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Federal Department of Home Affairs FDHA
Federal Office of Public Health FOPH
Consumer Protection Directorate

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HOLI COLOR POWDER
Important information for importers and distributors



Situation

The Holi festival of colors originating in India traditionally takes place around the spring equinox. The people participating wear white and throw colored pigments at each other. In recent years the Holi movement has also spread in Europe. At Holi festivals and color runs, people gather in public places or at running trails to throw colored powder at each other.

In 2015 a Holi party in Taiwan hit the headlines worldwide when a dust explosion killed 15 people and injured more than 500 others. The physical and chemical properties of the powder have to be examined carefully. Another worrying aspect of the practice is the high exposure of lungs to dust at events involving Holi color powder.

Composition of the powder

The powder is usually made on the basis of talc, corn flour (cornstarch) or rice flour. This type of powder is chosen because of its dust-like properties.

The pigments used to make the powder are synthetic, mostly originating from the food and cosmetics industry.

In addition the powder contains anticaking agents (sodium bicarbonate, calcium carbonate, tricalcium phosphate or silicon dioxide) and sometimes also preservatives (sodium benzoate, sodium bisulfite and sodium methyl 4-hydroxybenzoate) and fragrances.

Toxicological properties of the main constituents

The degree of danger depends on the constituents of the powder, particularly the size of the particles. Exposure to microscopically fine particles with a diameter of less than 10 micrometers (PM_{10}) is responsible for an increase in morbidity and mortality from diseases of the vascular and respiratory systems. According to the WHO there are no thresholds for PM_{10} (particulate matter ≤ 10 µm) and $PM_{2.5}$ (particulate matter ≤ 2.5 µm) below which no health-damaging effects can be expected. For this reason the percentage of suspended particulate matter should be limited as far as possible. Particles with an average diameter of <4–5 µm are particularly problematic from a toxicological point of view because they can penetrate to the alveolar surfaces of the lung. There are no cilia in the alveoli (air cells of the lungs), and particles are removed by phagocytosis facilitated by macrophages. This is a slow process, and saturation occurs rapidly in the event of chronic exposure. In humans, the elimination half-life of bioresistant particles deposited in the alveoli is around 400 days, depending on the size of the particles and the degree of inflammation induced.

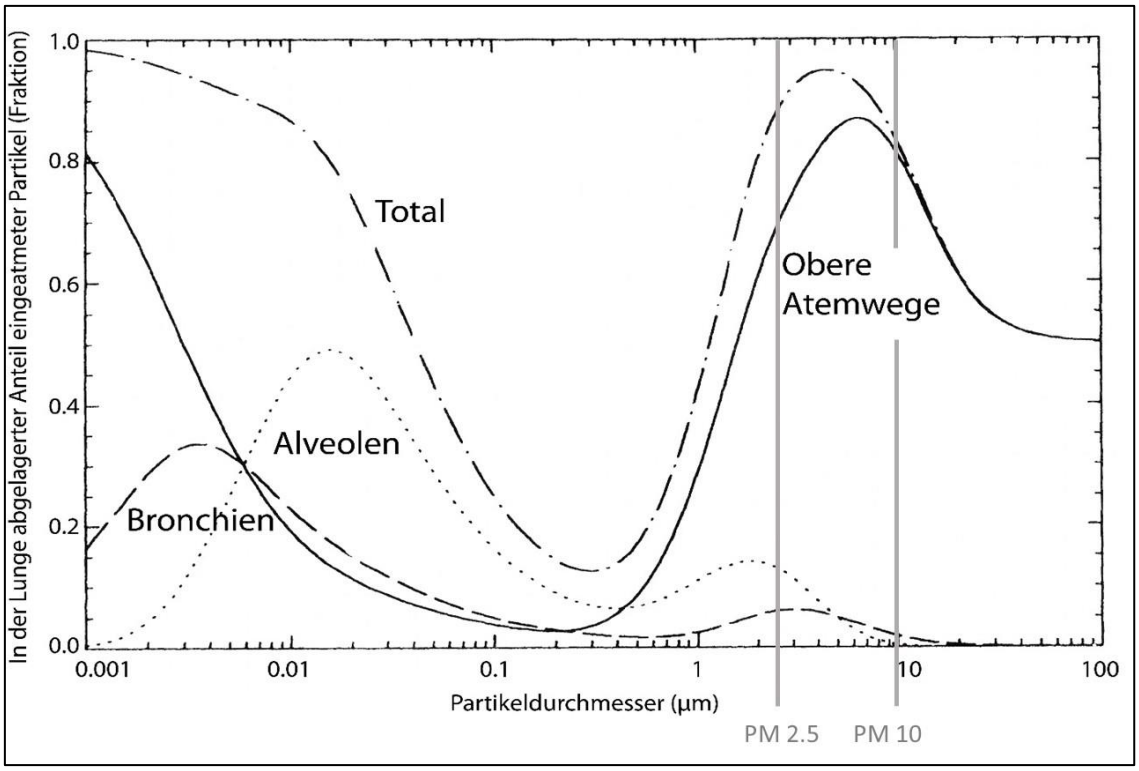

Figure 1. Modelled (ICRP Deposition Model) total and region-specific deposition of particles during nasal breathing. Average for men and women. Adapted from W.C. Hinds (Aerosol Technology, 1999).

Talc

The size of the talc particulate matter ranges from 1 to >100 µm.

Talc may contain natural impurities in the form of quartz (which can trigger silicosis) and asbestos fibers (categorized as carcinogenic to humans because they can cause a mesothelioma). If talc without these impurities is breathed in it can result in chronic bronchitis, interstitial inflammation and granuloma. Talc is a granular, bio-resistant type of dust that is difficult for the lungs to eliminate.

Acute exposure to talc can trigger serious breathing problems requiring intensive medical care. The effects of talc following acute exposure by inhalation are mainly due to its irritant and desiccant properties. The mucous membranes of the airways dry out, hindering the ciliary transport of foreign particles and their removal. It generally takes several hours before symptoms such as coughing, dyspnea (shortness of breath), vomiting and cyanosis occur. Aspirated talc can completely block the smaller airways and lead to pulmonary failure. Fatalities have also been reported in serious cases of intoxication by inhalation of talc.

Corn flour (cornstarch)

In their native state corn flour particles have a diameter of 1 to 20 µm, with the median at around 13 µm (Singh et al., 2003). In rare cases contact with corn flour can lead to sensitization, or trigger an acute reaction in people with existing allergies. There have been reports of allergic cross reactions between corn (maize) and stone fruits of the genus Prunus, and grass pollen.

Cornstarch can cause irritation and inflammation of the airways with elevated concentrations of eosinophilic leukocytes. High exposure to cornstarch by inhalation can lead to serious health issues requiring intensive medical intervention. Breathing in cornstarch can result in partial or complete blockage of the smaller airways, which can lead to inflammation of the lungs and pulmonary failure.

Rice flour (rice starch)

Rice starch has the same toxicological properties as cornstarch.

Pigments

According to the product safety data sheets available for certain powders, the pigments used originate from the food and cosmetics industries. This applies, for example, to Azorubine (CI 14720, E122), Sunset Yellow FCF (CI 15985, E110), Ponceau 4R (CI 16255, E124), Tartrazine (CI 19140, E102), Brilliant Blue FCF (CI 42090, E133) and Quinoline Yellow (CI 47005, E104). These pigments have only been tested for these applications, in other words for dermal and oral use. No data are available for toxicity in the event of exposure by inhalation. Most of the pigments used can have a phototoxic or sensitizing effect. As food additives they are subject to food-specific restrictions, i.e. acceptable daily intake (ADI). The warning label "may have an adverse effect on activity and attention in children" applies to most azo compounds (including E102, E110, E122, E124 and E129) and Quinoline Yellow (E104) (Regulation [EC] No 1333/2008).

Anticaking agents

- Bicarbonate can cause slight eye and respiratory tract irritation. No data are available on sensitization.
- Tricalcium phosphate irritates the eyes, skin and respiratory tract. Inhalation can cause chemical pneumonia.
- Silicon dioxide is nonhazardous. Its bio-resistance is low. After being inhaled it is dissolved in the pulmonary fluids (this applies particularly to the finest particles) and is rapidly eliminated.
- NaCl is safe, but in high concentrations can irritate the eyes and respiratory tract.
- Calcium carbonate or chalk (E170) can lead to serious eye damage and irritations of the skin and respiratory tract.

Preservatives

- Sodium benzoate can cause eye and respiratory tract irritations of the eyes and respiratory passages. It can trigger pseudo-allergic reactions (non-immune mediated nettle rash) in asthma, hay fever and skin allergy sufferers.
- Consumption of sodium bisulfite (E220) can trigger intolerance reactions in many people.
- Sodium methyl 4-hydroxybenzoate (E219) can lead to serious eye damage and skin irritation. So far there has been no study of the inhalation toxicity of this molecule.

Fragrances

Fragrances, regardless of whether they are of natural or synthetic origin, very often contain sensitizing molecules.

Besides the constituents mentioned above, a problematic aspect of Holi color powders is that they may be contaminated with bacteria or their endotoxins or with yeasts and fungi. In India, the contaminations and the presence of heavy metals in dyes are recurring public health issues.

Information on powders sampled and analyzed in Germany and Switzerland

The powders analyzed in Germany (BfR, 2014) contained talc, and according to the manufacturers were asbestos-free. Measurement of the distribution of particulate size revealed that particles less than 5 µm in diameter make up less than 1% of these powders. This means that if they are inhaled they mainly reach the upper airways.

Judging by the distribution profile of the particles, the powder samples collected in 2015 in Switzerland probably contain cornstarch to which anticaking agents have been added, which tallies with information from the manufacturers. Our analyses, however, refute the assumption that these powders do not contain any fine particles, with 96% of particles shown to have a diameter of ≤ 10 µm. Since, according to the sample tested, the mean diameter of the particles is between 2.5 and 3.65 µm, the particles can get through to the alveoli, which is problematic.

As for the pigments used, according to the German Federal Institute for Risk Assessment (BfR, 2014), given the minimal amounts of pigments in the samples analyzed an elevated risk for healthy consumers appears improbable. However, the pigments may trigger allergic reactions in sensitized people.

Relatively high concentrations of endotoxin were found in two of the three Swiss samples tested (LAL test).

More in-depth studies should be conducted to add to this information.

Exposure and risks

Dermal and oral

Exposure for a prolonged period can lead to redness, itchiness and irritation of the skin in people with sensitive skin. If the powder gets into the eyes it can lead to irritation, which can be exacerbated if contact lenses are worn. In most cases these symptoms disappear once the affected areas of the body are rinsed with water.

Inhalation

The BfR's exposure estimates during a festival are based on assumptions that are subject to uncertainty, as the data (for example measurements of particle concentrations during the entire event, density of participants, specifications of the talc [percentage of quartz, fibers, etc.]) is incomplete. The PM_{10} concentrations estimated over a period of 24 hours were, however, five times higher than the limit recommended by the WHO (50 µg/m^3). It is therefore not possible to exclude all risks for users, even for isolated exposure. It should be noted that in Switzerland, SUVA insurance has set limits at work of 2 and 3 mg/m^3 for exposure to talc and cornstarch respectively.

An estimate of exposure from the Swiss Federal Food Safety and Veterinary Office (FSVO), based on measurement data from a color run, also suggested that health risks cannot be excluded (FSVO, 2015).

Conclusion

Even though exposure is usually very brief, acute high exposure should be kept to a minimum. The inhalation toxicity of the constituents of Holi color powders has either been tested insufficiently, or analysis has shown pulmonary toxicity. For this reason Holi color powder should not be inhaled – as is also stated in many product safety data sheets.

The most sensitive groups of people (children, asthmatics, allergic persons, people with heart or respiratory diseases and the elderly) are at particular risk and should not be exposed to Holi powders.

Legislation

On the basis of their use, Holi color powders are regulated by the Swiss federal legislation on chemicals (ChemA, ChemO and ORRChem), which treats them as preparations.

Under the self-regulation rules in Article 5 ChemA[1] and Article 5 ChemO[2], manufacturers must ensure that substances or preparations do not endanger life or health. They must assess and classify substances and preparations according to their properties and package and label them in accordance with the type of hazard concerned, **before** passing them on to third parties or before their first use.

Under the definition in Article 4 ChemA, *manufacturer* means any natural or legal person that, by way of profession or trade, produces or extracts substances or preparations, or imports them for professional or commercial purposes.

[1] https://www.admin.ch/opc/en/classified-compilation/19995887/index.html#a5
[2] https://www.admin.ch/opc/en/classified-compilation/20141117/index.html#a5

Precautionary measures to be taken by manufacturers and importers

- The conditions under which substances and preparations are placed on the market are stipulated in the Chemicals Ordinance (ChemO)
- The **composition and the particle size distribution must be known** for each variation of the Holi color powder used so that the hazardousness can be assessed. The base material must be free of mineral fibers, asbestos and quartz. The distribution of particle size should be greater that PM_{10} to avoid alveolar permeability
- The manufacturer must make sure that the components of the mixture have been **tested for the intended use (inhalation)**. If this is not the case, the manufacturer must draw up an exposure scenario and conduct a risk assessment for users
- The **explosive properties** of the powders must be checked
- The Holi color powder must be **classified and labelled** according to the results of self-regulation. If need be, a safety data sheet must be produced
- It might be necessary to **notify the powders to the Swiss notification authority for chemicals**

Precautionary measures to be taken by event organizers

- Use only Holi color powder from reputable sources. A product safety data sheet may be requested from the manufacturer
- The people participating in the event involving Holi powder must be **informed of the dangers and corresponding protective measures** (information, protection for eyes, mouth and nose, etc.)
- Children, asthmatics, allergic persons, sick people and those with sensitive skin **are advised not to take part in events involving Holi color powder**
- Holi color powder must not be used indoor
- **Ignition sources must be eliminated** from events to exclude any possibility of explosion
- An appropriate **medical service** must be available at the event

Safety information for users

- **Children, asthmatics, allergic persons, sick people and those with sensitive skin should not take part in events** involving Holi powder.
- **Do not inhale** powder. If inhaled the powder **can get deep into the lungs**, possibly requiring medical treatment.
- **Precautions** such as wearing close-fitting glasses and a face mask **are recommended**.
- Holi color powder can **trigger allergic reactions** on contact.
- Owing to the risk of explosion, the **use of ignition sources** (lighters, etc.) is to be **strictly avoided** at events involving Holi color powders.

References and further literature

- CC 813.1 Federal Act on Protection against Dangerous Substances and Preparations (Chemicals Act, ChemA)
- CC 813.11 Ordinance on Protection against Dangerous Substances and Preparations (Chemicals Ordinance, ChemO)
- CC 814.81 Ordinance on the Reduction of Risks relating to the Use of Certain Particularly Dangerous Substances, Preparations and Articles (Chemical Risk Reduction Ordinance, ORRChem)
- Health assessment of Holi color powder. German Federal Institute for Risk Assessment (BfR), 2014
- Aid to assessing exposure to color powder and particulate at Holi events and color runs (in German): “Farbpulver-/Feinstaub-Exposition der Bevölkerung bei Holi-Veranstaltungen und Color-Runs”. Länderarbeitsgruppe Umweltbezogener Gesundheitsschutz (LAUG; state working group on environment-related health protection), 2015
- Risk assessment of Holi powder. Swiss Federal Food Safety and Veterinary Office (FSVO), 2015 (internal; in German)
- Risk assessment of Holi powder Part II: assessment of the irritant, sensitizing and inhalative effects and the ignitability and explosiveness of Holi powder. Swiss Federal Food Safety and Veterinary Office (FSVO), 2016 (internal; in German)

For more information:

Federal Office of Public Health:

- Chemical Products Division, 3003 Bern Tel. +41 58 462 96 40, bag-chem@bag.admin.ch, www.bag.admin.ch/chemikalien (page not available in English). To get to the Holi information in English from this page: → Chemikalien von A-Z → Holipulver. The English version of this factsheet is at the bottom, under “Dokumente”.

- The FOEN, FOPH and SECO common notification authority for chemicals, CH-8003 Bern Tel. +41 58 462 73 05, cheminfo@bag.admin.ch, https://www.anmeldestelle.admin.ch/chem/en/home.html

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