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

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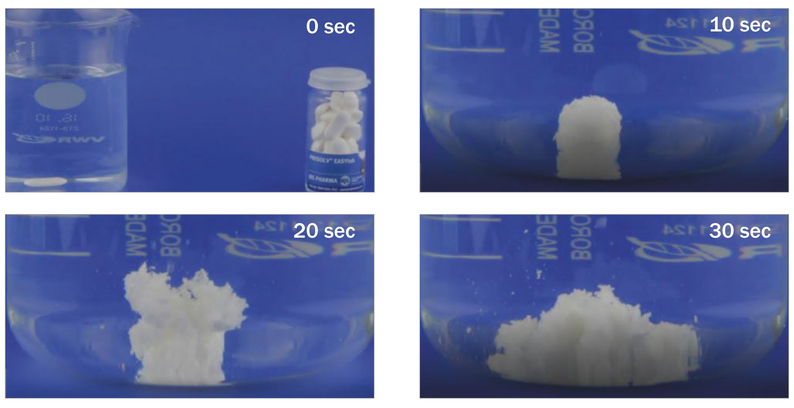
Introduction

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. Superdisintegrants 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 during manufacturing as well as storage. It is therefore important to understand the effect of high relative humidity on tablet surfaces.



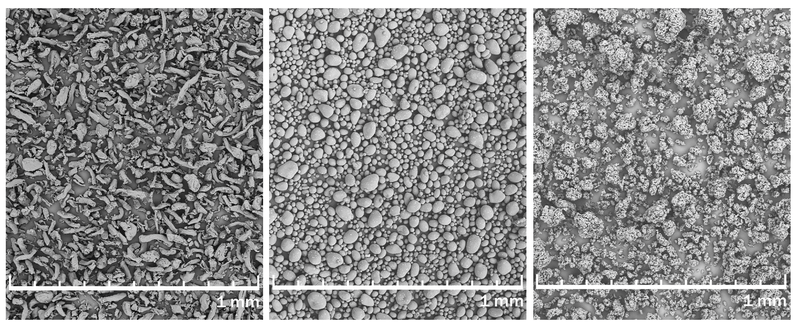
Pic. 1 Disintegration of a PROSOLV® EASYtab Tablet.

Materials and Methods

Tablets were made from 95 % of microcrystalline cellulose (MCC, VIVAPUR® 102) which represented the filling binder, 4 % superdisintegrant and 1 % sodium stearyl fumarate (PRUV®) as lubricant. The superdisintegrants were either croscarmellose sodium (CCS, VIVASOL®), sodium starch glycolate (SSG, EXPLOTAB®) or crospovidone (PVPP, VIVAPHARM® PVPP XL). Tablets were stored in an open dish at 40 °C / 75 % relative humidity for 24 hours. SEM pictures were taken either immediately after compression or after 24 hours.

Results

Before Exposure:
CCS and SSG exhibit a structure, which resembles that of their underivatised countertypes, i.e. fibrous cellulose and spherical potato starch respectively. PVPP has a spongy structure, often also referred to as popcorn-like.



Pic. 2 SEM Pictures of Plain CCS, SSG, and PVPP (from Left to Right)

Due to the similarity to MCC, being a major component of the tested tablets‘ matrix, CCS blends homogeneously into the structure of the tablets (Picture 3 a.). For SSG, by contrast, the roundish potato starch particles are clearly visible (Picture 3 b.). PVPP, too, is easy to detect on the freshly prepared tablets‘ surfaces (Picture 3 c.).

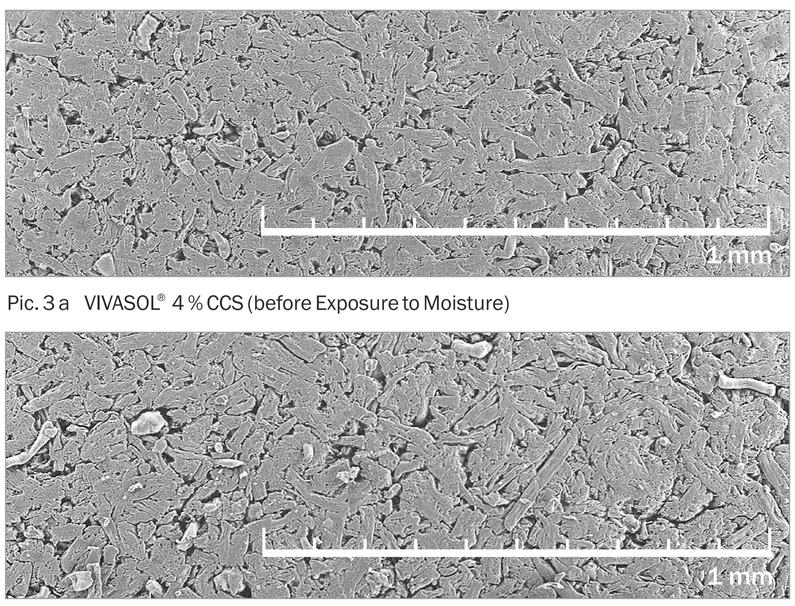
After exposure:
Irrespective of the type of disintegrant, all tablet surfaces showed clearly visible effects of the exposure to humidity. The nature of the change, however, was distinctly different from disintegrant to disintegrant. The different behavior is illustrated in Picture 3, lower row.
For CCS, the originally fibrous appearance was converted into more visible, elongated shapes under the influence of humidity. No structural effects, e.g. cracks, were observed in the surrounding tablet matrix (Picture 3 d.).
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, which reduced the SSG particles to their original size. The tablet surface surrounding the SSG particles, however, showed signs of deformation as a result of the expanding disintegrant (Picture 3 e.).
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 (Picture 3 f.).

Discussion

The observed effects of the humidity correlate with the prevailing disintegration mechanisms of CCS, SSG and PVPP respectively. 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 strongly expands, 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 irreversible, being a result of the 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 CCS is the best suited disintegrant to be used in aqueously filmcoated tablets. Further studies will be carried out to check the validity of these conclusions in actual film-coating trials.



Pic. 3 a VIVASOL® 4 % CCS (before Exposure to Moisture)
Pic. 3 b EXPLOTAB® 4 % SSG (before Exposure to Moisture)
Pic. 3 c VIVAPHARM® PVPP XL 4 % (before Exposure to Moisture)
Pic. 3 d VIVASOL® 4 % CCS (after Exposure to Moisture)
Pic. 3 e EXPLOTAB® 4 % SSG (after Exposure to Moisture)
Pic. 3 f VIVAPHARM® PVPP XL 4 % (after Exposure to Moisture)

Pic. 3 SEM Pictures of Tablet Surfaces before (Top Row) and after (Lower Row) Exposure to Moisture.

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