

Sensitization to green coffee bean (GCB) and castor bean (CB) allergens among dock workers

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Summary. Dock workers ($n = 218$) occupationally exposed to green coffee beans (GCB) were studied, using a specific questionnaire for allergic symptoms and skin tests for common and occupational allergens. Thirty-one workers (14.3%) complained of allergic symptoms of the eye, nose and bronchial system at the workplace. The prick tests, using both commercial allergens and specific extracts prepared from the most common types of coffee and their corresponding sacks, confirmed a sensitization in 21 workers (9.6%). A positive skin reaction to castor beans (CB) was found in nearly all these cases; in ten workers there was also a positive reaction to GCB allergens and in 14 cases prick tests were positive to extracts of sacks. There was a good concordance between prick tests and specific IgE for CB (95.0%) and also, but to a lesser extent, for GCB. The authors concluded that there is a significant risk of sensitization to CB and GCB allergens in dock workers occupied in handling green coffee bean, despite the fact that the exposure is not continuous. CB emerged as a common contaminant of GCB from various countries. For effective prevention, a modification of the methods of transport is required to avoid CB contamination to other products. Eliminating environmental dust during shipping operations is the most important preventive measure and it can be achieved by the use of containers, as some exporting countries are already doing.

Key words: Occupational sensitization – Green coffee bean – Castor bean – Dock workers

Introduction

The castor bean has been known as a potent allergen since 1923 when the first case of sensitization was recorded in a chemist making a study of this substance [1]. Since then allergic symptoms have been reported in oil mill workers, in populations around oil mills and also in regions where the substance has been used as a fertilizer [3, 6, 17, 21].

In 1950 the castor bean was suggested to be the antigen causing allergic diseases in coffee industry workers, especially those engaged in the roasting and grinding of the green coffee bean [4, 7]. Other substances were proposed as allergens for coffee workers: one was chlorogenic acid and another was coffee itself [2, 8, 12, 13, 14], but by now it has been demonstrated that the antigens from the green coffee bean (GCB) and the castor bean (CB) are distinct from each other and also unrelated to chlorogenic acid [11, 12, 14, 18, 19].

People handling GCB in sacks, as is the case of the dock workers, are exposed to inhalant allergens coming both from the coffee itself and from the sacks used for shipment. The sacks are often reused for coffee after having contained castor beans, or are stored in holds which previously contained castor bean or pomace: thus CB can be an accidental contaminant of GCB [2, 10, 11, 18].

We decided to study a group of dock workers in the principal Italian port for the coffee trade to evaluate the prevalence of work related symptoms and the relative importance of allergens from GCB, CB and extracts of sacks containing GCB, among these work-

ers intermittently involved in loading, unloading and storing GCB from different countries.

Materials and methods

Male dock labourers ($n = 218$) were investigated. Their mean age was 37.7 ± 6.6 years, with a mean duration of employment on the dock of 14.7 ± 5.2 years. The subjects were interviewed by a questionnaire for respiratory symptoms. There were additional questions dealing with hereditary and/or previous allergic diseases, smoking habits, departments where people were or had been working, whether they had symptoms related to work and, if so, of what type. The subjects were also asked to identify the substance considered responsible for the symptoms.

All workers were skin tested for common allergens (pollens, mites, dandruff), jute and GCB, using Lofarma (MI-Italy) commercial preparations. The workers symptomatic at work were invited to a second check, using CB commercial allergens and extracts prepared by Lofarma from the three most common kind of GCB (African, Brazilian, Cameroon) and from the corresponding bags: 27 out of 31 workers agreed to be retested. In these workers, IgE antibodies for CGB and CB were determined by RAST (Pharmacia Diagnostic AB, Uppsala) and measured using the Phadebas Rast units (PRU).

Skin tests were performed with an intradermal needle; skin reaction was measured after 20 min. The test was considered positive if the diameter of the wheal was larger than 3 mm.

As a control group for the skin occupational tests, we studied 53 workers engaged in general maintenance work in industry.

The forced vital capacity (FVC) and one second expiratory volume (FEV_1) were obtained from a forced expiratory spirometer (OHIO dry spirometer) in the subjects with work-related symptoms.

Results

Of the 218 workers interviewed by the questionnaire, 166 were asymptomatic (Table 1) and 50 of them had at least one positive skin test for common allergens. We also found two asymptomatic workers with a skin reaction positive to commercial coffee: in one case there was an aspecific skin hyperreactivity to all the allergens tested, while the other case had a positive

test to commercial coffee, but it was not possible to complete the tests with the other specific occupational extracts.

Twenty-one subjects (9.6%) complained of eye, nose or bronchial symptoms not related to work and in 16 cases a sensitization to common allergens was found.

To the question about symptoms of an allergic type related to work, 31 (14.3%) persons answered positively.

The mean length of exposure before the onset of the symptoms was 6 yrs (range 1–15). The most common symptoms (Table 2) were sneezing, congestion, lacrimation of the eye and running noses (19 persons); respiratory symptoms (coughing, wheezing of the chest and various degrees of dyspnea) were present in 12 workers and nine of them had eye and nasal symptoms as well. Itching of the skin was also very common but not quantified. Most subjects reported that the more dust there was in the surroundings, the worse their symptoms became, and all of them noticed an improvement when not at work.

Items identified by the questionnaire as the cause of symptoms at work were found to be consistent with the results of the prick tests. In fact 21 of the 22 subjects symptomatic when handling coffee sacks had skin tests positive for GCB, CB or extracts of sacks. Nine others related their symptoms to contact with cereal or simply to the environmental dust, and in six cases the skin tests confirmed this. Only four people, who complained of oculorhinitis at the work site, resulted skin negative to all occupational and common allergens.

Of the 31 subjects symptomatic at work, 27 consented to be retested for occupational allergens, using specific preparations; four persons refused the second check and of these only one was symptomatic and skin positive to commercial GCB.

The 53 workers in the control group, tested for the same occupational allergens, all resulted skin negative, while among dock workers tested the sec-

Table 1. Allergic symptoms and skin test reaction to occupational and common allergens in the 218 dock workers

	Skin tests				Total no.	% of total
	Positive GCB, CB, J (n)	Positive GCB, CB, J common allergens (n)	Positive common allergens (n)	Negative (n)		
With symptoms work related	13	8	6	4	31	14.3
With symptoms not work related	–	–	16	5	21	9.6
Without symptoms	1	1	50	114	166	76.1

GCB green coffee bean; CB castor bean; J extracts from jute sacks containing coffee

and time we found 20 cases with a confirmed sensitization to occupational allergens. Seven others had negative skin reactions and absence of specific IgE, and the data were concordant with the first check. Table 3 and Fig. 1 show the prevalence of skin tests

larger than 3 mm and the results of specific IgE determinations.

Nineteen of workers had skin tests positive to CB; sensitization was either single (4) or associated with a positive reaction to the other occupational extracts tested. In the presence of multiple sensitization the CB wheal was nearly always the largest, with 14 cases larger than 9 mm.

There was a good concordance (95.0%) between the prick tests and RAST for CB; specific IgE levels were high, except one case: III and IV classes according to Phadebas references.

Concerning GCB, we found ten workers skin positive to this allergen and in all cases there was also a sensitization to CB (more frequent) and/or to extracts of sacks. There was a good correspondence between commercial and specific preparations of this substance and also between prick and IgE levels: seven of the ten subjects had both positive skin tests and specific IgE for GCB, but IgE levels were lower than those of CB: II and III classes.

Positive skin reactions to extracts of sacks were found in 14 subjects and were especially associated with sacks from Africa.

Table 2. Skin reactivity in 31 symptomatic workers complaining of eye, nasal and bronchial symptoms at the work place

	Oculo-rhinitis (n)	Asth-matic symp-toms (n)	Oculo-rhinitis and asthma (n)	Total no.
<i>Skin tests</i>				
Positive GCB-J	8	0	5	13
Positive GCB-J- common allergens	4	1	3	8
Positive common allergens	3	2	1	6
Negative	4	—	—	4
Total no.	19	3	9	31

GCB green coffee bean; CB castor bean; J extracts from jute sacks containing GCB

Table 3. Skin test reactions to occupational allergens (extracts from three types of GCB, the corresponding sacks, commercial GCB, CB, jute) and RAST values in the 21 workers with symptoms related to work with coffee sacks

No.	Prick tests: wheal diameter										RAST	
	C ₁ (mm)	J ₁ (mm)	C ₂ (mm)	J ₂ (mm)	C ₃ (mm)	J ₃ (mm)	J _c (mm)	C _c (mm)	CB (mm)		CB class	GCB class
1	—	3	—	4	—	3	—	—	12		3	—
2	6	10	9	6	9	9	—	10	15		3	2
3	9	—	8	3	8	6	—	10	—		—	3
4	—	—	—	—	—	3	—	4	15		3	—
5	8	—	8	3	8	6	—	10	18		3	3
6	4	—	8	—	8	—	—	3	10		4	—
7	7	4	12	7	8	6	—	6	5		4	2
8	—	—	—	—	—	—	—	—	8		2	—
9	—	—	—	—	—	—	—	—	10		3	—
10	—	—	—	—	—	—	—	—	6		3	—
11	—	—	3	3	4	—	—	—	10		4	2
12	7	5	6	5	6	7	—	—	14		4	—
13	5	—	7	—	8	7	—	5	12		4	3
14	—	—	—	—	—	5	—	—	15		4	—
15	—	—	—	—	—	4	—	—	22		3	—
16	4	—	4	3	5	6	—	8	10		3	2
17	—	—	—	—	—	—	—	—	10		4	—
18	—	—	—	—	—	3	—	—	6		3	—
19	—	—	—	4	—	6	—	—	15		4	—
20	5	—	4	—	—	—	—	—	4		—	—
21	not tested								4	not tested		2

J_c commercial jute; C_c commercial coffee; CB commercial castor bean; C₁ African coffee; C₂ Brazilian coffee; C₃ Camerum coffee; J₁ African sacks; J₂ Brazilian sacks; J₃ Camerum sacks

The prevalence of atopies was higher among the 21 symptomatic workers with a documented sensitization to the occupational allergens (43% = 9/21) than among the other workers (37% = 74/198 and the difference was statistically significant ($P < 0.01$).

The length of exposure among people symptomatic at work and skin positive to occupational allergens was at least three years, but most of them (75%) had been engaged in the job from 6 to 15 yrs.

The percentage of workers sensitized to occupational allergens decreased with work seniority: there were 20% (2/10) of symptomatics in the group with a work seniority up to 6 yrs, 12.3% (17/137) in the group with 6–15 yrs of work and 4.3% (3/71) in the oldest group, but the data were without statistical significance.

Of the entire group 60% (131/218) were current smokers, and the percentage dropped slightly with work seniority: 66.6 and 63.3% smokers in the first two groups and 51.3% in those with more than 15 yrs of work seniority (p : NS).

We compared the prevalence of positive skin tests to the occupational allergens considered according to

smoking habits in each of the three classes of work seniority using the χ^2 test (Table 4), but we found no statistical differences.

Lung function was normal in 28 of 31 workers with symptoms at work; in three cases we found a slight obstruction: FVC 78 to 95% and FEV₁ 71 to 76% of the reference values.

Discussion and conclusion

Dock labourers are discontinuously exposed to GCB contained in sacks, but their work often occurs in confined and very dusty surroundings.

In this study, 9.6% (21/218) of the workers examined had allergic symptoms related to work with coffee sacks: this was confirmed by the questionnaire, the skin tests and RAST.

It may be that the level of sensitization is greater than that shown in our data; in fact it was difficult to carry out the necessary tests on these workers. Most of them do piece-work and do not undergo periodic medical checkups. The workers studied were considered "at the present exposed" but it is known that the port activity changes continuously in relation to the various shipments and it is impossible to estimate the exact number of people actually involved in handling sacks of GCB. Moreover, it may often happen that symptomatic workers manage to be moved to other jobs on the basis of seniority. This can create a "survivor population effect" that probably is, in our group, the cause of the decreasing prevalence of sensitized symptomatic workers in the group at highest seniority.

The properties of occupational allergens are determinant in the development of hypersensitivity and in our case two groups of substances are involved, namely GCB and CB. Green coffee beans are considered to have an allergen which is moderately potent and in the coffee roastery industry this allergen is responsible for allergic symptoms in a percentage of workers varying from 7 to 40% [9, 11, 16, 18, 19, 22, 23].

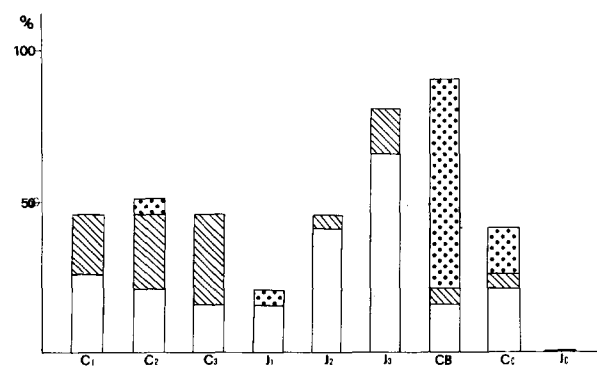


Fig. 1. Distribution of wheal diameters after skin tests with different types of GCB, extracts of sacks, commercial GCB, CB and jute in the 21 subjects symptomatic when handling coffee. C₁ African coffee; C₂ Brazilian coffee; C₃ Cameroon coffee; J₁ African sacks; J₂ Brazilian sacks; J₃ Cameroon sacks; CB Commercial castor bean; C_c commercial coffee; J_c commercial jute. □ Wheal 3–6 mm; ▨ Wheal 6–9 mm; ▩ Wheal > 9 mm

Table 4. Results of skin tests for occupational allergens (GCB; CB; extracts from sacks) in the three different classes of work seniority, dividing smokers and non smokers

Work seniority years	Smokers – Skin tests			Non smokers – Skin tests			Chi square test
	pos. (n)	neg. (n)	pos. %	pos. (n)	neg. (n)	pos. %	
0–5	2	5	28.5	0	3	–	NS
6–15	10	76	11.6	5	45	10	NS
> 15	3	35	7.9	0	34	–	NS
Total	15	116	11.4	5	82	5.7	NS

In the same industry, CB antigen was identified not only as a contaminant of some burlaps sacks in which the coffee beans arrived, but also as a widespread contaminant of the work environment and an important cause of sensitization [2, 6, 9, 10, 19]. It is no wonder then, that in the holds and storage areas where the contamination of GCB by CB is even more likely than in the roastery industry, this allergen has a prevalent role.

We found a sensitization to CB allergen in nearly all workers complaining of symptoms when handling sacks of coffee, and the results of prick tests and RAST gave a high concordance. The frequent coexistence of positive skin tests to CB and to extracts of sacks seems to indicate a widespread presence of this potent allergen, and not only in sacks from Brazil, as some authors had reported, relating this to the fact that this country produces CB [2, 10].

In our study we had ten workers complaining of allergic symptoms with a sensitization to GCB documented by prick tests and, nearly always, by RAST. This confirms the role of GCB as an occupational allergen. Nevertheless, the same workers also had positive skin tests to CB itself and or to extracts of sacks containing CB and GCB allergens [11, 15].

Other authors [9, 11, 19] examining the coffee industries have obtained results similar to our own, with more workers RAST positive to CB than to GCB. Osternam (18) suggested that CB, one of the most potent allergens known, initiates the sensitization process and thus facilitates the subsequent sensitization to GCB: this hypothesis is a very attractive one in our cases too.

The nature and intensity of exposure seem to play a role in sensitization, since nearly all symptomatic workers directly handled sacks from holds or storage areas and only two were engaged in supervisory jobs.

Unlike other studies [18] we found that the length of exposure in symptomatic workers does not differ from that of the entire population studied and the latency for the onset of eye, nasal or bronchial symptoms is extremely variable. We think that this finding may be related to the work organisation: in effect, the discontinuity of the work and the frequent turnover make it impossible to evaluate the true occupational exposure to any specific job.

The role of smoking habits and atopy in the risk of sensitization is still doubtful, although some authors believe that they are predisposing factors [9, 10, 18–20]. In our study there is no relation between smoking and occupational allergy; however, the number of atopics is higher among workers with allergic disease related to work with coffee. Therefore, it is possible that the castor bean has a role in facilitating sensitization to common allergens as well as to GCB.

In conclusion we may say that handling coffee sacks in the ports, especially when poor loading/unloading techniques are adopted, cause an exposure to high dust levels, with a risk of sensitization to CB and GCB which should be not underestimated. Although there are very few studies relating the level of exposure to the development of occupational allergies, an efficient environmental control of the processes involving sensitizer substances is the most important measure.

Shipping CB or pomace is a known source of risk of sensitization for seamen and regulations governing the transportation of this substance are necessary; also because they can contaminate other items, such as coffee sacks [2, 5, 11, 15]. The use of containers, recently introduced by some countries to ship GCB, could be, from the point of view of prevention, the best solution.

The identification of susceptible workers, during pre-employment controls, would be another way of preventing occupational allergic manifestations, but presently this is not feasible, above all, because very little is known about predisposing factors [10, 11, 20].

An early diagnosis is very often the only possibility for prevention and in our experience the use of a specific questionnaire proved to be very helpful in identifying people who needed to be moved to other jobs, or those who required more careful controls. In fact the results of the questionnaire were nearly always confirmed by prick tests and allowed us to limit more elaborate and expensive investigations to selected cases.

References

1. Bernton HS (1923) On occupational sensitization to the castor bean. *Am J Med Sci* 165: 196–202
2. Bernton HS (1973) On occupational sensitization—a hazard to the coffee industry. *JAMA* 223: 1146–1147
3. Charpin J, Zafiropoulos A, Simon L (1961) Asthmes professionnels dus aux oléagineux. *J Fr Med Chir Thorac* 15: 47–50
4. Coulson EF, Spies JR, Stevens H (1950) Identification of castor bean allergen in green coffee. *J Allergy* 21: 554–558
5. Davison AG, Britton JA, Forrester JA, Davies RJ, Hughes DTD (1983) Asthma in merchant seamen and laboratory workers caused by allergy to castor bean: analysis of allergens. *Clin Allergy* 13: 553–561
6. Figley KD, Eldor RM (1928) Endemic asthma due to castor bean dust. *J Am Med Assoc* 80: 79–82
7. Figley KD, Rawling FFA (1950) Castor bean: an industrial hazard as a contaminant of green coffee and used burlap bags. *J Allergy* 21: 545–553
8. Freedman SO, Krupey J, Sehon AH (1961) Chlorogenic acid: an allergen in green coffee bean. *Nature* 192: 241–243
9. Jones RN, Hughes JM, Lehrer SB, Butcher BT, et al (1982) Lung function consequences of exposure and hyper-

- sensitivity in workers who process green coffee bean. *Am Rev Resp Dis* 125:199–202
10. Karr RM, Davies RJ, Butcher BT, Wilson MR, Dharmarajan V, Salvaggio JE (1978a) Occupational asthma. *J Allergy Clin Immunol* 61:54–65
 11. Karr RM, Lehrer SB, Butcher BT, Salvaggio JE (1978b) Coffee workers's asthma: a clinical appraisal using the radioallergosorbent test. *J Allergy Clin Immunol* 62:143–148
 12. Kaye M, Freedman SO (1961) Allergy to raw coffee-an occupational disease. *Can Med Ass J* 84:69–71
 13. Layton LL, Greene FC, Corse JW, Panzani R (1964) Pure chlorogenic acid not allergic in atopy to green coffee: a specific protein is probably involved. *Nature* 203:188–189
 14. Layton LL, Greene FC, Panzani R (1965) Allergy to green coffee: failure of patients allergic to green coffee to react to chlorogenic acid, roasted coffee or orange. *J Allergy* 36:84–91
 15. Lehrer SB, Karr RM, Salvaggio JE (1978) Extraction and analysis of coffee bean allergens. *Clin Allergy* 8:217–226
 16. Marchisio M, Beretta F, Cortona G, Briatico-Vangosa G (1980) Metodi di indagine e valutazione del rischio in lavoratori esposti a polvere di caffè. *Med Lavoro* 1:76–81
 17. Mendes E, Cintra AU (1954) Collective asthma simulating an epidemic provoked by castor bean dust. *J Allergy* 25:256–259
 18. Osternam K, Zetterström O, Johansson SGO (1982) Coffee worker's allergy. *Allergy* 37:313–322
 19. Osternam K, Johansson SGO, Zetterström O (1985) Diagnostic tests in allergy to green coffee. *Allergy* 40:336–343
 20. Pauli G, Bessot JC, Dietemann-Molard A (1986) L'asthme professionnel: investigations et principales étiologies. *Bull Physiopatol Resp* 22:339–425
 21. Small WS (1952) Increasing castor bean allergy in Southern California due to fertilizer, *J Allergy* 23:406–415
 22. Smith D, Brott K, Koki G (1985) Respiratory impairment in coffee factory workers in the Asaro Valley of Papua Guinea. *Br J Ind Med* 42:495–498
 23. Zuskin E, Valic F, Kanceljak B (1981) Immunological and respiratory changes in coffee workers. *Thorax* 36:9–13

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