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RESEARCH ARTICLE

Ecofriendly Application of Coconut Coir Fibre Extraction Composites for the Production of Sculptures

Idorenyin Akpan ESSIEN[1], Wenikado S. GANAGANA[2]

[1]*Department of Fine and Applied Arts, Federal College of Education (Technical), Omoku, Rivers State, Nigeria.*

[2]*Department of Fine and Applied Arts, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.*

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Corresponding Author: Idorenyin Akpan ESSIEN, Department of Fine and Applied Arts, Federal College of Education (Technical), Omoku, Rivers State, Nigeria.

Abstract

The coconut (*Cocos nucifera*) fruits are extensively grown in tropical countries. The use of coconut husk derived coir fibre-reinforced bio-composites is on the rise nowadays due to the constantly increasing campaign for sustainable development, renewable, biodegradable, and recyclable materials. Generally, the coconut husk and shells are disposed of as waste materials; however, they can be utilized as prominent raw materials for environment-friendly bio-composite production. Coir fibres are strong and stiff which are prerequisites for coir fibre-reinforced bio-composite materials for sculpture. The study aims identifying the application of coconut coir fibre extracting composites for the production of ecofriendly sculptures, highlighting its economic value, unique characteristics and artistic potentials. It also examines the benefit of waste coconut coir fibre sculpture in wealth creation. The method used in this research is the studio methodology of process and experimentations. Thus, coconut coir fibre composite were created out of waste or discarded coconut husk, which were subsequently used for the creating of ecofriendly sculptures. A step-by-step approach is shown from the gathering, through the preparation of coconut coir fibre composites to the final execution of the works. Problems were encountered and solution provided. The works produced attest to the economic viability of coconut coir fibre waste as an ecofriendly alternative material in sculpture. The result of this research is a sculpture product that has aesthetic value and is beneficial to humanity and can be of economic value. The paper also made recommendation for students and researchers of coconut coir fibre waste.

Keywords: Coconut, Coir-Fibre, Extraction, Sustainability, Composite, Eco-friendly.

1. Introduction

Natural fibre-reinforced composite materials have received continuous attention due to their industrial application potential. Natural fibre is comparatively cheap, renewable, completely/partially recyclable, biodegradable, and ecofriendly, and synthetic products are continuously being replaced by natural products. The bio-based fibre materials including flax, hemp, ramin, jute, coir, hard and softwood materials; and rice husk are the biggest sources of bio-composite filler materials. Their availability, costing, lower density, and overall convenient mechanical features have made them attractive ecological materials as compared to synthetic fibres such as glass, carbon, nylon, and aramid. Natural fibre has a long history of usage for various products ranging from housing to construction and clothing. Natural fibre-reinforced composite are used in diverse applications such as construction, building, automobiles and aerospace. However, nowadays, synthetic fibre-reinforced

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products are still being used for producing composite materials because of the lack of adequate technology, research, and scientific innovations to utilize renewable natural fibre as a prominent replacement for biocomposite produce (Hasan, 2021).

Coconut coir fibre is light, fluffy material that falls off from thick mesocarp of coconut (*Cocos nucifera*) fruit when it is shredded during processing. The fibre is used for the manufacture of ropes, carpets, mats, hats and other related products. The fall off materials remain available as waste product of no industrial value and are normally incinerated or dumped without control (Vidhana and Somasiri, 1997).

However, in advanced countries, coconut coir fibre is compressed into bricks or bales wrapped and shipped for sale (Evans et al., 1996). They are used for preparing soilless growing media for cultivation of some ornamental plants or crops (Reynolds, 1974; Meerow, 1994). Some of the properties and composition of this bio-based material has been documented in literature (Tejano, 1985; Joseph and Sarma, 1997; Abad *et al.*, 2002). Its constituents include cellulose, non-cellulose and extractives such as pectins and tannins. These constituents make coconut coir fibre a useful adsorbent or natural ion exchanger because of the hydroxyl and carboxyl groups present in its composition. Many bio-based materials, mostly agricultural byproducts, have been utilized as bio-sorbents/ion exchangers for removal of cations/anions from solutions. Maize cob, sugarcane bagasse, peanut skin, banana pith, orange peel, (Randall et al., 1994; Low et al., 1995; Igwe and Abia, 2003; Krishnani et al., 2004; Perez marin, 2007). It is the aim of this study therefore, to highlight the applying process and utilization of ecofriendly coconut coir fibre as an alternative material extracted for the production of sculpture. Besides being environmentally friendly, it is also cost effective; the need to use these materials will no doubt encourage the recycling of other waste extracted materials in the production of sculpture.

Coconut coir fibre are emerges as a valuable resource from the husk of coconuts. Initially deemed as agricultural waste, the husk undergoes a transformational journey after extraction, culminating in the creation of ecofriendly intricate sculptures lies in understanding and harnessing the inherent properties of this versatile material.

2. Aesthetics Theory

Immanuel Kant, in his work on aesthetics and teleology, argues that it is our faculty of judgment that enable us to have experience of beauty and grasp those experiences as part of an ordered, natural world with purpose. Burnham (2016) explains that Kant's critique of judgment begins with an account of beauty. The initial issue is: what kind of judgment is it that results in the saying, for example, 'That is a beautiful sunset'. Kant argues that such aesthetic judgments (or judgments of taste) must have four key distinguishing features. First, they are distinguished, meaning that we take pleasure in something because we judge it beautiful, rather than judge it beautiful because we fine it pleasurable; second and third, such judgments are both universal and necessary. This means that the functional part of the activity of such a judgment is to expect others to agree with the artist. We may say "beauty is in the eye of the beholder that is not how we act. Instead, we debate and argue about our aesthetic judgments and especially about works of art and we tend to believe that such debates and arguments can actually achieve something. Beauty for many purposes, behaves as if it were a real property of object, like is weight or chemical composition. But Kant strongly maintains that universally and necessity are in fact a product of features of the human mind (Kant calls these features common sense), and that there is no objective property of a thing that makes it beautiful.

This theory is employed in this study because it is of the opinion that is 'either an arrangement of conditions intended to be capable of affording an experience with marked aesthetic character or (incidentally) an arrangement belonging to a class or type of arrangements that is typically intended to have this capacity' (The Aesthetic Point of View).

3. Materials and Methods

The first step in this journey involves the sourcing and acquisition of coconut waste, harvested primarily in tropical regions across Eastern Nigeria; Ikot Ekpene and Eastern Obolo, mature coconuts yield husk rich in fibrous material. Collaborations with local coconut farmers and native market, processing facilities ensure a steady supply chain, fostering viable partnerships within communities.

3.1 Sourcing and Extraction of Coconut Coir Fibre

Figure 1. *Model showing the sourcing and extraction of coconut coir fibre.* **Source:** *www.juridiconline.com*

3.2 Processing Techniques of Coconut Coir Fibre

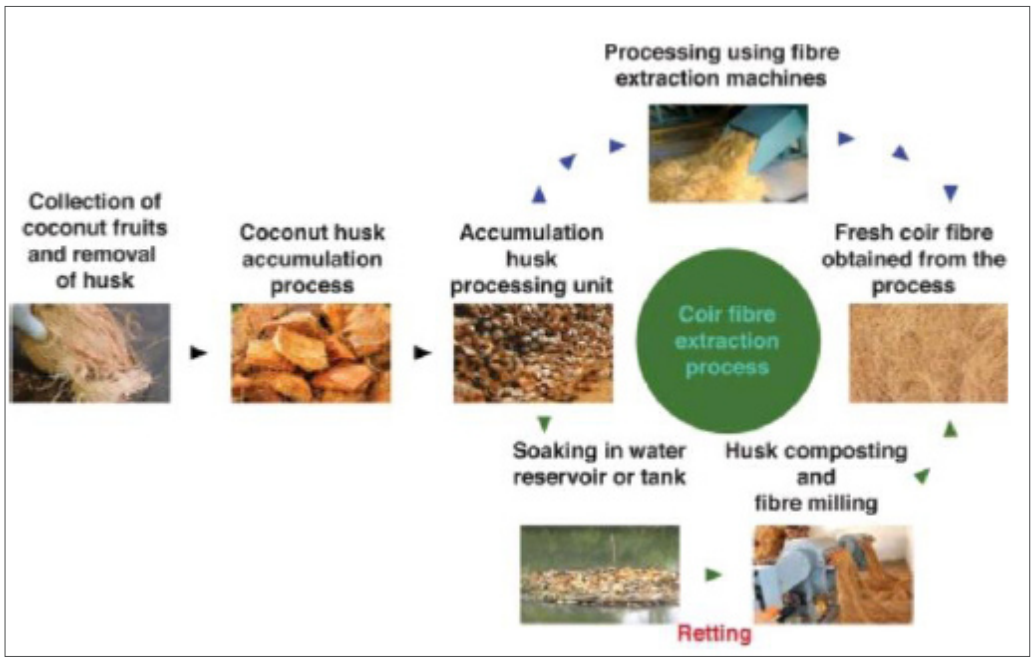

Figure 2. *Showing processing techniques of coconut coir fibre.* **Source:** *ScienceDirect.com*

Husk accumulation: Husk (coconut fibre) is gathered from the coconut farm where fruits are harvested manually when separated from the fruits by the farmers. The husks are also gathered from dust bins or dumpsites.

De-husking: Through manual labour processes, coconut husks are separated from the fruit, laying the groundwork for subsequent stages. The processes include:

1. *Retting* involves the immersion of coconut husk in freshwater, initiates the retting process, loosening fibres from the pith and preserving their integrity for sculptural applications.
2. *Beating and Separation:* The study used traditional methods of wooden mallets to facilitate the separation of fibres from the pith, ensuring uniformity and quality in the final product.
3. *Drying and Cleaning:* Sun drying methods reduce moisture content, while cleaning processes eliminate impurities, preparing the fibres for grinding and subsequent utilization. (Palaniswamy & Nair, 2018).

Step I: Sketches are made of various forms and images to be sculpted or produced.

Figure 3. *Sketches of squirrel*

The sketches were spontaneously done and only successful ones were taken for execution. Ochigbo (2006) asserted that sketch is a rough, quick made drawing. Sketch could be a personal motivation of work execution; it could be the framework of a successful artwork. Owing to this importance, sketches are the starting point of any artwork.

Stage II: Armatures are formed or constructed in the round on a base to be sculpted

Figure 4. *Armature construction of the squirrel*

Stage III: Stuffing of armature with styro-foam and fibre

Figure 5. *Stuffing of the armature*

Stage IV: The researcher mixed coconut coir fibre with glue to malleable consistency or workable state, which serves as a fibre pulp used for modelling the ecofriendly sculpture.

Figure 6. *Coconut coir fibre mixture*

Stage V: Here the researcher used the coconut coir fibre composite in building or modelling the squirrel with additive method to get the desired from and image.

Figure 7. *Shown additive modelling method*

The coconut coir fibre composite are used to model the conceptualized ecofriendly sculpture form. The additive methods are repeated severally till the finished sculpture is achieved. It should be noted that when the work is dry and it is realized the work need correction or adjustment, the subtractive method is applied.

Stage VI: The finished ecofriendly sculpture from coconut coir fibre. The finished sculpture is allowed to dry in the sun and is mounted since it is in the round.

Figure 8. *The squirrel*

3.3 Artistic Exploration

The processed coconut coir fibre serves as a media for artistic exploration, offering sculptors a medium rich with creative possibilities

- Form and Texture: The pliability of coconut coir fibre allows for the sculpting of intricate forms and textures, enabling artists to imbue the work with precision and details.
- Aesthetic Appeal: The organic texture and earthy tones inherent in coconut coir fibre imbue sculptors with a natural aesthetic, captivating qualities and evoking sensory experiences.

3.4 Sustainable Practices

Central to the wealth generation through coconut coir fibre sculpture production is the adoption of sustainable practices:

- Resource utilization: By repurposing coconut husks, a byproduct of coconut cultivation, artisans the chocking of termite and pest.

1. Avoiding moisture: Coconut fibre sculpture are susceptible to mold and decay when exposed to moisture. Keep sculptures in dry environments and avoid placing them in areas prone to humidity or direct contact with water.
2. Protective coating: Apply eco-friendly sealants or coatings to the surface of the sculpture to provide a protective barrier against moisture, dust and environmental pollutants. Ensure that the sealant used is compatible with natural materials and does not alter the appearance or texture of the sculpture.
3. Regular cleaning: Clean sculptures made from coconut fibre regularly to remove dust, dirt, and debris that can accumulate over time. Use a soft brush or cloth to gently remove surface particles without causing damage to the delicate fibre.
4. Avoiding direct sunlight: Exposure to direct

sunlight can cause fading and deterioration of coconut fibre sculptures over time. Place sculptures in shaded areas or use UV-filtering coatings to protect them from harmful sun exposure.

5. Proper handling: Handle coconut fibre sculpture with care to prevent damage to the delicate fibres. Avoid excessive touching or handling, and use gloves when necessary to protect the sculpture from oils and dirt on the skin.

3.5 Problems and Solution/Findings

Coconut coir fibre has a long-term tradition of usage in different application areas. For a long time, coir fibres have been used as ropes, yarns, mats, floor furnishings, sackings, insulation panels, and geotextiles. However, coir fibre is showing new potential in terms of commercial prospects for manufacturing sustainable and green composite products. The high-weight, low-cost, and thermally conductive bio-composite panels are new and innovative additions of coir fibre reinforced composites. All parts of the coconut plant have economic, social and cultural values; even the waste now has potential value as a raw material for various products. Coconut provides economic benefits and has become one of the most important commercial crops in the tropics, where they are referred to as "heaven trees" or "the tree of abundance". But the majority of artisans and sculptors are not aware of the beneficial characteristics of coconut fibre waste, although such waste is essential for the production of high-quality souvenirs and sculpture. Artisans have typically shown little interest in developing techniques that would enable them to produce higher quality products.

By recognizing the characteristics of coconut waste, the artisans could use the waste in the design of motifs on tourism souvenirs. Different types of coconut waste can be processed into various handicraft items like plates, cups, goblets, receptacles for trinkets etc. and sculptures for tourists, including pieces of coconut wood, shell, leaves and fibre. The most common waste types reported used as raw material for handicraft goods are coconut wood, about (45%) and shells (45%). Both of these coconut wastes were used by craftsman to produce various unique designs and motifs for handicraft goods of various sizes, shapes and functions. Coconut wood and shells have become the most popular raw materials because of their guaranteed availability, ease of processing into various designs and motifs, and amenability to being freely formed with various cutting and shaping techniques. The majority of craftsmen did not distinguish between coconut wood and shells according to types, structure, texture, and origin; all coconut waste types were generally considered similar, and only negligible number of craftsmen could distinguish between waste types and apply their knowledge for product shaping, patterning, motif design and print orientation.

Also findings revealed that, the coconut coir fibre, shell and wood which are mostly discarded as waste materials can be recycled and processed into fibre composites for the production of ecofriendly sculptures and at the same time rid the environment of waste. Studio analysis of coconut coir fibre shows that in strengths coconut coir fibre is potential biodegradability feature, awareness of sustainability throughout the world, constantly increasing demands toward natural fibre and associated byproduct reinforced bio-composites, lower density, higher stiffness and higher strengths, economical when produced manually on the industrial scale, minimizes/ eliminates hazardous effects from manufacturing operations, renewability and recyclability requires less energy for processing.

3.6 Weakness

Differences in inherent characteristics, weaker interfacial bonding, and more feasible production technology is not yet invented.

3.7 Opportunity

Demands an eco-friendly sustainable product are increasing, demands for a lightweight bio-composite material is high, researchers and manufacturers are paying more attention to natural fibre-reinforced bio-composite, bio-composite manufacturing is also implementing state of the art technology with improved scientific inventions and knowledge. Manufacturers are trying to be more sustainable to cope with more customer demands.

3.8 Threats

Climate change is having a critical impact, affecting the availability of raw materials (plant-based) all over the world. Each specialized application need specific high performance fibres, the cheaper price of synthetic materials; non-homogeneous quality of the natural fibres.

The study concluded that the coconut fibres are an effective media in the production of eco-friendly sculpture due to their inherent toughness, durability and pliability.

4. Conclusion

This study has provided an overall discussion/ studio practice on coconut coir fibre as a potential

natural sculpture material for producing eco-friendly sculptures. In the convergence of artistry, sustainability and economic enterprise lie the pathway to wealth through coconut fibre sculpture production. By harnessing the inherent qualities of these versatile materials, communities can cultivate prosperity while fostering environmental stewardship safety and cultural preservation. As sculptors mould raw fibres into works of arts, they sculpt not only forms but also opportunities for a brighter and more sustainable future.

4.1 Recommendations

It is therefore recommended that, students and researchers of alternative media in sculpture should venture into other ways of using the coconut husk coir fibre, shell, wood and processed to expand the frontiers of knowledge of these materials or any other material for that matter.

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