Production & Quality Evaluation of Cookies Enriched with β-Carotene by Blending Orange-Fleshed Sweet Potato & Wheat Flours for Alleviation of Nutritional Insecurity

Temesgen Laelago, Abebe Haile, Tigist Fekadu*
School of Nutrition, Food Science & Technology
Hawassa University


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Presentation Outline

- Background
- Objective
- Materials and Methods
- Result
- Discussion
- Conclusion
- Acknowledgement
1. Background

- A large segment of the world’s population especially in developing countries consume foods that are deficient in some micronutrients like vitamin A (Long et al., 2007).

- Vitamin A deficiency (VAD) is a major public health risk in developing countries; children and pregnant/lactating women being the most vulnerable (FAO, 2002).
Ethiopia

- 10% of <2yrs children consumed vitamin A rich fruits & vegetables (CSA, 2012)
- 10% night blindness in pregnant women in Sodo Wolaita (Hiwot et al., 2014)
- 12.8% national night blindness school children (EHNRI, 2006)
• Orange-fleshed sweet potato (OFSP) flour can serve as
  • source of β-carotene (pro-vitamin A) & energy & other nutrients
  • can add natural sweetness, color, flavor, to processed food products (Woolfe, 1992)
• Addition of various proportion of OFSP flour in wheat can increase carotenoids & fiber contents of food (Tilman et al., 2003)
2. Objective

- Developing pro-vitamin A rich cookies from composite flour of OFSP and evaluating its nutritional contents and organoleptic acceptability
3. Materials and Methods

3.1 Materials

- Kulfo variety OFSP which was harvested in Wondogenet, Ethiopia
- Randomly taken & packed by sack
- Wheat & the other ingredients purchased from the local market

3.2 Sample Analysis

- Chemical analyses were carried out at Public Health Research Institute, Addis Ababa, Ethiopia
3.3 Preparation of Orange-Fleshed Sweet Potato (OFSP) and Wheat Flours

- OFSP sorted, washed, peeled, cut into cubes, sliced, immersed, dried, milled, passed through 710 μm sieve, packed in high-density poly ethylene (HDPE) bag, labeled and stored in dry and dark places till further use.

- Wheat flour: sorted, sun dried, milled, sieved with similar sieve size, packed with HDPE bag and stored as above.
3.4 Formulations of Composite Flour and Recipes

- OFSP flour blended to wheat flour in the proportion of 10:90, 20:80, 30:70 and 40:60, and 100% soft wheat flour as control

- Recipes used
  - composite flour (380 g)
  - vegetable shortening (100 g)
  - granulated cane sugar (225 g)
  - beaten whole egg (21 g)
  - salt (3.75 g)
  - baking powder (1.8 g) and
  - water (36 mL)
Figure 1. Orange-fleshed sweet potato & wheat flour blended baked cookies

3.5 Chemical Analysis

- Crude fat, crude protein, crude fiber, ash, and phytate & moisture content of the sample were determined using (AOAC, 2000)
- β-carotene analyzed by following the procedure developed by Kimura & Rodriguez-Amaya (2003)
- Iron and zinc contents were determined according to the method of Osborne and Voogt (1978)
3.6 Sensory Evaluation

- Students of school of nutrition, food science & technology, Hawassa University, Ethiopia
- A nine-point hedonic scale with ranging from 1-9 was used
  - 9 represented the highest score (like extremely), 8 (like very much), .......1 (dislike extremely ... 
  - give honest, individual opinion, no discussion, rinsing mouth
3.7 Statistical Analysis

- SAS statistical package software version 9.3.1 was used
- One way ANOVA was used to test the main effect of proportions in the formulation at 5% level of significance
- Results reported as an average value of triplicate analysis (mean ± SD)
- Differences b/n treatments were determined by Fisher’s Least Significance Difference (LSD) method
- Statistical significance was set at p < 0.05
4. Result

- **Table 1. Effect of blending ratios on cookies proximate composition on dry weight basis (%)**

<table>
<thead>
<tr>
<th>Blend</th>
<th>Moisture</th>
<th>Ash</th>
<th>Crude protein</th>
<th>Crude fat</th>
<th>Crude fiber</th>
<th>Carbohydrate</th>
<th>Energy (Kcal/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP0</td>
<td>12.27 ± 02a</td>
<td>0.82 ± 0.01a</td>
<td>6.32 ± 0.10a</td>
<td>16.69 ± 0.02a</td>
<td>0.11 ± 0.08d</td>
<td>63.79 ± 0.11a</td>
<td>431.56 ± 8.05c</td>
</tr>
<tr>
<td>BP1</td>
<td>11.15 ± 0.12b</td>
<td>0.88 ± 0.01d</td>
<td>6.13 ± 0.03b</td>
<td>18.38 ± 0.15d</td>
<td>0.13 ± 0.02d</td>
<td>63.32 ± 0.13a</td>
<td>444.63 ± 2.14b</td>
</tr>
<tr>
<td>BP2</td>
<td>10.66 ± 0.08c</td>
<td>1.31 ± 0.03c</td>
<td>5.93 ± 0.09c</td>
<td>18.79 ± 0.07c</td>
<td>0.22 ± 0.01c</td>
<td>63.10 ± 0.04ab</td>
<td>445.48 ± 0.32b</td>
</tr>
<tr>
<td>BP3</td>
<td>9.90 ± 0.02d</td>
<td>1.51 ± 0.01b</td>
<td>5.59 ± 0.05d</td>
<td>19.46 ± 0.06b</td>
<td>0.40 ± 0.04b</td>
<td>63.01 ± 0.06b</td>
<td>449.57 ± 0.60ab</td>
</tr>
<tr>
<td>BP4</td>
<td>9.66 ± 0.04e</td>
<td>1.64 ± 0.02a</td>
<td>5.36 ± 0.10a</td>
<td>20.34 ± 0.09a</td>
<td>0.57 ± 0.04a</td>
<td>62.56 ± 0.25c</td>
<td>454.57 ± 0.17a</td>
</tr>
</tbody>
</table>

- BP0 = Wheat: OFSP -100:0.0, BP1 = OFSP:Wheat-10:90, BP2 = OFSP:Wheat-20:80, BP3 = OFSP:Wheat-30:70, and BP4= OFSP:Wheat-40:60. Values with the same column with different superscript letters are significantly different with each other (p < 0.05) and values are means ± SD.
Figure 2. β-carotene (μg/g) contents of the cookies developed from composite flours

- BP0 = Wheat:OFSP-100:0.0, BP1 = OFSP: Wheat-10:90, BP2 = OFSP: Wheat-20:80, BP3 = OFSP: Wheat-30:70 and BP4=OFSP: Wheat-40:60. Results are mean values of triplicate determination. a - e Means with different superscript letters in a figure are significantly different (p < 0.05).
Table 2. Iron, zinc & phytate contents & bioavailability of Fe and Zn of cookies made from composite flours (mg/100 g)

<table>
<thead>
<tr>
<th>Blends</th>
<th>Iron</th>
<th>Zinc</th>
<th>Phytate</th>
<th>Py:Fe Cv</th>
<th>Mv</th>
<th>Py:Zn Cv</th>
<th>Mv</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP0</td>
<td>9.14 ± 0.34&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.54 ± 0.20&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.04 ± 0.69&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.4</td>
<td>0.136</td>
<td>1.5</td>
<td>0.136</td>
</tr>
<tr>
<td>BP1</td>
<td>10.77 ± 0.11&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.52 ± 0.10&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.07 ± 0.41&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.4</td>
<td>0.108</td>
<td>1.5</td>
<td>0.210</td>
</tr>
<tr>
<td>BP2</td>
<td>14.84 ± 0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.25 ± 0.20&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.62 ± 0.80&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.4</td>
<td>0.057</td>
<td>1.5</td>
<td>0.429</td>
</tr>
<tr>
<td>BP3</td>
<td>16.36 ± 0.30&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.00 ± 0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.79 ± 0.40&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.4</td>
<td>0.048</td>
<td>1.5</td>
<td>0.452</td>
</tr>
<tr>
<td>BP4</td>
<td>22.14 ± 0.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.50 ± 0.04&lt;sup&gt;d&lt;/sup&gt;</td>
<td>7.46 ± 0.78&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.4</td>
<td>0.031</td>
<td>1.5</td>
<td>1.375</td>
</tr>
</tbody>
</table>

- BP0 = Wheat:OFSP-100:0.0, BP1 = OFSP:Wheat-10:90, BP2 = OFSP:Wheat-20:80, BP3 = OFSP:Wheat-30:70, and BP4= OFSP:Wheat-40:60. Results are mean values of triplicate determination. Values with the same column with different superscript letters are significantly different with each other (p < 0.05) and values are means ± SD. Note: Py - phytate, Fe - iron, Zn - zinc, Cv - Critical value, Mv - Measured value
Table 3. Sensory quality evaluation of cookies prepared from composite flours

<table>
<thead>
<tr>
<th>Blends</th>
<th>Appearance</th>
<th>Texture</th>
<th>Aroma</th>
<th>Taste</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP₀</td>
<td>7.80±0.66ᵃ</td>
<td>8.00±0.64ᵃ</td>
<td>7.53±0.68ᵃ</td>
<td>7.80±0.75ᵃ</td>
<td>7.87±0.68ᵃ</td>
</tr>
<tr>
<td>BP₁</td>
<td>7.30±0.65ᵇ</td>
<td>7.33±0.61ᵇ</td>
<td>7.10±0.76ᵇ</td>
<td>7.03±0.72ᵇ</td>
<td>7.80±0.61ᵃ</td>
</tr>
<tr>
<td>BP₂</td>
<td>6.83±0.65ᶜ</td>
<td>6.87±0.68ᶜ</td>
<td>6.53±0.51ᶜ</td>
<td>6.53±0.68ᶜ</td>
<td>6.87±0.63ᵇ</td>
</tr>
<tr>
<td>BP₃</td>
<td>6.77±0.68ᶜᵈ</td>
<td>6.17±0.79ᵈ</td>
<td>6.67±0.61ᶜ</td>
<td>6.47±0.68ᶜ</td>
<td>6.47±0.57ᶜ</td>
</tr>
<tr>
<td>BP₄</td>
<td>6.47±0.68ᵈ</td>
<td>6.17±0.65ᵈ</td>
<td>6.37±0.49ᶜ</td>
<td>6.57±0.73ᶜ</td>
<td>6.47±0.57ᶜ</td>
</tr>
</tbody>
</table>

- Values with the same column with different superscript letters are significantly different with each other (p < 0.05) and values are means ± SD.
5. Discussions

4.1. Proximate Composition of OFSP and Wheat Flour Cookies

• **Moisture contents**
  - composite flours cookies were significantly \((p < 0.05)\) lower than the BP0 (control, 12.27 ± 0.02\%)
  - decreased as the proportion of OFSP increased
  - might be due to the less moisture content of OFSP than soft wheat flour
  - lowest BP4 (9.66 ± 0.04\%)
• **Ash**: as the OFSP proportion increases in the composite flours the ash contents of the blend increases in line with Okorie and Onyeneke (2012)

• **Crude protein**
  - Reduced with increasing of OFSP flour proportion
  - In line with Shazia et al., 2012 and Okorie, 2012

• **Crud fat**
  - Progressive increment with addition of OFSP
  - In line with Oboh and Akindahunsi (2003); who reported fats present in a small extent in wheat than OFSP
- **Crude fiber**
  - Increased when more OFSP was added
  - May be due to the increased fiber contents of OFSP flour than soft wheat
  - Singh et al. (2008) also reported result in agreement with the present study

- **Carbohydrate**
  - Decreased when more OFSP was added
  - May be due to wheat flour has more starch granules than the OFSP

- **Energy**
  - Increase in energy with increase in proportion of OFSP flour
  - May be due to the increment of the crude fat content
β- Carotene

- Content in BP4 was 13.11 ± 0.02 μg/g (240 μg/100g)
- The content of β-carotene increased when more OFSP added to the wheat flour in the composite cookies
- β-carotene is a major source and precursor of dietary vitamin A to human health.
- The β-carotene from plant sources converted to vitamin A in human body to improve the diet of population in food based approach.
- Consumption of vitamin A rich OFSP can provide households with direct access to foods rich in β-carotene and the alleviation of VAD (Faber et al., 2002).
• **Iron** contents of composite flours cookies were significantly \((p < 0.05)\) higher than the control (BP0)
  • This may be due to OFSP iron content was greater than the wheat flour

• **Zinc** content decreased when more OFSP was added to the soft wheat flour cookies.
  • This may be due to the content of zinc was more in cereal (wheat) than roots (OFSP) based on the report of Sandsteed (2000).
• **Phytate** content of control (BP0) was significantly ($p < 0.05$) higher than the composite flour cookies phytate content.
  • May be high amount found in wheat flour than OFSP
  • Reduction is expected to enhance the bioavailability of minerals (Phillippy et al., 2004).

• **Bioavailability of Iron and Zinc**
  • Are bioavailable to consumers
  • Molar ratio of phytate: iron values were below the critical value (0.4) and phytate: zinc values were also below the critical value (1.5)
Sensory Evaluation

- As the level of OFSP flour increased the following characteristics acceptance decreased:
  - Appearance: subjected to the dark brown in color, in line with work by Mebpa et al. (2007)
  - Texture: creation of roughness and dullness of the surface
Cont...

- Aroma: panelists were not familiar with such newly developed products
  - Similar with Sharif et al. (2009) finding
- Taste: similar finding with Alam et al. (2007)
- Overall acceptability: changing the staple foods of a population in a certain society can influence the overall acceptability of new products
5. Conclusions

- The study was attempted to investigate the possibility of using orange-fleshed sweet potato (OFSP) flour for the production of $\beta$-carotene enriched cookies by blending with wheat flour.
- The proximate composition of cookies made from composite flours recorded more ash, crude fat, crude fiber and energy values by the addition of OFSP in the blend.
- The moisture, crude protein and carbohydrate contents decreased when more OFSP added to soft wheat flour.
• Cookies developed up to 40% OFSP supplementation with wheat flour was superior in β-carotene than the wheat flour (control)

• Result showed more than average of panelist scores in overall acceptability of developed cookies

• The use of OFSP-wheat flour blend in cookies formulation appeared to be promising from nutritional quality of view
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