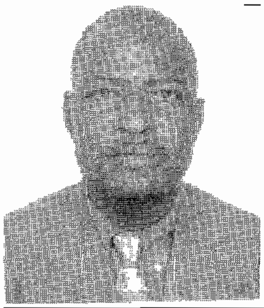

Charles Muyanja

PRODUCTION METHODS AND COMPOSITION OF *BUSHERA*: A Ugandan Traditional Fermented Cereal Beverage

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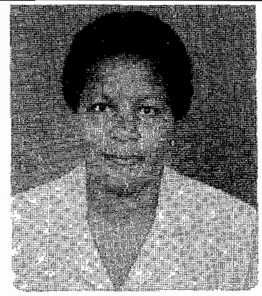

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ABSTRACT

A survey was conducted using a questionnaire to document the production methods of Bushera, a Ugandan traditional fermented cereal beverage, in the districts of Kabale and Rukungiri in the South Western region of Uganda. The chemical composition of raw materials and Bushera was determined using standard methods. Similarities in the production of Bushera in Kabale and Rukungiri districts were observed. In both districts, sorghum grains are usually (80% of respondents) soaked in water overnight (12 h), some households (20%) indicated a soaking period of 24-48 h. Eighty seven percent of the households soaked the grains in streams, rivers and ponds. The germination period for sorghum grains varied between two and four days. Sixty five percent of the households germinated the grains for two-three days. The duration of fermentation of Bushera ranged from one to six days. Most of the households (90%) consumed Bushera after two-four days of fermentation. The moisture, fat, protein and carbohydrate contents of germinated and non-germinated sorghum grains ranged from 8.8-12.4 %, 1.8-3.0 %, 7.2-10.8 % and 77.7-85.7%, respectively. Germinated sorghum flour had lower fat, protein and carbohydrate contents but higher ash and fibre than non-germinated sorghum flour. Germinated millet flour had higher moisture, protein and fibre compared to the non-germinated flour while the latter had higher ash and carbohydrate contents. Germination resulted in an increase in the concentration of sugars in both sorghum and millet grains. Great variations were observed in the proximate composition of Bushera obtained from the households. Under laboratory conditions, the protein content of Bushera produced from germinated grains was higher than Bushera from non-germinated grains (12.2% vs. 10.6%), on dry matter basis. Higher levels of iron, magnesium and zinc were observed in germinated grains due to addition of wood ash during germination. Germinated grains had lower phenol and tannin content compared to non-germinated grains.

Keywords: Germination, Fermentation, Sorghum, Millets, Bushera

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METHODS DE PRODUCTION ET COMPOSITION DE *BUSHERA:* UNE BOISSON DE CEREALES FERMENTEES TRADITIONELLE EN OUGANDA

RESUME

FRENCH

Une étude basée sur les réponses à un questionnaire a été menée pour documenter les méthodes de production du Bushera, une boisson de céréales fermentées traditionnelle en Ouganda, dans les districts de Kabale et Rukungiri situés dans la région sud-ouest de l'Ouganda. La composition chimique des matières premières et du Bushera a été établie par méthodes standard. On a observé des similarités dans la production du Bushera dans les districts de Kabale et de Rukungiri. Dans les deux districts, les graines de sorgho sont habituellement (80% des réponses) trempées dans de l'eau pendant une nuit (12h), certains ménages (20%) signalant une période de trempage de 24-48h.Les graines sont trempées dans des ruisseaux, rivières et étangs par 87% des ménages. La période de germination des graines de sorgho varie de 2 à 4 jours. Soixante-cinq pour cent des ménages font germer les graines pendant 2-3 jours. La durée de fermentation du Bushera va de 1 à 6 jours. La majorité des ménages (90%) consomment le Bushera après 2-4 jours de fermentation.

Le contenu des graines de sorgho germées et non germées en humidité, graisses, protéines et féculents était de 8,8-12,4%; 1,8-3.0%; 7,7-10,8%; et 77,7-80,2% respectivement. La farine de sorgho germé a

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une moindre teneur en graisses, protéines et féculents mais une plus forte teneur en cendres et fibres que la farine de sorgho non germé. La farine de millet germé contient plus d'humidité, protéines et fibres que la farine non germée, tandis que cette dernière a une plus forte teneur en cendres et féculents. La germination entraîne une augmentation de la concentration des sucres dans les graines de sorgho et de millet. On a constaté d'importantes variations dans la composition approximative du Bushera obtenu auprès des ménages. En laboratoire, le contenu en protéines du Bushera fait de graines germées était plus élevé que dans le Bushera de graines non germées (12,2% comparé à 10,6%), sur base de matières sèches. Des niveaux plus élevés de fer, magnésium et zinc ont été observés dans les graines germées en raison de l'apport de cendres de bois pendant la germination. Les graines germées avaient une plus basse teneur en phénol et en tanin comparé aux graines non germées.

Mots clés: Germination, Fermentation, Sorgho, Millet, Bushera

INTRODUCTION

Sorghum and millets are important food crops in arid and semi arid regions of the world and provide a starchy staple food for people in the tropical and subtropical regions of Africa, Asia, and Latin America [1]. Several procedures for processing of these grains into beverages have been extensively studied [2]. The production of beverages from sorghum and millet and mixtures with other cereals is carried out by villagers in all parts of Africa, Asia and Latin America [2]. Commercial sorghum malting has been developed in Nigeria and in the Republic of South Africa and Zimbabwe the brewing of one form of Kaffir beer has developed into a major industry [3].

In Uganda, sorghum (*Sorghum bicolor*, (L) Moench) and millet (*Eleusine corocana*) grains are used in the production of several traditional alcoholic beverages such as kwete, omuramba, tonto and ajon in addition to Bushera [4].

Bushera is the most common traditional fermented beverage produced in South-western Uganda. It is mainly prepared from sorghum grains which may be germinated or non-germinated. Bushera is produced at household level by spontaneous fermentation. It is consumed by all age groups, and is used both as a weaning food and a thirst quenching drink in the households and in Bushera bars. The microorganisms involved in the fermentation of Bushera have not been isolated and characterised.

As a baseline study leading up to research on isolation and characterisation of the microorganisms responsible for the spontaneous fermentation of Bushera, the traditional methods used to produce Bushera were surveyed in Kabale and Rukungiri districts in the South Western regions of Uganda. In this paper, a survey of the methods of production, the preparation of ingredients, the fermentation process and the uses of Bushera are presented. In addition, preliminary studies were made of selected chemical properties of the raw materials and prepared product. The acquired knowledge can be used to pave away for small-scale commercial production of Bushera.

MATERIALS AND METHODS

Materials

Germinated (black sorghum), non-germinated (brown sorghum) and millet grains and their respective flours were purchased from households and markets. Five samples of each material (500 g) were transported to the Department of Food Science and Technology, Makerere University, Kampala, Uganda. Samples were kept at -55°C until air freighted to the Department of Food Science at the Agricultural University of Norway, and then stored under refrigeration before the chemical analysis. Fifteen traditionally fermented Bushera samples were also purchased from different households.

Methods

Methodology of the Survey

A preliminary survey was conducted to identify the villages and households that produced Bushera and pre-test the questionnaire. The survey was conducted using an administered questionnaire in the selected villages of Kabale and Rukungiri districts. The questionnaire focused on the raw materials used for the production, preparation of the raw materials, fermentation process and its duration, sensory characteristics, utilisation and storage of Bushera. The questionnaire was used to interview forty-eight and fifty randomly selected households in Kabale and Rukungiri districts respectively.

Laboratory Preparation of sorghum Bushera

Bushera was prepared from germinated and non-germinated sorghum flour from the Kabale district at the Departments of Food Science and Technology, Makerere University and Agricultural University of Norway. Bushera was prepared by adding a quarter of germinated sorghum flour to three quarters of water (v/v), mixing thoroughly and then boiling for 5 minutes.

After boiling, the mixture was left to cool and then sorghum malt (7.5 g) was added to initiate fermentation. Fermentation was carried out ambient temperature (27-30°C) for 2 days. Bushera samples for analysis were withdrawn each day and frozen (-40°C) until analysis.

Chemical Analyses

The moisture, total ash and dry matter content were determined using the Association of Official Analytical Chemists (AOAC) methods [5]. The protein content was determined using the Kjeldahl method [5] using a factor of 5.65 to convert the amount of nitrogen to crude protein [6]. The fat content was determined by extraction with petroleum ether using Soxhlet apparatus (Tecator Soxhlet System, HT6, Sweden), AOAC methods [5]. Crude fibre content was determined by the dilute acid hydrolysis method from AOAC [5]. Total carbohydrate was calculated by difference. Mineral determination was carried out by AOAC methods [5]. The minerals analyzed were sodium, potassium, calcium, magnesium, manganese, iron, zinc and copper. Phosphorus was determined spectrophotometrically as described by Jacobs [7]. The total extractable phenols and tannins in non-germinated and germinated sorghum flour and the paste were determined using a method according to Julkunen [8]. Sugar concentrations were determined by high performance liquid chromatography (HPLC) [9]. The sugars (glucose, maltose and fructose) were detected using a Refractive Index detector (series, 2000, Perkin Elmer, Norwalk, USA). Standard sugar solutions (Sigma, St Louis, MO, USA) were used for calibration.

RESULTS

Survey Results

Preparation of raw materials

Figure 1 shows the processing steps for Bushera from sorghum. In Kabale and Rukungiri districts, sorghum grains are usually (80% of respondents) soaked in water overnight (12 h), although some households (20%) indicated a soaking period of 24-48 h. Grains are put into sacks and soaked in the stream, in the river, man-made ponds or at home in aluminum pans. Most of the households (87%) soaked the grains in streams, rivers and ponds. The remaining percentage soaked the grains at home in the aluminum pans. After soaking the grains, excess water is drained off, and then wood ash (a tenth of grain quantity) is mixed with the wet grains. The respondents reported that the wood ash is added to hasten the germination process and also to increase sweetness. The grains are then heaped on either banana leaves or papyrus mats.

Whole fresh leaves of a wild plant, Oluwoko (*Phytolacca dodecandra*), are also added at that point, however they are later removed. The grains are then covered with banana leaves or papyrus mats and left to germinate for two-four days. During germination, the sorghum grains are constantly mixed to avoid clumping together, and by the end of germination the grains have turned black (black sorghum). For millet, only grains to be used for malt are germinated and no wood ash is added. Sixty five percent of the households germinated the grains for two-three days whereas 35 % did it for four days. After germination, the grains are sun-dried for one-two days to a moisture content of less than 13%, and then cleaned, milled either using a grinding stone or a hammer mill and stored until use.

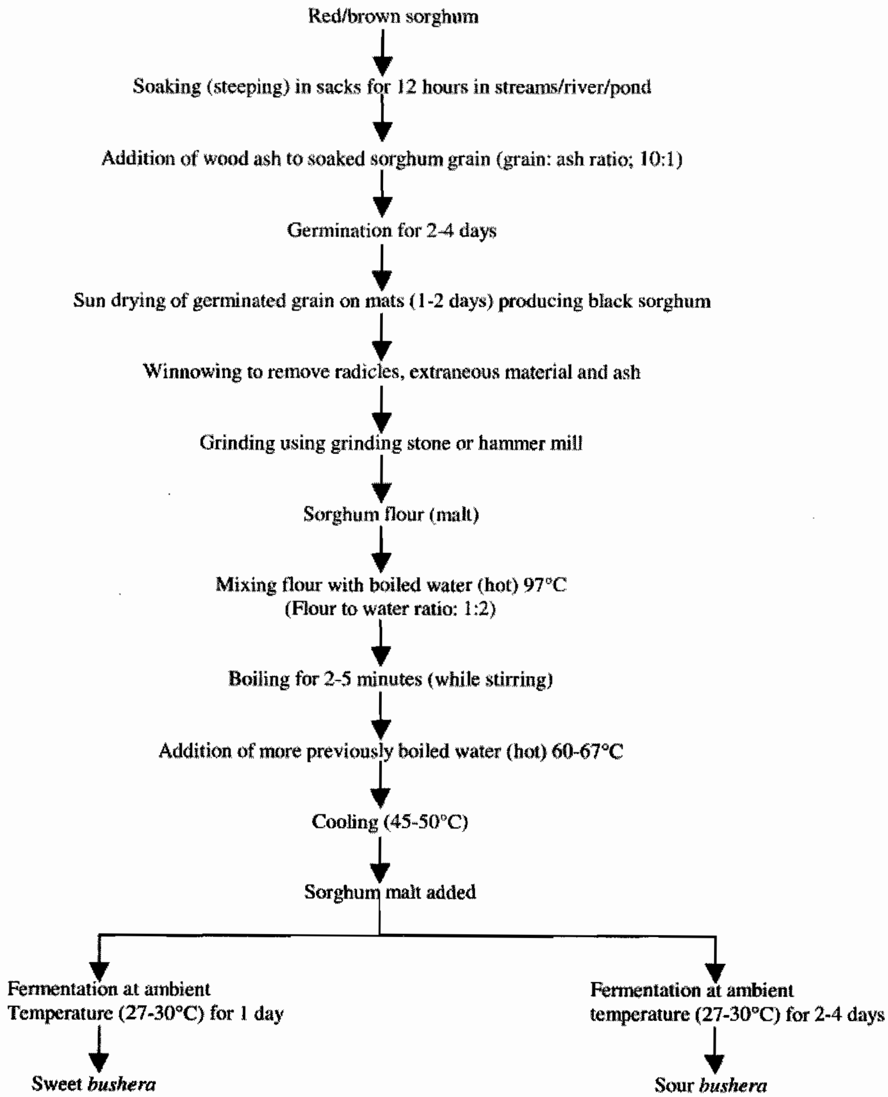
Production of Bushera

Both in Kabale and Rukungiri, the sorghum or millet flour is mixed with cooled boiled water to form a paste or slurry in a clay pot. Thereafter, more boiled water is added and the mixture is stirred and then boiled for about 2-5 minutes. The majority of the households (90%) boiled Bushera for 2-5 minutes and the remaining percentage indicated 15-30 minutes. After boiling, the mixture is then cooled, and germinated sorghum or millet flour or a mixture of both flours is added to initiate fermentation. The mixture is left to ferment at ambient temperature (27-30°C). In Rukungiri, some households (5%) add hot water directly to the flour instead of cooled boiled water in a clay pot, while stirring continuously to form a paste, then more hot water is added to obtain the required viscosity. The mixture is then left to cool and germinated sorghum flour is added to initiate fermentation. In Rukungiri, when a mixture of millet and sorghum flour is to be used to make Bushera, one or one and half parts of germinated sorghum is mixed with four parts of non-germinated or germinated millet flour and the procedure is followed as shown in Figure 1. However, if only non-germinated millet flour is used for Bushera production, malt of millet and sorghum (0.5-1.0 Kg) is added which is claimed to act as a sweetener and flavour enhancer.

Fermentation of Bushera

The households (100%) claimed that the production of Bushera from millet and sorghum is basically done to increase sweetness, impart sour taste, reduce viscosity, and to give a good flavour and improve the colour of the product. Fermentation is carried out in clay pots (20 litres) jerricans (20 litres) and plastic buckets (20 litres) at ambient temperature. The pots are covered with winnowing trays to allow aeration during fermentation. Usually, the first day of fermentation is performed in the clay pot and the Bushera is then transferred to plastic buckets. Sixty percent of the households fermented Bushera using clay pots. The clay pots are washed with cold or hot water whenever a new batch of Bushera is to be prepared.

Fig.1. *Flow diagram for production of sweet and sour sorghum Bushera*



Back-slopping was considered to lead to excessive sourness and low quality and was not commonly practiced. However, some households (30%) in Kabale district indicated that they practiced back-slopping. The fermentation period differed depending on the type of Bushera being produced, targeted consumers or consumer preference. For Sweet Bushera, the fermentation period ranged between 12-24 h whereas for Sour Bushera the fermentation time exceeded two days. Most of the households (90%) consumed Bushera after two-four days of fermentation.

Uses of Bushera

In Kabale and Rukungiri districts, Bushera is commonly produced both for consumption and sale. The frequency of consumption in the different households ranged between 3-10 times per day. The consumption of sweet and Sour Bushera differed from household to household. Sour Bushera was indicated to be mainly consumed by older people. Sour Bushera is usually not given to children due to its sour taste and ethanol content. The children are often fed non-fermented Bushera from non-germinated millet or sorghum flour. Bushera from germinated millet or sorghum flour was often claimed by the mothers to cause stomach problems (diarrhoea), poor growth, worms and malnutrition. This indicates the possible contamination of Bushera by pathogens. The families introduce Bushera as a weaning food in the children's diets after age of 5- 7 months. From the survey, fermented Bushera was also indicated to be good for elderly people and convalescents.

Many housewives produced Bushera commercially on a small scale. The amount of Bushera sold ranged from

20-160 litres per day depending on the consumer demand. The sale of Bushera was indicated to be profitable and the greatest turnover being realized on local market days. The age of the Bushera sold ranged between one to six days, with an average of three days. Fermentation duration exceeding four days was indicated to lower acceptability of Bushera due to over-souring (pH 3.5), maggot and worm infestation, which might as a result of poor hygiene.

Descriptive sensory characteristics of household Bushera from Kabale and Rukungiri districts

A good quality Sweet Bushera has a sweet taste, a pale brown in colour and an intermediate viscosity without off-flavours. A good quality Sour Bushera tastes slightly sour and should not be too watery, it should be slightly alcoholic (1.03%), covered with a layer of floating sorghum spent grains and should be slightly effervescent.

The fermentation process and its duration influence the quality of fermented Bushera. Other factors that affect the quality of Bushera porridge are insufficient boiling, which results in poor colour and flavour development, inadequate stirring, causing clumpiness. Poor storage of grains and inadequate cleaning of utensils may affect the quality of Bushera by imparting off flavours.

Chemical analyses

Table 1 shows the proximate composition of germinated and non-germinated millet and sorghum flour obtained from the households.

Moisture content and dry matter

The moisture content of non-germinated and germinated sorghum and millet flour ranged from 8.5 to 12.4 % (Table 1). Flour from germinated sorghum and millet had slightly higher moisture content than flour from non-germinated grain. The germinated grain flours had lower dry matter compared to their non-germinated counterparts. The moisture content of household Bushera varied between 87.78±3.38 and 90.0±6.79% whereas dry matter varied between 10.28±6.26 and 12.23±3.80% (Table 2). No significant difference was observed among these parameters.

Fat

The fat content in non-germinated and germinated sorghum and millet flour varied between 0.6 and 3.0% (Table 1). Flour from germinated sorghum had a lower fat content than the non-germinated sorghum. The fat content of non-germinated and germinated sorghum flour varied between 2.4 and 3.0% and 1.8 and 2.2% respectively. Flour from germinated and non-germinated millet had the same fat content (0.6%).

Protein

The protein contents of germinated and non-germinated sorghum and millet flour ranged from 7.2 to 10.8% (Table 1). The protein content of Bushera obtained from households varied between 8.97±0.01 and 9.63±2.81% (Table 2). The protein content of Bushera (0 day) made from germinated sorghum flour was found to be higher than that produced from non-germinated grains (Table 3). As fermentation progressed, protein content of Bushera from non-germinated sorghum flour increased whereas that of Bushera from germinated sorghum flour slightly decreased.

Carbohydrates

The carbohydrate content was highest in non-germinated grains (Table 1). The carbohydrate content of germinated flours ranged between 77.7 and 80.9% whereas that of non-germinated flour ranged between 80.2 and 85.7%. Millet flour obtained from both non-germinated and germinated grains had the highest amounts of carbohydrate (85.7 and 80.9% respectively).

Fibre

Flour from germinated grains had higher fibre content than flours obtained from non-germinated grains (Table 1). The fibre content of flour from non-germinated grains varied between 3.5 and 3.7% whereas that of germinated grains varied between 4.7 and 6.3%. Flour from germinated sorghum and millet grains had the highest amount of fibre (5.5 and 6.3% respectively).

Ash content

The ash content in all grain flours ranged from 2.1 to 4.9 % (Table 1). Germinated sorghum flour had higher ash content (4.9%) than non-germinated flour. Germinated millet flour had a lower ash content than flour from non-germinated millet grains. The fermentation process had little effect on the ash content of Bushera (Table 3). The ash content of Bushera porridge made from both germinated and non-germinated sorghum flour showed a slight decrease during fermentation. Bushera from household had ash content varying between 2.94±0.01 and 3.32 ±0.26%.

Sugars

The results in Table 4 show that germination resulted in an increased sugar concentration of both sorghum and millet grains. Higher levels of maltose, glucose, and fructose were observed in sorghum flour. The glucose content measured in non-germinated sorghum flour was 463.5±67.17 mg kg^{-1} whereas that of germinated sorghum flour was 1873±64.35 mg kg^{-1}. The lowest amount of maltose was observed in flour from non-germinated sorghum and millet (219.0±21.21mg kg^{-1} and 424.5±20.51mg kg^{-1}, respectively).

Mineral content
Mineral composition as determined for flour from germinated sorghum grains and wood ash is shown in Table 5. Levels of manganese, magnesium, potassium and zinc were higher in germinated grain flours. Calcium was detectable only in flour obtained from germinated grains. Wood ash used during germination/ soaking contained the highest amounts of minerals. Calcium and potassium were the minerals found in highest amounts (5.6 and 6.0 % respectively).

Tannins
Phenol content of germinated sorghum flour and non-germinated flour was 18.2 and 112 mg kg^{-1} respectively. Tannins were undetectable in germinated sorghum flour whereas non-germinated sorghum flour contained tannin levels of 94.5 mg kg^{-1}.

DISCUSSION

Survey

From the survey, it was observed that Oluwoko (*Phytolacca dodecandra*) leaves are added during germination and later removed. The reasons for this treatment are not clear, however the plant is known to be poisonous [10]. The most probable reason of addition of *Phytolacca dodecandra* leaves may be to inhibit the growth of molds during germination. On the other hand the leaves are thick, and on rotting may generate the heat, which may hasten the germination process.

The claim by the mothers that Bushera when fed to children cause stomach problems (diarrhoea) indicates the possible contamination of Bushera by pathogens. At the time when the fermented Bushera is recommended to be fed to children or infants, coliforms are highest (1-2 day fermentation) and this may explain the observed diarrhoea [11]. In a tropical environment, lack of refrigeration facilities at the household level enables the rapid proliferation of microbial contaminant in foods. The growth of pathogenic bacteria in porridges, which are prepared once a day for use during the whole day, may contribute to acute diarrhoea [12].

Chemical analysis

The variation in moisture content observed among the flours may be attributed to difference in the processing procedures, drying, storage conditions and genus variation. The results in this study showed that flour from germinated millet and sorghum had lower dry matter than that of flour from non-germinated grains. These findings are in agreement with those reported by other authors. A 61% reduction in dry matter was reported when the maize and sorghum grains were sprouted due to water imbibition [13]. The differences may be due to partial degradation and oxidation of starch to derive energy required for metabolic activities during germination. The decrease has also been attributed to leaching of material during soaking [14]. The loss of dry matter is influenced by cultivar, germination period and temperature [15].

Germination was reported to cause a decrease in the fat content of sorghum [14]. Similar trend was observed for sorghum in our study. The decrease in fat content may reflect its use as an energy source during germination and/or utilisation by microorganisms during soaking, germination and fermentation [15]. A slight increase in fat content has been observed with millet and has been attributed to synthesis of fat due to transformation of the disappearing starch during germination [13]. However in this study, no change in fat content of millet was observed. During natural lactic acid fermentation, no significant change was observed in crude fat content of sorghum [16]. The variation in reported fat content of grains may be attributed to different solvent systems used for extraction of kernel fat and variation between analyses. The difference in fat content may also be due to genera variation and even within the same genus variations may exist between varieties [17].

The values of protein content obtained for the different grain flours in our study agree with those reported in literature for these cereals [17, 18]. Germination has been reported to affect the protein content of grains [14]. Germination of finger, pearl and foxtail millets resulted in a slight decrease in total protein [19]. However, in our study, the protein content of flour from germinated grains was slightly higher than that obtained from non-germinated grains. Apparent increase in protein content observed in our study may reflect a loss in carbohydrates rather than actual increase in protein [11].

The initial high values of protein content in germinated sorghum Bushera may be explained by the loss of dry matter due to leaching of material and oxidation of substances in the grains during germination [15]. The decrease in protein content of Bushera from germinated sorghum flour may be attributed to the loss of low molecular weight nitrogen compounds, to solubilisation and in situ utilisation of soluble proteins during the fermentation [15, 20]. An increase in the protein content of millet was reported during fermentation [21]. Accumulation of protein has also been reported during fermentation [22]. However, the total protein was found unaltered during fermentation of millet [23]. The increased protein content in Bushera from non-germinated sorghum flour may be due to improved protein extractability reported during fermentation and attributed to microbial protease activity and breakdown of tannins and phytates, which are known to bind proteins [15].

The lower carbohydrate content of germinated grain flour can be explained by the gradual degradation of starch by enzymes during germination [14, 20]. Both soaking and germination have been found to influence the loss of starch [13]. In addition, the utilisation of some carbohydrates by the germinating grains with concomitant production of carbon dioxide may account for the lower carbohydrate content of germinated grains. Soluble carbohydrates also may be leached out during soaking of grains.

Germinated grain flour was observed to contain higher fibre content than non-germinated grain flour. This may be due to an apparent increase in the utilisation of other constituents such as starch during germination [24]. Crude fibre content has been reported to either decrease as in seeds of wheat or to increase as in millet grains during germination [14]. The soaking and germination periods and inclusion/exclusion of rootlets and shoots during milling of germinated grains also appear to influence the fibre content of the flour from germinated cereals.

Germinated sorghum flour had higher ash content than non-germinated flour due to addition of wood ash during germination. Germinated millet flour had a lower ash content than flour from non-germinated millet grains, possibly due to leakage of water-soluble salts. The higher ash content in Bushera from germinated sorghum flour is due to addition of wood ash during the process of germination.

The high ash content of household Bushera can also be attributed to loss of dry matter, especially carbohydrates, through respiration during sprouting [14, 20]. However, our results showed a reduction in ash content (Table 1) of millet flour as a result of germination. Other authors observed no definite trend in ash content during germination [16].

Higher levels of maltose, glucose, and fructose were observed in germinated sorghum flour. An increase in the activities of amylases and maltase causing a gradual decrease in starch with concomitant increase in reducing and non-reducing sugars were reported during germination of cereal grains [14]. Both soaking and germination periods have been shown to influence the loss of starch and accumulation of sugars in sorghum. The differences in sugar levels observed between sorghum and millet grains may be attributed to the differences in amylase activities. The activities of amylases were indicated to increase significantly during germination of cereal grains [14]. The extent of increase in activity varies with type of cereal grain, variety and conditions of germination [14].

Higher levels of minerals were noted in germinated grain flour. Germination was reported to increase the extractability of the trace elements like zinc, copper and magnesium [23]. The higher mineral levels of germinated sorghum flour used in our study may be attributed to the wood ash added (Table 2). The variations in the mineral content may be explained by leakage of soluble minerals during germination and release of minerals complexed with antinutritional factors, which are inactivated or destroyed during germination. The phytates which complex the minerals are degraded during germination [25]. It was suggested that addition of ash during germination improves the nutritive values in terms of mineral content especially as the soaking and cooking processes may cause mineral losses [26]. The low levels of phenol and tannin observed in this study in germinated sorghum flour may be attributed to soaking and fermentation. Reduction of tannin content during soaking and fermentation of grains was also reported [21]. Germination has been reported to decrease tannin content in sorghum and finger millet [17]. The low or undetectable tannin in germinated flour may be due to wood ash added during germination. Sorghum kernels treated with moistened wood ashes showed reduced extractable tannins (up to 97%) [24]. The alkali released when the grains are soaked overnight with moistened wood ash, was found to inactivate the tannins [17]. Tannins in grains impart the astringent taste that affects palatability, thereby reducing food intake and consequently retarded body growth [17]. This observation is very important, since the product is fed to children before prolonged fermentation. The poor iron availability in brown sorghum varieties is associated with their high tannins content [17].

CONCLUSION

The use of sorghum and millet grains for production of Bushera differs from one individual to another and from area to area. However, there are similarities in the production techniques of Bushera in Kabale and Rukungiri districts. The differences lie in the ratios of ash, water or flour and the duration of fermentation. Bushera can be made from both germinated and non-germinated millet and/or sorghum flour depending on the cultural practice, target consumer and dominating grain in a given area. Bushera quality is determined by raw materials used, raw material processing technique and duration of fermentation. Bushera is consumed, while fermentation is in progress, as a thin beverage in Kabale and Rukungiri districts. The process of soaking, wood ash treatment, germination and fermentation, which reduces or removes the tannins and/or phenols that have a negative effect on nutritive value of Bushera, should be encouraged. Due to these benefits, the feeding of Bushera from germinated grains to children should be encouraged. Germination and/or fermentation of various grains and legumes has been shown to be effective in improving their nutritive value [14,15,26,27].

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Table 1

Proximate composition (%) of sorghum and millet flour obtained from Rukungiri and Kabale districts

	Rukungiri				Kabale	
Parameter	BNS[a]	BKS[b]	NM[c]	GM[d]	BNS[a]	BKS[b]
Moisture	8.8	9.0	8.5	9.6	11.3	12.4
Fat	2.4	1.8	0.6	0.6	3.0	2.2
Protein	9.8	7.7	7.2	8.6	10.8	10.3
Ash	3.5	4.9	3.5	3.0	2.1	3.2
Fibre	3.5	5.5	3.7	6.3	3.5	4.7
Carbohydrates	80.2	79.4	85.7	80.9	80.6	77.7

Means are two independent determination expressed on dry weight basis [a]Brown Non-germinated sorghum, [b]Black germinated sorghum, [c]Non-germinated millet, [d]Germinated sorghum
Note: Brown is a natural colour of sorghum and Black is the colour attained after germination

Table 2

Some selected promimate composition patametres of household Bushera prepared from millet, sorghum and sorghum-millet combination obtained from Kabale district

	Moisture	Dry matter	Ash	Protein
Millet	90.0±6.79*	10.28±6.26	2.94±0.01	8.97±0.01
Sorghum-millet	87.88±3.40	12.12±3.80	2.85±0.21	9.59±1.25
Sorghum	87.78±3.80	12.23±3.80	3.32±0.26	9.63±2.81

*Results given as average of five determinations ± standard deviation

Table 3

Changes in ash and protein content (%) during fermentation of Bushera prepared in the laboratory

	Brown sorghum – Non-germinated Fermentation days			Black sorghum – germinated Fermentation days		
	0	1	2	0	1	2
Ash	2.49	2.11	2.21	4.09	3.64	3.31
Protein	7.79	12.38	11.63	14.38	10.13	11.95

Means of two independent determinations expressed on dry weight basis

Table 4
Sugar concentration (mg kg^{-1}) in germinated and non-germinated sorghum and millet flour

Flour	Maltose	Glucose	Frutose
Brown sorghum – non-germinated	219.0±21.21*	463.5±67.18	531.0±82.02
Black sorghum – germinated	1610.0±134.35	1873±64.35	841.0±5.66
Millet non-germinated	338.0±22.63	431.5±1485	424.5±20.51
Millet-germinated	862.5±61.52	942.0±14.14	544.5±36.06

*Results given as average of duplicate determinations ± standard deviation

Table 5
Mineral composition (%) of sorghum flour and wood ash obtained from Kabale district

	Na	K	Ca	P	Mg	Fe	Zn	Cu	Mn
Brown sorghum – non-germinated flour	0.03	1.38	Nd*	0.38	0.15	0.02	0.005	0.025	0.003
Black sorghum – germinated flour	0.02	1.88	0.23	0.38	0.23	0.02	0.060	0.014	0.023
Wood ash	4.4	5.6	6.0	Nd*	0.45	0.70	0.02	0.01	3.5

Means of two independent determinations and expressed on dry weight basis, Nd*: not detected

CONGRATULATORY MESSAGES
Re: Ruth Oniang'o's nomination to Kenya's 9th Parliament, 2003-2007

Dear Ruth,
First of all congratulations on your nomination to the ninth Parliament of Kenya. You are capable of serving Kenyans irrespective of the party you are known to support. You are familiar with the pitfalls of leaders, parties included. Let us keep in touch as you get to your busy office. Do not give up your fight for Africa; we need parliamentarians who understand the plight of scientists and you are our hope. We need governments to make firm commitments to feed its people and eliminate hunger, and no one can articulate that cause better than you. We need parliamentarians who are in touch with international arena and you know the corridors well. We need leaders who will prepare a better country for our children and grandchildren and you know what this means.

Prof. Shellemiah Keya
Former Vice Chancellor, Moi University
Now Technical Secretary, CGIAR

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Dear Ruth
I was delighted to read that you have been nominated to Parliament. This is great, we need people of your calibre to strengthen that institution, we need people who genuinely care about Kenya and its future, we need able legislators to make good laws, we need more intellectuals who must think of innovative solutions to our many serious problems, we need honest people who will insist on transparency, accountability and the rule of law...in short we need you in Parliament. I am confident that the country will be better off with you there. I am also very happy for you to have this opportunity to influence the policies of our country.

Former Permanent Secretary, Ministry of Finance, Kenya
Now with the World Bank, Washington