Production and Characterization of Juice Produced from Ethiopian Finger Millet

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Abstract

The study was conducted to produce and characterize juice from kebezo finger millet. Finger millet is one of the important crops in the semiarid tropics of Asia and Africa being best grows in low rain fall about 500-1000 mm. The production of finger millet in developing countries is about 97% of the total world production. It is also rich in vitamins, protein, minerals and carbohydrates. Thus, this research needs to produce and characterize flavored and tasty kebezo finger millet juice. The finger millet was collected from Gulomukada wereda with complete randomization sampling technique. The proximate composition of kebezo finger millet was investigated using the methods cited on international standard organizations and association of American chemists. The germination effect on the functional properties such as water absorption capacity, bulk density and swelling power was conducted and the final quality of the products was confirmed by sensory evaluation using nine point hedonic scales with ten panelists. The experimental design was designed using randomized block design to investigate the effects of temperature, time and flour size on quality attributes of the product such as viscosity, PH, density and conductivity. The result showed that, the average proximate compositions such as moisture, ash, protein, crude fat, dietary fiber and total carbohydrate of kebezo finger millet of 7.16, 2.49, 7.18, 1.43, 14.44 and 67.3% respectively. The water absorption capacity, bulk density and swelling power of kebezo finger millet with germination hours of 0, 24, 48, 72 showed that 38.89, 74.575, 78.84 and 84.85%, 0.83 g/ml, 0.76 g/ml, 0.73 g/ml and 0.72 g/ml and 6.15 ml, 4.45 ml, 4.15 ml and 3.75 ml respectively. Products produce with 0.7 mm flour size at 80°C cooked for 6 minutes operating conditions colored with sunset yellow food colorant and flavored with orange food flavor was become very viscous and get best overall acceptability by panelists with an overall acceptability of 8. Finally it can be concluded that cooking at (70-80)°C for (3-6) minute for the mixture of 100 g of 0.7 mm size flour and 500 ml boiled water and at the end of cooking blending with 15 gram of mango powder flavor, 180 ml of burned sugar solution and 6 gram of korarima flavored and tasty juice can drink and get all the nutritional values of finger millet.

Keywords: Kebezo finger millet; Korarima; Crop; Juice

Introduction

Millets are a group of highly variable small-seeded grains, widely grown around the world as cereal crops or grains for fodder and human food. They are important crops in the semiarid tropics of Asia and Africa (especially in India, Mali, Nigeria, Ethiopia and Niger), with 97% of millet production in developing countries [1]. They are commonly found between 1000 and 2000 m altitude in eastern and southern Africa and up to 2500-3000 m altitude in the Himalayas [2,3]. They grow best at about 23°C average temperature but can withstand some cooler and hotter conditions [2]. Annual rainfall ranging from 500-1000 mm, are suitable, provided it is well distributed during the growing season [3].

Finger millet (Eleusine coracana) is a fast growing cereal crop that reaches maturity within 3-6 months and sometimes in only 45 days [3]. The crop is favored due to its productivity and short growing season under dry, high-temperature conditions. Annual rainfall ranging from 500-1000 mm is suitable, provided it is well distributed during the growing season. The grain is readily digestible, highly nutritious and versatile: it can be cooked like rice, ground to make porridge or flour or used to make cakes [4]. It contains low phytic acid and it is rich in dietary fiber, iron, calcium, and vitamin B. These properties of the minor finger millets made the present consumers attracted to the consumption of millet [5].

Juice can also prepare from cereals, especially from the more nitrous cereal of tropics and subtropics region which is, finger millet [6]. This cereal is commonly known as “Dagussa” in Ethiopia and some people called it poor man’s food. Finger millet juice is not known in our country/ un-usual so the purpose of this study is studying the production and characterization of juice from the kebezo variety finger millet produced in eastern Tigray, Gulomukada wereda.

Methods and Materials

The sample kebezo Variaty finger millet was collected from Gulomukada wereda which is located in Eastern Tigray using completely randomization and transported through plastics pack to Adigrat University, Chemical Engineering laboratory. The physicochemical and proximate analysis of the finger millet and its product was done at Addis Pharmaceutical Factory (APF) and Dimma Beekeeping Dev’t and Honey Processing factory laboratories.

For analyzing size of raw finger millet an empty sieve was first weighed in electronic balance having maximum weighing capacity of 1 kg (in APF, Research and Development division formulation laboratory) and the sieves was arranged as (pan, 0.6 mm, 0.71 mm, 0.90 mm, 1 mm, 1.25 mm, 1.4 mm, 1.6 mm, 2 mm) in the Auto sieve shaker sieving machine working electrical. After that the last sieve (2 mm) was loaded

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with sample and set to sieve for 2 minutes and retained mass of sample in each sieve was weighed.

Then the percentage of retained finger millet was calculated as follows for each sieve:

\[
\% \text{ retained} = \frac{\text{mass of finger millet retained}}{\text{sample weight}} \times 100 \tag{1}
\]

Bulk density (BD) of finger millet flour was determined based on the methods used by Narayana and Narasinga-Rao in 1984 as cited by [7]. A mass of 50 g of finger millet flour sample was putted in to a 100 ml measuring cylinder. The cylinder was tapped on manually until a constant volume was obtained. Then the volume of the tapped sample was recorded. Then bulk density of the raw millet was calculated using the mass and tapped volume.

\[
\text{Bulk density} = \frac{\text{mass of finger millet sample}}{\text{tapped volume of the flour}} \tag{2}
\]

The swelling capacity of finger millet flour was determined using the method described by Okaka and Potter in 1977 as cited in Suresh Chandra and Samsher in 2013. 100 ml graduated cylinder was filled to a 250 ml graduated measuring cylinder and then weighing the water added to a sample of 1 g finger millet flour in beaker reported by [8] cited by [7] with some modifications. 10 ml of distilled deionized water was added, and shaken to avoid precipitation of sulfate solution was obtained or free of carbon or oxidation was completed, then the tubes was heated using Bunsen burner in fume-hood until all the smoke out from the solution. Then the ashed will be white or light grey in appearance or constant weight. When cooled to room temperature, each crucible and ash was reweighed. Weight of total ash is calculated by difference and expressed as percentage of the fresh sample.

\[
\% \text{ Ash} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \tag{3}
\]

The moisture content of finger millet flour was analyzed using AOAC official method 923.03. empty crucibles (made of platinum were dried in Nabertherm GMBH, Germany model of P330 MB2 muffle furnace for 15 minutes at 600°C and transferred to desiccators with granular silica gel to cool the crucibles, was stored for 15 minutes at the desiccators and weighed. The prepared finger millet flour samples about 2.5 g of fresh samples was transferred to the dried and weighed platinum crucibles. The crucibles and their contents were placed in Bunsen burner in fume-hood until all the smoke out from the sample and then transferred to Nabertherm GMBH, Germany model of P330 MB2 muffle furnace and were ashed for 8 hr at 600°C and after that removed from the muffle and then placed in desiccators for 15 minute to cool. Then the ashed will be white or light grey in appearance or constant weight. When cooled to room temperature, each crucible and ash was reweighed. Weight of total ash is calculated by difference and expressed as percentage of the fresh sample.

\[
\% \text{ Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \tag{4}
\]

The ash content of the flour was determined using gravimetric principle by AOAC official method 923.03. empty crucibles (made of platinum were dried in Nabertherm GMBH, Germany model of P330 MB2 muffle furnace for 15 minutes at 600°C and transferred to desiccators with granular silica gel to cool the crucibles, was stored for 15 minutes at the desiccators and weighed. The prepared finger millet flour samples about 2.5 g of fresh samples was transferred to the dried and weighed platinum crucibles. The crucibles and their contents were placed in Bunsen burner in fume-hood until all the smoke out from the sample and then transferred to Nabertherm GMBH, Germany model of P330 MB2 muffle furnace and were ashed for 8 hr at 600°C and after that removed from the muffle and then placed in desiccators for 15 minute to cool. Then the ashed will be white or light grey in appearance or constant weight. When cooled to room temperature, each crucible and ash was reweighed. Weight of total ash is calculated by difference and expressed as percentage of the fresh sample.

\[
\% \text{ Ash} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \tag{5}
\]

The protein content of the flour was analyzed using AOAC 920.87 standard official method and ASEAN manual of food analysis and the first step is determining the Total Kjeldahl Nitrogen in the following three steps. In the digestion step about 1 g of fresh samples (in duplicate) was taken in a Tecator tube and 21 ml of 98% concentrated sulfuric acid (ground 0.5 g of selenium metal with 100 g of potassium sulfate) and 0.04 g of CuSO4. As shown in Figure 1 the tubes was heated using Bunsen burner in fume hood. The digestion was continued until a clear colorless solution was obtained or free of carbon or oxidation was completed, about 90 minutes. The tubes were cooled in the hood and 150 ml of deionized water was added, and shaken to avoid precipitation of sulfate in the solution.

In Distillation step a 250 ml conical flask containing 50 ml of 4% boric acid-indicator solution with phenol phthalein indicator was placed for 15 minutes and were reweighed. Duplicates of the sample of finger millet flour were determined. The amount of water present in a sample is considered to be equal to the loss of weight after drying the sample to constant weight.

\[
\% \text{ Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \tag{5}
\]

where \( W_i \) is weight of empty dishes, \( W_f \) weight of sample, \( W_d \) weight of dried sample and dishes.

Figure 1: Digestion of finger millet flour (a) Before digestion started (b) Ongoing process of digestion (c) End of digestion.
under the condenser of the distiller for distillate receiving. The digested and diluted solution was transferred into the sample compartment of the distiller. The tubes were rinsed with two portions of about 5 ml de-ionized water and the rinses were added into the solution. An 80 ml of 50% sodium hydroxide solution was added into the compartment and washed down with a small amount of water. Then the unit was switched on at first stage to 5 and after heated the solution for 10. The process was continued until ≥ 150 ml solution of the sample was distilled, total volume of ≥ 200 ml. The tip was rinse with a few milliliter of water before the receiver was removed. To make solution to be distilled strongly alkali NaOH was not mixed until distillation set up was properly sited to prevent ammonia escape to environment due to strong acids reaction. In the third titration step the distilled solution was titrated with 0.1N HCl. Blank titration was done include two reagent blanks (containing all reagents used in nitrogen analysis except the sample) in every batch of analysis to subtract reagent nitrogen from the sample nitrogen also include the used distilled water.

\[ N = (\text{ml} 0.1 \text{N HCl sample} - \text{ml} 0.1 \text{N HCl blank}) \times 0.0014 \times N \]

\[ \text{Crude protein} = \text{Total nitrogen} \times \text{jones factor} \]

\[ \text{Crude fat g/100g fresh sample} = (W_2 - W_1) / W_D \]

Where, \( W_1 \) = weight of extraction flask before extraction (wt. of flask); \( W_2 \) = weight of fresh sample. \( W_3 \) = weight of extraction flask after extraction (wt. of flask and fat).

The crude fiber content of finger millet flour was determined using ISO 5498:1981 by gravimetric principle.

**Digestion**

About 1.6 g (was record as \( W_s \)) of fresh sample was placed into a 600 ml beaker, 200 ml of 1.25% \( \text{H}_2\text{SO}_4 \) was added, and boiled gently exactly for 30 min placing a watch glass over the mouth of the beaker. During boiling, the level of the sample solution was kept constant with hot distilled water. After 30 min boiling, 20 ml of 28% KOH was added and boil gently for a further 30 min, with occasional stirring.

**Filtration**

The bottom of a sintered glass crucible was covered with 10 mm sand layer and wetted with a little distilled water. The solution was poured from beaker into sintered glass crucible and then the vacuum pump was turned on. The wall of the beaker was rinsed with hot distilled water several times; washing was transferred to crucible and filter.

**Washing**

The residue in the crucible was washed with hot distilled water and filtered (repeated twice). The residue was washed with 1% \( \text{H}_2\text{SO}_4 \) and then was washed with hot distilled water and filtered; and again was washed with 1% NaOH and filtered. The residue was washed with hot distilled water and filtered; again washed with 1% \( \text{H}_2\text{SO}_4 \) and filtered. Finally the residue was washed with water-free acetone (Table 2).

**Drying and combustion**

The crucible with its content was dried for 2 h in a drying oven at 130°C and cooled for 30 min in the desiccators (with granular silica gel) and then weighed (recorded as \( W_s \)). The crucible was transferred to a small muffle furnace and incinerated for 30 min at 550°C. The crucible was cooled in the desiccators and weighed (recorded as \( W_s \)). Then the fiber was calculated as a residue after subtraction of the ash.

\[ \text{Crude fiber g/100g} = (W_s - W_f) / W_s \times 100 \]

where:

\( W_s \) = weight of (Crucible+Sample) after drying;

\( W_f \) = weight of (Crucible+Sample) after ashing;

\( W_f \) = weight of fresh sample.

A total carbohydrate content of finger millet flour was calculated from the equations cited in [7] with adding% of dietary fiber.

**Table 1:** Chemical composition of kebezo finger millet.

<table>
<thead>
<tr>
<th>Moisture content %</th>
<th>Ash content %</th>
<th>Protein content %</th>
<th>Crude fat %</th>
<th>Dietary fiber %</th>
<th>Carbohydrate</th>
<th>Total energy Kcal per 100 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.160 ± 0.003</td>
<td>2.485 ± 0.095</td>
<td>7.1805 ± 0.169</td>
<td>1.425 ± 0.056</td>
<td>14.444 ± 0.21</td>
<td>67.31 ± 0.0746</td>
<td>309.5</td>
</tr>
</tbody>
</table>

**Table 2:** Raw finger millet bulk density.

<table>
<thead>
<tr>
<th>Run no.</th>
<th>Bulk density (g/ml)</th>
<th>Sum</th>
<th>Average</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.538</td>
<td>2.966</td>
<td>1.483</td>
<td>0.055</td>
</tr>
<tr>
<td>2</td>
<td>1.428</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The viscosity of the juice was measured using HAAKE viscometer at 100 rpm using spindle size R 2 (0 - 400 mPas measuring capacity) in Adigrat APF formulation laboratory.

pH of the juice was measured using Toledo/ion/PH/5220 model PH meter in Adigrat APF physicochemical laboratory.

Conductivity of the juice was measured using 902 model PH/conductivity meter in Adigrat APF quality control department laboratory.

True density of the juice was measured using pycnometer meter in Adigrat APF quality control department laboratory. Empty pycnometer was weighed and filled with the juice, then again weighed. Holding the mass and volume of the pycnometer the density was calculated.

The sensory evaluations of the juice flavored with orange and pineapple flavor, colorants sunset yellow and Tartazine yellow and a control, in total of 5 coded products coded as (control (c), sunset yellow colored and orange flavored (SO), sunset yellow colored and pineapple flavored (SP), Tartazine colored and orange flavored (TO). Tartazine colored and pineapple flavored (TP) was prepared to panelists to evaluate the aroma, color, taste and overall acceptability using a nine point hedonic scale rated from 1(dislike extremely), 5 (neither like nor dislike) to 9 (like extremely). Ten panelists (7 males and 3 females), just before test session, panelists were given orientation about the procedure of sensory evaluation. The health status of the panelist was also considered during panelist selection (not severing from colds and allergies that affect their sensitivity for the product). Panelists were asked to rinse their mouth with tap water that was provided to them, just before test session and to use new strop when tasting each of the products. The scores marked by panelists were collected and an average was calculated for each parameter. One way Analysis of variance (ANOVA) was performed on the data collected using Microsoft excel.

The experimental design was designed using randomized block design to investigate the effects of temperature, time and flour size on quality attributes of the product such as viscosity, pH, density and conductivity. The results of the experiment were statistically analyzed using analysis of variance (ANOVA) with a probability p<0.05. All physical and chemical measurements were performed in duplicate. In the process effect analyze three factors with two levels and four responses were used as shown below Table 3.

### Results and Discussion

The result and discussion includes proximate nutritional composition of finger millet, germination effect on functional properties such as WAC, bulk density and swelling power; effect of temperature, time and size on the quantity parameters of the product and sensory evaluation.

### Proximate nutritional composition of finger millets

The proximate compositions of the kebezo finger millet are putted below in Table 4 and values are in mean of the duplicates plus or minus standard deviation (mean ± standard deviation).

The moisture content of the kebezo finger millet was found about 7.16%. This result is within the range of (6-12.73)% as reported by [9], but lower than the range (7.70 - 8.09)% reported by [7]. The ash content of 2.485% investigated by this research was on the range of 1.8% - 2.7% and 1.8% - 3.32% reported by [7] and [9] respectively. The crude protein content was found within the range of 4.9 to 11.3% as reported by [10] and 6.26 to 10.5% as reported by [9] research done on chemical composition of improved and local varieties of finger millets in Ethiopia. The crude fat content of the kebezo variety was found about 1.42% and this result is with the range of 1.3 to 1.8% as reported by [11], but the dietary fiber and total carbohydrate content of the kebezo finger millet was found about 14.44 and 67.31 respectively. These results are lower than the ranges (70-76)% as reported by [9] and (72-79.5)% as reported by [12] for carbohydrates and about 17.1% as reported by [10] and 22.0% as reported by [13] for dietary fiber. These lower contents in dietary fiber and carbohydrate may be due to environmental conditions, variety and other factors but still the dietary fiber content of the kebezo variety is higher than the dietary fiber content of wheat, rice, maize and sorghum (12.6, 4.6, 13.4, and 12.8%) as reported on [14].

### Physicochemical properties of finger millet

#### Size of raw finger millet

From the total sample 700 g used for size analyzing 406 g was found its size below 2 mm and above 1.6 mm and

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>Difference (DF)</th>
<th>Mean of squares</th>
<th>F-value</th>
<th>Prob&gt;F</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1.31</td>
<td>7</td>
<td>0.19</td>
<td>652.47</td>
<td>&lt;0.0001</td>
<td>Significant</td>
</tr>
<tr>
<td>A</td>
<td>0.087</td>
<td>1</td>
<td>0.087</td>
<td>302.70</td>
<td>&lt;0.0001</td>
<td>Significant</td>
</tr>
<tr>
<td>B</td>
<td>1.600E-003</td>
<td>1</td>
<td>1.600E-003</td>
<td>5.57</td>
<td>0.0480</td>
<td>Significant</td>
</tr>
<tr>
<td>C</td>
<td>0.71</td>
<td>1</td>
<td>0.71</td>
<td>2483.57</td>
<td>&lt;0.0001</td>
<td>Significant</td>
</tr>
<tr>
<td>AB</td>
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<td>0.41</td>
<td>1424.70</td>
<td>&lt;0.0001</td>
<td>Significant</td>
</tr>
<tr>
<td>AC</td>
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<td>0.093</td>
<td>323.57</td>
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<td>Significant</td>
</tr>
<tr>
<td>BC</td>
<td>4.225E-003</td>
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<td>4.225E-003</td>
<td>14.70</td>
<td>0.0050</td>
<td>Significant</td>
</tr>
<tr>
<td>ABC</td>
<td>3.600E-003</td>
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<td>3.600E-003</td>
<td>12.572</td>
<td>0.0076</td>
<td>Significant</td>
</tr>
</tbody>
</table>

Table 3: Analysis of variance (ANOVA) for pH.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>Difference (DF)</th>
<th>Mean of squares</th>
<th>F-value</th>
<th>Prob&gt;F</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>4.834E-004</td>
<td>7</td>
<td>6.909E-005</td>
<td>33.48</td>
<td>&lt;0.0001</td>
<td>Significant</td>
</tr>
<tr>
<td>A</td>
<td>1.406E-005</td>
<td>1</td>
<td>1.406E-005</td>
<td>6.82</td>
<td>0.0311</td>
<td>Significant</td>
</tr>
<tr>
<td>B</td>
<td>1.056E-005</td>
<td>1</td>
<td>1.056E-005</td>
<td>5.12</td>
<td>0.0535</td>
<td>Not-significant</td>
</tr>
<tr>
<td>C</td>
<td>1.406E-005</td>
<td>1</td>
<td>1.406E-005</td>
<td>6.82</td>
<td>0.0311</td>
<td>Significant</td>
</tr>
<tr>
<td>AB</td>
<td>4.556E-005</td>
<td>1</td>
<td>4.556E-005</td>
<td>22.09</td>
<td>0.0015</td>
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</tr>
<tr>
<td>AC</td>
<td>1.756E-004</td>
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<td>85.12</td>
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<td>66.94</td>
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<tr>
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<td>8.556E-005</td>
<td>41.48</td>
<td>0.0002</td>
<td>Significant</td>
</tr>
</tbody>
</table>

Table 4: Analysis of variance (ANOVA) for density.
28 g of it was found its size below 1.25 mm and above 1 mm. from this one it is concluded that the size of kebezo variety finger millet was found less than 2 mm and above 1 mm (2 mm-1 mm). This result matches with the ranges 1.8 mm-1 mm which is reported by [10].

**Bulk density of raw finger millet:** The bulk density of the kebezo variety analyzed using oil displacement principle as cited in [15] in duplicates and results were cited below Table 5.

**Malting effect on functional properties**

The functional properties of flours play important role in the manufacture of products. Water absorption capacity gives an indication of the amount of water available for gelatinization and the ability of flour to absorb water, depends on the availability of hydrophilic groups which bind water molecules [16], swelling power also an important indication of water absorption capacity of the flour without any mechanical operation.

Figure 1 shows water absorption capacity increases with increasing germination time of up to 72 hours but the increase in WAC from 24 hours to 72 hours is not much larger as 0 hours germination to 24 hours germination. The WAC of the un-germinated (control) finger millet flour was found 38.89% with standard deviation of 0.04 and increases to 74.575, 78.84 and 84.855 for 24 hours, 48 hours and 72 hours germination respectively, but these lower values may be due to finger millet variety, weather condition, milling technology, germination time at room temperature respectively. But these results are much lower to the results in as 84%, 99.5% for control and 24 hours germination time at room temperature respectively. But these results to 74.575, 78.84 and 84.855 for 24 hours, 48 hours and 72 hours germination respectively, but these lower values may be due to finger millet variety, weather condition, milling technology, germination condition (Table 6).

Figure 2 shows the effect of malting on bulk density of finger millet flour, the control flour had higher bulk density (0.8265 g/ml) which was significantly (p<0.05) higher than that of 24 hours, 48 hours and 72 hours germinated finger millet flour. The reduction of bulk density further increased from 24 hours to 72 hours germination, but the difference in between 48 hours and 72 hours germination is slightly low. This could be because germination tend to soften the seeds, thus making milling easier, with smaller particle sizes than unprocessed grain and due to enzymatic breakdown of starch to sugars during germination [17] as cited in Ref [7] The significance of this is the less bulky flours will have higher nutrient density, since more flour can be packaged in the same given volume.

Figure 3 also shows the other functional property of finger millet flour that is swelling power. This determines the amount of water to be swelled by the flour without any stirring.

**Process parameter effects**

Process parameters (time, size and temperature) effect on pH:
The Model F-value of 652.47 implies the model is significant. There is only a 0.01% chance that a 'Model F-Value' this large could occur due to noise. Values of "Prob>F" less than 0.0500 indicate model terms are significant. In this case temperature (T), time (t), size (s), temperature and time, temperature and size, size and time, size, time and temperature are significant model terms. The pH of the juice holding size and time constant at 6 minutes and 0.5 mm size with a least significant difference of 0.039 at 70°C and 80°C was 4.90 and 4.95 respectively as shown in above Figure 4a and 4b, on this graph at (c) and (d) helding time and size constant at 3 minute and 0.5 mm size with a list significant difference (LSD) of 0.039 at 70°C and 80°C was 5.08 and 4.78 respectively. Interpreting in this manner for effect of temperature holding time and size constant for effect of size holding temperature and time constant and for effect of time holding the rest constant to

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>Difference (DF)</th>
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<th>F-value</th>
<th>Prob&gt;F</th>
<th>Limit</th>
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<td>Model</td>
<td>1.092E+005</td>
<td>3</td>
<td>36390.73</td>
<td>9.96</td>
<td>0.0014</td>
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<td>9457.56</td>
<td>2.59</td>
<td>0.1338</td>
<td>Not-significant</td>
</tr>
<tr>
<td>B</td>
<td>59414.06</td>
<td>1</td>
<td>59414.06</td>
<td>16.25</td>
<td>0.0017</td>
<td>Significant</td>
</tr>
<tr>
<td>AC</td>
<td>40300.56</td>
<td>1</td>
<td>40300.56</td>
<td>11.02</td>
<td>0.0061</td>
<td>Significant</td>
</tr>
</tbody>
</table>

**Table 5:** Analysis of variance (ANOVA) for conductivity.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>Difference (DF)</th>
<th>Mean of squares</th>
<th>F-value</th>
<th>Prob&gt;F</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>164.25</td>
<td>3</td>
<td>54.75</td>
<td>8.48</td>
<td>0.0027</td>
<td>Significant</td>
</tr>
<tr>
<td>A</td>
<td>49.00</td>
<td>1</td>
<td>49.00</td>
<td>7.59</td>
<td>0.0175</td>
<td>Significant</td>
</tr>
<tr>
<td>B</td>
<td>90.25</td>
<td>1</td>
<td>90.25</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td>25.00</td>
<td>1</td>
<td>25.00</td>
<td>3.87</td>
<td>0.0727</td>
<td>Significant</td>
</tr>
</tbody>
</table>

**Table 6:** Analysis of variance (ANOVA) for viscosity.

**Figure 2:** Effect of malting (germinating) on WAC.

**Figure 3:** Effect of malting (germinating) on bulk density.
the analysis of variance model graphs. The effect of the three factors was analyzed and it is showed that time does not have effect but with increasing temperature and size PH decreases from the temperature and time vs PH graphs.

**Process parameters (time, size and temperature) effect on density:** The Model F-value of 33.48 implies the model is significant. There is only a 0.01% chance that a "Model F-Value" this large could occur due to noise. Values of 'Prob>F' less than 0.0500 indicate model terms are significant. In this case temperature (T), size (s), temperature (T) and time (t), temperature and size, size and time and combination of three are significant model terms.

The density of the juice helding size and time constant at 6 minutes and 0.5 mm size with a least significant difference of 0.0033 at 70°C and 80°C was 1.0785 g/ml and 1.0725 g/ml respectively as shown in below Figure 5a and 5b, on this graph at 3.5c and 3.5d helding time and size constant at 3 minute and 0.5 mm size with LSD of 0.0033 at 70°C and 80°C was 1.073 and 1.0695 g/ml respectively. Interpreting in this manner for effect of temperature holding time and size constant for effect of size holding temperature and time constant and for effect of time holding the rest constant to the analysis of variance model graphs. But time is not significant term but temperature and size are significant terms of the model. From the intepratations with increase in temperature density decreases, but with increase in size density decreases. This is true in reality an increase in temperature increases the mobility of a solution and as a result increase movement of particles.

**Process parameters (temperature, size and time) effect on conductivity:** The Model F-value of 9.95 implies the model is significant. There is only a 0.14% chance that a "Model F-Value" this large could occur due to noise. Values of 'Prob>F' less than 0.0500 indicate model terms are significant. In this case size and combination of temperature and size are significant model terms [18-25].

The conductivity of the juice helding temperature and time constant at 70°C and 3 minute with a least significant difference of 93.161 at 0.5 mm and 0.7 mm was 372.5 µS/cm and 594.25 µS/cm respectively as shown in Figure 6, on this graph at 3.6c and 3.6d helding temperature and time constant at 80°C and 3 minute with a least significant difference of 93.161 at 0.5 mm and 0.7 mm was 424.255 µS/cm and 445.75 µS/cm respectively. The finger millet juice have a PH on 6.15
the range of 4-5 and this can lead to the growth of yeast and mold, in addition to a few types of low-aid-tolerant bacteria since suitable acid condition. To avoid microbial spoilage, it is necessary to cause inactivation by applying heat by high temperature heating with very short exposition. The important parameter in heating of a liquid food product is its electrical conductivity behavior. And this parameter depends on temperature and on this research with increasing in size and temperature conductivity also increases. A similar behavior was observed by Hu and Mallikarjunan in 2004 for oysters, by Telis-Romero et al. for Brazilian orange juice and by Singh and Go swami in 2000 for cumin seed as cited in [25-29].

Process parameters (temperature, size and time) effect on viscosity The Model F-value of 8.48 implies the model is significant. There is only a 0.27% chance that a "Model F-Value" this large could occur due to noise. Values of "Prob>F" less than 0.0500 indicate model terms are significant. In this case temperature and time are significant model terms. Values greater than 0.1000 indicate the model terms are not significant (Table 7).

The viscosity of the juice helding size and time constant at 6 minutes and 0.5 mm size with a least significant difference of 3.9153 at 70°C and 80°C was 32.5 mPas and 38.5 mPas respectively as shown in below Figure 7a and 7b, on this graph at (c) and (d) holding time and size constant at 3 minute and 0.5 mm size with LSD of 3.9153 at 70°C and 80°C was 30.25 and 31.25 respectively so that with increase in temperature and time, increase in viscosity was observed. This is due to the reason that finger millet starch degrade at a temperature range of (70-80)°C and source of viscosity in solution of cereals are beta gulucans and simple sugars that forms during degradation of cereals starch [30-37].

Table 7: Effect of food colorant and flavor on sensory characteristics of finger millet juice.

<table>
<thead>
<tr>
<th>Product</th>
<th>Aroma</th>
<th>Color</th>
<th>Taste</th>
<th>Overall acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (C)</td>
<td>7.6 ± 1.28062</td>
<td>7.3 ± 1.34536</td>
<td>8.1 ± 0.9434</td>
<td>7.7 ± 1.1874</td>
</tr>
<tr>
<td>Tetrazine color and orange flavor (To)</td>
<td>7.4 ± 1.5620</td>
<td>8 ± 0.8944</td>
<td>7.9 ± 1.04433</td>
<td>7.7 ± 1.00499</td>
</tr>
<tr>
<td>Tetrazine color and pineapple flavor (Tp)</td>
<td>7.1 ± 2.11866</td>
<td>7.6 ± 0.8</td>
<td>7.7 ± 1.1</td>
<td>7.5 ± 1.8027</td>
</tr>
<tr>
<td>Sunset yellow color and orange flavor (So)</td>
<td>8.1 ± 1.22066</td>
<td>7.4 ± 1.35647</td>
<td>7.7 ± 0.9</td>
<td>8 ± 1.41421</td>
</tr>
<tr>
<td>Sunset yellow color and pineapple flavor (Sp)</td>
<td>7.8 ± 1.42829</td>
<td>7.5 ± 1.43178</td>
<td>7.9 ± 0.9434</td>
<td>7.8 ± 1.249</td>
</tr>
</tbody>
</table>

Effect on food colorant and additives on the sensory characteristics on finger millet juice: A total of five products including control juice was prepared for 10 panelist.
Conclusion

The study was aimed at the production and characterizing of juice from finger millet. The germination times (0, 24, 48, 72) hours essentially increase the water absorption capacity of the flour. Especially the large increase in water absorption was observed in between 0 and 24 hours of germination hours (from 38.89% to 74.56%) whereas the bulk density and swelling power of the finger millet flour decreases with increase in germination time. The significance of this is the less bulky flours will have higher nutrient density, since more flour can be packaged in the same given volume. The experimental design was designed using randomized block design to investigate the effects of temperature, time and flour size on quality attributes of the product such as viscosity, pH, density and conductivity. The results of the experiment were statistically analyzed using analysis of variance (ANOVA) with a probability p<0.05. The result showed that, the average proximate compositions such as moisture, ash, protein, crude fat, dietary fiber and total carbohydrate of kebezo finger millet of 7.16, 2.49, 7.18, 1.43, 14.44 and 67.3% respectively. The water absorption capacity, bulk density and swelling power of kebezo finger millet with germination hours of 0, 24, 48, 72 showed that 38.89, 74.575, 78.84 and 84.85%; 0.83 g/ml, 0.76 g/ml, 0.73 g/ml and 0.72 g/ml and 6.15 ml, 4.45 ml, 4.15 ml and 3.75 ml respectively. Products produce with 0.7 mm flour size at 80°C cooked for 6 minutes operating conditions colored with sunset yellow food colorant and flavored with orange food flavor was become very viscous and get best overall acceptability by panelists with an overall acceptability of 8. Finally it can be concluded that cooking at (70-80)°C for (3-6) minute for the mixture of 100 g of 0.7 mm size flour and 500 ml boiled water and at the end of cooking blending with 15 gram of mango powder flavor, 180 ml of burned sugar solution and 6 gram of korarima; a flavored and tasty juice can drink and get all the nutritional values of finger millet.

References