

Oat and Wheat as Contact Allergens in Personal Care Products

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Oat and wheat are used as ingredients in various cosmetics and personal care products because of their moisturizing properties. Impaired barrier functions in atopic dermatitis (AD) may increase the risks of sensitization to oat and wheat proteins via skin. Immediate- and delayed-type hypersensitivity reactions to oat and wheat in personal care products have been reported in previous studies, and most of those cases were patients with AD.

Patch testing with oat and wheat proteins should be performed more frequently, especially in atopic children. It may help identify contact dermatitis, which may be a cause of flares in patients with AD. Complete avoidance of oat- or wheat-derived products is suggested as we cannot conclude that some oat- or wheat-derived components such as oils are free of protein.

A popular trend in the personal care product industry is the use of natural substances from plant sources. Some plant-derived proteins/materials are added to products because of their benefits such as moisturizing properties. Oat and wheat are 2 of the commonly used ingredients, and their widespread use may raise concerns about the risks of sensitization via skin.

Because these proteins are large molecules, sensitization risk may be greatest in patients with atopic dermatitis (AD), particularly in children who have not yet developed tolerance via dietary exposure.

Allergic contact dermatitis to oat and wheat in personal care products are examples of protein contact dermatitis. The pathogenesis of protein contact dermatitis is not well understood. It is considered to be a combination of allergen-specific IgE-mediated type I hypersensitivity and delayed type I allergic reactions.¹ Impaired barrier functions together with the presence of IgE receptor molecules on epidermal Langerhans cells from patients with AD² may explain the higher possibility of cutaneous sensitization to large molecules such as proteins in patients with AD. Impaired barrier functions facilitate the penetration of proteins into the skin, which is normally limited because of high molecular weight. An allergen is captured by IgE, which then binds to the IgE receptor on antigen-presenting cells resulting in antigen presentation and T cell-mediated allergen-specific immune response.

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OAT

Oat (*Avena sativa*) is a kind of popular cereal grain belonging to the Poaceae (Graminaceae) family that is grown to harvest for its seeds. Oat is used in various ways in food and many personal care products. It is crushed into oatmeal or ground into oat flour. Various over-the-counter moisturizers contain oat proteins often referred to as colloidal oatmeal produced by finely grinding the oat and boiling it to extract.

Many forms of oat are used as an ingredient in personal care products including oat bran, oat kernel, oatmeal, oat peptide or protein, and oat starch. Oat is available in various products including bath gels, shampoos, conditioners, shaving gels, and moisturizing creams. Oat-containing moisturizers have been widely used as topical treatment of skin conditions especially AD. Colloidal oatmeal consists of polysaccharides, protein, lipids, saponins, vitamins, polyphenols, and flavonoids. The high concentration of starch and β -glucan is responsible for the water-holding function, whereas phenols have antioxidant and anti-inflammatory activity and also act as ultraviolet absorbers. The cleansing activity of oat is from saponins.³

As the barrier function of the skin is impaired in patients with AD, application of moisturizers is considered as an adjunct therapy recommended by international guidelines in the management of AD. Moisturizers help reduce xerosis and improve the barrier function.⁴ In addition, those containing oat extracts show anti-inflammatory properties. Avenanthramides are potent anti-inflammatory agents that seem to mediate the anti-irritant effects of oat by inhibiting NF- κ B signaling and the release of IL-8. This anti-inflammatory activity may also reduce the scratching-induced secondary inflammation that can occur in AD, preventing the disruption of skin barrier function.⁵ When emollients^{6,7} including some with oat extract⁷ are combined with corticosteroid, they reduce

steroid consumption and produce a steroid-sparing effect in the treatment of AD.

WHEAT

Wheat (*Triticum* species) is a kind of grass in the Poaceae (Gramineae) family being used throughout the world and has become 1 of the staple foods. The whole grain can be milled for white flour. The products of this are bran and germ. Wheat germ is a part of the wheat kernel that germinates to grow into a plant, and it contains protein, carbohydrate, fibers, fatty acids, minerals, folate, and B vitamins.⁸ Wheat germ oil contains oleic, linoleic, linolenic, palmitic, and stearic acids.⁹ These fatty acids may be used as raw materials for a variety of other chemicals useful in cosmetics as emollients, vehicles, and lubricants. They help maintain the moisture content of hair and skin, and protect skin and hair against environmental damage.

Various forms of wheat-derived materials may be used in personal care products such as wheat protein, wheat germ, wheat germ protein, wheat germ oil, wheat bran, wheat starch, wheat gluten, and wheat kernel. Proteins from wheat are processed through hydrolysis, and the product can preserve and improve skin moisture. Hydrolyzed wheat protein (HWP) is amber liquid when it is at room temperature.¹⁰ Hydrolyzed wheat protein is added to skin care and hair care products such as moisturizers, soaps, bath gels, and hair conditioners. It is an ingredient in cosmetic preparations such as concealers, face powders, eye makeup preparations, lipsticks, and lip glosses. It is also found in detergents, nail polishes, and cleansing lotions.

SENSITIZATION, TYPE I AND TYPE IV ALLERGIC CONTACT REACTIONS TO OAT AND WHEAT

Type IV or delayed-type hypersensitivity reaction is more difficult to recognize clinically than type I or immediate-type hypersensitivity

because of the delayed onset of rash after exposure and the prolonged rash from a single exposure. Therefore, case reporting can miss a substantial number of sensitized patients. To date, the prevalence of allergic contact dermatitis to oat and wheat is unknown because almost no patch testing to these allergens is performed. When patch testing in an exposed population of children with AD was performed, the prevalence of positive patch test results to oat proteins was 14.6% (44 of 302 patients) in 1 study.¹¹ In addition, processing in the manufacture of personal care products may function like cooking in terms of destroying protein structure to the point that the allergen loses the capacity to bind IgE and cause a type I response, but T cells can react to short peptide sequences and may still elicit a type IV response even in finished products.¹² Therefore, type IV may not be recognized when screening patients selected for antigen-specific IgE with skin prick tests (SPTs) or serologic tests.

Pigatto et al¹³ evaluated the frequency of sensitization to oat and rice colloidal suspensions in 30 atopic children with exposure to topical oat-containing products (6 months to 2 years) versus 13 atopic children without such exposure and versus healthy controls. Faint erythema at 24 hours interpreted as an irritant response occurred in 5 subjects, all of whom were atopic and previously exposed to topicals containing oat. Immediate urticarial reactions did not occur.¹³ The interpretation of atopy patch tests is not standardized, but we note that the occurrence of irritant reactions only in the exposed population is surprising.

Boussault et al¹¹ reported that results of oat atopy patch tests and/or SPTs were positive in 14.6% and 19.2% of patients with AD. In these children, results of open food challenge and repeat open application test were positive in 15.6% (5 of 32) and 28% (7 of 25) of patients, respectively. Atopy patch testing showed reactions to oat in 32% of children who used oat-containing moisturizers versus 0% in the nonusers group. Nearly 50% of children were less than 2 years. Multivariate analysis indicated that the risk factor for obtaining a positive oat atopy patch test result was the application of a moisturizer containing oat proteins. The authors suggested the avoidance of topical products containing oat proteins in infants

TABLE 1. Reports of Contact Urticaria and Allergic Contact Dermatitis to Oat in Personal Care Products

Type of Reaction	Product	Subject/Symptom	Test (Result)	Reference
Type 1	Moisturizing cream	A 33-year-old woman with AD and allergic rhinoconjunctivitis developed pruritic erythematous eruption on the face immediately after the application of the cream.	Patch test (negative to the cream as is) SPT (positive to the cream as is and the <i>Avena sativa</i> alcoholic extract) Specific IgE (slightly elevated to oat)	Vansina et al ¹⁴
Type IV	Oatmeal extract baths	Three children (aged 14 mo to 14 y) with AD had exacerbations of eczema after these baths and improved when they stopped using the product.	RAST (positive to oat) Patch tests (positive to oat)	Riboldi et al ¹⁵
Type IV	Moisturizing cream	A 3-year-old girl with AD and respiratory atopy developed a flare-up after the application of a moisturizer.	Patch test (positive to the cream as is, oat extract Rhealba [®] as is, and oat extract Rhealba [®] diluted) SPT (positive to <i>Avena sativa</i>)	Pazzaglia et al ¹⁶

RAST indicates radioallergosorbent test.

TABLE 2. Reports of Contact Urticaria and Allergic Contact Dermatitis to Wheat in Personal Care Products

Type of Reaction	Product	Subject/Symptom	Test (Result)	Reference
Type I	Moisturizing body cream	A 27-year-old woman without history of atopy developed a pruritic, erythematous, urticarial rash shortly after application.	Open application test (wheal and flare reaction to the cream as is, but negative to the ingredients) Patch test (negative to the cream as is) SPT (positive to HWP) Specific IgE (positive to HWP)	Varjonen et al ¹⁷
Type I	Eye cream and body moisturizer	A 46-year-old atopic woman developed contact urticaria upon applying an eyelid cream and a body moisturizer. She had generalized urticaria after eating preserved foods (sausages with lentils and a French cassoulet). There was no problem with eating cereal-based products like breads and pastries.	SPT (positive to preserved foods and the wheat gluten contained in them as an ingredient; the 2 creams and the HWPs used for their manufacture, pure gliadins and gluten component, were extracted from wheat flour. Specific IgE (elevated to wheat flour and gluten)	Pecquet et al ¹⁸
Type I	Moisturizers, shower gels, shampoos, and conditioners	Nine patients developed contact urticaria to cosmetics containing HWP, no allergies to traditional wheat products Six of them also experienced generalized urticaria or anaphylaxis to foods containing HWP	Skin tests (open tests and if negative, prick tests) (positive to cosmetics, foods, and HWP but no reactions to unmodified proteins) Specific IgE (low to moderate levels to wheat flour or gluten) Immunoblotting analyses (IgE from all patients reacted with almost all HWP tested)	Laurière et al ¹⁹
Type IV	Moisturizing cosmetic cream	A 64-year-old nonatopic woman with itchy erythematous edematous lesions on the eyelids, face, and neck	Patch test (positive reactions to the cosmetic cream as is and 1 of its ingredients [HWP 10% aqueous]) Open test (Negative at 30 min to HWP 10% aqueous)	Sanchez-Pérez et al ²⁰
Type IV	Emollient	A 3-year-old girl with AD developed skin eruption on the knees.	Patch test (positive to the emollient and palmitoyl HWP) SPT (negative to palmitoyl HWP and wheat) RAST (negative to wheat)	Livideanu et al ²¹

RAST indicates radioallergosorbent test.

with AD.¹¹ The possible risk of subsequent sensitization to food proteins facilitated by damaged or impaired skin barrier in atopic individuals needs to be considered.

There are case reports of contact urticaria and allergic contact dermatitis to oat and wheat in personal care products^{14–21} as shown in Table 1 and Table 2. Contact urticaria occurred to an oat extract emollient cream, and oral allergy syndrome was found to be correlated with eating oatmeal-containing biscuits and bread.¹⁴ In the report of Laurière et al,¹⁹ all patients were selected for their contact urticaria to cosmetics containing HWP and for their absence of allergy to traditional wheat products. The role of hydrolysis on the allergenicity of wheat proteins has been proposed.¹⁹

Some oat extracts used in cosmetics may not cross-react with the cereal protein at all. In a pilot study of atopic adults with known antigen-specific IgE to oat and/or wheat (defined by the positivity of either SPTs to wheat/oat extracts or presence of serum wheat/oat-specific IgE), no immediate or delayed allergic reactions occurred during the application of 2 colloidal Rhealba (Laboratoires Pierre Fabre, Castres, France) oat-based cosmetics (emollient and soap-free cleansing bar) over a 3-week period. No positive results for patch tests and SPTs to oat and/or wheat extracts were observed. It was proposed that oat proteins in the tested cosmetics (colloidal Rhealba oat extract) do not cross-react with oat and cereal allergens because allergens found in oat prick test results come from the oat pollen, whereas oat extracts contained in cosmetics are derived from the oat flour. The treatment did not aggravate the skin inflammation of AD, and most patients improved by the end of the study.²²

Wheat-dependent exercise-induced anaphylaxis is a form of wheat allergy induced by wheat ingestion combined with trigger factors including exercise and/or aspirin intake. In previous studies, patients with wheat-dependent exercise-induced anaphylaxis who used soap containing HWP were found to be sensitized to HWP via cutaneous and/or rhinoconjunctival route.^{23–25}

PROTEIN VERSUS OIL ALLERGENICITY

There are some issues regarding allergenicity of proteins and oils, which include impurity and cross-reaction. As we know that protein plays an important role for sensitization, is it safe for patients who are allergic to oat or wheat to use oat- or wheat-derived oils?

To answer this question, we consider peanut protein and oil as a model. In a study of allergenicity of peanut oils, crude peanut oil caused type I allergic reactions in 10% of allergic subjects and should continue to be avoided, whereas refined peanut oil did not pose a risk to any of the subjects. Crude peanut oil or cold pressed oil is a less processed oil, which is strongly flavored and has been shown to contain protein. Refined peanut oil refers to oil with physical and chemical methods of purification, including degumming, refining, bleaching, and deodorization. Protein has not been detected in unused refined peanut oil.²⁶ Fluocinolone acetonide 0.01% in peanut oil in children with AD is an effective alternative to the use

of topical corticosteroid agents in ointment, cream, and lotion forms in children, and it was well tolerated in patients with peanut allergic sensitivity.²⁷

The Cosmetic Ingredient Review (CIR) Expert Panel evaluated the results of laboratory and clinical tests on the safety of *Avena sativa* kernel oil, *Triticum aestivum* (Wheat) germ oil, *Triticum vulgare* (Wheat) germ oil, and *Triticum vulgare* germ oil unsaponifiables. They were not found to be an eye irritant, and exposure to these ingredients did not result in dermal sensitization.

The CIR Expert Panel also discussed the relationship between food allergy and the refined oil exposure. Individuals who are allergic to a plant protein rarely exhibit allergic reactions to the refined oil of the same plant. The panel has found a general lack of clinical effects for plant-derived fatty acids already reviewed.⁹ However, Olszewski et al²⁸ have demonstrated the presence of allergenic proteins in crude and refined peanut oil. These proteins are the same size as 2 allergens previously described in peanut protein extracts.²⁸

Therefore, it is essential to know the processing of the oils, the chance of contamination, and the protein content and immunoreactivity to recommend patients who are sensitized to oat or wheat protein to avoid products that contain oat or wheat oil. It is uncertain whether the minute amounts remaining could provoke allergic reactions in highly susceptible individuals. Determining the content and immunoreactivity of the residual protein of refined oils is crucial to assess the allergenic risk. Therefore, further studies are required to assess the allergenic risk, which may also be applied to other kinds of plant-derived oils.

It has also been found that wheat starch may contain proteins. Even gluten-free wheat starch products contained small amounts of gluten proteins, which may vary depending on the method of preparation.²⁹ According to the previous data, we cannot conclude that some oat- or wheat-derived components are free of protein.

CONCLUSION

Different results among the studies of oat and wheat sensitization and contact dermatitis may be due to several factors such as study population, type of allergy tests, and type and concentration of allergens. Although prick tests and serologic tests for antigen-specific IgE to oat and wheat are useful in detecting immediate reactions such as contact urticaria, patch testing may detect delayed reactions manifesting as contact dermatitis or flares of AD. Patch testing with oat and wheat proteins and extracts should be performed more frequently, especially in atopic children. It may help identify cutaneous sensitization and contact dermatitis, which may be the cause of flares in patients with AD.

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