Research Application Summary

The use of enzymes in the bio-processing of *Agave americana* and *Agave sisalana* fibres in Swaziland

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Abstract

This research was done in different agro-ecological zones in Swaziland where there are women and men *Agave* fibre decorticators and weavers. Current methods used to extract fibre from *Agave* spp. tend to pollute the environment since they use reagents that are not clean. The purpose of the study was to explore the use of enzymes as an alternative method for extraction, cleaning and softening of *Agave sisalana* and *Agave americana* fibres from the plants' leaves in order to obtain environmentally friendly products. This study which has just began, will assess the current status of sisal fibre processing in making products and evaluate the use of natural dyes. Preliminary results revealed that fibres obtained from sisal are not soft enough to be used in several products. This therefore calls for studies on resin application on the rough fibres to improve their texture.

Key words: *Agave americana*, *Agave sisalana*, enzymatic bio-processing, natural dyes, natural fibres

Résumé

Cette recherche a été effectuée dans les différentes zones agro-écologiques au Swaziland où il ya des femmes et des hommes décortiqueurs et tisserands des fibres d'*Agave*. Les méthodes actuelles utilisées pour extraire les fibres d'*Agave*spp ont tendance à polluer l'environnement, car elles utilisent des réactifs qui ne sont pas propres. Le but de cette étude était d'explorer l'utilisation d'enzymes comme une méthode alternative pour l'extraction, le nettoyage et le ramollissement des fibres d'*Agave sisalana et*d'*Agave americana*à partir des feuilles des plantes afin d'obtenir des produits respectueux de l'environnement. Cette étude, qui vient de commencer, permettra d'évaluer l'état actuel de traitement des fibres de sisal dans la fabrication des produits et d'évaluer l'utilisation des colorants naturels. Les résultats préliminaires ont révélé que les fibres obtenues à partir de sisal ne sont pas assez doux pour être utilisées dans plusieurs

produits. Ceci fait appel dès lors aux études sur l'application de résine sur les fibres rugueuses pour améliorer leur texture.

Mots clés: *Agave americana, Agave sisalana*, traitement bio-enzymatique, colorants naturels, fibres naturelles

Background

Swaziland is facing a decline and non-reliable rainfall which has led to a decline in food production (Swaziland Annual Vulnerability Assessment & Analysis Report, 2009; Oseni and Masarirambi, 2011). This calls for alternative ways of ensuring food security. Trade in natural fibres play a notable role in this regard, though the industry has not reached its maximum potential. The economic impact of the natural fibre industry is well established and recognised as a key driver for sustainable growth through agricultural and industrial revolutions, particularly for developing nations (Anandjiwala, 2006). Swaziland is no exception, her handicraft industry is operated by predominately unemployed rural women, who make and sell their products locally or in the region, or to export agents (Zwane and Masarirambi, 2009). Their work is adversely affected by poor quality fibre that results in non-wearable products. This therefore calls for research aimed at improving the properties and texture of processed *A. sisalana* fibres. Other plants with potential to produce fibre that can be used in the industry should be explored.

Literature Summary

Plant fibres are described as lignocellulosics, meaning they are resources comprised primarily of cellulose, hemicellulose, and lignin; structurally they have elongated cells with tapering ends (Reddy and Young, 2005; Khalil *et al*., 2006; Armstrong, 2010). Both *A. sisalana* and *A. americana* are monocotyledonous plants and perennial-monocarp (Lock, 1969). In Swaziland, *A. sisalana* grows in the wild with no one taking care of it, anyone interested in its fibres goes and harvests freely, while *A. americana* on the other hand is an ornamental plant, and is mostly found in urban areas.

Fibres from sisal are extracted manually using rudimentary tools like tin cans, floor polish container lids, aluminium containers, and any other steel or metal materials or modified and extracted faster by the use of a machine decorticator (Boguslavsky *et al*., 2007). Alternatively they can be extracted by using chemicals such as sodium hydroxide (NaOH) and hydrocloric acid (HCl) at high temperatures, though these methods do not comply with green chemistry. Enzymes can be used to replace these hazardous chemicals. Enzymes are biological catalysts, they

are biodegradable and they produce quality fibres without the negative aspects of stench and pollution of the environment. Enzymes used for fibre extraction include the following; cellulases, pectinases, lipidases while hemicellulases are used after decortication (Foulk *et al.,* 2002).

Study Description

This study was carried at the University of Swaziland, Kwaluseni Campus, Swaziland. The PRA was conducted in areas where there are associations of women dealing with sisal products, in the Hhohho and Shiselweni administrative regions of the country. *A. sisalana* leaves were randomly obtained from the women's sources, while *A. americana* leaves were also randomly obtained from urban areas. Decortication of fibres was done using different tools accessible to the rural women. The extracted fibres were air dried indoors and wrapped with a cotton cloth and stored in an area free of moist for further tests and analysis.

The extracted fibres will be tested for mechanical properties before and after enzymatic treatment. Properties to be tested are; breaking strength, apparent elongation, linear density, stiffness and absorbency. Natural dyes would be extracted from plants and dying would be done with help from Tintsaba Craft (industry partner). Resins would then be applied on the fibres to improve texture, and assessed by users.

Research Application

The study is still in its early stages. The PRAs have been conducted in all the target study areas. It has been found that most of the rural women use tins and polish tin lids and other steel tools for fibre extraction. These extraction methods are time consuming and tedious. Moreover these methods are crude and do not fully extract the fibres from leaves. The glue-like material in the leaves also keep some fibres stuck together, hence the need to use some enzymes to digest off these adhessives. The PRA study so far has revealed that fibre extraction is only done by rural women and some poor men. It has also been found that some women quit the project because of low financial returns attributed to the monopoly of the only buyer (Tintsaba Craft). Another finding is the unsustainable methods of sisal production by the women. Therefore these women need to be taught to practice sustainable ways of sisal plant production. One of these would be to set up sisal farms. Questionnaires are going to be distributed to the rural women through which they will identifying plants that can be used for dying the fibres. Laboratory work will thereafter commence.

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