Effect of drying process and partial substitution of wheat flour with cassava flours at different ratios on rheological properties and anti-nutritional factors

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Accepted 17 February, 2014

ABSTRACT

The aim of this study was to explore the effects of drying process and partial substitution at different ratio on rheological properties of cassava-wheat composite flour dough and also to determine the effect of drying process on anti-nutritional factors of Quelle and Kello varieties cassava flours which were obtained from Hawassa agricultural research center. The data were statistically analyzed using analysis of variance (ANOVA) in completely randomized design (CRD). The level of cyanide was found to be 1.99±0.06 mg/100g in each oven dried chips of both varieties resulted in flours whereas 2.49±0.74 and 1.64±0.08 mg/100g in sun dried Quelle and Kello cassava flour samples, in the given order. Furthermore, the level of phytate was found to be 3.88±0.0 and 3.62±0.11 mg/g in oven dried Kello and Quelle flour samples, respectively while 4.6 ±0.07 and 4.41±0.11 mg/g in sun dried Kello and Quelle flour samples, in the given order. The results showed that, the highest value of water absorption and tolerance index of composite dough samples was recorded 74.10 % and 591.50 FU for 30% sun dried Kello flour containing sample whereas the lowest was 52.5% and 36.50 FU for 10 % oven dried Kello flour, respectively. Furthermore, the highest value of dough development time, dough stability time, Time to breakdown and Farinograph quality number of composite dough samples were 5.60 min, 6.05 min, 7.50 min and 75.00 for 30% oven dried Quelle cassava flour containing sample, respectively whereas the lowest was 1.60 min, 1.10 min, 2.55 min and 25.50 for 10 % sun dried Kello flour containing samples, in the given order. It could be concluded that the substitution of cassava flour with wheat flour in dough making with substitution level up to 20 % did not adversely affect the quality farinograph properties of the dough and comparable to that produced from wheat dough.

Keywords: Anti-nutrition, cassava-wheat composite flour, drying process and farinograph properties.

INTRODUCTION

Cassava (Manihot esculenta Crantz) is the major food crop produced in many tropical regions of the developing world. It is providing energy to consumers due to the large amount of carbohydrates in its roots and the third most important food source in the tropics after rice and maize especially for developing countries in Africa, Asia and Latin-America. It has advantages over other crops particularly; in many of the developing world is its outstanding ecological adaptation, low
labor requirement, ease of cultivation, high yields, drought tolerant crops and successfully grown on marginal soils, where many other crops do not grow well (O’Brien et al., 1992). The major drawbacks of the cassava crop are the low tuber protein content, rapid tuber perishability following harvest, and high content of the cyanogenic glucosides.

In Ethiopia, this crop has been cultivated in the southern and southwestern regions for decades as an alternative food insecurity crop (Taye, 2000; Desse and Taye, 2001). In the Southern Ethiopia, particularly in Amaro-Kello area, cassava is almost used as a staple food. In Wolayta and Sidama Zone, cassava roots are widely consumed after washing and boiling or in the form of bread or “injera” (Ethiopia staple food) after mixing its flour with that of some cereal crops such as maize (Zea mays), wheat (Triticum aestivum L.), sorghum (Sorghum bicolor), or teff (Eragrostis tef) (Taye, 1994). Processing methods, storage experience and modes of consumption are not yet customized unlike most of cassava producing and consuming African countries. Cassava is one of the underutilized root crops in the country. The crop has been used in south western areas of Ethiopia mainly to tackle seasonal food shortage. Currently, some cassava varieties are being promoted in food insecure northern areas of Ethiopia. However, the distribution of the cultivars is not supported with proven food preparation techniques to increase nutrient density and cyanogenic free cassava based foods without affecting consumers taste.

Cassava flour is a good substitute for wheat flour in bread making (Essien, 2006). On the light of this, cocoyam, cassava, taro and other tuber crops have been found to be alternative sources of major raw materials for bread making (Giami et al., 2004). Most developing countries including Ethiopia are largest importer of American red winter wheat (Edema et al., 2005). This implies that these countries are dependent on foreign country for their bread production. Therefore the use of cassava flour for production of baked foods if feasible would help to lower the dependency of developing nations on imported wheat. The present study was therefore, mainly envisaged to explore the effect of drying process (sun and oven) on anti-nutritional factors of Qulle and Kello varieties cassava flours which were collected from Hawassa agricultural research center and to investigate the effect of drying process and partial substitution at different ratio on rheological properties of cassava-wheat composite flour dough.

MATERIALS AND METHODS

Materials

Commercial hard wheat flour was purchased from factory of Hawassa Flour Share Company, Ethiopia. About 100 kg Matured Qulle and Kello varieties of cassava (Manihot esculenta Crantz) roots was obtained from Hawassa Agricultural Research center (HARC), Ethiopia and then were processed with different drying methods (sun-dried and oven dried).

Experimental treatments and design

The experiment was conducted under three level of blending ratios [0:100 % as control, 10: 90 %, 20: 80 % and 30: 70 %], two cassava varieties (Qulle and Kello) and two drying methods (sun and oven). Factorial experiment with twelve treatment combinations and one reference (control) was arranged in a completely randomize design (CRD) with three replications.

Processing of cassava flours

Cassava (Qulle and Kello varieties) were thoroughly washed (separately), peeled, washed again, drained, sliced, soaked in water for 24 hours, blanched (100°C for 2 min), drained, oven dried (LCON53CF, Genlab, England) at 105°C for 24 hr and sun dried for 3 days, milled, sieved (0.35 mm mesh size) and packaged flour in well labeled polyethylene bag until used for composite flour preparation.

Composite flour preparation

Six blends were prepared by homogenously mixing Qulle flour and Kello flour, respectively with wheat flour in the following percentage proportions: 10:90, 20:80 and 30:70.

Determination of Anti-nutritional Factors

Analysis of total HCN

Hydrogen cyanide contents were determined using the alkaline picrate paper method as described by Bradbury (1999). Two grams of cassava flour samples was prepared into a paste and dissolved in 20 ml distilled water in test tubes. It was allowed to stay overnight. The solution was later filtered for cyanide determination. Five milliliters of the filtered solution was transferred into 10 ml test tubes. A calibration curve was prepared by dissolving various concentrations (0.0 to 2 ml stock) of KCN in distilled water. The absorbance of the solution was measured at 510 nm using a spectrophotometer (6505 uv/vis spectrophotometer, Model 6505, U.K, GENWAY) after immersing the exposed alkaline picrate papers (prepared from 1.4 g of crystal picric acid and 100 ml of sodium carbonate solution, made by dissolving 2.5 g of sodium carbonate in 100 ml of water) to the sample for about 30 min with occasional vortex mixing. The absorbance of the blank solution obtained by
immersing picrate paper without exposure to the sample was also measured at the same wave length for the sample. The absorbance of the blank was subtracted from the sample. The total HCN content in mg/100g was calculated by the equation (Bradbury et al., 1999).

Total HCN content (mg/100g) = 396 × absorbance

Phytic acid analysis

Phytic acid was determined through phytate phosphorus (Ph-p) analysis by the method described by Wheeler and Ferrel (1971). About 0.25 g of flour sample was extracted with 12.5 ml of 3% trichloroacetic acid for 45 min in a water bath (GLS 400 water bath, England) with vortex mixing (REAX top, Germany) at ambient temperature (230°C) and centrifuged (4000 rpm/10 min) (Centurion scientific Model 1020 DE, United Kingdom). The supernatant was used for phytate estimation. About 4 ml of 0.03 % FeCl3 was added to 10 ml of the sample solution and centrifuged. The clear supernatant was carefully decanted and the precipitate was washed by 20 ml of 3% TCA, 0.2 M of HCl and 20 ml distilled water. The precipitate was digested by concentrated H2SO4 and H2O2 (30%). Digestion converts the phosphorus into phosphate. The phosphate generated was analyzed by measuring the absorbance of phosphomolybdate blue generated on addition of ammonium molybdate [(NH4)6Mo7O24.4H2O] (Morrison, 1964). Aliquots of 0.0 to 1.2 ml stock (0.1 mg KH2PO4 with 250 ml H2O) were diluted to 20 ml for calibration curve and P level was analyzed as for the sample. The absorbance at 822 nm was read using spectrophotometer (6505 uv/vis spectrophotometer, Model 6505, U.K, and GENWAY). The absorbance for sample was subtracted from the blank and phosphorus level was estimated from the calibration curve. Then phytate was estimated from phytate phosphorus (i.e., phytate = P × 3.55).

Rheological property analysis of cassava-wheat composite flour dough

Water absorption (WAB in %), dough development time (DDT in min), dough stability time (DST in min), mixing tolerance index (MTI in FU), time to break down (TBD in min) and farinograph quality number (FQN) of dough prepared from the composite flours were determined using a Brabender Farinograph (T150 Electronic, Brabender Ohgdiusburg, Germany) equipped with a 50 g stainless bowl (method 54-21 AACC, 2000). Dough was made from 300 g of each composite flour with 100 ml of warm water filled inside a burette. The water is allowed to drop gradually into flour in mixing bowl where it formed dough with the aid of 2 z-shaped mixing blades, after which the remaining water in the burette is measured. The dynamometer of the farinograph was connected to a lever and scale system, and to a pen which traces a curve on a Kymograph chart.

Statistical Analysis

All the values reported are means of triplicate readings. The data were statistically analyzed using analysis of variance (ANOVA) in completely randomized design (CRD). Duncan multiple range test was used the test of significance to separate the means at $p <0.05$. Statistical analysis was carried out using the SAS (Version 9.0) system.

RESULTS AND DISCUSSIONS

Anti-nutritional Factors of Cassava Flour

The anti-nutritional factors are presented in Table 1 and figure 1 of Qulle and Kello cassava flour samples. Cyanide content was significantly (P≤0.05) affected by sun and oven drying process. Among the cassava flours, the highest HCN content (2.49 mg/100g) and the lowest HCN content (1.64 mg/100g) occurred to the sun dried Kello and Qulle variety of cassava flours, respectively. The oven dried chips of both varieties resulted in flours of 1.99 mg/100g HCN each. Kello flour was found to have the highest levels of cyanogenic potential within the range of 10 ppm (FAO/WHO, 1991) of the samples analyzed which could have been due to relatively inadequate post-harvest handling undertaken before the processing of flour and the variations of varietal. When the two processing methods are compared in terms of anti-nutrients reduction oven drying process was observed to be very effective processing method for optimum anti-nutrients reduction. The content of cyanide in the present study is less than 2.76 to 2.05 mg HCN/kg for raw and fermented cassava flour, respectively reported by (Enidiok et al., 2008). Similar results were also reported by many workers including Gomez et al. (1984) who obtained a reduction of 40 to 60 % after 3 days of sun drying and 75.41 % reduction by fermentation followed by sun drying (Tivana and Bvochora, 2005). Thus reduction of HCN content in cassava flours may be due to peeling and soaking of cassava tuber besides drying processes.

Among the sample of cassava flours those produced from sun dried chips of both varieties have the highest and significantly (p<0.05) different means as compared to the flours of oven dried chips of both varieties. The Kello variety flour was exhibited the higher acid content (3.88 mg/g) relative to the Quille flour which had acid content of 3.62 mg/g. The phytic acid contents of both varieties of cassava flour are found to be comparable to the values reported by Edeogu and Ekuma, (2007), which ranges from 253 to 400 mg/100g. The phytate concentration reported (67.4 mg/100g to 73.4 mg/100g) by Oboh and Elusiyan, (2007), for cassava flour is less than from the phytate content of the present study. Cassava flours analyzed is nutritionally limited due to its high phytate content as phytates have the potential to bind nutrients limiting bio-unavailability.
Table 1. Effect of drying process on anti-nutritional factors of both varieties of cassava flours

<table>
<thead>
<tr>
<th>Samples</th>
<th>Phylic acid (mg/g)</th>
<th>HCN (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKv</td>
<td>3.88±0.07</td>
<td>1.99±0.06</td>
</tr>
<tr>
<td>OQv</td>
<td>3.62±0.11</td>
<td>1.99±0.03</td>
</tr>
<tr>
<td>SKv</td>
<td>4.60±0.07</td>
<td>2.49±0.07</td>
</tr>
<tr>
<td>SQv</td>
<td>4.41±0.11</td>
<td>1.64±0.24</td>
</tr>
<tr>
<td>Mean</td>
<td>58.43</td>
<td>1.64</td>
</tr>
<tr>
<td>CV (%)</td>
<td>2.79</td>
<td>8.67</td>
</tr>
</tbody>
</table>

Results are mean values of triplicate determination (dwb) ± standard deviation. Means with the same superscript letters within a column are not significantly different (p>0.05). SKv= Sun dried Kello variety flour, OQv= Sun dried Quille flour, OKv = Oven dried Kello flour, OQv = Oven dried Quille flour, CV= Coefficient Variance, HCN= Hydrogen cyanide.

Rheological properties of cassava-wheat composite flour dough

The rheological behaviors were analysed by using Brabender Farinograph in terms of water absorption (%), dough development time (min), dough stability (min), Tolerance Index (MTI) (FU), Time to breakdown (min) and Farinograph Quality Number of composite flour dough’s samples. The farinograph characteristics are presented in Table 2 and figure 2 of Quille and Kello cassava/wheat composite flours dough samples.

Water absorption (WAB)

The highest value of water absorption was recorded 72.80±1.0 % for 30 % sun dried Quille flour mixed dough while the least was 52.50±0.1% for 10% oven dried Kello flour mixed dough sample. The water absorption values of all composite flour dough’s were statistically higher than that of wheat flour dough sample (51.35%). The values of water absorption in composite flour dough are increased with every increment of cassava flours. The increase in the water absorption of the composite flour may be attributed to the higher fiber and carbohydrate contents with increasing amounts of cassava flour substitution. The ability of cassava flour to absorb water has a significant correlation with its carbohydrate content. Several studies also reported that the dough made from composite flour absorbed more water than that made from wheat flour alone (Lee et al., 2001 and Morita et al., 2002). The absorption of more water during mixing is a typical characteristic of composite starches (Doxastakis et al., 2002). Increase in water absorption lead to the weakened dough and decrease dough development and dough stability time (Singh et al., 2008). Khalil et al. (2000) reported that addition of cassava flour to wheat flour increase water absorption and development time.

Development time

Development time is the time from the first addition of water to the time the dough reaches the point of greatest torque. During this phase of mixing, the water hydrates the flour components and the dough is developed. This parameter was significantly affected by drying process, variety and
Table 2. The effects of drying process and blending ratio on the farinograph properties of cassava (Quelle and Kello) with wheat composite flour doughs

<table>
<thead>
<tr>
<th>Treatments</th>
<th>WAB (%)</th>
<th>DDT (min)</th>
<th>DST (min)</th>
<th>MTI (FU)</th>
<th>TBD (min)</th>
<th>FQN</th>
</tr>
</thead>
<tbody>
<tr>
<td>OB1Kv</td>
<td>52.50±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.50±0.20&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.25±0.55&lt;sup&gt;c&lt;/sup&gt;</td>
<td>36.50±1.50&lt;sup&gt;g&lt;/sup&gt;</td>
<td>3.80±0.80&lt;sup&gt;c&lt;/sup&gt;</td>
<td>38.00±8.00&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>OB1Qv</td>
<td>52.55±0.25&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.30±0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.00±0.40&lt;sup&gt;c&lt;/sup&gt;</td>
<td>39.50±1.50&lt;sup&gt;g&lt;/sup&gt;</td>
<td>3.55±0.75&lt;sup&gt;a&lt;/sup&gt;</td>
<td>35.50±7.50&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>OB2Kv</td>
<td>55.55±0.05&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.55±0.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.80±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>63.00±1.00&lt;sup&gt;i&lt;/sup&gt;</td>
<td>2.40±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>24.00±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>OB2Qv</td>
<td>56.35±0.95&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.45±0.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.65±0.15&lt;sup&gt;c&lt;/sup&gt;</td>
<td>58.50±1.50&lt;sup&gt;i&lt;/sup&gt;</td>
<td>2.50±0.10&lt;sup&gt;e&lt;/sup&gt;</td>
<td>25.00±1.00&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>OB3Kv</td>
<td>56.60±0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.00±0.20&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.85±0.25&lt;sup&gt;b&lt;/sup&gt;</td>
<td>72.00±1.00&lt;sup&gt;i&lt;/sup&gt;</td>
<td>6.95±0.05&lt;sup&gt;e&lt;/sup&gt;</td>
<td>69.50±0.50&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>OB3Qv</td>
<td>56.30±0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.60±0.10&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.05±0.45&lt;sup&gt;b&lt;/sup&gt;</td>
<td>64.50±0.50&lt;sup&gt;i&lt;/sup&gt;</td>
<td>7.50±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>75.00±1.00&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>SB1Kv</td>
<td>54.95±3.85&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.60±0.40&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.10±0.10&lt;sup&gt;c&lt;/sup&gt;</td>
<td>115.00±3.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.55±0.15&lt;sup&gt;e&lt;/sup&gt;</td>
<td>25.50±1.50&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>SB1Qv</td>
<td>58.95±0.75&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.20±0.20&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.25±0.15&lt;sup&gt;c&lt;/sup&gt;</td>
<td>132.00±5.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.80±0.10&lt;sup&gt;e&lt;/sup&gt;</td>
<td>28.00±1.00&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>SB2Kv</td>
<td>64.45±0.65&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.85±0.15&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.75±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>309.50±13.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.30±0.10&lt;sup&gt;cde&lt;/sup&gt;</td>
<td>33.00±1.00&lt;sup&gt;cde&lt;/sup&gt;</td>
</tr>
<tr>
<td>SB2Qv</td>
<td>63.10±0.40&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.10±0.10&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.00±0.10&lt;sup&gt;d&lt;/sup&gt;</td>
<td>189.00±2.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.70±0.10&lt;sup&gt;cde&lt;/sup&gt;</td>
<td>27.00±1.00&lt;sup&gt;cde&lt;/sup&gt;</td>
</tr>
<tr>
<td>SB3Kv</td>
<td>74.10±1.60&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.30±0.20&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.65±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>591.50±2.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.45±0.15&lt;sup&gt;d&lt;/sup&gt;</td>
<td>24.50±1.50&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>SB3Qv</td>
<td>72.80±1.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.30±0.10&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.10±0.20&lt;sup&gt;d&lt;/sup&gt;</td>
<td>518.50±2.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.45±0.05&lt;sup&gt;cde&lt;/sup&gt;</td>
<td>24.50±0.50&lt;sup&gt;cde&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cont.</td>
<td>51.35±0.75&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.20±0.00&lt;sup&gt;d&lt;/sup&gt;</td>
<td>12.25±2.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17.50±6.50&lt;sup&gt;n&lt;/sup&gt;</td>
<td>18.65±1.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>186.50±13.50&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mean</td>
<td>59.20</td>
<td>2.46</td>
<td>3.22</td>
<td>169.77</td>
<td>4.74</td>
<td>47.38</td>
</tr>
<tr>
<td>CV (%)</td>
<td>2.15</td>
<td>6.93</td>
<td>6.54</td>
<td>10.35</td>
<td>10.35</td>
<td>10.35</td>
</tr>
</tbody>
</table>

Means in column followed with the same letter are not significantly different (P>0.05), WAB= Water absorption, DDT (min) = Dough Development time, DST (min) = Dough Stability time, MTI (FU) = Mixing Tolerance Index (MTI), TBD (min) = Time to breakdown, FQN = Farinograph quality number, Cont. = control (100 % wheat flour dough), (OB1Kv, OB2Kv and OB3Kv) = Dough from 10:90 %, 20:80 % and 30:70 % oven dried Kello variety cassava flour blended with wheat, respectively, (OB1Qv, OB2Qv and OB3Qv) = Dough from 10:90 %, 20:80 % and 30:70 % oven dried Quelle variety cassava flour blended with wheat, respectively, (SB1Kv, SB2Kv and SB3Kv) = Dough from 10:90 %, 20:80 % and 30:70 % sun dried Kello variety cassava flour blended with wheat, respectively, (SB1Qv, SB2Qv and SB3Qv) = Dough from 10:90 %, 20:80 % and 30:70 % sun dried Quelle variety cassava flour blended with wheat flour, respectively, Cv = coefficient variance.
The highest value of dough development time was recorded 5.60±0.1 min for 30% oven dried *Quelle* flour composite dough's and the lowest 1.30±0.0 min was for 10% oven dried *Quelle* flour containing dough's. The dough development time of the highest level of cassava flour (oven dried of both varieties) composite dough's was statistically higher than that of the control wheat flour dough (2.20 min). Increase in dough development time with addition of cassava.
flours may be due to higher fiber content of cassava flour, which picked up water slowly (Pomeranz et al., 1977). This is also may be due to decrease in their gluten contents and weakening of protein network due to proteolytic activity of composite flours.

**Dough stability time**

Dough stability time is the time in minutes during which the curve remains on 500 BU line. The longest dough stability time 5.85 min and 6.05 min were recorded for 30% oven dried Kello (OB3Kv) and Quille (OB3Qv) varieties of cassava flour composite dough’s. However, the highest two and significantly different from the rest of the data are 5.85 and 6.05 min of OB3Kv and OB3Qv, respectively. The shortest stability time 1.10 min was recorded for 10% sun dried Kello variety of cassava flour composite dough. The dough stability time of composite flour composite dough’s was significantly (p<0.05) lower than that of the control wheat flour dough (12.25 min). The dough stability time decreased as the blending ratio of both Quille and Kello varieties of cassava flour increased in white wheat flour due to the decrease in wheat gluten content. Similar results were obtained by Khalil et al., (2000) who found that the dough stability time of wheat flour substituted with cassava flour increased.

**Mixing tolerance index (MTI)**

The tolerance index (MTI) values clearly shows distinctions between those flours with oven dried cassava and sun dried cassava, with significantly differences (p<0.05) between the groups, within the composite flours having oven dried cassava those with the lowest cassava proportion (10 %) had significantly lower MTI 36.50 and 39.50 FU for Kello and Quille varieties, respectively than those of with higher proportions. The composite flours formed from sun dried cassava exhibited generally much higher MTI than those with oven dried cassava within this second group statistically the highest MTI (591.50 FU) occurred to the composite flour of sun dried Kello variety having the highest proportion (30 %) and the following very high value (518.50 FU) was recorded for composite flour of sun dried variety of the highest proportion (30 %). Significant differences were also noted between the MTI values of the other remaining values of this group. The MTI of cassava flour composite dough’s was significantly (p<0.05) higher than that of the control wheat flour dough (17.50 FU). The data showed that sun drying resulted in considerably high values of MTI for the dough’s

**Time to breakdown (TBD)**

The longest time (6.95 min) to breakdown of composite flour dough’s was recorded for 30 % oven dried Kello (OB3Kv) and 7.5 min for Quille (OB3Qv) varieties of cassava flour composite dough’s. The shortest time (2.4 min) was obtained for 20 % oven dried Kello (OB2Kv) variety of cassava flour composite dough’s. The time to breakdown (18.65 min) of control wheat flour dough was significantly higher than those of the composite flour dough’s. The time to breakdown of composite flour dough’s increased as the cassava flours proportion increased in wheat flour with respect to varieties and drying process.

**Farinograph quality number (FQN)**

The highest FQN (75) was observed for treatment combination with 30% oven dried Quille (OB3Qv) and 69.5 for Kello (OB3Kv) variety of cassava flour composite dough’s. The lowest values (24 to 25) were OB2Kv, OB2Qv, and SB3Kv and SB3Qv varieties of cassava flour composite dough’s. The farinograph quality number of white wheat flour (186.50) was significantly higher than those of the composite flour dough’s. The farinograph quality number of composite flour dough’s increased as the cassava flours blending ratios increased in wheat flour. Dough stability is affected due to the increased farinograph quality number.

**CONCLUSIONS**

The present study showed that the farinograph properties and anti-nutritional factors were significantly affected by drying process and partial substitution of both cassava varieties (Quille and Kello) at different ratio in wheat flour. The hydrogen cyanide (HCN) levels of the flours which were prepared from two cassava varieties were found below the maximum allowable limit (10ppm) by FAO and thus safe for human consumption. This indicates that there is efficiency in the method that is used for drying of cassava into flour rendering it safe for consumption. The water absorption, dough development time, mixing tolerance index and farinograph quality number of composite flour dough’s were influenced as the cassava flours level increased in wheat flour. The substitution of cassava flour with wheat flour with substitution level up to 20 % did not adversely affect the quality properties of dough; comparable to that produced from wheat flour in the farinograph properties. Studied cultivars from Hawassa Agricultural Research Center (HARC) had low cyanide levels which were all below the WHO/FAO recommendations (<10 mg cyanide
equivalents/kg on dwb) and thus could all be safely recommended for consumption without acute toxicity to humans. Utilization of cassava flour composite product should be advised for human consumption in order to ameliorate food security situation and improve nutrient density of cassava based foods. When the two processing methods are compared in terms of anti-nutrients reduction, oven drying was observed to be very effective processing method for optimum anti-nutrients reduction. The substitution of cassava flour with wheat flour in dough making with substitution level up to 20% did not adversely affect farinograph properties of the dough and comparable to the quality that produced from wheat dough.

ACKNOWLEDGEMENT

Authors thank Hawassa Agricultural Research Centre (HARC), for supplying the cassava roots samples used in this work, the Ministry of Education of the Government Ethiopia for granting financial support and Food Science and Postharvest Technology Department of Haramaya University for the all rounded support in providing reagents, chemicals and all their laboratory facilities.

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