Abstract
Experiments were conducted in Regional Food Research analysis centre Lucknow. Apple pomace powder was obtained after extracting the juice from apples and then further the pomace obtained was dried in the tray dryer, so that complete drying may be obtained. This was accomplished using various equipments such as tray dyer, soxhlet apparatus etc. After the apple pomace powder was obtained it was incorporated in the bread in various proportions, further physio-chemical analysis was done and it was found that the protein content in the powder was found to be in good quantity. Moisture content, ash content, fiber content was also analysed. Sensory analysis of the developed bread was done on the basis of nine point headonic scale. Shelf life study was also accomplished where not much variation was found during one week storage.

I. INTRODUCTION
Apple (Malus domestica) is the most favored fruit of millions of people and is a widely grown fruit in temperate regions of the globe (Kaushal and Joshi 1995, Kaushal et al. 2002, Agrahari and Khurdiya, 2003). Apple is one of the important fruit crops known to mankind and is produced all over the world in the temperate climate (FAO, 1989). In India, it is grown mainly in the northern states including Himachal Pradesh and Jammu and Kashmir where large scale apple processing plants are located (Shah and Masoodi, 1994). Most of the production of the fruit is used for table purpose but a portion is being processed into various products of which apple juice is processed to a greater extent. The world production of apple is about 58 million tons from an area of about 5.26 million ha (FAO, 2005). Presently, India is the 9th largest producer of apples in the world contributing about one-third of total apple production of the world with an annual production of 1.42 million tons from an area of 0.25 million ha. It is the 4th major fruit
crop of India (GOI ,2004). Apple pomace is a primary by-product of the apple juice industry. It has been estimated that about 25 per cent of the fresh fruit is lost as pomace (Wang and Thomas, 1989). Apple processing is carried out to manufacture numerous food products such as juice, pie, sauce, jams and fresh cuts, which result in significant volumes of waste by-products (Rupasinghe and Kean, 2008). These processes utilize approximately 75% of fresh weight of fruit while 25% is left as waste (Shah et al., 1994). Every year apple processing industries produce more than 5500 tonnes of apple processing by-products in Nova Scotia. Apple processing by-products mainly constitute pomace (containing peel, core, calyx, stem and seed left after juice processing), cores, peels and rejects from processing industry. These under-utilized biomasses represent a major disposal problem for the industry concerned because of their uncontrollable fermentation and high chemical oxygen demand 250-300 g/kg; (Masoodi, 1998). However, these by-products, especially apple pomace, are also rich in both soluble and insoluble carbohydrates and appear to be excellent substrates for bio-processes (Vendruscolo et al., 2008). Apple fibre has been incorporated into cookies, granola bars and muffins to produce high fibre bakery products (Deuel, 1986).

Use of apple pomace has been made through fermentation into several products including citric acid, ethanol, pigment etc. The most promising method for complete utilization of apple pomace may be through solid state fermentation with yeasts, separating out ethanol and using the left over protein rich material after drying as an animal feed. The increasing demand for ethanol for various industrial solvents, cleansing agent, and preservatives has necessitated increased production of this alcohol. Although for many years regarded as a waste product, at present apple pomace should be considered as a source of DF and phenolics. The content of dietary fiber (DF) constitutes is on the average 50% of dry weight, whereas phenolics may vary from 1200 to 4000 mg/kg dry weight [Schieber et al., 2003; Rodriguez et al., 2006]. In recent studies it was found that the use of white flour derived from the processing of whole wheat grain, which is aimed at improving the aesthetic value of white bread, has also led to the drastic reduction in the nutritional density and fibre content when compared to bread made from whole grain cereals Maneju et al., (2011).

II. OBJECTIVE OF THE STUDY
The objectives of this research work are
1) To prepare apple pomace powder and to study its nutritional analysis.
2) To study the physico-chemical and sensory analysis of apple pomace incorporated bread.
3) To study the shelf life of apple pomace incorporated bread.

III. MATERIALS AND METHODS
This chapter describes the material, process manufacturing methods, equipments, experimental setup and test parameters used to accomplish the experimental work done
to attain the desired objectives of the study entitled, ‘Study On The Effect Of Apple Pomace Powder In Bread and Its Shelf Life’. The effect of different proportions of apple pomace flour on the organoleptic parameters, overall acceptability and the shelf life of developed bread were also studied by the experimental studies. The experimental studies were carried out in laboratories of Regional Food Research and Analysis centre, Lucknow.

**Procurement of raw materials**

Good quality of apples and other major ingredients i.e., refined flour, baking powder, were purchased from local market of Lucknow.

**Table 1: Experimental Plan**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameter</th>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Product</td>
<td>1</td>
<td>Bread</td>
</tr>
<tr>
<td>2</td>
<td>Ingredients</td>
<td>4</td>
<td>Refined Flour, Apple Pomace Powder, Salt, Shortening Agent</td>
</tr>
<tr>
<td>3</td>
<td>Processing</td>
<td>2</td>
<td>Extraction of juice, preparation of Pomace powder</td>
</tr>
<tr>
<td>4</td>
<td>Samples</td>
<td>4</td>
<td>T-0 (control), T-1, T-2, T-3</td>
</tr>
<tr>
<td>5</td>
<td>Analysis</td>
<td>3</td>
<td>Physiochemical Analysis, Sensory Analysis, Shelf Life Study</td>
</tr>
<tr>
<td>6</td>
<td>Packaging Material</td>
<td>1</td>
<td>HDPE</td>
</tr>
<tr>
<td>7</td>
<td>Storage condition</td>
<td>1</td>
<td>Ambient temp.</td>
</tr>
</tbody>
</table>

**IV. PREPARATION OF APPLE POMACE POWDER**

Apple Pomace

\[\rightarrow\]

Traying

\[\rightarrow\]

Drying at 55-66° C for 12hr

\[\rightarrow\]

Scraping the dried mats

\[\rightarrow\]

Grinding

\[\rightarrow\]

Packing

*Figure 1: Process flow chart for the preparation of apple pomace powder*
Preparation of Bread

1. **Refined Flour+Apple Pomace Powder**
2. **Sugar** → **Sieve** → **Salt**
3. **Shortening + water** → **Baking powder**
4. **Kneading**
5. **Fermentation (2 hours 30 min)**
6. **Remix (25 sec) and recover (25 min)**
7. **Sheeting**
8. **Moulding and proofing (55 min)**
9. **Baking (217°C for 30 min)**
Table 3: Ingredients used in the preparation of Bread (in g)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameter</th>
<th>T-0</th>
<th>T-1</th>
<th>T-2</th>
<th>T-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Refined Flour</td>
<td>100</td>
<td>80</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>Apple Pomace Powder</td>
<td>00</td>
<td>20</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>Salt</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>Sugar</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Baking Powder</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

V. PHYSIO-CHEMICAL ANALYSIS FOR APPLE POMACE POWDER AND THE DEVELOPED BREAD

**Moisture content**
The moisture content of the developed biscuit was determined by the method described in AACC (2000).

\[
\text{moisture}(\%) = \frac{100(w_1 - w_2)}{w_1 - w} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1)
\]

Where,
- \(W\)=weight in gram of the empty moisture dish.
- \(W_1\)=weight in gram of the moisture dish with the material before drying.
- \(W_2\)=weight in gram of the moisture dish with the material after drying.

**Ash content**
The ash content was determined by the method described in AACC (2000), Method no. 08-01.

\[
\text{total ash mass} = \frac{100(w_2 - w_1)}{w_1 - w} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots (2)
\]

Where,
- \(W\)=weight in gram of the empty dish.
- \(W_1\)=weight in gram of the dish with dried material taken for test.
- \(W_2\)=weight in gram of the dish with the ash.

**Fat content**
The fat content was determined by the method described in AACC (2000), Method no. 30-25.

\[
\text{fat\%} = \frac{\text{wt. of sample after drying} - \text{wt. of empty cup}}{\text{weight of sample taken}} \times 100 \quad \ldots \ldots (3)
\]

**Physical Parameters**
**Spread Ratio**
The spread ratio was determined by using this formula.
Thickness: The thickness was measured in mm by screw gauge.

Volume: Volume of biscuit is defined as the area of the biscuit multiplied by thickness.

\[ volume (cm^3) = \frac{d^2\pi T}{4} \] .......................... (5)

\( t = \) Average thickness of biscuit (mm)  
\( d = \) Diameter of biscuit (mm)

Diameter: The diameter was measured in mm by Vernier caliper.

Density: After calculating volume, density was obtained by ratio of weight of volume (AACC 1983).

\[ density \left( \frac{g}{cm^3} \right) = \frac{mass \ of \ sample (g)}{volume \ of \ sample (cm^3)} \] .......................... (6)

Sensory analysis of developed biscuits
The samples were evaluated on the basis of color, taste, flavor, texture and overall acceptability by a panel of judges using a 9-point hedonic scale.

VI. RESULTS AND DISCUSSION

Proximate analysis of apple pomace powder is presented in Table 4.1. The ash content of apple pomace powder was 1.4% and the moisture content was 6.1%. Apple pomace had a good quantity of protein content i.e., 7.0% and quite low fiber content i.e., 1.33%. The fat content in apple pomace powder was quite low i.e., 0.71%. The calcium content was found to be 8.5%. The iron content was found to be 0.308%.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameter</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Moisture (d.b.)</td>
<td>6.1±0.2</td>
</tr>
<tr>
<td>2</td>
<td>Ash</td>
<td>1.4±0.6</td>
</tr>
<tr>
<td>3</td>
<td>Protein</td>
<td>7.0±0.04</td>
</tr>
<tr>
<td>4</td>
<td>Fiber</td>
<td>1.4±0.2</td>
</tr>
<tr>
<td>5</td>
<td>Fat</td>
<td>1.2±0.1</td>
</tr>
</tbody>
</table>

6.1 Physical parameters of developed bread
The results showed that \( T_0 \) exhibited maximum diameter 4.5 cm, followed by \( T_1 \) (4.47 cm) and \( T_2 \) (4.45 cm) while minimum diameter (4.41 cm) was observed in \( T_3 \). Similarly, \( T_0 \) exhibited maximum thickness (0.86 cm), followed by \( T_1 \) (0.84 cm) and \( T_2 \) (0.84 cm) while minimum thickness (0.83 cm) was observed in \( T_3 \). Spread ratio of \( T_0 \) was (5.23), followed by \( T_1 \) (5.32) and \( T_2 \) (5.29) while (5.25) spread ratio was observed in \( T_3 \). Volume was also found to decrease with increase in the incorporation level of PP i.e., \( T_0 \).
(13.6 cm³), T₁ (13.2 cm³), T₂ (13.1 cm³), T₃ (12.7 cm³). Similarly, density of the developed bread was also found to decrease with increase in the incorporation level of PP i.e., T₀ (0.86 g/cm³), T₁ (0.89 g/cm³), T₂ (0.89 g/cm³), T₃ (0.92 g/cm³).

### Table 5: Physical parameters of developed bread

<table>
<thead>
<tr>
<th>No. of Treatments</th>
<th>Diameter (cm)</th>
<th>Thickness (cm)</th>
<th>Spread Ratio</th>
<th>Volume (cm³)</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀</td>
<td>4.50</td>
<td>0.86</td>
<td>5.23</td>
<td>13.6</td>
<td>0.86</td>
</tr>
<tr>
<td>T₁</td>
<td>4.47</td>
<td>0.84</td>
<td>5.32</td>
<td>13.2</td>
<td>0.89</td>
</tr>
<tr>
<td>T₂</td>
<td>4.45</td>
<td>0.84</td>
<td>5.29</td>
<td>13.1</td>
<td>0.89</td>
</tr>
<tr>
<td>T₃</td>
<td>4.41</td>
<td>0.83</td>
<td>5.25</td>
<td>12.7</td>
<td>0.92</td>
</tr>
</tbody>
</table>

![Figure 3 : Physical parameters of developed bread](image)

### 6.2 Sensory Evaluation of Apple Pomace Incorporated Bread

Bread supplemented by different levels of substitutions of apple pomace flour were sensory evaluated and compared with control bread (100% refined flour). It was evident that there was a significant difference between the treatments due to taste, texture, flavor and overall acceptability. Data indicated that the score of bread containing 20% apple pomace flour were found to be the most acceptable. At 20% level of incorporation, all the attributes scored highest level. The color scores of bread with 20% apple pomace flour reached maximum than to the rest of the proportions similar to the control sample. Thus, incorporation of apple pomace flour at 20% level improved the sensory attributes namely texture, flavor, color and overall acceptability. The nutritional quality of the developed bread was enhanced due to the addition on apple pomace flour. Thus, the
sensory evaluation table 4.4 depicts that highest amount of apple pomace powder that can be incorporated to develop acceptable bread was 20%, i.e. sample T1 was the best regarding all sensory attributes. The results were in conformity with Radhna gupta (2006).

Table 6: Sensory evaluation of developed biscuits

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Colour</th>
<th>Taste</th>
<th>Flavor</th>
<th>Texture</th>
<th>OAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>8.66</td>
<td>8.66</td>
<td>8.00</td>
<td>8.66</td>
<td>9.00</td>
</tr>
<tr>
<td>T1</td>
<td>8.33</td>
<td>8.66</td>
<td>8.33</td>
<td>8.66</td>
<td>8.6</td>
</tr>
<tr>
<td>T2</td>
<td>8.0</td>
<td>8.0</td>
<td>7.33</td>
<td>8.33</td>
<td>8.0</td>
</tr>
<tr>
<td>T3</td>
<td>7.66</td>
<td>7.33</td>
<td>6.66</td>
<td>7.33</td>
<td>7.33</td>
</tr>
</tbody>
</table>

Figure 4 : Sensory parameters of apple pomace incorporated bread

6.3 Physico-chemical analysis of Apple pomace powder incorporated bread during Shelf Life Study

It was observed that there was a significant decrease in the moisture content in samples T0, T1, T2 and T3. During one week storage. Moisture loss might be due to storage conditions and packaging material. The ash content of experiments (T1, T2, T3) was found to increase slightly with the increasing substitution of apple pomace powder. Ash content was found minimum in the control sample (T0). The protein content of experiments (T1, T2, T3) was found to increase with the increasing substitution. The fat content of experiments (T1, T2, T3) was found to decrease with the increasing substitution. Fat content was found maximum in the control sample (T0) because Refined flour contains more amount of fat content as compared to apple pomace powder.

VII. CONCLUSION

It is concluded that highly nutritious bread may be prepared by incorporating a level of 20% of pomace powder without adversely affecting the overall acceptability of the product. Among four treatments the second treatment i.e., 80:20 sample was found to be
the best depending upon different sensory attributes like color, taste, flavor, texture and over all acceptability. This was so because the values for all the sensory attribute was maximum for sample containing 80% refined flour and 20% pomace powder as compared to other treatments. The incorporation of different levels of apple pomace powder in refined flour as well as storage period significantly affected the chemical composition of the developed bread. There was significant increase in ash, moisture, fiber content with increasing levels of apple pomace powder. Protein content was found to increase as the amount of pomace powder was increased in the bread. Thus, all the objective of this study were fulfilled and bread having 20% apple pomace powder was found to be approximately similar results compared with refined flour bread with much better nutrition and taste with satisfactory storage life.

VIII. REFERENCES


TO CITE THIS PAPER