

Nutritional Composition and Organoleptic Properties of Composite Maize Porridge

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Abstract

Porridge is one of the most popular staple food eaten by many people in some developed countries, most especially African countries. This study was aimed at exploring the potentials of compositing maize with wheat to produce porridge. Composite flours in ratios of 10:90%, 20:80%, 30:70% and 40:60% (maize:wheat) were formulated to produce composite porridge while 100% wheat flour was used as the control sample. The nutritional compositions of the composite flour produced were evaluated. Organoleptic evaluation of the composite porridge produced was also conducted using a 7-point hedonic scale; results obtained were subjected to inferential and descriptive statistics. Results from this study revealed that the protein content of composite flour ranged between 6.14% to 15.10%, with the control sample having the highest protein content 15.10% and composite flour, which contains 40% maize had the lowest protein content of 6.14%. However, the composite flour had a higher percentage of fat, ash, crude fiber, moisture and carbohydrates content than the control sample. Furthermore, organoleptic results showed that there existed no significant difference between the 100% wheat porridge and porridge with 10% and 20% maize flour. Findings from this study established that compositing 10% to 20% maize with wheat flour to produce porridge concealed its nutritional as well as organoleptic qualities, which competed favorably with 100% wheat porridge. Therefore, commercial production of 10% to 20% composite porridge flour can be encouraged globally.

Keywords: Wheat flour; Maize flour; Composite porridge; Nutritional; Organoleptic attributes

Introduction

Maize (*Zea mays*) is one of the highest produced grain crops with an annual production of about 875 million tons, which is a major staple food containing about 80% of the total calories [1]. It is known to be a traditional staple diet, especially to families with a very low income. Maize majorly supplies starch and its flour is used in home cooking as well as processed food products [2]. Sweetener and high fructose syrups can also be produced from fermented maize. Maize flour can be made into a thick porridge known with different names such as Ugali or Ogi (Nigeria), meal pap (South Africa), Polenta (Italy), Angu (Brazil), Mamaliga (Romania) [3].

Wheat, another popular crop is known to contain higher nutritional value among other cereal crops grown as staple foods. It is a very rich source of minerals, fiber, essential amino acids, phytochemicals and fat-soluble vitamins [4]. Wheat flour has about 14% moisture content and good amylase activity with attractive appearance [5]. Alternatively, flour produced from oats, cassava, and maize has been used to supplement the use of wheat flour in food processing because of the high demand, cost of buying and geographical scarcity of wheat flour [6].

Concerning composite flours, they are mixtures of flours from cereals (e.g. rice, maize, and millet), roots and tubers crops such as peanut, sweet potato and cassava with or without wheat flour [6]. This helps in managing costs associated with the importation of wheat flour in some countries where wheat is not grown due to climate change [7]. There are so many advantages to the use of composite flour in developing countries, some of which are: better overall usage of domestic agricultural products, reduction in the cost of money spent on foods, availability of more protein-rich foods and promotion of indigenous crops. Moreover, the protein quality of maize is deficient in Tryptophan and Lysine while that of wheat lacks essential amino acids Threonine and Lysine. Hence, the need for compositing these two cereal crops to produce porridge flour, this will enhance the nutritional qualities of these cereals protein, promote utilization of maize and also reduce complete reliance on

imported wheat in many countries [8]. This present study was therefore aimed at investigating the influence of compositing maize with wheat in the production of porridge flour and evaluating the organoleptic attributes of porridge meal produced from flour blends of wheat and maize. This was with a view to promote further utilization of maize and reduce total dependence on wheat in foods production, thus improving the lives and income of local farmers.

Materials and Methods

Procurement of raw materials

Wheat and white maize varieties were procured from a local market in Kwa-Dlangezwa area, Kwa-Zulu Natal province, South Africa. All chemicals and reagents of analytical grade were procured from a registered laboratory.

Maize flour production

Figure 1 depicts the maize flour production.

Production of wheat flour: Figure 2 depicts the production of wheat flour.

Formulation of composites: Composite flours in ratios of 10:90, 20:80, 30:70 and 40:60 w/w for maize and wheat flour were formulated to produce composite porridge while the control sample used was 100% wheat flour.

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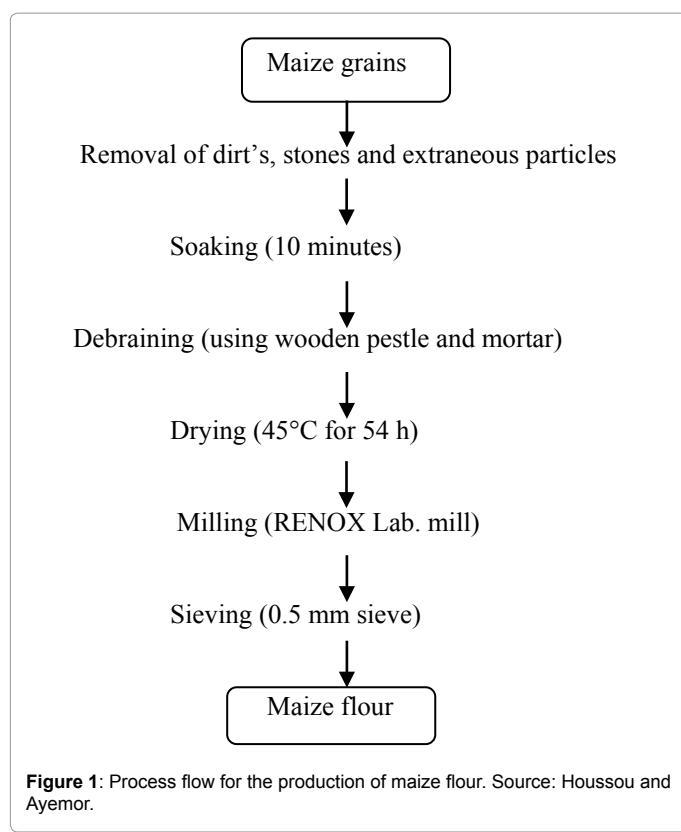


Figure 1: Process flow for the production of maize flour. Source: Houssou and Ayemor.

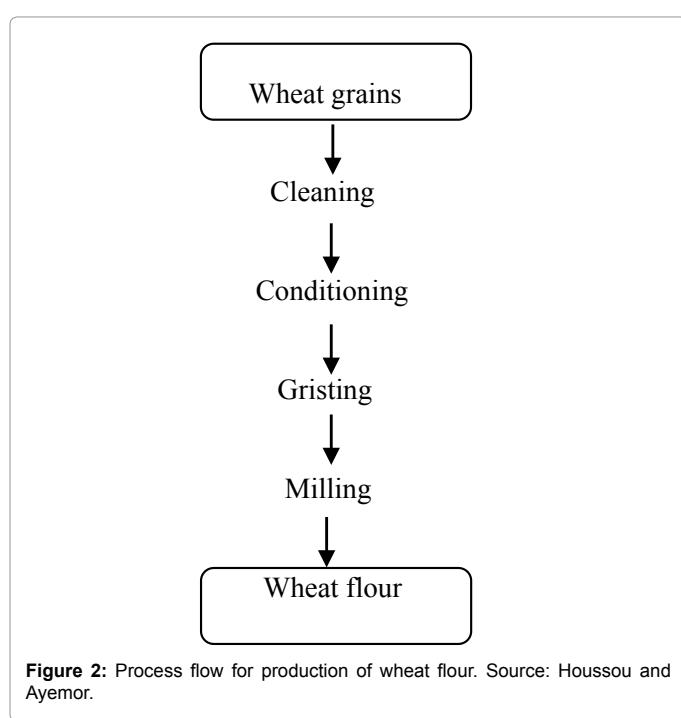


Figure 2: Process flow for production of wheat flour. Source: Houssou and Ayemor.

Porridge preparation: A clean tap water (600 ml) was poured in a saucepan and brought to boil after which 250 g of the composite flour produced was added to the pan while stirring. A pinch of salt added to all samples and stirred consistently for about 7 mins. The mixture was heated while stirring continuously to avoid the formation of lumps until it got boiled for 5 mins [9]. The procedure was repeated for all

other composite flours, using 100% wheat flour as the control. Porridge was served in a flat plate and ready for sensory evaluation.

Proximate analysis of the composite porridge flour

Protein content determination: Crude protein was determined following the Kjeldahl nitrogen method described by AOAC [10] and calculated using:

$$\% \text{ Nitrogen} = \frac{0.28}{\text{Weight of sample in gram}} \times A (\text{Volume(ml) of } 0.1 \text{ M H}_2\text{SO}_4) \quad (1)$$

Fat content determination: Fat content was determined as described by Adeyeye and Akingbala [11] and AOAC [10] using the Soxhlet extraction method and calculated as:

$$\% \text{ Ether extract} = \frac{\text{Final weight of flask}-\text{Initial weight of flask}}{\text{Sample weight}} \times 100 \quad (2)$$

Moisture content determination: The moisture content of composite flour produced was determined using the oven as described by AOAC [10] and calculated as:

$$\% \text{ Moisture content} = \frac{\text{Loss in weight of sample}}{\text{Original weight}} \times 100 \quad (3)$$

Ash content determination: About 2 g of each sample was ignited at 600°C in a muffle furnace for 6 hours while the residue was cooled in a desiccator and weighed [10].

$$\% \text{ Ash} = \frac{\text{Weight of Ash}}{\text{Original weight of sample}} \times 100 \quad (4)$$

Crude fiber content determination: The crude fiber was also determined by AOAC [10] method and calculated as:

$$\% \text{ Crude fiber} = \frac{\text{Weight of Residue}-\text{Weight of Ash}}{\text{Weight of sample}} \times 100 \quad (5)$$

Carbohydrate content determination: The carbohydrate content of each of the sample was calculated as:

$$\% \text{ Carbohydrate} = 100\% - (\% \text{ crude protein} + \% \text{ crude fat} + \% \text{ crude fiber} + \% \text{ ash} + \% \text{ moisture}) \quad (6)$$

Sensory evaluation of composite porridge: The sensory evaluations of the composite porridges produced from the different blends were conducted. Parameters evaluated were texture, aroma, taste, colour/appearance, and overall acceptability using a 7 point hedonic scale (1 represented dislike extremely and 7 represented like extremely).

Statistical analysis

The results from this study were subjected to statistical analysis to determine possible differences among samples by Duncan's multiple range test using the SPSS programme [12]. Significant differences were expressed at $p < 0.05$ [13].

Results and Discussion

Proximate analysis

The results of the proximate analyses on the composite flour produced are presented in Table 1. A significance difference ($p \leq 0.05$) was observed in the protein content of the composite flour ranged between $5.96 \pm 0.09\%$ and $15.10 \pm 0.45\%$, with Sample A having the highest protein content. However, the higher the percentage of maize

| Samples (Maize: Wheat) | Protein (%) | Fat (%) | Moisture (%) | Ash (%) | Fiber (%) | Carbohydrates (%) |
|------------------------|---------------------------|--------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| A | 15.10 ± 0.45 ^a | 1.82 ± 0.04 ^c | 9.86 ± 0.01 ^b | 1.52 ± 0.02 ^c | 11.71 ± 0.09 ^d | 59.99 ± 0.03 ^d |
| B | 10.39 ± 0.30 ^b | 1.94 ± 0.03 ^c | 10.09 ± 0.09 ^a | 1.69 ± 0.01 ^c | 13.28 ± 0.05 ^c | 62.61 ± 0.04 ^c |
| C | 8.81 ± 0.12 ^c | 2.15 ± 0.09 ^b | 10.41 ± 0.03 ^a | 1.71 ± 0.03 ^c | 13.45 ± 0.04 ^c | 63.47 ± 0.06 ^b |
| D | 5.96 ± 0.09 ^d | 2.48 ± 0.02 ^b | 10.76 ± 0.04 ^a | 2.06 ± 0.05 ^b | 14.93 ± 0.10 ^b | 63.81 ± 0.03 ^b |
| E | 6.14 ± 0.06 ^e | 2.57 ± 0.01 ^a | 10.91 ± 0.05 ^a | 2.32 ± 0.0 9 ^a | 15.27 ± 0.50 ^d | 65.79 ± 0.12 ^d |

Sample A=100% wheat flour; Sample B =10% maize, 90% wheat; Sample C=20% maize, 80% wheat; Sample D=30% maize, 70% wheat; Sample E=40% maize, 60% wheat

The same superscript on the same mean column followed by is significantly not different at 5% level significance

Table 1: Proximate composition of composite flour.

| Samples | Taste | Appearance | Texture | Aroma | Overall Acceptability |
|---------|---------------------------|--------------------------|--------------------------|---------------------------|--------------------------|
| A | 7.81 ± 0.15 ^a | 8.25 ± 0.30 ^a | 6.73 ± 0.15 ^a | 5.97 ± 0.66 ^a | 6.79 ± 0.25 ^a |
| B | 7.69 ± 0.91 ^a | 8.09 ± 0.04 ^a | 6.65 ± 0.09 ^a | 6.73 ± 1.59 ^b | 6.70 ± 0.37 ^a |
| C | 7.42 ± 0.22 ^a | 7.87 ± 0.51 ^b | 6.49 ± 0.4 ^a | 6.68 ± 1.27 ^b | 6.52 ± 0.19 ^b |
| D | 7.01 ± 0.43 ^{ab} | 7.54 ± 0.27 ^b | 6.31 ± 0.67 ^a | 6.43 ± 0.47 ^{bc} | 5.31 ± 0.04 ^c |
| E | 6.54 ± 0.15 ^b | 7.21 ± 0.14 ^b | 5.84 ± 0.73 ^b | 4.85 ± 1.37 ^c | 4.86 ± 0.54 ^c |

Sample A=100% wheat flour, Sample B =10% maize, 90% wheat; Sample C=20% maize, 80% wheat; Sample D=30% maize, 70% wheat; Sample E=40% maize, 60% wheat
The same superscript on the same mean column followed by is significantly not different at 5% level significance

Table 2: Organoleptic evaluation of composite porridge.

flour, the lower the protein contents of the composite porridge as the least protein value was observed in the porridge containing 40% maize flour.

The high protein content observed in 100% wheat flour indicated that wheat contained significant amounts of protein than maize. This higher protein content might be due to higher protein digestibility in the sample as well as the presence of total essential amino acids in wheat. The protein value recorded for the composite flours decreased with an increase in the percentage of maize composited with wheat.

Moreover, the moisture content of all the composite flour ranged between 9.86 ± 0.01% and 10.91 ± 0.05% with sample E having the highest value. This result confirmed that maize had higher moisture content than wheat; which further indicated that wheat can stay longer during storage than maize. However, compositing wheat and maize can prolong the shelf life of maize [14,15] also observed a similar trend during the production of composite bread using wheat and sorghum.

However, the fat, ash, crude fiber and carbohydrates content of all the composite flours were higher than the control (sample A). With that, the ash contents decreased with a decrease in the percentage of maize in the composite flour, ranged from 1.52 ± 0.02% for Sample A to 2.32 ± 0.09% for Sample E. This was within the specified range of ash content in foods as reported by Adelek et al. [16]. The range of ash contents observed in this study depicted that the composites flour produced are rich in significant amounts of mineral [17,18]. A similar increase in ash content in wheat-cassava composite flour was also reported by Masamba and Jinazali [19].

Similarly, the crude fiber content of the composite porridge flour significantly ($p \leq 0.05$) ranged between (11.71 ± 0.09)% and (15.27 ± 0.50)%. Whole wheat flour (Sample A) had the lowest fibre content of 11.71% while the highest 15.27% was recorded for Sample containing 40% maize flour. The increase observed in the crude fibre content of all the composite samples might be as a result of excess crude fibre in maize than in wheat. However, compositing maize with wheat resulted in composite porridge flour with a reasonable amount of crude fibre. In another finding, an increase in substitution level of maize flour contributed to the increased crude fibre content of the composite

porridge, unlike the whole wheat porridge. Crude fibres are known to be indigestible to the digestive system of man, which are significant to colon and heart because they have the ability to delay the release of gastric juice, modulate inflammations of the intestines and also improve the bulk of food [20].

Moreover, fat content also increased with increase in the percentage of maize, ranged between 1.82 ± 0.04% and 2.48 ± 0.02% with Sample E having the highest value while Sample A had the lowest fat content. This might be because maize had a high content of fat than other cereals.

Sample A (100% wheat) had the lowest carbohydrate content of 59.99 ± 0.03% whereas Sample E containing 40% maize had the highest content of 65.79 ± 0.12%. This confirmed that maize contained more carbohydrates and high satiety value than wheat [21] also observed a similar increase in carbohydrate content in composite cake because maize contained a high amount of starch.

Organoleptic evaluation of composite porridge

The mean results of the organoleptic analyses on the composite porridge are shown in Table 2. All the composite porridges produced competed positively with the control porridge (Sample A) in all the parameters evaluated. For taste scores, Samples B and C (10% maize: 90% wheat and 20% maize: 80% wheat) had mean scores of 7.79 and 7.42 respectively. This depicted that compositing maize with wheat to produce porridge positively affected the taste of the porridge significantly when compared to the control Sample A. Sample B and C also recorded higher mean scores for aroma, texture, and color whereas Sample D and E (30% maize: 70% wheat and 40% maize: 60% wheat respectively) had lower sensory scores in all parameters evaluated.

Furthermore, the mean scores for Sample B in terms of appearance, texture, and aroma were 8.09, 6.65 and 6.73 respectively, these were not significantly different from Sample A. From the result, composite porridge containing 10% maize had the finest and best color. Samples D and E containing 30% and 40% maize respectively had lower scores in all the organoleptic parameters evaluated and not significantly different from each other. They were rated lower by the panelists probably due to their change in taste, color, and texture.

Considering the scores for the organoleptic qualities the overall acceptability of all the samples varied from 4.86-6.89, with Sample E having the lowest score while Sample A had the highest score. Porridges containing 10% and 20% (Samples B and C) had overall acceptability scores of 6.70 and 6.52 respectively. Sample B was preferred comparably to Sample A (6.79), this may be attributed to the similar taste, texture, appearance, and texture it had with Sample A. Similar results were also reported from the comparative study on composite bread with wheat and cassava [22,23] also had similar report on the organoleptic acceptability of composite porridge from sorghum and bean. Likewise, higher overall acceptability of maize-Bambara groundnut complementary food was reported by Mbata et al. [24]. Therefore, producing a composite wheat porridge containing 10% to 20% maize can compete favorably with 100% wheat porridge in all organoleptic parameters [25,26].

Conclusion

This study concluded that different substitution level of maize flour with wheat does not have a significant effect on the nutritional value of the composite porridge flour produced. The overall acceptability of the composite porridge increased with a decrease in the percentage of maize added. Sample E containing the highest percentage of maize was not accepted by the panelists in all the quality attributes evaluated. However, Sample B was accepted in all the organoleptic parameters evaluated. Findings from this study established that the overall acceptability of the composite porridges was influenced by aroma, texture, color, and appearance. Therefore, 90% wheat with 10% to 20% maize composite porridge could be produced and commercialized without affecting any nutritional and sensory quality attributes.

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