

■ BRIEF COMMUNICATION ■

Activated Charcoal Suppresses Breeding of the House Dust Mite, *Dermatophagoides Pteronyssinus*, in Culture

House dust mite sensitized asthmatics are advised to practice allergen avoidance. Charcoal pillows are used in Korea with unsubstantiated claims regarding their efficacy in alleviating asthma symptoms. We tested the effects of activated charcoal on breeding of house dust mites in culture. Twenty live adult house dust mites (*Dermatophagoides pteronyssinus*) were inoculated, 10 replicates, on culture media containing 0%, 1%, 3%, 5%, 10%, and 20% activated charcoal and incubated at 25°C and a relative humidity of 75%. After four weeks, the mean numbers of live house dust mites were 286, 176, 46, 16, 7, and 0 for the 0%, 1%, 3%, 5%, 10%, and 20% charcoal-containing culture media, respectively. Thus, activated charcoal suppresses breeding of house dust mites and offers a new promising method for house dust mite control.

Key Words : *Dermatophagoides Pteronyssinus*; House Dust Mite; Activated Charcoal; Survival; Allergy

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House dust mites are known to be a dominant risk factor for the development of allergic asthma in susceptible individuals (1), and in those sensitized, house dust mite allergen levels are associated with the clinical activity of asthma (2). House dust mite sensitized patients are encouraged to practice allergen avoidance, especially in the bedroom where we spend about a third of our lives in close contact with house dust mite allergen laden bedding items (3). Among house dust mite allergen avoidance measures advocated are semi-impermeable pillow, mattress and duvet encasings; humidity reduction; acaricidal agents; hot washing of bedding; and carpet removal (4).

In Korea, activated charcoal-filled pillows are sold with many unsubstantiated health benefits, including beneficial effects on asthma. To our knowledge, no published studies have looked at the effect of activated charcoal on house dust mite survival. The purpose of this study was to determine the effect of different concentrations of activated charcoal in culture media on the survival of the house dust mite, *Dermatophagoides pteronyssinus* (Acari: Pyroglyphidae) under controlled temperature and relative humidity conditions.

A bulk mite culture medium was prepared consisting of 40% wheat germ, 40% granulated yeast, 15% commercial

gold fish food, and 5% dried daphnia. Five different charcoal-containing mite culture media were prepared by adding appropriate amounts of 100–400 mesh activated charcoal powder (Sigma-Aldrich, St. Louis, MO, U.S.A.) to finish with final charcoal concentrations of 1%, 3%, 5%, 10%, and 20%. The mite culture medium without added charcoal represented the 0% concentration. Sufficient quantities (1 gram) of these six mite culture media were added to small 60 × 15 mm Petri dishes (Corning, New York, NY, U.S.A.). For each mite culture medium charcoal concentration (including 0%), 10 Petri dishes were prepared. These were then moisture equilibrated (75% relative humidity) in culture chambers (Lock & Lock, Youngin, Korea) for five days.

Twenty live adult house dust mites (*D. pteronyssinus*) were added to each Petrie dish. The Petri dishes were sealed with Parafilm™ and cultured for four weeks at 25°C and 75% relative humidity. Live house dust mites were then harvested from each Petri dish by the saturated saline floating method (5) and enumerated under a stereo microscope (Leica, Heerbrugg, Switzerland).

For harvesting the house dust mites, the entire contents of each Petri dish were transferred to a 50 mL centrifuge tube and filled with saturated saline. After mixing, the tubes were

centrifuged for 10 min at 1,000 rpm, the supernatant removed, refilled with saturated saline and centrifuged again as above.

The supernatant was poured evenly over Whatman No.2 110 mm diameter filter paper on which we had made stripes for easier counting of house dust mites. House dust mites were considered live if translucent and moving, while dead house dust mites generally were non-moving, dark brown in colour, and shrunk or denatured.

Data is presented as mean numbers of harvested live house dust mites and percentage reduction, with 95% confidence intervals (95% CI). Statistical analysis was done by paired t-test, with a statistical significance set at the p 0.05 level.

After four weeks of cultivation, there was a steady and significant non-linear decrease in the number of live house dust mites recovered with increasing concentrations of activated charcoal in the culture media (Table 1). The percentage decrease (95% CI) in live house dust mites recovered for the 1%, 3%, 5%, and 10% active charcoal culture media concentrations were 31.8% (9.0-51.0), 80.6% (76.3-86.7), 93.8% (87.4-98.2), and 99.3% (94.7-99.8), respectively.

These reductions were statistically significant at all activated charcoal concentrations (Table 1). At a concentration of 20% activated charcoal no live house dust mites could be recovered in all 10 Petri dishes, thus giving a 100% decrease.

This study has demonstrated that activated charcoal added to culture media significantly suppressed breeding of the house dust mite, *D. pteronyssinus*. At a concentration of 20% activated charcoal no live house dust mites were recoverable after four weeks of cultivation. Even at a concentration of 5% activated charcoal, a reduction of greater than 90% in live house dust mites was achieved.

House dust mite sensitized patients are encouraged to practice allergen avoidance, especially in the bedroom. Special attention has been given to bedding due to the close proximity of these, especially pillows, to the airways when asleep. Thus, it has been strongly recommended that allergic patients cover all bedding items with semi-permeable covers. Some

Table 1. Number of live house dust mites recovered after four weeks of culture with varying concentrations of activated charcoal

Sample	0%	1%	3%	5%	10%	20%
1	252	110	49	12	4	0
2	248	103	42	15	3	0
3	267	146	45	7	6	0
4	280	239	46	16	5	0
5	218	117	55	7	7	0
6	291	110	50	14	2	0
7	293	212	30	0	9	0
8	334	256	34	3	2	0
9	212	248	75	46	3	0
10	190	223	33	38	24	0
Mean	258	176	50	16	7	0
95% CI	227-290	130-223	35-57	6-26	2-11	

Constant temperature: 25°C; constant relative humidity: 75%.

studies have shown that reducing allergen exposure by these means has a beneficial effect on asthma symptoms (6, 7), although others have shown no beneficial effect (8, 9)

The role that different types of pillows have in the development of allergic diseases and asthma symptoms has recently drawn attention since Strachan and Carey demonstrated that synthetic pillows were associated with severe asthma in adolescence (10). Subsequently it was shown that synthetic pillows have much higher levels of house dust mite allergens than feather pillows (11). This is due to the tighter weave on feather pillows that blocks house dust mites from entering these pillows (12). These findings led to many cross-sectional studies, all consistently showing that synthetic pillows are associated with allergic diseases, or a protective effect of feather pillows (reviewed in 13).

Pillows containing activated charcoal are used in Korea, where they are claimed to be beneficial for asthmatics. To our knowledge, no formal studies on these claims have been conducted. There are two ways that manufacturers incorporate activated charcoal into pillows. Some use activated charcoal of 100-500 mesh (similar to that used in our study) to fill the pillows, while others use fine charcoal-coated threading.

There are plausible reasons why activated charcoal suppresses breeding of house dust mites. Firstly, activated charcoal is able to absorb large quantities of moisture and thus could reduce relative humidity constantly to below 50%. Arlian estimated that 10 days at 28°C and 50% relative humidity is lethal for *D. pteronyssinus* (14), although a recent study suggested that in other countries, such as New Zealand, house dust mites tended to live twice as long under these conditions (15). However, in our study this mechanism is unlikely as the cultures were kept at a constant relative humidity of 75% during the culture period of four weeks.

It may be that the house dust mites ingested some of the activated charcoal and scoured their stomach linings, making them unable to feed and thus starve to death. Alternatively, the ingested charcoal may have absorbed water and essential nutrients, leading to their demise. These suggestions have not, to our knowledge, been tested.

Activated charcoal has many uses, including treatment for severe drug overdoses (16), as an absorbent in air purifiers, as a spill absorbent, and as purification for contaminated solutions. Activated charcoal may now be of use to control house dust mites in bedding. Further trials are required to find the optimum concentration activated charcoal required to suppress breeding of house dust mites in bedding. If effective, then trials are warranted to assess its effect on asthma symptoms reduction and reduced needs for pharmacological control.

REFERENCES

1. Squillace SP, Sporik RB, Rakes G, Couture N, Lawrence A, Merriam S, Zhang J, Platts-Mills TA. *Sensitization to dust mites as a dominant*

- risk factor for asthma among adolescents living in central Virginia. Multiple regression analysis of a population-based study. *Am J Respir Crit Care Med* 1997; 156: 1760-4.
2. Custovic A, Taggart SC, Francis HC, Chapman MD, Woodcock A. Exposure to house dust mite allergens and the clinical activity of asthma. *J Allergy Clin Immunol* 1996; 98: 64-72.
 3. Mills S, Siebers R, Wickens K, Crane J, Purdie G, Fitzharris P. House dust mite allergen in individual bedding components in New Zealand. *N Z Med J* 2002; 115: 151-3.
 4. Siebers RW, Fitzharris P, Crane J. Beds, bedrooms, bedding and bugs. Anything new between the sheets? *Clin Exp Allergy* 1996; 26: 1225-7.
 5. Ree HL, Jeon SH, Lee IY, Hong CS, Lee DK. Fauna and geographical distribution of house dust mites in Korea. *Korean J Parasit* 1997; 35: 9-17.
 6. Frederick JM, Warner JO, Jessop WJ, Enander I, Warner JA. Effect of a bed covering system in children with asthma and house dust mite hypersensitivity. *Eur Respir J* 1997; 10: 361-6.
 7. van den Bemt L, van Knapen L, de Vries MP, Jansen M, Cloosterman S, van Schayck CP. Clinical effectiveness of a mite allergen-impermeable bed-covering system in asthmatic mite-sensitive patients. *J Allergy Clin Immunol* 2004; 114: 858-62.
 8. Woodcock A, Forster L, Matthews E, Martin J, Letley L, Vickers M, Britton J, Strachan D, Howarth P, Altmann D, Frost C, Custovic A; Medical Research Council General Practice Research Framework. Control of exposure to mite allergen and allergen-impermeable bed covers for adults with asthma. *N Engl J Med* 2003; 349: 225-36.
 9. Terreehorst I, Hak E, Oosting AJ, Tempels-Pavlica Z, de Monchy JG, Brujinzeel-Koomen CA, Aalberse RC, Gerth van Wijk R. Evaluation of impermeable covers for bedding in patients with allergic rhinitis. *N Engl J Med* 2003; 349: 237-46.
 10. Strachan DP, Carey IM. Home environment and severe asthma in adolescence: a population based case-control study. *BMJ* 1995; 311: 1053-6.
 11. Kemp TJ, Siebers RW, Fishwick D, O'Grady GB, Fitzharris P, Crane J. House dust mite allergen in pillows. *BMJ* 1996; 313: 916.
 12. Siebers R, Fitzharris P, Crane J. Feather bedding and allergic disease in children: a cover story? *Clin Exp Allergy* 2002; 32: 1119-23.
 13. Siebers R, Nam HS, Crane J. Permeability of synthetic and feather pillows to live house dust mites and house dust. *Clin Exp Allergy* 2004; 34: 888-90.
 14. Arlian LG. Dehydration and survival of the European house dust mite, *Dermatophagoides pteronyssinus*. *J Med Entomol* 1975; 437-42.
 15. Pike AJ, Cunningham MJ, Lester PJ. Development of *Dermatophagoides pteronyssinus* (Acari: Pyroglyphidae) at constant and simultaneously fluctuating temperature and humidity conditions. *J Med Entomol* 2005; 42: 266-9.
 16. Heard K. Gastrointestinal decontamination. *Med Clin North Am* 2005; 89: 1067-78.