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Effect of Steeping and Germination on the Diastatic Activity and Sugar Content in Amaranth Grains and Viscosity of Porridge

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ABSTRACT

According to Kenya Demographic Health Survey, 7% of children under five years were wasted with those between 12 to 23 months having the highest levels of wasting (7.5%). The children suffer from protein energy malnutrition (PEM) which may lead to physical, mental and motor development retardation. Children are most at risk of PEM during introduction of complementary foods usually thin porridge prepared predominantly from cereals and starchy tubers. Such porridge is high in starch, limiting intake due to thick consistency and children`s small stomachs. There is need to develop nutrient-dense complementary foods. Amaranth grain has high biological value proteins and a better amino acid profile than nearly all cereals. It is also rich in essential fatty acids. However it is not commonly used as a complementary food in Kenya. It could give a nutrient dense complementary food with suitable processing methods. The main objective was to determine the effect of steeping and germination time on diastatic activity, reducing and non reducing sugar content of amaranth grains and the viscosity of porridge made from these grains. The grains were steeped and germinated for various periods. Diastatic activity, reducing and non reducing sugar content of grains and viscosity of their porridge were determined. After steeping for 5 hour and germination for 72 hours, diastatic activity increased about two and a half times, reducing sugars content increased by 13.1% while non reducing sugars increased by 17%. The viscosity was least (100 ns/m^2) after steeping for 5 hours and germinating for 72 hours. Steeping and germination of amaranth grain increased diastatic activity enhancing conversion of starch to sugars reflected by increase in sugars. The viscosity of porridge made from the steeped and germinated grain significantly reduced. This could encourage use of more flour in making complementary foods increasing dry matter utilization and nutrients consumed.

KEYWORDS: Protein Energy Malnutrition, Complementary foods, Starch, Dry matter, Nutrient Density.

INTRODUCTION

Malnutrition covers a broad spectrum of ills, including under nutrition, specific nutrient deficiencies, and over nutrition. It kills, maims, retards, cripples, blinds and impairs human development on a truly massive scale worldwide [23]. According to Kenya Demographic Health Survey (2010), malnutrition levels among children under five years remain high. The proportion of stunted children declined from 35 percent in 2000 to 30 percent 2003. Since 2003 to the period 2008-09, the proportion of stunted children has remained unchanged. Overall, the proportion of children who are wasted has changed little since 2000. Further, there was a slight decline in the proportion of underweight children between 2000 and 2003, but almost no change between 2003 and 2008-09 [12]. The children fail to reach their full potential of growth and development. Further they suffer long term deprivation of energy and nutrients and consequently chronic protein energy malnutrition (PEM), often accompanied by micronutrient deficiencies. A major cause of malnutrition in Kenya is inadequate dietary intake both in terms of quality and quantity [5]. The most commonly used first complementary food for babies in Kenya is porridge [13] [12]. Most families often depend on inadequately processed traditional foods consisting mainly of unsupplemented cereal porridges made from maize, sorghum and millet. These staples may not contain adequate energy and nutrients. These staples are plant based. Plant-based diets are often associated with micronutrient deficits, exacerbated in part by poor micronutrient bioavailability [8],[24]. Therefore the children may develop PEM and micro-nutrient deficiencies.

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Complementary foods are needed to fill the gap between the total nutritional needs of the child and the amounts provided by breast milk [25]. Some of the challenges during this period may include the use of complementary foods that are too bulky for the children with a tiny stomach to eat the necessary quantities or that provide adequate nutrients and energy to meet their requirements. There is need therefore, to develop nutrient-dense, less bulky complementary foods which could contribute to mitigating PEM and micronutrient deficiencies. A number of traditional food processing technologies such as germination and lactic acid fermentation have been proposed as a means to improve nutrient density of complementary foods [17].

There is currently, a lot of interest in the amaranth plant, whose leaves are eaten as a vegetable in many parts of Kenya. Amaranth seed contains more protein than other grains such as wheat, maize, rice and sorghum. It contains high levels of minerals especially iron, phosphorus, magnesium, vitamin A and E [4]. It is highly recommended for infants because of its high protein digestibility, absorption and retention by the baby`s body system. There is a need to develop processing methods that would enhance the utilization of amaranth grain. Steeping and germination are some of the traditional methods that have been proposed as increasing the nutrient bioavailability (especially micronutrients) in plant based foods. There is need to find out if they improve the quality of amaranth grain and the optimum period for steeping and germination (with regard to quality enhancement). The diastatic activity,viscosity, reducing and non reducing sugars will determine the taste and consistency of a food product after steeping and germination.

Objective

To determine the effect of steeping and germination time on diastatic activity, reducing and non reducing sugar content of amaranth grain and viscosity of porridge made from it.

MATERIALS AND METHODS

Raw materials

Amaranth grains were purchased from farmers in Meru. The aim was so that the grains could be bought from the same farmers for consistency in the nutritional value.

Steeping and germination

Amaranth grain samples were weighed in to a clean gauze. They were steeped for 5 hours, 10 hours, 15 hours, 20 hours and 24 hours. After steeping for the respective time periods, they were germinated for 24, 48 and 72 hours respectively. They were then dried in an incubator at 50^0C and milled in to fine flour (200 mesh).

Laboratory analysis

The samples were analyzed for diastatic activity, reducing and non reducing sugars according to AOAC methods 932.04, 939.03 and 939.04 [1] respectively.

Determination of viscosity

Samples (Flour from steeped and germinated amaranth grain) were prepared to pass through sieve 0.5mm. Samples (25g) of the ingredients were boiled in 500ml of distilled water to gelatinize the starch, cooled to 25^0C, then viscosity determined by a Brookfield viscometer (model B type BM Japan) [(2]; [20]; [14]; [19]. The Spindle was attached to the shaft. The viscometer was leveled. The sample was filled in to a 600-mL beaker. The spindle was immersed in the sample to the indentation in the neck of the spindle. Then the viscometer was turned on. The specification combination used was speed 12 revolutions per second and spindle number 3. Three readings from each sample were taken and an average recorded. The readings were taken at 25^0 C, the temperature at which porridge is consumed. The speed of the spindle used was adjusted according to the thickness of each sample. To get the final viscosity in newton metre per second squared, a factor of 100 was used to multiply the figure obtained.

Calculation Viscosity, (Ns/m^2) = reading x factor.

RESULTS AND DISCUSSION

Effect of steeping and germination on diastatic activity of amaranth grains

Diastatic activity of flour is a measure of the ability of flour to produce maltose from its starch by action of its own amylase (diastase). Ungerminated amaranth grain had a diastatic activity of 213.7mg maltose per 10g while diastatic activity was highest (631.4 7mg maltose per 10g) for amaranth grain steeped for 5 hours. After steeping for 5 hours the diastatic activity was highest for amaranth grain germinated for 72 hours (1658.9 mg maltose per 10 g). The diastatic activity varied with steeping and with germination time as shown by Figures 1 and 2.

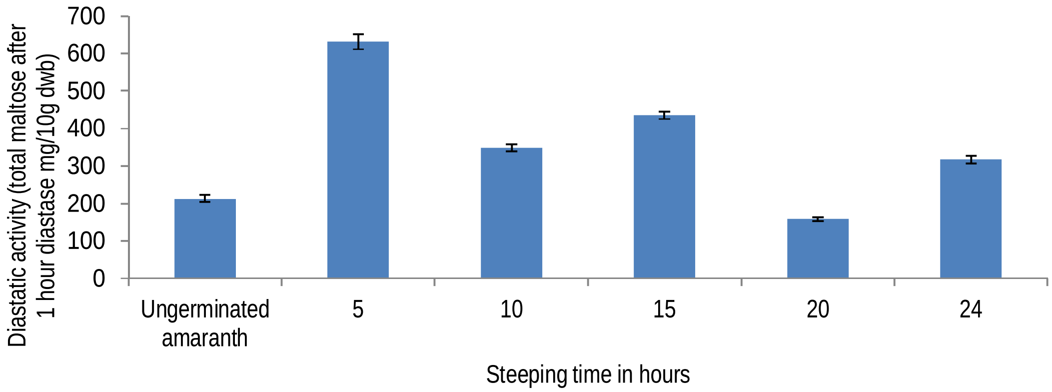

Figure 1:The effect of steeping time on the diastatic activityof amaranth grains

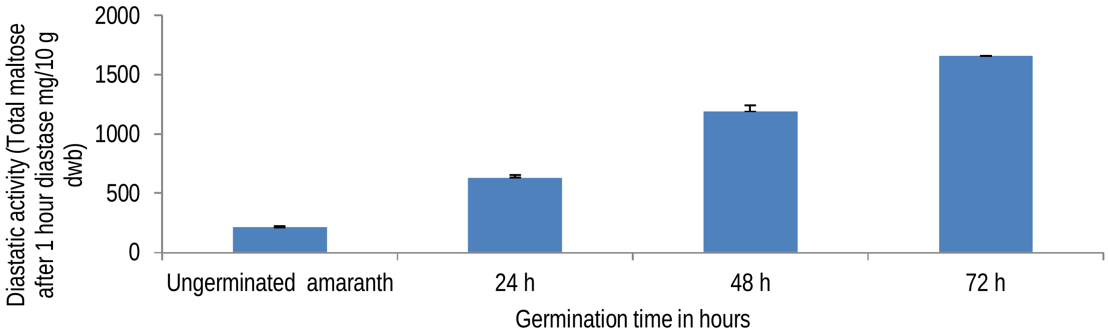

Figure 2: Effect of germination on the diastatic activity of amaranth grains (Steeping 5 hours)

Effect of steeping and germination on reducing sugars in amaranth grains

The reducing sugars content in ungerminated amaranth grains was 132.4 mg maltose per 10 g (1.32%) and highest after 15 hours steeping 1316.6 (13.6%) mg maltose per 10 g. After steeping for 5 hours the reducing sugar content was highest after germination for 24 hours 1313.5 maltose per 10 g (13.1%). As the grain were steeped and germinated for various periods of time the reducing sugars varied as shown by Figures 3 and 4.

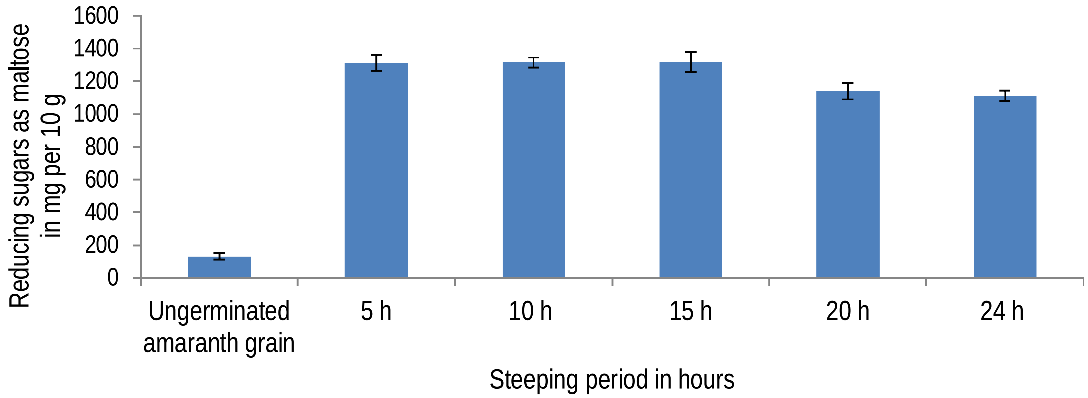

Figure 3:The effect of steeping time on the reducing sugars in amaranth grains on dry weight basis.

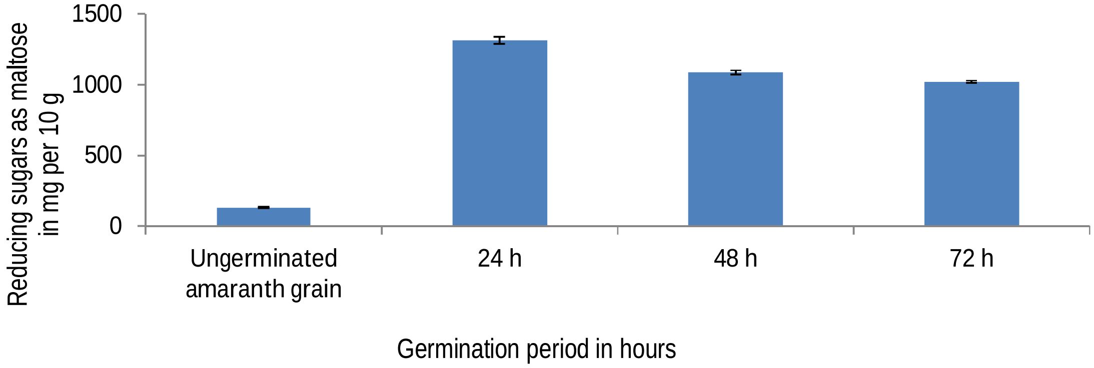

Figure 4:The effect of germination time on the reducing sugars in amaranth grain on dry weight basis. (Steeping 5 hours)

Effect of steeping and germination on non reducing sugars in amaranth grains

The non reducing sugars in ungerminated amaranth grains was 2.6 mg sucrose per 10 g (0.026%). Steeping for 20 hours resulted in the highest non reducing sugar content 117.0 mg sucrose per 10 g (11.7%) as shown in Figure 5. Steeping for 5 hours and germination for 72 hours resulted in 169.5 mg sucrose per 10 g (17.0%) Figure 6.

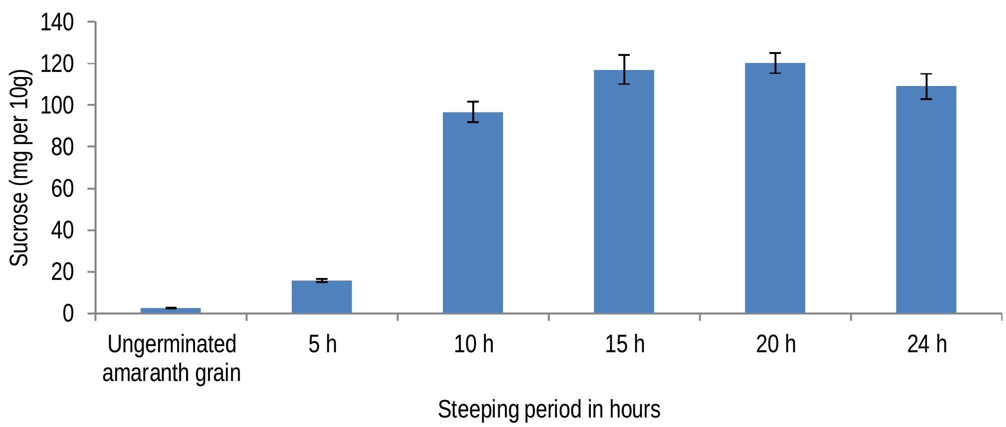

Figure 5:The effect of steeping time on the non reducing sugars in amaranth grains on dry weight basis.

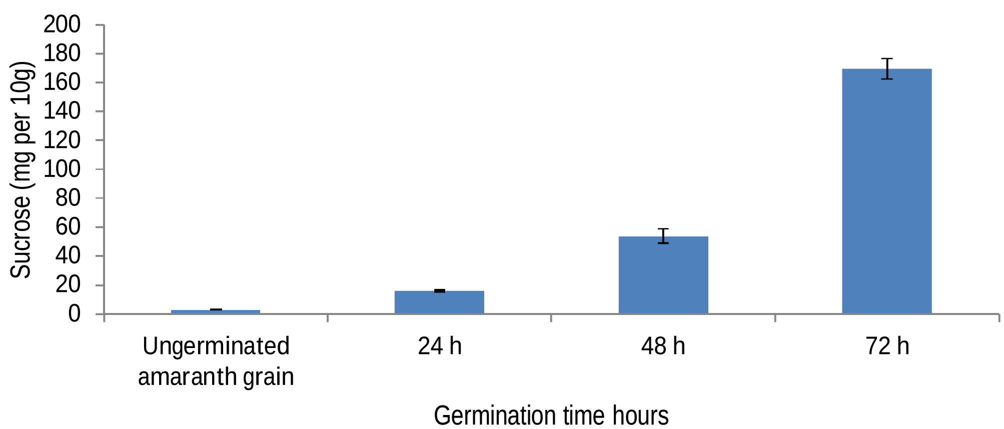

Figure 6:The effect of germination time on non reducing sugars in amaranth grains on dry weight basis (5 hours steeping)

Effect of steeping and germination on viscosity of porridge made from amaranth grains

The viscosity of ungerminated amaranth grain porridge was 600 Ns/m^2 being the highest and it reduced with steeping time as shown by Figure 7 with steeping for 24 hours having the least viscosity of porridge (300 $Ns/m^{2)}$. The porridge from amaranth steeped for 5 hours and germinated for 72 hour had the least viscosity (100.4 $Ns/m^{2)}$ as given by Figure 8.

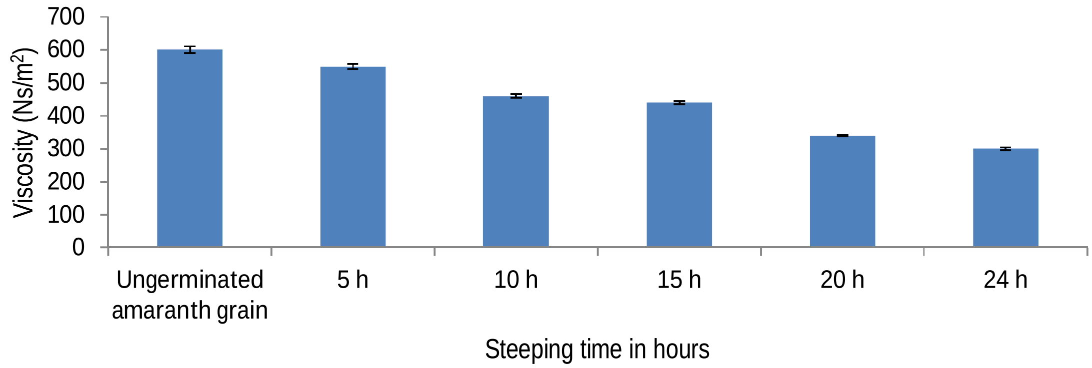

Figure 7: The effect of Steeping time on non reducing sugars in amaranth grains on dry weight basis.

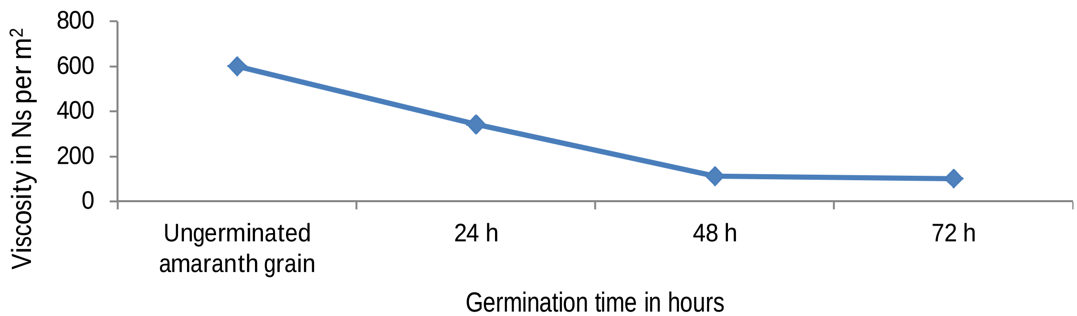

Figure 8: The effect of germination time on non reducing sugars in amaranth grains on dry weight basis (5 hours steeping).

DISCUSSION

The results show that amaranth grain starch content reduced with increase in steeping and germination time.

It has been reported that amylase inhibitory activity decreases with time during sprouting [18]. Diastatic activity increase is caused by an increase in activity of amylase enymes developed during germination and to some limited extent by amylases of microbial origin[17]. The increase in the reducing and non reducing sugars could be attributed to hydrolysis of starch into shorter chain polysaccharides by amylolytic enzymes.

These results agree with those reported by other researchers though on different grains. Coulibaly and Chen (2011) reported that foxtail millet during germination had a drastic increase in total soluble sugars (0.995% to 12.995%) in 6 days. They further reported that the reducing sugars increased to a maximum on the third day. Weil (1990) reported that during gemination enymatic activity among other amylolytic activity caused the production of maltose, maltotriose and dextrin from starch hydrolysis. Mbithi-mwikya et al (2000) reported there was a large increase in diastatic activity, from 3.8 to 35 mg maltose per g of dry matter for finger millet. They further reported that overall finger millet starch decreased from 71.3% to 35.1% from 0 to 96 hours; maltose and sucrose increased from 3.1 to 17.5 and 1.8 to 12.8% respectively during the same period. According to Mbithi-mwikya *et al* (2000), between 36 and 48 hours there was a sharp increase in sugars and overall maltose increased from 3.1 to 17.5%. Kouakou et al (2008) similarly reported that millet grain steeped and germinated for 0 to 8 days resulted in an increase in soluble sugars (reducing and total) from days 1 to 4. Similar results had been found by [10] in chickpea grain [11] in mungbean, in pearl millet by [16] and [3] in paddy rice.

In this study increasing steeping and germination time resulted in a decrease in starch content and a decrease in viscosity. This is due to starch being broken down in to sugars. Similarly Helland et al (2002) found that increasing germination time led to increased production of alpha-amylase and corresponded to decrease in viscosity in porridge made from maize. In addition using amylase rich flour from germinated wheat reduced the viscosity of traditional cereal preparations by more than 90% [21]. Mbithi-mwikya *et al*, (2000) reported that the viscosity of 10% dry matter slurry of fingermillet decreased to close-to-zero values within the first 48 hour of germination. The cooked paste viscosity of malted sorghum was considerably lower than that of the roller-dried sorghum [7]. Ayernor and Ocloo (2007) also reported a reduction in rice malt paste.

Conclusion

The longer the steeping and germination period the more the diastatic activity, the more the reducing and non reducing sugars and the lower the viscosity. Germination reduces the starch content of thin porridge by breaking it down. When the starch content is reduced the viscosity of the thin porridge is reduced. When the viscosity is reduced then more dry matter can be taken in the complementary food improving the nutrients available to the children. The steeping and germination period is crucial for optimum reduction in viscosity and enhanced nutrient availability

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