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Extraction and Textile Qualities of Fibers from Some Xerophytic Plants

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ABSTRACT

The significant of natural fiber in artistic manipulations cannot be overestimated, hence there is need to resuscitate its extraction and production. A study was conducted on the extraction and the textile potentials of fibers from four xerophytic plants namely: *Agave sisaliana*, *Agave americana*, *Pandanus sanderi* and *Sanservieria trifasciate*. Six different solutions: A- 2 L of cold water and 10 g of caustic soda (NaOH); B-2 L of cold water and 20 g NaOH; C-2 L of hot water and 10 g NaOH; D-2 L of hot water and 20 g of NaOH; E-2 L of hot water (control 1) and F-2 L of cold water (control 2)} were assessed for there fiber extraction capacity and the quality of fiber using retting traditional method for three days. The results of this experiment showed highest level of retting in plants soaked in solution D followed by solution B and the lowest from solution A after the first three days. *Agave americana* fiber was more subtle, smooth and with fine strands. Fiber extraction process was firstly completed in solution D followed by solution C while solutions E and F plants were still undergoing fiber retting process after 14 days. All the plants had sized and unsized fibers of different qualities. The utilization of solution D is recommended in traditional retting of fibers since all plants fiber extracted in this solution had the best structure and *Agave americana* gave the best fiber. Natural fiber extraction is economical and harnessing these potentials will contribute immensely to the industrial artistic world development.

Key words: Xerophytic plants, natural fiber, retting, fiber qualities

INTRODUCTION

Fibres are strands or filaments which are derived from vegetable, animal, or petroleum products which discovery and subsequent use in different types or levels of production marked a new epoch in textile science and technology (Verloove, 2005). From investigations and research, it can be noticed that fiber can be extracted from animals, plants and minerals. Animal fibers are wool, hair, etc and secretions, such as silk. Plants fibers may be seed hairs, such as cotton; bast (stem) fibre, such as linen; leaf fiber, such as sisal; and husk fiber, such as coconut (International Year of Natural Fibres, 2009; McGovern, 1990). Uzoechi (1991) studied kenaf and pineapple plants and the extraction of their fiber contents. But Wingate (1964) describes fiber as a hair-like unit of raw material of which cloths are made, or a basic unit used in the fabrication of textile yarns and fabrics. She gave a detailed study on the extraction of these fibers. The fiber strength, the staple length, its pliability, elasticity and other fiber properties were exhaustively discussed.

Presently, natural fibers are hardly seen around at the market or anywhere so to say. All that is seen around us these days are mainly industrial twines or what are popularly known as nylon twine. This was the situation of thing in Tanzania after 1994 when the synthetic fibers outmarches the natural fiber production from sisal change the trend of production and affecting their economy. Obviously one can say rightfully that the already investigated natural fibers are out of use and also becoming absolute. Truely, the nylon or artificial fibers in use now can serve the same purpose as the natural fibers but the two can never be equated (especially in artistic manipulation). The soft and tough nature of the natural fibers can never be equated to the hard and coarse nature of the man-made nylon fiber especially when they are handled in tying or knotting of any type (Msahli *et al*., 2007). Cruse (2008) reported on the utilization of xerophytic plants as a dependant factor upon complete utilization of the extractive of a particular species and applause *Agave* species for natural fiber yield.

The extraction of natural fibers from plants and their uses for production of fabrics and other woven or constructed textile materials has played major role in textile development. Before this development, man had made fabrics or body covering with figs, animal skins and tree barks. The failure of these improvised materials to fulfill its purpose compelled man to further amplify their search for a suitable substance for clothing which are found in fibers. The positive impart of natural fibre in developing textile, book production and brick making industries cannot be underestimated.

The leaves of Agave plants have been reported to be rich in textile fibers that belong to the class hard fibers (Lewin and Pearse, 1985; Verloove, 2005; Msahli *et al*., 2007; Cruse, 2008). There is an increase in research interest on the availability of xenophytes and new and uncommon ones are been discovered due to the role p layed by these plants in improving mans' economy (Clement and Foster, 1994; Verloove, 2005), Hence, this research aimed at identifying, extracting and bringing out the dwindling nature of some Nigerian xerophytic plants fiber and their utilization in the development of new materials for textile.

MATERIALS AND METHODS

This experiment was conducted in the studio of the Department of Fine and Applied Art, University of Nigeria, Nsukka, Nigeria between 17th January and 14th February, 2009.

Plants species used and their locations: Although, these plants are desert or semi desert plants, they are being planted for formal and architectural effects. As a result they can be seen at strategic points within the compounds of the University of Nigeria, Nsukka and in several other places and roads were they are used as ornamental plants. The plants used are *Agave sisaliana* (AS) (Fig. 1), *Pandanus sanderi* (PS), (Fig. 2), *Agave americana* (AA) (Fig. 3) and *Sanservieria*

Fig. 1: *Pandanus sanderi*

Fig. 2: *Agave americana*

Fig. 3: *Agave sisaliana*

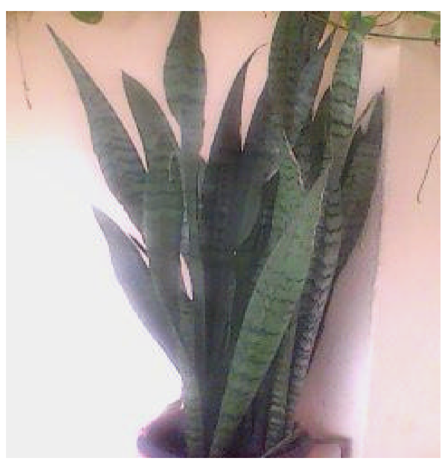

Fig. 4: *Sanservieria trifasciate*

trifasciate (ST) (Fig. 4). These are scattered at the Departments of Fine and Applied Arts, Education, Agriculture and Mass Communication. Other places where these plants can be seen are

Works Department and residential areas with staff quarters. They were all planted as decorative plants hence referred to as ornamental plants. Another vital place where these plants can be located within the University is at the Botanical Garden of the Department of Botany and Forestry.

After locating these plants, some samples were taken to a plant taxonomist for identification. They were collected from the parent stock and labeled 1-4 based on their plate numbers. Each of these was cut into six parts measuring six inches apart.

Experimental set-up for fiber extraction: Hollen and Saddler (1969) retting by tank method was modified and adopted. In this study a catalyst, caustic soda was used to fasten the retting period and a control set-up was introduced.

The plants used in this experiment were labeled 1-4. They were given five different treatments with each having a control and labeled 1a-f; 2a-f; 3a-f; 4a-f. There were six bowls containing 2 L of water, three were hot while the rest were cold; 10, 20 and 0 g of caustic soda were added, respectively. The ones that do not contain caustic soda is the control experiment. These were labeled serially from a-f.

The plant materials were cut from the parent stock. 6 sized of each plant was cut and submerged into the different bowls already labeled A-F. Twenty-four bowls were used for this experiment. The experiment lasted for two weeks and the specimens were observed for the first three days and within the last week.

Qualitative analysis of the specimen: The observations made were recorded for the retting rate, effect of the treatment and fiber quality of the plant specimen.

RESULTS

In this treatment A, Plant 1a was still very strong and green with a little sign of retting. In plant 2a, large area showed signs of fermentation or retting, but is still with patches of green coloration; therefore retting is yet to be completed. Plant 3a was still very green but with a very little sign of fermentation. Plant 4a was still strong and green but with a very little sign of fermentation. In this treatment all plant species showed low rate of retting and therefore needed to be observed for more couple of days.

In this treatment B, it was noticed that plant 1b, though still green, has become soft, an indication of retting taking place. Plant 2b was very soft showing high level of retting though still green. Plant 3b showed high level of retting but still green; though patches of colour changing were seen indicating rot. Plant 4b was still green with a little sign of fermentation.

Generally, in this treatment the catalyst added has hastened the retting rate.

It was in treatment C that; plant 1c had softened a little but still very green. It had signs of retting. Plant 2c had also softened and showed high rate of fermentation with the colour turning grey in some areas; showing indications of retting while a little patches of green were still seen. Plant 3c also had softened showing high level of fermentation and had almost equal area of grey and green indicating uniform retting. Plant 4c had signs of softening, but showing low rate of fermentation and still green. Finally, the above showed that plants 2c and 3c showed high level of fermentation in hot water solution of caustic soda even in low acidic level.

In this treatment D, plants 1d, 2d, 3d and 4d all have fermented and are ready for the second stage which is washing.

In treatment E, plant 1e showed a colour change from green to brown indicating the effect of heat but still very strong. Plant 2e showed signs of fermentation by softening a little. It also changed to brown due to heat. Plant 3e also has the same colour as plant 2e but is still strong. Plant 4e showed no sign of fermentation, still very strong and had little brownish colouration.

Plants 1f, 2f, 3f and 4f are still green with a little sign of fermentation in water in treatment F.

Conclusively, the four plants in treatment D showed high level of retting in hot but high alkaline (20 g) solution. The second in retting is treatment B which has 20 g of caustic soda in cold water. The third is treatment C which has 10 g of the catalyst in hot water. Lastly is specimen A which has 10 g of the catalyst in cold water. Generally, it was observed that retting was fast in high catalyst solution but very fast if the solution is formed with hot water.

Within the first two weeks, treatment D was ready for washing out after a while of retting. Plant 1d produced a creamy coloured fiber which was very easy to wash out. Plant 2d produced a fine white fiber. Plant 3d produced a thin fiber most of which was lost in water during washing due to long retting period. Plant 4d produced a semi white fiber. Of all the fibers produced, plant 2d is more subtle, smooth and has fine strands.

On the eleventh day, in treatment C, three out of the four plant specimens were ready for washing so another couple of days were accorded to the specimen. In completely two weeks, the plants were washed out of the solution. It was observed that though with longer period of retting, Plants yielded more fiber. The colours remained as they were in treatment D, but plant 3d was lost completely during washing.

Also, plants in treatment B and A were washed out and plant 3 was completely lost during washing. More fibers were also realized and the colours were a little darker than what was obtained in C and D. Treatments E and F were still not ready for washing out.

DISCUSSION

The morphology and structure of xenophyte cannot be appreciated in textile without proper extraction method which will improve the quality of the natural fiber produced. Proper washing and rinsing of the fibers were necessary so as to remove the binding tissues that bind the fibers together similar report was made by Cruse (2008).

The drying was followed up with seizing. This is a finishing process in the production of yarn in which substances such as glue, wax, casein or clay is added to the yarn (cloth) to give it additional strength, smoothness, or weight. In this experiment, wax was used for seizing. Half of each specimen was seized while the remaining half was unseized.

During seizing with candle wax, it was observed that the wax helped in separating the fibers into single filaments. In plant 1, the sized fiber was soft, smooth and finer, increasing the bristle nature of the fiber because it has been separated into single filaments. But the strength increased when more of the filaments are twisted together. The unseized is less bristle and more durable because the filaments are clapped together, but when separated, the fiber is more susceptible to breakage. In plant 2, the sized fiber is more coarse than the unsized but it is smoother. This fiber is better used for making ropes. In plant 3, the sized fiber is firm and more durable than the unsized which is easily broken (Wingate, 1964; Cowan and Jungerman, 1969; Ickis, 1971; Udeani, 2008). In plant 4, the sized fiber is smooth and finer than the unsized though a little coarse but durable.

At spinning, fibers exist in continuous fibrous form similar observations were made by Msahli *et al.* (2007) and International Year of Natural Fibers (2009). These continuous filaments are not used in their state, but are cut into short lengths called staple and spun in order to them more strength by binding them together to produce a continuous yarn that is tough and durable (Nkenoye, 1993). In the studies carried out by Msahli *et al.* (2005, 2006) and Chaabouni *et al.* (2004), the mechanical behavior of technical fiber is related to its fine structure and this is the basis for its utilization. To spin, some of these short length fibers are drawn out and twisted into yarn or thread. The twist can be inserted in either clockwise and/or anticlockwise direction(s). Clockwise is referred to as "Z" twist while anticlockwise is S twist.

The ever growing cost of foreign art materials recently is an encouraging factor for further explorations into various aids that will ease off or reduce the cost of art production. It was due to this reason coupled with the dwindling nature of our fiber art that the writer embarked in this experiment. The glaring question now is whether this art and the resultant art will be appreciated and what its prospects are in the art industries in particular and the nation in general.

In the first instance, this fiber will be highly appreciated in art. Just like raffia fiber, these fibers are used to produce products that can be used for decorative purposes which can be used for gifts and souvenirs e.g., tapestries. Secondly, the exploration reflects the use of material and cultural advancement as well as artistic and technological development. Thirdly, the study of these fibers and their incorporation into art especially fiber art will encourage the development of small scale industries in Nigeria. Fourthly, the development of material resources will be enhanced and the advancement of indigenous creativity because local material will be applied in diversified areas of art, science and technology. Fifthly, this exploration will bring to bare the abundance of local materials for the development of fiber art in Nigeria. Like raffia, pineapple and kanef fibers, these fibers-*Agave sisaliana*, *Agave americana*, *Sansevieria* sp. and *Pandanus sanderi* can also be used in our textile industries or used locally to produce items such as ropes, codes, macramé and wall hanging. Natural fibers have been generally considered to be more environmentally friendly than synthetics in production and disposal (International Year of Natural Fibers, 2009).

In summary, it can be claimed that the availability of these plants-*Agave sisaliana*, *Agave americana*, *Sanseveria* and *Pandanus sanderi* in our climatic zone is enough to maximize the use and adaptiveness of these fibers in our every day fiber usage. The fact that they are all tropical plants makes it possible for each to be cultivated in plantations so as to produce them in commercial quantity. If the natural law of making use of what we have is applied, these fiber properties should be improved in any way they are lacking in workability. This is to enhance the usefulness and as such their potentials will be fully utilized.

Also, this experiment has opened up avenues for more plants to be explored and most importantly, it has encouraged greatly the search for knowledge of one's environment. Finally the application of chemistry into the effort of fiber extraction shows that art and other disciplines are interwoven and none can exist in isolation.

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