The Effect of a Clean-Label, Plant-Based Natural Glidant on the Flow Properties of Multiple Model Powders Compared to a Synthetic Glidant

Sarah S. Aboelela, Robert Theisen, Manish Ghimire, Ali Rajabi-Siahboomi
Colorcon, Inc. Harleysville, PA 19438, USA

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Introduction

Powder handling in the nutraceutical industry can be challenging due to poor flow properties, cohesiveness, and stickiness. Glidants such as silicon dioxide are commonly added to nutraceutical powders to enhance powder flow and reduce cohesion. Synthetic silicon dioxide grades are commonly used but they are not considered label friendly. For nutraceutical supplements the consumer desire for products with recognizable and label friendly ingredients continues to grow; so, there is a clear need for effective clean label natural excipients, including glidants.

In this study, the performance of a natural plant-based glidant and a commonly used synthetic glidant, Cab-O-Sil M-5P were compared. Four commonly used model materials with different powder flow properties were evaluated for their physical and morphological properties.

Methods

Model powder materials: caffeine anhydrous; guar gum; Starch 1500®, partially pregelatinized maize starch, and StarCap®, superior flow maize starch, were studied.

Binary blends of glidant and each model powder were prepared at 1, 2 and 4% w/w inclusion levels by mixing for 3 minutes. The surface morphology of both glidants and the four model materials was examined using scanning electron microscopy (SEM) at 5 kV.

The particle size distribution (PSD) of Cab-O-Sil M-5P and natural glidant were determined using a laser diffraction system, Malvern Scirocco 2000. Particle size was measured at 2 bar and 50% feeding rate where the obscuration was maintained between 5 – 10 %.

Powder flow of the pure materials and the binary blends were characterized in terms of flowability index and angle of repose using Flodex™ instrument and Hosokawa Micron Powder Tester (PT-X).

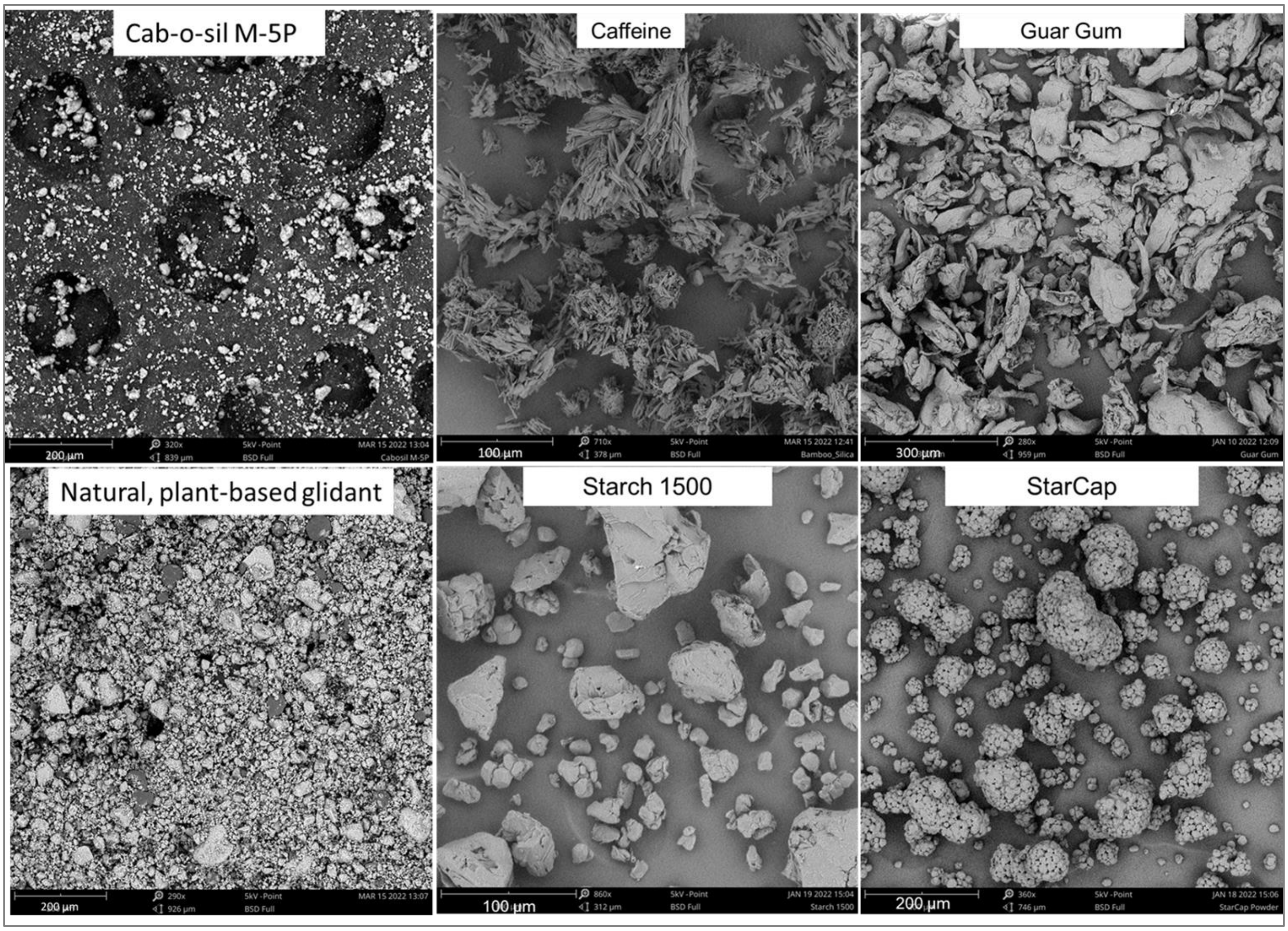
Flodex testing was performed following Hanson's method1. The smallest disk hole in millimetres to allow the powder to fall through three consecutive times is considered the flowability index. The smaller the flowability index, the better flow. Flodex testing was performed for all binary blends (1, 2 and 4%w/w) while the angle of repose measurements was determined only for the 1%w/w binary blend (n=2).

Results

SEM images (Figure 1) showed that the plant-based glidant and Cab-O-Sil M-5P had mostly round morphology with small geometric particle sizes.

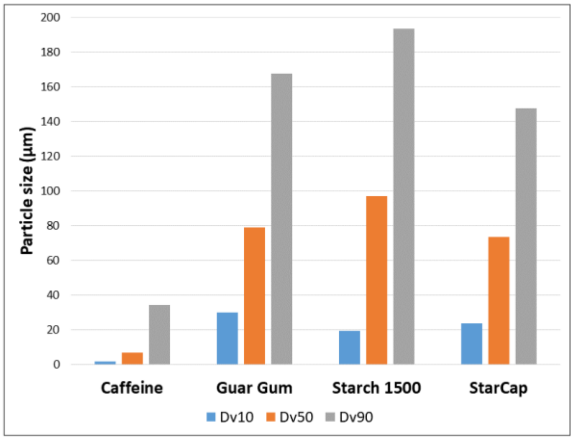
The four model powders were shown to have varying surface morphologies. Caffeine anhydrous had a needle crystalline structure in an aggregated form. Guar gum had fibrous nature while Starch 1500 had a non-uniform shape with a non-porous structure; while StarCap had a spherical shape that demonstrated a porous structure.

Figure 1. SEM Images Depicting the Surface Morphology



The plant-based glidant had a comparable average particle size to Cab-O-Sil M-5P. Among the four model powders, as shown in Figure 2, caffeine anhydrous had the smallest average particle size of 7.0 µm and Starch 1500 had the largest size of 97.0 µm. StarCap and guar gum had average particle sizes of 73.4 and 78.9 µm, respectively.

Figure 2. Particle Size Distribution of Study Materials



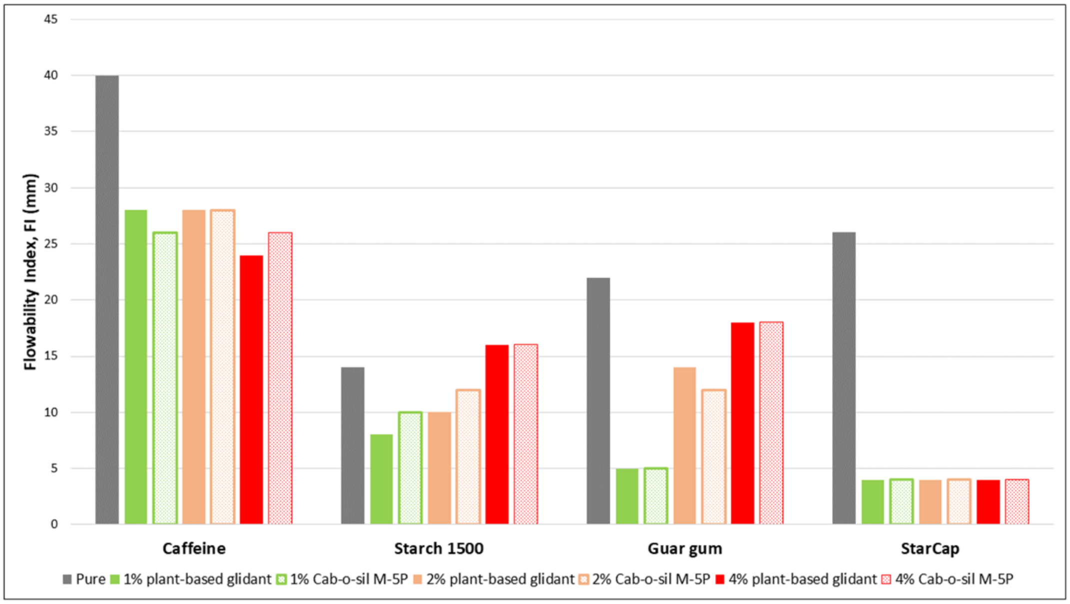
The flowability indices of the four model powders were inversely proportional related to their average particle size (Figures 2 and 3).

Caffeine anhydrous with the smallest particle size had the highest flowability index of 40. This was followed respectively by StarCap, guar gum and Starch 1500 with flowability indices of 26, 22 and 14.

The addition of the plant-based glidant (Figure 3) at 1% w/w resulted in comparable enhancement in powder flow to Cab-O-Sil M-5P for all four model powders.

Increasing the level of glidant to 4% did not significantly affect the flowability indices of caffeine anhydrous and StarCap but deteriorated the powder flow of guar gum and Starch 1500 as shown in Figure 3.

Figure 3. Flowability Index of Materials at 0, 1, 2 and 4% w/w Glidant Inclusion Levels



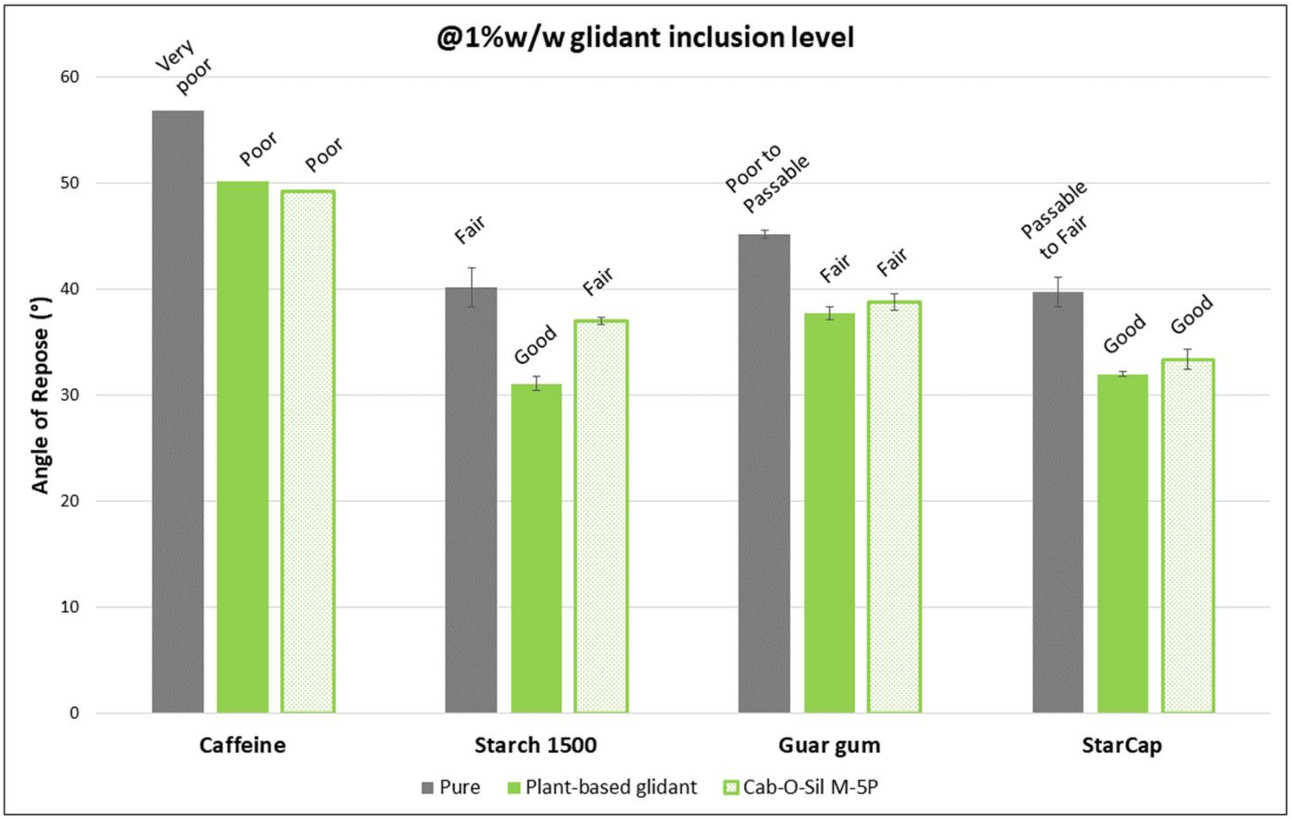
Like Cab-O-Sil M-5P, the plant-based glidant enhanced the angle of repose powder flow property for all four model powders as shown in Figure 4.

Needle-structured caffeine anhydrous had the highest angle of repose of 56.9°, indicating very poor powder flow property based on the USP <1174> angle of repose classification2. The two glidant grades enhanced the powder flow of caffeine anhydrous from the very poor to the poor category.

The angle of repose for guar gum was improved from passable/poor to fair whereas StarCap was enhanced from fair/passable to good.

Starch 1500 presented the only discrepancy between the two glidant grades with the plant-based grade enhancing the powder flow of pure Starch 1500 from fair to good rather than remaining fair for Cab-O-Sil M-5P.

Figure 4. Angle of Repose of Host Materials at 0 (pure) and 1% w/w Glidant Inclusion Level



Conclusions

The natural, plant-based glidant enhanced the flow properties of all the model powders at a 1% w/w inclusion level.

The plant-based glidant demonstrated the same efficiency as one of the most used synthetic glidants, Cab-O-Sil M-5P.

The clean label natural glidant can replace the use of synthetic glidants in nutraceutical supplements, providing label friendly ingredients that increase consumer preference and satisfaction.

References

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2. United States Pharmacopeia. USP <1174>. https://www.usp.org/sites/default/files/usp/document/harmonization/gen-chapter/g05_pf_30_6_2004.pdf. Accessed [07.29.2022]

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North America	Europe/Middle East/Africa	Latin America	India	China
+1-215-699-7733	**+44-(0)-1322-293000**	**+54-1-5556-7700**	**+91-832-6727373**	**+86-21-61982300**

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