Academic Journal of Excellence Bi-Annual Peer Reviewed Journal

ECO-BIOTECHNOLOGICAL TRANSFORMATION OF CHENOPODIUM MURALE: EXPLORING VERMITECHNOLOGY THROUGH THE LENS OF VISUAL ARTS

Dr. Anu Verma [1], Dr. Veena Bansal [2]

1 Head and Associate Professor, Department of Botany, Seth Gyaniram Bansidhar Podar College, Nawalgarh, Jhunjhunu, Rajasthan, India; Affiliated to Pandit Deendayal Upadhyaya Shekhawati University, Sikar, Rajasthan, India

2 Associate Professor, Department of Fine Arts, Faculty of Visual & Performing Arts, Guru Kashi University, Talwandi Sabo, Bathinda, Punjab, India

ABSTRACT

Vermitechnology provides a biological route for converting plant residues into a more stable organic material through the combined action of earthworms and microorganisms. This study examines a vermicomposting case involving Chenopodium murale, cow dung, and the epigeic earthworm Eisenia fetida, and then considers how the documented material transformation may be interpreted within visual-arts research. The biological case records survival, growth, reproduction, and changes in the physical appearance of the feed material. The visual-arts discussion focuses on process, materiality, living agency, ecological responsibility, and the perceptible movement from recognizable plant matter to a darker and more homogeneous substrate. Rather than presenting vermicompost itself as an established art material, the paper treats vermicomposting as a time-based ecological process that can be observed, documented, and critically interpreted. The resulting framework brings plant science and visual inquiry into dialogue while keeping their methods, evidence, and ethical responsibilities distinct.

Keywords: vermitechnology, vermicomposting, Chenopodium murale, Eisenia fetida, eco-art, bioart, visual arts, materiality, sustainability

Introduction

Sustainable art and design increasingly engage with the life history of materials rather than only with their final appearance. Plant residues, soil organisms, discarded biomass, and decomposition can therefore be studied not merely as environmental subjects but as active material processes. Vermicomposting is especially relevant to this discussion because its visible outcome develops through biological activity over time: organic matter changes in colour, texture, structure, and ecological function as earthworms and microorganisms work within the substrate.

The scientific basis of this paper is the experimental work of Verma A. on the vermicomposting of Chenopodium murale with cow dung and E. fetida [17]. That study treated harvested weed biomass as a usable organic resource and recorded the response of earthworms to different feed mixtures. Its approach is consistent with vermicomposting research that describes earthworms and microbial communities as complementary agents in the stabilization and biological processing of organic wastes [4,14].

The visual-arts inquiry begins with a related but different question: how can a biological transformation be read as a material and visual event without turning scientific evidence into metaphor alone? Eco-art has addressed environmental systems, damaged landscapes, waste, and regeneration, while bioart has brought living organisms and biological processes into artistic and critical practice [1,16,18,20]. These traditions make vermitechnology relevant to contemporary visual research because its form is produced through interactions among biomass, organisms, moisture, time, and human care.

Accordingly, the paper develops an interdisciplinary interpretation of five connected themes: ecological transformation, living agency, material change, temporality, and visual documentation. Scientific observations remain the evidential foundation of the case study, while artistic interpretation is used to examine what the transformation can communicate about material value, care, sustainability, and processes of becoming.

Vermitechnology as Eco-Biotechnology

Vermicomposting is a managed form of biodegradation in which microorganisms perform much of the chemical decomposition while earthworms fragment, ingest, mix, and redistribute the organic substrate. Their activity changes the physical organization of the material and increases the interface between feed particles and microbial communities. It is therefore more accurate to understand vermicomposting as an interacting biological system than as an effect produced by earthworms alone [4,14].

Epigeic earthworms such as Eisenia fetida are widely used in vermicomposting because they feed near the surface on decaying organic matter and reproduce effectively under suitable conditions. Experimental studies show that growth, survival, and fecundity are strongly influenced by feed quality, food availability, population density, and environmental conditions [5,7,11]. In practical terms, the substrate is not inert waste: it is the living environment in which the organisms responsible for transformation must function.

Feed preparation is equally important. Fresh organic residues may heat during early decomposition or develop conditions that are unsuitable for earthworms. Preliminary stabilization can reduce these risks; Nair and colleagues showed that pre-composting supported subsequent vermicomposting of kitchen waste by improving initial stabilization and moisture management [10]. In the C. murale case, the weed-cow-dung mixtures were likewise allowed to stabilize before earthworms were introduced [17].

Ecologically, vermitechnology redirects biodegradable material from disposal toward a regenerative cycle. Reviews of the field associate vermicomposting with waste management, nutrient recovery, and soil improvement, while also noting the need for careful substrate design and operational control [14]. Earlier work on earthworms and soil productivity further supports the connection between earthworm activity, soil processes, and plant performance [15]. This circular material logic is particularly relevant to visual practices concerned with the origin, transformation, and afterlife of materials.

Chenopodium murale as Transformable Weed Biomass

The word 'weed' reflects a human judgement about where a plant is considered useful or unwanted. Once removed from an agricultural field, weed biomass may be burned or discarded, but it can also be treated as biodegradable feedstock. The C. murale study follows this second route, examining whether locally available plant matter can be transformed through managed vermicomposting rather than treated simply as waste [17].

Comparable research with Parthenium hysterophorus has shown that invasive plant material can be incorporated into cow-dung-based vermicomposting systems when the mixture is appropriately proportioned [19]. This shift is conceptually important: the management problem is no longer limited to removal of unwanted biomass but extends to its responsible conversion into a material that can re-enter an ecological nutrient cycle.

For visual arts, this reclassification opens a productive line of inquiry. The same plant matter may be read first as disorder or interference and later as fertile, processed material. The change is therefore both physical and cultural. Documenting that change allows artists and researchers to

Academic Journal of Excellence Bi-Annual Peer Reviewed Journal

examine how ideas of waste, usefulness, decay, and regeneration are attached to material states.

Visual Arts Framework

Eco-Art and Environmental Aesthetics

Eco-art offers a useful framework because it treats ecological relationships and consequences as part of artistic meaning, not merely as themes to be represented. Brown surveys contemporary practices that connect art with ecological systems [1], while Weintraub emphasizes material choices, participation, and environmental responsibility within ecological art [18]. Kagan similarly argues for a systems-based understanding of sustainability in which cultural practice must address interdependence rather than isolated objects [9].

Vermicomposting fits this systems perspective because no single element explains the final material. Plant residues, cow dung, earthworms, microorganisms, moisture, containers, time, and maintenance operate together. A visual interpretation can therefore focus on relationships and transitions rather than on a self-contained object. The ecological process becomes legible through the changing material and through the network of conditions that made that change possible.

Bioart, Living Agency, and Care

Bioart is relevant where artistic practice encounters living systems, biological knowledge, and questions of agency. Yetisen and colleagues describe bioart as a field in which biological materials, organisms, and methods enter creative and critical contexts [20]. In this study, earthworms are not symbols added to an artwork; their feeding, movement, digestion, and interaction with microorganisms materially alter the substrate.

Acknowledging that participation does not assign human artistic intention to earthworms. It simply recognizes that the result is partly produced by living activity that cannot be reduced to the artist's hand. This distinction also carries an ethical obligation. Vaage notes that work involving living systems requires attention to bioethical responsibility as well as artistic interpretation [16]. A responsible visual project based on vermiculture must therefore prioritize suitable feed, moisture, aeration, temperature, and humane handling.

Materiality, Texture, Colour, and Process

The strongest visual connection lies in materiality. In the source photographs, fibrous plant matter with visible green fragments gradually gives way to a darker, finer, and more uniform material. Surface, grain, density, tone, and form all change. These are familiar visual properties, but here they arise from decomposition and stabilization rather than from the direct application of a studio technique.

Material ecology provides a useful conceptual bridge because it relates material properties to processes of formation and environmental context [12]. Vermicomposting illustrates this relationship at a biological scale: the final appearance cannot be separated from the organisms and conditions through which it emerged. The material is generated through interaction, which makes the process especially relevant to art practices centred on duration, transformation, and becoming. In Indian visual traditions, research on natural and traditional pigments similarly shows that colour, surface, and visual meaning are shaped by material knowledge, preparation, and cultural context [23,24,25].

Time is therefore not a background variable but a material dimension of the work. The initial feed and the final vermicompost are visually distinct, yet the meaning of the transformation lies in the interval between them. Repeated photography, drawing, field notes, close studies of surface change, or a time-based installation could make that interval visible without altering the scientific procedure.

Methodological Approach

The study adopts an interdisciplinary interpretive case-study method. Biological observations, experimental photographs, and descriptions of the vermicomposting procedure are derived from Verma's earlier manuscript [17]. The visual-arts analysis is developed through scholarship on eco-art, bioart, material ecology, and ecological art education. No additional biological experiment or new statistical analysis is claimed here; the purpose is to interpret the documented transformation while maintaining clear provenance for the scientific evidence.

Biological Case Study: Experimental Context

The biological case used fresh cow dung and C. murale as feed materials. The weed was collected, cut into smaller pieces, and combined with cow dung in mixtures containing progressively larger proportions of plant biomass. Eisenia fetida served as the decomposer species. Before the worms were introduced, the feed materials underwent an initial stabilization period, after which the units were maintained under conditions intended to support earthworm activity and prevent excessive drying [17].

Survival, growth, and reproduction were observed over time. Earthworms and cocoons were periodically separated from the substrate for observation and then returned to the relevant units. At the end of the process, the material was dried enough to permit separation of worms and cocoons, then sieved and stored. The procedure produced a clear visual sequence from weed-containing feed to stabilized vermicompost [17].

Figure 1

Experimental vermicomposting setup used in the biological case study.

Note. Photograph from the experimental documentation of Verma [17]. The image records the container-based arrangement used to maintain multiple vermicomposting units.

Visual Documentation and Interpretive Procedure

Visual analysis was based on three kinds of evidence: the experimental setting, the appearance of the initial feed, and the appearance of the final vermicompost. The photographs are treated as research documentation rather than as autonomous artworks. They preserve information about experimental arrangement, visible plant fragments, surface irregularity, and the later change in colour and texture. These observations are then read in relation to process, material agency, ecological change, and the revaluation of waste.

Figure 2

Initial weed-containing feed mixture before full vermicomposting.

Note. Photograph from Verma [17]. Visible plant fragments and the uneven surface establish a baseline for comparing later material transformation.

Figure 3

Final vermicompost after biological processing.

Note. Photograph from Verma [17]. In comparison with the initial feed, the processed material appears darker, finer, and more homogeneous.

Results and Interdisciplinary Interpretation

Biological Transformation of the Feed Material

The source experiment reported survival of earthworms across the tested feed mixtures, while growth and reproduction varied with substrate composition [17]. C. murale could therefore be incorporated into cow-dung-based feed without preventing the vermicomposting process. Mixtures with an intermediate amount of weed biomass produced favourable overall responses, whereas very high weed content did not consistently improve performance. This is consistent with research showing that earthworm responses depend on feed quality, palatability, degradability, and resource availability [7,11].

Earthworm biomass increased during the active feeding phase and later declined or stabilized as readily available food became limited. Reproductive patterns also changed over time and between mixtures. These observations are important to the visual interpretation because they show that the system is continuously changing: organisms respond to the substrate while, at the same time, altering the material environment in which they live.

From Recognizable Plant to Transformed Matter

The material transition is immediately visible. At the beginning, leaves and stems remain identifiable and the surface is heterogeneous. After processing, recognizable plant form is largely lost and the material becomes darker, finer, and more uniform. That apparent visual simplification is the outcome of a complex sequence involving fragmentation, microbial decomposition, ingestion, casting, mixing, drying, and sieving.

For visual arts, this difference matters because the material does not merely represent ecological change; it physically records it. The final texture and tone are not decorative effects imposed after the event but consequences of biological activity. The researcher can therefore work with documentation of an actual transformation rather than imitate decomposition through a separate visual effect.

Earthworms as Ecological Co-Producers

Studio practice often assumes a maker working upon passive matter. Vermitechnology complicates that relationship. Earthworms fragment and redistribute the feed while microorganisms continue biochemical decomposition. Human action remains essential in preparation, monitoring, containment, and care, but the final material state is not produced by human action alone.

The term 'co-producer' is useful only in a material sense. Earthworms do not make art in the cultural or intentional sense, yet their biological activity contributes directly to the material that is later observed, photographed, or displayed. Bioart scholarship has made questions of authorship, control, and living agency especially visible [16,20]. In this context, the artist or researcher may act less as a sole maker and more as a caretaker, observer, editor, and interpreter of an ecological process.

Time, Texture, and the Aesthetics of Process

The case also demonstrates that time is an active condition of material formation. The feed cannot become vermicompost instantaneously without eliminating the ecological process under study. Earthworms must feed, microorganisms must act, and plant structures must gradually break down.

Academic Journal of Excellence Bi-Annual Peer Reviewed Journal

Duration is therefore part of the material logic of the process.

This temporal quality aligns with process-based art, where stages of change may carry as much meaning as the final state. A visual study might use photographs taken from a fixed viewpoint, close-up records of texture, drawings made at intervals, or an installation that places starting and finished materials beside documentary evidence. Such approaches reveal the stages that are otherwise compressed into the phrase 'waste became compost.'

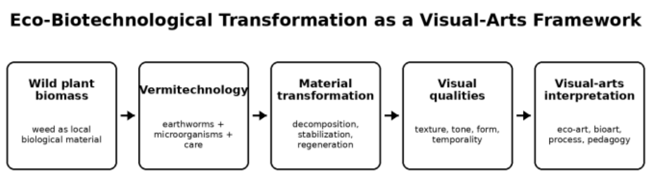

Figure 4

Interdisciplinary framework linking vermitechnology with visual-arts interpretation.

Note. Authors' conceptualization. The figure distinguishes biological transformation from artistic interpretation while showing the sequence through which a weed-management process can become a subject of visual research.

Vermitechnology Through the Lens of Visual Arts

Waste, Value, and Ecological Reframing

The transformation of C. murale also raises a question of value. Before processing, the plant is treated as unwanted vegetation; afterwards, its organic matter contributes to a useful soil amendment. Eco-art frequently works with discarded or ecologically charged materials in order to expose assumptions about consumption, value, and disposal [18]. In the present case, however, revaluation is functional as well as symbolic: the material acquires a different ecological role.

This makes vermitechnology relevant to sustainable visual practice without requiring the biological material to become a permanent art object. Documentation, drawing, text, mapping, and temporary display can communicate the transformation with a relatively light material footprint while the vermicompost continues to serve an ecological purpose.

Comparative Eco-Art Precedents

Agnes Denes's Wheatfield—A Confrontation (1982) transformed approximately 1.5 acres of the Battery Park City landfill in Lower Manhattan into a cultivated wheat field. The work placed food production beside some of the world's most valuable urban real estate, making land use, economic value, waste, and ecological responsibility visible within a single temporary intervention [13]. For the present study, Denes's project is relevant because material transformation becomes a way of questioning how society assigns value to land and biological resources.

Mel Chin's Revival Field (1991–ongoing) provides a closer art–science parallel. Developed with agronomist Rufus Chaney, the project used hyperaccumulator plants at a contaminated site to investigate whether living vegetation could extract heavy metals from soil [2]. Its importance lies not in illustrating remediation but in making a real ecological process part of the artistic method. Vermitechnology shares this emphasis on living agents, measurable biological change, and care-based management.

Joseph Beuys's 7000 Oaks, initiated at Documenta 7 in Kassel in 1982, linked the planting of 7,000 trees with basalt markers and extended the artwork across several years of urban participation; the Kassel phase was completed in 1987 [3]. The project shows how ecological art can operate through duration, maintenance, public involvement, and cumulative material change. Those qualities offer a useful precedent for interpreting a vermicomposting project as a process that develops through repeated care rather than through a single moment of artistic production.

Together, these precedents clarify the position of the present study. Denes foregrounds questions of value and land; Chin demonstrates an art–science process driven by living systems; and Beuys emphasizes long-term ecological and social participation. The vermitechnology case does not duplicate any of these works, but it shares their interest in transformation, material agency, duration, and ecological responsibility.

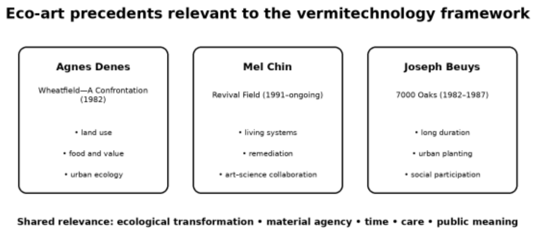

Figure 5

Comparative eco-art precedents relevant to vermitechnology: Denes, Chin, and Beuys.

Note. Authors' conceptual diagram based on the documented projects cited in references [2], [3], and [13]. No copyrighted artwork is reproduced.

Place-Based Art and Ecological Literacy

The case is also strongly place-based. The C. murale biomass came from a local agricultural setting in Rajasthan, and the experimental work was undertaken within that regional context [17]. Place-based art education connects creative practice with local environments, communities, and material conditions [6], while eco-art education has been proposed as a means of developing ecological literacy through making and reflection [8].

A teaching project based on vermicomposting could therefore combine plant identification, field observation, photography or drawing, process documentation, and scientific explanation. Fine-arts students would gain direct experience of material change, while science students could explore visual methods for communicating processes that are often described only in technical terms. The value of the collaboration lies in reciprocal literacy rather than in collapsing one discipline into the other. Research on traditional pigments in contemporary art education further supports the value of connecting inherited material knowledge with practical studio learning [26].

Implications for Fine Arts Practice

Several practice-based directions follow from this framework. Vermitechnology can be documented through serial photography; the transition from plant matter to vermicompost can support studies of texture, tone, and organic form; the involvement of earthworms can prompt questions about authorship and care; and the reclassification of a weed as useful material can support conceptual work on waste, land use, and regeneration. Community projects may also combine environmental observation with drawing, photography, storytelling, and composting demonstrations.

The present argument should not be extended to claim that vermicompost is automatically suitable as a pigment, archival medium, sculptural binder, or indoor display material. Such applications would require separate testing for durability, adhesion, microbial safety, conservation behaviour, and interactions with other materials. At this stage, the strongest artistic contribution lies in observing, framing, and communicating the ecological process itself.

Ethics, Safety, and Responsible Practice

Any visual practice involving vermiculture must begin with the welfare of the organisms. Earthworms require suitable feed, moisture, aeration, temperature, and protection from harmful conditions. They should not be deliberately stressed for visual effect. This position is consistent with bioart ethics, which treats living systems as subjects of care rather than neutral materials available for unrestricted manipulation [16].

Material safety must also be separated from ecological usefulness. The original experiment assessed vermicomposting performance; it did not certify vermicompost for studio handling, indoor display, or long-term conservation [17]. Any future practice that increases direct exposure or creates airborne particles would therefore require appropriate hygiene and material assessment.

Image ethics and research transparency are equally important. Photographs from the biological experiment should remain identified as scientific documentation, with their source and context clearly stated. New artistic images should record when and how they were produced. This distinction protects provenance and helps readers separate conclusions based on biological observation from those developed through artistic interpretation.

Limitations and Future Research

The principal limitation is that the visual-arts component is interpretive. The original experiment did not test audience response, artistic material performance, conservation behaviour, or visual perception. The paper therefore proposes a research framework rather than reporting a completed practice-based art experiment. Its conclusions also arise from one plant species, one earthworm species, a particular substrate system, and a specific regional setting.

Future work could document vermicomposting prospectively through standardized photography, macro-imaging, drawing, field notes, and reflective journals. Collaborative teams of artists and botanists could develop visual atlases of decomposition that retain scientific labels while examining colour, texture, form, and temporal rhythm. Practice-based studies could then compare installations, artist books, ecological maps, and participatory workshops as different modes of communicating the same biological transformation.

Community-based research is another promising direction. Weeds, soil, compost, and organic waste are familiar elements of everyday landscapes, making vermitechnology an accessible starting point for discussions of ecological responsibility. A community project might combine weed identification, composting, drawing, photography, and local narratives while keeping the regenerative biological process at the centre of the activity.

Conclusion

The transformation of C. murale demonstrates a credible meeting point between vermitechnology and visual arts when the relationship is framed through process, materiality, living agency, time, and ecological meaning. The case study shows that weed biomass can participate in a managed system with cow dung and E. fetida, producing an observable change from recognizable plant fragments to a finer and more homogeneous material [17].

Visual interpretation adds questions that biological reporting does not usually foreground. Eco-art draws attention to sustainability and environmental responsibility; bioart brings living agency and ethical care into view; material ecology connects appearance with processes of formation; and process-based practice makes duration itself part of the visual meaning. These perspectives complement rather than replace the scientific explanation.

The interdisciplinary contribution of the study therefore lies in recognizing that ecological transformation already contains relationships among matter, organisms, time, care, and value. When those relationships are documented responsibly, vermitechnology can become a rigorous subject for contemporary fine-arts research while retaining its primary ecological role as a method for transforming organic biomass.

References

[1] Brown, A. (2014). Art & ecology now. Thames & Hudson.

[2] Chin, M. (n.d.). Revival Field. https://melchin.org/oeuvre/revival-field/

[3] Dia Art Foundation. (n.d.). Joseph Beuys, 7000 Oaks.

https://www.diaart.org/exhibition/exhibitions-projects/joseph-beuys-7000-oaks-site

[4] Domínguez, J. (2004). State-of-the-art and new perspectives on vermicomposting research. In C. A. Edwards (Ed.), Earthworm ecology (2nd ed., pp. 401–424). CRC Press. https://doi.org/10.1201/9781420039719.ch20

[5] Edwards, C. A., Domínguez, J., & Neuhauser, E. F. (1998). Growth and reproduction of Perionyx excavatus (Perr.) (Megascolecidae) as factors in organic waste management. Biology and Fertility of Soils, 27(2), 155–161. https://doi.org/10.1007/s003740050414

[6] Graham, M. A. (2007). Art, ecology and art education: Locating art education in a critical place-based pedagogy. Studies in Art Education, 48(4), 375–391. https://doi.org/10.1080/00393541.2007.11650115

[7] Gunadi, B., & Edwards, C. A. (2003). The effects of multiple applications of different organic wastes on the growth, fecundity and survival of Eisenia fetida (Savigny) (Lumbricidae). Pedobiologia, 47(4), 321–329. https://doi.org/10.1078/0031-4056-00196

[8] Inwood, H. (2008). Mapping eco-art education. Canadian Review of Art Education: Research and Issues, 35, 57–73.

[9] Kagan, S. (2011). Art and sustainability: Connecting patterns for a culture of complexity. transcript Verlag. https://doi.org/10.14361/transcript.9783839418031

[10] Nair, J., Sekiozoic, V., & Anda, M. (2006). Effect of pre-composting on vermicomposting of kitchen waste. Bioresource Technology, 97(16), 2091–2095. https://doi.org/10.1016/j.biortech.2005.09.020

[11] Neuhauser, E. F., Hartenstein, R., & Kaplan, D. L. (1980). Growth of the earthworm Eisenia foetida in relation to population density and food rationing. Oikos, 35(1), 93–98. https://doi.org/10.2307/3544730

[12] Oxman, N., Ortiz, C., Gramazio, F., & Kohler, M. (2015). Material ecology. Computer-Aided Design, 60, 1–2. https://doi.org/10.1016/j.cad.2014.05.009

[13] Public Art Fund. (1982). Wheatfields for Manhattan. https://www.publicartfund.org/exhibitions/view/wheatfields-for-manhattan/

[14] Thirunavukkarasu, A., Sivashankar, R., Nithya, R., Sathya, A. B., Priyadharshini, V., Kumar, B. P., Muthuveni, M., & Krishnamoorthy, S. (2023). Sustainable organic waste management using vermicomposting: A critical review on the prevailing research gaps and opportunities. Environmental Science: Processes & Impacts, 25, 364–381. https://doi.org/10.1039/D2EM00324D

[15] Tomati, U., & Galli, E. (1995). Earthworms, soil fertility and plant productivity. Acta Zoologica Fennica, 196, 11–14.

[16] Vaage, N. S. (2016). What ethics for bioart? NanoEthics, 10(1), 87–104. https://doi.org/10.1007/s11569-016-0253-6

[17] Verma, A. (n.d.). An eco-biotechnology approach for wild plant management through vermitechnology [published book chapter manuscript]. Department of Botany, Seth Gyaniram Bansidhar Podar College.

[18] Weintraub, L. (2012). To life! Eco art in pursuit of a sustainable planet. University of California Press. https://doi.org/10.1525/9780520954236

[19] Yadav, A., & Garg, V. K. (2011). Vermicomposting—An effective tool for the management of invasive weed Parthenium hysterophorus. Bioresource Technology, 102(10), 5891–5895. https://doi.org/10.1016/j.biortech.2011.02.062

[20] Yetisen, A. K., Davis, J., Coskun, A. F., Church, G. M., & Yun, S. H. (2015). Bioart. Trends in Biotechnology, 33(12), 724–734. https://doi.org/10.1016/j.tibtech.2015.09.011

[21] Verma A. TACKWEED MANAGEMENT THROUGH VERMITECHNOLOGY IN AGRICULTURE

FIELD THROUGH RED WRIGGLERS (2019) 4 (5) URL https://ajeee.co.in/index.php/ajeee/article/view/456

[22] Verma A., Kaur I. 2016. [22] Biological activity of red wriggler earthworm using puncture wine weed with cow dung as substrate. Indian Journal of Weed Science, 48 (3). Doi. 10.5958/0974-8164.2016.00092.7. pg 353-355

[23] Bansal, V., & Roshni. (2026). Pigment traditions in Indian miniature painting. Academic Journal of Excellence. ISSN 3108-012X. OpenAIRE Indexed; International publication. Published on 22 June 2026. DOI: 10.5281/zenodo.21203542. https://doi.org/10.5281/zenodo.21203542

[24] Bansal, V. (2026). Earth to expression: Traditional pigments in Indian art. In A. Verma & T. Joshi (Eds.), Nourishing the Planet: Sustainable Nutritional Resources, Climate and Biotechnology (pp. 129–143). EDU Academic Incorporation. ISBN 978-93-92620-87-4. https://pub.eduacademic.co.in/product/nourishing-the-planet-sustainable-nutritional-resources-climate-and-biotechnology/

[25] Bansal, V., & Roshni. (2026). Traditional pigments across Indian art forms. In A. Verma & T. Joshi (Eds.), Nourishing the Planet: Sustainable Nutritional Resources, Climate and Biotechnology (pp. 193–204). EDU Academic Incorporation. ISBN 978-93-92620-87-4. https://pub.eduacademic.co.in/product/nourishing-the-planet-sustainable-nutritional-resources-climate-and-biotechnology/

[26] Bansal, V. (2026). Traditional pigments in contemporary art education. In A. Verma & T. Joshi (Eds.), Nourishing the Planet: Sustainable Nutritional Resources, Climate and Biotechnology (pp. 279–288). EDU Academic Incorporation. ISBN 978-93-92620-87-4. https://pub.eduacademic.co.in/product/nourishing-the-planet-sustainable-nutritional-resources-climate-and-biotechnology/