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Sensitization and allergy to pineapple and coconut juice in patients followed up for allergic diseases in Parakou, Benin

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ABSTRACT

Objectives: Little is known about adverse food reactions. The aim of this study was to investigate the sensitization and allergy to two tropical fruits, pineapple (*Ananas comosus*) and coconut (*Cocos nucifera*), among patients followed up for allergic disease in Borgou Teaching Hospital in Parakou, Benin.

Materials and Methods: A prospective cross-sectional study was conducted in 2021. Adult patients (≥18 years) who were followed up for allergic asthma, rhinitis, or conjunctivitis were included in the study. Information on clinical manifestations following pineapple juice or coconut water drinking was collected, and skin prick testing was carried out.

Results: Overall, 101 patients were enrolled, male-female ratio of 0.4:1 and mean age of 33.4 (±14.4) years. Clinical manifestations were triggered by pineapple in 53.5%, mainly mouth and lip pruritus (38.6%). The prevalence of sensitization was 36.6%. Allergy was diagnosed in 24.8% (or 46.3% of those who complained) and was associated with mouth and lip pruritus (odds ratio [OR] = 4.1; 95% confidence interval [CI] = 1.6–10.6; P = 0.003), bronchospasm (OR = 3.7;95%CI = 1.1–12.7; P = 0.031), allergic rhinitis (OR = 3.5; 95%CI = 1.2–10.4; P = 0.020), and conjunctivitis (OR = 4.4; 95%CI = 1.6–12.5; P = 0.007). Clinical manifestations after ingestion of coconut water reportedly occurred in 18.8% and were mostly bronchospasm (8.9%). The prevalence of sensitization was 20.8%. Allergies were diagnosed in 6.9% (or 33.3% of those who complained), with no association found with demographic or clinical characteristics.

Conclusion: Pineapple is a common cause of food allergy among patients who are followed up in Borgou Teaching Hospital, while coconut is less responsible for this disorder. More studies are required to improve knowledge of allergic diseases in Sub-Saharan Africa, which is facing an epidemiological transition.

Keywords: Pineapple, Coconut, Skin prick testing, Allergy, Benin, West Africa

INTRODUCTION

With globalization and changes in lifestyles and culinary habits, there is an increase in the number of adverse reactions that may occur following food ingestion.[1] These reactions are a major public health concern, affecting hundreds of millions of people globally and altering considerably their quality of life, as they often lead to dietary avoidance and nutritional deficiencies.[1] Up to

15–20% of the global population is estimated to suffer from these conditions, which may involve several systems, including mucocutaneous, cardiovascular, respiratory, digestive, and central nervous systems.[2] Some of the reactions can even be life-threatening, with the development of anaphylaxis.[3] Several mechanisms, such as immunological, including food allergy or non-immunological toxic, pharmacologic, and metabolic reactions, may lead to these conditions.[4]

Despite the pejorative consequences cited above, these diseases remain poorly studied in low- and middle-income countries, in contrast to more developed settings, where most of the studies have been carried out and focused on foods found in those settings.[5]

Pineapple (*Ananas comosus*) and coconut (*Cocos nucifera*) are two main tropical fruits that are largely consumed in sub-Saharan Africa. Pineapple is the third most commercialized tropical fruit in the world, after bananas and mangoes, with a growing demand.[6,7] This sweet fruit has numerous nutrients offering many health benefits,[7] with its main component, the bromelain, being attributed several virtues, including anti-inflammatory, fibrinolytic, anti-platelet aggregation, anti-edema, anti-cancer, and digestive properties.[6-8] As for coconut, this smooth fruit is also well appreciated, with a unique chemical composition of minerals, amino acids, sugars, vitamins, and phytohormones.[9,10]

In our routine practice, patients most often cite both fruits as the cause of adverse reactions during medical consultations in our setting. An allergic mechanism is usually suspected by patients or some practitioners, leading to their systematic avoidance. However, the foods may induce other types of reactions, such as mucosal irritation or intolerance. The present study was initiated to investigate to what extent cutaneous sensitization to both fruits, synonymous with allergy, was present among those followed up for allergic diseases in our setting.

MATERIALS AND METHODS

Study design

This was a cross-sectional study using data prospectively collected between January 15 and September 15, 2021.

Setting

The study took place at the Borgou Teaching Hospital in Parakou City, in the north-central part of Benin, West Africa.

Patients

The source population was constituted of all patients who accessed care for allergic diseases during the study period in Pulmonology, Ear, Nose, Throat, or Ophthalmology Departments in the Borgou Teaching Hospital. Of them, those who were aged 18 years and above and who consented to participate in the survey were consecutively included. The sample size was calculated using the Schwartz formula. Based on an estimated prevalence of food allergy of 5% among patients suffering from allergic rhinitis, derived from one study carried out in the Democratic Republic of Congo,[11] a confidence level equal to 95% and an error risk α of 5%, the minimal calculated sample size was $n = (1.96)^2 \times 0.05 \times (1–0.05)/(0.05)^2 = 73$.

Overall, 101 patients were included in the study.

Data collection

Data was collected on a previously tested and validated survey form by three medical students at the end of their training. They were previously trained in the best way of carrying out skin prick testing (SPT). All the tests were performed under the supervision of an experienced pneumo-allergist physician. They were also briefed on the use of an emergency kit in the event of any anaphylactic reaction. Once informed consent was obtained, patients were interviewed face-to-face. Information was collected on their history, types of allergic diseases, and non-allergic conditions. They were systematically asked whether they had reproducibly any symptoms after pineapple or coconut juice consumption, and if so, the kind of clinical features, as well as the time taken for these to occur after drinking the juice. Information on the other comorbidities and lifestyles was also collected. SPT was carried out with pineapple juice and coconut water. International recommendations on the technique, reading, and interpretation of the tests were followed. [12,13]

Diagnostic criteria

Sensitization to pineapple or coconut was diagnosed if the positive control was positive, the negative control was negative, and the diameter of the wheel from each of them was at least 3 mm greater than that of the negative control.[12,13] In addition, an allergy to pineapple or coconut was diagnosed if there was a reproducible and compatible clinical history of symptoms after pineapple or coconut juice consumption, respectively, in a sensitized person. Mucosal irritation was considered if there were transient sensations of tingling, burning, or pain in the mouth, lips, or tongue without sensitization. Food intolerance was considered likely if there were digestive symptoms such as nausea/vomiting and diarrhea, whether these were associated with mucocutaneous signs such as urticaria with a negative result to SPT. [14]

Data analysis

Data was entered into the EpiData Entry Client software (v4.6.0.0). They were analyzed using RStudio (version 4.3.1.) software. Quantitative variables were described using

means (±standard deviation), and categorical variables were summarized using frequencies and percentages. Factors associated with an allergy to pineapple or coconut were assessed by bivariate analysis using the Chi-square test (or Fisher's exact test if the expected value in one cell in the contingency table was <5). The odds ratios (OR), their 95% confidence interval (CI), and *P*-values were determined. The level of significance was set at <5% ($P < 0.05$).

RESULTS

Characteristics of the study population

The male-female of the 101 patients who were included was 0.4:1, and the mean age was 33.4 (±14.4). Familial atopy was reported by 74 (73.3%) patients. They were under treatment at the hospital as follows: allergic rhinitis (60; 59.4%), asthma (57; 56.4%), and allergic conjunctivitis (44; 43.6%).

Clinical manifestations following pineapple juice consumption and sensitization

Overall, 54 (53.5%) reported symptoms related to clinical abnormalities after drinking pineapple juice. These occurred less than an hour after ingestion of the fruit. Mouth and lip pruritus (39; 36.8%) were by far the most important complaint, followed by symptoms consistent with allergic conjunctivitis (20; 19.8%) or rhinitis (17; 16.8%) [Table 1]. After SPT, sensitization to pineapple was found in 37 (36.6%) patients. An allergy to pineapple was diagnosed in 25 (24.8%) patients; this represented 46.3% of the 54 patients who reported clinical manifestations after having ingested the fruit. A mucosal irritation was found in 12 (11.9%) patients and in 17 (16.8%) patients; there were clinical manifestations with negative results to SPT [Table 2]. These patients represented 31.5% (17/54) of those who were symptomatic. After bi-variate analysis, factors associated with pineapple allergy were mouth and lip pruritus (OR = 4.1; 95% CI = 1.6–10.6; $P = 0.003$), bronchospasm (OR = 3.7; 95% CI = 1.1–12.7; $P = 0.031$), allergic rhinitis (OR = 3.5; 95% CI = 1.2–10.4; $P = 0.020$), and conjunctivitis (OR = 4.4; 95% CI = 1.6–12.5; $P = 0.007$) [Table 3].

Table 1: Frequencies of clinical manifestations following pineapple juice consumption reported by participants, Borgou teaching hospital, Benin, 2021.

	Number	Percentage
No complaint	47	46.5
Mouth and lip pruritus	39	36.8
Allergic conjunctivitis related symptoms	20	19.8
Allergic rhinitis-related symptoms	17	16.8
Bronchospasm	12	11.9
Urticaria	4	4.0
Complaints suggestive of anaphylaxis*	4	4.0
Gastro-intestinal complaints	1	1.0
Total patients investigated	101	

*Complaints suggestive of anaphylaxis include: (i) Mucocutaneous manifestations and bronchospasm; or (ii) mucocutaneous and digestive manifestations; or (iii) digestive manifestations and bronchospasm; or (iv) mucocutaneous and digestive manifestations and bronchospasm or drop in blood pressure

Clinical manifestations following coconut water consumption and sensitization

Nineteen (18.8%) patients reported clinical manifestations after coconut water ingestion. The most common clinical manifestation was bronchospasm (9; 8.9%) [Table 4]. Sensitization to coconut water was found in 21 (20.8%) patients. 17 (16.8%) patients were diagnosed with sensitization to both pineapple and coconut water. No significant association was found between sensitization to coconut water and demographic or clinical characteristics. Based on the clinical history and SPT result, an allergy to coconut was confirmed in 7 (6.9%) patients [Table 5]. They represented 33.3% of the 19 patients who reported symptoms after coconut water ingestion. There were 11 (10.9%) symptomatic patients with negative results to SPT (57.9% of those who complained of clinical manifestations).

DISCUSSION

This study complements the few reports in the literature investigating cutaneous sensitization and adverse reactions with tropical fruits in sub-Saharan Africa.

Overall, reports of clinical manifestations after pineapple ingestion were quite common among allergic patients followed in the center, being reported by about half of the patients who were followed up. As for the clinical manifestations, like other studies in the literature,[15,16] mouth and lip pruritus were the most reported in nearly four out of ten patients. Interestingly, after having performed SPT with

Table 2: Patient status regarding pineapple after clinical investigation and SPT, Borgou teaching hospital, Benin, 2021.

	n	Percentage
No clinical manifestation and negative result at SPT	35	34.7
Allergy	25	24.8
Mucosal irritation	12	11.9
Clinical manifestation and negative result at SPT	17	16.8
No clinical manifestation and positive result at SPT	12	11.9
Total patients investigated	101	

SPT: Skin prick testing

Table 3: Factors associated with pineapple juice allergy among allergic patients, Borgou teaching hospital, Benin, 2021.

	n/N	(%)	OR	95% CI OR	*P*-value
Gender					
Male	8/30	(26.7)	1	0.3–2.3	0.772
Female	17/71	(23.9)	0.9		
Age			0.97	0.8–26.0	0.171
Family atopy					
No	7/27	(25.9)	1	0.3–2.5	0.869
Yes	18/74	(24.3)	0.9		
Mouth and lip pruritus					
No	9/62	(14.5)	1	1.6–10.6	0.003
Yes	16/39	(41)	4.1		
Gastro-intestinal complaints					
No	24/100	(24)	1	-	0.247*
Yes	1/1	(100)	-		
Bronchospasm					
No	19/89	(21.4)	1	1.1–12.7	0.031*
Yes	6/12	(50)	3.7		
Allergic rhinitis					
No	17/84	(20.2)	1	1.2–10.4	0.020*
Yes	8/17	(47.1)	3.5		
Allergic conjunctivitis					
No	15/81	(18.5)	1	1.6–12.5	0.007*
Yes	10/20	(50)	4.4		
Urticaria					
No	23/97	(23.7)	1	0.4–24.1	0.255*
Yes	2/4	(50)	3.2		
Complaints suggestive of anaphylaxis**					
No	24/97	(24.7)	1	0.1–10.2	1.000*
Yes	1/4	(25)	1.01		

*Fisher exact test, OR: Odds Ratio, 95%CI: 95% confidence interval odds ratio. **Complaints suggestive of anaphylaxis include: (i) Mucocutaneous manifestations and bronchospasm; or (ii) mucocutaneous and digestive manifestations; or (iii) digestive manifestations and bronchospasm; or (iv) mucocutaneous and digestive manifestations and bronchospasm or drop in blood pressure. OR: Odds ratio, CI: Confidence interval, n/N: Patients with allergy/Total patients

Table 4: Frequencies of clinical manifestations following coconut water ingestion reported by participants, Borgou teaching hospital, Benin, 2021.

	Number	Percentage
No complaint	82	81.2
Bronchospasm	9	8.9
Mouth and lip pruritus	6	5.9
Allergic rhinitis-related symptoms	4	4.0
Allergic conjunctivitis-related symptoms	3	3.0
Complaints suggestive of anaphylaxis*	2	2.0
Urticaria	1	1.0
Gastrointestinal complaints	1	1.0
Total patients investigated	101	

*Complaints suggestive of anaphylaxis include: (i) Mucocutaneous manifestations and bronchospasm; or (ii) mucocutaneous and digestive manifestations; or (iii) digestive manifestations and bronchospasm; or (iv) mucocutaneous and digestive manifestations and bronchospasm or drop in blood pressure

Table 5: Patient status regarding coconut after clinical investigation and SPT, Borgou teaching hospital, 2021.

	n	Percentage
No clinical manifestations and negative result at SPT	68	67.3
Allergic reaction	7	6.9
Mucosal irritation	1	1
Clinical manifestations and negative result at SPT	11	10.9
No clinical reaction and positive result at SPT	14	13.9
Total	101	100

SPT: Skin prick testing

pineapple juice, sensitization was observed in one-third of patients. When considering the clinical history, an allergy to pineapple was diagnosed in almost a quarter of the patients or almost half of those who were symptomatic.

The proportion of patients allergic to pineapple was quite high, confirming local community perceptions that pineapple is a food commonly implicated in allergic reactions. Cases of sensitization and allergy to pineapple have also been reported in the literature from elsewhere. In one study from Ghana, pineapple was the second most commonly reported food with adverse reactions after beans, and it was one of two foods, along with peanuts, to which sensitization was most common.[17] In another study from Mexico, 8.9% of patients had an oral allergy syndrome, of whom 62.5% were sensitized to pineapple, the main causative food found in the survey.[16] In a nationwide survey in Korea, 41.7% of 648 hay fever patients had pollen-food allergy syndrome, of whom the causative food was pineapple in 13.7% of cases.[18] In another report from Denmark, among 16.7% of young adults with pollen-food syndrome, pineapple was the third most commonly reported food after kiwi fruit and hazelnuts.[19] Reindl *et al*. demonstrated immediate reactions after pineapple juice consumption in 5% of those suffering from the pollen-food syndrome in their study population.[20] A number of sensitizations to pineapple have also been reported by Camero-Martínez *et al*. in Spain among patients who were treated for allergies.[21]

Due to limited technical resources, we were not able to carry out recombinant testing. However, based on previous literature, two main allergens responsible for allergic reactions to pineapple have been identified: Ana c 1 and Ana c 2.[22,23] Ana c 1 is a pan-allergen profilin that mainly causes food-pollen allergic syndromes and is responsible for numerous cross-reactivities with pollens such as birch and phleum, with latex, and with many other fruits such as papaya, avocado, banana, passion fruit, melon, mango, kiwi, peach, tomato, and chestnut.[20,24] Sensitization to this profilin

protein, which is degradable by heat and digestive enzymes, mostly occurs through inhalation, and clinical features are often non-severe. In contrast, Ana c 2, a major allergen contained in Bromelain, which is more thermostable, may induce severe reactions such as anaphylaxis.[23]

With respect to clinical features, along with mouth and lip pruritus, bronchospasm, allergic rhinitis, and conjunctivitis were significantly associated with pineapple allergy diagnosis. Very few patients complained of anaphylaxis-like symptoms, contrary to what has been reported from other studies. [3,20] For instance, in a systematic review of 358 cases of anaphylaxis reported in China between 1980 and 2007, pineapple was the most frequently incriminated food, accounting for 25% of cases.[3]

In contrast to pineapple, complaints of adverse reactions from coconut and coconut-induced cutaneous sensitization were found less frequently. Approximately one person in five complained of clinical manifestations, mostly asthma-like symptoms, and was found to be sensitized to coconut; an allergy to this fruit was confirmed in one-third of those who reported clinical features. In the literature, there are few reports on coconut allergy, but sometimes severe reactions do occur. Thus, Kim and Hussain reported a 2% prevalence of allergy to coconut among patients who were diagnosed with an allergy to latex.[25] Nine cases of anaphylaxis and 26 other cases with less severe immunoglobulin E (IgE)-mediated allergy to coconut were reported by Pathmanandavel *et al*. in 2020 from Australia in a pediatric population.[26] Severe reactions were reported in a 6-year-old child and a 64-year-old woman, respectively.[27,28] Allergic reactions with this fruit are mainly attributed to sensitization to coc n 1, a protein in the vicilin family.[29,30]

Elsewhere, several patients complained of symptoms, but the SPT results were negative. These patients represent nearly one-third and one-half of those who reported symptoms after ingestion of pineapple juice and coconut water, respectively. Some of these patients may include those who are allergic but whose diagnosis would have required a specific IgE antibody dosage to be confirmed, but this was not possible in our study due to the unavailability of the reagents in our setting, along with other resource constraints. In addition, this group of patients may include those who are simply intolerant to these fruits.

From a practical point of view, clarifying the mechanism(s) underlining the adverse reactions triggered by the fruit would be helpful to improve patient management and quality of life. For instance, a mucosal irritation triggered by pineapple may allow continued ingestion of the fruit taken with dairy products or with salt; intolerant patients might be able to consume small quantities; those experiencing non-severe allergic reactions might benefit from heating pineapple before eating, while anaphylaxis would require avoidance and epinephrine prescription. [3,31,32]

A strength of this study was the use of a native food for conducting SPT and this has been shown previously to have a higher sensitivity and a better negative predictive value compared with commercial extracts.[33] One limitation, however, was the absence of oral challenge testing, mainly because patients were reluctant to undertake this, with the possibility of an anaphylactic reaction occurring during the test. However, a compatible clinical history combined with a positive SPT result is well-validated for the diagnosis of allergy.[13]

Finally, there is a need to improve the diagnosis and management of allergic diseases in sub-Saharan Africa, which is experiencing a rapid epidemiological transition. Likewise, we call for more research on these conditions to find out any particularities in this region. This may include, for instance, the investigation of environmental factors contributing to food allergies in sub-Saharan Africa.

CONCLUSION

Among patients who were followed up in Borgou Teaching Hospital, pineapple is a common cause of sensitization and allergy, diagnosed in approximately one-quarter of patients. In contrast, coconuts are less frequently responsible for sensitization and allergy, diagnosed in one in fifteen patients. More studies are required to improve knowledge of allergic diseases in sub-Saharan Africa.

Ethical approval

The study was approved by the Local Ethics Committee ("Comité Local d'Ethique pour la Recherche Biomédicale de l'Université de Parakou, CLERB-UP") before implementation, Reference numbers: 0587/CLERB-UP/P/SP/R/SA and 0588/CLERB-UP/P/SP/R/SA, dated January 15, 2021.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the

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REFERENCES

1. Skypala I. Adverse food reactions--an emerging issue for adults. J Am Diet Assoc 2011;111:1877-91.
2. Erlewyn-Lajeunesse M, Weir T, Brown L, Howells H, Rowley J, Grainger-Allen E, *et al*. Fifteen-minute consultation: The EATERS method for the diagnosis of food allergies. Arch Dis Child Educ Pract Ed 2019;104:286-91.
3. Ji K, Chen J, Li M, Liu Z, Wang C, Zhan Z, *et al*. Anaphylactic shock and lethal anaphylaxis caused by food consumption in China. Trends Food Sci Technol 2009;20:227-31.
4. Cox AL, Sicherer SH. Classification of adverse food reactions. J Food Allergy 2020;2:3-6.
5. Hossny E, Ebisawa M, El-Gamal Y, Arasi S, Dahdah L, El-Owaidy R, *et al*. Challenges of managing food allergy in the developing world. World Allergy Organ J 2019;12:100089.
6. Mohd Ali M, Hashim N, Abd Aziz S, Lasekan O. Pineapple (*Ananas comosus*): A comprehensive review of nutritional values, volatile compounds, health benefits, and potential food products. Food Res Int 2020;137:109675.
7. Chaudhary V, Kumar V, Singh K, Kumar R, Kumar V, Vipul Chaudhary C. Pineapple (*Ananas cosmosus*) product processing: A review. J Pharmacogn Phytochem 2019;8:4642-52.
8. Taussig SJ, Batkin S. Bromelain, the enzyme complex of pineapple (*Ananas comosus*) and its clinical application. An update. J Ethnopharmacol 1988;22:191-203.
9. Yong JW, Ge L, Ng YF, Tan SN. The chemical composition and biological properties of coconut (*Cocos nucifera* L.) water. Molecules 2009;14:5144-64.
10. DebMandal M, Mandal S. Coconut (*Cocos nucifera* L.: Arecaceae): In health promotion and disease prevention. Asian Pac J Trop Med 2011;4:241-7.
11. Nyembue TD, Ntumba W, Omadjela LA, Muyunga C, Hellings PW, Jorissen M. Sensitization rate and clinical profile of Congolese patients with rhinitis. Allergy Rhinol (Providence) 2012;3:e16-24.
12. Société de Pneumologie de Langue Française. Recommandations de la SPLF sur asthme et allergie. Conférence d'expert-Texte court. Rev Mal Respir 2007;24:221-32.
13. Ruby R. Caronica Giorgio walter. In: Stephen TH, Richard FL, Michael SB, editors. WAO White book on allergy-update 2013. Milwaukee, Wisconsin: World Allergy Organization; 2013.
14. Onyimba F, Crowe SE, Johnson S, Leung J. Food allergies and intolerances: A clinical approach to the diagnosis and management of adverse reactions to food. Clin Gastroenterol Hepatol 2021;19:2230-40.e1.
15. Osawa Y, Ito Y, Takahashi N, Sugimoto C, Kohno Y, Mori S, *et al*. Epidemiological study of oral allergy syndrome in birch pollen dispersal-free regions. Allergol Int 2020;69:246-52.
16. Bedolla-Barajas M, Kestler-Gramajo A, Alcalá-Padilla G, Morales-Romero J. Prevalence of oral allergy syndrome in children with allergic diseases. Allergol Immunopathol (Madr) 2017;45:127-33.
17. Obeng BB, Amoah AS, Larbi IA, Yazdanbakhsh M, Van Ree R, Boakye DA, *et al*. Food allergy in Ghanaian schoolchildren: Data on sensitization and reported food allergy. Int Arch Allergy Immunol 2011;155:63-73.
18. Kim MA, Kim DK, Yang HJ, Yoo Y, Ahn Y, Park HS, *et al*. Pollen-food allergy syndrome in Korean pollinosis patients: A nationwide survey. Allergy Asthma Immunol Res 2018;10:648-61.
19. Osterballe M, Mortz CG, Hansen TK, Andersen KE, Bindslev-Jensen C. The prevalence of food hypersensitivity in young adults. Pediatr Allergy Immunol 2009;20:686-92.
20. Reindl J, Rihs HP, Scheurer S, Wangorsch A, Haustein D, Vieths S. IgE reactivity to profilin in pollen-sensitized subjects with adverse reactions to banana and pineapple. Int Arch Allergy Immunol 2002;128:105-14.
21. Camero-Martínez H, López-García AI, Rivero-Yeverino D, Caballero-López CG, Arana-Muñoz O, Papaqui-Tapia S, *et al*. Frequency of skin reactivity to food allergens in allergic patients. Rev Alerg Mex 2017;64:291-7.
22. Karoui O, Leimgruber A, Spertini F. Intérêt des allergènes recombinants dans la pratique de l'allergologie. Rev Med Suisse 2013;9:22-7.
23. Liang J, Xu J, Pan J, Ge M, Zong K. Identification of the main allergenic proteins in high hydrostatic pressure pineapple juice and assessing the influence of pressure on their allergenicity. Int J Food Prop 2015;18:2134-44.
24. Brehler R, Theissen U, Mohr C, Luger T. "Latex-fruit syndrome": Frequency of cross-reacting IgE antibodies. Allergy 1997;52:404-10.
25. Kim KT, Hussain H. Prevalence of food allergy in 137 latex-allergic patients. Allergy Asthma Proc 1999;20:95-7.
26. Pathmanandavel K, Kaur N, Joshi P, Ford LS. Anaphylaxis and allergy to coconut: An Australian pediatric case series. J Allergy Clin Immunol Pract 2020;8:3657-9.
27. Martin E, Tornero P, De Barrio M, Pérez CI, Beitia JM, Baeza ML, *et al*. Monosensitization to coconut. J Allergy Clin Immunol 2004;113:S315.
28. Anagnostou K. Coconut allergy revisited. Children (Basel) 2017;4:85.
29. Saha B, Sircar G, Pandey N, Gupta Bhattacharya S. Mining novel allergens from coconut pollen employing manual *de novo* sequencing and homology-driven proteomics. J Proteome Res 2015;14:4823-33.
30. Benito C, González-Mancebo E, De Durana MD, Tolón RM, Fernández-Rivas M. Identification of a 7S globulin as a novel coconut allergen. Ann Allergy Asthma Immunol 2007;98:580-4.
31. Jutamongkon R, Charoenrein S. Effect of temperature on the stability of fruit bromelain from smooth cayenne pineapple. Kasetsart J Nat Sci 2010;44:943-8.
32. Knox S, Lang D, Hoyt A. The many flavors of pineapple reactions. Ann Allergy Asthma Immunol 2019;123:519-21.
33. Kattan JD, Sicherer SH. Optimizing the diagnosis of food allergy. Immunol Allergy Clin North Am 2015;35:61-76.

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