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Biomimetic Design Concepts in African Textile Prints: Embracing Nature's Influence on Fashion and Textiles

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Abstract

Purpose: The purpose of this study is to provide a comprehensive review of biomimetic-inspired concepts in surface African printed textiles and fashion products and analyse their cultural and philosophical significance.

Methodology/Design: An integrative review was adopted using the constrained snowball approach. Google Scholar was the main database used for this review. Eight seed articles were identified after which bibliography coupling was done to identify important articles worthy of inclusion based on the main terms in the topic. The co-citation functionality in Google Scholar was used to further identify and select recent articles that meet the inclusion criteria set out. Subsequently, the second, third and fourth-generation co-citation articles that meet our inclusion criteria were reviewed after which local and international news portals and blogs about African print design and fashion were searched.

Findings: A design concept is an idea behind what we see and appreciate aesthetically. The concept may be inspired by physical objects or situations, values, or beliefs in the case of African settings. It is also established in their research that every single element of a given African pattern has a distinct meaning and is purposely presented to represent some values in a society. The African textiles' surface designs are inspired by different sources. These include a wide range of natural to artificial objects, cultural symbols, values, proverbs, and beliefs. The Indigenous designs were made up of designs from nature while the contemporary African designs are comprised of designs inspired by technology.

Practical and Social Implications: Practically, integrating biomimetic design into African textiles can enhance sustainability in the fashion industry, promoting eco-friendly production methods. Socially, this approach fosters cultural pride and community engagement, as it highlights the rich heritage of African designs while encouraging collaboration among local artisans.

Originality: The article explored the incorporation of biomimetic design concepts in African textile prints, showcasing how deeply nature influences fashion and textiles. It provides a fresh viewpoint by linking traditional African designs with contemporary practices, helping to enhance our appreciation for cultural heritage. Ultimately, this will be a valuable resource for designers, researchers, and industry professionals who want to merge creativity with a commitment to environmental sustainability.

Keywords

Biomimicry, textiles, fashion, accessories, African prints, surface textile design

1 | INTRODUCTION

The structural design and mechanisms, in our natural world, have been inspirations scientists and researchers use to seek practical solutions to technological problems. Hence the prevalent use of the term "discover" for most scientific breakthroughs instead of "create" (Teodorescu, 2014). Nature is endowed with advanced materials, objects, and processes that work from the larger scale to the

nanoscale (Bhushan, 2009). The emerging arena of biomimetics enables one to mimic biology or nature to come up with nanomaterials, nanodevices, and other technological inventions to solve human challenges (Bhushan, 2009). Additionally, there is sufficient indication to suggest that our ancestors looked to nature for inspiration to conceive new materials and devices long before the term biomimetics was coined (Eadie & Ghosh, 2011). For instance, the early weaving, spinning, making fire, the use of natural colours, and many others support the fact that there was the imitation of natural occurrences to address human challenges.

Nature is filled with an enormous record of structures and principles that have been demonstrated to be ahead of that of man-made (Ilwich et al., 2006). Architectural structures have developed rapidly over time from the living caves in pre-historic times, through the making of huts, mud houses, and brick houses to the designing and construction of high scrapper buildings in the towns and cities. These advancements in architecture are largely influenced by advanced technology. With the animal kingdom as a foundation of motivation, Shu-Yang et al. (2004) seek to instil a shift in thinking about the application of biological principles to design and architecture. Their main concern is the examination of how organisms have gotten used to varied environments and hence translate the acquired principles into the built environment. It is also worth noting that architects in Zimbabwe are researching how termites can adjust to the temperature, humidity, and airflow in their hills to be able to construct more comfortable buildings (Hu, 2019). The designs of buildings have been significantly influenced by nature's abundant designs. Badarnah and Kadri presented a design concept that is capable of reducing energy demands by employing special structural features together with other principles that take up water from local fog events catatonically (Badarnah & Kadri, 2015).

Textiles offer exclusive opportunities to imitate nature in many directions. The fundamental sections of each textile structure at the most elementary level of the hierarchy (from nano to micro) are organic, many of which are natural. In addition, like many natural functional surfaces, textile surfaces also offer great prospects for coming up with new functionality. All these allow an easier way to borrow the biomimetic principles of nature in the textile field than in other industrial areas. Fabric water resistance, self-cleaning, and drag reduction are some of the functionalities that have been fruitfully integrated with textile products. The thermal insulation properties of duck feathers, penguins, and polar bears have inspired the manufacture of textile articles for cold weather. The aesthetic aspect could not be neglected, especially when it comes to clothing, hence researchers have turned their attention to beautiful textiles with vivid colours with inspiration from butterflies, birds, and beetles (Teodorescu, 2014). In recent times, over the last two decades, biomimetics has been applied in many fields, especially in science, engineering, and art, however, literature on biomimicry in surface African printed textile design is limited despite the prevalence of nature-inspired designs and items such as totems for promoting African clan identities. The study focuses on surface African print Design concepts (from plants and animals), contemporary African Textile prints, biomimetics-inspired fashion design, and accessories as a way of projecting African identity in African textile prints.

Biomimicry in textile innovation has primarily addressed technical challenges and enhanced material functionalities. For example, polar bear fur has inspired thermally insulating textiles that decrease energy consumption in cold climates (Wang et al., 2018). The self-cleaning properties of lotus leaves have been emulated to produce fabrics that reduce water usage and chemical treatments. Additionally, studies have utilized shark skin to design water-resistant and drag-reducing surfaces for textiles, demonstrating the versatility of biomimetic principles (Bhushan, 2009). These advancements are often the result of

interdisciplinary collaborations, integrating insights from engineering, material science, and nanotechnology. The focus remains on functionality, sustainability, and efficiency, aligning with the priorities of industrialized contexts.

However, African biomimicry is characterized by its incorporation of cultural symbolism alongside functional design. Global practices prioritize technical performance; however, African textile designs are fundamentally anchored in cultural narratives (Kunkhet & Chudasri, 2022). Animal-inspired motifs, such as tortoise shells symbolizing resilience and butterflies representing transformation, carry societal values and spiritual meanings. Moreover, colours in African textiles possess deep symbolic meaning. Green symbolizes fertility and vitality, whereas gold denotes royalty and wealth (Adom, 2017). The cultural dimensions augment the aesthetic and emotional significance of African textile designs. African practices emphasize sustainability with natural dyes and materials, embodying eco-conscious traditions that precede contemporary sustainability discussions. In contrast, global biomimicry utilizes advanced technologies to enhance eco-efficiency, exemplified by the creation of synthetic fibres modelled after natural processes.

2 | METHODOLOGY

The integrative constrained snowball methodology comprising four sequential phases was used; thus delineation of seed articles, the identification of secondary sources, the expansion to additional pertinent literature, and the exploration of contemporary research or media articles similar to the literature (Jalali & Wohlin, 2012)

Step 1: Defining the Domain and Identifying Seed Articles. Initially, the research domain was meticulously delineated to facilitate concentrated data collection. The investigation specifically focused on biomimicry within African textiles, with particular emphasis on nature-inspired surface designs, biomimetic colour schemes, and fashion accessories. Key terms such as "biomimicry," "biomimetics in textiles," "African textile design," "nature-inspired fashion," and "biomimetic fashion accessories" were employed to query scholarly databases, including Google Scholar, JSTOR, and Taylor & Francis. Foundation articles were selected based on their pertinence to the objectives of the study and adherence to the inclusion criteria. The criteria for selection encompassed articles that: addressed biomimicry or nature-inspired design concepts within textiles; discussed African textiles, motifs, fashion trends, or indigenous design methodologies; and explored biomimetic principles applied to design and construction in contemporary fashion. A total of eight (8) foundational articles were identified during this phase. These foundational studies constituted the basis for subsequent exploration of relevant literature. Seed articles serve as the fundamental basis of constrained snowballing, as they direct the systematic identification of subsequent sources (Wohlin et al., 2020).

Step 2: Identifying Relevant Secondary Articles. The subsequent phase entailed a thorough analysis of the reference lists of the selected seed articles (bibliographic coupling) to identify studies that were closely aligned with the research domain. Furthermore, the "cited by" lists of the seed articles were scrutinised through Google Scholar's citation tracking feature. This methodological approach ensured the inclusion of studies that directly engaged with biomimicry in textiles or African design traditions. Consequently, this process resulted in the identification of 15 secondary articles pertinent to the theme.

Step 3: Identifying further relevant articles to ensure the comprehensiveness of the literature review, additional searches were performed on the articles identified in the preceding phase Bibliographic coupling, a common technique in systematic reviews, helps locate studies that share thematic or methodological similarities (Zupic & Čater, 2015). The "snowballing" technique was expanded to encompass studies that cited secondary sources, with particular attention paid to third-generation citations. Articles were meticulously screened for relevance, inclusion, and quality, thereby ensuring that only studies directly addressing the research inquiries were selected. By this stage, an additional 12 articles were incorporated. These contributions enriched the literature pool, providing deeper insights into biomimicry-inspired textile motifs, fashion accessories, and the representation of African cultural identity through textile prints.

Step 4: Keyword/Phrase search for trending articles and grey literature. Ultimately, a keyword search was conducted on the traditional Google search to capture recent advancements and trending articles in the domains of biomimicry and African fashion. This step was essential to ensure that the study encompassed current literature, including recent news articles, reports, blogs, and case studies reflecting emerging trends. Keywords such as 'today's African fashion', 'textile innovations from nature', 'fashion items inspired by the natural world', and 'cultural textile elements' were featured across multiple online spaces, fashion editorials, and sector reports. This conclusive search yielded eight (8) recent articles that provided contemporary examples of biomimicry applications in African textile and fashion design. Finally, this review systematically identified 43 relevant articles to explore biomimicry in African textiles, surface prints, and fashion accessories.

3 | Biomimetics in Textiles

Biomimetics, as has been described earlier, is the imitation of nature's functionality in natural objects and is adopted with the aid of technology to solve human problems. These adaptations are considered largely to be eco-friendly and sustainable leaving no or little negative impact on the environment. In this section, the paper looks at the various areas where biomimetics has been applied in Textiles for the benefit of mankind and the promotion of Textile products.

Studies have shown the adaptability of the polar bear in cold weather which has revealed how textile fibre can be improved developed or mimicked to produce and maintain thermal properties in a fabric. This was still a challenge to combine excellent thermal and mechanical properties with good weaving ability in synthetic fibres. This is particularly true for scale-personal thermal management, which has been estimated to account for around 47% of housewarming energy consumption. The production of synthetic fabrics that can generate and retain heat without compromising on the other important physical and mechanical properties of the fabric has emerged. This has gone a long way to reducing the cost of fuel and energy to provide heating systems in the cold regions of the world (Cui et al., 2018).

As a way to provide comfort by textiles to the body, inspiration from the directional water transport and unobstructed heat dissipation functions of transpiration in plants, a biomimetic textile with a hierarchical porous structure has been developed for personal drying and cooling. This breakthrough technology is the improvement of personal drying and cooling textiles, which are not restricted to the removal of excessive sweat but can also be applied to prevent undesired and linked heat stress, thus creating a comfortable microclimate for the human body (Miao et al., 2021). Many excellent reviews and research have been done on biomimetic applications of textiles (Abbott & Ellison, 2008; Weerasinghe & Perera, 2019). However, little literature exists on biomimetic applications in African textile surface designs despite the prevalence of such designs in the African markets. This article seeks to review the concept of biomimicry (animate and inanimate) in surface-printed African Textile designs. Generally, African textile surface designs are mostly inspired by nature (such as plants, animals, rocks, human beings, and the like). Africans find nature as a way of connecting to their creator through their fabric designs. Therefore, African textile prints have tremendously utilised nature-inspired designs to promote the African identity. The design concepts vary from natural or man-made objects to proverbs, values, and traditional symbols.

3.1| Biomimicry as Design Concepts African Textile Prints

A design concept is an idea behind what we see and appreciate aesthetically. The concept may be inspired by physical objects or situations, values, or beliefs in the case of African settings. In terms of textiles, there are numerous ways to develop design patterns from different ethnic symbols, proverbs, and values as mentioned earlier. To develop a design based on African style under given conditions seems easy, but this is not always true. Gathering information such as the type of motifs, powerful patterns, and colouring styles along with their basic usage are things to be considered. In terms of the colour collection and its combination of patterns, it is a bit hard as one must select them carefully to convey the intended message. These can be obtained either through contrastive colours or by maintaining the equality of dynamics in the handling of lightness and darkness in colours. Thus, this selection must be in line with the chosen type of usage, like ceremonial clothes, daily based dresses, or other purposes to bring an everlasting impression (Chen & Peng, 2013). It is also established in their research that every single element of a given African pattern has a distinct meaning and is purposely presented to represent some values in a society.

For the traditional African textiles, such as the kente, Adinkra design of Ghana, the Bogolanfini of Mali and Burkina Faso, etc., the design concepts are based on wise sayings, beliefs, values, proverbs, and symbols developed from historic happenings. These textile designs are aimed at communicating to the world the richness of African culture and values. Hence, every single rudiment of any African pattern or design has distinct implications and it is consciously given to epitomise values in an African society. These values are usually entrenched in the form of curves, lines, or complete emblems to carry spiritual connotations, hope, and other veiled values (Debeli et al., 2013). Furthermore, the application of bold colours performs a significant role in the design concepts of African Textiles. This is exemplified in the use of two contrasting colours such as dark and light, hot and calm of equivalent strength, by not compromising on the quality of hue across patterns, is always a strategy which leads viewers to focus. It is also significant to note, as acknowledged by Akinwumi (2008) that most mechanical African prints are of foreign design concepts that ought to be corrected to reflect Africanity and its true culture. Technology is helping the course of improving the adaptation and merger of designs of African origin and abroad. To design textiles and prints that reflect the African identity, more exploration has to be done focusing on things that exist in Africa beyond our values, proverbs, and beliefs (Akinwumi, 2008). Nature offers a lot in terms of design concepts that connect Africans to their belief systems. Nature-inspired design concepts are abundant but have not been fully exploited. With varied technological tools available, critical examination of natural things in Africa can help generate a lot of design ideas.

The African textiles' surface designs are inspired by different sources. These include a wide range of natural to artificial objects, cultural symbols, values, proverbs, and beliefs. The Indigenous designs were made up of designs from nature while the contemporary African designs are comprised of designs inspired by technology. Some of these sources of surface design concepts are as follows.

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3.1.1| Surface designs from animals.

Africans have some reverence for animals hence the use of some as representatives for their clans, especially among the Akans of Ghana. Animals such as birds, crabs, elephants, antelopes, leopards, and many others, are used as surface designs to tell stories about African societies (Ebele, 2017). The speed bird African print design (Figure 1b) also known as 'Sika wo ntaban' in Akan, Ghana (money has wings), shows a high-speed flying bird which signifies how time changes concerning money. It tells how money gained can easily be wasted if care is not taken. The bird with eggs (Figure 1a) also means that whatever is destined to be successful will be successful. It does not matter what one goes through in life, persistence and hard work will be crowned with success.



Figure 1. (a) Birds with eggs, 'abuburo kosua' (b) speed bird, 'sika wo ntaban'. Images are freely available on the web from (Buy Pink & Blue African Print Ankara Fabric | By the Yard, 2022-03-20.)

There are other animal-inspired designs such as the use of patterns of animal skins for African prints for example the design pattern that mimics the skin of the tiger, leopard, zebra, cats, and shells of sea animals. The use of such powerful animal patterns connotes power impacted on the user or the wearer. Apart from the use of the real animal skin to produce leather that is sat on, and worn by chiefs, an imitation of such design patterns is used for African prints which are usually patronized by royals or the affluent in the society to show their social status in the community. The Zebra animal print in Figure 2(a) is printed on cloths, rugs, bedspreads, and many other soft furnishing products.



Figure 2. (a) Zebra animal print, black and white (WovenYou, 2024), (b) seamless pattern safari wildlife isolated white background African animals (Premium Vector, 2021), (c) *Afafranta* (Butterfly) wax print (Enock et al., 2018), (d) "*Akyekyedee Akyi*" Tortise back (Blackstar, 2024).

The use of animals as motifs for African prints highly depends on the ethnic group, the society, and the country as a whole. Families, societies, and ethnic groups have strong relationships in some countries such as those in West Africa especially the Akans of Ghana. The Akan families of Ghana have a special reverence for animals especially those they believe have connections with the families. Hence such animals are used in various designs and prints of those families. More so, some designs and motifs are used to communicate the moral values and ills of society. The butterfly in Figure 2(c) signifies change, transformation, grace, and a new level in the life of an individual. In Figure 2(d), the textile print design has the motif of the tortoise's back which means nothing can pears the back of the tortoise. In terms of cultural significance, the animal tortoise in the culture of Ghanaians represents independence and self-sufficiency (Enock et al., 2018).

3.1.2 | Design concepts from plants

Quite a significant surface designs of African textile prints are made up of plants since the major occupation, especially in the Sub Sahara part of the continent, is agriculture or farming. The African relates more to nature and for that matter plants which provide food, medicine, shelter, and clothing. The designs are made of floral (flower) patterns, trees, leaves, and the back of trees. These designs are made with bold colours in shades of green, yellow and red. This helps Africans to connect with nature. Figures 3(a) and 3(b) are African prints with design concepts from plants and plant products.



Figures 3. (a) Ahwene pa akasa (literally translated as precious and quality beads make no noise) African print and (b)Pink/Orange Ankara wax print from Nigeria. Images are freely available from (*Buy Pink & Blue African Print Ankara Fabric* | *By the Yard* | *Printing on Fabric, African Print, African Print Fabric*, 2022-06-21)

The tropical nature of the African continent especially the sub-Saharan region makes it imperative to connect with the forest produce or products even in what they wear. The psychological feel of the coolness and freshness of plants and their flowers contributes to the continued use of design patterns. Ironically, most of these designs do not match the exact motifs in most African prints. This is because the names of the fabrics are given by the fabric retailers hence the difficulty in connecting the designs with the given names unless it is explained to the perceiver. A typical example is shown in Figure 3(a) where a floral design is linked to a bead by the name given to the fabric.

3.2| Biomimetic Colours in African Printed Surface Textile Designs

Nature has a wide range of colours that inspire technology, architecture, fashion, textiles, paintings, and even automobile manufacturing. In Africa, for that matter Ghana, colours mean more than the eye

can perceive. Colours have symbolism which plays a significant role in the day-to-day activities of Ghanaians. Colours also have various uses or functions and each of them is associated with nature. In Table 1, some of these colours, their functions, and their association with nature as far as the Ghanaian community is concerned are outlined.

Colours	Connection with nature	Symbolic meaning	Function(s)
Blue	Colour of the sky	Peaceful environment and rule of a queen	Use as a love charm, teenage years and marital rites
Green	Vegetation cover	Represent fertility, newness, growth, and vitality	Purification of spots for sacred ceremonies, outdooring, and naming ceremonies
Brown	Earth and rotten items	It shows rotten things and events in the past	Grieving, hunting, and farming
Gold	Gold, juice of ripe pineapple.	Riches and royalty,	Used as colours for outdooring, marriage, festivals, and ceremonies
Silver	Colour of metals and items	female royalty	it shows royalty among women/sub-leaders
Red	Blood, red tomato	blood relations and danger.	Funeral, Used to show caution or danger.
White	white clay, cotton fibre, and some eggshells.	Joy, victory, happiness, purity, virginity, the perfection of God.	Used at joyous occasions like birth, outdooring, marriage ceremonies, victory at war, and funerals of old people
Grey	Residue of burnt items	Reduced to nothingness	Used to show remorsefulness
Black	Charcoal and night	Sadness, strength, old fashion.	For funerals, used in making charms against wild animals and for body painting.

able 1. The symbolic int	erpretation of colours b	y the Ghanaian communit	y (Adom, 2017)	
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As a result of Ghanaians' attachment to the significance of colours, fabrics of different colours are carefully selected to suit the occasion. Colours such as green, gold, silver, and white are usually used for joyous occasions like marriage, church, festivals ceremonies, etc. On the other hand, black and red are often used for sad and serious ceremonies such as funerals and agitations.

3.3| Contemporary African Textile Prints

African prints, fundamentally, trace their roots to Javanese production techniques. This is because there is a connection between the form shaping of the present prints and several other European, Arab, and Asian artistic traditions (Akinwumi, 2008). Most of the designs of the African print are of foreign concepts though related to nature. Akinwumi (2008) again posits that the promotion of African prints has been significantly enhanced by the action of retail traders who have become the producers' agents. These traders develop inspiring indigenous names for each design according to the communities' beliefs and values. It is also worth noting that there has been prevalent use of nature-based design images which were adapted from non-African conventions right from the commencement of African prints in Africa. It does further prove that the term, 'African print', a misleading term was invented by its producers to convince African buyers. This dishonesty, unfortunately, has lived on till contemporary times. However, in contemporary times, most of the design concepts are influenced by retailers, especially the market women or traders (Akinwumi, 2008). The design motifs are mostly of African values, symbols, proverbs, and beliefs.

It is also significant to note that the names of contemporary African textile prints are named by the traders. The African textile prints are no longer controlled by the Westerners but by the indigenous textile dealers who dictate the designs that sell. African prints have evolved with time in terms of colour, theme or design concepts, and consumer preference. These have set out varied differences and similarities between the old African prints and the contemporary new African prints, for example, the fancy prints. Some of the known old but still invoke African textiles include the Adinkra (a stamped fabric from Ghana), Aso-Oke (woven stripe fabric from Yuroba, Nigeria), Ndop (dyed indigo fabric from Cameroon), Bogolan (mud cloth from Mali), Kente (woven cloth from Ghana) and many others which has stood the test of times till date (Debeli et al., 2013). The batik or the Java Prints were the few prints to first arrive in the western part of Africa.

The old designs had motifs of birds, plants, and important features on the African continent that were made to reflect Africanity according to the Dutch who wanted to attract more customers to the African market (Akinwumi, 2008; Tsekpo, 2020). Even though they succeeded in their marketing strategy, the local traders also rebranded the designs with new names and themes that reflected the African traditions and beliefs and catchy titles they believed would make the cloth sell. Due to this influence, new designs were made to communicate African values, proverbs, and symbols. Some of the striking differences between the old African prints and contemporary African prints are colour variations, production techniques, and varied textile materials used for the printing. Since the old prints made by indigenous Africans were made with natural dyes, for example, the Adinkra cloth from Ghana was stamped with dyes from plants (Badie) which places limitations on the number of colour applications (Fröse et al., 2019; Kusumastuti et al., 2019). But with the industrial revolution in the 20th century with modern printing machines and synthetic dyes of various colour ranges, more intricate and complex African designs are being produced. Apart from the innovations in textiles derived from nature, fashion design has also adopted more inspiration from nature. The next section explains how fashion has utilized the biomimicry principles to produce creative garments.

4 | Biomimetic Inspired Fashion Design

As early as 1940, a Swiss engineer by the name of George de Mastral observed the tendency of the fruit of the burr to stick to animals such as dogs' hair (Abbott & Ellison, 2008; Kapsali & Dunamore, 2008). He used a simple microscope to detect the hooks on the fruit which stick to animal hair. He also found out that an obtrusive fruit with a length of 1 cm had a lot of crammed hook-like predictions. These attached themselves to peoples' dresses or animals' hair, helping seeds to be dispersed widely. Encouraged by this, de Mastral used nylon to make velcro fasteners that have exceptional adhesive strength and are practically used as an alternative for buttons or hooks in clothing and shoes. The fashion industry has seen a boost in recent times in nature-inspired fashion outfits. African fashion is no exception as it transcends even into fashion accessories. History has it that, the first cloth created for man after man sinned was the use of leaves to cover man's nakedness. This was followed using animal skin until other fibres were discovered and converted into clothing.

4.1| Nature-inspired fashion

An observation from the natural world can be a great inspiration to us and better kindles limitless innovations or creativities. And these creativities may well be adopted and used as explanations for difficulties faced in the process of fashion design. Utilizing the concept of Biomimicry to perceive our ITFP-GH —

immediate living animals and plants, we will discover that many living mechanisms are beyond what man can understand (Chen & Peng, 2013). Nature is filled with limitless colours and structures or forms that are useful inspirations for fashion design. Hence, a lot of fashion designers are turning to nature to advance their creativity and innovations. Several runways for fashion exhibitions feature a lot of designs developed from the concepts of biomimicry (Wood, 2019). In this regard, plants and animals are the major focus for such design inspirations with a focus on bioinspired colours, patterns, and structures. Animals such as birds offer incredible design inspiration for fashion designs (Briggs-Goode & Townsend, 2011; Vincent, 2016). Figure 4 shows some bird-inspired fashion designs that show elegance and unique styles.



Figure 4. Biomimicry in fashion. (a) shows a fashion design (left) inspired by a bird called Stellar's jay, (b) a long free-moving coloured tube inspired by a flamingo bird, (c) a Rufus hummingbird known for its extraordinary flight skill. Images are freely available on the web from (*Fashion Designs Inspired By Nature – Vuing.Com*, 2022.)(Das et al., 2015; Calderin, 2009; Pan et al., 2014)

Colour is one of the essential elements of art that plays a critical role in clothing design. Hence, fashion designers are quite cautious in organising colours and other elements of art to bring out a perfect design outfit. This has been heavily aided by the adaptation of biomimicry concepts of taking inspiration from nature especially the display of colour in animals, insects, plants, and other natural objects (Wood, 2019; Jeong et al., 2015). Nature's presentation of colours offers a great viewing delight as it has natural harmony and is in the right proportions as well. One of a million examples is the fashion design inspired by the insect called the periodical cicada with elegant shades of green and transparent wings (Figure 5).



Figure 5. A full female dress inspired by a periodical cicada. Image freely available on the web from (Darlene Copeland Prater, 2021)

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It is also significant to note that underwater natural objects such as plants, fish, shells, and animals also give wonderful inspiration to textiles and fashion design in terms of colour and functionalities. The drag resistance of sharks adopted into swimming suit apparel, and the antimicrobial resistance of shark skin imitated into medical textiles among others, have proven beyond doubt that nature even beneath the waters has something to offer mankind. The beauty of Betta Splendens, a fighting fish super delta butterfly pink in colour inspires exquisite garments (left of Figure 6). The adaptation of the design and colours from such natural sources connects back to nature especially when we wear the product close to our bodies.



Figure 6. Garment (left) inspired by Betta Splendens fighting fish. Image credit to (Jill Sherman (@fashion.Biologique) • Instagram Photos and Videos, 2021-12-27.)

Several other inspirations for fashion design are abundant in plants too. This can be found in the leaves, flowers (floral patterns), and back and branches of trees among other parts that give awesome fashion design ideas (JØrgensen & Liddo, 2007; Singh et al., 2012; Tsolmonchimeg & Ahn, 2019). Inspiration from the floral parts of the plants offers a wide range of designs, patterns, and colours. The colours often look bold and attractive, which serves as one of the purposes of clothing. Figure 7 exhibits a Chinese-lanten-lily flower (right) that has inspired the design of the fashionable garment (left).



Figure 7. Plant (flower) inspired garment. Image is freely available on the web from (*Fashion Designs Inspired By Nature – Vuing.Com*, 2021-06-17.)

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In Africa, indigenous clothing is mostly connected to nature because natural materials are usually used as inputs. African fashion is mostly dominated by clothing constructed from African textile prints complemented with local African fashion accessories. Indigenous African fashion includes body art such as body painting, incisions, body scarification, etc. The indigenous African fashions are tribally influenced as they may differ from one tribe, society, or country to country (Ampomah, 2015; Ebele, 2017; Calderin, 2009). One such tribal fashion is by the Omo River people of Ethiopia for their teenage girls in Figure 8. They combine natural plants with flowers, body painting, and fabrics or without fabric to mimic nature.



Figure 8. Nature-inspired Tribal Fashion, Ethiopia. Image credit to (*AMARA - Beautiful Young Suri Girl, Red and Pink Flowers – Giovanna Photography*, 2022-06-21)

Notwithstanding, indigenous African fashion design concepts, contemporary African fashion has designs that mimic nature by the designs on the fabric used and its accompanying accessories. The fashion designs are usually made of purely African textile prints or a combination of foreign fabrics and accessories. Modern nature-inspired African fashion can be seen in Figure 9. The fashionable Ghanaian Kente women's dress (Figure 9a) with matching headgear, colourful necklace, and earrings with a bracelet and a ring to go with. This is usually worn on occasions such as weddings, naming rites, and during festivals. Second to the right (Figures 9b, d, and h) are traditional African floral print designs with carefully selected accessories to match. Fashion for men is usually simple and less elaborate but the African men's fashion may be detailed and elaborate as well. The designs are made of different colour combinations with accessories such as hats, bracelets, walking sticks, shoes and finger rings that match (Figure 9c). The cooler of the shirt as seen is a floral design with a red background on brown khaki trousers. It may be for occasions such as weddings, churches, naming ceremonies, etc.



Figure 9. Nature-inspired African fashion for men and women: (a) kente dress with matching accessories (b) African Textile print dress with accessories (c) men's dress, (d) and (h) female Ankara design (e) formal African print wear (f) and (g) are casual wear with African prints combinations. Images credit to (Tunde African Men's Suit// Men's Clothing African | Etsy | African Attire for Men, Nigerian Men Fashion, Latest African Wear for Men, 2022-06-21)

4.2| Biomimetic fashion accessories

Fashion accessories are a very integral part of African fashion in both indigenous and contemporary designs. An African woman will always compliment her outfit with one or more accessories as a way of promoting beauty (Abraham & Howard, 2017). The accessories range from headgear or hats, rings of all types (ear, nose, fingers), bracelets, footwear, bags, anklets, necklaces, purses, etc, and spectacles for the modern African woman. Fashion accessories for African women are as important as the dresses themselves (Chikovo, 2020; Ebele, 2017). Most of the fashion accessories are made of local materials such as beads, plant products, rocks, leather, and local African textile prints which are gaining popularity locally and in the international arena of fashion (Abraham & Howard, 2017; Aziz et al., 2019). These accessories are mostly nature-inspired as a way of connecting the African to his environment, hence the use of natural objects as inspiration for the fashion accessories. These nature-inspired objects are colourful, elegant, and symbolic to portray the African identity. Going into specificity, the headgear can be a folded and twisted cloth (Gele), a hat made of straw or grass (Figure 10e), or raw plant products such as flowers and the like. Accessories such as earrings are made in butterfly shapes (Figure 10h), floral designs (Figure 10g) made of printed fabric (Figures 10a and 10c), finger rings made of snake designs (Figure 10f), necklaces made of beads, wood, and calabash and sometimes embellished with printed African fabrics (Figures 10a and 10e).

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Figure 10. Nature-inspired African fashion accessories: (a) accessories made of printed fabric (a purse, beaded necklace, and earring), (b) wrist band designed with African print, (c) shoes, bags, and earrings with floral printed fabric, (d) shoes finished with kente prints, (e) Ethiopia women adorned in straw hats and decorated beads; (f) golden finger ring shaped like a snake: (g) and h) metal cast floral and butterfly earring designs. Images credit to (Chikovo, 2020; Creative African Fashion Accessories | By Marihanacraft - Fashion - Nigeria, 2024-12-15; Ebele, 2017).

In Africa, shoes used as accessories are adopted as foreign. However, there have been positive attempts to modernize them to suit the African taste by using printed African fabrics as raw materials (Figures 10c and 10d). The fashionable nature-inspired shoes not only connect the African to nature but also show how innovative the African can be in terms of fashion and accessories. Bracelets, as accessories, come in different forms, shapes, sizes, materials, and colours. Very common materials used in making bracelets are beads, shells, cowries, calabash, pebbles, and plastics embellished with printed African textiles which are also a mimicry of nature (Figure 10b). The African sense of fashion is very unique in the sense that the entire outfit of a person for an occasion could be nature-inspired (Karen, 2019). This attitude towards fashion can be deliberate or unconscious, but the general output is always admirable and on point. Hence, it is important to note that nature cannot be ignored even in the face of advanced technology.

5 | IMPLICATIONS OF FINDINGS

The worldwide recognition of African textile prints provides an opportunity for the promotion and marketing of African cultural heritage and identity on an international scale. The biomimicry evident in these prints serves as an inspiration for artists and designers from diverse cultures, promoting intercultural interaction and collaboration. The study highlights nature-inspired designs, aligning with the increasing trend of sustainable fashion and promoting environmentally responsible practices globally. Promoting African textile prints enhances economic incentives, creating growth opportunities for African communities. The preservation of traditional prints safeguards African cultural heritage and customs. This study promotes international collaboration, impacts global market trends, and guides education and training initiatives, enhancing competencies in biomimicry and sustainable design.

6 | LIMITATIONS OF THE STUDY

Even though the review methodology has a sound structure it was however limited by certain indications. The dependence on co-citation features and limited snowballing might create an echo chamber effect whereby the range of literature is paned onto narrowly defined related works. More so, the methodology did not factor incorporation of traditional African design knowledge which is largely found in oral or visual archives. This void highlights the necessity of an improved approach in condolences capturing the comprehensive nature of African textile heritage.

7 | CONCLUSION AND FUTURE STUDIES

There have been several developments in textile design from technical textiles to textile surface modification to mimic the natural properties of nature for human comfort and environmental sustainability. The African textile print designs are mostly nature-inspired. The design motifs are made of natural objects such as plants, animals, rocks, etc. In the area of fashion, biomimicry has helped develop clothing that solves the specific needs of the individual without causing major harm to the body and the environment. It has been discovered that biomimetic concepts are applied in garment design and construction due to the variety of colours and forms nature offers. African fashion accessories are also designed with inspiration from nature to connect mankind to its environment and as positive steps of innovation and improvisation. Nature-inspired industrialization is the way to go with technological advancement to reduce its negative impacts on the environment. There must be an exploration of nature from both the physical (outward) and internal (microscopic view) for more design concepts. African textiles, renowned for their vibrant colours, patterns, and cultural significance, will leverage biomimicry to not only preserve their rich heritage but also address environmental concerns. The future of biomimicry in African prints will see designers drawing inspiration from nature's efficient and sustainable systems, allowing them to develop textiles with minimal impact on the environment.

One thrilling possibility lies in studying the intricate patterns and behaviours of African animals and plants to develop unique surface prints. Nature's camouflage techniques, for instance, could be translated into stunning textile designs that provide both aesthetic appeal and functional benefits like natural cooling or insulation. Biomimicry is again expected to drive advancements in textile production processes. By mimicking the self-cleaning properties of certain plants and animals, textile manufacturing methods can be developed to reduce water usage and the need for harmful chemicals. This shift towards bio-inspired techniques will align the African textile industry with global sustainability goals. Moreover, biomimicry will influence the fashion industry by encouraging the use of renewable and biodegradable materials. Designers will explore alternatives to traditional fabrics, focusing on natural fibres sourced from regenerative agriculture or even exploring the possibilities of fabricating textiles from upcycled or recycled materials. Partnerships between scientists, engineers, and fashion designers will become increasingly common, resulting in cutting-edge innovations. 3D-printed textiles inspired by the structural strength of spider silk, for example, could revolutionize African fashion, enabling the creation of intricate garments that are both visually stunning and environmentally friendly. In terms of manufacturing, biomimicry will encourage the development of textile production facilities that mimic the efficiency and adaptability of natural ecosystems.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.



CONFLICT OF INTEREST STATEMENT

There is no conflict of interest regarding this manuscript

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