



Sensory Evaluation of Ugali Prepared from Blends of Cereal Flours and High Quality Cassava Flour in Mwanza Region, Tanzania

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Authors' contributions

This work was carried out in collaboration among all authors. Authors EMK, MLK and CMC contributed to concept development, questionnaire design, data analysis and interpretation, manuscript preparation and finalization. Author EET contributed to manuscript preparation and manuscript finalization. Authors DGM and PWM contributed to data analysis and interpretation and manuscript finalization. All authors read and approved the final manuscript.

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ABSTRACT

Objective: Ugali is an important meal in many parts of Eastern and Southern Africa and is typically prepared from a single staple food like maize, cassava, millet and sorghum or their composite. The objective of this study was to understand the perception of sensory parameters when varying ratios of maize (refined and unrefined) and sorghum flour when substituted with high quality cassava flour (HQCF) 80%, 60%, 40% and 20% in the preparation of ugali.

Methodology: The samples of ugali prepared were randomly subjected to panelists to evaluate sensory attributes preferred most by panelists. Thirty semi trained panelists who were females and males aged above 18 years participated and gave information on sensory signals. The panelists evaluated the samples independently and recorded the rating of the samples in the sensory evaluation questionnaire. The sensory parameters of ugali assessed were color, cookerability, taste, texture, aroma and general acceptability using a five point hedonic scale.

Results: Ugali made from the blends of unrefined maize flour (Dona) and HQCF as well as sorghum flour and HQCF at the ratio of 20:80 and 20:80 respectively were highly acceptable by

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panelists (mean score < 3). Ugali made from refined maize flour (Sembe) blended with HQCF at ratio of 80:20 was also preferred by panelists (mean score < 3) as compared to ugali made from other ratios. The highly acceptability (mean score < 3) of the ugali was influenced by color, cookerability, taste, texture, aroma. At these flour ratios the blends of flours resulted in increment of protein, fats and slightly decrease in starch content.

Conclusion: Blending HQCF and cereals (sorghum and maize) flours improved the organoleptic and nutritional properties of ugali.

Keywords: Sensory evaluation; ugali; cassava flour; Mwanza.

1. INTRODUCTION

Desk and field research findings suggest that residents of both urban and rural areas in Tanzania consume ugali (20-30% solid) at least in one meal of the day [1,2]. Repetitiveness consumption of ugali is a consequence of experience on its sensory qualities [3,4], accessibility of cassava and cereals and affordable price [3,4]. Urban sprawl has produced a growing number of low and middle income commuters who live in the outskirts of large metropolis and work in the city centers [5]. On this backdrop, food product developed to suffice their needs should be more natural and less processed [6], inexpensive, familiar, convenience and tasty [7,8]. Any modification in ugali should maintain consistency in sensory qualities and price to warrant sustainable consumption [5,7]. Understanding the perception of individual attribute of food by consumers is paramount for successful product development [9].

The blending of cassava and cereal flours is a common practice in urban areas specifically in lake zone [4,10,11]. Ugali produced customarily have improved taste [4,11] and change in prices is relatively low [4]. On the other hand, consumers appreciation to nutritious and healthy food is an increasingly habit in every parts of the global [12]. Cassava although providing enough calories and beneficial fibers [13,14], is low in fat and protein content [14]. Whereas, cereal flour's drawback is that the proteins are not complete because of the low content of essential amino acids such as lysine, tryptophan and threonine [15,16]. Active and healthy life person needs not only enough kilocalories to eat but also protein, fat and micronutrients. Thus blending of cassava with cereals (maize, sorghum and millet) enriches nutritional value offering comparative gains and minimizing their nutritional discrepancies [2]. Cereals especially when used as whole are good source providing a good

proportion of carbohydrates, proteins, vitamins and minerals [3,17].

Ugali, although rated among the staple food in the country, its preparation by either household or food vendors base on experience resulting into inconsistency in sensory quality. The lack of appropriate ratios of blends of cassava and cereal flour may affect consumption as ugali sensory qualities varies even from the same chef [4]. Aligned to this, descriptive analysis plays major role in appreciating intrinsic factors that influence consumer's liking or disliking of the food product [4,18]. Sensory intrinsic factors such taste, color, texture, and aroma signals are sensed by consumers even before consumption of the food [7,19]. Therefore, the objective of this study was aimed at determining appropriate level of blends of high quality cassava flour (HQCF) and cereal flours for the preparation of ugali among the lake zone communities of Tanzania.

2. MATERIALS AND METHODS

2.1 Materials

High quality cassava flour (HQCF) which is unfermented cassava flour [4] was prepared from Mkombozi cassava variety was purchased from Mkombozi cassava processing center in Sengerema district. The unrefined maize flour (Dona), sorghum flour and refined maize flour (Sembe) were purchased from Mwanza city central market.

2.2 Formulation of Composite Flours

The high quality cassava flour (HQCF) was mixed separately with either unrefined maize flour (Dona), refined maize flour (Sembe) or sorghum flour at the ratio of 20:80, 40:60, 60:40, 80:20 and 0:100. A total of fifteen samples were formulated based on these ratios. The ratio of 0:100 were used as the control and the resulted blended flours were weighing one kilogram each.

2.3 Preparation of Ugali

The flour was gradually added to two liters of boiling water and stirred continuously to form a uniform ugali or until a desired consistency was achieved (ugali). Unblended flours from unrefined maize (Dona), sorghum and refined maize (sembe) flour used for making ugali separately in the same manner as explained above and termed as control.

2.4 Sensory Evaluation of Ugali

The descriptive analysis described in [20] with slight changes was used to evaluate sensory profile of ugali to determine the most preferred ratio (20:80, 40:60, 60:40, 80:20 and 0:100) of blends of HQCF and cereal flours. Thirty, semi trained panelists (16 males and 14 females) aged between 20 and 60 years from Lake Zone Agricultural Research and Development Institute (LZARDI) who are familiar with eating ugali were participated in the sensory evaluation. Small piece of cooked samples of ugali (HQCF: Sembe, HQCF: Dona and HQCF: Sorghum) was placed on labeled plates, given random numbers to differentiate from one another. The panelist evaluated the samples independently and recorded the rate of preference of the samples of ugali in the sensory evaluation questionnaire. The sensory characteristics of ugali evaluated were color, cookability, taste, texture, aroma and general acceptability using a five point hedonic scale: 1, Like very much; 2, Like slightly; 3, neither like nor dislike; 4, Dislike slightly; 5, Dislike very much. The ugali with a mean score < 3 for a given sensory characteristic was considered satisfactory and a mean score > 3 was considered unsatisfactory for that sensory characteristic. The panelists were provided with clean drinking water to rinse the mouth before testing each sample of ugali and in between tests. The samples of ugali from three blends of flours were evaluated on the same day as well as the same environment.

2.5 Proximate Composition Analysis

The determination of the physical and chemical composition of flours samples viz: moisture content, ash content, protein content, fat content, and starch content were determined by the methods described by Helrich K [21]. The pH of HQCF and cereal flours was measured using the pH meter as described by Mlingi L. V. [22].

2.6 Data Analysis

All data obtained from proximate composition analysis and sensory evaluation of ugali prepared from the blends of cereal flours and high quality cassava flour were subjected to one way analysis of variance (ANOVA) and means were separated by Duncan Multiple Range Test using SPSS Statistics 22.0 version.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Flours

The proximate analyses of sorghum, maize (sembe and dona) flours ((Table 1) used in various blends showed a substantial amount of proteins (9.01 to 10.04%) and fats (2.50 to 3.10%) to that of HQCF (0.98% protein and 0.62% fats). A low amount of protein and fats in HQCF has been documented [14,23]. The moisture content of all flours ranged from 11.13% to 12.74% and was within the acceptable levels for dried flour reported in another research [24]. The slight increment of moisture content in HQCF could be attributed to the tendency of cassava starch uptake and withholding water [25,26]. The starch content ranged from 63.19 to 75.98%, low starch content observed in dona whilst sembe showed a slight high starch content. A range of starch content of sorghum flour 65.57% to 76.28% was reported by [27]. The starch content of Dona was within the range 60.38 to 66.31% [28] and 61 to 78% [29] of other reported researches. The slight high starch content of sembe (75.98%) over dona (63.19%) both made from maize could be associated with a removal of brans and germ during the refining process resulting into concentrated starch. Refined grains have higher starch content than whole grains [30]. Moreover, Onyango [31] studying physical properties of dry-milled maize meals and their relationship with the texture of stiff and thin porridge found the refined maize meals to have concentrated carbohydrate and low in protein, fat, ash and fiber than whole milled maize meals. The starch content of HQCF was 67.69%, according to [14] HQCF contains a starch between 66.48 and 68.73%. The ash value for sorghum flour was 1.75% dona 1.14%, Sembe 0.57%, and HQCF 1.54%. The ash value of sorghum in this study concurs to value (1.12 to 2.29%) obtained in Ethiopia [32]. The pH of flours was between 5.51 to 6.67 which fell within the acceptable value (5.5 -7.0) of HQCF [33] and this range value indicates unfermented HQCF [14]. The pH for cereal flours was close to neutral pH.

Table 1. Proximate composition of flours used in blends

Flour	Protein (%)	Fat (%)	Starch (%)	Moisture (%)	Ash (%)	pH
Sorghum	10.04+0.06	3.10+0.09	70.50+0.07	11.13+0.00	1.75+0.01	6.67+0.01
Dona	9.01+0.03	3.38+0.01	63.19+1.48	10.74+0.13	1.14+0.02	6.48+0.01
Sembe	8.94+0.24	2.50+0.15	75.98+2.58	12.23+0.12	0.57+0.00	6.19+0.00
HQCF	0.98+0.06	0.62+0.00	67.69+2.00	12.61+0.05	1.54+0.00	5.51+0.05

3.2 Ugali Made from Blends of Unrefined Maize (Dona) Flour and HQCF

The sensory mean scores of ugali made from blends of unrefined maize flour (Dona) and HQCF are presented in Table 2. Panelists did not notice any difference ($P > 0.05$) in color amongst ugali made from blends of unrefined maize flour (Dona) and HQCF. The increase in HQCF above 40% produced the color which looked more attractive whilst deviating away from the control sample ($P < 0.005$). These findings are inconsistent with the reported findings on the blends of cassava and maize flour in Kenya [10]. This inconsistency was because of the white color of HQCF which normally produced without fermented in contrast to the fermented cassava flour used in the study conducted in Kenya [14]. Cookerability in this study refer to the processes which cassava flour or maize flour or sorghum flour or their blends with HQCF and boiled water were mixed and stirring constantly using a wooden spoon at mild heat to produce a homogeneous ugali [4]. Cookerability is normally influenced by cooking techniques employed during cooking of ugali. Poor cooking techniques may affect the homogeneity of ugali and definitely other sensory parameters, specifically the appearance, taste and texture. It should be noted that cookerability is subjective, meaning that the cook has to decide the level of homogeneity based on experience. Cookerability of all samples were rated acceptable (mean score < 3).

The taste scores were statistically significant ($P < 0.05$) except for 20:80 that was highly preferred. Generally, increasing of HQCF promoted a good taste, texture and aroma liking to panelists even though all samples rated acceptable (mean score < 3). In this study all sensory parameters influenced the liking with color observed the most important contributor for every ratio of blends of unrefined maize flour (Dona) and cassava flour. Consumers of ugali usually pay more attention on color/appearance and taste. The unrefined maize blended with HQCF at 20:80 was highly rated acceptable and differed significantly with control.

3.3 Ugali Made from Blends of Refined Maize Flour (Sembe) and HQCF

The results of the sensory parameters of ugali made from blends of Sembe and HQCF are presented in Table 3. The panel results revealed that color of ugali was rated acceptable (mean score < 3) for all ratios. The color of sample prepared at ratio 80:20 differed significant ($P < 0.05$) with control sample (100:0) and was the one highly liked. Blending refined maize flour with low amount of HQCF was found to improve cookerability, taste, texture and aroma. Both sembe and HQCF had a white color which is more preferred by consumers in the lake zone. Comparing the color of ugali made from the blends of dona and HQCF to that of sembe and HQCF, one would expect the later rated high at high amount of HQCF. In contrary, dona:HQCF color was the highly preferred. Though appeared inconsequent expectation, the observation established that increasing amount of HQCF in sembe caused stickiness of ugali in the palm of the hand when it was kneaded to form a ball before chewing. Suggestively this might have affected the liking of sembe:HQCF at higher amount in contrary to dona:HQCF. Agreeing with [9] that product's sensory attributes may not be so direct as other subjective and complex dimensions are also influencing preference. The gummy texture that produced because of gelatinization of cassava when reconstituted in warm water was potential attribute to consider [3]. The general acceptability was at 20% inclusion of HQCF.

3.4 Ugali Made from Blends of Sorghum Flour and HQCF

The sensory evaluation results of ugali made from the blends of sorghum and HQCF are displayed in Table 4. Significant different ($P < 0.05$) was observed in color, cookerability, taste and aroma of blended samples over a control. The progressive increase of HQCF stimulated sensory signals of liking of composite product. This result concurs to the previous reported findings on the blend of cassava and sorghum flour at the ratio of 4:1 which preferred

Table 2. Sensory evaluation scores for color, cookerability, taste, texture, aroma and general acceptability from ugali made from the blends of unrefined maize flour (Dona) and cassava flour (HQCF) at different ratios

Dona: HQCF	Color	Cookerability	Taste	Texture	Aroma	General acceptability
100:0	1.98 ± 0.04 ^{ab}	2.16 ± 0.04 ^b	2.39 ± 0.02 ^a	2.41 ± 0.05 ^a	2.48 ± 0.07 ^a	2.59 ± 0.08 ^a
80:20	1.77 ± 0.08 ^{bc}	2.86 ± 0.12 ^a	2.40 ± 0.03 ^a	2.35 ± 0.10 ^{ab}	2.44 ± 0.05 ^a	2.49 ± 0.13 ^a
60:40	1.72 ± 0.10 ^c	2.13 ± 0.09 ^b	2.30 ± 0.09 ^a	2.27 ± 0.06 ^b	2.15 ± 0.05 ^b	2.10 ± 0.03 ^b
40:60	1.72 ± 0.15 ^c	1.95 ± 0.02 ^c	2.26 ± 0.18 ^a	2.13 ± 0.06 ^c	2.36 ± 0.18 ^a	2.01 ± 0.14 ^b
20:80	1.64 ± 0.01 ^c	2.02 ± 0.04 ^{bc}	1.96 ± 0.04 ^b	2.02 ± 0.04 ^c	2.12 ± 0.02 ^b	1.99 ± 0.09 ^b

Mean scores within a parameter followed by the different superscript are not significantly different ($P > 0.05$)

Table 3. Sensory evaluation mean scores for color, cookerability, taste, texture, aroma and general acceptability from ugali made from the blends of refined maize flour and cassava flour (HQCF) at different ratios

Sembe: HQCF	Color	Cookerability	Taste	Texture	Aroma	General acceptability
100:0	1.74 ± 0.09 ^c	1.98 ± 0.12 ^b	2.44 ± 0.08 ^{ab}	1.88 ± 0.08 ^c	2.29 ± 0.12 ^b	2.11 ± 0.09 ^{bc}
80:20	1.57 ± 0.06 ^c	1.71 ± 0.08 ^c	1.94 ± 0.08 ^c	1.94 ± 0.08 ^{bc}	1.94 ± 0.09 ^c	1.94 ± 0.09 ^c
60:40	2.09 ± 0.07 ^b	2.14 ± 0.08 ^b	1.96 ± 0.10 ^c	2.09 ± 0.07 ^b	2.19 ± 0.08 ^b	2.23 ± 0.08 ^b
40:60	2.26 ± 0.16 ^b	2.20 ± 0.17 ^b	2.38 ± 0.15 ^a	2.11 ± 0.11 ^b	2.54 ± 0.09 ^a	2.52 ± 0.10 ^a
20:80	2.70 ± 0.06 ^a	2.46 ± 0.13 ^a	2.18 ± 0.08 ^b	2.44 ± 0.09 ^a	2.44 ± 0.08 ^a	2.48 ± 0.08 ^a

Mean scores within a parameter followed by the same superscript are not significantly different ($P > 0.05$)

Table 4. Sensory evaluation mean scores for color, cookerability, taste, texture, aroma and general acceptability from ugali made from the blends of sorghum flour and cassava flour (HQCF) at different ratios

Sorghum: HQCF	Color	Cookerability	Taste	Texture	Aroma	General acceptability
100:0	3.63 ± 0.03 ^a	3.16 ± 0.07 ^a	3.65 ± 0.07 ^a	3.27 ± 0.1 ^a	3.47 ± 0.02 ^a	3.87 ± 0.15 ^a
80:20	2.67 ± 0.07 ^b	2.59 ± 0.42 ^b	3.02 ± 0.11 ^b	2.87 ± 0.06 ^b	2.61 ± 0.05 ^b	3.09 ± 0.07 ^b
60:40	2.24 ± 0.08 ^c	2.09 ± 0.13 ^c	2.56 ± 0.09 ^c	2.49 ± 0.13 ^c	2.37 ± 0.08 ^c	2.27 ± 0.1 ^c
40:60	2.03 ± 0.089 ^d	2.08 ± 0.11 ^c	2.44 ± 0.06 ^c	2.33 ± 0.06 ^d	2.37 ± 0.15 ^c	2.24 ± 0.11 ^c
20:80	1.68 ± 0.08 ^e	1.54 ± 0.11 ^d	1.55 ± 0.08 ^d	1.74 ± 0.04 ^e	1.64 ± 0.08 ^d	1.54 ± 0.08 ^d

Mean scores within a parameter followed by the same superscript are not significantly different ($P > 0.05$)

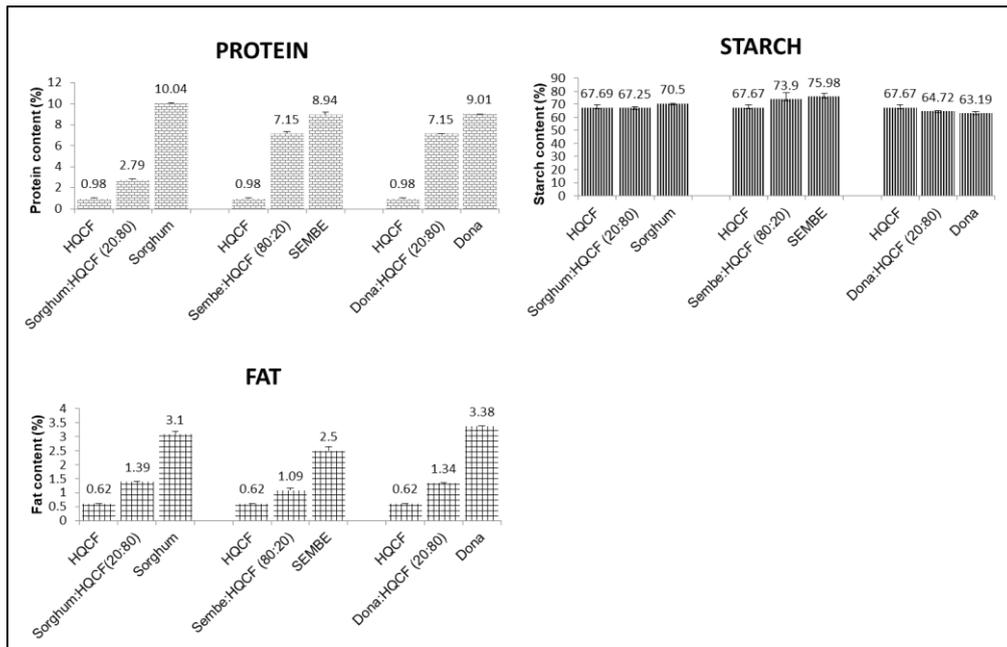


Fig. 1. Protein, fat and starch contents of blended HQCF with cereal flours at ratios preferred by panelists

in Kakamenga county western province of Kenya [3,34]. Muhihi et al. [35] reported women preferred taste of ugali made from sorghum. Small amount of sorghum in the composite flours minimize effects of bitter taste due to presence of polyphenols [3,16] also an intense red-brown color is reduced. The general acceptability by panelists was 20:80 blends of sorghum and HQCF.

3.5 Protein, Fat and Starch Contents of Blended HQCF with Cereal Flours

The results (Fig. 1) of blending HQCF with cereals improved nutrient contents. The blends of HQCF and cereals had the protein level increased by 1.81% for sorghum, 6.17% for sembe and 6.17% for dona. HQCF has had 0.62% fat content increased up to 1.39%, 1.09% and 1.34% fats when blended with sorghum, sembe and dona in respective order. The level of starch content showed a slight change in the blends of HQCF and sorghum or sembe or dona. The findings suggest nutritional content association with the percentage at which the blends of flours were made. A similar result was reported for malt-sorghum-soya composite flour [36]. As the sensory attributes influence the likeness, equally nutritional properties fascinate health-conscious consumers. The blends of HQCF and cereal flours resulted in products that were familiar by consumers, tasty and nutritious.

4. CONCLUSION

The results suggested that high quality cassava flour (HQCF) can be used to substitute refined maize flour (Sembe), unrefined maize flour (Dona) and sorghum flour at 20%, 80% and 80% respectively to improve the sensory attributes and general acceptability of ugali. Therefore efforts should be made in promoting the use of composite flour in making ugali to create demand for cassava flour which in turn will increase the production, processing and utilization of cassava and hence contribute to food security especially for small scale cassava farmers and cassava processors in the rural areas.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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