

# Feeding the Skin? Foods in Personal Care Products and the Risk of Allergy

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The interrupted skin barrier seen in atopic dermatitis (AD) increases exposure to environmental antigens including those in food, which contributes to the increased prevalence of food allergies in the AD population. This relationship is further explored in the dual allergen exposure hypothesis, which examines the differences in immune system response between cutaneous and oral exposures. It was previously thought that avoiding early oral exposure would decrease the likelihood of developing food allergy; however, several studies have demonstrated that earlier oral exposure increases tolerance. On the other hand, exposure to food antigens through the skin activates the helper T-cell 2 pathway, which promotes development of allergy. There have also been several studies demonstrating that aggressive treatment of AD decreases the risk of developing food allergies. Based on these findings, there is concern that inclusion of food-based ingredients in personal care products, such as moisturizers that act as main components of AD treatment regimens, may increase the likelihood of developing allergies to the included foods. However, there are many commonly used food-based ingredients that have low rates of allergy, which raises the question of why some antigens are more likely to result in allergic sensitization while many others remain benign. **KEYWORDS:** Atopic dermatitis, food allergy, dual allergen exposure hypothesis, food-based ingredients, personal care products

Many patients are impacted by allergic diseases, including atopic dermatitis (AD) and food allergies, prompting extensive research into their interconnectedness.<sup>1,2</sup> Research indicates that individuals with AD have a higher prevalence of food sensitization and food allergy compared with those without AD.<sup>3</sup> Importantly, the risk of developing food allergies correlates with the severity and early onset of AD. Children with more severe AD are at a higher risk of developing food allergies.<sup>4,5</sup> A compromised skin barrier in patients with AD facilitates the entry of allergens, including food proteins, leading to sensitization. This transcutaneous exposure is a key factor in the development of food allergies among these individuals.<sup>6</sup>

The dual allergen exposure hypothesis (DAEH) helps explain the well-established association between AD and food allergy. The DAEH proposes that early transcutaneous exposure to food allergens results in food allergies; however, early oral exposure to food allergens increases the chance of tolerance, protecting against allergy.<sup>7</sup> As demonstrated in Figure 1, the hypothesized mechanism for transcutaneous exposure involves Langerhans cells presenting the food allergen to naïve T cells, leading to a helper T cell ( $T_H$ ) 2 response. The  $T_H$ 2 response is responsible for humoral immunity, including immunoglobulin E (IgE) production by B cells. In contrast, when food allergens are taken up by dendritic cells and presented to naïve T cells in the gastrointestinal tract, this prompts a Th1 and regulatory T-cell response, which helps to establish tolerance.<sup>7</sup> Recent literature builds upon this theory, referencing conditions such as celiac disease that have both intestinal and cutaneous presentations, which

suggests that sensitization through the skin may also have a direct impact on the gut.<sup>8</sup>

Historically, it was thought that early oral exposure to food allergens increased the likelihood of developing food allergy. Previous allergy guidelines encouraged excluding common allergenic foods for any child with a high risk of atopic disorders until the age of 3.<sup>9</sup> However, these guidelines have been altered since being disputed by several studies. The Learning Early About Peanut Allergy study was a randomized trial that found that early introduction of peanuts into infant diets significantly reduced the likelihood of developing peanut allergy in high-risk children.<sup>10</sup>

Along with studying early food introduction, there have also been trials examining whether aggressive treatment of AD, ostensibly to improve the skin barrier and decrease cutaneous sensitization, could lead to a decrease in the development of food allergy. The two-step egg introduction for prevention of egg allergy in high-risk infants with eczema (PETIT) study investigated the stepwise introduction of egg plus aggressive treatment of patient's atopic dermatitis.<sup>11</sup> Remarkably, the PETIT study found that 8% of patients in the egg introduction plus aggressive AD treatment group developed egg allergy, compared to 38% of patients in the placebo group, suggesting that controlling the AD may lead to decreased risk of food allergy.<sup>11</sup>

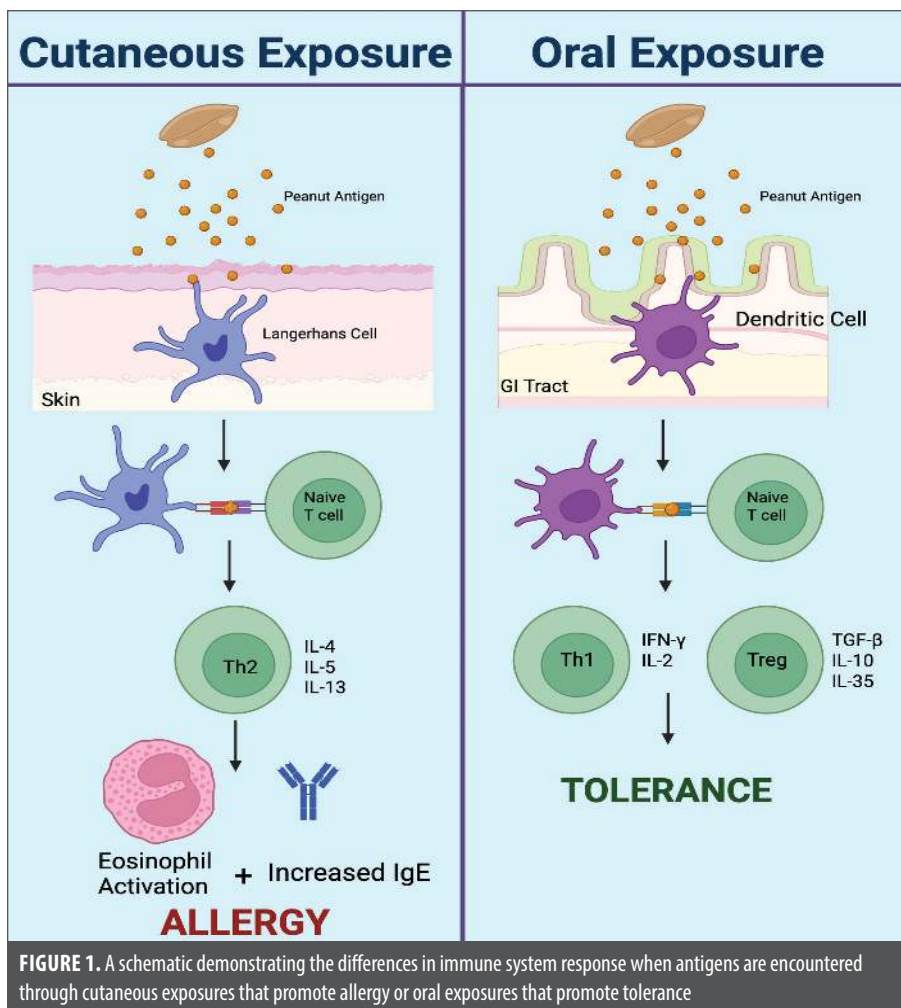
Another study examined the development of egg allergy in patients with AD but solely compared enhanced early skin treatment of AD to conventional reactive treatment. The enhanced group received topical corticosteroids on both lesional and nonlesional skin as proactive therapy.

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The conventional reactive treatment group received topical corticosteroids only on lesional skin. The investigators found that enhanced treatment significantly reduced hen's egg allergy, with 31.4% of the enhanced treatment group developing allergy, compared to 41.9% of the conventional treatment group.<sup>12</sup> These studies support the notion that aggressive treatment of AD decreases the likelihood of developing food allergy. These findings align with DAEH and support that transcutaneous exposure is a main pathway to developing sensitization to food allergens.

Both the PETIT trial and the study examining egg allergy rates between different AD treatments suggest that treatment of AD can decrease the likelihood of developing food sensitization. One of the foundations of AD treatment is moisturization. However, given that many moisturizers contain food-related ingredients, it is important to consider the

potential for sensitization, as patients will apply these to their damaged skin barrier. For example, the Avon Longitudinal Study of Parents and Children found a significant relationship with the use of skin preparations containing peanut oil and peanut allergy.<sup>4</sup>

Oat has moisturizing and anti-inflammatory properties and is one of the most common food ingredients found in skin care products, particularly those directed toward patients with eczema.<sup>13</sup> A common oat-containing moisturizer was used in the STOP-AD trial. The STOP-AD trial investigated whether daily moisturizer use from birth to 2 months reduced the incidence of AD in high-risk infants at 12 months. Notably, the study found a lower incidence of AD in the oat-containing moisturizer group (32.8%) compared to the control group (46.4%).<sup>14</sup>

In response to the publication of this trial, Ryczaj et al<sup>15</sup> warned of potential adverse effects of products with food-based ingredients. The

oat-derived ingredients in skin care products could lead to immediate and delayed-type sensitivity reactions, with the majority of these cases occurring in patients with AD.<sup>16</sup> Specifically, it was demonstrated that children with AD have high oat sensitization through oat atopy patch tests and skin prick tests. In this study, 32% of oat cream users had a positive atopy patch test in comparison to 0% in the nonusers group.<sup>17</sup> There has also been one case report of anaphylaxis to oats after cutaneous sensitization through skin care products for treatment of AD.<sup>18</sup> However, the STOP-AD trial authors responded with the results of a post-study survey, including food frequency and food diaries, of participating families at 1 year. In the survey results, no child who participated in the study, in either arm, reported to any allergic reactions to oats.<sup>19</sup> The STOP-AD authors concluded: "Given the wide use of oat-containing products and the extremely low incidence of clinical reactions to oat protein, the real-world risk of percutaneous sensitization to oat leading to clinically significant reactions must be very low generally, and specifically much lower than to other more allergenic foods such as peanut."<sup>19</sup> In addition to oat, there are several other frequently used ingredients in moisturizers that have not been demonstrated to increased likelihood of food allergy. This calls into question why certain foods are more likely to elicit allergic reactions in moisturizers compared to others, despite the mechanistic understanding of sensitization through the skin.

Importantly, there are variations in the level of allergenicity between different foods. In the US, only 9 foods account for 90% of symptomatic allergic reactions from food proteins.<sup>20</sup> Many sources report on 11 high-priority food allergens, and this list does not include oat or coconut.<sup>21,22</sup> In fact, oat allergy is so infrequent that a multicenter food challenge study used oat for the placebo food challenge, which emphasizes the scarcity of oat allergy.<sup>23</sup>

There are several studies examining the differences in allergic potency between foods by determining the Eliciting Dose values for these allergenic foods.<sup>21,22,24</sup> The Eliciting Dose values are defined as the number of milligrams of total protein in an allergenic food predicted to elicit objective allergic reactions in 1% (ED01) of the allergic population. The discrete dose ED01 for several allergenic foods include 0.05mg of cashew, 0.2mg of peanut, 0.2mg of egg,

0.2mg of milk, 0.7mg of wheat, and 26.2mg of shrimp.<sup>24</sup> These Eliciting Dose values allow for direct comparison of allergenic potencies between foods; cashew was found to be the most potent at the ED01 value. Table 1 shows the allergenicity of different foods relative to one another based on their eliciting dose for 50% of the allergic population (ED50). ED50 was specifically selected for this table based on the recommendation from the International Life Science Institute noting that ED50 is the best parameter for comparing the different potencies of food allergens.<sup>25</sup> As the purpose of these studies is to establish reference doses for precautionary food labeling for the most common allergens, there are limited data regarding eliciting doses for other moisturizer-related ingredients such as oat. Further investigation is needed to understand the variability in the pathophysiology of both cutaneous and oral sensitization leading to differing ranges of food allergy risk in patients with AD and the general population.

Additionally, when patients are diagnosed with AD, food triggers are often suspected and elimination diets are considered.<sup>10</sup> One study found that up to 71% of patients with AD had attempted some type of dietary modification to try to improve their disease.<sup>26</sup> Given the frequency at which elimination diets are trialed by patients, the potential outcomes of the reintroduction of avoided foods are important to highlight when discussing treatment options with patients. A retrospective review of 298 patients with AD who previously tolerated foods found that when the eliminated foods were reintroduced, nearly 1 in 5 (19%) patients now demonstrated symptoms of acute IgE reactions. In other words, patients who were not allergic to foods at the start were now allergic after dietary elimination. Worse, 30% of these reactions met criteria for anaphylaxis.<sup>27</sup> This study demonstrates the necessity of continuous oral exposure to food allergens to maintain tolerance and the potentially severe consequences of trialing elimination diets.

Overall, as the prevalence of AD and food allergy remains high, it is important to continue to investigate the relationship between these two diagnoses and the DAEH. Previous investigations have included trialing prevention strategies such as enhanced treatment of AD with topical corticosteroids and adapting allergy guidelines to begin earlier introduction of highly

allergenic foods. The STOP-AD trial studied daily emollient use for the prevention of AD and maintenance of the skin barrier to block cutaneous sensitization of food allergens. Even though they used a moisturizer that contained oat ingredients, no cases of oat allergy were reported, and oat allergy remains rare in the population despite widespread addition of oat to skincare products. This study, along with the established common use of food-related ingredients in skin care products, raises the question as to why we are more susceptible to develop sensitization to certain foods.

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**TABLE 1.** ED50-based data from analysis of the top 14 allergenic foods<sup>22</sup>

FOOD	ED50 VALUE (mg)
Mustard	17.2
Egg	94.5
Milk	124
Cashew	129
Peanut	165
Wheat	174
Walnut	235
Sesame	306
Lupin	387
Fish	418
Hazelnut	489
Celery	666
Soy	1779
Shrimp	7906
Oat	No ED50 values
Coconut	
Sunflower seed	
Cocoa butter	
Almond oil	

ED50: estimated amount of protein of allergenic foods predicted to elicit objective allergic reaction in 50% of the allergic population

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