Proximate, Antinutritional, Microbial, and Sensory Acceptability of Bread Formulated from Wheat (\textit{Triticum aestivum}) and Amaranth (\textit{Amaranthus caudatus})

Aemiro Tadesse Zula,\textsuperscript{1} Dagim Alemayehu Ayele,\textsuperscript{1} and Woinshet Abera Egigayhu\textsuperscript{2}

\textsuperscript{1}School of Nutrition, Food Science and Technology, Center of Excellence in Human Nutrition, Hawassa University, Ethiopia
\textsuperscript{2}Center of Food Science and Nutrition, Addis Ababa University, Ethiopia

Correspondence should be addressed to Aemiro Tadesse Zula; aemtadzu@gmail.com

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Abstract

Background. Breads are made throughout the world. Bread can be prepared from cereal like wheat, maize, and rice. Nowadays, needs for nutritious products is increasing [1]. Similarly, interests towards underutilized crops have also been increasing with the aim of improving global food security and to ease an adverse effect of climate changes. Amaranth is one of nutritionally balanced and naturally grown underutilized crops, but it is mainly considered weed in Africa including Ethiopia. Method. The aim of the study is to develop bread from wheat and Amaranth and to evaluate proximate composition, antinutritional, microbial, and sensory acceptability of bread. The experiment contained 100% wheat as control and four blending proportions (90% wheat and 10% amaranth, 80% wheat and 20% amaranth, 70% wheat and 30% amaranth, and 60% wheat and 40% amaranth). A complete randomized design is used for proximate composition, antinutritional, and microbial data analysis whereas a randomized complete block design with three replications was applied for sensory acceptability. SAS for windows version 9 was used for data analysis. Result. The study revealed that moisture, protein, fat, fiber, and antinutritional content were increased as Amaranth concentration is increased from 10% to 40%. However, carbohydrate, microbial load, and sensory acceptability were decreased. But the gross energy is constant. Conclusion. From the study, it can be concluded that beside the good nutritional profile of Amaranthus, it has antinutritional content which needs to limit the concentration of Amaranth in blending with other grains during product development.

1. Introduction

Bread is popular worldwide, and it can be prepared from cereal like wheat, maize, and rice. Nowadays, needs for nutritious products is increasing [1]. Similarly, interests towards underutilized crops have also been increasing with the aim of improving global food and nutrition security. Amaranth is one of nutritionally balanced and naturally grown underutilized crops [2], but it is mainly considered weed in Africa including Ethiopia. Thus, engaging in Amaranth cultivation and appreciation for consumption could be valuable for reducing existed both food and nutrition insecurities in developing countries like Ethiopia.

The consumption of bread from wheat is popular. But the limited nutritional profile of wheat is an alarm to think for other cereal which is good in nutritional profile so as to complement it with wheat in bread production [3]. According to Ikram et al., 2010, Amaranthus has carbohydrate (48–69%), protein (12–18%), and fat (5–8%). It has also high concentration of limiting amino acids like lysine (0.747 g) and tryptophan (0.181 g) [4] with numerous benefits. Beside all these, it is also relatively good in sulfur-containing amino acids which are limited in the pulse crops at the normal circumstance high amount of iron, zinc, and calcium [5].

Amaranthus is known in Ethiopia specifically in south and south west parts, but limited concern has been given to the crop. However, in some areas, it is used to prepare local beverage known as “Chaqa,” porridge, pancake-like bread (injera), bread, borde, \textit{kitta} (unleavened bread), and atmit, though bread from wheat and Amaranthus could be good...
for nutritional profile of bread as it provides energy, vitamins, and minerals.

2. Material and Methods

2.1. Sources and Preparation of Materials. The raw materials for preparation of bread were wheat and Amaranthus. Wheat was obtained from Hawassa local market, and Amaranthus was obtained from Gamo zone (Arba Minch). The grains were sorted, and extraneous material was removed then washed, cleaned, and sun dried. Both the dried whole wheat and Amaranthus were later milled using cyclone mill and sieved into fine flour of uniform particle size by passing them through a 0.5 mm mesh screen.

2.2. Preparation of Wheat Flour. The extraneous matter was removed from wheat, and then, the grain was washed, cleaned using tap water, drained, sundried, and milled using a cyclone mill to pass through a 0.5 mm mesh screen so as to get the flour. The milled grain was then packed by polyethylene bag and finally stored at room temperature.

2.3. Preparation of Amaranthus Flour. The Amaranthus grain was cleaned from extraneous matter and soaked in steam water for 12 h with 1:3 (w/v) concentration to ensure effective removal of antinutrients [6]. The initial temperature of steam was around 70°C held for 10 minutes, and the water was changed at a six-hour interval. The Amaranthus grain was sundried and milled using a cyclone mill (Tecator AB, Haganas, Sweden) to pass through a 0.5 mm mesh screen and filled in polyethylene bags. After getting the flours of Amaranthus and wheat, it was mixed according to the formulation (Table 1).

2.4. Preparation of Bread. Preparation of dough for bread was done by mixing 1% iodized salt, composite flour, yeast, and water. After mixing all ingredients, composite flour was kneaded until it becomes soft, smooth, and stiff and kept for two and half hours for rising (fermentation). Preheated local clay griddle (Mitad) was used for baking, and the leaf of enset (Ensete ventricosum) was used for wrapping the dough to be baked. The baking was continued until a brown color appeared (which will take about 25 minutes at 150°C). The bread which was prepared was kept at room temperature to cool down, wrapped using polyethylene bags.

2.5. Chemical Composition Analysis. The proximate composition of bread was determined according to [7]. The moisture content was determined using official method 934.01, ash content was determined using official method of 923.03, crude fat content was determined using official method of 920.39, crude protein was determined using official method of 981.10, crude fiber was determined by [8], and total carbohydrate was determined by difference method. Condensed tannin and phytate contents were determined by using the method used by [9]. The phytate content was calculated by dividing the measured value of phytic acid by molecular weight (240) of phytic acid.

2.6. Microbial Analysis of Bread. Total mold, yeast, and bacteria counts were carried out on bread samples after 2-day room temperature storage using the procedure of [10]. Bread samples were taken aseptically and homogenized in 99 ml sterile peptone water 0.1% in a blender for about 2 minutes, and serial dilutions were made. Dilution of 0.1 ml was spread plated in sterile Petri dishes, the stomacher dilutions of 10⁻¹, 10⁻², 10⁻³, 10⁻⁴, and 10⁻⁵ were prepared by using 9 ml peptone water tubes and plate count agar (PCA) with the addition of chloramphenicol and incubated at 25°C for 5 days for mold and yeast count, and molten plate count agar (PCA) was used and incubated for 48 hours at 35°C for total bacterial count. Counts of visible colonies by using colony counter were made and expressed as log CFU/g of the original sample.

2.7. Sensory Evaluation of Breads. The bread samples were coded with three digit numbers, and randomly, the samples were given to randomly presented panelists in a random order. The sensory evaluation was carried out using a five-point hedonic scale (1 = dislike very much, 2 = dislike, 3 = neither like nor dislike, 4 = like, and 5 = like very much) in terms of color, taste, aroma, texture, and overall acceptability with 20 panelists in triplicate.

2.8. Experimental Design. Treatments with blending at different proportions of wheat and amaranth (90:10, 80:20 and 70:30, 60:40) and 100% wheat (control) were used to assess chemical composition, microbial load, and sensory acceptability. A complete randomized design was used for chemical composition and microbial load analysis whereas a randomized complete block design (RCBD) was used for sensory acceptability analysis.

2.9. Data Analysis. One-way analysis of variance using SAS software version 9 was used for data analysis. The mean separation was done using Tukey’s HSD test at \( p < 0.05 \).

3. Result and Discussion

3.1. Proximate Compositions. The proximate composition of bread formulated from wheat and Amaranthus is presented in (Table 2). Moisture content of bread is varied from 7.18 to 7.71. Bread made from 20%, 30%, and 40% of Amaranthus had higher \((p < 0.05)\) moisture content as compared to control and 10% Amaranthus-blended bread. The study revealed that the moisture content was increased as Amaranthus concentration is increased. The higher moisture content of bread made from higher Amaranthus concentration is might be due to high water absorption capacity of Amaranthus as reported by [11].

<table>
<thead>
<tr>
<th>Composite flour</th>
<th>C</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat flour</td>
<td>100%</td>
<td>90%</td>
<td>80%</td>
<td>70%</td>
<td>60%</td>
</tr>
<tr>
<td>Amaranthus flour</td>
<td>_</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
</tr>
</tbody>
</table>

C is control (100% wheat), C1 is 90% wheat and 10% Amaranthus, C2 is 80% wheat and 20% Amaranthus, C3 is 70% wheat and 30% Amaranthus, and C4 is 60% wheat and 40% Amaranthus.
Table 2: Effect of blending ratio on proximate composition of wheat-amaranth bread.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Fiber (%)</th>
<th>Carbohydrate (%)</th>
<th>Energy (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>7.18 ± 0.02c</td>
<td>8.17 ± 0.13b</td>
<td>3.95 ± 0.01c</td>
<td>1.36 ± 0.00d</td>
<td>1.86 ± 0.01c</td>
<td>77.48 ± 0.14a</td>
<td>378.15 ± 0.38a</td>
</tr>
<tr>
<td>C1</td>
<td>7.25 ± 0.03b</td>
<td>8.23 ± 0.35b</td>
<td>4.12 ± 0.29b</td>
<td>1.35 ± 0.01d</td>
<td>1.95 ± 0.01c</td>
<td>77.10 ± 0.24c</td>
<td>378.46 ± 0.29a</td>
</tr>
<tr>
<td>C2</td>
<td>7.67 ± 0.14a</td>
<td>9.34 ± 0.34ab</td>
<td>4.42 ± 0.08ab</td>
<td>1.46 ± 0.27c</td>
<td>2.16 ± 0.27b</td>
<td>74.95 ± 0.18b</td>
<td>376.94 ± 0.51a</td>
</tr>
<tr>
<td>C3</td>
<td>7.86 ± 0.11a</td>
<td>9.83 ± 0.13a</td>
<td>4.66 ± 0.01ab</td>
<td>1.78 ± 0.28b</td>
<td>2.78 ± 0.28a</td>
<td>73.09 ± 0.28c</td>
<td>376.62 ± 0.42a</td>
</tr>
<tr>
<td>C4</td>
<td>7.71 ± 0.02a</td>
<td>9.96 ± 0.12a</td>
<td>4.94 ± 0.02a</td>
<td>1.99 ± 0.02a</td>
<td>2.99 ± 0.02b</td>
<td>73.41 ± 0.15b</td>
<td>377.94 ± 0.35a</td>
</tr>
</tbody>
</table>

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Amaranthus, and Amaranthus concentration increases as the protein content increases. The increase in protein content might be due to the fact that Amaranthus has high protein content as compared to wheat [12].

The fat content is varied from 3.95 to 4.94. Bread made from 10%, 20%, 30%, and 40% Amaranthus had higher (p < 0.05) fat content as compared to control (100% wheat). The study showed, as amaranthus concentration increases from 10% to 40%, the fat content was increased. The increase in fat content as Amaranthus increased is because Amaranthus has higher nutritional profile as compared to wheat and other cereals as reported by [13].

The ash content of bread is varied from 1.36 to 1.99. Bread made from 20%, 30%, and 40% of Amaranthus had higher (p < 0.05) ash content as compared to bread made from 10% Amaranthus and control (100% wheat). The increase in ash content might be due to Amaranthus having higher mineral content than wheat.

The fiber content is varied from 1.86 to 2.99. The fiber content is slightly increased as Amaranthus concentration is increased from 10% to 40%. However, bread made from 30% and 40% Amaranthus had significantly higher (p < 0.05) fiber content as compared to control (100% wheat), 10%, and 20%. The increase in fiber content as Amaranthus increased is because Amaranthus has good nutritional profile and higher fiber content as it is a very fine cereal as compared to wheat [12].

The carbohydrate is varied from 77.48 to 73.41. The carbohydrate is slightly decreased as Amaranthus concentration is increased from 10% to 40%. The decrease in carbohydrate as Amaranthus increased is because of the increase in moisture, protein, fat, ash, and fiber.

The gross energy is varied from 378.15 to 377.94. The energy is insignificantly decreased (p > 0.05). The increase in gross energy might be due to the increase in carbohydrate as Amaranthus concentration is increased.

3.2 Antinutritional Content. The antinutritional content of bread formulated from wheat and Amaranthus is presented in (Figure 1). The antinutritional (phytate and tannin) content of bread is varied from 4.19 to 5.31 and 1.63 to 1.98, respectively. Bread made from 30% and 40% of Amaranthus had similar (p > 0.05) phytate content, and similarly, bread made from 10%, 20%, and 30% of Amaranthus had also similar (p > 0.05) phytate content, but they had higher (p < 0.05) phytate content as compared to control (100% wheat). Bread made from 10%, 20%, and 30% of Amaranthus had similar protein content increases as compared to wheat [12].

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**Conflicts of Interest**
The authors declare that they have no competing interests.

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References


