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Ancestral cuisine as regenerative social technologies in Amazon: Eco-humanist perspectives towards a critical sustainable chemistry

Aymara Llanque Zonta[1,2] and Vânia G. Zuin Zeidler[1]

"Ancestral cuisine" is a reflection from the regenerative agriculture to the culinary, to exemplify the integral relationships between nature and culture, based on the food preparation and consumption practices of indigenous and peasant populations. Socio-scientific studies were taken as a reference, and other secondary sources around the Amazon, especially in northern Peru, Colombia, and Brazil, where conventional monoculture food systems coexist with more traditional forms of food production and consumption. Based mainly on the experiences of women cooks, their culinary and the knowledge transmission, we review and discuss the social technologies and the chemical processes involved, as a starting point of food sustainability criteria to contribute to the ontological shift in the human-nature relationship.

Addresses
[1] Faculty of Sustainability, Leuphana University, Germany
[2] Helmholtz Centre for Environmental Research GmbH – UFZ, Germany

Corresponding author: Zuin Zeidler, Vânia G. (vania.zuin@leuphana.de)

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Introduction

The ancestral cuisine of Amazonian indigenous peoples exemplifies the complex interactions between forest, agrarian, and agroforestry landscapes and the communities that inhabit the region. These culinary practices reflect eco-humanist perspectives, offering a counterpoint to agro-industrial food systems that are increasingly influencing the diets of Amazonian populations. For example, the metaphor of the *Wisiré*, referred to in the Colombian Amazon as the "loss of spirit" or a deviation from the path of knowledge, describes a state in which a person, appearing pale or anemic, in disharmony. Healing *Wisiré* requires restoring balance between the human and nonhuman realms through specific rituals and diets [1]. *Wisiré* intertwines spirituality [2] with food systems and their social-ecological dimensions [3,4], where ingredients, nutrients, and culinary practices in the Amazon are relevant [5]. A study by Valdivia-Gago and collaborators [6] analyzed seasonal variability in the nutritional status of Shawi children under five in the Peruvian Amazon, showing an increase in chronic malnutrition (from 39.2% to 41.9%) and a high prevalence of anemia (66.2%); related to parental roles and diversified productive activities in child nutrition. Reviving ancestral diets, with ingredients that come from diversified productive activities, would be one way of combating malnutrition, among other interconnected ecosystem problems, because they promote diversity with high cultural value.

The praxis related to sustainable bio-based resources and greener processes to produce safer and healthier food can be seen in ancestral indigenous practices. Indigenous communities rely on traditional food with high nutrient content. For example, the antioxidant and nutritional activity of traditional raw and cooked foods consumed by communities in India were analyzed, and the results showed that these raw or minimally processed traditional foods compared to more processed or ultra-processed ones demonstrated the highest content of fat, fiber, protein, vitamin C and polyphenols, as well as zinc, manganese, and magnesium, highlighting the ability of these foods to improve people's well-being [7]. In the Amazon indigenous communities reproduce their diets with minimally processed food, using cassava *(Manihot esculenta)*, corn, rice, beans, pineapple, banana, watermelon, pumpkin; combined with the collection of other native fruit species, e.g. umbu (*Spondias tuberosa*) and açaí (*Euterpe precatoria*). Green and sustainable chemistry approaches, it can be observed, e.g. the use of organic waste (peels, seeds, bagasse etc.) deposited in the planting, increasing soil fertilization, and practices without hazardous materials, neither high energy consumption nor intensive land and water usage compared to conventional industrialized production [8].

Diversified productive activities are part of the mechanisms achieving regenerative agriculture models, combining socio-ecological components. It includes soil management (reduced soil disturbance) [9], crop rotation, and polyculture combined; collecting and small-scale farming (wide genetic variety of the plants, providing effective disease control and insect predation); agroforestry, forest management [10]; as well as social aspects, related to land and seeds access and local knowledge application decided in a cooperative way [11]. Regeneration as a praxis of indigenous people has entered and grown in several scientific fields [12–15], showing to be increasingly relevant for sustainability, especially in the context of critical sustainable chemistry. The traditional production activities provide the conditions for the reproduction of food practices based on local diets, including seasonal ingredients, making integral systems that benefit human and environmental health, where indigenous peoples live. In this regard, regenerative practices are the basis for the nutrition of Amazonian populations, and a central element reproducing culinary traditions [16].

Changes in Amazonian diets toward an unnourished polluted world

Since the traditional productive systems are collapsing, e.g. an effect of deforestation, traditional ingredients are replaced by products from conventional monocultural food systems [17], worsening malnutrition in territories that produce high-value organic foods. Conventional food systems are responsible for one-third of greenhouse gas emissions [18], restrict land access, increase hunger, and cause diet-related diseases, exposing the power asymmetries behind these crises [19]. For example, the expansion of the soy-cattle agroindustry in the Brazilian Amazon impoverishes small farmers and indigenous communities and intensifying frictions between traditional and ultra-processed foods [20]. The literature indicates that deforestation and biodiversity loss are related not only with monoculture's expansion, but also with the growth of extractive infrastructures and illicit economies in the Amazon [21], making relevant the need for an integrated evaluation of food systems to address social injustices.

Maluf et al. [20] explore how the asymmetry between indigenous peoples and traditional communities versus the agro-industrial sector (such as soybean growers, ranchers, and agribusinesses) impacts access to adequate and healthy food. While the expansion of food supply includes products from other regions, it reduces the consumption of fresh, local foods and increases the consumption of ultra-processed products marketed by the same transnational corporations that dominate globalized food systems. In Amazonian localities supermarket chains are gaining prominence, transforming infrastructure and food consumption patterns. This analysis reveals how power dynamics shape food systems [22,23].

This contradiction raises the question: What do rural Amazon residents consume? Understanding food experience in different territories is crucial, as available ingredients, cooking processes, and motivations shape the regenerative cycle [24,25]. Jacobi et al. [26] note that many consumers live in "food deserts" due to historical segregation. Organic agriculture certification often ignores issues like landscape homogenization and benefit inequities, showing sustainability in food systems is tied to food security and adequate nutrition rights [27]. Cielo and Vera [28] found that in scarcity contexts, self-sufficient production gains importance. Regenerative agriculture, while promising, requires integration with production, distribution, and consumption systems. This approach supports solidarity economy [26,27] and was recognized at (UN Climate Change Conference) COP 28 as one possible solution to the climate crisis and biodiversity loss [4].

The conventional agri-food model is altering eating habits and the quality of ingredients in the Amazon. Research in critical sustainable chemistry addresses these challenges, going beyond waste-to-bioenergy conversion, and integrating reflections on food systems [4]. This approach, linked to "food democracy," seeks to restore justice in the face of corporate control toward more critical sustainable sciences, including chemistry [10].

Food colonization: a historical problem

The current food situation in the Amazon cannot be understood without first reviewing its historical context. Between the 19th and 20th centuries, Amazonian populations have been providers of rubber (*Hevea brasiliensis*) for the global market [29]. Archives of the consolidation of the rubber economy show how indigenous people were displaced to extraction camps [30,31], governed by European and mestizo migrants. In these camps, indigenous women took on domestic tasks, such as cooking and feeding, and it was common for them to breastfeed their masters' children before their own. Simultaneously, traditional food practices were reduced, not only due to the limited availability of ingredients because of the rubber extraction focus [30], but also due to changes in recipes, cooking methods, and the time dedicated to food preparation, affecting both daily meals and ritualistic or festive moments.

The current production of organic cacao *(Theobroma cacao) and* Brazilian nuts (*Bertholletia excelsa*) under fair trade labels generate similar dynamics. Today, sustainable production and healthy eating labels have become privileges. Healthy food brands can price their products up to five times more expensive than unhealthy diets, combined with aspects such as convenience, satiety, and driving the consumption of ultra-processed foods [20]. Households in Europe, North America, and Asia nourish

their children with Amazonian products like Peruvian cacao and Bolivian Brazil nuts, purchasing certified products at higher prices. However, profits are concentrated in the transformation and commercialization processes [32], which typically occur in Global North countries, while Amazonian communities face high certification costs [33]. In areas where self-sufficiency production is weak, communities depend on purchased foods, often of lower quality. Additionally, advertising and modern dietary practices are promoting increased consumption of ultra-processed food by vulnerable groups, reinforcing dominant narratives about food as a whole [18,20]. Saurith [24] notes that dietary guidelines are still based on studies from the Global North countries, often overlooking local food practices.

In this context, we explore ancestral cuisine as a social technology to exemplify how culinary traditions contain different ways of producing and consuming food in an environment pressured by conventional food systems, which its body of knowledge seeks to contribute to build diverse and alternative regenerative materialities, spatialities, temporalities, and paths that are healthier for all by revealing and questioning unjust, nonemancipatory, exclusionary, and socio-environmentally unsustainable power structures.

Sustainable food practices and ancestral knowledge in diets

Despite the advancement of the agro-industrial food system in Amazonian diets, ancestral knowledge persists in the cuisine yet, demonstrating more sustainable models. Ancestral cuisine, beyond being a symbolic construct, reflects cultural and ethical identities, simplifying and minimizing processes, using renewable resources and maintaining only the necessary molecular complexity [4]. In fact, food for indigenous people is something that needs thinking, elaboration, time, climatic and biological conditions, collaboration, and solidarity, harvesting or slaughtering of other forms of life. Such interdependence with nature—and its processes and cycles—is noted all times in the act of eating. This experience demands another sensitivity, other viewpoints that cannot be neglected [34].Where indigenous and rural lifestyles persist, traditions guide careful ecosystem management [35,36]. For example, in the Peruvian Amazon, communities coexist with export-oriented and self-consumption food systems, women play a key role [37] in traditional agriculture, cultivating commercial cacao [38] combined with cassava *(M. esculenta)*, sweet potato *(Ipomoea batatas)*, plantain (*Musa paradisiaca)*, charapita pepper *(Capsicum frutescens)*, and sachapapa *(Dioscorea trifida)* for self-consumption. Those products are included in the culinary heritage, like plantain and cassava flour, produced during rainy seasons, later used in dry-season dishes; or the Amazonian stuffed plantain dish, made with ripe plantain, Brazilian nuts and cheese, cooked over a wood fire. This dish is rich in antioxidants, selenium, carbohydrates and fats, showing the preservation potential of traditional agriculture [39].

Species like camu-camu *(Myrciaria dubia)*, annatto *(Bixa orellana)*, macambo *(Theobroma bicolor)* and cupuaçu *(Theobroma grandiflorum)* [40] are used in juices, sweets, and cosmetics, emphasize the value of Amazonian cuisine as an ever-evolving food-cultural system. Quintero's [41] study demonstrates that, in the Amazonian context, an agroforestry system model with five species can provide 44% of daily caloric needs; even though monoculture systems provide higher caloric yields, the absence of essential nutrients can be verified.

Complementarily, traditional Amazonian cuisine remains a complex cultural system, rich with rituals that integrate bodies with territories through agricultural, forestry, and spiritual practices [36]. The health of the system depends both on the management of agrobiodiversity and on the healing, prescriptions passed down orally in rituals [42]. For instance, in the Colombian Amazon the leaves of carurú *(Amaranthus hibridus)*, rich in lysine, calcium, and iron are part of the Amazonian diet and offered with prayers. Similarly, Chicatana ants *(Atta mexicana)*, containing high content of protein and lipids, are part of these diets [43].

Also the preparation of *masato*, a drink with ceremonial value, that involves cooking, mashing, and sometimes chewing the cassava to start fermentation using enzymes from saliva. *Masato* is shared during community celebrations, emphasizing its role in cultural continuity and sacred beliefs. For some communities, *masato* is seen as a food that strengthens the spirit, linking nourishment to ancestral cosmology, where food is essential and tied to creation myths. Another fermented plant-based milk made from palm fruits is *chicha de aguaje (Mauritia flexuosa)* rich in beta-carotene, vitamins C and E, and are known for their antioxidant properties and their ability to combat malnutrition, and *chicha de ungurahui (Oenocarpus bataua)* that contains essential fatty acids, proteins, and fiber, used also as a natural purgative for infections like amoebiasis. Amazonian palms are gaining recognition in international markets as superfoods.

The festive calendar mirrors the agricultural cycle, with celebrations like Carnival marking rainy and dry seasons. In Perú, carnival features the *Humisha* tradition, where a decorated tree is cut down to collect gifts, later distributed among families as an act of reciprocity. This celebration reflects the "economy of affection," understood as personal investments in reciprocal relationships to achieve otherwise unattainable goals [44].

The narratives accompanying the transmission of culinary knowledge emphasize the relational value of nature

in the worldview of these communities [45]. The study by Berlowitz et al. [46] analyzes the use of psychoactives, like Ayahuasca (*Banisteriopsis caapi*), in Peruvian Amazon indigenous communities through the traditional medicine diet. This involves social, behavioral, and dietary restrictions, combined with consuming specially prepared plants [47].

The cultural identity linked to cuisine encompasses products, utensils, procedures, recipes, and traditions (Figure 1). Cuisine reflects ways of life by putting inherited culinary knowledge into practice. In the Peruvian Amazon, dishes like corn and cassava breads, made with products from traditional agriculture, connecting the territory and memory through food. In some cases, more recently, these dishes incorporate ingredients from conventional systems [48].

Revitalization of ancestral cuisine: final reflexions and perspectives

The political-culinary dimension of food systems, understood as how culinary practices function as tools to negotiate political identities, while also reflecting dynamics of power, belonging, and resistance [49,50] is essential for imagining more democratic, just, and supportive systemic and educative transformations, where the care and reproduction of life are central. Ancestral cuisine as acts of care has the potential to generate systemic changes, particularly regarding justice in sustainability [51]. The revitalization of ancestral cuisine can draw inspiration from ongoing initiatives such as the "Decolonize Your Food" campaign led by the Indigenous Peoples Network of "Slow Food," which in 2023 engaged 370 communities in 86 countries to preserve their food heritage, fostering biodiversity, and local economies [52].

Another example is the strategy promoted by the Amazon Cooperation Treaty Organization (ACTO) and the Food and Agriculture Organization of the UN (FAO), which in 2024 developed an investment plan in the continental Amazon to promote nutritional food security [53]. The educational experience in the Amazon with the Yucuna Indigenous people showcases women using their knowledge and leadership as indigenous wisdom keepers to rebuild their food history [54]. Similarly, the Wampís indigenous people of the Peruvian Amazon are reclaiming traditional diets to reduce dependence on imported foods within the framework of their autonomous territorial government [55]. The "Reto Alimentarte" initiative in Caquetá highlights culinary entrepreneurs utilizing non-timber Amazonian Forest products in commercial gastronomy [56]. Institutional market initiatives like Peru's Qali Warma Program provide nutritious meals to children in public schools, including Amazonian indigenous communities, enhancing health and school attendance, toward revitalization of indigenous knowledge [57,58].

Therefore, adopting a critical perspective on science could promote the creation of more sustainable and regenerative food systems, because food builds cultural and political manifestations, as described here for ancestral cuisine as regenerative technologies. Food based regenerative practices is certainly an ethical goal, as obtaining proteins of animal origin such as fishing and/or hunting for subsistence, consumed with minimal processing. Critical sustainable chemistry linked to indigenous ancestral practices can help identify and project processes to optimize the use and recovery of bio-based materials, leaving all food processes and products as simple as possible, avoiding losses and emphasizing the intrinsic traceability that exists in

Figure 1

Traditional Peruvian Amazonian dish made with cassava, mashed plantain, and fish, wrapped in bijao leaves (*Calathea lutea*) and cooked in water. It uses unprocessed ingredients and is practical for transport without utensils, highlighting the relevance of ancestral cuisine. Photo by Llanque, 2024.

indigenous practices, which have no unnecessary chemical complications for food production and consumption [4,59]. These demonstrate the value of promoting practices that incorporate elements of traditional cuisine and diversify ways to produce and consume food, where actors at different levels create measures rooted in the context and based on a sustainable approach, proving that food nourishes not only the body, but also the collective memory and their socio-environment, reflecting a history beyond monoculture and monotony.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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