## Juglone Dermatitis: Allergy or Irritant?

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#### Introduction

Juglone, a powerful chemical  $(C_{10}H_8O_3)$  found in black walnut (*Juglans nigra* L.) and other *Juglans* species, is known to be toxic to some neighboring plants, and juice from the hulls of the nuts has caused dermatitis on some people hulling the nuts. Two U. S. Forest Service employees developed a blistering type rash following exposure to black walnut hulls and bark chips. A case history concerning the exposure and reaction of one of the people states that on a hot, humid day in October he was hulling black walnuts by squashing them between two bricks, thus splattering juice from the hulls over his face, hands and forearms. "That night, after I had gone to bed, my face and arms started itching. The next morning my face, hands and arms were covered with red, itchy bumps that looked like poison ivy. Some areas, especially around the wrists, had already begun to blister."

The other afflicted Forest Service employee, a technician who worked daily with black walnut, wrote: "On June 29, I went to the Blackwell tract to prune limbs off black walnut trees. I was using a small chain saw. The temperature was ranging from  $95^{\circ}$  to  $100^{\circ}$  F, with very high humidity. As I pruned limbs that were chest high, the wood chips from the saw were sticking to my arms, face and neck. At approximately noon, I noticed my arms were stained and starting to burn. By 1 or 2 p.m., the burning was getting pretty painful. The next morning there was some swelling on my arms; several blisters had formed; and some of them had burst and were running."

Because several hundred people work in black walnut plantations or gather and hull the fruit, we decided to determine whether the dermatitis caused by walnut juice (probably juglone) is an irritant or an allergic reaction.

#### **Methods and Procedures**

To determine the type reaction we used two methods: questionnaires and patch tests. First, we thought it was necessary to determine whether other people had experienced similar problems with black walnut. So, in the *Walnut Council Newsletter* of July 1979 Funk and Williams published an article entitled "Can Juglone Be Hazardous To Your Health?" In the article a request was made for those who had suffered similar experiences with black walnut to notify us. Then a questionnaire dealing with the following was sent to the persons responding to the article:

- 1. Why there was exposure to walnut.
- 2. Time of year person was exposed.
- 3. Temperature and general weather conditions.
- 4. Person's physical condition.

- 5. Parts of the body affected.
- 6. Time elapsed between exposure and evidence of reaction.
- 7. Similar reactions before or since exposure.
- 8. Past history of exposure to black walnut.

Second, we patch-tested a number of individuals to determine: (1) the type of reaction produced by black walnut, (2) the time period required to produce a reaction, and (3) what part of the black walnut tree actually produced a reaction.

We first tried a commercially prepared extract from Hollister-Stier Laboratories', a wood oleoresin in alcohol, which was a 1:10 strength. The extract was placed on a testing patch and taped to the inner forearm for 48 hours. Ten subjects, including the two foresters known to have reacted to black walnut, were tested. None of the 10 volunteers reacted. Either the strength of the commercial extract was not sufficient to cause reaction, and/or the extract did not contain some vital material from the black walnut.

After this failure, we devised a way to use a piece of black walnut bark taped to the inner arm during the summers of 1979 and 1980. The 1979 test was done on six Hoosier National Forest employees, including the two Forest Service people known to be susceptible to walnut dermatitis. Bark from 1-year-old black walnut seedlings was used.

The 1980 test was done with Forest Service volunteers at Carbondale, Illinois, the headquarters for all the Forest Service research with black walnut. This group of 19 volunteers included people who had never been exposed to black walnut, and others who had been working with the species up to 10 years. Six were tested with green bark from current year's growth and 15 were tested with brown, 1-year-old-bark from older trees; two were tested with both.

The test procedure in 1979 and 1980 was as follows:

1. Cut a piece of bark about  $\frac{1}{2}$ -inch square and tape into close contact with bare skin (inside the arm) using surgical tape or masking tape.

2. Leave in place for 4 hours. (If the area becomes uncomfortable prior to the recommended 4 hours completion time, remove patch and record length of time patch is in place and condition under which it was removed.) The bark patch was left in place from 1 to 24 hours on the Hoosier volunteers in the 1979 test.

3. Observe and record reaction at patch site immediately after patch removal and 24 hours after patch removal.

## Results

## Questionnaire

The response to the call for information in the Walnut Council Newsletter was minimal. We received only seven replies. However, from those respondents who did answer our questionnaire, a pattern did emerge. All those who had experienced reaction similar to those of the foresters were working with live walnut trees. Four were pruning; one was hulling nuts; one was logging; and one was removing vines from the trees (the vine remover may not be appropriate because the species of the vine is suspect).

All of the episodes of contact dermatitis took place between the months of July and October. All respondents commented that the weather was very

<sup>&#</sup>x27;Mention of trade names does not constitute endorsement of the products by the USDA Forest Service.

hot-about 90° F-and very humid, and stated that they were perspiring freely at the time of infection. Areas affected included hands, forearms, and in one case, the waistline where sawdust had settled.

The reactions of the respondents were all similar. Within an hour of exposure each reaction began as a reddened area which developed blisters over the exposed area. One respondent reported tissue swelling. Another reported coughing when the nuts were being cracked. All but one respondent had had previous exposure to black walnut.

# **Patch Tests**

The immediate reaction noticed by most volunteers was a burning and itching sensation under the patch material. When the patch was removed the area on some was pinkish and tender to touch. After 24 hours, blisters had formed on the test area. The blisters disappeared on all volunteers within seven days.

## 1979 Patch Test

All six volunteers experienced some immediate reaction; five people had a burning sensation and one had an itching sensation. Twenty-four hours later four of those with the initial burning sensation had blistering. One of those with the initial burning sensation and the one with the initial itching sensation experienced no further reaction.

#### **1980 Patch Test**

The initial reaction for the six tested with green bark was: none for one, pinkish skin for two, pink and slightly raised skin for one, tender skin for one, and blistered skin for one. Twenty-four hours after the patches were removed four of the above had or developed blisters; those that didn't were the one with no initial reaction and the one with pink and raised skin.

Brown bark seemed less toxic. Initial reaction for the 15 tested with brown bark was: none for eight, burning and pink skin for two, burning and slightly raised for two, slightly raised for one, pink and raised for one, and stinging for one. Skin condition twenty-four hours after patch removal was as follows: no reaction for the eight with no initial reaction; of those that had had an initial reaction, three cleared up and four developed blisters. Both volunteers tested by both green and brown bark patches suffered reactions under the green bark patches but were unaffected by the brown bark patches:

## Discussion

The substance in black walnut that probably causes the dermatitis is juglone, 5-hydroxy-1, 4-naththoquinone (6). Juglone is found virtually in all parts of the living black walnut tree-stems, leaves, fruits, and roots (3). Brissemoret and Combes (3), as well as Daglish (4), confirm, however, that there is a definite seasonal variation in the amount and potency of the chemical in the trees. According to Daglish (4) the highest concentrations are found in the winter buds, green twigs, male catkins, and the husks of very young fruits. The seasonal variation of juglone is substantiated by the work of Lee and Campbell (7) which shows that there is a definite increase of juglone in the hulls and leaves in the months of July to September.

Juglone is a known allelopathic agent. Black walnut has been known since ancient times to inhibit growth of trees and plants growing close by (9). It has been shown that hydrojuglone, a nontoxic substance, is oxidized by the air or

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some other oxidizing substance (8). This oxidized form penetrates into the soil and selectively inhibits growth of nearby plants (4,7,9).

This same oxidation process which causes allelopathy also causes dermatitis of animals and man. In 1905 Brissemoret and Combes (3) applied a pommade of juglone, lanoline, and petroleum jelly on the skin of a rabbit. The results were "blackening of the tegument, formation of blisters, slight edema, thickening and hypertrophy of the epidermis." In 1931, Louis Schwartz (10), senior surgeon at U. S. Public Health Services, recorded several incidents of dermatitis in a cabinetmaking factory where Brazilian walnut wood was being used. The reactions described by Dr. Schwartz were similar in description to those demonstrated by the rabbit-edema – blistering and hypertrophy of the epidermis.

In 1954, Dr. John M. Siegel (11) in Archives of Dermatitis and Syphilology gives a case history of a 44-year-old white male with complaints of burning, itching, and "blistering eruption in the finger webs" after a day of picking black walnuts.

In 1937, R. Barniske (2) related a case history of a 36-year-old female, who experienced blistering and erythema of her hands after working with walnut husks. Barniske thought this reaction was secondary to juglone. His testing was done with material from "several weeks old and already brown walnut husk." The test results were negative, but he "attributed this to the fact that the reponsible toxins in question (tannic acids and juglone), due to their chemical characteristics, already were present in the oxydized, *i.e.*, no longer active, form in the stored walnut husks."

Arndt (1) distinguishes between "irritant contact dermatitis" (which he divides into mild and strong) and "allergic contact dermatitis" as follows:

"Primary irritant contact dermatitis is a nonallergic reaction of the skin caused by exposure to an irritating substance. There are two types of irritants: (1) mild, relative or marginal irritants, which require repeated and/or prolonged contact to produce inflammation (*i.e.*, soaps and detergents), (2) strong or absolute irritants, which are such damaging substances that they will injure skin immediately on contact (weeds and alkalis)."

"Allergic contact dermatitis is a manifestation of delayed hypersensitivity and results from the exposure of sensitized individuals to contact allergins...The incubation period after initial sensitization to an antigen is 5 to 21 days, while the reaction time after subsequent re-exposures is 12 to 48 hours."

According to Arndt (1) mild irritants produce erythema, microvesiculations and oozing, whereas strong irritants cause blistering, erosion, and ulcerations. On the other hand a typical allergic reaction consists of grouped or linear tense vesicles and blisters. It can be accompanied by severe edema.

## **Conclusions and Recommendations**

Our work shows that the contact dermatitis experienced by people exposed to the juglone of black walnut is probably an irritant rather than an allergic reaction because: (1) the reactions occurred immediately, (2) the reactions were blisterings and erosions, and (3) the reactions occurred in most people who were exposed to juglone. This affirms the work of Siegel (11) who stated, "The absence of dermatitis on other exposed parts of the body and hands which were also heavily stained with walnut juice. ..points toward a primary irritant effect of the walnut juice as the cause rather than allergic sensitivity." Barniske (2) supports the premise that the chemical juglone is the primary irritant. If conditions are favorable, most people exposed to juglone will develop contact dermatitis. People are more sensitive to juglone poisoning during hot weather, especially when it is hot and humid. The two Forest Service people were working with walnut during unusually warm or hot humid weather and so were all of the respondents to the *Walnut Council Newsletter*. Conditions for inflammation seem even more favorable when the victim perspires.

To prevent juglone dermatitis:

- 1. Avoid the juice from walnut stems, nuts, leaves, and roots.
- 2. Avoid hot days for pruning walnut trees or hulling the nuts.
- 3. Wear protective clothing:
  - a. Rubber gloves when gathering or hulling nuts.
  - b. Long sleeve shirt, buttoned at the throat, when pruning walnut trees.
- 4. Wash off any walnut chips, or juice from the walnut hull, as soon as possible.

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