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# Mustard allergy in children and cross-reaction: Case report

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## ABSTRACT

**Aims:** Food allergy to mustard is often unrecognised in children; however, it deserves early recognition as a potentially severe immunoglobulin e (IgE)--mediated allergy with a risk of anaphylaxis. The aim of this work is to show the value of performing an oral challenge test to confirm the diagnosis of mustard allergy.

**Presentation of case:** We report the observation of a child who presented with allergy to yellow mustard with all the allergological work-up performed.

**Discussion:** The diagnosis of mustard allergy is delicate; on the basis of the clinical history and the food investigation, as mustard is consumed mainly in a masked form. Cross-allergies are common with mugwort, nuts and rosacea. No threshold value for skin tests or specific IgE can be considered sufficient to confirm or not the diagnosis of food allergy or the secondary acquisition of tolerance to mustard.

**Conclusion:** Oral challenge test is the gold standard for confirming the diagnosis of food allergy; reducing the risk of accidental exposure; validating or not the avoidance diet; and improving quality of life.

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*Keywords:* Mustard, Oral challenge test, Children, Mugwort syndrome, Anaphylaxis

## 1. INTRODUCTION

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Cow's milk, egg, wheat, peanut and fish are the main causes of food allergy in children. In addition to these potential allergens, some unusual foods can cause allergic reactions in sensitive individuals: mustard, sesame, and condiments. Mustard allergy is an immediate immunoglobulin e (IgE) dependent allergy and has been reported for many years with a high

35 persistence of the allergy into adulthood [1]. We report the observation of a child who  
36 presented with allergy to yellow mustard with all the allergological work-up performed.

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## 38 **2. PRESENTATION OF CASE**

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40 We report the clinical observation of a 5 year old child, with a personal history of atopic  
41 dermatitis since the age of 3 years, under dermocorticoids during flare-ups, and a family  
42 history of atopy: his mother is asthmatic. The introduction of cow's milk, eggs and fish was  
43 done without problems. At the age of 4, during a meal, he ingested chicken meat  
44 accompanied by chips containing prepared mustard; without any notion of exertion; 30 min  
45 later, appearance of a generalized pruritic erythematous maculo-papular eruption evoking  
46 urticaria, put on antihistamines with regression of the symptoms. An allergological work-up  
47 revealed skin sensitisation to mustard = 20mm, to house dust mites = 12mm and to moulds  
48 more than 50% of the positive control, no sensitisation to pollen was found in our patient. A  
49 specific IgE assay by multi-allergen test showed a positive result for mustard = 4KU/L,  
50 almond = 4KU/L. At the end of this assessment, the parents decided to exclude mustard  
51 from the diet. After oral consent from the parents, an oral challenge test open to mustard  
52 was recommended. In this particular case of mustard, it is not easy to appropriately mask its  
53 strong taste, we managed to do so by using a yoghurt-based vehicle with a vanilla flavour.  
54 The following protocol was followed: Increasing doses from 10 mg, 30 mg and 100 mg were  
55 administered with an interval of 20 minutes, immediately the child developed resolved  
56 generalized urticaria after administration of the antihistamine. The child is kept under  
57 supervision for 3 hours. Allergy to mustard was found at a cumulative reactogenic dose of  
58 140mg.

## 59 **3. DISCUSSION**

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61 Mustard belongs to the Brassicaceae family, which includes more than 3200 species and  
62 375 genera. Other vegetables in the same family include: broccoli, cauliflower, cabbage,  
63 radish, and turnip. 3 most common varieties of mustard: Yellow mustard (*Brassica alba*);  
64 common source of table mustard. Black mustard (*Brassica nigra*): important source of oil,  
65 used in the pharmaceutical industry for poultices. Brown mustard (*Brassica juncea*): used as  
66 a spice, vegetable and oil. Mustard seeds are sold whole, ground into powder or further  
67 processed into prepared mustard. Mustard is widely consumed in foods as a sauce or food  
68 additive; mustard is found in: condiments, spices, barbecue sauce, ketchup, mayonnaise,  
69 dehydrated mashed potatoes, and sausages [1]. Mustard seeds contain 20-30% protein, 6-  
70 12% fat and 12-18% carbohydrates [1]. It has been reported that sensitization to mustard  
71 may occur through breastfeeding or in utero [2]. Mustard has been shown to be highly  
72 allergenic, with a trigger dose of 0.05 mg, one of the lowest trigger doses of the major  
73 allergenic foods [3]. Cases of exercise-induced anaphylaxis to mustard have been reported  
74 in the literature [2]. White mustard is an occupational allergen widely used in Chinese herbal  
75 medicine [3]. The various symptoms of mustard allergy that have been observed over the  
76 years are mainly mucocutaneous manifestations (urticaria, angioedema, hoarse voice);  
77 respiratory symptoms (wheezing, bronchospasm, recurrent cough, nasal congestion, chest  
78 tightness, angioedema); gastrointestinal manifestations (epigastralgia, nausea, vomiting,  
79 diarrhea, abdominal pain); cardiovascular manifestations (tachycardia, hypotension, chest  
80 pain) [4]. Mustard includes irritants such as isothiocyanates that can cause contact  
81 dermatitis following non-immunological basophil degranulation without IgE involvement; a  
82 reaction with superficial necrosis has been observed in 5% of cases [6]. The best resource  
83 for determining the likelihood of a hidden allergen causing an allergic reaction is to take a  
84 detailed history of the allergic reaction, the presence of cofactors (medication, physical  
85 exertion), the suspected food, the type of food and where it was consumed. Skin testing as a  
86 first line of defense; using native foods such as ground and suspended mustard seed or

87 mustard oil; a papule at 8 mm would have a sensitivity of 50% and specificity of 90% [6].  
 88 Mustard seeds may be contaminated with moulds or mites and therefore a risk of false-  
 89 positive results [4]. As a second line of defense; the specific IgE test. Four major allergens of  
 90 yellow mustard have been identified and characterized (Table 1): Sin a 1 is a 2S albumin  
 91 storage protein. Sin a 2 is an 11S globulin, which is used as a marker for predicting symptom  
 92 severity [7]. Sin a 3 is a non-specific lipid transfer protein (nsLTP). Sin a 4 is a plant profilin.  
 93 Bra j 1: is a 2S albumin, a major brown mustard allergen.

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 95 **Table 1. The different major mustard allergens and cross-allergies.**  
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Allergen	Molecular weight (Kda)	Protein family	Variety	Cross-allergy
<b>Sin a1</b>	14	2S albumin seed storage protein	yellow mustard	Bra j1 sunflower rapeseed Bn III
<b>Sin a2</b>	51	11S globulins	yellow mustard	11S globulins from nuts
<b>Sin a3</b>	12	non-specific lipid transfer proteins (nsLTP)	yellow mustard	Bra o 3 (cabbage) 65 Pru p 3 (peach) 50%. Mal d 3 (apple) Prua v 3 (cherry) Cor a 8 (hazelnut) Art v 3 (mugwort)
<b>Sin a4</b>	13/14	Plant profilin	yellow mustard	Cuc m 2 (melon) 80 Pru p4 (peach) Bet v 2 (birch) Art v 4 (mugwort)
<b>Bra j1</b>	14	2S albumin seed storage protein	brown mustard	Sin a1 sunflower

97 Most mustard allergens are resistant to heat and acidity and remain intact for up to 60  
 98 minutes after gastric and intestinal digestion [8]. A case report showed cross-reactivity of  
 99 mustard with broccoli, turnip, rapeseed via 2S albumins [8]. Characterization of Sin a 1 and  
 100 Bra j 1 revealed homologous epitopes between the two allergens and thus cross-reactivity  
 101 [1]. One study showed that sunflower seed 2S albumin cross-reacts with mustard 2S  
 102 albumin [9]. The Sin 2 protein shares epitopes with the 11S globulins allergenic to tree nuts,  
 103 but not to peanut [9]. Sin a 3 and Sin a 4 are associated with cross-reactivity to many pollens  
 104 - birch, mugwort and plant foods of the Rosaceae family [8]. Sin a 3 shows 65% similarity to  
 105 cabbage LTP, 50% similarity to peach LTP [8]. Sin a 4 has about 80% similarity to melon  
 106 profilin [8]. Mustard and mugwort allergy syndrome can be caused by both LTPs and  
 107 profilins [8]. Total serum IgE is not relevant [10]. Oral challenge testing is the gold standard  
 108 for confirming the diagnosis of food allergy; reducing the risk of accidental exposure;  
 109 validating or not the avoidance diet; and improving quality of life. Two protocols have been  
 110 published. The first, by Morisset [5], involves giving increasing doses of prepared brown  
 111 mustard containing 33.6% mustard seed, starting at 10mg at 20 minute intervals up to a  
 112 cumulative dose of 1g [10]. The second of Figureoa [3], is to give increasing doses of  
 113 prepared yellow mustard containing 14% mustard seed, starting at 80mg at 15 minute  
 114 intervals until a clinical reaction occurs or until a cumulative dose of 10g is reached [10]. The  
 115 lowest dose of mustard administered that caused clinical manifestations differed between  
 116 studies. Only 23-58% of mustard sensitizations were accompanied by a positive oral  
 117 challenge test [3]. 3] The more often the sensitization was discovered during a work-up for

118 atopic dermatitis, the more often the test was negative [4]. Unfortunately, there are no  
119 published data on the development of tolerance.

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#### 121 **4. CONCLUSION**

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123 Mustard allergy accounts for 1% of food allergies in children [10]. It is a potentially severe  
124 IgE-mediated allergy with a risk of anaphylaxis. No threshold value for skin tests or specific  
125 IgE can be considered sufficient to confirm or not the diagnosis of food allergy or the  
126 secondary acquisition of tolerance to mustard. An oral challenge test is necessary to confirm  
127 the diagnosis or to assess tolerance.

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#### 129 **CONSENT**

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131 All authors declare that 'written informed consent was obtained from the patient (for  
132 publication of this case report and accompanying images)

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135

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#### 139 **COMPETING INTERESTS**

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141 The authors declare no conflict of interest

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#### 143 **AUTHORS' CONTRIBUTIONS**

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145 All authors read and approved the final version of the manuscript.

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