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Evaluating the Potential Impact of Oat-Based Skincare on Celiac Disease Patients with Compromised Skin Integrity

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Abstract

Oats, frequently incorporated into skincare formulations for their anti-inflammatory, moisturizing, and barrier-repairing properties, may present an overlooked risk to individuals with celiac disease, particularly when applied to compromised skin. Although pure oats are inherently gluten-free, the widespread contamination with gluten-containing grains like wheat, barley, or rye during agricultural and processing stages introduces the potential for gluten exposure through topical application. This raises important questions about whether gluten proteins, when applied to damaged skin, might penetrate the epidermal barrier and contribute to immune responses in genetically predisposed celiac patients, given that even minute amounts of gluten can trigger systemic symptoms. Emerging evidence suggests that transdermal absorption of gluten peptides through impaired skin integrity might bypass the gastrointestinal route, yet the precise mechanisms and clinical significance of this pathway remain poorly understood. The role of compromised skin in facilitating gluten absorption and the possible activation of $CD4^+$ T-cells, mimicking gastrointestinal pathways, warrants further investigation. Additionally, the ability of gluten peptides to reach deeper dermal layers and potentially enter the systemic circulation remains speculative, though theoretically possible in severely disrupted skin barriers. Without clinical and molecular studies to determine the risk of topical gluten exposure, particularly in celiac patients with skin injuries, there remains a potential for undetected immune activation and

subsequent adverse health outcomes in this sensitive population.

Keywords

Oat-Based Skincare, Anti-Inflammatory, Skin Barrier, Celiac Disease, Gluten Contamination, Compromised Skin, Transdermal Absorption, Gluten Peptides, Immune Activation, Gluten-Free Formulations, Topical Exposure Risks

1. Introduction

Oats have a long history of use in skincare, dating back to ancient Egypt and Rome, where oats were used in baths to soothe dry and irritated skin. Their modern reintroduction into dermatological formulations began in the 20th century, when studies confirmed their anti-inflammatory and barrier-restoring properties [1]. Specifically, colloidal oatmeal gained FDA approval as a skin protectant in 2003, solidifying its role in managing conditions such as atopic dermatitis, xerosis, and pruritus [2]. These therapeutic benefits are largely attributed to the unique bioactive compounds in oats, including avenanthramides and beta-glucans, which demonstrate anti-inflammatory, antioxidant, and skin-hydrating properties.

Despite the therapeutic advantages, the issue of gluten contamination in oats emerged with research, revealing high rates of cross-contamination during cultivation, transportation, and processing. A seminal study published in *The New England Journal of Medicine* in 1995 demonstrated that oats themselves do not contain gliadin, and that moderate oat consumption as part of a gluten-free diet is generally safe for most celiac patients. However, the study did not specifically address the risks associated with gluten contamination of oats from wheat, barley, or rye during processing [3]. This was later complicated when a 2008 study found that up to 75% of commercially available oats labeled as "gluten-free" contained gluten levels exceeding the FDA threshold of 20 parts per million (ppm) due to inadequate segregation during processing [4]. Such contamination poses significant risks for individuals with celiac disease, especially when oats are consumed or applied to compromised skin, potentially exposing the immune system to gluten peptides. These findings led to the development of rigorous gluten-free certification protocols within the food industry, including dedicated facilities, equipment, and batch testing to minimize contamination. However, similar measures have not been universally implemented in the skincare industry, leaving gaps in quality control and consumer protection.

Oats have become a staple ingredient in skincare, valued for their ability to soothe and protect the skin, particularly in products formulated for sensitive or irritated skin. Colloidal oatmeal, in particular, is widely used for its anti-inflammatory, antioxidant, and moisture-retaining properties, making it effective in managing conditions like eczema, psoriasis, and xerosis [1] [5]. These benefits, combined with oats' gentle nature, have made them a popular choice for topical

applications in both over-the-counter and prescription formulations. However, despite their widespread use, questions remain about the safety of topical oat-based products for individuals with celiac disease, a condition marked by an immune response to gluten.

Celiac disease is a chronic autoimmune disorder triggered by the ingestion of gluten, a protein found in wheat, barley, and rye. In individuals with this condition, even trace amounts of gluten can cause an immune reaction that leads to inflammation and damage of the small intestine. The immune response is primarily mediated by the activation of T-cells in response to gluten-derived peptides, which can have systemic effects, manifesting as gastrointestinal symptoms and other complications. Although oats are often considered "gluten-free", there is a substantial risk of cross-contamination with gluten-containing products [6] [7]. Given the strict dietary restrictions required to avoid gluten exposure, the potential for transdermal exposure via skincare products is a concern that has yet to be fully understood.

Transdermal exposure may be facilitated by the dermatological manifestations of celiac disease, such as dermatitis herpetiformis, which is marked by cutaneous inflammation and blistering. Compromised skin barrier integrity makes the epidermis more susceptible to environmental factors, including gluten peptides. Other conditions that impair the barrier, including atopic dermatitis and psoriasis, are also associated with celiac disease. As a result, individuals with celiac disease might face a higher risk of transdermal gluten exposure than the general population. This risk is further complicated by the use of topical oat-based products, which are often recommended for treating conditions of skin barrier dysfunction.

The Celiac Disease Foundation asserts that gluten cannot be absorbed transdermally, except through lip products, where absorption and subsequent ingestion are more likely [8]. For instance, one study demonstrated allergic sensitization to gluten following transdermal exposure in a mouse model, albeit with wheat rather than oats [9]. Another study found that hydrolyzed wheat protein could activate immune pathways and sensitize hypersensitivity reactions in mice upon transdermal exposure [10]. Further, The Cosmetic Ingredient Review (CIR) Expert Panel deemed that hydrolyzed wheat gluten and protein are safe for cosmetic use when formulated peptides are restricted to an average weight of 3500 Da or less [11]. While this restriction reduces the risk of skin penetration, the evidence still raises important questions about whether individuals with compromised skin barriers, such as those with celiac disease, might experience heightened sensitivity or immune responses.

This review aims to critically assess the potential risks associated with topical oat-based products, particularly in celiac patients with compromised skin integrity. We will explore the current evidence regarding transdermal absorption of gluten, the possibility of immune activation through damaged skin, and the implications for clinical practice and product safety. By addressing these issues, we hope to clarify the risks and provide guidance for dermatologists and manufacturers to better

protect individuals with celiac disease.

2. Review

2.1. Celiac Disease: Mechanism and Immune Response to Gluten

Celiac disease is a complex autoimmune disorder that arises from an abnormal immune response to gluten, a protein composite found in wheat, barley, and rye. The pathophysiology of celiac disease is multifactorial, involving a combination of genetic, environmental, and immune factors, with gluten serving as the primary environmental trigger. The hallmark of this disease is the inappropriate activation of the immune system following gluten ingestion, which primarily affects the small intestine. In genetically predisposed individuals, gluten peptides trigger a cascade of immune events that result in inflammation and damage to the intestinal mucosa, leading to villous atrophy and malabsorption [12]. Pathological findings manifest clinically as diarrhea, abdominal pain, and dermatitis, stemming from the immune system's inappropriate response to gluten.

Upon ingestion, gluten is partially digested into peptides, including gliadin, which is particularly problematic for individuals with celiac disease. Once in the small intestine, gliadin peptides are deamidated by the enzyme tissue transglutaminase (tTG), an enzymatic process that enhances their immunogenicity. These deamidated peptides are then presented by antigen-presenting cells (APCs) to $CD4^+$ T-cells in individuals who possess specific genetic markers: human leukocyte antigen DQ2 (HLA-DQ2) or HLA-DQ8. These HLA molecules play a crucial role in the presentation of gluten peptides to T-cells, and the presence of these markers is a necessary, though not sufficient, requirement for the development of celiac disease [12].

The interaction between gluten peptides and $CD4^+$ T-cells initiates a strong Th1-type immune response characterized by the release of pro-inflammatory cytokines such as interferon-gamma (IFN-γ) [12]. This leads to the recruitment of additional immune cells, amplifying the inflammatory response within the intestinal mucosa. The resulting chronic inflammation damages the villi—the finger-like projections that line the small intestine and are responsible for nutrient absorption—leading to the characteristic villous atrophy observed in celiac patients. Over time, this damage can cause malabsorption of essential nutrients, leading to symptoms such as diarrhea, weight loss, anemia, and fatigue [12]. The immune response to gluten involves various immune cells and generalized inflammatory mechanisms.

In addition to the cellular immune response, celiac disease is also associated with the production of antibodies. The most prominent of these are anti-tissue transglutaminase (anti-tTG) and anti-gliadin antibodies (AGA) [12]. Anti-tTG antibodies are the most sensitive and specific markers for celiac disease and are thought to contribute to the tissue damage in the small intestine. Anti-gliadin antibodies target the gliadin component of gluten and are often elevated in untreated celiac disease. Even though these antibodies can be detected through serological

testing, they are no longer used for diagnostic workup of celiac disease due to their low specificity, only being reserved for cases of *non-celiac* gluten sensitivity [12]. Overall, these antibodies permit targeted destruction of the intestinal mucosa, account for disease manifestations, and are useful diagnostic markers.

While the primary effects of celiac disease manifest in the gastrointestinal tract, the condition can also lead to systemic complications, known as extraintestinal manifestations. These can occur in various organ systems and may present with a wide range of symptoms, often making the disease more difficult to diagnose. A common extraintestinal manifestation is dermatitis herpetiformis, a blistering skin condition characterized by intensely itchy, raised lesions. This is considered a direct manifestation of gluten sensitivity and is thought to be caused by the deposition of IgA antibodies in the skin [12]. The pruritic nature of this dermatological condition may result in secondary excoriations, ulcerations, and irritation. Neurological complications, such as peripheral neuropathy and ataxia, have also been reported in celiac disease, possibly due to the immune response targeting neural tissues. Other extraintestinal effects may include liver dysfunction, bone disorders like osteoporosis, and reproductive issues such as infertility [12]. Multisystemic effects make celiac disease a particularly challenging condition for those affected.

The systemic nature of celiac disease underscores the importance of strictly adhering to a gluten-free diet, as even minimal exposure to gluten can trigger immune responses that extend beyond the gastrointestinal tract. For individuals with undiagnosed or untreated celiac disease, ongoing gluten exposure can lead to long-term complications, including an increased risk of certain cancers, such as enteropathy-associated T-cell lymphoma (EATL) [12]. These systemic effects highlight the broader implications of gluten sensitivity and the importance of careful management of gluten exposure, not only through diet but potentially through other routes of exposure, such as topical products that may contain gluten, although further research is needed to clarify the significance of this risk.

2.2. Oats in Skincare: Properties and Uses

Oats have long been utilized in skincare for their wide range of therapeutic benefits, making them a popular ingredient in formulations designed for sensitive and compromised skin. One of their key properties is their ability to function as a highly effective moisturizer [13]. Colloidal oatmeal, the finely milled form of oats commonly used in skincare products, creates a protective barrier on the skin that prevents moisture loss while also delivering water to the skin's outer layers [13]. This hydration not only soothes dry skin but also supports the maintenance of the skin's natural barrier function, which is essential for protecting against environmental irritants and pathogens.

Another significant property of oats is their potent anti-inflammatory effects, which have been well-documented in clinical settings. Oats contain various bioactive compounds, such as avenanthramides and beta-glucans, which have been

shown to reduce inflammation and alleviate itching [14]. Avenanthramides, in particular, exhibit antioxidant properties, helping to neutralize free radicals that can exacerbate skin irritation and inflammation. The ability of oats to calm inflammatory responses makes them especially beneficial for managing conditions such as eczema, where inflamed and itchy skin is a primary symptom. Additionally, beta-glucans enhance the skin's barrier repair mechanisms by promoting the regeneration of the skin's structural proteins and lipids, further contributing to the healing of damaged or irritated skin [15]. Actions of oats make them clinically advantageous in the management of inflammatory skin conditions.

Given these benefits, oat-based products are prevalent in formulations for individuals with sensitive skin, particularly in the treatment of various dermatological conditions. Skincare products containing oats are frequently recommended for conditions like atopic dermatitis, psoriasis, and xerosis (*i.e.*, dry skin), where maintaining the integrity of the skin barrier is critical. For instance, colloidal oatmeal is often incorporated into moisturizers, cleansers, and bath products to provide relief from itching and inflammation associated with eczema flares [13]. Similarly, its soothing properties make it an excellent choice for managing the symptoms of psoriasis, where inflammation and scaling are prominent [14]. Oats are also considered suitable for use in pediatric dermatology, as their gentle nature makes them safe for infants and young children with sensitive or reactive skin. They are also suggested as a safe, cost-effective alternative for the treatment of mild-to-moderate atopic dermatitis in children [16], including African American children [17]. Beyond their fast-acting clinical improvement of active symptoms, clinical trials have also demonstrated that oat-based emollients could be safely applied in children as maintenance therapy, leading to fewer symptom flare-ups [18]. Thus, in clinical practice, oat-based formulations are often favored for their efficacy and tolerability in a wide range of dermatological conditions and patient populations.

Despite the benefits of oats, there is growing concern regarding the risk of gluten contamination in oat-based skincare products. Oats are naturally gluten-free, but they are frequently grown and processed alongside gluten-containing grains such as wheat, barley, and rye. This proximity during farming, harvesting, and processing can result in cross-contamination, where small amounts of gluten inadvertently enter oat supplies [19]. For individuals with celiac disease, even trace amounts of gluten can provoke an immune response, leading to potentially severe health consequences. Although most gluten-related reactions occur through ingestion, the possibility of transdermal absorption, when oats are applied to broken or damaged skin warrants further consideration, as more research is needed to clarify this risk for celiac patients [20]. The absence of gluten labeling on many skincare products further complicates the issue, as it leaves individuals with gluten sensitivities unsure of the safety of these formulations [19]. While oats remain a valuable ingredient in dermatology due to their therapeutic properties, the risk of gluten contamination necessitates greater scrutiny. Clear gluten-free labeling and

rigorous quality control during processing are essential to ensure that oat-based skincare products are safe for all users, particularly those with celiac disease.

The skincare industry frequently incorporates oats into products for their well-documented anti-inflammatory, moisturizing, and barrier-repairing properties. However, a critical issue that remains insufficiently addressed is gluten contamination during the processing of oats. While oats are naturally gluten-free, contamination with gluten-containing grains such as wheat, barley, or rye commonly occurs during cultivation, harvesting, transportation, and processing. This presents a potential risk for individuals with celiac disease or gluten sensitivity when using oat-based skincare products, particularly on compromised skin.

Within the food industry, rigorous protocols have been developed to produce certified gluten-free oats, including dedicated fields for cultivation, separate processing facilities, and thorough testing to ensure gluten content falls below 20 parts per million (ppm), the threshold recognized by the U.S. Food and Drug Administration (FDA) for labeling a product as gluten-free. However, the skincare industry often lacks comparable rigor. Many manufacturers of oat-based skincare products do not explicitly test for gluten contamination or label their products as gluten-free. This lack of standardization stems from the assumption that topical products pose minimal risk for systemic gluten exposure, an assumption increasingly challenged by emerging research on transdermal absorption through compromised skin.

Some brands have adopted gluten-free certification for their skincare products, primarily to cater to consumer demand rather than to meet regulatory requirements. These certifications typically involve third-party testing to verify the absence of gluten in raw materials and final formulations. However, the absence of universally mandated testing and labeling standards for gluten in topical products means that cross-contamination can easily go undetected. For example, oats sourced for skincare formulations may share processing equipment with gluten-containing grains, and without stringent segregation and testing protocols, contamination is almost inevitable.

The skincare industry's failure to uniformly address gluten contamination stems from several factors, including the lack of regulatory mandates, the perceived low risk of transdermal gluten absorption, and cost considerations. Unlike the food industry, where gluten-free labeling is tightly regulated, there is no consistent requirement for manufacturers to disclose gluten content in topical products. This gap leaves consumers—particularly those with celiac disease—without the information needed to make informed decisions. Moreover, the lack of research specifically evaluating the safety of gluten-contaminated skincare products exacerbates the challenge, as manufacturers often cite the absence of conclusive evidence to justify not testing for gluten contamination. Additionally, many skincare manufacturers prioritize cost-efficiency, sourcing oats from suppliers that do not specialize in gluten-free processing. The use of non-dedicated facilities and equipment for oats increases the risk of contamination. Without a financial or

regulatory incentive, manufacturers may not invest in gluten-free certification or adopt the rigorous quality control measures needed to ensure gluten-free status.

To enhance safety, the skincare industry must adopt stricter standards for gluten contamination in oat-based products. These should include sourcing oats exclusively from certified gluten-free suppliers, implementing dedicated processing lines to prevent cross-contamination, and conducting routine testing for gluten at multiple stages of production. Regulatory agencies could play a key role by extending gluten-free labeling requirements to topical products, creating a standardized framework that ensures consumer protection. Furthermore, increased investment in research to evaluate the potential for transdermal gluten absorption in compromised skin could provide the evidence needed to drive these changes. Until these measures are widely adopted, individuals with celiac disease or gluten sensitivity remain at potential risk, highlighting the need for cautious product recommendations by healthcare professionals. By addressing these shortcomings, the skincare industry can not only enhance product safety but also build trust with consumers seeking dermatological solutions tailored to their specific health needs.

2.3. Potential Routes of Gluten Exposure through Topical Application

As the body's largest organ, the skin is a crucial barrier against environmental insults, pathogens, and harmful substances. Under normal conditions, the skin's outermost layer, the stratum corneum, provides a protective shield by preventing the entry of foreign molecules, including allergens and toxins, while retaining moisture. This barrier function is maintained through a complex structure composed of tightly packed corneocytes (dead skin cells) embedded in a matrix of lipids, which acts as both a physical and biochemical barrier. Additionally, the skin's acid mantle, a thin film of sebum and sweat, further inhibits the growth of harmful microorganisms and prevents the penetration of irritants [20]. Together, these elements form a robust defense system that typically prevents large molecules, such as gluten peptides, from penetrating the deeper layers of the skin and entering systemic circulation.

However, in certain dermatological conditions, the integrity of the skin barrier can become compromised, significantly increasing its permeability. In conditions such as eczema (atopic dermatitis), psoriasis, and various types of wounds, the lipid matrix of the stratum corneum is disrupted, and the corneocytes lose their organized structure [20]. This disruption leads to an impaired barrier that is more permeable to external substances, including allergens, chemicals, and microbes [20]. In eczema, for example, the skin becomes inflamed and cracked, allowing allergens and irritants to penetrate more easily, triggering immune responses that exacerbate the condition. Similarly, open wounds and erosions provide direct access for substances to enter the dermis, bypassing the normal protective layers [20]. This raises the question of whether gluten, when applied topically, could penetrate through broken skin and elicit an immune response in individuals with

celiac disease.

The possibility of transdermal absorption of gluten peptides through compromised skin remains a topic of debate. Gluten is a relatively large protein molecule; under normal circumstances, the skin's barrier is expected to prevent its penetration. However, in the context of damaged skin, some evidence suggests that larger molecules, including proteins, may bypass the stratum corneum and enter deeper layers of the skin, particularly when the barrier is impaired [20]. Research on transdermal drug delivery has demonstrated that compounds, including peptides, can be absorbed through broken or compromised skin, albeit at lower rates than oral or intravenous routes. This phenomenon has been recreated when lipids are removed from the stratum corneum with acetone, demonstrating increased transepidermal water loss and impaired epidermal barrier function [20]. In addition, many topical drug formulations aim to enhance the chemical penetration of this lipid barrier [20]. While no studies have definitively confirmed the transdermal absorption of gluten specifically, these findings raise the possibility that, under certain conditions, gluten peptides could penetrate the skin and interact with immune cells in the dermis.

On the other hand, some evidence argues against significant transdermal absorption of gluten. The majority of gluten exposure-related immune responses in celiac disease occur through the ingestion of gluten, where it interacts with the gastrointestinal tract. Studies exploring the penetration of allergens through the skin have generally focused on smaller molecules or those specifically designed for transdermal absorption. One study analyzed the transdermal absorption of deamidated and hydrolyzed gliadin, the main allergen in wheat, and found a severe allergic response in previously sensitized mice [21]. This demonstrates that when gluten peptides are prepared with peptide-bond hydrolysis and side chain deamidation, cutaneous sensitization is possible and thus a cause of allergic reactions [21]. Given gluten's relatively large size and the skin’s inherent protective mechanisms, some researchers remain skeptical that it could be absorbed in sufficient quantities to trigger a systemic response, even through damaged skin [11]. Additionally, the skin’s immune cells, such as Langerhans cells and macrophages, may degrade gluten peptides before interacting with T-cells, further reducing the likelihood of a systemic reaction.

Despite these uncertainties, the theoretical basis for immune activation through transdermal gluten exposure in celiac patients is rooted in the immune pathways that underlie the disease. In celiac disease, the ingestion of gluten leads to the deamidation of gluten peptides by tissue transglutaminase (tTG) in the gastrointestinal mucosa. These deamidated peptides are then presented by antigen-presenting cells (APCs) to $CD4^+$ T-cells, specifically in individuals with HLA-DQ2 or HLA-DQ8 genotypes, which are critical for the development of the autoimmune response [21]. This cascade produces pro-inflammatory cytokines and antibodies, leading to intestinal damage and systemic manifestations. Theoretically, if gluten peptides were to penetrate through damaged skin, they could interact with APCs

in the dermis, initiating a similar immune response.

Although the gastrointestinal tract is the primary site of gluten processing in celiac disease, the presence of immune cells capable of antigen presentation in the skin suggests that gluten peptides could, in theory, be recognized by the immune system. This is especially relevant in the context of dermatitis herpetiformis, a cutaneous manifestation of celiac disease where IgA antibodies against tTG and gluten accumulate in the skin, leading to blistering and inflammation. In patients with this condition, the cutaneous barrier is often impaired secondary to inflammation, skin lesion formation, and excoriations. These patients, then, are especially vulnerable to gluten peptide exposure from oat-based topical products [20] [21]. The occurrence of skin-specific immune responses in celiac disease raises the possibility that gluten exposure through damaged skin could activate immune pathways similar to those observed in the gut.

While the evidence for transdermal gluten absorption remains inconclusive, the possibility of immune activation through damaged skin in celiac patients cannot be entirely ruled out. Further research is needed to better understand the permeability of gluten peptides through compromised skin and to determine whether this could lead to clinically significant immune responses. For individuals with celiac disease, particularly those with existing skin conditions, this represents a potential risk that warrants careful consideration.

The potential for gluten contamination in skincare products extends beyond oat-based formulations, encompassing a variety of other ingredients derived from grains such as wheat, barley, and rye. Ingredients like hydrolyzed wheat protein, commonly used in moisturizers, shampoos, and conditioners for its conditioning properties, pose a similar risk of gluten exposure [22]. Studies have documented cases of contact urticaria and systemic allergic reactions linked to hydrolyzed wheat protein in individuals with gluten sensitivities. For example, a 2015 case series highlighted severe allergic reactions in patients exposed to personal care products containing hydrolyzed wheat protein (HWP). Patients experienced reactions such as urticaria and anaphylaxis after using HWP-containing products, often in combination with consuming wheat-containing foods, raising concerns about the safety of such ingredients for individuals with gluten-related disorders, including celiac disease [23]. Additionally, barley-derived ingredients like *Hordeum vulgare* extract, often incorporated into anti-aging products for their antioxidant properties, also carry a contamination risk [24]. These potential exposures emphasize the need for broader regulatory measures and consumer education regarding grain-derived components in skincare.

Beyond gluten, examining the transdermal absorption of other allergens and irritants could offer valuable insights into the risks associated with skincare products for sensitive populations. Allergens such as nickel, parabens, and formaldehyde-releasing preservatives are well-known for their potential to cause contact dermatitis through skin exposure. Research has shown that nickel, despite being a metal, can penetrate the skin barrier and elicit immune responses, especially in

individuals with nickel sensitivity [25]. Similarly, studies on parabens, commonly used as preservatives, indicate that they can penetrate the stratum corneum and enter systemic circulation, raising questions about their safety for long-term use [26]. These findings emphasize the importance of understanding the permeability of the skin barrier and the potential for systemic absorption of various compounds, particularly in individuals with compromised skin integrity.

A more comprehensive exploration of allergen and irritant absorption could also inform safety protocols for product development and labeling. For instance, while gluten contamination remains a significant concern for celiac patients, the skincare industry has yet to adopt stringent testing for other allergenic or irritant compounds. This gap not only leaves vulnerable populations at risk but also highlights a broader need for harmonized safety standards across the personal care industry. By expanding research to include a wider range of allergens and irritants, dermatologists and manufacturers can better assess the safety of skincare products and develop targeted recommendations for sensitive populations, yielding a more inclusive approach to dermatological care.

2.4. Current Evidence in the Literature

The potential for topical gluten exposure to trigger immune responses in individuals with celiac disease has sparked both interest and skepticism within the medical and scientific communities. Very few case reports and studies have explored the risks associated with gluten in skincare products [11] [21] [27] [28]. Thus, current evidence remains limited and sometimes conflicting. Although they may provide intriguing data points, these studies often lack rigorous controls or detailed exploration of whether gluten was definitively absorbed through the skin.

Studies or case reports that support the risk of gluten exposure via topical products generally highlight scenarios where the skin barrier is compromised, such as in eczema, burns, or open wounds. Some case studies have discussed patients who reported flare-ups of celiac-related symptoms following the use of gluten-containing personal care products. For example, a case study in Japan reported an allergic reaction to facial soap composed of hydrolyzed wheat protein (HWP), and in one case, the patient also noticed eyelid edema after consuming bread. Although this patient did not have a formal diagnosis of celiac disease, one can infer that she does have some degree of gluten sensitivity. The researchers then sampled the patient's blood for IgE antibodies and found that they reacted with polypeptides in an HWP preparation [11]. In addition, another case report described an individual with dermatitis herpetiformis who experienced worsening of celiac-related gastrointestinal systems and rash after using a gluten-containing body lotion [27]. These cases lend credence to the theory that gluten can exacerbate symptoms when the skin or skin barrier is compromised, though causality remains difficult to establish without more definitive evidence.

On the other hand, a body of research has questioned the likelihood of significant gluten absorption through intact or even damaged skin. One study examined

the molecular size of gluten peptides, noting that they are too large to easily penetrate the stratum corneum, even when the skin barrier is impaired [11]. In particular, research on transdermal drug delivery systems emphasizes that molecules larger than 500 daltons generally struggle to pass through the skin, and gluten far exceeds this size threshold [29]. Other studies have pointed to the role of proteolytic enzymes in the skin, which may degrade gluten peptides before they can reach immune-activating sites. The skin contains a variety of enzymes, including proteases, which are capable of breaking down proteins like gluten into smaller fragments. These fragments may then become less immunogenic, further decreasing the likelihood of triggering an immune response. One study analyzed the fact that peptide-bond hydrolysis and side-chain deamidation of the gliadin molecule are necessary for cutaneous sensitization [21]. While naturally occurring proteases in our skin, such as pepsin, can hydrolyze proteins, they cannot cause deamidation. Thus, gliadin is not able to cause a cutaneous allergic reaction without prior biochemical modification [21]. This collective body of evidence suggests that the structural and biochemical properties of gluten, combined with the protective mechanisms of skin, make significant absorption and subsequent immune activation through the skin more challenging and less probable.

In analyzing the available data, it becomes evident that the current body of evidence is inconclusive. Case reports and anecdotal evidence provide some support for the idea that gluten-containing topical products may aggravate symptoms in certain individuals, especially those with dermatitis herpetiformis [27] [28]. However, the small sample sizes and lack of rigorous study designs make it difficult to draw definitive conclusions. Additionally, the studies refuting transdermal gluten absorption present a strong argument based on molecular size and skin physiology [11] [21], though these findings do not fully account for cases where patients with damaged skin have reported adverse reactions.

The strength of the current evidence lies primarily in studies that explore the molecular limitations of gluten absorption and the protective mechanisms of the skin. However, given the few documented reports of adverse reactions, there is a clear need for more extensive, controlled studies to better understand the risks associated with topical gluten exposure. Future research should focus on both biochemical assays of gluten penetration through compromised skin and clinical studies involving larger cohorts of celiac patients to more definitively assess the risk. Until such data is available, the question of whether topical gluten exposure presents a tangible risk to individuals with celiac disease remains open to further investigation.

2.5. Clinical Implications for Celiac Patients Using Oat-Based Products

The use of oat-based skincare products presents unique risks for individuals with celiac disease, especially when these products are cross-contaminated with gluten during the manufacturing process [6] [7]. While oats themselves are gluten-free,

the potential for contamination with wheat, barley, or rye during harvesting, transport, or processing raises concerns about inadvertent gluten exposure. For celiac patients, who must adhere to a strict gluten-free diet to avoid triggering an autoimmune response, even minute amounts of gluten can lead to gastrointestinal symptoms, nutritional deficiencies, and systemic inflammation. In the context of skincare, gluten contamination may exacerbate symptoms if the skin barrier is compromised, permitting transdermal exposure, although this remains a controversial area of research.

For dermatologists treating celiac patients, it is crucial to consider the possibility of gluten exposure through topical products. Patients with celiac disease often suffer from associated skin conditions such as dermatitis herpetiformis, eczema, or psoriasis, which may require the use of moisturizers, emollients, and other skincare treatments [30]. Given that many of these products contain oats due to their soothing and anti-inflammatory properties, clinicians must be vigilant in selecting products that are certified gluten-free or have been rigorously tested for cross-contamination. Educating patients about the potential risks of gluten exposure through skincare is also important, particularly for those with sensitive or compromised skin, as they may be at greater risk for adverse reactions. Dermatologists should emphasize the importance of reading ingredient labels and seeking out brands that provide transparency regarding their production practices.

Labeling and regulatory oversight of gluten contamination in cosmetics and skincare products pose additional challenges for both clinicians and patients. Unlike food products, skincare and cosmetic items are not always required to list gluten content or contamination risks on their labels [31]. This makes it difficult for celiac patients to make informed choices when choosing products. Although some manufacturers voluntarily label their products as gluten-free, this practice is inconsistent, and there is currently no standardized testing or regulatory framework for ensuring gluten-free claims in the skincare industry. As a result, celiac patients may unknowingly be exposed to gluten through products labeled as safe for sensitive skin but not tested for gluten contamination [31]. This lack of regulation creates an added burden for patients who must navigate an already complex and restrictive gluten-free lifestyle.

To address these challenges, there is a clear need for more rigorous labeling standards and regulations for gluten in personal care products. A list of manufacturers would be a good starting place for practitioners when searching for gluten-free medications, and even provided links to some websites with information about the gluten content of medicines [32]. Advocacy from healthcare providers and patient organizations could push for changes in the skincare industry, encouraging manufacturers to adopt more transparent practices and implement stricter testing protocols. Dermatologists can play a key role in raising awareness of these issues among their patients and advocating for better labeling practices within the industry. Until more comprehensive regulations are in place, clinicians should guide celiac patients toward trusted brands known for gluten-free

certification and encourage them to communicate directly with manufacturers when in doubt.

The risk of gluten exposure through skincare products remains a critical area of ongoing research, due to the significant concern for cross-contamination in oat-based products for patients with celiac disease. Dermatologists must remain cognizant of these risks when recommending skincare treatments and should make efforts to educate their patients on the importance of selecting gluten-free products. Patients should be advised to carefully examine the ingredients listed on cosmetics for the words "wheat", "barley", "malt", "rye", "oat", "triticum vulgare", "hordeum vulgare", "secale cereale", and "avena sativa" [31]. Simultaneously, efforts should be made to improve labeling transparency and regulatory oversight to better protect this vulnerable population from inadvertent gluten exposure.

Individuals with celiac disease must exercise caution when selecting skincare products, particularly those containing oats. While these oat-based products are often highly regarded and widely endorsed by healthcare providers for the management of various inflammatory skin conditions in the general population, they pose potential risks for celiac patients. Given the possibility of gluten cross-contamination, dermatologists should carefully consider recommending these products to celiac patients, particularly in cases where the skin barrier is compromised. This concern is especially pertinent for individuals with conditions that compromise the skin barrier, such as those suffering from dermatitis herpetiformis, where gluten exposure through skincare products could potentially exacerbate symptoms, though more research is needed to confirm this risk. It is imperative for dermatologists to educate their patients on these risks, empowering them to make informed and safe decisions in their skincare regimens.

In clinical practice, oat-based formulations are often favored for their efficacy and tolerability in a wide range of dermatological conditions and patient populations. However, when managing patients with celiac disease or those suspected of gluten sensitivity, clinicians should exercise caution and take specific steps to mitigate potential risks. First, conduct a thorough patient history to determine if the individual has a confirmed diagnosis of celiac disease, known gluten sensitivity, or compromised skin barriers due to conditions such as eczema, psoriasis, or wounds. For these patients, recommend only skincare products that are explicitly labeled as gluten-free and have undergone independent third-party certification to verify the absence of gluten contamination.

When prescribing or recommending oat-based products, emphasize the importance of avoiding formulations that do not clearly state their gluten-free status, especially for use on damaged or inflamed skin. For high-risk patients, consider alternatives to oat-based products, such as formulations containing rice, quinoa, or flaxseed extracts, which can provide similar anti-inflammatory and barrier-repairing benefits without the risk of gluten exposure. Educate patients about the importance of reading ingredient labels and recognizing potential sources of gluten contamination, such as wheat derivatives, barley, or rye, often listed under unfamiliar names.

In cases where patients already use oat-based products without clear gluten-free labeling, monitor them for signs of cutaneous or systemic reactions that could indicate gluten exposure, such as localized irritation, rash, or gastrointestinal symptoms. For individuals with open wounds or severely compromised skin, advise against using any product with potential gluten contamination until the risk is better understood through ongoing research. By adopting these specific, actionable practices, clinicians can balance the benefits of oat-based formulations with the unique safety concerns of celiac patients, ensuring both efficacy and patient well-being.

2.6. Research Gaps and Future Directions

Despite increasing attention to the potential risks of gluten exposure through skincare products, significant gaps remain in our understanding of whether and how gluten peptides can be absorbed through compromised skin. To date, much of the concern surrounding topical gluten exposure is based on theoretical risks and anecdotal evidence, with limited clinical data to either confirm or refute these concerns. Well-designed clinical trials that specifically investigate transdermal gluten absorption in celiac patients are needed to determine the actual risk posed by contaminated skincare products. Additionally, molecular studies could help examine whether gluten peptides can penetrate the skin barrier, particularly in individuals with skin conditions like eczema or dermatitis herpetiformis that compromise barrier integrity.

Improving product safety for celiac patients represents a critical area for future development. Current regulations around gluten contamination in skincare products are minimal, and the absence of standardized gluten-free certification for cosmetics leaves celiac patients at risk. A dedicated certification system, similar to that used in the food industry, could provide patients and healthcare providers with more reliable information about the safety of topical products. Such an initiative would require collaboration between dermatologists, regulatory bodies, and the skincare industry to ensure accurate testing and labeling of gluten-free products.

Another promising avenue for future research lies in identifying biomarkers that could signal systemic responses to topical gluten exposure. Biomarkers such as specific antibodies or inflammatory markers may offer insights into whether transdermal gluten absorption is triggering immune responses in predisposed individuals. By developing reliable biomarkers, researchers could better assess the impact of topical gluten on celiac patients, guiding more precise recommendations for product safety and patient care. Addressing these research gaps is essential to safeguard the health of celiac patients in an environment where gluten exposure may occur beyond the gastrointestinal tract.

3. Conclusions

The potential risk of gluten exposure through topical oat-based skincare products in celiac disease patients, particularly when applied to compromised skin, warrants careful consideration. While gluten's primary mode of triggering an immune response is through ingestion, concerns arise about its potential absorption

through damaged skin, where the barrier function is impaired. Although current evidence remains inconclusive, the possibility of immune activation in predisposed individuals cannot be dismissed. Future studies should focus on controlled clinical trials involving celiac patients with and without impaired skin barriers to evaluate the extent of gluten peptide penetration and its potential systemic effects. These trials should incorporate advanced imaging techniques, such as fluorescence-tagged gluten peptides, to trace their penetration through the epidermis and dermis. Additionally, longitudinal studies could assess whether repeated topical exposure to gluten-containing products in predisposed individuals leads to measurable systemic immune responses or symptom exacerbation. Molecular research should aim to elucidate the mechanisms underlying transdermal gluten absorption and immune activation, particularly the role of $CD4^+$ T-cells and other antigen-presenting cells in initiating an inflammatory cascade. This could involve in vitro models using reconstructed human skin and co-culture systems with immune cells to replicate the interaction between gluten peptides and the skin's immune environment under different conditions.

To address current challenges, skincare manufacturers should establish standardized testing protocols for detecting gluten contamination in raw materials and finished products, with a focus on quantifying gluten levels and ensuring they fall below thresholds deemed safe for celiac patients. The industry should invest in the development of alternative formulations that provide the anti-inflammatory, barrier-repairing, and moisturizing benefits of oats using gluten-free botanical extracts or synthetic analogs with similar properties. Regulatory bodies should encourage or mandate gluten-free certification for topical products marketed to sensitive populations. Clear and standardized labeling guidelines must be implemented to differentiate products that are gluten-free from those that may pose a risk of cross-contamination.

From a clinical perspective, healthcare providers should develop evidence-based guidelines for recommending skincare products to celiac patients, particularly those with skin injuries or conditions compromising the epidermal barrier. Educational initiatives targeting clinicians, pharmacists, and consumers could further raise awareness about the potential risks of topical gluten exposure and promote informed decision-making. Collaborative efforts between researchers, manufacturers, and healthcare professionals are essential to bridge the current knowledge gaps. By conducting targeted research, improving product formulations, and enhancing public awareness, the skincare industry and medical community can ensure the safety and efficacy of products for celiac patients, even in the context of compromised skin integrity.

Authors' Contributions

Kelly Frasier conceptualized and drafted the manuscript. All authors wrote a section of the manuscript. Kelly Frasier provided critical revisions and contributed to the interpretation of emerging evidence related to gluten contamination in skincare products. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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