the initial total viable count was $4.3 \times 10^2$ cfu/g and after three months of storage the total viable count in LDPE was $10.0 \times 10^2$ cfu/g and in aluminum laminated packets was $8.2 \times 10^2$ cfu/g. The studies indicated that the formulated noodles packed in the selected packaging materials had microbial load within the permissible limits at room temperature throughout the storage period, which showed the stability of the product. According to BIS, standard plate count of 50,000 cfu/g has been specified for high protein mixes (ISI, 1974) [14] and ready to eat rich extruded snacks (ISI, 1980) [15].

**Table 5:** Total viable count (cfu/g) of optimized QPM noodles and control refined wheat flour noodles during storage

<table>
<thead>
<tr>
<th>Storage period</th>
<th>Optimized QPM noodles</th>
<th></th>
<th>RWF noodles</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LDPE</td>
<td>Aluminum laminated packets</td>
<td>LDPE</td>
<td>Aluminum laminated packets</td>
</tr>
<tr>
<td>0</td>
<td>$5.0 \times 10^2$</td>
<td>$5.0 \times 10^2$</td>
<td>$4.3 \times 10^2$</td>
<td>$4.3 \times 10^2$</td>
</tr>
<tr>
<td>30</td>
<td>$7.2 \times 10^2$</td>
<td>$6.9 \times 10^2$</td>
<td>$5.8 \times 10^2$</td>
<td>$4.3 \times 10^2$</td>
</tr>
<tr>
<td>60</td>
<td>$8.0 \times 10^2$</td>
<td>$7.7 \times 10^2$</td>
<td>$7.8 \times 10^2$</td>
<td>$6.6 \times 10^2$</td>
</tr>
<tr>
<td>90</td>
<td>$12.0 \times 10^2$</td>
<td>$9.0 \times 10^2$</td>
<td>$10.0 \times 10^2$</td>
<td>$8.2 \times 10^2$</td>
</tr>
</tbody>
</table>

#QPM: RWF+ gluten+ water used for dough making+ guar gum=44:44 + 12 g +53 ml + 0.2 g
LDPE= Low Density Polyethylene

**References**


11. Isengard HD. Water content, one of the most important properties of food. Food Control 2001;12(7):395-400.