Research Application Summary

Unravelling the potential of sweet sorghum for sugar production in Kenya

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Abstract

Sorghum (*Sorghum bicolor* (L.) Moench is an important food and increasingly industrial crop and serves as a source for starch and sugars for biofuel production world wide and especially in sub-Saharan Africa. Sweet sorghum (*Sorghum bicolor* L.) Moench) is one of many types of cultivated sorghum, noted for its high sugar content in the stem juice. Even though the technologies to process sugar products from sweet-sorghum exits, the constraints for its large-scale cultivation are the limited availability of genotypes suited to different agro-climatic conditions in sub-Sahara Africa. Kenya the leading producer and consumer of sugar in Eastern and Central Africa currently only depends on sugarcane for sugar. The purpose of this study is to characterise sweet sorghum introductions from regional as well as international sources to support a breeding programme that will provide Kenyan and African farmers with high yielding sweet sorghum germplasm. The study will use a combination of molecular tools such as single sequence repeat (SSR) markers and amplified fragment length polymorphism (AFLP) markers, quantitative trait loci (QTL) identification as well as phenotypic profiling of sweet sorghum lines for sucrose. Outputs from the study will include germplasm that could directly be used for sucrose production and breeding lines for further improvement.

Key words: Kenya, QTL, SSR, sugar, sweet sorghum

Résumé

Le sorgho (*Sorghum bicolor* (L.) Moench) est un aliment important et une culture de plus en plus industrielle et sert de source pour l'amidon et les sucres pour la production de biocarburants dans le monde entier et en particulier en Afrique sub-saharienne. Le Sorgho sucré (*Sorghum bicolor* (L.) Moench) est l'un de nombreux types de sorgho cultivé, à noter pour sa forte teneur en sucre dans le jus de la tige. Même si les technologies de transformation des produits de sucre à partir du sorgho sucré existent, les contraintes pour sa culture à grande échelle sont la disponibilité limitée de génotypes adaptés aux

différentes conditions agro-climatiques en Afrique sub-saharienne. Le Kenya, le premier producteur et consommateur du sucre en Afrique centrale et en Afrique orientale actuellement ne dépend que de la canne à sucre pour la production du sucre. Le but de cette étude est de caractériser l'introduction du sorgho sucré de sources régionales ainsi qu'internationales pour soutenir le programme de reproduction qui offrira aux agriculteurs du Kenya et de l'Afrique un matériel génétique du sorgho sucré de grand rendement. L'étude utilisera une combinaison d'outils moléculaires tels que les marqueurs de répétition séquentielle simples (SSR) et ceux de polymorphisme de longueur des fragments amplifiés (AFLP), l'identification quantitative des locus de caractères (QTL) ainsi que le profilage phénotypique des lignées de sorgho sucré pour le saccharose. Les résultats de l'étude comprendront du matériel génétique qui pourrait être directement utilisé pour la production du saccharose et des lignées de reproduction pour l'amélioration ultérieure.

Mots clés: Kenya, QTL, SSR, sucre, sorgho sucré

Background

The size of high potential agricultural land in Kenya is dwindling as population increases. This leaves large expanses of low potential and semi arid lands that cannot support the production of key food crops such as wheat, rice and maize. Demand for renewable energy sources and biofuel, which would minimise pollution, is expected to rise rapidly in the coming years. Sweet sorghum by virtue of its C 4 photosynthetic system and rapid dry matter accumulation serves as an excellent bioenergy crop.

Through exploitation of sweet sorghum for food and as source for ethanol production, poverty reduction can be addressed by linking farmers with new biofuel markets. The bagasse after extraction of juice from sweet sorghum can be used for animal feed, vermin composting and co-generation of power (Reddy *et al*., 2005; Srinivasa Rao *et al.*, 2009). Further, the bagasse has a higher biological value than the bagasse from sugarcane when used as forage for animals, as it is rich in micronutrients and minerals (Seetharama *et al*., 2002).

Literature Summary

Sweet sorghum (*Sorghum bicolor* [L] Moench) is a single-stemmed cereal grass with a plant height of more than 2 m. In many cases, it is taller than grain sorghum. Sorghum is a short day plant and cultivars differ in their sensitivity to photoperiod. Sensitivity to photoperiod is a genetically controlled character and can be bred or selected for. The crop has become more

attractive to breeders due to its capacity to provide renewable energy products, industrial commodities, and food and animal feed. Because sweet sorghum is a multipurpose crop, it has potential to aid development in semi-arid regions. Sweet sorghum stalk are rich in sugars, which can be primarily used for biofuel production. It can produce up to 7000 L of ethanol/ha (Seetharam, 2005). Other utilisation can include processing it into syrup, grains for human consumption, stillage fibre and animal feed. The strong presence of G × E as depicted by genotypic inconsistencies across environments in sweet sorghum has necessitated multi-location evaluation of materials, especially those intended for the semi-arid tropics (Alagarswamy and Chandra, 1998). Many reports have been made on the inheritance of stem sugar in sorghum. Earlier reports suggested partial dominance with Schlehuber (1945) reporting hybrids intermediate between the two parents in total solids and sucrose. Later on, a single gene "X" was reported to control sugar accumulation (Baocheng *et al*., 1986).

Study Description

A collection of sorghum cultivars and land races were sampled from farmers´ fields and gene banks in the regional and world-wide based on phenotypic indicators of sugar content. These materials have been screened for the first cropping seasons to identify the most promising ones for syrup, jaggery and molasses production. The materials were evaluated in western Kenya the major sorghum producing area of Kenya in Kibos, Alupe and Homabay in a Randomised Complete Block Design. So far we have assembled up to 18 varieties from ICRISAT, Argentina, USA and Kenya Agricultural Research Institute. The key phenotypic parameters that were used in screening of the sorghum collection included: stalk population, stalk length, biomass, juice quality and sucrose content.

Genetic diversity, variability analysis and quantitative trait loci identification will be done at Biosciences East and Central Africa (BeCA) facility in International Livestock Research Institute (ILRI) campus, Nairobi.

Research Application

Preliminary findings show that some of the sweet sorghum varieties like JESV 91-104 DL, IESV 92-008 DL and IS 2331 have great potential for production of sugar, juice and biomass and are well adapted for production in Western Kenya.

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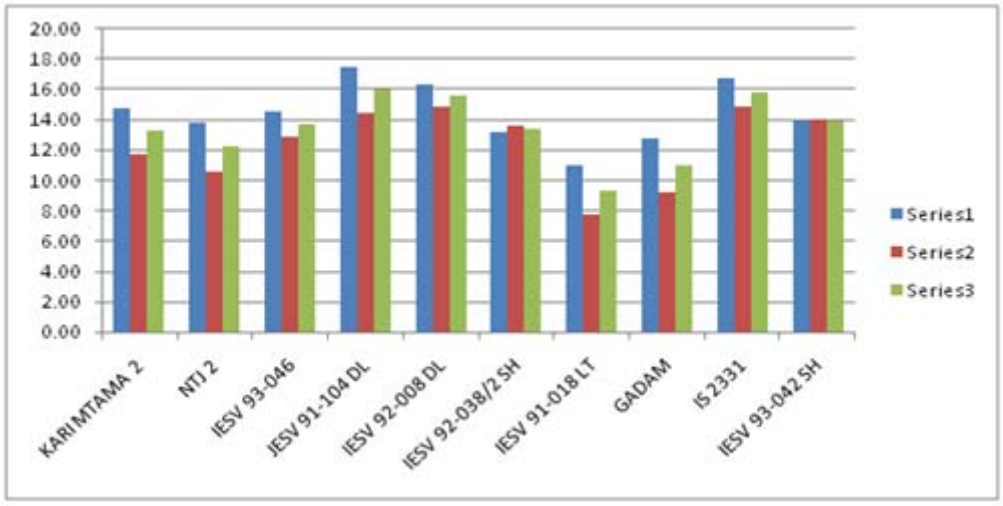

Figure 1. Brix % values of 10 sweet sorghum varieties in Kibos and Alupe sites.

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