Startab®
Directly Compressible Starch

Colorcon®

Characterization of Powder and Compression Properties of StarTab®, Directly Compressible Starch

Authors: M. Rane[1], M. Roberts[2], J. Tran-Dinh[1], P. Smith[3], and A. Rajabi-Siahboomi[1]

[1]Colorcon, Inc., Harleysville, PA 19438, USA,
[2]Liverpool John Moores University, School of Pharmacy and Biomolecular Sciences, Liverpool L3 3AF, UK,
[3]Colorcon Ltd., Dartford DA2 6QD, UK | APS, UK Poster Reprint 2019

Introduction

Starch is one of the earliest and most widely used excipients in pharmaceutical solid dosage forms. Typical applications include use as capsule filler, disintegrating agent and wet granulation binder. There are many starch options available, varying by plant source, composition (ratio between amylose and amylopectin content), physical and chemical modifications. Although some modifications impart specific benefits, such as improved binding or moisture management properties, none of the products have been designed specifically for use in direct compression. StarTab®, directly compressible starch is designed to fill this gap by leveraging the useful properties of starch, such as a stability inertness, moisture imbibement, good disintegrant properties and wide regulatory acceptance. The purpose of this study was to investigate and characterize the powder and compression properties of StarTab for tablet manufacturing.

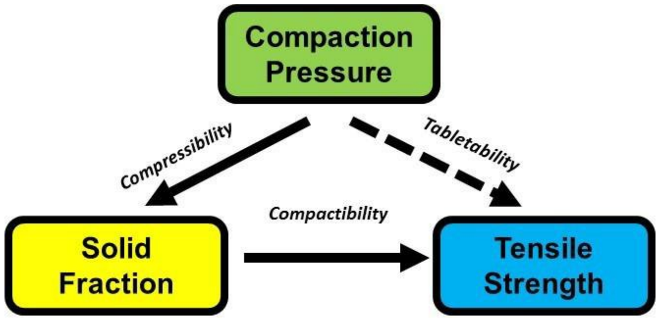
Methods

Native corn starch and StarTab were compared for their powder flow characteristics using powder rheometer (FT4, Freeman, USA), bulk and tapped density (Varian, USA), minimum orifice diameter and powder flow (Flodex, Hansen, USA), surface morphology using SEM (Phenom, USA) and particle size distribution (Malvern, USA). The materials were lubricated using 0.25% magnesium stearate and evaluated for compaction properties using Stylcam 100R rotary press simulator (Medel'Pharm, France) with 7 mm round flat-faced tooling at an individual tablet weight of 150 mg. The compression cycle followed a generic rotary press profile that corresponded to 7.5 – 30 mS dwell time. Measurements of punch displacement, compaction force (used to calculate compaction pressure) and ejection force were determined using Analis software. True powder density was determined using Helium pycnometer (AccuPyc, Micromeritics, USA). Tensile strength and solid fraction were calculated using equation 1 and 2 respectively. Compressibility, compactibility and tabletability graphs were plotted based on Figure 1, using tensile strength, solid fraction and compaction pressure data.[1] The lubricated blends were also subjected to rotary tablet compression (4 station Piccola, USA) fitted with 10 mm round flat-faced B-tooling at 50 rpm turret speed with compression force between 10 to 30 kN. Power paddle feeder was used on the turret.

Tensile Strength (σ) = $2F/\pi DH$ (equation1)
Solid Fraction (SF) = $W/\rho.V$ (equation 2)

where F, D, H, W and V are tablet hardness, diameter, thickness, weight and volume respectively; ρ is true density

Figure 1. Compaction Terminology[1]



Results

Powder Property

Figure 2 shows scanning electron microscope image (SEM) of StarTab, directly compressible starch. The particles have optimized morphology, almost spherical in shape, which results in excellent flow. StarTab has a mean particle size (d50) of about 90 microns; which is in the range for most directly compressible excipients. StarTab demonstrates excellent flow properties compared to native corn starch, based on compressibility index, Hausner ratio and angle of repose as shown in Table 1.[2]

The Flodex minimum orifice diameter required for StarTab to flow was 4 mm (the lowest) suggesting excellent flow from a flat surface into die cavity.[3-4]

Data from FT4 powder rheometer (Table 1) suggests that native corn starch has high particle-to-particle, particle-surface and particle-air interaction resulting in cohesion, as indicated by high values for wall friction angle, air pressure drop across powder, aeration energy, specific energy and cohesion value. StarTab, on the other hand gave low values for these measurements indicating practically cohesionless behaviour. This would make it 'easier' to move in a high-stress environment and slide against stainless steel 316L (corrosion resistant grade of steel used in pharmaceutical equipment, such as hopper and blender). It is very permeable to air, which helps in easy and rapid air escape during movement of powder on the turret and into the die cavity, ensuring uniform die-fill and low weight variation. High stability index (Table 1) in a variable flow rate test indicates that it has no segregation potential.

Figure 2. Particle Size Distribution by Malvern Analyzer and Morphology by SEM of StarTab and Native Corn Starch

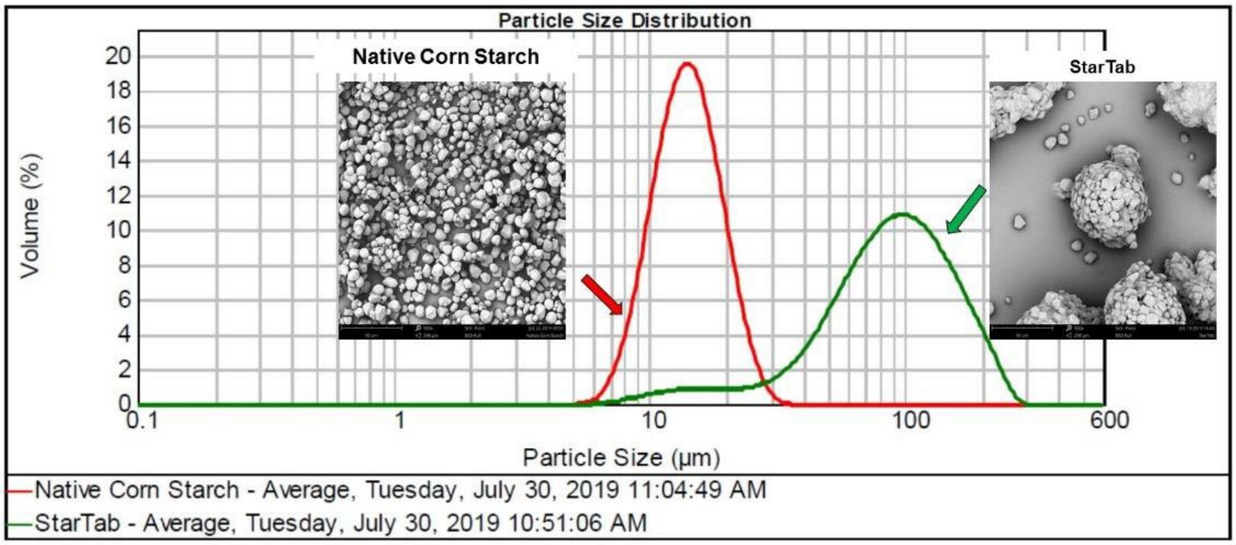


Table 1. Powder Flow Characteristics of StarTab Compared to Native Corn Starch

Powder Flow Testing	StarTab	Native Corn Starch
BD (g/mL)	0.57	0.51
TD (g/mL)	0.70	0.84
Hausner ratio	1.22	1.65
Compressibility index (%)	18.00	40.00
Angle of repose (°)	32.3	53.2
Flodex minimum orifice diameter (mm)	4	30
Flow rate from 4mm (g/min)	37.58	No flow
Particle size, d10 (µm)	36.90	9.49
Particle size, d50 (µm)	89.77	14.01
Particle size, d90 (µm)	171.37	20.59
Particle size, d4,3 (µm)	97.74	14.62
Cohesion (kPa)	0.01	0.53

Table 1. Powder Flow Characteristics of StarTab Compared to Native Corn Starch (continued)

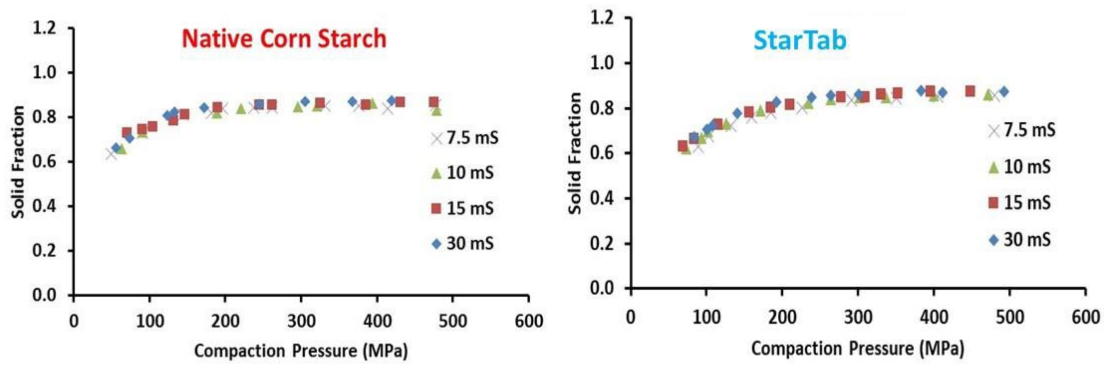
Powder Flow Testing	StarTab	Native Corn Starch
Wall friction angle (WFA, °)	6.48	8.10
Pressure drop across powder bed (mBar) @ 15 kPa	3.05	21.3
Aeration energy (AE, mJ)	2.35	119.00
Compressibility percentage (CPS%)	2.76	8,56
Basic free flow energy (BFE, mJ)	1102	747
Specific energy (SE, mJ/g)	4.96	7.94
Stability index (SI)	1.02	1.10

Compaction Simulation

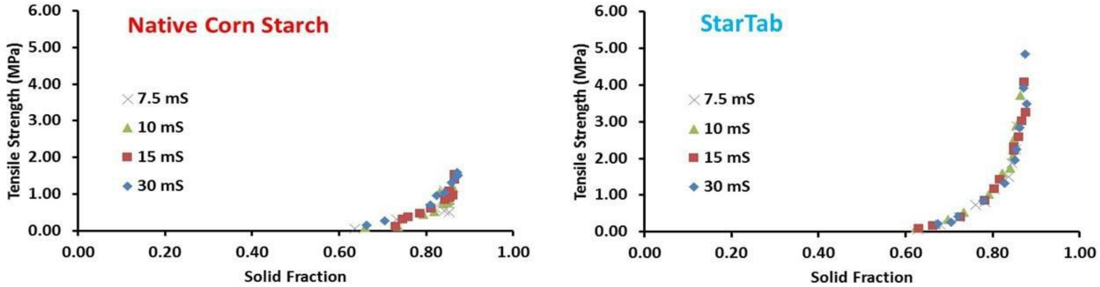
StarTab and native corn starch were lubricated with 0.25% magnesium stearate and subjected to compaction simulation. Native corn starch had significant flow issues whereas StarTab had excellent flow. StarTab and native corn starch were both found to be compressible, forming compact with higher than 0.8 (80%) solid fraction. StarTab demonstrated superior compactibility and tabletability (Figure 3A, 3B, 3C). During compaction simulation, native corn starch had significant flow issues, whereas StarTab had no flow related problems.

Figure 3. Comparison Between Native Corn Starch and StarTab for (A) Compressibility, (B) Compactibility and (C) Tabletability

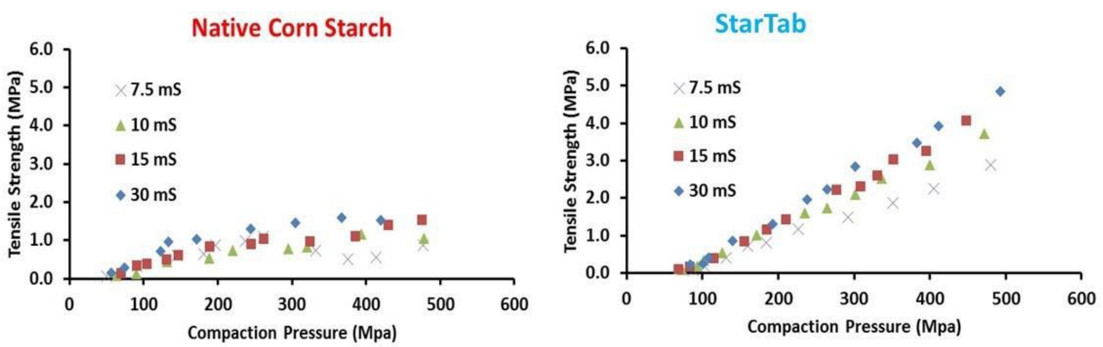
(A)



(B)



(C)



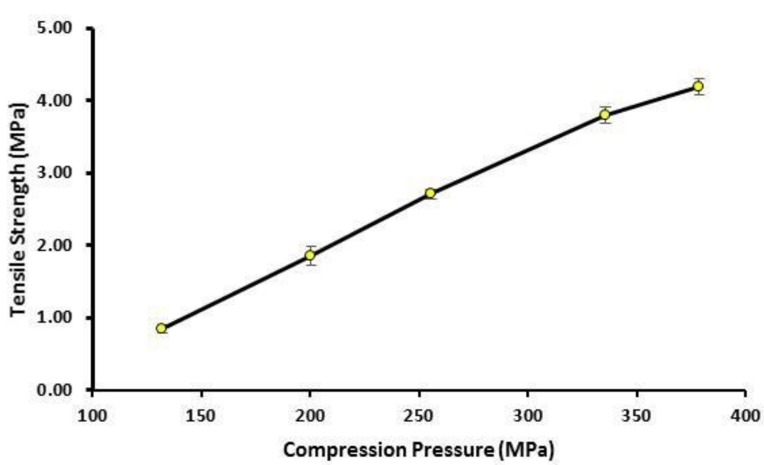
Rotary Compression Tableting

Individual blends of StarTab and native corn starch blends, lubricated with 0.25% w/w magnesium stearate, were compacted using rotary tablet compression at 50 rpm turret speed. Powder paddle feeder was used to control the flow of powder. Native corn starch did not flow from the hopper, so tablets were not compressed and had a severe ratholing problem. Attempts to initiate flow, such as use of vibration on hopper with rubber mallet or increasing powder paddle feeder, did not work. Conversely, StarTab had excellent flow and placebo tablets with uniform weight, hardness, thickness, and ejection force could be produced at increasing compression pressure. All the placebo tablets disintegrated within 3 minutes and they had extremely low, or no friability (Table 2). Tensile strength of StarTab placebo tablets increased with greater compression pressure (Figure 4). StarTab placebo tablets exhibited pH independent disintegration (data not shown here).

Table 2. Effect of Compression Force on Properties of StarTab Placebo Tablets Compressed on Piccola Lab Scale Rotary Press

StarTab Placebo Tablet Property	10kN	15kN	20kN	25kN	30kN
Weight, mg*	397.32 ± 1.31	400.06 ± 2.48	402.76 ± 1.27	403.34 ± 0.86	403.39 ± 0.98
Thickness, mg*	4.34 ± 0.01	4.09 ± 0.02	4.02 ± 0.02	3.97 ± 0.01	3.96 ± 0.01
Hardness, kP*	5.84 ± 0.38	12.17 ± 0.84	17.43 ± 0.37	24.17 ± 0.75	26.55 ± 0.71
Ejection force, N	179.61	170.50	164.57	160.88	155.63
Friability, % (at 100 rev)	0.55	0.13	0.12	0.07	0.06
Disintegration time in water, min	0.83	1.08	1.87	2.32	2.39

Figure 4. Effect of Compression Pressure on Tensile Strength of StarTab Placebo Tablets Compressed on Piccola Rotary Tablet Press.



Startab®
Directly Compressible Starch

Conclusions

StarTab, directly compressible starch showed superior powder flow and tablet compression properties compared to native corn starch. This new excipient is designed, through particle optimization, for high speed direct compression of tablets. Early trials have indicated that StarTab will simplify tablet formulations and provide significant productivity during development and tablet manufacturing.

References

1. Tye, C., Sun, C. and Amidon, G. 2005. Evaluation of the effects of tableting speed on the relationships between compaction pressure, tablet tensile strength, and tablet solid fraction. JPS, 94(3), pg. 465-474.
2. USP 42 General chapter <1174> Powder flow.
3. Zhou, D. and Qiu, Y. 2010. Understanding material properties in pharmaceutical product development and manufacturing: powder flow and mechanical properties. J. validation Tech., pg. 65-77.
4. Gioia, A.1980. Intrinsic flowability: a new technology for powder-flowability classification. Pharmaceutical Tech.

For more information, contact your Colorcon representative or call:

North America
+1-215-699-7733

Europe/Middle East/Africa
+44-(0)-1322-293000

Latin America
+54-11-5556-7700

India
+91-832-6727373

China
+86-21-61982300

www.colorcon.com

Colorcon®