

Sensitization to Green Coffee Beans and Work-Related Allergic Symptoms in Coffee Workers

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Background Occupational respiratory allergy to green coffee beans (GCB) and to castor beans (CB) was studied in 112 workers in a modern coffee manufacturing plant of Trieste (Italy), where the process is completely automatic, the environmental conditions are good and where exposure to CB can be considered absent because since 1970, only new sacks have been used for coffee transportation.

Methods All subjects were interviewed by a trained doctor using a questionnaire to investigate allergic symptoms and predisposing factors. Sensitization to GCB and to common allergens (pollens, molds, house dust mites) were evaluated by the skin-prick test. The serum of subjects with a positive skin-prick test to GCB or who had symptoms at work was tested for specific IgE (RAST) for GCB and CB. Lung function was evaluated by a Ponigraph spirometer.

Results Sensitization to GCB was found in 25.8% of green coffee workers (31 cases), in 2.7% of roasted coffee workers (37 cases) and in 4.5% of the clerks (44 cases), $p < 0.01$. The evaluation of IgE specific for CB gave positive results only in 3 of 10 subjects sensitized to GCB. A total of 20% of GCB workers (6 cases) complained of work-related respiratory symptoms (asthma and/or rhinitis) compared with only one subject in the roasted coffee group and one in the control group ($p < 0.01$). Asthma was reported by 2/31 of the green coffee workers and by 1/44 of roasted coffee workers.

Conclusions There was a significant correlation between sensitization to GCB and work related symptoms ($p < 0.01$), common allergic symptoms ($p < 0.05$) and atopy by prick test (< 0.01). These results point to the need to evaluate atopic status in workers and identify the most susceptible subjects, with the aim of informing them of their at-risk status and monitoring their progress. This makes it possible to diagnose sooner those symptoms possibly indicative of a work-related disease, because even in presence of good environmental conditions and even when symptoms are mild, it is almost always the atopic subjects who are affected. *Am. J. Ind. Med.* 34:623-627, 1998. © 1998 Wiley-Liss, Inc.

KEY WORDS; green coffee bean; occupational exposure; hypersensitivity; professional asthma

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INTRODUCTION

The risk of sensitization to green coffee beans (GCB) in coffee workers is well known. In 1950, Frigley and Rawling described the first cases of asthma in sensitized workers; since then many investigators have found a high prevalence of allergic respiratory diseases related to occupational

allergens as GCB and CB [Lherer et al., 1978; Davies et al., 1983; Kaye and Freedman, 1961; Karr et al., 1978; Jones et al., 1984]: asthma prevalence ranged from 4% [Jones et al., 1984] to 12.7% [Thomas et al., 1991], depending on the years of work, while skin sensitization to GCB ranged from 9.6% to 26.9%: the highest rates were found in a recent Italian study conducted by Romano et al., in which only workers exposed to GCB were considered.

The role of GCB sensitization in coffee workers has been closely studied and its allergenic determinants have been investigated with electrophoretic and monoclonal mouse anti-human IgE. In GCB, the allergenic determinants were identified in nine protein bands of 15–60 kD and in roasted coffee in one protein of 43 kD [Lemiere et al., 1996].

There is another important allergen related to GCB exposure: the castor bean (CB), which is a primary cause of sensitization. It is a possible contaminant of the sacks used to transport GCB, as shown by RAST-inhibition techniques in previous studies of dock workers in Trieste [De Zotti et al., 1988; Patussi et al., 1991], because the sacks have been either used previously to transport CB or stored in contaminated ship containers [Romano et al., 1995]. CB is a potent allergen that, in the past, was the most important determinant of allergic disease in green coffee workers. However, during the past few years, roasted coffee producers have started using new sacks that should have reduced the effect of CB contamination and sensitization. In addition, the better working conditions which have come about in recent years thanks to automatization of the GCB roasting process should have reduced sensitization and symptoms in exposed workers.

The aim of our study was to evaluate allergic symptoms and sensitization in a modern coffee manufacturing plant in Trieste, Italy, where the process is completely automated and where exposure to castor bean can be considered absent because since 1970, only new sacks have been used for coffee transportation. We were particularly concerned to evaluate work-related diseases, predisposing factors and the efficacy of prevention measures.

MATERIALS AND METHODS

The airborne dust was sampled during the workshift at all worksites and measured as described previously [HSE, 1986]. The size distribution of green coffee dust collected in the factory was performed by laser technique.

Of the workers asked to take part in the study, all those exposed to GCB agreed to participate (31 cases), 37/54 (68%) of those exposed to roasted coffee and 44/92 (49%) of the white collar workers, who were considered our control group. All subjects were interviewed by a trained doctor using a questionnaire to investigate allergic symptoms and predisposing factors: hereditary or previous allergic diseases, smoking habit, previous pulmonary diseases. Smokers were defined as those who had smoked at least one cigarette a day or equivalent in other tobacco products for at

least 1 year and nonsmokers as those who had stopped smoking at least two years before the study. Chronic bronchitis was defined as cough productive of sputum on most days for at least 3 months of each year, for 2 or more consecutive years. Work-related asthma was defined as the presence of attacks of cough, wheeze, and dyspnea that appeared only at work or that became significantly worse at work. Work-related rhinitis was defined as the presence of sneezing or of itchy, running nose during the work period.

All workers were skin tested with common allergens including perennial allergens (*Dermathophagoides farinae* and *pteronyssinus*, dog and cat danders, and *Alternaria* spp.), pollens (Gramineae, *Parietaria* spp., Betulaceae, Corylaceae, Oleaceae), and green coffee bean extract (*Lofarma allergeni* Milano). The positive control was 1% histamine dihydrogen chloride solution and the negative control was 1% glycerinate solution. All tests were read at 15 min, and a wheal of ≥ 3 mm was considered positive.

The serum of subjects with positive skin-prick test to GCB or who had symptoms at work was tested for specific IgE (RAST-Sferikit Lofarma Allergeni Milano) for GCB and CB [Wide et al., 1967].

Lung function was evaluated by measuring the forced vital capacity (FVC), 1-sec expiratory volume (FEV1), and medium expiratory flow of 25%, 50%, and 75% (MEF 25, MEF 50, MEF 75), using a Ponigraph spirometer (Cosmed, Rome). The values obtained were compared with the theoretical data proposed by the European Community for Coal and Steel in 1983. Informed consent was obtained from all subjects before the study.

STATISTICAL PROCEDURE

Data analysis was performed with SPSS for Windows. Continuous data were summarized as means (SD). The difference between means was tested by Student's t-test. The χ^2 test was applied to data tabulated in 2×2 and 3×2 contingency tables.

RESULTS

The airborne dust sampled during the workshift showed that the total dust concentration ranged from 0.07 to 0.30 mg/mc in the green coffee processing area and from 0.08 to 1.75 mg/mc in roasted coffee manufacture (7 samples, 2 hr each, geometric mean 0.15 mg/m³c). Size distribution of green coffee dust is reported in Figure 1, and the respirable fraction ($< 10 \mu\text{m}$) was ($< 0.4\%$).

The characteristics of the population analyzed are reported in Table I, divided into the three exposure groups. The groups were similar for age, work seniority, smoking habit, common allergic symptoms, and prick test for common allergens. There were more men among the green coffee workers (83.9%) than in the other two groups ($p < 0.01$). The participation rate for the controls was low but the composition of group was considered representative of the

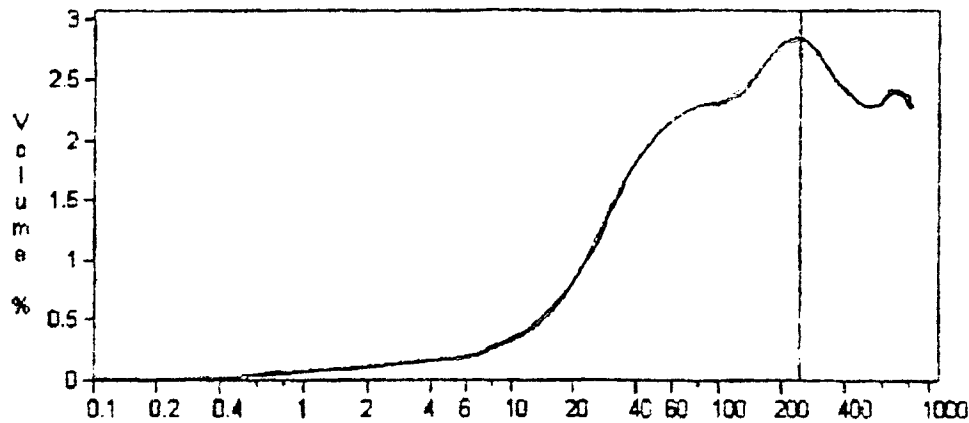


FIGURE 1. Size distribution of green coffee bean dust collected in work area: Trieste 1996.

TABLE I. Characteristics of the Coffee Workers Surveyed in Trieste 1996

Total	Green coffee (n = 31)	Roasted coffee (n = 54)	White collar (n = 92)	p
Surveyed subjects no. (%)	31 (100)	37 (68)	44 (49)	
Age (yr) mean (SD)	33.7 (7.5)	34.8 (9.7)	33.6 (8.0)	NS
Work seniority (yr) mean (SD)	9.2 (6.0)	9.1 (5.9)	9.5 (8.8)	NS
Smokers (%)	17 (54.8)	19 (51.4)	18 (40.9)	NS
Male (%)	26 (83.9)	18 (48.6)	13 (29.5)	<0.01
Work-related symptoms:	6 (19.4)	1 (2.7)	1 (2.3)	<0.01
Rhinoconjunctivitis (%)	4 (12.9)		1 (2.3)	
Asthma (%)	2 (6.5)	1 (2.7)	—	
Common allergic symptoms ^a (%)	12 (38.7)	12 (32.4)	16 (36.4)	NS
Prick tests				
Common allergens (%)	18 (58.1)	18 (48.6)	24 (54.5)	NS
GCB (%)	8 (25.8)	1 (2.7)	2 (4.5)	<0.01

GCB, green coffee beans; SD, standard deviation; NS, not significant.

^aSymptoms related to common allergens (house dust mites, pollens, cat and dog danders).

total population (age, seniority of work, smoking habit, atopy, and allergic respiratory symptoms to common allergens).

Six green coffee workers (20%) complained of work-related symptoms compared to only one subject in the roasted coffee group and one in the control group ($p < 0.01$). Asthma was reported by 2/31 of the green coffee workers, while one woman who was working in the roasted coffee area reported a cough when the level of dust was high, and this was therefore classified as asthma.

Sensitization to GCB, evaluated by skin-prick test, was found in 25.8% of green coffee workers, in 2.7% of roasted coffee workers and in 4.5% of the clerks considered ($p < 0.01$).

The characteristics of the 11 subjects with skin-prick test positive to GCB are reported in Table II: 10 of them were also prick test positive to common allergens and 7 also reported common allergic respiratory symptoms (5 rhinoconjunctivitis and 2 asthma) to house dust mites or to pollens; 7

had work-related symptoms at work. Wheals ranged from 4 to 10 mm, and in 5 cases we found specific IgE in serum, always in subjects symptomatic during work. The evaluation of IgE specific for castor bean gave positive results in 3 of 10 subjects tested, all working with green coffee.

The role of atopic status is summarized in Table III: skin-prick positivity to GCB was significantly related to common allergic symptoms, to a skin test positive to common allergens and to symptoms during work ($p < 0.05$), while no relationship was found with smoking habits. Only one subject, suffering from work-related conjunctivitis, had a prick test negative to GCB, while all the other symptomatic subjects were also SPT positive to GCB.

The results of lung function tests are reported in Table IV. No significant differences were found related to work exposure or green coffee bean sensitization, while significant differences emerged in FEV1 between smokers and nonsmokers.

TABLE II. Characteristics of Workers With Skin-Prick Test Positive to Green Coffee Bean, Trieste

	Sex	Age (yr)	Work (yr)	Atopy by prick	Allergic symptoms	WRS	Prick $\varnothing$ (mm)	CGB Rast CI	CB Rast CI	Exposure
1	m	27	2	+	+	C + R	10	I	II	Green
2	m	32	9	+	+	C + R	6	III	I	Green
3	m	32	7	+	+	R	5	0	0	Green
4	m	35	10	+	+	—	4	0	0	Green
5	m	34	16	—	—	R	4	0	IV	Green
6	m	33	6	+	+	A	3	III	n.d	Green
7	f	24	6	+	—	—	3	0	0	Green
8	m	48	9	+	—	—	2	0	0	Green
9	f	28	8	+	—	A	9	II	0	Rosted
10	f	29	8	+	+	R	7	II	0	Clerk
11	f	24	2	+	+	—	4	0	0	Clerk

C, conjunctivitis; R, rhinitis; A, asthma; WRS, work-related symptoms; ND, not done.

TABLE III. Atopy, Work-Related Symptoms, and Skin Sensitization to Green Coffee Bean in Coffee Workers, Trieste 1996

	GCB prick test		p
	(–)	(+)	
	n. (%) 101 (90.2)	n. (%) 11 (9.8)	
Common allergic symptoms ^a	33 (32.7)	7 (65.6)	<0.05
Atopy by prick test	50 (49.5)	10 (90.9)	<0.01
Work-related symptoms	1 (1.0)	7 (63.6)	<0.01
Conjunctivitis	1 (1.0)	0	
Rhinoconjunctivitis	—	5 (45.4)	
Asthma	—	2 (18.2)	
Smokers (%)	46 (47.5)	6 (54.5)	NS

GCB, green coffee bean; NS, not significant.

^aSymptoms related to common allergens (house dust mites, pollens, cat and dog danders).**TABLE IV.** Results of Lung Function Test in Survey of Coffee Workers, Trieste 1996

	FVC% (Mean $\pm$ SD)	FEV1% (Mean $\pm$ SD)	IT% (Mean $\pm$ SD)
Exposure			
White-collar workers	100.8 $\pm$ 13.3	104.8 $\pm$ 14.1	96.7 $\pm$ 8.4
Green coffee	101.1 $\pm$ 14.5	100.0 $\pm$ 15.1	99.3 $\pm$ 8.2
Roasted coffee	103.4 $\pm$ 10.4	100.8 $\pm$ 10.2	97.7 $\pm$ 6.0
p	NS	NS	NS
Prick test			
Green coffee (+)	101.9 $\pm$ 13.7	98.6 $\pm$ 13.1	95.9 $\pm$ 15.2
Green coffee (–)	104.7 $\pm$ 13.2	102.4 $\pm$ 13.8	98.0 $\pm$ 8.0
p	NS	NS	NS
Smokers	102.7 $\pm$ 13.8	99.2 $\pm$ 14.1	96.6 $\pm$ 8.4
Nonsmokers	106.1 $\pm$ 12.6	104.8 $\pm$ 12.9	99.0 $\pm$ 6.9
p	NS	<0.05	NS

FVC, forced vital capacity; FEV1, 1-sec expiratory flow; IT, Tiffenau index; NS, not significant.

DISCUSSION

Green coffee bean is a well-known allergen capable of causing allergic respiratory symptoms in workers exposed. Not surprisingly, as reported in another Italian study [Romano et al., 1995], we found that sensitization to GCB was significantly higher in workers exposed to green coffee (25.8%) than in those exposed to roasted coffee (2.7%) and in white collar workers (4.5%). There was a striking difference in levels of sensitization between green and roasted coffee workers; this finding confirms the higher power of sensitization of GCB respect of that of roasted coffee [Lemiere et al., 1996], also if levels of exposure were higher in roasted coffee area.

The CB seemed to play a minor role in our study: the presence of castor bean-specific IgE in the serum was found

in only 3 of 10 subjects sensitized to green coffee bean. This is clearly the result of the introduction in 1970 of the policy of using only new sacks to transport green coffee. The low prevalence of CB sensitization shows the benefits of this prevention measure: it is well known that CBs can contaminate old sacks used for GCB transport [De Zotti et al., 1988; Patussi et al., 1991; Romano et al., 1995] and that it is the most important allergen in others studies where CB can be considered a sack contaminant [Figley and Rawling, 1950; Thomas et al., 1991; Thorpe et al., 1988; Romano et al., 1995]. Previous studies have shown that sensitization to CB in workers exposed to green coffee was very high: De Zotti and colleagues found skin sensitization to CB in 71% of Trieste dock workers sensitized to green coffee bean and

more recently, Romano and colleagues found that 57.1% of subjects in a coffee processing plant who had skin-prick test positivity to GCB were also sensitized to CB.

In general, the work-related allergic respiratory symptoms complained of were mild: only 2/68 workers (3%) in the processing plant complained of significant respiratory symptoms (asthma or cough). In fact, if we consider the two groups of workers together (green coffee and roasted coffee) the prevalence of symptoms was lower than that reported in other studies: Kaye and Freedman [1961] and Davies et al. [1983] found that 10% of exposed workers complained of respiratory symptoms and that half of these had asthma; in 1978, Karr et al. reported a 9% prevalence of respiratory symptoms, while in 1981, Zuskin's study of 45 nonsmoking female workers demonstrated a prevalence of asthma of 8.9%. In a sample of Trieste dock workers with no continuous exposure to GCB, De Zotti et al. [1983] found work-related symptoms in 14.3%, while in 1991, Thomas et al. found asthma in 12.7% of his study population. In all these studies, the population exposed to GCB was found to have a higher prevalence of symptoms: in our study almost all symptoms were present in people exposed to GCB.

The evaluation of predisposing factors was extremely revealing: there was a significant correlation between sensitization to GCB and work-related symptoms, and atopy by prick test or to common allergic symptoms, as found by other authors [Osterman et al., 1982; Venables, 1987; De Zotti et al., 1988; Thomas et al., 1991; Romano et al., 1995]. In fact, in the 11 cases positive to green coffee, 10 showed evident polysensitization to common allergens, and 7 complained of allergic symptoms caused by pollens or house dust mites. Similarly, of the 8 subjects with work-related symptoms, 6 were atopic by prick and all of them also reported perennial or seasonal symptoms with common allergens.

These results point to the need to evaluate atopic status in workers and identify the most susceptible subjects, with the aim of informing them of their at-risk status and monitoring their progress. This makes it possible to diagnose sooner those symptoms possibly indicative of a work-related disease, because even in the presence of good environmental conditions and even when symptoms are mild, it is almost always the atopic subjects who are affected.

No positive relationship was found between smoking habits and sensitization to GCB in contrast with results reported by Venables that suggested a role of smoking habit in increasing the penetration of occupational allergens at high molecular weight. These results are in accord with our previous study on Trieste dock workers exposed to GCB [De Zotti et al., 1988].

REFERENCES

- Davies RJ, Blainey AD, Pepys J (1983): Occupational asthma. In Middleton E Jr, Reed CE, Ellis EF, Adkinson NF Jr, Yunginger JW (eds): "Allergy: Principles and Practice." 2nd Ed. St Louis: CV Mosby. pp 385–401.
- De Zotti R, Patussi V, Fiorito A, Larese F (1988): Sensitization to green coffee bean (GCB) and castor bean (CB) allergens among dock workers. *Int Arch Occup Environ Health* 61:7–12.
- European Community for Coal and Steel (1983): Standardized lung function testing. *Bull. Eur Physiopathol Respir* (suppl 5):7–92.
- Figley KD, Rawling FA (1950): Castor bean: An industrial hazard as a contaminant of green dust and used burlap bags. *J Allergy* 21:545–558.
- Fiorito A, De Zotti R, Larese F (1992): Atopy and occupational asthma. In "Patologia Respiratoria da Esposizione a Farine." Trieste: Istituto di Medicina del Lavoro Regione Friuli Venezia Giulia, pp 337–339.
- Health and Safety Executive (1986): "Methods for the Determination of Hazardous Substances No 14. General Methods for the Gravimetric Determination of Respirable and Total Inhalable Dust." London: HMSO.
- Jones RN, Hughes JM, Lehres SB (1982): Lung function consequences of exposure and hypersensitivity in workers who process green coffee beans. *Am Rev Respir Dis* 125:199.
- Jones RN, Hughes JM, Lehrer SB (1984): Lung function effects of exposure and hypersensitivity to green coffee bean. In Gee JB, Morgan WKC, Brooks SM (eds): "Occupational Lung Disease." New York: Raven Press, pp 190–197.
- Karr RM, Lehrer SB, Butcher BT, Salvaggio JE (1978) Coffee worker's asthma: A clinical appraisal using the radioallergosorbent test. *J Allergy Clin Immunol* 62:143–148.
- Kaye M, Freedman SO (1961) Allergy to raw coffee. An occupational disease. *Can Med Assoc J* 84:469.
- Lehrer SB, Karr RM, Salvaggio JE (1978): Extraction and analysis of coffee bean allergens. *Clin Allergy* 8:217–226.
- Lemiere C, Malo JL, McCants M, Lehrer S (1996): Occupational asthma caused by roasted coffee: Immunologic evidence that roasted coffee contains the same antigens as green coffee, but a lower concentration. *J Allergy Clin Immunol* 98:464–467.
- Osterman K, Zetterstrom O, Johansson S (1982) Coffee worker's allergy. *Allergy* 37:314–322.
- Patussi V, De Zotti R, Riva G, Fiorito A, Larese F (1990) Allergic manifestations due to castor beans: An undue risk for the dock workers handling green coffee beans. *Med Lav* 81:301–307.
- Romano C, Sulotto F, Piolatto G, Ciacco C, Capellaro E, Falagiani P, Constable DW, Verga A, Scansetti G (1995) Factors related to the development of sensitization to green coffee and castor bean allergens among coffee workers. *Clin Exp Allergy* 25:643–650.
- Thomas KE, Trigg CJ, Baxter PJ, Topping M, Lacey J, Crook B, Whitehead P, Bennet JB, Davies RJ (1991) Factors relating to the development of respiratory symptoms in coffee process workers. *Br J Ind Med* 48:314.
- Thorpe SC, Kennedy DM, Panzani R, Lessof MH (1988) Allergy to castor bean 1. Its relationship to sensitization to common inhalant allergens (atopy). *J Allergy Clin Immunol* 82:62–66.
- Venables KM (1987) Epidemiology and the prevention of occupational asthma. (Editorial.) *Br J Ind Med* 44:73–75.
- Wide L, Bennich H, Johansson SGO (1967): Diagnosis of allergy by an in-vitro test for allergen antibodies. *Lancet* 2:1105–1107.
- Zuskin E, Valic F, Skuric Z (1979) Respiratory function in coffee workers. *Br J Ind Med* 36:117.
- Zuskin E, Valic F, Kanceljak B (1981) Immunological and respiratory changes in coffee workers. *Thorax* 36:9–13.