

# Balsam of Peru: Past and Future

Andrew Scheman, MD,\* Ella-Marie Rakowski, BS,† Vincent Chou, BS,\* Anam Chhatriwala,‡ Jeremy Ross, BS,‡ and Sharon E. Jacob, MD§

**Balsam of Peru (BOP) is a well-known contact allergen that is one of the most prevalent in the United States. For some patients allergic to BOP, external avoidance of fragrance is not enough to eliminate their dermatitis. A BOP avoidance diet has been shown to help many of these patients. This article reviews BOP allergens found in food. A special patch test series of allergens found in BOP along with data regarding which foods contain specific BOP constituents makes it possible to design potential targeted, refined, and simplified diets for BOP systemic contact dermatitis.**

**B**ALSAM OF Peru (BOP), or *Myroxylon pereirae*, is a thick fluid with a cinnamon-vanilla-like odor that is secreted from the tree *Myroxylon balsamum pereirae*. Balsam of Peru is involved in healing wounds on the tree's surface where the bark has been damaged or cut off.<sup>1</sup> Although this tree is native to present-day El Salvador, it was discovered during a period of Peruvian colonialism, hence the name BOP.

Balsam of Peru consists of a mixture of potential contact allergens including cinnamoin oils (which contain cinnamates, eugenol, and vanillin), benzoic acid derivatives, and coniferin derivatives.<sup>2</sup> Chemicals found in BOP are commonly in spices and flavoring agents and in cosmetic, fragrance, and medicinal products. Balsam of Peru is a well-known contact allergen and is one of the most prevalent in the United States according to data provided by The North American Contact Dermatitis Group.<sup>3,4</sup>

Although BOP extract itself is not commonly used in cosmetic products,<sup>5</sup> it is chemically related to many fragrances<sup>2</sup> and is considered a marker for fragrance allergy.

For some patients allergic to BOP, external avoidance of fragrance is not enough to eliminate their dermatitis. For a substantial number of these patients, ingesting BOP-containing foods or beverages can also trigger systemic contact dermatitis.<sup>6–8</sup> A diet avoiding foods containing allergens related to BOP has been demonstrated to significantly help many of these patients.<sup>6</sup> A BOP elimination diet avoids foods containing BOP constituents such as eugenol, cinnamates, vanillin, and benzoic acid derivatives. These potential allergens are commonly found in citrus fruits, sweets, tomatoes, certain spices, condiments, and some liquors.<sup>9</sup>

Research exploring the constituents of BOP continues to be useful in identifying potentially allergenic components of BOP.

From the \*Northwestern University Medical Center; †Michigan State University, East Lansing; ‡College of Medicine, University of Illinois, Chicago, IL; and §University of California San Diego, San Diego, CA.

Address reprint requests to Andrew Scheman, MD, 1535 Lake Cook Rd, Suite 401, Northbrook, IL 60062. E-mail: andrewscheman@yahoo.com.

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Hausen et al<sup>2</sup> have identified a large number of potential allergens in BOP and have suggested a special screening series of relevant allergens to more accurately identify allergy to specific components of BOP. These screening ingredients can be separated into the following subgroups of allergens: cinnamates, eugenol, vanillin, benzoic acid derivatives, ferulic acid derivatives, and coniferins. Some of the allergens on this screening series are more relevant to food than others.

Because potential BOP allergens can be divided into several distinct subgroups of potential allergens, allergic individuals may really only be sensitized to certain BOP components. If this is the case, it is likely that it is possible to use patch test screening ingredients for each subgroup of food-related BOP components and then provide patients with a more targeted avoidance diet that may be easier to follow and adhere to.

To avoid BOP-related systemic contact dermatitis more effectively, however, a more specific food-avoidance list is desirable. Information is needed regarding which foods contain specific BOP constituents and which alternatives are available to avoid this exposure. This type of information would potentially allow for a more targeted and refined list of specific foods to avoid for BOP-allergic patients. The objective of this article is ultimately to refine and simplify the BOP avoidance diet.

## METHODS

Online resources were utilized to identify which specific BOP constituents are in various foods and beverages. Based on the BOP allergens found in each food, more targeted BOP diets are recommended for allergic patients. Using other online resources, food-avoidance lists were created for each subgroup of BOP allergens. In addition, specific alternative food and beverage products that are free of specific BOP components were identified.

## Balsam of Peru Screening Allergen Subsets

The BOP screening series recommended by Hausen et al<sup>2</sup> contains many allergens related to food. These allergens can be

further divided into eugenol, cinnamate, vanillin, benzoate, ferulic acid, and coniferin subgroups. We propose the allergens in Table 1 as reasonable screening allergens for each BOP subgroup. Sources and concentrations of these allergens are listed in Table 1.

### Case Illustration

A 25-year-old patient with widespread eczema was patch tested by one of the authors (A. S.) to the 2012 North American Contact Dermatitis Group standard, cosmetic, food, spice, dental care, textile, and laundry product series (206 patches), which were read at 48 and 96 hours. Contact urticaria testing result to 47 allergens (patches applied to volar arms, removed at 30 minutes, and then read every 15 minutes for 1 hour) was negative.

At 96 hours, there were 3<sup>+</sup> reactions to fragrance mix I, BOP, eugenol, isoeugenol, laurel oil, clove oil, cinnamon, ylang ylang oil, and lemongrass oil. There was a 2<sup>+</sup> reaction to propolis. Testing to cinnamic alcohol, cinnamic aldehyde, vanilla, vanillin, benzoic acid, and sodium benzoate was negative.

Fragrance mix I, laurel oil, clove oil, cinnamon, and ylang ylang contain eugenol and/or isoeugenol.<sup>10–13</sup> East Indian lemongrass contains methyl eugenol.<sup>13</sup> Propolis (which contains a benzoate of coniferyl alcohol and a ferulate but does not contain eugenol or isoeugenol) often cross-reacts with BOP.

Based on these results, the patient was instructed to avoid the food in the eugenol subgroup. Some foods in the traditional BOP diet (citrus peel, wine) did not need to be avoided. The patient noted significant improvement over the subsequent month with avoidance.

### Eugenol Subgroup

Eugenol and/or isoeugenol are found in most of the foods on the BOP diet. Therefore, patients allergic to either eugenol or isoeugenol must avoid most items on the traditional BOP diet. However, there are notable exceptions. People allergic to eugenol may not need to avoid citrus fruits<sup>14</sup> or wine<sup>12</sup> (Table 2). Although cassia (Chinese cinnamon) does not appear to contain eugenol-related compounds,<sup>15</sup> actual cinnamon does,<sup>12,16</sup> and cinnamon

should therefore be avoided by eugenol-sensitive individuals.<sup>2</sup> Although vanillin can be synthesized from eugenol,<sup>17</sup> the 2 compounds are separate and distinct.<sup>2</sup> Analysis of vanilla shows that it contains at most trace amounts of eugenol.<sup>17</sup> Therefore, vanilla may not need to be avoided by all persons allergic to eugenol. On the other hand, artificial vanilla should be avoided by individuals allergic to eugenol because eugenol is sometimes added to artificial vanilla.<sup>17</sup> Products flavored with vanillin alone, however, should be acceptable. Online data show that basil and bay leaves are also significant sources of exposure to eugenol.<sup>10</sup> These foods are not usually included in the traditional BOP avoidance diet but should be added.

In addition, most curry powder contains proprietary mixtures of spices.<sup>18</sup> Because many contain nutmeg and/or cinnamon, curry is sometimes a problem for eugenol-sensitive patients.<sup>12,19</sup> Likewise, other foods eliminated on the BOP diet may contain spices that need to be avoided by eugenol-sensitive individuals. Some of these foods include vermouth (cinnamon and cloves),<sup>20</sup> cola (cinnamon, nutmeg),<sup>20</sup> and pickles (cloves, dill, cinnamon, allspice, bay leaves, mace).<sup>21</sup> Chocolate, which contains vanilla, is not likely to be a problem; however, chocolate flavored with artificial vanilla should be avoided by patients allergic to the eugenol group.<sup>12,17</sup> Patients allergic only to BOP and eugenol subgroup allergens may only need to avoid the eugenol subgroup foods identified in Table 2. The information in Table 2 should also be useful for patients allergic to eugenol or isoeugenol who are not allergic to BOP.

### Vanillin Subgroup

Vanillin is also found in a number of foods on the BOP avoidance diet. Specifically, vanillin is found mostly in foods containing cloves,<sup>21</sup> vanilla,<sup>17</sup> and those flavored with vanillin. These foods, which should be avoided by vanillin-allergic individuals, include chocolate (vanilla),<sup>12</sup> curry (cloves),<sup>18</sup> vermouth (clove),<sup>20</sup> cola (vanilla),<sup>20</sup> wine (vanillin),<sup>12</sup> and pickled items (cloves).<sup>21</sup> Foods and spices such as tomato,<sup>3</sup> cinnamon,<sup>12</sup> cassia,<sup>15</sup> nutmeg,<sup>19</sup> mace,<sup>19</sup> allspice,<sup>22</sup> bay leaves,<sup>10</sup> basil,<sup>10</sup> and dill<sup>12</sup> do not appear to contain vanillin and may be tolerated by vanillin-sensitive patients. In addition to the above foods on the BOP diet, asparagus contains vanillin.<sup>23</sup> Patients allergic only to BOP and vanillin may only need to avoid the foods that contain vanillin identified in Table 2. The information in Table 2 will also be useful for patients allergic to vanillin who are not allergic to BOP.

### Cinnamate Subgroup

Cinnamic compounds are found in numerous foods on the traditional BOP diet; however, there are a number of exceptions. Specifically, many of the spices avoided on the BOP diet do not appear to contain cinnamic compounds. Therefore, individuals allergic only to BOP and the cinnamate group may not need to avoid cloves,<sup>10</sup> nutmeg,<sup>19</sup> mace,<sup>19</sup> vanilla,<sup>17</sup> allspice,<sup>22</sup> or dill<sup>12</sup> (Table 2). Although dill does not contain cinnamates per se, many

**TABLE 1. Screening Allergens for BOP Subgroups**

| Subgroup     | Screening Allergens                                                                     |
|--------------|-----------------------------------------------------------------------------------------|
| Eugenol      | Eugenol (2% pet)*<br>Isoeugenol (2% pet)*                                               |
| Vanillin     | Vanillin (10% pet)*                                                                     |
| Cinnamate    | Cinnamic aldehyde (1% pet)*<br>Cinnamic alcohol (2% pet)*<br>Benzyl cinnamate (5% pet)† |
| Benzoate     | Benzoic acid (5% pet)*<br>Sodium benzoate (5% pet)*                                     |
| Ferulic acid | Ferulic acid (5% pet) <sup>2</sup>                                                      |
| Coniferin    | Coniferyl alcohol (5% pet) <sup>2</sup>                                                 |

\*Available through Chemotechnique Diagnostics, Vellinge, Sweden.

†Available through allergEAZE, Calgary, Canada.

Pet, petrolatum.

**TABLE 2. Constituents of Food on the BOP Diet<sup>6</sup>**

|                                  | Eugenol | Cinnamates | Benzoic Acid | Vanillin | Ferulic Acid | Coniferins                                    |
|----------------------------------|---------|------------|--------------|----------|--------------|-----------------------------------------------|
| Citrus peel                      |         | x          |              |          | x            |                                               |
| Sweet food                       | x       | x          | P            | x        |              |                                               |
| Chocolate                        | x       | x          | x            | x        |              |                                               |
| Vanilla                          |         |            | x            | x        |              |                                               |
| Synthetic vanilla                | +/-     |            |              | x        |              |                                               |
| Cola                             | x       | x          | x            | x        | x            |                                               |
| Tomato                           | x       | x          |              |          | x            | x                                             |
| Cinnamon                         | x       | x          | x            |          |              |                                               |
| Cassia                           |         | x          | x            |          |              |                                               |
| Cloves                           | x       |            |              | x        |              |                                               |
| Nutmeg and mace                  | x       |            |              |          |              |                                               |
| Dill                             | x       |            |              |          | x            |                                               |
| Allspice                         | x       |            |              |          |              |                                               |
| Anise                            | x       | x          | x            |          |              |                                               |
| Bay leaves and basil             | x       | x          |              |          |              |                                               |
| Curry powder                     | x       | x          |              | x        |              |                                               |
| Spiced condiments                | x       | x          | x            |          |              |                                               |
| Pickles                          | x       | x          | x            | x        | x            |                                               |
| Pâté                             | x       | x          | x            | x        | x            |                                               |
| Perfumed tea and tobacco         | x       | x          |              | x        |              |                                               |
| Wine                             |         | x          |              | x        | x            | x                                             |
| Beer                             | x       | x          |              | x        |              | x (product of fermentation of brewer's yeast) |
| Gin                              | x       | x          |              |          | x            |                                               |
| Vermouth                         | x       | x          | x            | x        | x            |                                               |
| Whiskey                          | x       |            |              | x        | x            | x                                             |
| Spiced Liquors                   | x       | x          |              | x        |              |                                               |
| Beets                            |         |            |              |          |              | x                                             |
| Asparagus                        |         |            |              | x        |              | x                                             |
| Wheat and rye                    |         |            |              |          | x            |                                               |
| Brewer's yeast                   |         |            | P            |          |              | x (product of fermentation)                   |
| Food with benzoate preservatives |         |            | P            |          |              |                                               |

P, benzoates are not intrinsically contained in these food but may be added as a preservative; x, present; +/-, may or may not be present.

pickled items have other spices added in addition to dill, and therefore, pickled items should still be avoided. However, recipes with added dill should be acceptable. Chocolate occasionally is seasoned with some cinnamon and could occasionally be a problem for these individuals.<sup>12</sup> Patients allergic only to BOP and cinnamates may only need to avoid the cinnamate group foods identified in Table 2. The information in Table 2 also is a resource for avoiding cinnamic compounds for individuals who need to avoid these allergens but are not allergic to BOP.

### Benzoate Subgroup

Individuals allergic to benzoic acid and chemically related benzoates need to consider 2 possible sources of exposure. Benzoic acid occurs naturally in vanilla,<sup>17</sup> cinnamon,<sup>12</sup> anise,<sup>25</sup> and cassia (Chinese cinnamon)<sup>15</sup> as well as foods containing these spices, such as chocolate, cola, spiced condiments, pickles, and vermouth. In addition to these foods on the BOP avoidance diet, benzoates occur naturally in milk products, fruits, potatoes, beans, soy, nuts, cereals, and honey.<sup>26</sup>

The exact threshold for inducing systemic contact allergy is unknown, however, the amount of benzoates these foods contain naturally is far lower than the amounts added as preservatives and it is likely that avoidance of benzoate preservatives in foods and toothpaste will yield the greatest benefit.<sup>26</sup> One exception is fruit in the *vaccinium* genus (ie cranberry, blueberry, and huckleberry), which naturally contain high levels of benzoic acid comparable to amounts added in preservatives. These fruit should be avoided by individuals on the benzoate-free diet. Sodas, baked beans, and many other foods contain benzoic acid or benzoates added as preservatives, and a recently published benzoate-free diet lists foods containing benzoates and available alternatives.<sup>26</sup> Many foods with added benzoate preservatives are not ones found on the traditional BOP diet. Nevertheless, these foods should be avoided by patients allergic to the benzoate subgroup. Patients allergic only to BOP and benzoate subgroup allergens should refer to the diet shown in Table 3.

In addition, it could be speculated that individuals allergic only to BOP and benzoate subgroup allergens are probably not

**TABLE 3. Benzoate Diet**

| Food Category                                                 | Avoid                                                                                                                                                                                                                                                                                                 | Alternatives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Baby food                                                     | Pedialyte solution                                                                                                                                                                                                                                                                                    | Avoid                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Beverages                                                     | Sodas, energy drinks, coffee, powder and liquid drink mixes, fruit drinks, juices, alcoholic mixes, lemonades, flavored teas, flavored water, sparkling water                                                                                                                                         | Izze Sparkling Juice, La Croix Sparkling Water, San Pellegrino Sparkling Lemon or Orange Beverage, Marinelli's Apple Juice, Mott's Apple Juice, RW Knudsen juices, Indian Summer Apple Cider, Welch's Grape Juice, Gatorade, Ocean Spray Cranberry 100% Juice OK. Read labels for other items in group.                                                                                                                                                                                                  |
| Bread and flour products                                      | Pitas, tortillas, taco shells, bread                                                                                                                                                                                                                                                                  | Nature's Pride Oven Classics Bread, Azteca Tortillas, Ortega Hard Taco Shells, Nature's Oven Bagels, One Republic Artisan-Style Pitas OK. Read labels for other items in group.                                                                                                                                                                                                                                                                                                                          |
| Breakfast food                                                | Cereal bars, breakfast bars, pancakes, General Mills Fruity Cheerios, waffles, fruit/oatmeal bar, protein bars, prepackaged breakfast sandwiches                                                                                                                                                      | Bisquick Baking and Pancake Mix, Kellogg's Nutri-Grain Cereal Bars, Health Valley Cereal Bars, Kashi TLC Soft Baked Cereal Bars OK. Read labels for other items in group.                                                                                                                                                                                                                                                                                                                                |
| Condiments/dressings                                          | Prepackaged olives, prepackaged garlic, hummus, preserves, jam, spreads, mustard, horseradish sauce, hot sauce, prepackaged peppers, giardinera peppers, salsa, salad dressings, ketchup, barbecue sauce, marmelades, mayonnaise, marinades, syrup, Asian sauces (peanut, wasabi, and soy sauce, etc) | Heinz Tomato Ketchup, French's Mustard, Open Pit BBQ Sauce, Heinz Chili Sauce, Boar's Head Horseradish Sauce, Smucker's Jelly or Preserves, Newman's Own Salad Dressing, Tobasco Sauce, Tribe Hummus, Hellman's Mayonnaise Real, Shandy Maple Farms Organic Syrup, Nature's Promise Organics Honey Golden Honey, LaChoy Soy Sauce All Purpose, Krinos Olives Kalamata, Pompeian Red Wine Vinegar OK. Make others from scratch. Use fresh garlic and fresh peppers. Read labels for other items in group. |
| Sweet dessert/snack food                                      | Cake, cake mix, brownie, brownie mix, cookies, doughnuts, pastries, pies, cobblers, cream puffs, cheesecake, dessert toppings, pie fillings, sorbets, popsicles, jello, candy, fruit snacks                                                                                                           | Jell-O Pudding or Gelatin Cups, Nabisco Teddy Grahams, Edhy's Fruit Bars, Pepperidge Farm Cookies OK. Read labels for other items in group.                                                                                                                                                                                                                                                                                                                                                              |
| Egg products                                                  | Prepackaged hard boiled eggs                                                                                                                                                                                                                                                                          | Boil eggs at home; avoid prepackaged boiled eggs.                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Fast food                                                     | Almost all fast food                                                                                                                                                                                                                                                                                  | Avoid                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Seafood                                                       | Canned or prepackaged fish                                                                                                                                                                                                                                                                            | Blue Star Crabmeat, Gorton's brand frozen fish OK. Read labels for other items in group.                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Fruits/vegetables                                             | Canned or prepackaged fruits and vegetables (frozen and nonfrozen)                                                                                                                                                                                                                                    | Ocean Spray Craisins, SunMaid raisins OK. Freeze fresh vegetables and fruits. Read labels for other items in group.                                                                                                                                                                                                                                                                                                                                                                                      |
| Meat products                                                 | Prepackaged meats (ie, ham, shredded beef, etc)                                                                                                                                                                                                                                                       | Oscar Meyer Bacon, Bob Evans Sausage, Oscar Meyer DeliFresh Turkey, Ham, or Chicken, Jimmy Dean's All Natural Pork Sausage, Vienna Beef Franks or Polish Sausage, Buddig Packaged Meats OK. Read labels for other items in group.                                                                                                                                                                                                                                                                        |
| Dairy products                                                | Butter, margarine, oil spreads, cottage cheese, cream cheese, cheese, dips, ice cream, ice cream cakes, custard, pudding, powdered shake mixes, milkshakes, yogurt                                                                                                                                    | Daisy Sour Cream or Cottage Cheese, Yoplait Original Yogurt, Dean's whipping cream, Philadelphia Original Cream Cheese, Dannon All Natural Yogurt, Land O Lakes Butter, Kraft Cheese, Edy's Fruit Bars, Haagen Dazs Ice Cream. Read labels for other items in group.                                                                                                                                                                                                                                     |
| Over-the-counter medicines, vitamins, and dietary supplements | Medications with coated tablets or liquid form, protein bar, protein shakes and mixes, vitamins (hard and chewable), aloe vera juices                                                                                                                                                                 | Many uncoated pills, EAS 100% Whey Protein OK. Read labels for other items in group.                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Prepared meals                                                | Instant microwavable food                                                                                                                                                                                                                                                                             | Cook at home. Read labels for items in group.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

**TABLE 3.** (Continued)

| Food Category                            | Avoid                                                                                                                        | Alternatives                                                                                                                  |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Soups                                    | Canned, prepackaged, instant soups                                                                                           | Some Progresso brand canned soups, Swanson Chicken or Beef Broth OK. Make from scratch. Read labels for other items in group. |
| Spices, seasonings, and cooking products | Sweet 'N Low Liquid Sweetener, Mrs. Dash marinades, food colorings and dyes, artificial flavorings, packaged seasoning mixes | Use sugar, natural flavors, and individual seasonings; avoid food color                                                       |

allergic to most fragrances, with the exception of those containing benzoate-related fragrances such as benzyl salicylate, benzyl benzoate, and benzyl cinnamate. Therefore, a patient allergic to BOP and benzoate subgroup allergens, who tests negative to these 3 fragrances, may not need to avoid fragrance.

### Ferulic Acid Group

Ferulic acid is an organic compound found in the cell wall of many plants. Ferulic acid and its derivatives are abundant in citrus fruits,<sup>26</sup> vegetables (tomato, asparagus),<sup>27,28</sup> apples,<sup>28</sup> pineapples,<sup>28</sup> and foods likely to contain citrus (such as citrus marmalades, pastries with citrus peel, wine, and vermouth). Additionally, research shows ferulic acid to be a component of cereal grains such as wheat and rye.<sup>30,31</sup> Furthermore, one online source includes ferulic acid as a component of dill.<sup>13</sup> If this is true, then foods containing dill, such as pickles, may also need to be avoided. Persons allergic to only BOP and ferulic acid compounds should avoid these foods (Table 2).

### Coniferin Subgroup

Coniferins are not found in food items on the traditional BOP diet. Coniferyl alcohol is present in beets,<sup>32</sup> asparagus,<sup>23,33</sup> and whiskey<sup>34,35</sup> and is a fermentation product of brewer's yeast (thus, it is likely to be found in beer and leavened bakery products).<sup>36</sup> It has been suggested that this allergen is also found in milk and beet sugar; however, no reliable sources to support this were located. Patients allergic to only BOP and coniferin allergens should avoid coniferin subgroup foods identified in Table 2.

### Patients Allergic to Screening Ingredients in More Than 1 Subgroup

The situation becomes more complicated for patients allergic to screening ingredients in more than 1 subgroup. These patients will need to avoid foods listed in all of the relevant subgroups. Therefore, some of these individuals will need to avoid most or all of the foods on the traditional BOP diet and other foods identified in this article that were not traditionally on this diet.

### Specific Foods Found on the BOP Diet

The next section discusses how to avoid various spices and other foods on the BOP diet. Many of these spices are hidden in seemingly

unlikely foods and will not be successfully avoided unless patients are educated on where these spices are found. At this time, evidence-based research in the medical literature is missing for this information. However, although not as reliable a source, Internet-based resources can help give some insight.

### Tomato

Tomatoes come in many forms and are prevalent in many different cuisines. In one study, 45 patients who tested positive to BOP and other related allergens were placed on the BOP avoidance diet and were contacted 9 to 14 months later.<sup>6</sup> Of 45, 21 (47%) had complete or significant improvement of their dermatitis. Notably, in this study, the most common relevant food item that triggered flares of the patients' dermatitis was tomatoes.<sup>6</sup> Tomatoes contain eugenol, cinnamates, ferulic acid, and coniferyl alcohol and should be avoided by patients allergic to these subgroups.<sup>3</sup> Tomatoes can be strained, ground, diced, peeled, or dried and are prevalent in Italian, Mexican, southwestern American, and many other cuisines. They are often bases for soups, stews, sauces, dips, salsas, and juices. They are also found in condiments, such as ketchup, barbeque and steak sauce, and marinara sauce.<sup>9</sup> Common dishes that contain tomatoes include pasta, pizza, omelets, salads, and chili.<sup>37</sup> As the most common provocative food allergen in BOP diet, individuals tested positive to the BOP constituents found in tomatoes must be adamant in avoiding sauces, soups, condiments, and other foods that may contain tomato in any one of its forms.

### Citrus Peel

Citrus peel includes orange, lemon, lime, cumequat, and grapefruit peel. Citrus peel is often used in marmalade, candy, tea, and as garnishes for juices, cocktails, and salads.<sup>38</sup> It may also be used in roasting chicken, certain brandies, chutney, jam, and other various sauces.<sup>38</sup> Citrus peel is occasionally used to prevent the hardening and coagulation of brown sugar.<sup>38</sup> Citrus peel is the second most commonly reported allergen to cause flare-ups in BOP-sensitive individuals.<sup>6</sup> Of the BOP components, citrus peel contains cinnamates and ferulic acid; thus, those found positive to this subgroup must avoid certain candies, marmalades, jams, and other various foods that contain citrus peels.

## Cloves

Cloves are dried flower buds of *Syzygium aromaticum*, indigenous to the Maluku islands in Indonesia.<sup>39</sup> Cloves contain the BOP components eugenol and vanillin; thus, those testing positive to the eugenol and vanillin subgroups must avoid cloves and foods that contain it.<sup>11</sup> Cloves can be ground or used whole and are often used in African, Middle Eastern, Indian, and Pakistani cuisines. Cloves are often used to add flavor to curries and marinades and to season ham, sausage, mincemeat pies, fish, preserves, and pickles.<sup>37</sup> Cloves are also commonly combined with fruits to make sauces and syrups used in a variety of sweets, such as pies, sweet breads, and spiced peaches. In beverages, cloves are often used to flavor certain teas and alcoholic beverages.<sup>37</sup> Clove oil is also used to flavor synthetic vanilla.<sup>17</sup> Clove cigarettes contain shredded cloves in addition to tobacco.<sup>40</sup> To avoid cloves, individuals must avoid certain sweets, syrups, marinated meats, and beverages that may contain cloves.

## Nutmeg and Mace

Nutmeg and mace are spices that both derive from the plant *Myristica fragrans*, which are indigenous to the Spice Islands of Indonesia.<sup>41</sup> Although the nutmeg is the seed, mace is derived from the seed covering.<sup>42</sup> Both nutmeg and mace contain eugenol, and individuals who test positive for eugenol must avoid both spices. Nutmeg is often known for its use in sweet foods and beverages, which include pies, cakes, puddings, hot chocolate, eggnog, and alcoholic punches.<sup>37</sup> Nutmeg is less commonly known as a seasoning in meat marinades, stews, curries, omelets, soufflés, and cheese-based sauces.<sup>37</sup> Similar to nutmeg, mace is responsible for the traditional flavor of doughnuts and is also found in many other sweet foods such as cakes, pies, custards, puddings, cookies, scones, and biscuits.<sup>37,43</sup> Mace is also used to flavor traditional frankfurters and also other seasoned meats, crab cakes, salads, curries, soups, and stews.<sup>37,43</sup> In addition, mace is found in certain beverages such as Red Bull cola and chai teas.<sup>37</sup> To be successful in avoiding nutmeg and mace, one must avoid sweets, meats, soups, and beverages that potentially contain either of these related spices.

## Vanilla

Vanilla is used either as a bean or extract and is commonly known to flavor a wide variety of sweets, which include ice cream, caramel crème, custards, cakes, cookies, puddings, pancakes, cornmeal, maple syrup, pancakes, yogurt, and even chocolate.<sup>37</sup> It is also used to flavor lobster bisque, pumpkin soup, and fruit salads. In beverages, vanilla is used in certain smoothies and teas.<sup>37</sup> Less well known is vanilla's use as a counterpoint to tomatoes and chili peppers in Latino cuisine.<sup>42</sup> Vanilla contains vanillin and benzoic acid, and those that test positive to these subgroups must avoid sweet food, beverages, and other foods that are flavored with vanilla. Artificial vanilla may just contain vanillin, but eugenol or clove oil (which contains eugenol and vanillin) may be added.<sup>14</sup>

## Cinnamon

Cinnamon, a spice harvested from the inner bark of several species of genus *Cinnamomum*, is native to the island of Sri Lanka and is among the most provocative foods reported by BOP-sensitive patients.<sup>6</sup> It contains eugenol, cinnamates, and benzoates, and individuals who test positive to these BOP subgroups must avoid cinnamon.<sup>12</sup> Similar to cinnamon, cassia (Chinese cinnamon) contains cinnamates and benzoates; however, cassia does not contain eugenol.<sup>15</sup> Cinnamon is used in sweet foods, such as pastries, cereals, candies, cookies, cakes, pies, and muffins. Cinnamon is also used as a seasoning for savory dishes and meats and can also be added to teas, hot chocolates, and rum.<sup>37</sup>

## Dill

Dill, or *Anethum graveolens*, is a plant indigenous to the Mediterranean region and Southern Russia and is harvested for its seeds and leaves.<sup>42</sup> Dill seed, most commonly associated with cuisines from Scandinavia and Germany, is often sprinkled over certain casseroles and used in salad dressings. Dill leaves, on the other hand, are used to season fish, shellfish, vegetables, and dips.<sup>9</sup> Dill is also used in marinades and spreads and in the pickling process of cucumbers.<sup>9,21</sup> Dill contains the BOP components eugenol and ferulic acid, and individuals tested positive for these subgroups must avoid dill and any food in which it is used as a seasoning or marinade.<sup>12</sup>

## Allspice

Allspice is a dried fruit of the *Pimenta Dioica*, a tree indigenous to the Greater Antilles of the Caribbean, Central America, and southern Mexico<sup>42</sup> and is also known as pimento. It is prevalent in Caribbean cuisine, used in mole sauces in Mexican and Central American cuisine, and used to flavor stews and meat dishes in Middle Eastern cuisine, especially in Palestinian cooking.<sup>44</sup> In Western cuisine, allspice is used in desserts such as applesauce, fruit compotes, and oatmeal cookies.<sup>37</sup> Allspice is also used in sauces, stews, pot roasts, soups, and barbecue rubs.<sup>37</sup> In addition, pimentos are often stuffed into olives for use in garnishing alcoholic drinks. Allspice contains eugenol, and patients allergic to the eugenol subgroup must avoid any sweet foods, soups, meats, and other dishes that use allspice as a seasoning.<sup>22</sup>

## Basil and Bay Leaves

Basil, *Ocimum basilium*, is native to tropical Asia and Pacific islands and used commonly in Italian, Mediterranean, and Southeast Asian cuisine.<sup>37,45</sup> Basil is often combined with tomato or other ingredients for sauces (such as pesto), soups, stews, pasta, stir fry, and salads<sup>9</sup> and is also used to season a variety of meats.<sup>37</sup> Bay leaves, from the plant *Laurus nobilis* of the Mediterranean shores, are used in European, Mediterranean, Indian, and Western cuisine in various soups, stews, meats, seafood, and cooked vegetables, especially in slow-cooked dishes.<sup>37</sup>

Laurel oil is also derived from this plant.<sup>46</sup> Both basil and bay leaves contain eugenol and cinnamates of the BOP components, and thus, individuals tested positive to these subgroups must avoid the variety of foods and dishes that contain basil or bay leaves.<sup>10</sup>

### Compound Food

Some of the foods and beverages mentioned on the traditional BOP diet are compound foods containing multiple ingredients that may contain BOP-related spices and flavorings. Some of these foods include curry powder, chocolate, pickles, cola, wine, and vermouth.

Curry powder is an amalgam of different spices that include cumin, coriander, ginger, red and black pepper, dill seed, cardamom, cinnamon, turmeric, nutmeg, and cloves<sup>17</sup> and is found in Indian, Thai, Caribbean, Japanese, English, Australian, Middle Eastern, and South and Southeast Asian cuisine in vegetables, soups, stews, meatloaf, pastas, and burgers.<sup>37</sup> Curry powder, which contains cloves, cinnamon, or nutmeg, may therefore contain the BOP components eugenol, cinnamates, vanillin, and ferulic acid.<sup>11,12,19</sup>

Chocolate is found in many sweets, from cakes and pastries to candy and ice cream, and is also used to cover strawberries, pretzels, nuts, and raisins, and used in dips, spreads, and fillings.<sup>37</sup> Chocolate contains eugenol, cinnamates, and vanillin.<sup>12,17</sup>

Pickles differ in which BOP component they contain depending on which spices are added during the pickling process of cucumbers. If cloves, dill, allspice, bay leaves, or mace are used in this process, then the pickles contain only eugenol.<sup>10,12,19,21,22</sup> If cinnamon is used, then they contain eugenol as well as cinnamates.<sup>12</sup>

In addition to its use in cocktails, vermouth is used in seasoning certain seafood and grilled chicken dishes.<sup>48</sup> Vermouth may contain eugenol, vanillin, ferulic acid, and benzoic acid.<sup>11,12,14</sup>

Cola is known for its use as a soda beverage but can also be used in a marinade for meats.<sup>37</sup> Cola contains eugenol, cinnamates, vanillin, and ferulic acid.<sup>12,17,19</sup>

Wine can be found as wine vinegar, cooking wine, and balsamic vinegar, as well as in sauerkraut, salad dressing, and some mustards.<sup>9</sup> Wine contains the BOP components cinnamates, vanillin, ferulic acid, and coniferins.<sup>12</sup>

Although pâté itself may only contain the allergen benzoic acid, used in this case as a preservative,<sup>25</sup> numerous other allergens found in the BOP diet may be used as seasoning. Pâté is often seasoned with French four spice (Quatre épices), a mixture of pepper, cloves, nutmeg, ginger, and occasionally, allspice or cinnamon.<sup>48,49</sup> Eugenol, cinnamates, benzoic acid, vanillin, and ferulic acid may therefore be found in pâté because of the addition of cloves, nutmeg, cinnamon, and allspice.<sup>11,12,19,22</sup> Aside from individuals allergic only to the coniferin subgroup, pâté should be avoided by all BOP-allergic patients.

Spiced condiments, liqueurs, teas, and tobacco may contain almost any spices and should be avoided by patients allergic to any of the BOP subgroups. In addition, gin contains eugenol,

cinnamates, and ferulic acid and should be added to the BOP diet for patients allergic to these groups.<sup>50</sup>

### CONCLUSIONS

In this article, we have divided BOP-related allergens into subgroups and have proposed screening ingredients for each subgroup. The BOP-related allergens found in foods are identified, and the use of these foods in cuisine is discussed. Several foods that are not included on the traditional BOP diet have been added. For example, bay leaves and basil contain eugenol and should be included on the BOP diet. On the other hand, we found no evidence that ginger contains BOP-related allergens. Foods related to ferulic acid and coniferins were added to the BOP diet for selected individuals allergic to these substances. Patients allergic to only BOP and screening ingredients for 1 BOP subgroup may only need to avoid the specific BOP-related foods that are relevant to this subgroup and not have an absolute BOP-free diet. Individuals allergic to screening ingredients for a particular subgroup should also avoid foods relevant to this subgroup even if testing to BOP itself is negative. Because low-grade irritant reactions to BOP are common, we caution that physicians be careful not to embark on a targeted BOP diet when only weak, questionable reactions are present on patch testing. Because limited data currently exist, data from future studies will ultimately determine the usefulness of the subsets of the BOP diet described in this article.

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