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The *Belanger* Tradition of the Sasak People: An Ethnoscientific Study of Cultural, Chemical, and Ecological Dimensions

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Abstract: The Belanger tradition is an indigenous Sasak hair-cleansing practice that integrates cultural values, ethnochemical knowledge, and environmental sustainability. This study investigates the *Belanger* tradition, a Sasak hair-cleansing ritual utilizing natural ingredients such as coconut milk, hibiscus leaves, and kaffir lime. Employing a qualitative ethnochemical approach, data were collected through in-depth interviews, participatory observation, and documentation at three sites in Lombok. The findings reveal that *Belanger* transcends mere physical hair treatment; it embodies a holistic practice of physical and spiritual purification, reinforced by its socio-cultural role in strengthening community bonds and intergenerational knowledge transmission. Scientific analysis demonstrates that the selected ingredients possess bioactive properties with clear ethnochemical rationales. Coconut milk, rich in lauric acid, provides conditioning and antimicrobial benefits. Kaffir lime offers essential oils and flavonoids with antifungal and antioxidant activities, while hibiscus leaves contribute natural saponins for gentle cleansing. The traditional practice of roasting coconut further enhances its adsorptive capacity through mild pyrolysis. Environmentally, the tradition exemplifies a sustainable model, as all materials are biodegradable and locally sourced, in contrast to the persistent chemical waste associated with synthetic shampoos. Thus, this research concludes that *Belanger* represents a significant convergence of indigenous wisdom and empirical science. It serves not only as a cultural heritage but also as a viable case study for sustainable cosmetic practices and context-based science education, highlighting the relevance of local knowledge in contemporary discourses on health, ecology, and cultural preservation.

Keywords: *Belanger*; Ethnochemistry; Indigenous Knowledge; Sasak Tradition; Sustainable Cosmetics.

Introduction

Indonesia is renowned for its remarkable cultural plurality, encompassing a vast spectrum of religions, ethnicities, languages, and traditional customs. This profound diversity constitutes a defining national characteristic, harmonized under the national motto, *Bhinneka Tunggal Ika* (Unity in Diversity). Scholarly accounts, such as the work of anthropologist Melalatoa cited by [1], document that the archipelago is home to more than 500 distinct ethnic groups dispersed across approximately 17,000 islands, each possessing and nurturing unique cultural practices.

One fundamental element of culture is tradition. Traditions are cultural practices preserved and transmitted intergenerationally, originating from ancestral wisdom. In Indonesia, traditions are not merely relics of the past but constitute a vital part of the collective national identity, embodying core values that guide community life. The specific manifestations of tradition vary across communities, shaped by distinct social, environmental, and cultural contexts. As an integral component of both culture and the social environment, tradition exerts a significant influence on societal dynamics, including, as noted by [2], the character formation of adolescents.

In a scientific context, traditional practices such as *Belanger* can be analyzed through an ethnochemical lens, a field that examines the intersection of cultural practices and their underlying chemical principles. The natural ingredients utilized in this tradition possess distinct chemical compositions that contribute to hair and scalp health. For instance, coconut oil, a staple in various hair care regimens, is renowned for its efficacy in repairing damaged hair. Derived from coconut kernels, this oil is rich in medium-chain fatty acids, primarily lauric acid, along with capric, oleic, and linoleic acids. These compounds confer antimicrobial, antifungal, and antiviral properties, which are vital for maintaining a healthy scalp environment [3]. Similarly, kaffir lime leaves contain essential oils known for their antimicrobial activity and characteristic fresh aroma. Consequently, the *Belanger* tradition represents a profound convergence of indigenous wisdom and empirical scientific principles, sustained intergenerationally often as tacit knowledge.

This study aims to explore in depth the inherent chemical values within the *Belanger* tradition and to elucidate its socio-cultural significance. Beyond its contribution to preserving Sasak cultural heritage, this research seeks to demonstrate that the traditional practices of local communities possess a substantive scientific foundation and can serve as a valuable resource for education in modern ethnochemistry. Accordingly, the specific objectives of this article are: (1) to describe the meaning and purpose of the *Belanger* tradition for the Sasak people of

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Lombok; (2) to identify the processes, materials, and tools employed in the tradition; and (3) to analyze the ethnoscientific values embedded in the *Belanger* practice.

Research Method

This study employed a descriptive qualitative approach, which is designed to describe and interpret a phenomenon based on data obtained directly from the community within its natural setting [4]. Qualitative data analysis involves the systematic process of searching for, organizing, and interpreting data gathered from in-depth interviews, participatory observation, and documentation to build a coherent understanding that can be communicated effectively [5]. The research was conducted at three sites in Lombok: the urban area of Sekarbela (Mataram City), Repok Village (Masbagik, East Lombok Regency), and Ketare Village (Pujut, Central Lombok Regency). These sites were selected purposively based on the criterion that they host communities where knowledge and practice of the *Belanger* tradition remain active. Fieldwork was carried out over a one-month period in October 2025.

Data were gathered utilizing three primary techniques: in-depth interviews, participatory observation, and documentation. In-depth interviews were conducted with three key informants, purposively selected based on their recognized expertise and generational knowledge of the *Belanger* tradition. A semi-structured interview guide was employed, focusing on several core themes: the historical background of the tradition, the detailed implementation process, the specific materials and their preparation, and the perceived socio-cultural and spiritual significance.

Participatory observation was conducted to gather firsthand experience and visual data on the procurement, preparation, and application of natural ingredients, including coconut milk, hibiscus leaves, and kaffir lime. Furthermore, documentation techniques, comprising photographic records and audio-visual recordings of the process, were employed to triangulate and corroborate the data obtained from interviews and observations, thereby enhancing the robustness of the findings.

The collected data were analyzed following a systematic thematic analysis procedure. The process involved several iterative stages: (1) transcription and familiarization with the data corpus; (2) initial coding of significant statements from interviews, field notes, and documents; (3) grouping codes into preliminary categories based on similarities; (4) developing and refining these categories into overarching themes that capture the core processes, materials, and socio-cultural values of the *Belanger* tradition; and (5) constructing a coherent narrative explanation.

To ensure the trustworthiness of the analysis, method triangulation (comparing data from interviews, observations, and documents) was rigorously applied. Furthermore, a member-checking procedure was conducted, whereby preliminary findings and interpretations were presented to key informants to verify the factual accuracy and appropriateness of the cultural interpretations. This analytical approach ensures that the research results provide a valid, nuanced, and comprehensive representation of the tradition.

Results and Discussion

The primary findings from in-depth interviews with three key informants regarding the *Bekejames* or *Belanger* tradition yield a profound understanding of its meaning, process, and underlying philosophical values. The analysis reveals that this tradition transcends a mere hygienic or cosmetic activity of hair treatment using natural ingredients such as roasted coconut, candlenuts, and flowers. It embodies a profound spiritual symbolism deeply rooted in the Sasak worldview.

Informants consistently described *Belanger* as a ritual of holistic purification, encompassing both physical and spiritual aspects. Within this cultural framework, hair is perceived not merely as a biological feature but as a body part that accumulates various energies and life experiences, including negative residues. The ritualistic cleansing process is thus intended to facilitate the release of these burdens and impurities, preparing the individual to embark on a new life phase with clarity and purity.

Furthermore, each natural element employed in the ritual carries a specific symbolic meaning. Water, kaffir lime, hibiscus leaves, and grated coconut collectively symbolize purity, spiritual balance, and the maintenance of a harmonious relationship between humans, nature, and the divine. This indigenous philosophy underscores the Sasak principle of maintaining inner and outer cleanliness as a fundamental prerequisite for a life of peace (*slamet*) and divine blessing.

The ingredients used in the *Belanger* tradition are figures 1, 2 and 3.

Figure 1. Coconut (*Cocos nucifera*)

Figure 2. Kaffir Lime (*Citrus hystrix*)

Figure 3. Hibiscus Leaves

The *Belanger* ritual is traditionally performed during significant life transitions and communal events, serving as a rite of passage. Key occasions include pre-wedding preparations, post-illness recovery, and the days leading up to major religious observances. The ritual is predominantly conducted in the morning, aligning with culturally auspicious days, notably Wednesdays and Fridays or integrated into larger ceremonial cycles such as the *pedak api* (a traditional fire ceremony).

The choice of location is intrinsic to the ritual's meaning. It is typically held in natural settings considered sacred, such as springs, clear rivers, or lakes. These sites are selected based on the indigenous belief that flowing or pristine water possesses an inherent purifying power (toya urip, or living water) and conveys natural blessings. Furthermore, water in this context symbolizes the source of life and continuity, thereby deepening the ritual's objective of spiritual and physical renewal.

The *Belanger* ritual follows a structured sequence, each stage imbued with specific intent. It commences with the sprinkling of floral-infused water (*air bunga*) over the hair, an initial act symbolizing purification and the invocation of positive essence. Subsequently, the hair is washed and meticulously massaged with a prepared concoction, typically made from crushed hibiscus leaves or kaffir lime. This step is described as crucial for cleansing the scalp and imparting a characteristic freshness.

Furthermore, informants detailed a key restorative phase involving the application of coconut milk. Grated coconut is first roasted to intensify its properties, then squeezed to yield a thick, nutrient-rich emulsion. This coconut milk is applied generously to the hair and left to absorb for a duration, allowing its nourishing compounds to penetrate the hair shaft. The entire process is ideally conducted under the morning sun, facilitating natural drying, which is believed to enhance the treatment's efficacy. The ritual culminates with the gentle combing of the hair, which serves to remove any residual ingredients while leaving the hair smooth, fragrant, and symbolically unburdened.

A pivotal spiritual component of the *Belanger* ritual is the recitation of a dedicated prayer or *mantra*. These incantations, which may vary in specific form across different Sasak villages, are universally intended to invoke safety (*selamat*), purification (*bersih*), and divine blessings (*berkah*) for the individual's life journey. The core meaning remains consistent: to spiritually cleanse the practitioner of all impurities and to welcome a new life phase with a purified heart and mind.

One example provided by an informant is the following *mantra*:

" Bismillahirrahmanirrahim jarang putih pinggir gunung, sembilan rampih daun manggil, walaupun banyak gadis manis, hanya aku macam dewi rengganis."

This *mantra* integrates Islamic invocation (*Bismillah*) with deep-rooted indigenous imagery of purity (the white mountain peak), spiritual calling (the nine leaves), and idealized beauty (the Javanese mythological figure Dewi Rengganis). It is believed that recitation channels positive energy, thereby radiating inner purity and beauty qualities deemed essential for the individual's renewal from within.

The knowledge system underlying the *Belanger* tradition is sustained through intergenerational transmission, primarily facilitated by family elders and respected community figures. This pedagogical process relies on oral instruction and experiential learning via direct participation in rituals, ensuring the preservation of both procedural knowledge and the associated cultural values within Sasak society.

However, informants consistently highlighted significant transformations in the tradition's contemporary practice. While historically performed as a sacred, multi-stage ritual with complete ceremonial implements, *Belanger* has undergone a process of simplification and, in some cases, attrition. Many individuals now perform only the core material application, such as applying coconut milk, often decontextualized from its original ritual framework. A decline in the frequency of practice was also noted, attributed primarily to the dual pressures of modernization and the diminishing engagement of the younger generation with customary practices perceived as time-consuming or less relevant to modern life.

Ecological Dimension and Sustainability

From an ecological standpoint, the *Belanger* tradition exemplifies a sustainable practice with an inherently low environmental footprint. The ritual exclusively utilizes biodegradable and locally sourced ingredients, water, coconuts, flowers, and leaves, generating no hazardous chemical waste. This aspect of the tradition embeds an implicit environmental ethic, as the community is concomitantly taught to protect clean water sources and utilize natural resources judiciously. This embedded ecological wisdom highlights a core principle of Sasak local knowledge: maintaining a harmonious and reciprocal relationship (*keseimbangan*) between humans and their natural environment. The tradition, therefore, operates not merely as a personal care ritual but as a cultural mechanism that reinforces sustainable resource management and environmental stewardship within the community's value system.

The findings of this study demonstrate that the *Belanger* tradition embodies a profound synthesis of indigenous knowledge and empirically supported scientific principles. This ritual practice transcends its immediate function as a hair treatment, serving as a holistic system that integrates chemical, biological, socio-cultural, and environmental dimensions. As such, *Belanger* presents a compelling case study for culture-based science learning (*ethnoscience*), where local cultural practices provide a meaningful context for understanding universal scientific concepts

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Chemical Aspects

From a chemical perspective, the preparatory step of roasting grated coconut is a critical, non-random procedure with distinct physicochemical objectives. The application of heat initiates a mild pyrolysis process, converting a portion of the coconut's triglycerides into simpler carbon compounds and generating activated carbon with a microporous structure. This significantly enhances the material's adsorption capacity, enabling it to effectively bind and remove excess sebum, environmental pollutants, and chemical residues from the hair and scalp [6]. Concurrently, the thermal treatment is reported to increase the concentration of phenolic compounds and antioxidants, which may help protect hair keratin from oxidative stress [7].

Crucially, this process does not negate the key beneficial properties of the coconut. The abundant medium-chain fatty acids, predominantly lauric acid ($C_{12}H_{24}O_2$), remain active and function as potent natural antimicrobial and antifungal agents, thereby contributing to scalp health by

inhibiting microorganisms associated with dandruff and irritation. Thus, the Sasak practice of roasting aligns with a sophisticated understanding of material transformation, optimizing the coconut for both cleansing (via adsorption) and bioactive (via antimicrobial and antioxidant activity) functions.

The efficacy of coconut milk in the *Belanger* ritual is substantiated by its distinctive biochemical profile and documented cosmeceutical benefits. Chemically, coconut milk is notably rich in medium-chain fatty acids, with lauric acid constituting its predominant lipid component approximately 47.1% of its total fatty acid content [8]. When applied topically, this lipid fraction demonstrates a remarkable affinity for hair keratin. Research in cosmetic science has shown that coconut oil, due to its low molecular weight and straight-chain structure, can effectively penetrate the hair shaft, reduce protein loss during washing and grooming, and provide superior moisturization compared to other oils [9]. Therefore, within the *Belanger* practice, coconut milk functions not merely as a symbolic element but as a bioactive agent that genuinely nourishes, strengthens, and improves the condition of the hair, thereby supporting overall scalp health.

The beneficial properties of coconut milk extend to its starchy component, which serves as a nutrient-dense treatment for hair and scalp health. This starch contains calories, fats, proteins, and minerals like calcium, which collectively contribute to softening and nourishing hair, and may even help mitigate the appearance of premature greying. Its primary function is to provide intense hydration, moisturizing both the scalp and hair strands, thereby improving overall hair vitality. Due to these emollient and nutritive qualities, coconut milk starch is widely recognized in cosmetic applications, particularly as a key ingredient in natural hair masks used for restorative care, such as after chemical straightening treatments like rebonding [10]. This is supported by the compositional analysis of [11], who note that coconut milk is "rich in nutritious oils, healthy fats, and proteins that are very good for hair follicles." The application of coconut milk starch in hair masks is thus validated for its efficacy in nourishing, moisturizing, and improving hair condition, which can create a healthier environment conducive to hair growth.

Furthermore, the *Belanger* process incorporates botanical ingredients with recognized bioactive properties, notably kaffir lime (*Citrus hystrix*), which is traditionally employed as a dandruff remedy. The peel of kaffir lime is rich in volatile essential oils, primarily composed of limonene and citronellal, which have demonstrated potent antifungal activity against scalp pathogens such as *Malassezia* spp. [12]. Beyond its essential oils, kaffir lime contains a spectrum of secondary metabolites, including flavonoids and saponins. Notably, the flavonoid hesperidin is present, a compound scientifically validated for its anti-inflammatory and antioxidant activities, as well as its ability to inhibit prostaglandin synthesis, which can soothe scalp irritation [13]. Thus, the inclusion of kaffir lime in the *Belanger* ritual aligns with an ethnopharmacological rationale, addressing both the microbial and inflammatory components often associated with dandruff and scalp discomfort.

Beyond its dandruff-remedying properties, kaffir lime (*Citrus hystrix*) serves multiple functions in hair and scalp care within the *Belanger* tradition. The acidic juice of the fruit acts as a clarifying agent and natural shampoo, effectively removing residual oils and unpleasant odors from the hair and scalp, thereby imparting a sense of freshness [14]. Moreover, when used as a hair tonic, its juice is believed to help strengthen the hair root and prevent hair loss. The leaves employed in the ritual are equally significant, containing essential oils predominantly limonene and citral that contribute to antimicrobial activity against the scalp microbiota, while providing the characteristic refreshing aroma integral to the sensory experience of the ritual. Intriguingly, the bioactive portfolio of kaffir lime extends beyond cosmeceutical uses. Research indicates that its leaves contain a complex of compounds, including flavonoids, saponins, and terpenes, which have demonstrated efficacy as biolarvicides [15]. This broad-spectrum bioactivity underscores the plant's potent chemical ecology and highlights the depth of indigenous knowledge in selecting a multifunctional ingredient that addresses hygiene, scent, and potential scalp parasites within a single traditional practice.

In addition, the *Belanger* ritual incorporates hibiscus leaves (*Hibiscus tiliaceus*), a selection grounded in their distinctive phytochemical profile. These leaves are notably rich in saponins, flavonoids, and tannins, which collectively provide a synergistic action for hair and scalp care. Saponins function as natural surfactants, producing a gentle, cleansing lather that effectively removes dirt and excess sebum without stripping the scalp's natural oils or causing irritation, a property not commonly found in other locally available leaves [16]. Concurrently, flavonoids offer antioxidant protection, safeguarding hair follicles and scalp tissue from oxidative stress induced by free radicals. The tannins present contribute astringent and antimicrobial properties, which help to tighten the scalp's pores, reduce excess oiliness, alleviate itching, and combat microbial activity associated with dandruff [17]. Therefore, the use of *Hibiscus tiliaceus* is not arbitrary but represents a purposeful selection based on an implicit understanding of its multifunctional phytochemistry for holistic hair cleansing, conditioning, and scalp health maintenance.

Collectively, the chemical properties of these natural ingredients, coconut, kaffir lime, and hibiscus, underscore the tradition's inherent environmental sustainability and its alignment with green cosmetic principles. Unlike many synthetic shampoos, which often contain persistent chemicals like silicones and sulfates that can accumulate in the environment, the organic compounds in the *Belanger* ingredients are fully biodegradable. They break down into harmless substances through natural biological processes, leaving no long-term ecological footprint. Moreover, this biodegradability does not come at the cost of efficacy. As demonstrated, each plant-based component offers targeted, multifunctional benefits for hair and scalp health, ranging from cleansing and conditioning to antimicrobial and antioxidant protection. Therefore, the *Belanger* tradition exemplifies a sustainable, closed-loop system where the "waste" from the ritual effectively nourishes the local ecosystem while the treatment itself nourishes the individual, presenting a holistic model of wellness that integrates personal care with environmental stewardship.

In summary, the *Belanger* tradition provides a tangible, culturally rich context for core concepts in chemistry. The materials and processes can be systematically analyzed through the lens of organic chemistry, exemplified by carbon-based compounds such as medium-chain triglycerides (fats) in coconut, terpenoids (essential oils) in kaffir lime, and phenolic compounds (flavonoids, tannins) in hibiscus leaves, all of which undergo controlled thermal transformations (e.g., roasting). Furthermore, the practice illustrates principles of physical chemistry, particularly in the formation of stable oil-in-water emulsions (such as coconut milk with aqueous extracts) and the manipulation of pH for cleansing and scalp health (via the acidic juice of kaffir lime). These connections are synthesized in Table 1, which maps specific ritual elements to their corresponding chemical concepts and learning outcomes, thereby framing *Belanger* as a viable and engaging resource for context-based chemistry education. The roasting of coconut in the *Belanger* tradition is a critical step that induces a controlled thermal transformation, best understood through the principles of pyrolysis and the Maillard reaction. When grated coconut is heated directly over a flame, it undergoes mild pyrolysis, a thermal decomposition of organic material in a limited-oxygen environment. This process does not lead to complete combustion but rather generates new volatile, low-molecular-weight compounds, including aromatic hydrocarbons and phenols, which contribute to the characteristic smoky and nutty aroma of the roasted coconut [8]. The ethnoscientific analysis of the primary *Belanger* materials, synthesizing their traditional use, bioactive components, and scientific basis, is comprehensively summarized in Table 1.

Table 1. Correspondence between *Belanger* ritual elements, their chemical and biological properties, and potential science education concepts.

Material	Bioactive Components	Traditional Function/ Belief	Scientific Rationale / Mechanism	Relevant Chemistry / Biology Concept
Coconut (*Cocos nucifera*) – Milk	Medium-chain triglycerides (Lauric acid C12:0, Capric acid C10:0), Proteins.	Nourishes and strengthens hair; acts as a conditioner.	Forms a protective lipid layer on the hair cuticle, reducing protein loss; lauric acid has antimicrobial properties.	Organic Chemistry (Lipids), Emulsion Science, Antimicrobial Activity.
Coconut - Roasted	Activated carbon (from mild pyrolysis), modified lipids and proteins.	Enhances cleansing power and imparts a purifying, aromatic smoke.	Pyrolysis creates a microporous structure with high adsorption capacity for dirt/oil; the Maillard reaction generates aromatic compounds.	Thermal Decomposition (Pyrolysis), Adsorption, Organic Synthesis (Maillard Reaction).
Kaffir Lime (*Citrus hystrix*) - Fruit/Juice	Citric acid, Ascorbic acid (Vitamin C), Flavonoids (e.g., Hesperidin).	Cleanses scalp, removes odor, freshens, and prevents hair loss.	Low pH helps cleanse scalp; antioxidants protect follicles; astringent properties may tighten pores.	Acid-Base Chemistry, Antioxidant Biochemistry, Plant Secondary Metabolites.
Kaffir Lime - Leaves	Essential oils (Limonene, Citral), Flavonoids, Saponins.	Provides fragrance and antimicrobial protection for the scalp.	Limonene and citral exhibit antifungal/antibacterial activity (e.g., against *Malassezia* spp.).	Volatile Organic Compounds, Phytochemistry, Microbiology.
Hibiscus Leaves (*Hibiscus tiliaceus*)	Saponins, Flavonoids, Tannins.	Produces cleansing lather, reduces dandruff and itchiness.	Saponins act as natural surfactants, while tannins possess astringent and antimicrobial properties.	Natural Surfactants, Phenolic Compounds (Tannins), Colloid Science.
Flower Water (*Air Bunga*)	Aqueous extract of volatile compounds from various flowers.	Symbolic initial purification and invocation of positive essence.	Provides a mild aromatic and potentially slightly antiseptic initial rinse.	Solutions, Aromatherapy Principles, Solubility.

Simultaneously, the application of heat facilitates the Maillard reaction, a non-enzymatic browning reaction between amino acids (from proteins) and reducing sugars present in the coconut. This reaction is responsible for the formation of a complex array of heterocyclic aromatic compounds (e.g., pyrazines, furans), which significantly enhance the depth and richness of the aroma profile. These newly formed volatile compounds infuse the coconut meat and subsequently blend into the extracted milk during the pressing process.

From a functional perspective, this thermal treatment also modifies the physicochemical properties of the coconut's constituents. The denaturation of proteins can enhance their role as natural emulsifiers, potentially improving the stability of the oil-in-water emulsion in the resulting coconut milk. Furthermore, mild pyrolysis can increase the adsorptive capacity of the coconut matrix by creating a microporous, charcoal-like structure, which may enhance its efficacy in binding to and removing impurities from the hair and scalp during the ritual. Thus, the roasting process is not merely for aroma; it is a deliberate, knowledge-based practice that optimizes both the sensory appeal and the cleansing efficacy of the primary ingredient.

Biological Aspects

From a biological and physiological standpoint, the *Belanger* tradition directly engages with the health and homeostasis of the hair and scalp ecosystem. Structurally, hair is primarily composed of keratin, a structural protein vulnerable to damage from environmental and chemical stress. The application of lipid-rich coconut milk and plant extracts functions as a natural conditioner that helps to seal the hair cuticle, reduce protein loss, and maintain keratin integrity, thereby improving hair strength and elasticity [18]. The ritualistic scalp massage is not merely a customary gesture; it serves a vital biological function. This mechanical stimulation enhances local blood circulation (hyperemia) around the hair follicles (Papilla), improving the delivery of oxygen and essential nutrients while promoting the removal of metabolic waste. This process can create a more favorable microenvironment for hair health and is coupled with a neurophysiological response that induces relaxation, reducing stress, a known contributor to hair problems [19].

Furthermore, the deliberate practice of drying the hair under the morning sun integrates an environmental factor with a biological benefit. The warmth facilitates the natural evaporation of moisture, preventing a damp scalp environment conducive to fungal growth. Concurrently, exposure to mild ultraviolet (UV) radiation in sunlight can have a mild antimicrobial effect on the scalp surface, helping to regulate the microbiota [20]. Thus, each stage of the *Belanger* ritual demonstrates a synergistic alignment with biological principles aimed at preserving scalp health and hair vitality.

The *Belanger* tradition also incorporates elements that address microbial ecology and psychosomatic well-being. From a microbiological standpoint, the bioactive compounds in its ingredients, such as the essential oils (e.g., limonene, citral) in kaffir lime and the antimicrobial fatty acids (e.g., lauric acid) in coconut, create an environment on the scalp that can inhibit the proliferation of commensal and pathogenic microorganisms. This includes fungi like *Malassezia globosa*, a primary agent associated with dandruff, and bacteria that contribute to unpleasant scalp odors, thereby promoting a healthier scalp microbiome [21].

Beyond physical and microbial effects, the ritual's spiritual component exerts a significant psychophysiological influence. The recitation of dedicated prayers or *mantras* during the process is not merely symbolic; it can induce a meditative state, lowering cortisol levels (the primary stress hormone) and reducing psychological stress. This reduction in stress is physiologically beneficial for hair health, as chronic stress is a known risk factor for conditions like telogen effluvium (temporary hair loss). Furthermore, this practice reinforces the participant's cognitive and emotional engagement with the ritual's core purpose of inner purification, creating a powerful mind-body connection that enhances the overall efficacy and meaning of the tradition [22].

Socio-Cultural Dimensions

The *Belanger* tradition functions as a vital socio-cultural institution, embedding and transmitting core values of community, ancestral wisdom, and environmental-spiritual harmony. Its practice is inherently collective, typically involving family or community members. This collaborative execution fosters social cohesion, mutual cooperation (*gotong royong*), and reinforces intergenerational bonds, thereby strengthening the social fabric of Sasak society. Fundamentally, *Belanger* serves as a dynamic medium for cultural reproduction. The ritual provides a structured context in which elders (*sesepuh*) actively transmit tacit knowledge, encompassing procedural skills, the symbolic meanings of ingredients and actions, and accompanying prayers or mantras, to the younger generation. This ensures the continuity of intangible cultural heritage beyond mere technical knowledge.

Comparative Environmental Impact: Synthetic Shampoo vs. *Belanger* Ingredients. A critical environmental advantage of the *Belanger* tradition lies in the stark contrast between its waste profile and that of conventional synthetic shampoos. Wastewater from synthetic shampoos is typically laden with persistent surfactants, such as Sodium Lauryl Sulfate (SLS) and linear alkylbenzene sulfonate (LAS). These compounds are recalcitrant to biodegradation, leading to elevated levels of Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) in water bodies, key indicators of organic pollution that deplete dissolved oxygen and harm aquatic life. Empirical data indicate that domestic wastewater containing such surfactants averages a COD of 250–400 mg/L and a BOD of 150–250 mg/L, significantly exceeding the regulatory limits for domestic effluent (maximum COD 100 mg/L and BOD 30 mg/L) as stipulated in Indonesia's Ministerial Regulation No. 11 of 2025 [23].

Conversely, the "waste" generated from *Belanger*'s natural ingredients is inherently biocompatible and circular. Residual materials from kaffir lime retain valuable flavonoids and dietary fiber, which can be repurposed into functional foods or compost [24]. Hibiscus leaves, with their natural saponins, produce a cleansing foam that does not significantly contribute to COD/BOD loads [25]. Coconut milk residues consist of biodegradable vegetable oils and proteins [25], while the spent roasted coconut can be viewed as a form of natural activated carbon with potential applications as an adsorbent for water purification [6]. Therefore, while synthetic shampoo waste poses a documented risk of persistent aquatic pollution, the by-products of the *Belanger* tradition are not only readily assimilated by the environment but also hold potential secondary utility, transitioning from "waste" to "resource" within a local ecological framework.

Conclusion

This study concludes that the *Belanger* tradition of the Sasak people represents a sophisticated, integrated system of indigenous knowledge where cultural practice, empirical science, and environmental ethics converge. Through an ethnochemical and socio-cultural analysis, it is evident that *Belanger* is far more than a hair-cleansing ritual; it is a holistic rite of purification that encompasses physical, spiritual, and communal dimensions. The findings demonstrate that the natural ingredients, coconut, kaffir lime, and hibiscus leaves, are not arbitrarily chosen but are functionally validated by their chemical and biological properties. These include the conditioning and antimicrobial

action of lauric acid, the antifungal and antioxidant activities of essential oils and flavonoids, and the natural surfactant properties of saponins. These scientific rationales substantiate the tradition's efficacy in hair and scalp care. Furthermore, the ritual operates as a vital socio-cultural institution. It reinforces community bonds through collective practice, facilitates the intergenerational transmission of intangible cultural heritage, and embodies a local ecological philosophy based on sustainable resource use and spiritual reverence for nature. Crucially, from an environmental standpoint, *Belanger* presents a model of sustainable personal care. In contrast to synthetic alternatives, its fully biodegradable materials impose no toxic burden on ecosystems and align with the principles of a circular bio-economy. Therefore, this research affirms that *Belanger* is a significant repository of local wisdom with contemporary relevance. It offers valuable insights for the fields of ethnochemistry, green cosmetics, and culture-based science education. Preserving and studying such traditions is essential not only for cultural continuity but also for inspiring sustainable and holistic approaches to health and well-being in the modern world.

Author's Contribution

S. W. Al Idrus: Conceptualization, research design, ethnoscientific analysis of cultural and chemical. Rahmawati: field data collection, documentation of the Belanger tradition. Nurhidayatullah: ecological analysis, data validation

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