

Enzymatic processing of *Agave sisalana* and *Ananas comosus* plant fibres and fibre waste for diversified use

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Abstract

This study is being carried out to (i) characterise and explore the use of enzymes as an alternative method of fibre softening for sisal (*Agave sisalana*) and pineapple (*Ananas comosus*) leaves, (ii) determine the fabric hand on sisal jewelry after resin application, and (iii) develop and analyse a non-woven structure from the waste of treated *Agave sisalana* and *Ananas comosus* fibres in order to diversify current uses. Experiments will be conducted on enzymatic treatment of fibres from the afore-mentioned leaves. Application of resins will improve the texture of wearable *Agave sisalana* and *Ananas comosus* products. Results will contribute towards comfort in wearing sisal products and subsequent product demand. The emergence of local entrepreneurship in new undertakings such as environmentally sensitive manufacturing, value-added processing of agricultural output and commerce-related opportunities is deemed essential in government's striving to reduce unemployment and create wealth.

Key words: *Agave sisalana*, *Ananas comosus*, enzymatic treatment, Swaziland

Résumé

Cette étude est réalisée avec les objectifs suivants: (i) caractériser et explorer l'utilisation d'enzymes comme une méthode alternative d'adoucissement de fibres de sisal (*Agave sisalana*) et des feuilles d'ananas (*Ananascomosus*), (ii) déterminer la main du tissu sur les bijoux en sisal après l'application de la résine et (iii) élaborer et analyser une structure non-tissée à partir des déchets des fibres traitées d'*Agave sisalana* et d'*Ananascomosus* afin de diversifier les utilisations actuelles. Des expériences seront menées sur le traitement enzymatique des fibres à partir des feuilles susmentionnées. L'application des résines permettra d'améliorer la texture de produits portables d'*Agave sisalana* et d'*Ananascomosus*. Les résultats contribueront au confort de porter des produits de sisal et de la demande ultérieure des produits. L'émergence de

l'entrepreneuriat local à des entreprises nouvelles telles que la fabrication environnementalement sensible, la transformation à valeur ajoutée de la production agricole et les opportunités liées au commerce, est considérée comme essentielle dans l'effort du gouvernement pour réduire le chômage et créer de la richesse.

Mots clés: *Agave sisalana* et *Ananas comosus*, traitement enzymatique, Swaziland

Background

The handicraft industry in Swaziland works with rural women in product development and exports most of its products to countries like United States of America, Japan and Europe. A wide range of the products are made from natural fibres and serve as the rural women's source of livelihood (Zwane and Masarirambi, 2009). The Agave plants have thus proven to be useful to a majority of women in Swaziland especially in rural areas. Work needs to be undertaken to improve fibre extraction methods, fibre yield determination, fibre testing, production of fibre based nonwoven fabrics, composites and geotextiles of importance to Swaziland, preparation, extraction and analysis of chemical extracts for local use and export. With the need for many farmers to diversify their economic activities, the future potential of many fibres is yet to be realised. In Swaziland, only *Agave sisalana* is used for craft items yet there are other abundant plants like *Agave americana* and *Ananas comosus* which also have potential of producing good fibres. Thus, there is need to explore use of such plants. Moreover, if waste materials from plant fibres are properly utilised, more economic opportunities can be offered by improving the availability of some essential raw materials in addition to maintaining a healthier rural environment.

Literature Summary

In Swaziland, sisal grows wild as a weed in places where it was previously cultivated. This provides a widespread, ready source for natural fibers, albeit one that must be harvested, processed and prepared, all by hand. In rural communities, the women use rudimentary tools like cans, lids or aluminium containers to manually extract fibres from the leaves. Alternatively, manual decorticating can be done through the use of a machine decorticator modified to have a rotor, which prevents the blockage of machine by pulp or fibre waste and does a satisfactory job (Zwane and Masarirambi, 2009). Some of the plant fibres are not widely used in product development due to their harsh hand properties. Chemical extraction involves

the use of acids, alkalis and enzymes (Zwane and Cloud, 2002). Analytical studies on plant fibres have focused on the effect of chemical treatment using alkali in improving pulping and bleaching processes of raw fibre materials. Sodium hydroxide is often used, but it is not approved by environmentalists because it is not eco-friendly. This means there is need for better extraction and treatment methods of the natural fibres, which are efficient and environmental friendly.

Key drivers of growth and renewed interest in the field of natural fibres are attributed to new environmental awareness and regulations. Enzymatic treatment of plant fibres is used for eco-friendly processing (Anandjiwala, 2006). Enzymatic processing degrades the lignocellulosic complex in fibre swelling, lowers the degree of polymerization and makes fibres more pliable and softer. For enzymatic fibre extraction, a combination of enzymes such as pectinases, hemicellulases and cellulases are generally used with a pre- or post-chemical treatment. Despite being eco-friendly, enzymatic processing has not gained popularity in industries of developing countries (Anandjiwala, 2006), such as Swaziland. Enzymes are biodegradable, can be reused, and are effective at relatively lower process temperatures (Jarvis and Mazzocchi, 1973). All these factors make them extremely interesting from the point of view of an industry that strives to reduce its operational costs, environmental impact and to appeal to the environmentally conscious consumer.

Study Description

Participatory Rural Appraisals (PRAs) will be conducted in the northern parts of Hhohho and Lavumisa to collect information on the current situation and challenges faced by the sisal weavers in the country. Formal questionnaires that have been designed will be used to collect organised data from the participants. Sisal and pineapple plants will be harvested for leaves that will be suitable for fibre extraction from Mayiwane and Malkerns respectively. Leaves will be sorted according to size and thorns will be removed where necessary using knives in preparation for decorticating. Fibres will be extracted using current decorticating methods, which include: use of polish cans against wooden boards for sisal and bamboo stripper for pineapple. Decorticated fibres will be dried in the shade. Proper drying is important as fibre quality depends largely on moisture content (Yayock, Lombin and Owonubi, 1988).

A group of selected enzymes will be used to further extract the fibres chemically from the cementing layers, and their

properties will be determined. Women from Tintsaba will assist with dyeing and spinning the fibres using natural dyes sourced from local flora. Small mats will be made and different finishes will be applied to improve the texture qualities of the products and nonwoven structures will be made from the dried fibre waste. Yarn spun from intermediate technologies will be evaluated for strength, evenness, and linear density for the different fibre types. Texture will be assessed by a panel of sisal weavers, export agent and a formal producer that focuses on product development.

Research Progress

Consultative meetings have been conducted with women in different parts of the country; all of them use only sisal plants and utilise mechanical decortication methods. These crude fibre extraction methods are tedious, high energy and time demanding in production of craft items. The women have difficulty in securing raw material from distant mountain sites and the lack of diversity in the fibre market seems to limit their profit making potential. However, through the sales of their handicrafts, the women earn the money needed to buy basic food and clothing, access medical care and pay school fees and thus there is hope of achieving the millennium development goals (MDGs).

The Project aims at improving the incomes and food security of Swaziland's disadvantaged smallholder families, particularly women on Swazi Nation Land (SNL). It sets out to improve incomes of smallholders and standards of living of disadvantaged smallholders on SNL. There is hope to strengthen the groups or individuals already supported under the Tintsaba Master Weavers in Sisal and address constraints to raised productivity particularly the need to introduce new systems of production that will yield high quality fibres and quantity products. With production set to increase, thanks to an increase in the global consumer demand, local women will be able to improve their livelihoods even more.

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