

CASTOR BEAN: AN INDUSTRIAL HAZARD AS A CONTAMINANT OF GREEN COFFEE DUST AND USED BURLAP BAGS

KARL D. FIGLEY, M.D., AND FRANK F. A. RAWLING, M.D., TOLEDO, OHIO

SINCE April, 1949, we have discovered 9 cases of sensitivity to the castor bean allergen. All 9 patients suffered severe symptoms of acute allergic rhinitis and/or asthma from inhaling the allergen. The patients were all adults. Four of them worked in the office of 1 coffee-roasting plant in Toledo; a fifth was employed to seal cartons containing sacks of roasted coffee in the same plant. Two other patients had worked in the warehouse of another coffee roasting plant in Toledo, thus making altogether 7 patients connected with the coffee-processing industry. Patients 8 and 9 worked in factories devoted to stamping small metal parts, in no way connected with the coffee industry. All 9 of these patients gave strongly positive skin reactions by scratch test to castor bean allergen. All 9 owed their difficulty to breathing dust from burlap bags which had at one time contained, or had been contaminated by, castor beans or castor bean pomace.

The 4 office workers were in a large open office occupied by some 60 people. This office was separated from the coffee-storage warehouse by only a corridor containing several open ventilating windows near the ceiling. A swinging door gave access to the warehouse from the corridor. A men's wash-room opening off the office at the side opposite the corridor contained a large exhaust fan, operated during working hours. Thus this fan pulled a large volume of air from the coffee warehouse, through the swinging door and then into the office, through the open ventilating windows lining the corridor.

The storage warehouse held 1 or more freight trainloads of bags of green coffee. Near the office side of the warehouse were 2 cleaning machines. Into the hopper of these machines several bags of green coffee were poured at a time. By a shaking process the hull and chaff were removed from the beans. The area for some distance around the machines was inches deep with this green coffee dust, and of course the ventilating fan, above-mentioned, pulled much of this dust into the office through the open windows of the corridor. Dust was plainly visible on many of the office desks. We shall refer to this dust as "green coffee dust" to denote that it originated from the cleaning process applied to raw (green) coffee beans.

Patient 5, a young man of 27 years, had worked at this same coffee-roasting plant for 16 months. His job was to seal cartons of 1-pound sacks of roasted coffee as they came from the weighing machine. Ordinarily, he had no trouble doing this work. On several occasions during rush periods, he had been obliged to help unload bags of green coffee from freight cars. Recently, each time at this job, he had developed severe attacks of asthma incapacitating him for several days. He identified the green coffee dust as the cause of his asthma, for he had an immediate attack when collecting some of this dust.

Patients 6 and 7, 2 coffee warehouse employees, handled bags of green coffee in a roasting plant located several miles from the 1 first mentioned. Conditions were exactly similar there so far as exposure to green coffee dust was concerned; the same shaking process was used to clean the raw coffee beans. After some years of employment both these men were obliged to quit

their jobs; one in 1939, and one in 1944, because of frequent severe asthma which they attributed to the green coffee dust.

Patient 8 had run a pressing machine for 8 years in a factory that stamps out small metal parts. In early fall of 1949 he noted much sneezing, particularly at work. On October 28, he developed his first severe, acute asthma, lasting 3 days. This patient made the observation that his sneezing was often associated with shaking out a burlap bag that was used to hold small metal parts as they came from the machine. These bags came from a pile of second-hand burlap bags. Not every bag would cause sneezing.

Patient 9,* a man of 30 years, was a shipping clerk for a Columbus manufacturing and supply company. In October, 1941, he began to have frequent attacks of asthma, for which he first consulted Dr. Mitchell in January, 1942. At that time he gave minor positive skin tests to flaxseed and kapok seed. Foods, pollens, mold spores, and other inhalants, including house dust, gave negative tests.

Dr. Mitchell's further history was as follows: "On February 19, 1942, he reported severe asthma while handling burlap sacks used to ship castings and mentioned the sacks had been used before because there were beans in some of them. He recalled that on February 6, 20 minutes after entering the plant, his eyes became red, swollen, and itchy. He could not see and had to be led away from the room where he was working. His forehead and neck were covered with hives, but he had no asthma on this occasion.

"A test with my own burlap extract was negative. He was asked to bring in some of the sacks from the plant. A few beans were found in the seams, and these were sent to Dr. Karl Figley for identification, since it was suspected they were castor beans. The sacks were labeled in Spanish or Portuguese. Dr. Figley identified the beans as castor beans, by extracting them and testing a known castor bean-sensitive patient with the extract. Puncture test with an extract from the beans as well as an extract made from the burlap sack were strongly positive on the patient."

The two coffee-roasting plants, referred to previously, imported coffee from Brazil and Colombia, South America. For the most part the coffee was shipped in new bags, either so-called "grass bags" (caroa fibre) or burlap (jute) bags. However, we were informed that during World War II, when new bags were not procurable, coffee was occasionally shipped in used bags. (We suspect that this practice still obtains at times.)

Castor bean is the seed of the plant, *Ricinus communis*. This plant is extensively grown in South America. Castor bean is shipped in burlap bags to various ports chiefly on the eastern United States coast. From there the bags of castor beans are transshipped by freight to crushing mills located principally on the East Coast. There the oil is pressed from the beans. The "cake" or residue remaining is ground into powdered form. This is known in the trade as castor pomace. Its chief use is for fertilizer.

From the above it is apparent that bags of green coffee may become contaminated by castor bean allergen in several ways: (1) green coffee may be

*The history of Patient 9 is included through the kindness of Dr. John H. Mitchell of Columbus, Ohio.

shipped from South America in used bags that previously contained castor beans or castor pomace; (2) bags of green coffee may become contaminated in the holds of vessels, that contain or, more likely, previously contained bags of castor beans; and (3) bags of green coffee may become contaminated in freight cars which previously contained bags of castor beans or castor pomace.

We mention these possibilities because executives in the coffee-roasting plants insist that the green coffee they import is shipped only in new, unused bags. Unfortunately, we have been unable to secure from the coffee warehouses a bag that has been unquestionably contaminated with castor bean or castor pomace. One has no way of selecting such a bag from the thousands of bags in storage.

When first asked to ascertain the cause of the severe symptoms in the 4 office workers, we assumed, after surveying the premises, that it was the green coffee dust. Upon further testing when all gave more strongly positive skin reactions to castor bean allergen, we knew this was more than a coincidence. However, from this study it is interesting to note that in several cases the coffee fraction in the green coffee dust was a factor as well as the castor bean component of the dust. Later, we will discuss this observation more fully.

TABLE I. REACTIONS TO SCRATCH TESTS

CASES	GREEN COFFEE DUST (CONTAINS CASTOR BEAN COMPONENT)	WASHED EXTRACT OF COFFEE BEAN (NO CASTOR BEAN COMPONENT)	CASTOR BEAN ALLERGEN CB-1A	OTHER REACTIONS (30 ROUTINE TESTS)
1. Office worker	++	Negative	++++	None
2. Office worker	+++	++	++++	Flaxseed +
3. Office worker	+++	+++	++++	House dust +
4. Office worker	++	++	+++	Flaxseed +
5. Coffee sealer	++	Negative	++++	None
6. Warehouse workers	++	Negative	++++	None
7. Warehouse worker	+++	+++	++++	House dust ++++ Ragweed +++
8. Press operator	++	Negative	++++	Cottonseed + Flaxseed +
9. Shipping clerk (Dr. Mitchell's case)	Not done	Not done	++++	Kapok seed + Flaxseed ++
10. Manager of coffee-roasting plant	+++	+++	Negative	House dust +
50 control cases of allergic rhinitis and asthma	Negative	Negative	Negative	

Table I shows that the first 9 patients listed all reacted strongly by scratch (dermal) test to purified castor bean allergen.¹ Eight of these also reacted to green coffee dust extract, which represented a mixture of coffee bean allergen plus a minute component of castor bean allergen. (Case 9, Dr. Mitchell's patient, was not tested with coffee dust or coffee bean extract.) Four of the 8 failed to react to an extract of green coffee beans carefully washed to exclude castor bean contaminant. Thus it may be assumed that 4 of the 8 patients are sensitive to castor bean allergen only, while the other 4 are sensitive, not only to castor bean allergen, but to a lesser degree to the coffee bean allergen present in the green coffee dust.

A tenth case is listed in Table I. This was the manager of 1 of the coffee-roasting plants who has held this position for 20 years. He was first seen in 1941 with the complaint of perennial rhinitis and occasional asthma which he attributed to inhalation of green coffee dust. Tests done at that time gave positive skin reactions to this dust. When the present study was begun in 1949, he again reacted to an extract of green coffee dust and 1 of washed coffee bean, but failed to react to castor bean allergen.

We said above that for various reasons we have been unable to secure from a coffee-roasting plant or the metal-stamping plant a burlap bag that unquestionably had contained castor bean or castor pomace. For proof of our thesis, it is necessary to demonstrate the presence of castor bean allergen in such a bag. However, we do have a supply of green coffee dust collected from the vicinity of the cleaning machines in one of the coffee-roasting plants. This dust answers the same purpose as a bag would, for the dust came only from green coffee shipped in burlap or "grass" bags. This green coffee dust is a fine, tan-colored powder mixed with particles of hull and chaff from the raw coffee. It contains some twigs and other extraneous matter, and in particular, contains innumerable tiny fibers of the burlap bags. (None of our patients reacted on skin test to an extract made from a new burlap bag.)

We have assumed that green coffee dust consists not only of the chaff of the coffee bean principally, but that it contains a more or less minute component of castor bean allergen from bags that have been contaminated by contact with castor bean or castor bean pomace. We know that the CB-1A fraction of castor bean is heat stable.¹ We assumed that the coffee bean allergen was heat labile. Therefore, it occurred to us that boiling green coffee dust extract would inactivate its coffee allergen, but leave unaltered the castor bean allergen present. By testing a patient who reacted to both castor bean and coffee bean, with boiled extracts of green coffee dust and raw coffee bean, if he reacted to the test with boiled green coffee dust but failed to react to boiled extract of washed coffee bean, this would speak for the presence of the heat-stable castor bean allergen in the green coffee dust.

Patient 7 was available for study. He was a man of 48 years who was obliged to quit his job at the roasting plant in 1939 because of severe asthma. Following this he remained asthma-free for some time, but consulted us recently because of recurrence of asthma in mild degree. This was found to be due to sensitivity to house dust and ragweed pollen.

From Table II, it is seen that our patient initially reacted to green coffee dust, green coffee bean, and castor bean, as well as to house dust and ragweed pollen. However, our experiment struck a snag, for we found that boiling for 6 minutes, and even autoclaving for 20 minutes at 15 pounds' pressure (250° C.) failed to inactivate the coffee bean extract. Therefore, it appears that coffee bean contains an important allergenic fraction that is heat stable. This has not been stressed in the literature. It has been our impression that the rare cases of coffee sensitivity have been on the basis of inhalation rather than ingestion. To follow up this lead we tested our patient with an extract of roasted coffee and obtained a negative reaction. The temperature in the roasting ovens is about 400° F. (244° C.). This negative reaction to extract

of roasted coffee shows that the roasting process successfully destroys the allergenic fraction of the coffee bean. All our patients stated they could freely imbibe an infusion of roasted coffee without the production of allergic symptoms.

Patient 3 was also available for study. He was a man, aged 22, who began work in the office of the coffee-roasting plant in April, 1947. In the late summer of 1947, he developed symptoms of perennial allergic rhinitis which persisted until first seen by us in April, 1949. Some 6 weeks prior to April, 1949, he developed recurring asthmatic attacks which rapidly became more severe and frequent. After the coffee-dust exposure situation was corrected about June, 1949, this man and the other office workers have remained symptom-free.

TABLE II. PATIENT 7. SCRATCH AND PASSIVE TRANSFER TESTS WITH COFFEE AND CASTOR BEAN EXTRACTS

DIRECT TESTS ON BACK. SCRATCH METHOD (11/23/49)		PASSIVE TRANSFER TESTS (1/5/50)	
1. Green coffee dust	+++	1. Green coffee dust	++
2. Green coffee bean	+++	(1:100 dilution)	
3. Castor bean allergen CB-1A (1:100,000 dilution)	++++	2. Green coffee bean	++
4. House dust	++++	(1:100 dilution)	
5. Ragweed	+++	3. CB-1A	++ (wheal 10 × 10 mm.)
6. Extract new burlap bag	Negative	(1 mγ* per each 0.025 ml. saline)	
ALL EXTRACTS BOILED IN WATER BATH 6 MINUTES (12/19/49)		4. CB-1A	+++ (wheal 20 × 15 mm.)
1. Green coffee dust	++	10 mγ per each 0.025 ml. saline)	
2. Green coffee bean	+++	5. CB-1A	++++ (wheal 30 × 15 mm.)
3. Castor pomace	++++	(100 mγ per each 0.025 ml. saline)	
ALL EXTRACTS AUTOCLAVED AT 15 LBS. PRESSURE FOR 20 MINUTES (12/22/49)		6. Green coffee dust	++
1. Green coffee dust	++	(1:100 dilution; autoclaved)	
2. Green coffee bean	+++	7. Green coffee bean	++
3. Castor pomace	+++	(1:100 dilution; autoclaved)	
(2/27/50)		8. House dust	+++
1:10 Extract of roasted coffee	Negative	9. Ragweed	Negative
		1:1000 dilution)	
		10. Ragweed	+
		1:100 dilution)	
		11. Roasted coffee ex-tract	Negative
		(1:10 dilution)	

*Milligamma (mγ) = 0.000,001 milligram.

All extracts gave negative control tests.

As shown by Table III, the direct tests done on this patient duplicate those done on Patient 7 (Table II). Passive transfer tests using serum from Patients 3 and 7 merely corroborate the results of direct testing. One point in the passive transfer tests is worthy of notice, namely, the exquisite sensitivity of these patients to the potent castor bean fraction CB-1A. As Tables II and III show, the tests with these very weak CB-1A dilutions on the recipients' sensitized skin were as large as one would expect in most instances of direct testing with less potent allergens. In particular, high dilutions of castor bean allergen gave much larger tests than the coffee bean extract. Although this study of these patients' reactions to various tests failed to achieve our purpose, namely, to prove the presence of castor bean allergen in green coffee dust, we report it at some length because of our finding of the amazing heat stability of the dominant allergen in the coffee bean.

TABLE III. PATIENT 3. SCRATCH AND PASSIVE TRANSFER TESTS WITH COFFEE AND CASTOR BEAN EXTRACTS

DIRECT TESTS ON BACK. SCRATCH METHOD (5/5/49)		PASSIVE TRANSFER TESTS (4/5/50)	
1. Green coffee dust	+++	1. Green coffee dust (1:100 dilution)	++
2. Green coffee bean	++++	2. Green coffee bean (1:100 dilution)	+++
3. Castor bean allergen CB-1A	++++	3. CB-1A 1 my per each 0.025 ml. saline	+
4. House dust	+++	4. CB-1A 10 my per each 0.025 ml. saline	++
5. Extract new burlap bag	Negative	5. CB-1A 100 my per each 0.025 ml. saline	+++
(4/3/50)		6. Boiled extract green coffee bean	+++
1. Boiled extract green coffee bean	++++	7. Autoclaved extract of green coffee bean	++
2. Autoclaved extract green coffee bean	+++	8. Extract of roasted coffee (1:10 dilution)	Negative
3. Extract of roasted coffee (10 per cent)	Negative	9. House dust	+++

All extracts gave negative control tests.

Our failure to prove the identity of castor bean allergen by indirect evidence prompted discussion of this problem with Dr. Henry Stevens* who was currently engaged in a relevant investigation. At his request a sample of green coffee dust was submitted for examination by the Schultz-Dale technique. Following is the report of this examination by Dr. E. J. Coulson*:

"A 1:10 extract of green coffee dust (Our No. 1501) was made in physiological salt solution with addition of toluene to saturation for preservation: (10 Gm. of No. 1501 mixed with 90 c.c. of 0.9 per cent NaCl, saturated with toluene.) After standing 20 days at room temperature, with occasional mixing, the mixture was filtered through paper.

"The extract was compared with our castor bean allergen, CB-1A, for specificity and potency of this allergen. Uterine muscle from guinea pigs sensitized with CB-1A reacted to the coffee dust extract. The same extract induced no reaction in muscle from normal control animals. Results provided convincing evidence that the coffee-dust extract contained castor bean allergen.

"Estimated equivalence to CB-1A:

1:10 extract of green coffee dust (No. 1501) contained castor bean allergen equivalent to 0.14 p.p.m. of CB-1A.

The green coffee dust contained castor bean allergen equivalent to 1.4 p.p.m. of CB-1A."

This, then, is the proof that the green coffee dust examined contained castor bean allergen.

In 1945, Bernton, under the title of "Castor Bean Sensitiveness,"² reported the case of a man who developed castor bean sensitivity from exposure to burlap sacks which had contained castor pomace. We recommend Bernton's article to all who read this report. It is the most complete treatise to date on the subject of castor bean sensitivity, with all-inclusive references.

*Allergen Research Division, Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

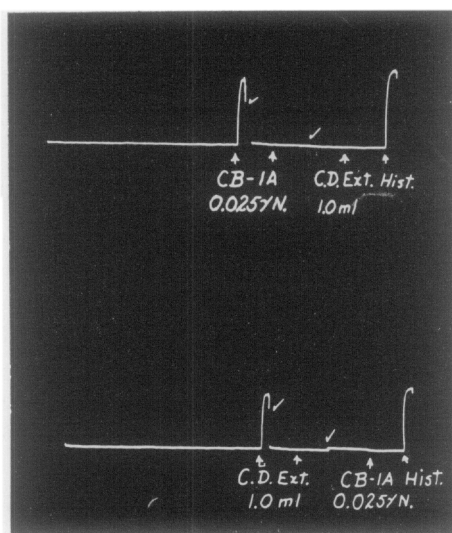


Fig. 1.—Identification of CB-1A in green coffee dust extract. This guinea pig was sensitized with CB-1A. CB-1A induced a contraction in the sensitized uterus and desensitized to CB-1A. (Five ml. of coffee dust extract induced no response in tissues from nonsensitized animals.)

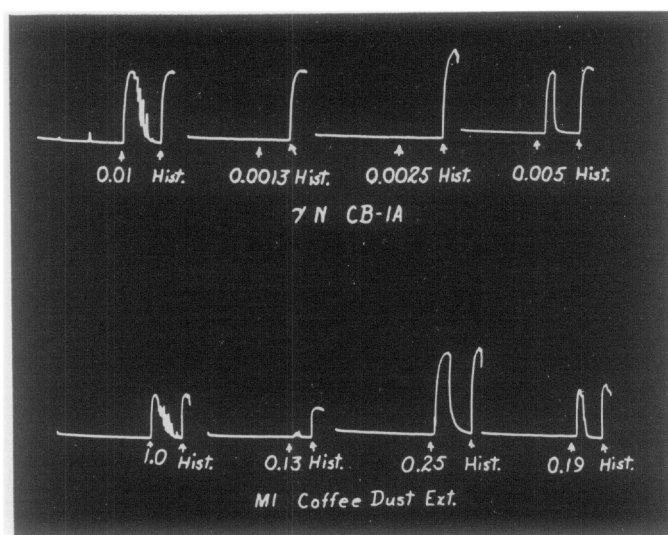


Fig. 2.—Estimation of CB-1A in green coffee dust extract. Each continuous tracing represents a separate uterine strip from an animal sensitized with CB-1A. The contraction induced by 0.19 ml. of coffee dust extract was equivalent to the response induced by 0.005 γ N of CB-1A. CB-1A contains 18.4 per cent nitrogen. Hence, the coffee dust extract contained 0.14 γ CB-1A per ml.

In our opinion, castor bean contains the most potent allergenic fractions known to man. In addition, castor bean contains a powerful toxic albumen, ricin, which rivals cobra venom or diphtheria toxin in potency. Accordingly, ordinary aqueous extracts of castor bean should never be used even for scratch testing; never should castor bean extract of any description be used for direct intracutaneous skin testing. An extract from which the ricin has not been removed will cause more or less severe toxic lymphangitis—even on scratch testing. As for intracutaneous testing, dericinized extracts highly diluted may cause alarming constitutional reactions. For practical purposes, dericinized castor bean extracts may be purchased from any of several commercial firms which sell test materials.

Here follows the most informative reply of Mr. R. L. Beyer, Manager of The Castor & Industrial Soybean Oil Department of Spencer Kellogg & Sons, Inc., to an inquiry regarding the extent of castor bean importation:

“During 1948, the United States imported castorseed for consumption as follows:

COUNTRY	POUNDS
Mexico	4,800
Guatemala	10,000
Salvador	172,380
Haiti	5,792,046
Ecuador	5,141,787
Brazil	289,295,370
Netherlands	700
France	13,426
Siam	2,080,330
Total	302,510,839

“It is obvious from these figures that Brazil is by far the most important source of our castorseed. Haiti and Ecuador also contribute substantially.

“Castorseed crushing mills of importance in the United States are located as follows:

Edgewater, N. J.
 Bayonne, N. J.
 Jersey City, N. J.
 Blue Point, Long Island
 Los Angeles, Calif.

“Castor pomace, as far as we know, is used only as a fertilizer. It is particularly popular as a fertilizer for tobacco and for citrus fruits.

“Castorseed from Brazil normally is shipped in 60-kilo. bags made of either caroa fiber or jute fiber. Our Edgewater, N. J., mill quite frequently reconditions these bags and uses them for the shipment of castor pomace. I believe some of the castorseed bags may be resold in the New York market to dealers.

“It does seem possible that bags that contained castor pomace, if carelessly handled, would be possible causes of allergic difficulty for susceptible persons.

“It seems highly unlikely to me that coffee would be shipped in bags that had contained castorseed or castor pomace, because I have been under

the impression that coffee moves in its original bags from Brazil and is customarily shipped in new bags down there."

The report of these 9 cases of castor-bean sensitivity is presented to call attention to a widespread, highly potent allergen which we feel has been somewhat neglected, or at least overlooked. Our discussion shows that thousands of bags of castor bean and castor pomace are in transit annually through our nation. After reaching their destination, many of the bags when empty are sold through junk dealers and put to other uses. Eventually they may come to rest in our homes. What householder is unable, on request, to produce a burlap bag from the basement, attic, or garage? It follows that dericimized extract of castor bean should be included in the routine list of testing substances of every practicing allergist. Its use may reveal the cause of occasional puzzling cases of inhalant allergy.

In 1928, one of us (K. D. F.) was the co-author of an article³ reporting a large number of cases of asthma caused by castor-pomace dust emanating from a castor bean-crushing mill in east Toledo. It may be of interest to relate that the matter finally found its way into the courts, and that in 1932 the Common Pleas Court, later sustained by the Court of Appeals, ordered a permanent injunction against the processing of castor bean in Toledo. Soon after, the plant was dismantled and castor bean asthma became a rarity in our experience. Occasionally we have since encountered castor bean-sensitive persons whose sensitivity could be traced to previous residence near this mill. However, only recently have we discovered the 9 cases reported herein, whose trouble came from contact with other sources than the former Toledo castor bean-crushing mill. None of these 9 patients ever lived in the vicinity of this mill prior to its dismantling.

SUMMARY

1. Nine cases of sensitivity to the castor bean allergen are reported. The source of contact was dust from burlap bags used (1) in shipping green coffee, or (2) in shipping metal castings. These bags had been contaminated by contact with castor bean or castor pomace.

2. Dericimized castor bean extract should be included in the allergist's routine list of testing materials.

3. Only dericimized castor bean extract should be used for skin testing, and then only by the scratch (dermal) method. Never should even weak dilutions of any type of castor bean extract be used for direct intracutaneous testing.

4. The coffee bean contains a dominant allergenic fraction that is stable on autoclaving for 20 minutes at 15 pounds' pressure, but is inactivated by the commercial roasting process.

REFERENCES

1. Spies, Joseph R., and Coulson, E. J.: The Chemistry of Allergens. VIII. Isolation and Properties of an Active Protein-Polysaccharidic Fraction, CB-1A, From Castor Beans, *J. Am. Chem. Soc.* **65**: 1720-1725, 1943.
2. Bernton, H. S.: Castor Bean Sensitiveness, *J. South. Med. Ass'n* **38**: 670-677, 1945.
3. Figley, K. D., and Elrod, R. J.: Endemic Asthma Due to Castor Bean Dust, *J. A. M. A.* **90**: 79, 1928.