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RECEIVED 02 July 2024

ACCEPTED 31 July 2024

PUBLISHED 21 August 2024

CITATION

Pietarinen H and Qureshi A (2024) Blurring bioart boundaries.
Front. Commun. 9:1458493.
doi: 10.3389/fcomm.2024.1458493

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Blurring bioart boundaries

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This study investigates the intersection of bioart and posthumanistic perspectives through the innovative use of reindeer by-products, specifically reindeer blood, as a medium for artistic expression. Utilising an Arts-Based Research (ABR) approach, the research investigates the methodological, ethical, and cultural dimensions of integrating waste materials into creative practices. The project repurposes reindeer blood, an often-overlooked by-product of reindeer herding, to provoke ethical discussions on sustainability and cultural sensitivity within the arts. Experiments in the BioARTech laboratory transform reindeer blood into air-dried pigment, which is then incorporated into glassblowing and surface pattern design. These innovative techniques challenge traditional boundaries of artistic materials and prompt deeper reflections on human-nature relationships. Exhibitions across Finland highlight the ethical application of this unique Northern material, highlighting its cultural significance and promoting a reimagining of our interconnectedness with the natural world. Ultimately the study expands the artistic repertoire and advocates for more harmonious and sustainable futures through pioneering bioart practices.

KEYWORDS

bioart, posthumanism, arts-based research, human-nonhuman relationship, animal by-products, artistic experimentation, sustainable art practices, ethics

1 Introduction and background

Imagine a painting brought to life with the vibrant rhythms of natural materials instead of just chemically enhanced paint and pigments, or a glass piece incorporating unusual natural waste materials as artistic elements, blending the lines between art and nature. This study seeks to explore this unfamiliar territory, where traditional boundaries collapse and new research paths emerge. The authors (artist-researchers) of this study are guided by the principles of posthumanism which offers deep insights into the fluid nature of identity, agency, and morality (Haraway, 1991). The language of the life sciences provides artists with a valuable communication tool for exploring evolving concepts of identity (Myers, 2015). In this vast expanse of artistic expression, bioart emerges as a beacon, encouraging us to reconsider our assumptions and reinvent the fundamental core of creativity (Kac, 2007).

Borrowing from Stracey (2009), this study focuses on the posthumanistic approach within bioart as a platform for critically reflecting on the ethical implications of manipulating natural materials for artistic purposes. As bioartists investigate genetic engineering, biotechnology, and synthetic biology, issues such as agency, consent, and environmental impact become crucial (Vaage, 2016). Posthumanistic discourse encourages bioartists to question the power dynamics inherent in their creative processes and the ethical implications of their interventions in biological systems. By acknowledging the agency and vitality of non-human entities, posthumanist scholars challenge anthropocentric attitudes toward the environment and advocate for more symbiotic modes of coexistence (Barad, 2007). Through this lens, bioart becomes not only a platform for aesthetic experimentation but also a site for ethical inquiry and dialogue, challenging

viewers to confront their assumptions about the boundaries of life and the responsibilities of human creators, as [Herbrechter \(2023\)](#) asserts.

Bioart intervenes in life processes, pushing its boundaries through the creation or alteration of natural materials, suggests [Kac \(2007\)](#). Unlike traditional art forms, bioart surpasses representation, residing inside the world of the living. The resulting bioart creations become integrated into the ongoing process of evolution and, if capable of reproduction, may endure as long as life exists on Earth. Consequently, bioart prompts novel inquiries into the future trajectories of life, evolution, society, and artistic expression. According to [Beaudoin \(2021\)](#), ‘bioartistic practices have the potential to contribute to a broader reconfiguration of human beings and their relationships with the environment, providing productive avenues for addressing the environmental crisis’ (p. 165). By decentering the human subject and embracing a more-than-human perspective, bioartists can envision worlds where humans and non-human entities collaborate, co-create, and co-evolve ([Kac, 2007](#)). Through speculative narratives within bioart, audiences are encouraged to consider the possibilities offered by advancements in our artistic imagination, as well as the implications these innovations may have on shaping our shared futures.

The authors of this study began their exploration with a posthuman design project called *Life Between Art and Blood*, ([Pietarinen and Qureshi, 2023a,b,c](#)). Using an arts-based research (ABR) approach, they sought to integrate posthuman design and kinship between humans and non-humans within the BioARTech laboratory, which experiments with Northern waste materials ([BioARTech Laboratory | Faculty of Art and Design | University of Lapland, n.d.](#)). This qualitative research aims to repurpose reindeer blood, a by-product of reindeer herding, rather than treating it as waste, and to generate new ideas related to this material ([Kontturi, 2012](#); [Pietarinen and Qureshi, 2023a,b,c](#); [Qureshi et al., 2023](#)). Rooted in ABR, which highlights experiential knowledge generation and the integration of artistic practice with scholarly inquiry ([Barone and Eisner, 2012](#)), this study explores the multifaceted implications of reindeer blood as a medium for artistic expression, while also investigating the societal, environmental, and cultural implications of this approach.

1.1 Ethical considerations

Although the research involved the use of animal by-products (ABP), ethical considerations were addressed through the European Commission’s Ethics self-assessment, ensuring that methods, materials, and results did not cause harm to humans, animals, or the environment ([Biorisk Management, 2006](#); [EU Grants, 2021](#)). The use of animal blood in ABR currently lacks significant economic value and often sparks ethical controversy. While animal exploitation is more prominent in industries such as fashion and textile design, philosophical considerations surrounding animals have traditionally centred on rationality and sensitivity, acknowledged as essential issues in animal research ethics since the 1970s ([Aaltola, 2004](#)). Keeping this in view, this study also looked into the ethical implications of using reindeer blood in artistic expression, shedding light on the various moral reactions and perspectives it elicits. Ethical inquiries concerning reindeer blood research range from practical considerations to broader ethical principles and solutions encompassing human, non-human, and animal interactions. The study clarifies that no animals were harmed, nor is that

the study’s aim. Instead, the objective is to repurpose ABP to stimulate deeper conversations about responsibly managing waste materials.

This exploration also intersects with the long-standing tradition of Indigenous peoples using animal blood to create scenes on cave walls, commonly referred to as Rock Art. Unlike Western perspectives that may classify these creations as mere artistic expressions, Indigenous communities view them as integral to ceremonial rituals, reflecting profound cultural significance ([Eliade, 1959](#); [Morris and Staikidis, 2023](#)). This distinction raises critical questions about the interpretation of bioart and the ethical implications of using ABP in contemporary practices. The ethical considerations in this research also extend to honouring Indigenous perspectives, inviting a deeper examination of how bioart can respect and incorporate Indigenous knowledge systems ([Haraway, 2020](#)) while acknowledging the cultural and spiritual dimensions inherent in these materials.

2 Materials and methods

2.1 Reindeer herding in Finnish Lapland

Reindeer herding stands as a central attraction for visitors to Lapland, celebrated not only for its economic contributions but also for its profound cultural significance. The practice of reindeer herding is deeply rooted in principles of ethics and ecology, underlining its sustainable approach to utilising natural resources ([Pietarinen et al., 2023a,b](#)). In Finnish Lapland, the year of a reindeer follows the northern rhythms of nature. In Finland, an estimated 120,000–130,000 reindeer are born every year and about 100,000 reindeer are slaughtered annually in autumn and early wintertime. Almost all the reindeer slaughterhouses in Finland are owned by the *Reindeer Herding Association* (Paliskunta). This is a unique system because in other Nordic countries, reindeer slaughterhouses are owned by companies outside of reindeer husbandry, while the entire Finnish reindeer slaughterhouses are operated by reindeer husbandry entrepreneurs.

Nowadays, about two million kilograms of by-products are produced in reindeer slaughterhouses in Finland. The largest number of by-products are stomachs, digestive systems, loins, heads and blood. Only reindeer meat is maximally used, while the waste is typically delivered to landfills. A wide range of reindeer by-products should be used to preserve resources. For example, reindeer blood has high nutritional and energetic value, and reindeer fur, with its thickness (up to 3–3.5 centimetres, approximately 1,700 hairs/cm²), acts like a natural insulation layer. Furthermore, reindeer by-products contribute extensively to various sectors beyond traditional consumption. They are employed as raw materials in designed goods, pet food production, and specialised facilities for technical applications, biogas generation, and composting. This multifaceted utilisation not only enhances economic efficiency but also aligns with sustainable practices by minimising waste and maximising resource efficiency ([Laaksonen, 2016](#); [Majuri et al., 2019](#); [Muuttoranta, 2019](#); [Mattila, 2021](#)).

2.2 Research environment and artistic experiments

The BioARTech laboratory, located within the University of Lapland’s Faculty of Art and Design, served as the primary research

hub where the artist-researchers of this study probed into new frontiers. This dedicated space facilitated safe experimentation and the development of innovative methodologies for working with reindeer by-products, notably blood. Activities in the laboratory were characterised by a commitment to material-driven design and co-creation, where the inherent characteristics of materials themselves played a pivotal role in shaping creative processes. Through a series of carefully designed experiments, the artist-researchers explored the artistic potential of reindeer blood. This approach nurtured a dynamic exchange between theoretical insights and practical applications, pushing the boundaries of artistic exploration. Insights gained from these experiments were showcased in several exhibitions between 2023 and 2024. These included *Blood, Ice and Tears: Life Between Art and Blood* at Gallery Kopio, University of Lapland (Bergström et al., 2023; Pietarinen et al., 2023a), *Materials Matter* as part of Innovation in Lapland through Design and Art, Gallery Hämärä, University of Lapland (Pietarinen et al., 2023b) and *North Meets South* at Gallery Seinä, University of Lapland (Miettinen et al., 2024).

Haraway (2020) underscores the importance of reflecting on the implications of using non-human materials, emphasising the interconnected relationship between humanity and the natural world. This perspective resonates with the cultural beliefs of the Sámi people, as demonstrated by duojár (Sami handicraft expert) Magga (2024), who prioritised respect for nature and acknowledged the interconnectedness of human actions with the environment. This holistic approach underscores the ethical use of natural resources and recognises the intricate web of life, where each entity holds significance. Within Sámi culture, practices such as Duodji, the traditional Sámi handicraft not only involve craftsmanship with natural materials but also reflect a deep respect for reindeer life. These cultural practices serve as a reminder of the shared relationship between humans and nature, advocating for sustainable coexistence and harmony within the ecological framework.

For instance, conversations of the Norwegian artists duo Karoline Sætre and Øyvind Novak Jenssen provided a tangible exploration of similar themes, particularly regarding their innovative use of blood as a central element in their work. Sætre and Jenssen have extensively engaged with various ABPs, including fish intestine, skin, and gallbladder, integrating them into projects that blend dining experiences, place-making, and contemporary art. Their installations and performances often take the form of events where audiences can taste dishes prepared from locally sourced raw materials, exemplified by their *Felles Jord, Delt Bord* (Shared Earth, Shared Table) installation and performance in Harstad, Northern Norway (Sætre and Jenssen, 2023, 2024). In this particular example, participants were invited to dine at a long table crafted from burnt wood, symbolising a communal gathering that embraced the local environment's essence. Thus, reminding us that such immersive experiences not only engage with the senses but also prompt reflections on the interconnectedness between humans and their surroundings.

2.3 Ethical debates and public concerns on the use of reindeer blood

In this research, the concept of the abject and uncanny in bioart, characterised by its ability to evoke intellectual uncertainty and bring to light elements that challenge conventional

understanding, was a prominent theme (Jentsch, 1906; Campagna, 2018; Sederholm, 2020; Eco, 2021). Using reindeer blood as an ABP in this project generated discussions at international conferences. It generated significant ethical concerns, leading to debates and astonishment at several events. Notably, these discussions took place at the Textile Intersections conference at Loughborough University London (2023) and the Critical Arctic Studies Symposium at the Arctic Center at the University of Lapland (2023). These platforms highlighted the complex ethical landscape surrounding the use of ABP in art, particularly focusing on the intersection of cultural practices, sustainability, and artistic innovation.

At these conferences, several critical questions emerged from attendees, reflecting a broad spectrum of ethical considerations. One of the most pressing questions was, "How many reindeer have died because of the *Life Between Art and Blood* research?" This question underscored concerns about the direct impact of artistic projects on reindeer populations and the potential for such projects to contribute to animal deaths, raising ethical questions about the justification of using ABP for art. Another frequently asked question was, "From where and how do you get the reindeer blood?" This inquiry highlighted concerns regarding the sourcing of reindeer blood, emphasising the need for transparency in the supply chain. It reflects broader societal concerns about the origins of materials used in creative practices, ensuring that they are sourced responsibly and ethically. Attendees also questioned the broader ethical implications of using reindeer blood in research, asking, "Is it ethical to use reindeer blood for research purposes?" This question invited a deeper discussion on the moral responsibilities of the authors of this study. It challenged them to justify using such materials in non-traditional ways, prompting a re-evaluation of ethical standards in bioart. Practical concerns about handling reindeer blood were also raised with the question, "Do you handle reindeer blood with your bare hands?" This question pointed to personal safety and hygiene, as well as the proper handling and processing of ABP. Lastly, the question, "What do reindeer herders think about this research?" brought greater attention towards the perspectives of Indigenous and local communities who are directly involved in reindeer herding. This question also touched on the potential cultural appropriation and the need to engage with reindeer herders collaboratively and respectfully.

2.4 Research inquiries and insights

Understanding these questions and ethical issues arising from what artist-researchers can do, what is their role in this study, and more specifically how living material is received, was needed (Vaage, 2016). In response to these questions, this article addresses the following research inquiries: (i) What methodological and theoretical considerations emerge when using reindeer blood as a medium for artistic expression, and how do these influence the public perception of such practices?, (ii) How can ABR methodologies be adapted to incorporate reindeer blood and other non-human materials in a sustainable and ethically responsible manner? and (iii) In what ways can incorporating reindeer blood into artistic activities encourage cultural dialogue and understanding between human and non-human communities, impacting the broader cultural, environmental and societal landscape regarding the use of unconventional materials?

These questions underscore the necessity for discourse, collaboration, and shared understanding in material studies.

The first research inquiry investigates the methodological and theoretical considerations that arose when using reindeer blood as a medium for artistic expression. Methodologically, it was understood that we must navigate the ethical sourcing and handling of the blood, ensuring that its use aligns with both legal and ethical standards. The selection of reindeer blood, classified as an ABP is deliberate due to its unique properties and cultural significance within the context of Finnish Lapland. ABP refer to materials of animal origin that people do not consume. In this experiment, 14 litres of low-risk (Category 3) frozen reindeer blood was delivered directly to one of the author's doorsteps. Reindeer blood can also be purchased in regular grocery stores in Finland. Handling, storage, and transportation of such by-products are regulated by stringent health guidelines outlined by the European Parliament (Regulation No. 1774/2002), ensuring compliance with ethical standards and environmental safety protocols. For instance, low-risk material category 3 means that the blood originates from healthy animals or has been obtained from reindeer declared fit for human consumption after undergoing an antemortem inspection (Animal by-Product, 2008; Regulation (EC), 2009; Commission Regulation (EU) No 142/2011, 2011; Mattila, 2021).

The second research inquiry focuses on how ABR methodologies can be adapted to incorporate reindeer blood and other non-human materials in a sustainable and ethically responsible manner. Adapting ABR methodologies involves several key strategies. Ethical sourcing is paramount, ensuring that materials are obtained from responsible and sustainable practices. Regulatory compliance with health and safety standards protects both artists and the environment. Collaborative practices with local communities, including Indigenous groups such as the Sámi, ensure cultural sensitivity and respect. Educational initiatives can raise awareness about the ethical and environmental implications of using non-human materials, promoting informed dialogue and understanding. Sustainable design practices can minimise waste and maximise the use of all parts of the reindeer by-products, enhancing the overall sustainability of the practice.

The third research inquiry examines how incorporating reindeer blood into artistic activities can encourage cultural dialogue and understanding between human and non-human communities, impacting the broader cultural, environmental, and societal landscape regarding the use of unconventional materials. Incorporating reindeer blood into artistic projects highlights the cultural significance of reindeer herding for Indigenous communities, raises awareness about sustainability and ethical considerations, and advances interdisciplinary collaboration. Artistic experiments using reindeer blood can captivate public interest, sparking curiosity and deeper conversations about the interconnectedness of human and non-human life, the value of biodiversity, and the need for harmonious coexistence. Through these efforts, artists can create a ripple effect, influencing broader societal attitudes towards the use of unconventional materials and promoting a more integrated and holistic view of our relationship with the natural world.

2.5 Porohelmi (reindeer pearl)

Considering the inquiries and insights mentioned earlier, this experiment investigated the transformative potential of organic

material, focusing initially on reindeer blood, which, despite its unsettling connotations, was transformed into an air-dried red pigment for artistic exploration. The direct interaction with the blood using bare hands elicited both caring and unsettling experiences for the artist-researchers. This interaction raised a sense of connection and responsibility towards the material, leading to a deeper appreciation and “care” for it. This can be illustrated through the properties of blood, such as the colour changes from fresh red to rust brown, it effectively stains fabric, and the stains fade upon washing. Similarly, a textile printed or woven with blood can be interpreted from multiple perspectives, symbolising themes of life, passion, and mortality. This challenged traditional notions about the relationship between humans and non-human within the framework of posthuman design.

The creative process began as the artist-researchers collaborated with a multidisciplinary glassblowing expert team at Ikaalinen College of Crafts and Design to experiment with air-dried reindeer blood pigment in glassblowing and surface pattern design (see Figure 1). This partnership offered a fertile ground to explore how the blood pigment adhered to and was applied on various surfaces, ranging from traditional materials like wood and paper to unconventional mediums such as gluten plastic, beeswax, and bio-based thermoplastic. This exploration aimed to reveal how the pigment could be used to create intricate patterns and textures, enhancing the visual and tactile experience of the artwork. Moreover, the team experimented with different temperatures and techniques to understand how the pigment interacted with molten glass. This stage was characterised by iterative trials, where the pigment's behaviour under various conditions was meticulously documented. This required precise control of temperature and timing to ensure that the pigment was effectively fused into the glass without compromising the clarity and integrity of the material. The resulting glass objects, including spheres and patterned surfaces, captured the unique visual qualities of the blood pigment.

This entire process took place during a week-long workshop, where the artists collaborated intensively working with the expert glassblowing team for 5 h each day (Pietarinen et al., 2024). Through detailed documentation and reflection, the artist-researchers aimed to capture the unique aspects of their creative process, including the tools used, outcomes achieved, and insights gained for future artistic applications of blood materials. One researcher participated remotely, observing the workshop online intermittently to provide a viewer's perspective. This dual approach allowed the authors to analyse the data comprehensively from both physical and virtual viewpoints, ensuring thorough documentation and perspective integration among all collaborators.

The final artwork *Porohelmi* emerged from this experimental process as a series of glass spheres infused with reindeer blood pigment. The name, meaning “reindeer pearl” in Finnish, reflects the translucent, lustrous quality of the glass, reminiscent of water pearls. The spheres were designed to embody a sense of organic beauty and fragility, symbolising the interconnectedness of life and the momentary nature of existence. The process of integrating reindeer blood pigment into glassblowing involved several stages, each contributing to the development of this artistic work. The glass spheres were not merely decorative but served as a medium to explore and express broader themes. The use of blood pigment highlighted

the material's inherent duality—its association with both life-giving and life-ending forces. The transformation of blood from a biological substance to an artistic pigment underscored a journey from raw nature to refined art, encapsulating a narrative of change and continuity.

Subsequently, the artwork was showcased at the *Growing Season* Exhibition at Taito Gallery, Craft Corner in Helsinki (Pietarinen and Qureshi, 2024) as part of the Bio Colours Conference organised by the University of Helsinki (see Figures 2, 3). During the exhibition, the artwork gathered significant interest and prompted inquiries from the



FIGURE 1
Glassblowing workshop at Ikaalinen College of Crafts and Design, Finland (2024). Experimenting with air-dried reindeer blood pigment for surface pattern design (left); Blowing glass with expert Eija Yli-Knuutila and author Heidi Pietarinen (right). Photo credits: Merja Virta.

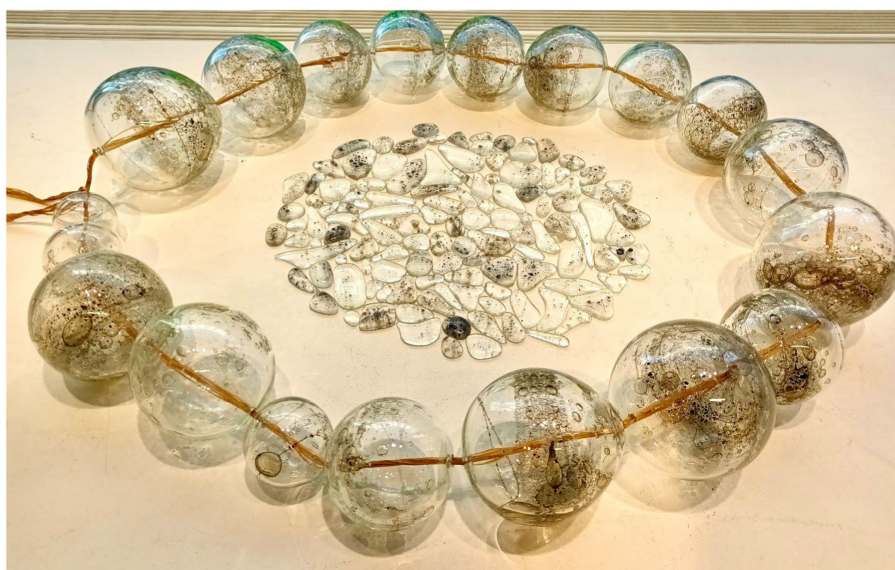


FIGURE 2
Porohelmi (Reindeer Pearl), Exhibited at Taito Gallery, Craft Corner in Helsinki, Finland (2024); Materials: Glass, air-dried reindeer blood and vein thread; Technique: Glass blowing; Experts: Eija Yli-Knuutila and Merja Virta; Photo credits: Heidi Pietarinen.



FIGURE 3

Closeup of air-dried reindeer blood blown into glass. Porohelmi (Reindeer Pearl), Exhibited at Taito Gallery, Craft Corner in Helsinki, Finland (2024). Materials: Glass, air-dried reindeer blood and vein thread; Technique: Glass blowing; Experts: Eija Yli-Knuutila and Merja Virta; Photo credits: Heidi Pietarinen.

audience. Unlike previous instances, this time the artist-researchers were equipped to address questions arising from the uncharted territory they had initially ventured into. Feedback from the audience and critics emphasised the provoking nature of the work and its capacity to stimulate thought on cultural, environmental, and societal themes. The artwork's ability to bridge traditional craft with contemporary issues reflected a successful fusion of artistic innovation and conceptual depth. This ongoing process of knowledge dissemination, dialogue and exploration continues to uncover new possibilities and insights. Moreover, this experiment not only expanded the artistic repertoire of the team but also ignited critical discussions about the cultural, environmental, and societal implications of employing unconventional materials in artistic activities.

3 Results and discussion

Reindeer blood, as a by-product, exhibits fascinating and unique properties that defy easy categorisation. Audiences at the exhibitions found it challenging to believe that the surface pattern design on glass was created using air-dried reindeer blood pigment. One attendee exclaimed in disbelief, "Is it really reindeer blood?" Another inquired, "How does the colour change to black, and yet it appears as if snow is trapped in the glass?" Observers also noted that the round and smooth glass surfaces allowed them to clearly discern the intricate patterns, reminiscent of a snowstorm. For the artist-researchers themselves, the patterns on the glass surface differed significantly from those achieved with other substances like "soda" (sodium oxide,

Na₂O) or snow used for processing modifications. The process and outcomes of working with reindeer blood pigment prompted deep reflection and exploration, challenging conventional perceptions of materials in artistic practices.

The unifying theme across all previous exhibitions and the latest *Porohelmi* exhibition was a deep respect for Northern nature and its by-products, with a focus on finding innovative ways to incorporate diverse elements into art and design. The dissemination of *Porohelmi* represents a significant achievement in blending traditional techniques with innovative material use. The artwork served as a shred of evidence of the potential of reimagining materials and pushing the boundaries of artistic practice, inviting viewers to engage with complex themes of life, transformation, and materiality. This approach demonstrated that blurring the boundaries of bioart requires more than just artistic expression—it demands dialogue, networks, collegial encounters, and shared authorship, fostering a sense of kinship between humans and non-humans. The use of reindeer blood raised immediate questions about mutual respect for nature, highlighting that humans cannot thrive without a harmonious relationship with the natural environment. It reminds artist-researchers to consider the multiple and interconnected entities that every new material inevitably influences and shapes (Haraway, 2020).

Additionally, the research relies on observations and lacks a clearly defined sample size or systematic methodology for selecting public responses. Scoping studies emphasise breadth over depth, aiming to map the existing knowledge landscape and identify key themes, gaps, and areas for further exploration rather than producing definitive statistical conclusions (Munn et al., 2018). In this study, findings arose from spontaneous public reactions and feedback observed during conference presentations and exhibitions, providing valuable insights into audience perceptions and responses. Such qualitative data act as an initial exploration of themes and variables that merit further investigation, aligning with the aims of scoping studies, which prioritise understanding the scope of an issue over establishing concrete cause-and-effect relationships (Peters et al., 2015). While the lack of a structured sampling method and calculative approach may limit the findings, on the other hand, it reflects the exploratory nature of this research. By showcasing diverse perspectives, this study contributes to future inquiries into the intersection of art, ethics, and public engagement, paving the way for more systematic investigations (Arksey and O'Malley, 2005).

4 Conclusion

In conclusion, the exploration of reindeer blood has illuminated thoughtful themes of interconnectedness, empathy development towards a more balanced ecosystem, and a critical examination of human supremacy over other species. Through the lens of posthumanism, this research has sought to decenter the traditional view of humans as autonomous and fully separate from nature. Instead, it proposes a vision where humans are understood as part of a broader assemblage, co-evolving with other life forms and deeply embedded within the environment, materiality, and technology (Nayar, 2013, p. 13 and Keski-Korsu, 2019, p. 237). Looking ahead, the insights gained from this research underscore the importance of

continuing to explore and integrate non-human entities into creative processes. As we navigate the complexities of a rapidly changing world, embracing a posthuman perspective invites us to reconsider our roles and responsibilities towards all forms of life, encouraging a more harmonious coexistence with the natural world. In essence, the exploration of reindeer blood has demonstrated the transformative potential of unconventional materials, challenging us to reimagine our relationship with nature and each other in ways that are both innovative and harmonious.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

HP: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. AQ: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

We would like to acknowledge Eija Yli-Knuutila and Merja Virta from Ikaalinen College of Crafts and Design for their cooperation in conducting the glassblowing workshop. We also acknowledge the reindeer herder, Niina Mattila for providing the reindeer blood. We greatly appreciate the contribution.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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