

Irritant contact dermatitis caused by needle-like calcium oxalate crystals, raphides, in *Agave tequilana* among workers in tequila distilleries and agave plantations

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It was found that needle-like calcium oxalate crystals, raphides, are found abundantly in all tissues of *Agave tequilana* plants; thus, 1 droplet (0.03 ml) of juice pressed from leaves contains 100–150 crystals, 30–500 μm in length, sharpened at both ends. In tequila distilleries, 5/6 of the workers who handle the agave stems have experienced the characteristic irritation. In contrast, only 1/3 of workers in agave plantations who harvest agave plants, complain of the irritation. It is confirmed that all the irritation suffered in both distilleries and plantations takes place at bodily locations where the plants come into contact with the worker's skin in the course of their work.

Key words: irritant contact dermatitis; agave; raphide; calcium oxalate; occupational; tequila making; agave harvesting; agriculture; distilleries. © Munksgaard, 2001.

Accepted for publication 25 May 2000

Many plant tissues contain calcium oxalate crystals of diverse forms (1), among which raphides are needle-like $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ crystals sharpened at both ends. It is known that raphides cause the irritant action of some plants such as fishtail palm (2). Bruynzeel (3) and Julian & Bowers (4) have suspected that raphides are causative of the flower and bulb dermatitis widely seen in daffodil pickers and workers in flower bulb industries. The common houseplant, dieffenbachia, is known to produce a painful oral mucous injury from raphides when chewed (5, 6). Schmidt & Moulton (7) showed a photograph of a raphide crystal from a plant stuck in the skin of a piglet causing dermatitis.

Wattendorff (8), Epelie et al. (9), and Ishii (10) reported that raphides were found abundantly in *Agave americana* plants. Cases of irritant contact dermatitis caused by *A. americana* were reported (11–13). However, the authors could not specify the causal substance but suspected that calcium oxalate as well as saponins and other plant constituents were responsible for the dermatitis. In 1984, Sakai et al. (14) studied, electron microscopically, raphides from 14 genera in 7 families in re-

lation to irritation. They found that raphide crystals longer than 180 μm in length caused irritation and that *A. americana* contained crystals larger than 200 μm .

Most agave species are native to Mexico and many agave species are planted currently, in particular *Agave tequilana* for tequila making. In tequila making, the stored carbohydrates in *A. tequilana* are hydrolyzed by steam heating for 2 days and the hydrolysates fermented, followed by double distillation. Mexico consumed 672,000 tons of the stem of *A. tequilana* and produced 170,000 m^3 of tequila in 1998 (15).

“Mal de agaveros” (agave worker's sickness) is the term used for the dermatitis which is widespread among agave workers. In this paper, we have studied dermatitis found in workers who have to come in contact with agave plants. We also suffered irritation, accompanied by many red weals, in the course of studying the chemical constituents of *A. tequilana*. Many raphides were found in the sap and other parts of the plant. The crystals caused us a similar dermatitis within an hour of contact, with more inflammation the next day.

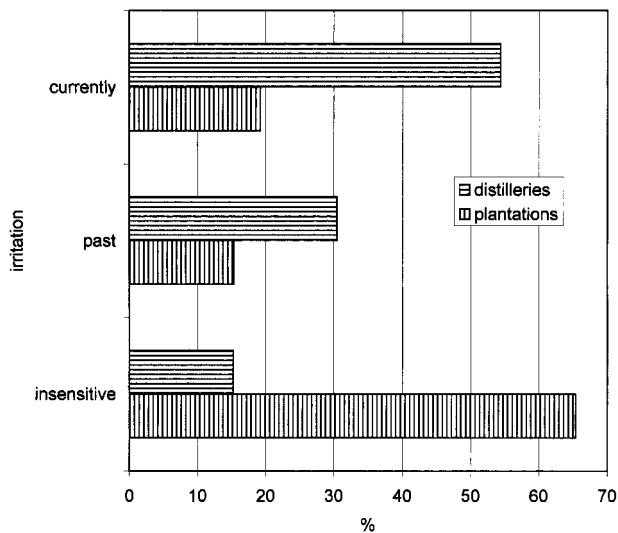


Fig. 1. Susceptibility to agave-caused irritation in distilleries and plantations.

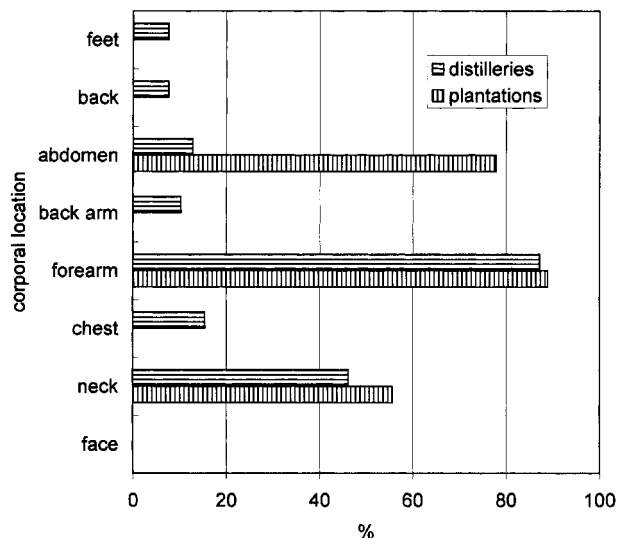


Fig. 2. Bodily locations of agave-caused irritation in distilleries and plantations.

Materials and Methods

Isolation and cleaning of raphide crystals

A leaf of *A. tequilana* was planed and approximately 30 g of thin shavings were held with tweezers and shaken in a 150-ml beaker containing 80 ml of water for 5 min. The greenish turbid suspension was strained through 60 mm-nylon netting (Nitex, E-Net-NTX-60, purchased from Agent Aquaculture, Redmond, WA, USA). The strained suspension was allowed to stand for 3 min before pipetting out the supernatant liquid leaving approximately 0.5 cm in height. The suspension was transferred to a 20 ml vial and the supernatant

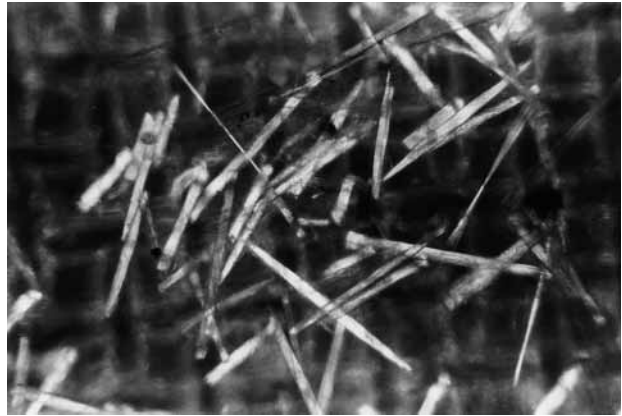


Fig. 3. Raphide crystals on a disk of polyethylene sheet imprinted with a stainless steel screen as seen in the background, measuring 125 μ m each side of the blocks.

liquid was pipetted out. Then, 15 ml of a saturated $(\text{NH}_4)_2\text{SO}_4$ solution was poured into the suspension in the vial and allowed to stand for 1 min before pipetting out the supernatant liquid. The crystals were rinsed using deionized water at least $5\times$.

Questionnaire

The questionnaire consisted of (1) the name of the volunteer, (2) age, (3) type of occupation, (4) length of time engaged in the occupation, (5) history of the appearance of weals and their severity, (6) bodily locations where weals appeared on the last occasion. Questionnaires were given to volunteers who engaged in occupations in which they had to touch fresh agave plants in Los Camichines and La Rogaña distilleries and agave plantations. A questioner registered the answers.

Results and Discussion

Questionnaires were given to male workers in agave plantations (26 persons) and tequila distilleries (46 persons) who had frequent opportunity to touch fresh agave plants. No female worker was found in these occupations. The persons who had suffered from agave-originated irritation within the previous month are classified as "current", those who had never suffered as "insensitive", and those who had suffered the dermatitis previously, but not during the past month, as "past." Fig. 1 shows the % representation of each classification for the distilleries and plantations, separately. In distilleries, over 50% of the workers suffered from dermatitis in the "current" category, 30% in the "past" and only 15% were "insensitive". However, 2/3 of the plantation workers were reported "insen-

sitive". The workers in agave plantations are exposed to strong tropical sunshine and spiny agave leaves and weeds. Therefore, the irritation by raphides may not be strong enough compared to other hazards in these severe environments.

Fig. 2 shows the classification of the irritation under bodily locations in the distilleries and plantations. The forearms and neck were the major irritated locations in both workplaces. Irritation at these locations is probably due to the fact that the workers carry the agave stems using mainly the forearms and shoulders.

However, irritation on the abdomen was complained of in almost 80% of the affected workers in the plantations, compared to only 10% in the distilleries. It seems that less clothing is worn in the plantations because of strong sunshine and the absence of neighbors; thus, there is a high risk of agave flesh or its sap touching the naked abdomen.

Fig. 3 shows a polarized optical microscopic image of cleaned raphides. Special care had to be taken not to allow crystal-containing materials to touch the skin while studying raphides, since we were soon suffering from weals on coming into contact with aqueous suspensions of raphides.

It was observed that the pressed juice of agave leaves contained 4000–6000 raphide crystals per ml. Thus, when 20 ml of a raphide suspension (4000 crystals/ml) prepared from cleaned raphides was passed gently through a single and double layered wet cotton cloth, 75 and 92%, respectively, of crystals were retained on the cloth. Therefore, suitably designed clothes in tequila distilleries and agave plantations could prevent most hazards of raphides from agave plants.

A scourer locally called "estropajo", made from fibers of agave leaves, is used throughout Mexico for washing and cleaning dishes. Estropajos were purchased in local markets in Guadalajara, Jal., Mexico, since there were complaints about irritation from using estropajos while bathing. Raphides were found in all the merchandise examined. The starting material, leaves of *A. lechugia*, was examined and many raphides were found.

Acknowledgements

Photographs of the raphides were taken by Ms. Hilda Palacios Juarez and Dr. Jose Turrado Saucedo, Departamento de Celulosa y Papel, Universidad de Guadalajara, Las Agujas, Jal., Mexico. We

thank Mr. Carlos Antonio Mujica, Mr. Mario García, Mr. Adrián Mercado and Mr. Andres de Loera, Departamento de Química, Universidad Autonoma de Guadalajara, Guadalajara, Jal., Mexico, for their technical assistance.

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