Rheological properties of papaya enriched wheat flour for baked products

Anam Ansari*, Ali Asghar, Aamir Shehzad and Saira Tanweer

National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan

Corresponding author: sairatanweer1116@gmail.com

ABSTRACT

Papaya can be used as fat replacer in the recipes of different food products without any difficulties in processing as well as in the rheological properties. The rheological characteristics of papaya enriched wheat flour indicated that farinograph characteristics (water absorption, dough development time, dough stability time, arrival time and departure time) of flour affected by addition of papaya powder. The study showed that water absorption decreased by the addition of papaya powder. The highest water absorption was recorded in T1 (59.8%) and in T5 minimum absorption (56.6%). The results showed that water absorption, dough development and departure time decreased with the addition of papaya powder. Dough development time was maximum in T1 (3.8 min) and in other treatments it decreased by the increasing level of powder. T5 (25% papaya powder) has less dough stability time (2.6 min) as compared to other treatments, while T0 (control) showed more time (9.4 min). Analysis of variance showed that arrival time showed significant effect as compared to other characteristics which depicted highly significant results. Amylograph results also indicated that peak viscosity time decreased by the addition of powder from 1829 to 1520 BU.

Key Words: Fat replacer, Rheological properties of wheat flour, Farinograph, Amylograph

INTRODUCTION

Papaya, *Carica papaya* Linn is a popular fruit for its food and dietetic perspective all around the globe. *Carica papaya* Linn is the best recognized species among the four genera of family, Caricaceae (Krishna et al., 2008). *Carica papaya* belongs to tropical fruit, having orange-red, yellow-green and yellow-orange hues, and rich orange pulp. Papaya fruit is oblong shape ranging 3-6 inch in length and flesh color ranging from yellow to orange in ripen form (Pomper et al., 1999). Papaya is famous for its nutrition potential as well as whole plant is popular for its medicinal properties (Aravind et al., 2013). Belize rank at 1st position among papaya producing countries with the production of 896,429 Hg/Ha. Papayas are produced in about 60 countries, with the bulk of production occurring in developing economies. Pakistan is at No 50th among papaya producing countries with the production of 51,387 Hg/ Ha in the year 2011.

Nowadays papaya is used in the baked products for the weight conscious persons that seek about the nutrition. The use of composite flours has been advantageous in supplying carbohydrate for human nutrition as well as encouraging better use of local or domestic agricultural products as flour. Papaya based products can also be used as carbohydrate-based and fat-reducing agents in baked food recipes. When papaya puree pulp is used in the preparation of baked foods that it cause to decrease to trans-fatty acid, total fatty acid caloric content and increase overall nutritional value. It was proved from literature that the baked products having 25% papaya were also liked by the consumer (Wiese and Duffrin, 2003).

In baking and other food applications, pectin from fruits forms a film around the tiny air bubbles in the batter. In baked products papaya fruit can be used as carbohydrate based fat replacer (Duffrin et al., 2001) as a natural source of fruit flavor (McGrath and Karahadian, 1994). Particularly in baked products fat imparts flavor, mouth feel as well as it affects the textural properties of the product and consequently its acceptance. Papaya puree can also be used in thermally processed food like jams, jellies, ice cream and other beverage products (Bhattacharya and Rastogi, 1998). Addition of fat alternative in baked products affects the deformation property of baked products. As the level of fat alternative increased, the tenderness of baked products started to decreased. In some types of fat substitutes total fat replacement showed minimum resistant in deformation of baked products.

MATERIAL AND METHODS

Rheological characteristics
The physical properties of flour supplemented with different level of papaya powder, such as water absorption, dough development time, dough stability time, mixing tolerance index and softening of dough was studied by Brabender Farinograph according to their respective method as outlined in AACC (2000).

1. Farinograph studies
Brabender Farinograph was used to prepare the farinograms of the treatment flour according to the instructions provided in AACC (2000) Method No. 54-21. Farinograph equipped with a bowl of 50 g capacity was used and constant flour weight method was employed. The parameters given in AACC (2000) were interpreted from each farinogram according to the instructions as detailed below.

a. Water absorption
Water absorption is the percentage of water required to reach at the center of curve on 500 Brabender Unit (BU) at maximum consistency of the dough.

b. Dough development time
This is the time required for the curve to reach its full development or maximum consistency. High peak values are usually associated with the strong wheat, which have longer mixing times.

c. Dough stability time
This is the time that top of the curve remains above the 500 BU lines and is measured from arrival time to departure time. Greater tolerance would indicate that the flour can stand for more mixing and longer fermentation conditions.

d. Mixing tolerance index (MTI)
This is an indication that how fast the flour will break down after it has reached its full development time. It is measured in Brabender Unit (BU) from the height of the curve at its peak to height of curve five minutes after the peak.

e. Softening of dough (SOD)
It is measured in Brabender Unit (BU) from the height of the curve at its peak to the height of curve twelve minutes after the peak.

f. Arrival time
The arrival time was noted as the time from the start of the graph to the top of the curve first intersected the 500 BU lines.

g. Departure time
This was observed as the time interval from the start of the curve until the top of the curve started to decline from 500 BU lines.

2. Amylograph studies
Amylograph characteristics of flour are related to heating behavior of the starch content of the flour. Alpha amylase activity was studied for index for biochemical change in BU. According to the method No. 22-12 given in AACC (2000) the straight grade flour sample and blend (flour+ papaya powder) was run through Brabender- visco. Amylograph equipped with 65 g capacity bowl to determine dough characteristics. A sample of 65 g of flour was combined with 450 ml of distilled water and mixed to make slurry. The slurry was stirred while being heated in the amylograph, beginning at 30ºC and increasing at constant rate of 1.5ºC per minute until the slurry reaches 95ºC. The amylograph was recorded the resistance to stirring as a viscosity curve on graph paper. Peak viscosity was the maximum resistance of a heated flour and water slurry to mixing with pins. It was expressed in Brabender Units (BU).

RESULTS AND DISCUSSION
Rheological analysis
1. Farinograph studies
The rheological characteristics of flour containing various level of papaya powder were studied for water absorption, dough development time, departure time, arrival time and dough stability time by using Brabender Farinograph. The data pertaining to the effect of various concentration of papaya powder on farinograph characteristics of flour is presented in Table 2.

a. Water absorption
Water absorption related to the capacity of flour to absorb water. The data pertaining to the analysis of variance showed in (Table 1). The data indicated that there was a significant difference among treatments. The data about water absorption indicated that there was a significant difference among treatments regarding water absorption. It is obvious from the mean values of data that the water absorption capacity for control flour was 58.3% (Table 2). Data showed that water absorption was higher in T₁ followed by T₂, T₆, T₃, T₄ and T₅. The highest water absorption was in T₁ (59.8%) and in T₃ lowest water absorption (56.6%) was observed. The result revealed that the water absorption decreased with the addition of papaya powder. Likewise Vijayalakshmi and Malathi (2010) studied the papaya fortified spaghetti to combat vitamin A deficiency. They concluded that water absorption decreased with the increase of papaya powder.

b. Dough development time
It is the time required for the development of gluten. The data pertaining to the analysis of variance for dough development time is given in Table 1. The data indicated that there was a significant difference among treatment regarding the DDT. Dough development time was found to be in the range of 4.3 to 1.7 min. Mean values presented in Table 2. The values obtained in this study are in line with the findings of Azizi and Rao (2004). The results are also in close agreement to the findings of Ahmad (2002) and Sim et al., (2009).

Table 1: ANOVA for farinograph characteristics of flour containing papaya powder

<table>
<thead>
<tr>
<th>SOV</th>
<th>df</th>
<th>Water absorption (%)</th>
<th>Dough development time (min)</th>
<th>Dough stability time (min)</th>
<th>Arraiival time (min)</th>
<th>Departure time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments</td>
<td>5</td>
<td>3.76**</td>
<td>2.22**</td>
<td>20.59**</td>
<td>0.13*</td>
<td>13.98**</td>
</tr>
<tr>
<td>Error</td>
<td>12</td>
<td>0.108</td>
<td>0.05</td>
<td>0.07</td>
<td>0.036</td>
<td>0.12</td>
</tr>
</tbody>
</table>

*=Significant **=Highly Significant

Table 2: Farinograph characteristics of flour containing papaya powder

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Water Absorption (%)</th>
<th>Dough development time</th>
<th>Dough stability time (min)</th>
<th>Arrival time (min)</th>
<th>Departure time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀</td>
<td>58.3c</td>
<td>1.7d</td>
<td>9.4a</td>
<td>1.4c</td>
<td>10.5a</td>
</tr>
<tr>
<td>T₁</td>
<td>59.8a</td>
<td>3.8a</td>
<td>4.4b</td>
<td>2.0a</td>
<td>6.3b</td>
</tr>
<tr>
<td>T₂</td>
<td>59.1b</td>
<td>3.4ab</td>
<td>3.5c</td>
<td>1.3c</td>
<td>5.7bc</td>
</tr>
<tr>
<td>T₃</td>
<td>58.7bc</td>
<td>3.2ab</td>
<td>3.2cd</td>
<td>1.5abc</td>
<td>5.4c</td>
</tr>
<tr>
<td>T₄</td>
<td>57.5d</td>
<td>2.7c</td>
<td>2.9de</td>
<td>1.5c</td>
<td>5.0d</td>
</tr>
<tr>
<td>T₅</td>
<td>56.6e</td>
<td>1.9d</td>
<td>2.6e</td>
<td>1.7ab</td>
<td>4.5d</td>
</tr>
</tbody>
</table>

Means carrying same letters do not differ significantly.
T₀= (control)
T₁= (5% papaya powder)
T₂= (10% papaya powder)
T₃= (15% papaya powder)
T₄= (20% papaya powder)
T₅= (25% papaya powder)
Table 3: ANOVA for peak viscosity

<table>
<thead>
<tr>
<th>SOV</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments</td>
<td>5</td>
<td>163707</td>
<td>32741.3</td>
<td>14.1**</td>
</tr>
<tr>
<td>Error</td>
<td>12</td>
<td>27887</td>
<td>2323.9</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>191593</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**=Highly Significant

Table 4: Amylograph characteristics of flour containing papaya

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Peak Viscosity (BU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀</td>
<td>1829±80.47\textsuperscript{a}</td>
</tr>
<tr>
<td>T₁</td>
<td>1770±77.8\textsuperscript{b}</td>
</tr>
<tr>
<td>T₂</td>
<td>1680±73.92\textsuperscript{c}</td>
</tr>
<tr>
<td>T₃</td>
<td>1641±72.2\textsuperscript{d}</td>
</tr>
<tr>
<td>T₄</td>
<td>1560±68.64\textsuperscript{e}</td>
</tr>
<tr>
<td>T₅</td>
<td>1520±66.88\textsuperscript{f}</td>
</tr>
</tbody>
</table>

Means carrying same letters do not differ significantly.

T₀= (control)  
T₁= (5% papaya powder)  
T₂= (10% papaya powder)  
T₃= (15% papaya powder)  
T₄= (20% papaya powder)  
T₅= (25% papaya powder)
c. Dough stability time

Analysis of variance related to departure time showed in Table 1. Result pertaining highly significant difference among treatments. The data relating to dough stability time is presented to Table 2. The result showed that there is a momentous significance difference among treatments. Dough stability time decreased as the papaya powder level increases. The maximum dough stability time was observed in T0 followed by T1, T2, T3, T4 and T5.

The results of present study are proved by the study of Vijayalakshmi and Malathi (2010). They concluded that peak viscosity and temperature at peak viscosity both decreased with the increase of papaya powder. Similarly Sudha et al. (2007), found that by adding apple pomace as dietary fiber in baked products decreased the dough stability time, indicating weakening of the dough.

d. Arrival time

The point on the graph where the top of the curve reaches the 500 BU line is the arrival time. It is the measurement of the rate at which water is taken up by the flour. The increase in protein gluten of wheat is affective on the arrival time. Analysis of variance related to departure time showed in Table 1. Table showed significant difference among treatments. The result pertaining the arrival time of treatment showed in Table 2. The maximum arrival time is for T5 (4.7 min) and minimum for T3 (1.5 min).

e. Departure time

The departure time was observed as the time interval from the start of the curve to reach the point where the top of the curve left 500 BU line. The statistical analysis of departure time is presented in Table 1. ANOVA showed highly significant difference among treatments, while means are shown in the Table 2. Departure time varied from 10.5-4.7 minutes among treatments. T0 showed maximum time (10.5 min) and T3 showed minimum of 3 min.

2. Amylograph

The amylograph represents the starch content of the flour and its behavior during heating. Amylograph points out the alpha amylase activity during gelation period of starch. In present research work wheat flour was substituted with papaya powder that reduces the amylase activity. Alpha amylase activity observed to decrease. The decrease in peak viscosity is due to the increase in powder level in flour. Table 3 showed the statistical analysis of amylograph. The result showed a significant difference among treatments related to peak viscosity. The peak viscosity time was observed and it was noted that peak viscosity decreased from 1829 to 1520 BU. It showed that as the level of fiber increased, peak viscosity started to decreased. The result related to amylograph showed in Table 4.

Suyong et al., (2005) studied the effect of shortening on physical and rheological properties of baked products. They concluded that peak viscosity decreased as the level of shortening increased. The results are proved by the findings of Sudha et al. (2007.) It is depicted from the study that amylase activity decreased with the increase of fiber content from 950 to 730 BU while the viscosity also reduced from 1760 to 970 BU respectively. Likewise Vijayalakshmi and Malathi (2010) studied the papaya fortified spaghetti to combat vitamin A deficiency. They concluded that peak viscosity and temperature at peak viscosity both decreased with the increase of papaya powder.

REFERENCE

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