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REVIEW

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Poppy seed anaphylaxis: clinical and allergic features

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Abstract

Poppy seeds are increasingly used for flavoring, for example, in cakes, bread, and fruit salads, and it is gaining popularity globally. Most case reports of poppy seed allergy are in children. Ingestion of cake, in which ground poppy seed is used, is mostly associated with anaphylactic reactions. Reactions may occur even with minimal amounts or traces. In sera of patients allergic to poppy seeds, four IgE-reactive poppy seed proteins were identified. Cross allergy with sesame and buckwheat are reported. Cross-reaction is described with nuts (cashew and walnut), wheat, rye flour, buckwheat, rice, and kiwi. Although rare, allergy to poppy seed is often rapid, generalized, and potentially life-threatening and, therefore, should be considered in allergic work-up. Therapy of poppy seed allergy/anaphylaxis is based on an elimination diet. However, oral desensitization could be hypothesized in some high-risk allergic patients, according to other reports of oral desensitization in seed anaphylaxis.

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Introduction

Poppy seeds are obtained from the poppy plant (*Papaver somniferum*), an annual herb native to southeastern Europe and western Asia and cultivated extensively in Asia and Central and South America. In Europe, poppy is cultivated mainly in Turkey, the Czech Republic, and Spain.¹ The plant can have white, pink, red, or purple flowers. Seeds are small and often contained in capsules that are about 3 cm in diameter. The latex from capsules contains a wide range of alkaloids, including morphine and opium. Poppy seeds do not contain opium alkaloids but can become contaminated with them as a result of insect damage or through poor harvesting practices.² Seeds are highly nutritious and have beneficial effects on health, so they are increasingly used for flavoring, for example, in cakes, bread, and fruit salads, and it gaining popularity globally. Poppy oil is used to manufacture paints, varnishes, soaps, and sometimes as a coloring agent for cough syrups and other products.

Materials and Methods

We performed a literature search in Medline through PubMed using default keywords related to poppy seed anaphylaxis. Original studies and review articles, in English, were identified from 1990 up to October 2025.

Poppy seeds sensitization

Reports of allergic-type I sensitivity to poppy seeds are rare, but sensitization is not infrequent in some areas of the world. In India, a sensitization rate of 8.7% was observed among the general population.³ In Europe, the mean sensitization rate was 3% in polisensitized adults⁴ and 4.8% in schoolchildren.⁵ The differences in the occurrence of sensitization to various plant source foods depend on genetics, geographical location, and is related to pollen and food exposure.^{5,6}

Poppy seeds allergy and anaphylaxis

Reports of anaphylaxis are very rare in Europe. An exception has been observed in a small population of 139 Czech patients, where poppy seed elicited anaphylaxis in 14% of 83 children and in 25% of 56 adult patients with food allergy.⁷ Jensen-Jarolim et al.⁸ studied 11 pollen-allergic patients (6 patients under 18 years of age) with adverse reactions after ingestion of food containing poppy seeds. All had oral allergic plus systemic clinical manifestations, and one patient, 29 years old, had anaphylaxis. It was also reported that 10/11 patients had adverse reactions to other foods (in 8 because of nuts). Podzhilkova et al.⁹ recently published a small study of 36 children suspected of poppy seed allergy because of case history or elevated specific IgE (sIgE) or positive skin prick tests (SPT) to poppy seed during the evaluation of food allergy; 10 were positive for an oral provocation test (OPT), and 5 had severe clinical manifestations (Sampson Symptom Score ≥ 4 : grade 4 reaction; oral allergy syndrome, generalized pruritus, urticaria, angioedema, conjunctivitis, rhinorrhea, abdominal pain, nausea, sensation of throat tightness/pruritus, asthma with wheezing, dyspnea, and hoarseness/barky cough/difficulty swallowing). Few other single case reports of poppy seed anaphylaxis are described in the literature. Most patients are <18 years old, the cake was the most frequent cause and concomitant sesame allergy was often reported to be associated with food reaction. In most cases, nut sensitization was also reported (Table 1).

Poppy seed allergens

Poppy seed contains Bet v 1 and profilin homologues, which indicates the possibility of cross-reactivity with other plants containing these panallergens. Initially, in a study of 11 sera from poppy seed-sensitive patients, 10 demonstrated binding to a 45 kDa protein, which was considered a major allergen.⁸ A similar 46 kDa protein was identified by a later study on a patient who developed anaphylaxis

Table 1 Poppy seed anaphylaxis case reports: clinical and allergic features.

Author year	Cause	Diagnosis	Clinical manifestations	Age (yrs)	Other allergy	Pollen/Nuts sensitization
Kalyoncu 1993 ¹⁰	Bread, ice cream	SPT sIgE	D, LE	27	-	yes/?
Frantzen 2000 ¹¹	Cake	CH/SPT/sIgE	AP/A/D	52	-	yes/yes
Oppel 2006 ¹²	Cake	CH/SPT/sIgE/ T/OC/IB	E/A/C/D	17	sesame	yes/yes
Keskin 2006 ¹³	Inhalation/ Crisps ingestion	CH/SPT/sIgE	E/A/C/D	16	-	no/yes
Panasoff 2008 ¹⁴	Cake	CH/SPT/sIgE	AP/U/H	17	sesame	?/yes
Yavuz 2015 ¹⁵	Muffin	CH/SPT	FP/E/A/N/D	5	-	??
Kovalczyk 2020 ¹⁶	Cake	CH/SPTsIgE/CRD	U/R/C/W/SB	8	sesame	yes/yes

Diagnosis: CH = clinical history, SPT=skin prick test, sIgE=serum IgE, OC=oral challenge, T=tryptase, IB=immunoblotting, ?=not reported. Clinical manifestations: AP=abdominal pain, E=erythema, U=urticaria, A=angioedema, R=rhinitis, C=conjunctivitis, W=wheezing, TS=throat swelling, LE=laryngeal edema, SB=shortness of breath, D=dyspnea, N=nausea, FP=facial pruritus.

within minutes of consuming poppy seed.¹² In other immunoblotting studies, reactive bands of 14, 17, and 34 kDa were found in poppy seed extract.^{8,17,18} In a recent study⁹ using sera of patients allergic to poppy seeds, four IgE-reactive poppy seed proteins were identified; two were identified as poppy seed vicilin (Pap s 1) and legumin (Pap s 2), the two seed storage proteins being homologous to important allergens found in tree nuts such as hazelnut,¹⁹ walnut,²⁰ and cashew,²¹ as well in seeds such as buckwheat²² and sesame.²³ Poppy seed molecular allergens are described in Table 2.²⁴

Associated allergies and cross-reactions

In anaphylaxis case reports of literature involving poppy seeds, allergy associated with sesame was often reported (Table 1).^{25,26} Moreover, a poppy seed-induced anaphylaxis in a 17-year-old girl with concomitant sensitization to buckwheat has been observed.¹² Varga et al.¹⁷ reported the case of a patient who experienced anaphylaxis to buckwheat and showed clinical manifestations of oral allergy syndrome after ingesting poppy seed. Asero et al.²⁷ reported cross-reactivity between sesame and poppy protein extracts (molecular mass, 10-12 kDa) and suggested that the major sesame allergens Ses i 1 or Ses i 2 may cross-react with poppy seed 2S albumin. Poppy seed also displays cross-reactivity with proteins present in wheat, rye flour, buckwheat, rice, and kiwi.^{8,28,29}

Diagnosis

Diagnosis of poppy seed anaphylaxis is based on clinical history, SPT, serum IgE determinations, and OPT in doubtful cases. SPT is usually performed through prick by prick¹⁶ or within house saline-extracted allergens from freshly ground poppy seeds.^{12,14,16} Podzhilkova et al. showed an SPT wheal size >6.6 mm as the optimal cut-off in the ROC curve, with a specificity of 80% and a sensitivity of 65%, and the optimal cut-off point of IgE to Pap s 1 as 2.6 kUA/L, with a sensitivity and specificity of 100% and 77%, respectively.⁹

Serum-sIgE to poppy seed can be determined with Immulonite (Immulonite 2000, 3gAllergy™, Siemens Medical

Solutions Diagnostics, New Jersey, USA; IMMUNOCAP <https://www.thermofisher.com/phadia/wo/en/resources/allergen-encyclopedia/f224.html>). Component-resolved diagnostics can be performed using the ALEX test (Macro Array Diagnostics, Vienna, Austria) to identify the presence of Pap s 2S albumin. OPT should be used only in cases with inconclusive allergic workup. According to Podzhilkova et al., the poppy seed challenge included up to 7 steps: 1 seed, 3 seeds, 10 seeds, 30 seeds, 100 seeds (40 mg), 300 seeds (120 mg), and 1000 seeds (400 mg) in 30-minute intervals.⁹ Oppel et al.¹² used different amounts in ground and unground poppy seed. Oral administration of up to 10 g of unground poppy seeds used for rolls and yoghurts did not cause any clinical manifestations. A ten-fold lower amount of ground poppy seeds, as used for traditional poppy seed cakes, caused a severe anaphylactic reaction. Therefore, the physical destruction of poppy seeds seems crucial for anaphylactic reactions. Most of the described poppy seed anaphylactic reactions (Table 1) occurred after the cake was ingested.

Therapy

Therapy of poppy seed anaphylaxis is based on an elimination diet and prompt treatment in the case of an allergic reaction. However, oral desensitization could be hypothesized in some high-risk allergic patients.

In the recent EAACI guidelines, oral allergen-specific immunotherapy is recommended for children and adolescents with peanut allergy and suggested for milk and egg allergies (generally after 4 years of age for milk and egg).³⁰ There are some reports of oral desensitization to seeds, such as sesame and sunflower.^{31,32-35}

Sesame OIT has clinical and immunologic efficacy in children^{33,34} with a maintenance dose of approximately 1,000 mg sesame protein³³ or 1,200,³⁴ and even with low doses (200 mg).³⁶

Furthermore, a study on sesame allergy treated with oral immunotherapy coadjuvated to omalizumab showed an alternative promising desensitization strategy.³²

Sesame OIT demonstrated an acceptable safety profile; nonetheless, given the possibility of adverse events, it was recommended that treatment be conducted in specialized centers.

Table 2 Molecular allergens described in poppy seeds^{8,9,12,18}

Species	Allergen	Biochemical name	Molecular weight
<i>Papaver somniferum</i> (Opium poppy)	Pap s 1	Vicilin (7S globulin) with N-terminal alpha-hairpinin peptides	10 kDa, 17 kDa (alpha-hairpinins), 50 kDa (vicilin)
	Pap s 2	Legumin (11S globulin) seed storage protein	52 kDa (nonreducing), 30 kDa + 20 kDa (reducing)
	Pap s 3	Late embryogenesis abundant protein 5 (LEA-5); small hydrophilic seed protein	10 kDa
	Pap s 1.0101(27-424)	α-hairpinin orvicilin buriedpeptide (VBP) family	Unprocessed:47.872 kDa; processed peptides: 5.98-5.30 kDa
	Pap s 17kD	PR-10, Bet v 1 homologue	17kDa
	Pap s 34kD	Unknown	34kDa
	Pap s Profilin	Profilin	14-19kDa

There are few data on sunflower OIT. In a case reported by Baloch et al., gradual dose escalation every two weeks to a maintenance dose of 580 mg of protein allowed tolerance of sunflower oil-containing foods and products with precautionary allergen labeling.³⁷

In a case series of ten patients, a median maintenance dose of 1.2 g of sunflower seed protein was reached. However, a considerable number of patients with side effects were reported.³⁶

Poppy seed OIT has been used only in one case with multiallergen oral immunotherapy, dosing every 2-4 weeks in the range of 4, 8, 16, 31, 62, 125, 250, 500, and 1000 mg.³⁸ However, there was no information on the efficacy and adverse effects of this specific OIT. Moreover, high-quality trials defining safety and efficacy of multifoed OIT are lacking.³⁰

Therefore, an eventual use of poppy seed OIT should be carefully evaluated in relation to other published seed OIT studies. A shared decision-making between patients and allergists is mandatory.

Conclusions

In conclusion, poppy seeds are increasingly used for flavoring, for example, in cakes, bread, and fruit salads, and it is gaining popularity globally. Although rare, allergy to poppy seed is often rapid, generalized, and potentially life-threatening and, therefore, should be considered in allergic work-up. Our narrative review has some limitations, such as selection bias in case report data and lack of standardized testing for poppy seed allergens. The establishment of international registries for rare food allergies may contribute to reducing current gaps in research.

Data Availability Statement

We encourage all authors of articles published in MDPI journals to share their research data. In this section, please provide details regarding where data supporting reported results can be found, including links to publicly archived datasets analyzed or generated during the study. Where no new data were created, or where data are unavailable because of privacy or ethical restrictions, a statement is still required. Suggested Data Availability Statements are available in section “MDPI Research Data Policies” at <https://www.mdpi.com/ethics>.

Mandatory Disclosure on Use of Artificial Intelligence

The authors declare that no AI-assisted tools were used in the preparation of this manuscript. All references have been manually verified for accuracy and relevance.

Author Contributions

Conceptualization, investigation, resources, data curation, and writing—original draft preparation was done by E.N.;

writing—review and editing was the responsibility of E.N., C.M., L.C., S.A., S.B., L.C., R.C., M.G., L.L., F.M., F.S., and M.M.D.G.; visualization and supervision was done by E.N. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

MG reports personal fees from Sanofi, Thermo Fisher Scientific.

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