DEVELOPMENT AND QUALITY EVALUATION OF EXTRUDED FORTIFIED CORN SNACK

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ABSTRACT
Extruded fortified corn snack was developed by single type screw extruder using Corn Meal, Oat Meal and Whey Protein Concentrate. The studies were conducted on incorporation of different ratios of CM, OM and WPC used and shelf life study was conducted for two months. Three different ratios of CM, OM and WPC were taken in the proportion of (90:7:3) for the first (80:16:4) second and (70:25:5) third treatment. Spinach and mint leaves were used for flavoring and seasoning. Physico-chemical and sensory analysis of the samples were evaluated. During storage it was observed that moisture content of the sample showed slight increase whereas there was a slight decrease in all the other proximate analysis. But it was observed that all the proximate parameters were increased from the control sample to the different treatments. Among the treatments the one with 80% and 70% CM were found nutritive. Depending upon the sensory attributes also the sample having 80% CM was found satisfactory for storage and is the most acceptable sample. Therefore the snack developed is a high fiber low calorie snack which can be recommended to the diabetic and obese people.

Keywords: Corn meal, Extrusion, Fortified snack, low calorie, Oat meal.

INTRODUCTION
A snack is a portion of food oftentimes smaller than that of a regular meal that is generally eaten between meals. Consumers these days demand for whole grain snacks that are low in fat, high in protein, high in dietary fiber and deliver balanced nutrition. Extrusion technology has taken the snack food category far from the domain of the potato chip and pretzel that dominated it for decades. Extrusion processing is popular in the food industry and can efficiently create novel products that might not be possible with other processing methods (Cisneros and Kokini 2002) such as snacks and ready to eat foods. Extrudates are microbiologically safe, can be stored for long periods because of low moisture without need for refrigeration and requires less labor for handling and less packaging materials and storage space (Filli and Nkama, 2007).

Extrusion cooking is a high-temperature; short-time (HTST) technology applied in many food production processes and considered as a continuous cooking, mixing, and forming process with low cost and high efficiency (Ryu et al., 1993; Abd El-Hady et al., 1998; Ding et al., 2005.) Extruder is a thermodynamic unit which involves the combination of heat, pressure and mechanical shear. The process is achieved by screw and barrel tube mechanism. Feed material in granular form are fed into the extruder barrel, then screw, then convey the material and compress and work in shear to transform the granular feed material into a semi solid plasticized mass the food is then extruded through an interchangeable die and cut at die either by rotating knives or subsequently by guillotine knives to form a variety of shapes. During extrusion, the cooking temperature could be as high as 180-190 °C; residence time is usually 20-40 seconds.

The results of cooking the food ingredients during extrusion are gelatinization of starch, denaturation of protein, inactivation of raw food enzymes, destruction of naturally occurring toxic substances, diminishing of microbial counts in the final product. Advantages of food extrusion are versatility, high productivity, low cost, product shapes, high product quality, and energy efficiency, production of new foods, and no effluents or waste.

Commeal is a meal (course flour) ground from dried maize. It is rich in phosphorus, magnesium, manganese, zinc, copper, iron and selenium. The fiber in commeal
helps to promote colon health and prevent constipation. The fiber in commeal lowers cholesterol levels. Commeal is gluten–free. It is beneficial for managing diabetes.

Oats (Avena sativa) provide one of the richest sources of the dietary soluble. It contains more lipids i.e., 5-9% (Peterson and Wood, 1997: ) than any other cereal crops and is rich in unsaturated fats. The presence of total and free sugars in oats is very low in comparison to other cereal grains (Lambo, 2004). Oatmeal helps in fighting obesity as its soluble fiber slows down digestion. The important nutritional attributes of oats relate to the lowering of blood cholesterol and sugar (Webster, 1986).

Whey protein is a mixture of globular proteins isolated from whey, the liquid material created as a by-product of cheese production from milk.). Successful incorporation of whey into extruded products increases utilization of whey products and improve the nutrient density of snacks by increasing the protein content. Addition of whey protein can enhance their nutritional value because their incorporation in extruded products may provide a nutritionally sound and economical approach to fortification (Allen et al. 2007). Whey protein concentrate as a valuable source of proteins and minerals is one of the highest-quality components for possible extrudates enrichment.

Spinach has a high nutritional value and is extremely rich in antioxidants. It’s low in calories yet very high in vitamins, minerals and other phytonutrients. Mints are aromatic herbs that have a distinct aroma and fragrance. In this study extruded fortified corn snack was developed and the shelf life study of the snack was conducted for two months at an interval of 20 days on the basis of physico-chemical parameters and sensory attributes.

Extruded product developed will show good functional characteristics with improved health benefits (more fiber and protein content) due to whey protein and spinach addition to corn. The decision to adopt extrusion cooking was motivated by the need to improve nutritional status, physical state and the functionality of the end product.

MATERIALS AND METHODS

The materials such as corn meal, oat meal, whey protein concentrate, spinach powder, mint leaves powder, spices, oil, and salt were procured from the local market of Allahabad. The development of the extruded fortified corn snack was done at Cen Percent Food Products, Naini Industrial Area, Allahabad. The quality evaluation of the developed extruded fortified snack was done in the department of Food Process Engineering, SHIATS, Allahabad. The experimental procedure of this study is shown as follow in table 1.

Table 1 Formulation of Extruded Fortified Corn Snack

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T&lt;sub&gt;0&lt;/sub&gt;</td>
</tr>
<tr>
<td>Corn meal (%)</td>
<td>100</td>
</tr>
<tr>
<td>Oat meal (%)</td>
<td>_</td>
</tr>
<tr>
<td>Whey protein concentrate (%)</td>
<td>_</td>
</tr>
<tr>
<td>Spinach powder (%)</td>
<td>_</td>
</tr>
<tr>
<td>Mint leaves (%)</td>
<td>10</td>
</tr>
</tbody>
</table>

DEVELOPMENT OF EXTRUDED FORTIFIED CORN SNACK PHYSICO-CHEMICAL ANALYSIS

Crude Protein, Total Ash was determined by standard method given by (A.O.A.C., 1980).Crude fiber determined by the method of (A.O.A.C., 1984). Fat and Moisture content was determined by the method given according to (A.O.A.C., 1999). Iron content determined by the method of (A.A.C.C., 2000). Carbohydrate Content was determined by the Anthrone method. Ascorbic Acid Content was determined by titration method.

Sensory evaluation was conducted on 9-point Hedonic Scale. The samples were evaluated on the basis of 3 parameters; Color Taste, Flavor Appearance, Texture. Overall acceptability. The acceptance test was carried out using a structured hedonic scale, with extremes of 1 (disliked extremely) and 9 (liked extremely) to analyze the following attributes: appearance, color, texture, aroma and taste.

The data recording during the course of investigation were subjected to statistical analysis by “Analysis of variance” technique (Fisher and Yates, 1968) for drawing conclusion. Two way ANOVA with replication was done. The significant and non-significant treatment affect was judge with the help of F (variance ratio) table. The significant different between the means was tested against the critical difference at 5% level.

RESULTS AND DISCUSSION

MOISTURE CONTENT

The effect of storage period on the moisture content of extruded fortified corn snack prepared with...
The difference in carbohydrates content in the sample got highest score than other samples due to the lesser moisture content in the sample. Increase in moisture content has been associated with increase in fiber content (Akhtar et al., 2008; Elleuch et al., 2011). The moisture content decreases considerably in different treatments from T0 to T3. A significant increase is observed in all the treatments from T0 to T3 with the increase in shelf life from 0 to 60 days. In treatment T3 it was found that there was a slight increase in moisture content during its storage period which makes it more acceptable as compared to other treatments.

The data clearly indicated that there was slight decrease in protein content of sample T1, T2 & T3 including the control sample T0. The protein content of sample T3 was got higher than sample T2 as shown in Table 3.

This is due to in the present study the formulation is based on different treatment on different ratios of whey protein concentrate added to the sample. From the ANOVA Table it is evident that the calculated value of F due to treatment is greater than the tabulated value at 5 percent probability level. The protein content increases considerably in different treatments from T0 to T3 due to different proportions of whey protein concentrate added to the treatments. A significant decrease was also observed in all the treatments from T0 to T3 with the increase in shelf life from 0 to 60 days. Similar findings were cited by Osundahunsi (2006) in scientific literature.
Fig 4 Protein Content of Extruded Fortified Corn Snack packed in HDPE during storage

FAT CONTENT

The decrease in fat content in extruded snack may be attributed to the development of rancidity as a result of lipids hydrolysis that occurs during storage. The fat deterioration during storage may be attributed to activity of lipase enzyme which split off the fat into free fatty acids and glycerol in the presence of catalyst like moisture, light and heat. From the ANOVA Table it is evident that the calculated value of F due to treatment is greater than the tabulated value at 5 percent probability level. Therefore it can be concluded that significant effect of treatment on fat content of T<sub>2</sub> and T<sub>3</sub> sample was observed at interval of 20 days during the storage days. The fat content increases considerably in different treatments from T<sub>0</sub> to T<sub>3</sub> due to increasing proportions of whey added to the treatments.

<table>
<thead>
<tr>
<th>S.N0</th>
<th>0 DAYS</th>
<th>30 DAYS</th>
<th>60 DAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&lt;sub&gt;0&lt;/sub&gt; (%)</td>
<td>14.67</td>
<td>14.09</td>
<td>13.81</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt; (%)</td>
<td>16.58</td>
<td>16.02</td>
<td>15.85</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt; (%)</td>
<td>18.36</td>
<td>18.15</td>
<td>17.91</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt; (%)</td>
<td>20.51</td>
<td>20.44</td>
<td>20.38</td>
</tr>
<tr>
<td>f-test</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>S.Ed. (±)</td>
<td>0.240527</td>
<td>0.290617</td>
<td>0.150963</td>
</tr>
<tr>
<td>C.D at (0.05)</td>
<td>0.536377</td>
<td>0.648078</td>
<td>0.336648</td>
</tr>
</tbody>
</table>

ASH CONTENT

The ash content increases considerably in different treatments from T<sub>0</sub> to T<sub>3</sub> due to increasing proportions of oat and spinach added to the treatments. A significant decrease was also observed in all the treatments from T<sub>2</sub> to T<sub>3</sub> with the increase in shelf life from 0 to 60 days. Similar results were obtained from the scientific literature by Bhattacharya et al., (1994).

<table>
<thead>
<tr>
<th>S.N0</th>
<th>0 DAYS</th>
<th>30 DAYS</th>
<th>60 DAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&lt;sub&gt;0&lt;/sub&gt; (%)</td>
<td>3.393</td>
<td>3.229</td>
<td>3.021</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt; (%)</td>
<td>5.496</td>
<td>5.399</td>
<td>5.366</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt; (%)</td>
<td>6.978</td>
<td>6.878</td>
<td>6.618</td>
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</tbody>
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sensory attributes of the extruded fortified snack was studied for all the treatments. The shelf life analysis was conducted for two months at an interval of 20 days to evaluate best of the sample among all the treatment.

REFERENCES


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