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Reprinted from AMERICAN INDUSTRIAL HYGIENE ASSOCIATION JOURNAL
Volume 29, July-August, 1968

Fibrous and Mineral Content of Cosmetic Talcum Products

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In searching for sources of fibers ubiquitous to our everyday environment and of respirable size, the authors examined 22 talcum products commonly available on retail shelves and found fiber contents ranging from 8 to 30% by count, with an average of 19%. Fibrous particulates were generally under 1.0 μ in diameter with lengths ranging from 1.5 to 6.0 μ. From 0.3 to 3.0% quartz was found in 21 of the samples and the remaining sample had 54.4% quartz. The samples were also analyzed for metals; with four exceptions, the levels of cobalt, nickel, chromium and manganese were low. Further research will be needed to assess the significance of these findings.

REPORTS OF FINDING pulmonary fibrous bodies, previously referred to as "asbestos" and now as "ferruginous" bodies, in the lungs of persons coming to autopsy in hospitals in a number of cities have recently been increasing. The first report of these morphologically distinctive fibrous bodies in the sputum and lungs of asbestos workers was made in 1906 by Marchand.[1] Current interest dates from 1963 when Thompson *et al.*[2] found these fibrous bodies in the lungs in 26.4% of the autopsies in a series of examinations in Cape Town. Subsequent investigations[3-6] provide evidence that the occurrence of these bodies in the lungs of urban residents is not restricted to those in isolated localities and is not a one-time chance observation.

The identity of the fibrous core of these coated bodies, however, was never determined by the investigators. The fibers were routinely considered as asbestos bodies on the basis of their morphological structure.

In searching for the sources of these ubiquitous fibers, Cralley *et al.*[7] reported that talcum powder contained a significant percentage of respirable fibers and was a potential source of the ferruginous bodies observed in the lungs of humans. This observation led to further study to characterize cosmetic talcum products.

The major purpose of the investigation reported here was to develop and present data on some of the constituents found in cosmetic talcum products and to discuss their health aspects in the light of today's knowledge. It is not our intent to make a general appraisal of health factors in the use of talcum products because of the many variables involved and the limited data available on the consumption of various "sources of talcs" in the formulation and use of cosmetic talcum products. The potential health aspects of some of the data, however, are discussed.

Twenty-two cosmetic talcum products (representing body powder, bath powder, and all purpose powder) purchased off-the-shelf, were analyzed for fibrous content, selected metals, and quartz. The data and a discussion of their possible significance follow.

Analysis of Talcum Products

Talc is a natural mineral, hydrous magnesium silicate, with the general formula (OH)$_2$-

Presented at the American Industrial Hygiene Conference May 13-17, 1968, St. Louis, Missouri.

TABLE I
Designated Analyses of Cosmetic Talcum Products

Talcum Product No.	% Fibers	% Free SiO_2	ppm* Co	ppm* Cr	ppm* Ni	ppm* Mn	mg/gm** Zr	mg/gm** Ti	mg/gm** Zn	mg/gm** Fe	mg/gm** Mg	mg/gm** Si	mg/gm** Al
1	19	0.3	13	9	13	16	<10	0.9	ND	20	>17	>10	30
2	21	0.4	<10	<10	<10	23	"	0.5	5	10	"	"	6
3	23	0.2	<10	<10	20	78	"	0.3	ND	7	"	"	5
4	19	2.2	67	240	1270	55	"	0.8	40	30	"	"	40
5	30	0.6	<10	<10	14	<10	"	0.2	ND	6	"	"	5
6	18	1.5	21	14	16	13	"	0.1	"	15	"	"	60
7	14	2.1	ND	<10	17	14	"	0.4	"	10	"	"	5
8	19	3.6	< 9	320	479	45	"	0.3	"	15	"	"	3
9	21	53.4	<11	ND	<10	14	20	20.0	ND	8	[illegible] 5	"	>100
10	8	0.9	25	<12	24	33	<10	30.0	40	12	>1[illegible]	"	30
11	8	1.4	18	22	20	61	"	20.0	10	50	"		40
12	25	1.3	10	13	17	41	"	0.8	ND	10	"	"	8
13	26	1.7	ND	<10	<10	19	"	0.8	"	10	"	"	10
14	28	1.3	<10	10	<10	26	"	0.8	"	10	"	"	15
15	28	1.9	<10	<10	16	24	"	0.3	"	10	"	"	9
16	12	1.2	<11	<11	16	62	"	10.0	"	20	"	"	15
17	13	1.7	<10	10	19	70	30	10.0	"	20	"	"	12
18	16	0.4	16	< 9	14	18	<10	0.5	5	15	"	"	40
19	18	1.0	<10	<10	21	16	"	0.7	ND	10	"	"	6
20	16	1.2	22	10	29	50	"	0.8	40	10	"	"	40
21	25	3.3	10	9	19	26	"	0.6	5	10	"	"	10
22	14	0.5	14	1170	1210	84	"	0.3	ND	30	"	"	4

*Microgram of metal per gram of sample.
**Milligram of element per gram of sample.

$Mg_3Si_4O_{10}$. Talc mineral is formed by the hydrothermal alteration of serpentine and tremolite or directly from unserpentinized ultrabasic rocks. Talc may also be formed by the thermal metamorphism of silicous dolomites.[10-12] The characteristics of the mineral deposits vary widely from the pure talc formula and from each other according to the mineralogy involved. Some deposits may contain varying amounts of tremolite, chrysotile, pyrophylite, or serpentine, or other basic material from which the talc may be derived. The deposits may also contain varying amounts of metals such as iron, nickel, cobalt, chromium, and manganese as associated minerals, as well as silica. Cosmetic talcum may be basically pure talc or may be a formulation of talc with other materials such as clay, chalk, stearates, etc. Zinc, titanium, manganese, and iron compounds may be added as pigments and opacifiers.

The particle-size distribution and percentage by count of fibers in the talcum particulates were determined by dispersing the talcum in water, filtering the mixture through an "AA" membrane filter, and measuring with a phase contrast microscope at 450 magnification. The percentage of free silica was determined by x-ray diffraction. Cobalt, chromium, nickel, and manganese were determined by means of atomic absorption spectrophotometry. Zirconium, titanium, zinc, iron, and magnesium were determined by means of semi-quantitative emission spectrography.

Table I gives analytical data on 22 different cosmetic talcum products. Figures 1 and 2 are representative photomicrographs of two talcum specimens showing the presence of fibers.

Size Distribution of Talcum Particulates

Seven of the twenty-two talcum products were selected for size-distribution measurements of the fibrous and non-fibrous particulate components.

The diameter of 80 to 95% of all the particulates in these samples was under 5.0 microns (μ). The median of the diameter of the non-fibrous particulates in the seven products ranged from 0.7 to 2.0 μ, with a median average around 1.0 μ.

A fiber is defined as a particulate having at least a 1:3 ratio of diameter to length. The fibrous particulates in the seven products were

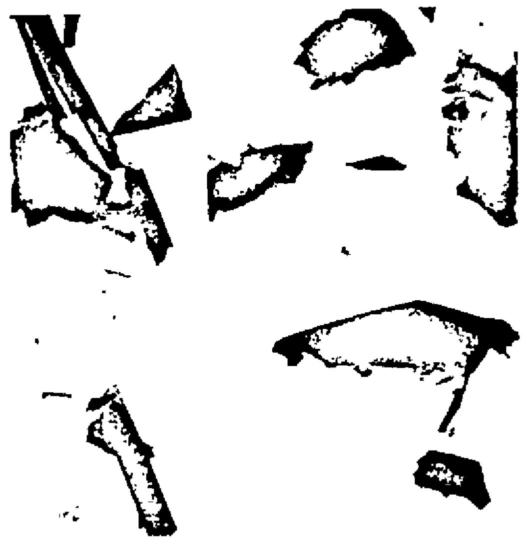

FIGURE 1. Photomicrograph of talcum specimen showing presence of fibers (430 ×).

FIGURE 2. Photomicrograph of talcum specimen showing presence of fibers (430 ×).

generally under 1.0 μ in diameter, with lengths ranging from 1.5 to 6.0 μ.

The 22 talcum products analyzed showed fiber contents ranging from 8 to 30% by count of the total talcum particulates with an average of 19%. Although the specific fibrous materials were not identified, they were predominantly fibrous talc, as shown by x-ray diffraction, with the probable presence in minor amounts of other fibrous minerals such as tremolite, anthophylite, chrysotile, and pyrophyllite.

The electron microscope, with its higher power of resolution, shows a number of sub-micron diameter particulates not visible by means of phase contrast microscopy.

Free Silica

In 8 of the 22 talcum products (Table I), the presence of quartz ranged from 0.5 to 1.0%; in 13 products, 1.2 to 3.0% quartz, and in 1 product, 54.4% quartz.

Metals

With the exception of talcum products Nos. 4, 8, and 22 (Table I), the cobalt content of the products analyzed was under 25 parts per million by weight (ppm), chromium under 22 ppm, nickel under 29 ppm, and manganese under 78 ppm. Product No. 4 had a nickel content of 1270 ppm; chromium 340 ppm, and cobalt, 67 ppm. Product No. 8 contained 479 ppm nickel and 329 ppm chromium. Product No. 22 contained 1210 ppm nickel and 1170 ppm chromium. Qualitative tests showed some of the chromium in the talcum products to be in the hexavalent state. The nickel, chromium, cobalt, and manganese in the talcum products may have come from the talc mineral deposit[illegible] or from the alloy metals of the pulverizing equipment used in reducing the talc.[illegible]

The zirconium content of the products was all under 10 milligrams per gram (mg/gm) except for products Nos. 9 and 1[illegible] which had 20 and [illegible] mg/gm, respectively. [illegible] titanium, zinc, and iron ranged from a few [illegible] to 5[illegible] mg/[illegible] talcum and were [illegible] present as pigments or opacifiers. The [illegible] magnesium content of the products was [illegible] mg/gm, except for product No. [illegible] which had only [illegible] mg/gm. The [illegible] also present as an [illegible] of [illegible] products.

The aluminum and silicas were in all probability associated either with the talc molecule, or additives such as kaolin, or the base material from which the talc was derived.

Known Health Effects of Talc

Much of our knowledge of the health effects of talc is derived from studies of occupational exposures in its mining, milling, and industrial use. In extrapolating this knowledge to the cosmetic use of talcum powder, it must be recognized that the pattern of exposures in the use of talcum product varies markedly from person to person, not only in frequency of use but also in amount and in location.

In contrast to industrial exposures where the pattern is likely to be more continuous with accompanying peaks, exposure in the use of cosmetic talcum products is very intermittent with peak exposures dominating. The exposure pattern may continue a lifetime, especially if the use of talcum is established in the earlier years as a part of personal habits. The air-borne dosage to workers from industrial exposures to talc that have resulted in injury to health were undoubtedly much higher, however, than would be predicted from the use of cosmetic talcum products.

Mining, Milling, and Industrial Use

The clinical entity of talc pneumoconiosis, "talcosis," has been observed repeatedly in workers with long exposure to talc in its mining, milling, and industrial use.[14-17] Elongated, terminally clubbed pulmonary fibrous bodies, both segmented and unsegmented and similar in morphology to ferruginous bodies, have been found in talc workers, but these workers had received a mixed exposure—to talc, tremolite, anthophyllite, and silica.[18,19] In one study[20] the mortality rate from cancer of the lung and pleura was four times greater for a group of talc workers than for the general population. In pulmonary cancer from asbestos, the role of fibers and trace metals is uncertain. Some investigators have assumed the fibers play a dominant and direct role, more recent investigations indicate that the fibers may have been only an index concealing a spectrum of unidentified agents and relationship.[13]

Surgical and Cosmetic Use

The only reported cutaneous reactions from the use of talcum powder are talc granulomas, and these have been rare.[21,22] Talcum powder, however, is no longer used on surgical gloves and should not be applied to broken skin. Occasionally, perfume oils used in talcum powder formulations sensitize the skin and produce dermatitis.[23,24]

Conclusions

With the exception of 4 of the 22 cosmetic talcum products analyzed, the levels of free silica, cobalt, nickel, chromium, and manganese were generally of a low magnitude and within a narrow range. It is not known whether the four products represent a significant proportion of sales in the industry or to what extent the sources of the talc in these four formulations are the same as sources of talc specified for use in other talcum products in the competitive market. The levels of silica, chromium, and nickel in these four products are sufficiently high, however, to be of concern in their potential to cause disease.

All of the 22 talcum products analyzed have an appreciable fiber content, ranging from 8 to 30% by count of the total talcum particulates, and averaging 19%. The fibrous material was predominantly talc but probably contained minor amounts of tremolite, anthophyllite, and chrysotile as these are often present in fibrous talc mineral deposits. Cosmetic talcum products should be included as a source of the fibers, from which may be derived ferruginous bodies observed in the lungs of humans. The meaning of the presence of these ferruginous bodies, however, is uncertain.

Industry has the know-how to safely handle [illegible] material as well as toxic metals such as nickel, chromium, cobalt, and manganese once adequate criteria have been established. Unknown [illegible] amounts of [illegible] materials in products that may be [illegible] without [illegible]. For this [illegible] investigations [illegible] are necessary in this area.

Acknowledgments

The authors acknowledge, with appreciation, the technical assistance of Harrold B. Norris who made the free silica determinations; Patricia L. Maurer who made the atomic absorption spectrophotometric determinations for nickel, cobalt, chromium, and manganese; John R. Carlberg who made the emission spectrographic determinations for zirconium, titanium, zinc, iron, magnesium, and aluminum; and Stephen Bayer and Ralph Zumwalde for the fiber determinations.

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