TECHNICAL INFORMATION

The Effect of Humidity on Tablet Surfaces Containing Different Types of Superdisintegrants

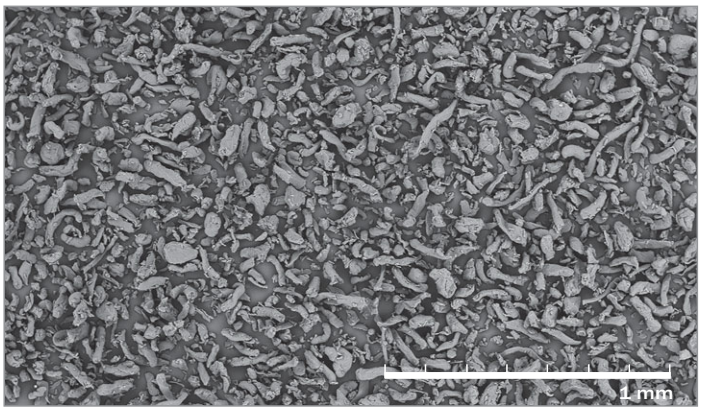
Abstract

The effect of superdisintegrants is triggered by their interaction with water. The question addressed in the present study is, to what extent already high relative humidity affects tablets containing different superdisintegrants. Tablets were exposed to a high relative humidity environment for a defined period of time. The tablet surfaces were then examined by SEM. A clear dependence of the tablet surface behavior on the type of disintegrant used was observed. The findings were consistent with the postulated mechanisms of the tested disintegrants and may help to enable rational disintegrant selection, especially for tablets which have to withstand humid storage or filmcoating conditions.

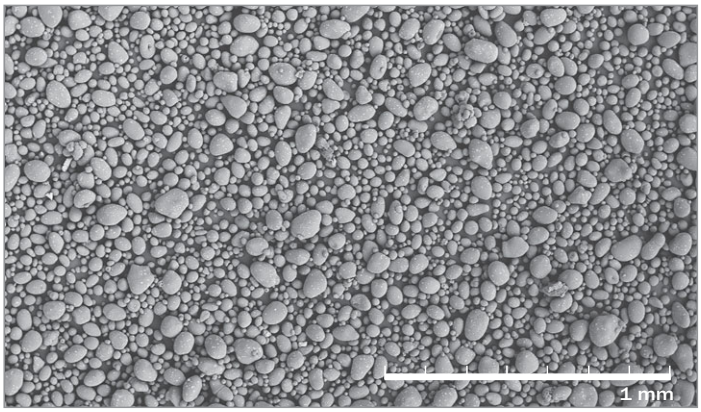
Introduction

While it is desirable for processing, handling and packaging purposes, to produce tablets of high mechanical strength, the same tablets are supposed to disintegrate rapidly upon contact with water. Superdisintergrants built into tablet formulations help to bridge these two extremes. The three main mechanisms exhibited by disintegrants are swelling, wicking (i.e. transportation of water into and throughout the tablet matrix), and shape recovery (i.e. a delayed and controlled elastic recovery). Swelling can be attributed to sodium starch glycolate (SSG) as its prevailing behavior. Croscarmellose sodium (CCS) shows predominantly wicking, whereas crospovidone (PVPP) is characterised by strong shape recovery. It is noteworthy, though, that none of the disintegrants falls into one sole category.

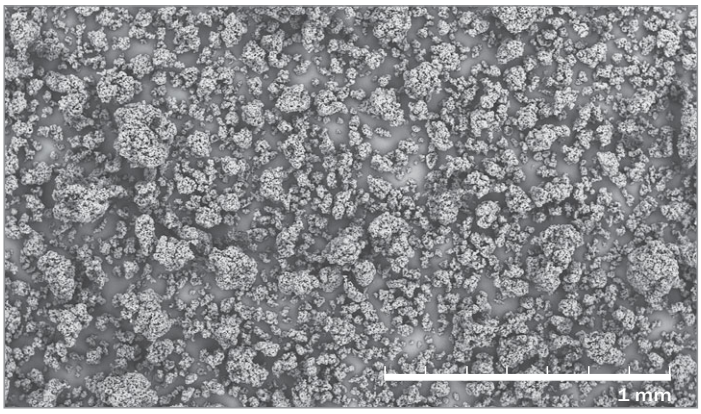
Rather, all disintegrants show combined mechanisms, albeit in different ratios. Irrespective of the type, all mechanisms are triggered by water. While interaction with liquid water is desired, unintended interaction with water vapour may possibly occur as well. Individually blister-packed tablets are very efficiently protected against humidity. Mulit-unit containers, on the other hand, may present a risk of exposure to excessive humidity under unfavorable climatic conditions. Filmcoating processes, too, may lead to temporary exposure, especially if the process has to be run under “wet“ conditions for technical reasons. It is therefore important to understand the effect of high relative humidity on tablet surfaces. In order to investigate into this field, tablets containing 4 % of CCS, SSG and PVPP (**VIVASOL®** , **EXPLOTAB®** and **VIVAPHARM® PVPP XL** respectively), were prepared. SEMs of tablet surfaces were taken immediately after compaction and after 24 hours of open-dish storage at 40 °C / 75 % r.h.



Pic. 1a **VIVASOL®** Croscarmellose Sodium (CSS)



Pic. 1b **EXPLOTAB®** Sodium Starch Glycolate (SSG)



Pic. 1b **VIVAPHARM® PVPP XL** Crospovidone

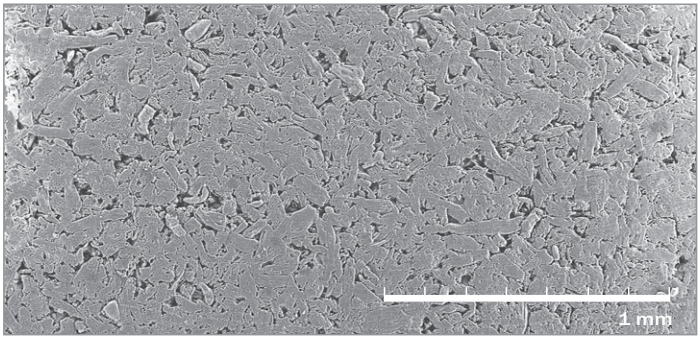
Results

Before Exposure:

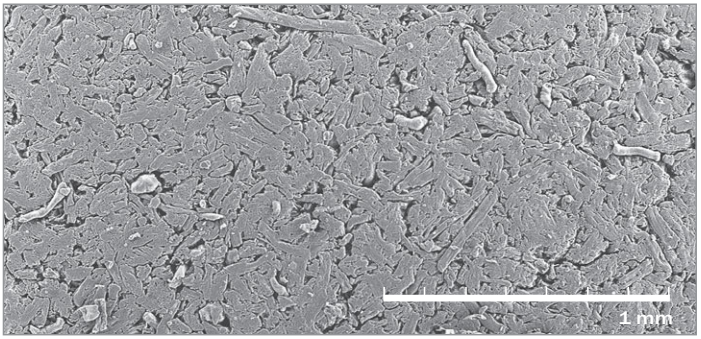
Pictures 1 a-c show SEMs of the disintegrants used in the study. CCS and SSG exhibit a structure, which resembles that of their underivatised countertypes, i.e. cellulose and potato starch respectively. PVPP has a spongy structure, often also referred to as popcorn-like. Due to the similarity to MCC, being a major component of the tested tablets' matrix, CCS blends homogeneously into the structure of the tablets. For SSG, by contrast, the roundish potato starch particles are clearly visible. PVPP, too, is easy to detect on the freshly prepared tablets' surfaces (Pic. 2 a-c).

After exposure:

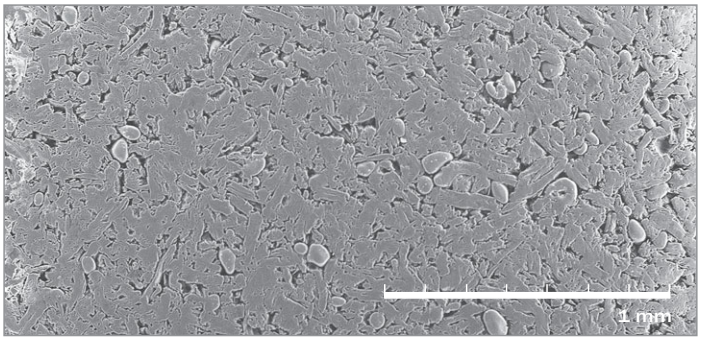
Irrespective of the type of disintegrant, all tablet surfaces showed clearly visible effects of the exposure to humidity. The nature of the change, however, was distinctly different from disintegrant to disintegrant. The different behavior is illustrated in Pictures 3 a-c.



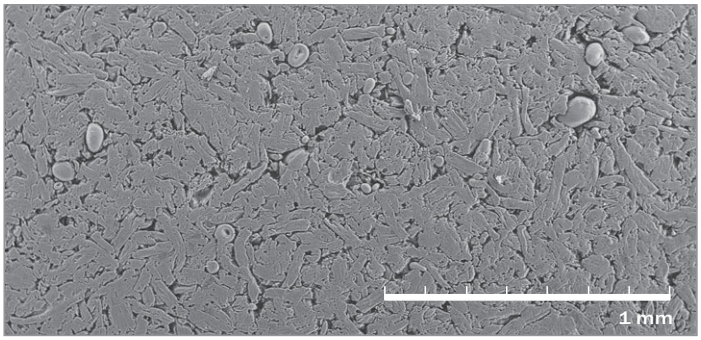
Pic. 2a **VIVASOL**® 4 % CCS (before exposure to moisture)



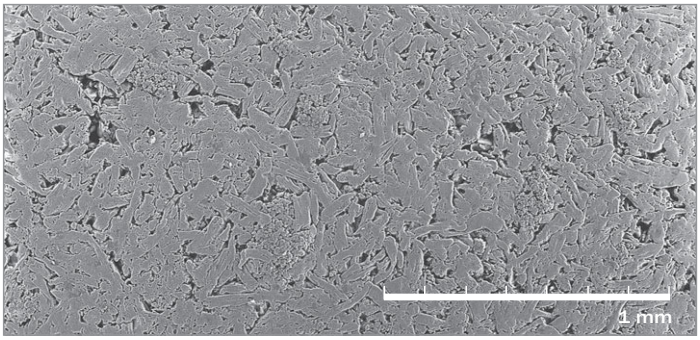
Pic. 3a **VIVASOL**® 4 % CCS (after exposure to moisture)



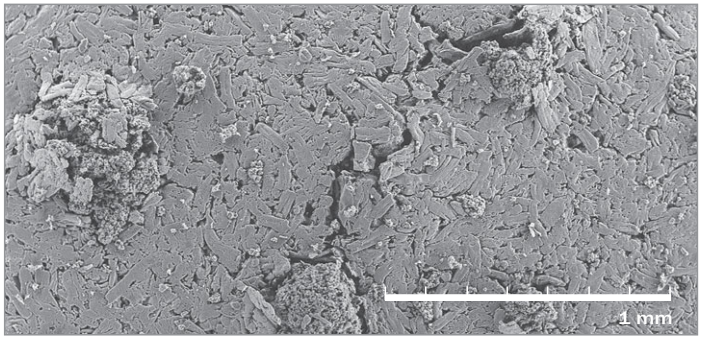
Pic. 2b **EXPLOTAB**® 4 % SSG (before exposure to moisture)



Pic. 3b **EXPLOTAB**® 4 % SSG (after exposure to moisture)



Pic. 2c **VIVAPHARM**® **PVPP XL** 4 % (before exposure to moisture)



Pic. 3c **VIVAPHARM**® **PVPP XL** 4 % (after exposure to moisture)

For **CCS**, the originally fibrous appearance was converted into hose-like structures under the influence of humidity.
No structural effects, e.g. cracks, were observed, though, in the surrounding tablet matrix (Pic. 3 a).

SSG is known for its strong swelling potential. This effect is not directly visible in the micrographs because of the drying occurring during the process of SEM sample preparation. This is supported by the fact, that the post-exposure SSG particles often showed indentations, whereas the untreated SSG particles had a smooth surface. The tablet surface surrounding the SSG particles showed signs of deformation as a result of the expanding disintegrant (Pic 3 b).

The behavior of **PVPP** was again fundamentally different from that of CCS and SSG. Even after drying in the SEM preparation, the PVPP particles still protruded from the tablet surface.
The expansion of the disintegrant led to visible crack formation on the tablet surface (Pic. 3 c).

Discussion

The observed effects of the humidity correlate with the prevailing disintegration mechanisms of CCS, SSG and PVPP respectivley. CCS as a mainly wicking disintegrant, primarily conveys water and shows only moderate swelling, as supported by the undamaged surface. Its effect can be visualised as a hose, which will be straightened when filled with water but will not fundamentally change its structure and volume. SSG, by contrast, acts like a balloon, which expands a lot, when inflated and will resume its original size when deflated. PVPP finally, acts like a loaded spring, which is released by contact with water. Unlike SSG, its expansion is mainly a result of the irreversible release of stored elastic energy.

Conclusion

All disintegrants tested interacted with humidity.
The exposure of unprotected tablets containing disintegrants to moisture, should therefore be avoided as far as possible. Protective packaging is strongly recommended, especially for climate zones with high moisture. Short term exposure followed by subsequent drying, as for instance in filmcoating processes may be tolerable if the different mechanisms of disintegrant action are taken into consideration:

- PVPP expands elastically, triggered by contact with water. This expansion is only partially reversible upon withdrawal of water.
- SSG swells reversibly in contact with water. It will resume its original particle size, but may cause damages to the surface in its swollen state.
- CCS undergoes moderate morphological changes when exposed to humidity, not damaging the tablet matrix.

In light of these findings, it would appear that **VIVASOL**® CCS is the best suited disintegrant to be used in aqueously film-coated tablets.

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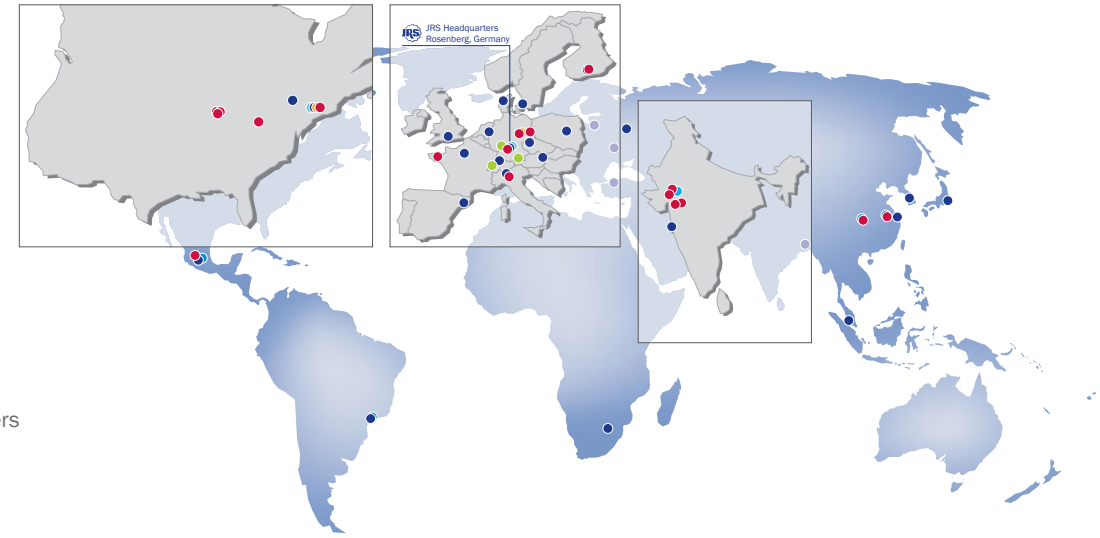

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