StarTab®
Directly Compressible Starch

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Characterization of Directly Compressible Starch using Loss in Weight Compact Feeder in a Continuous Manufacturing Line

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Introduction

StarTab®, Directly Compressible Starch, is designed to simplify the formulation and manufacture of tablets.[1] It is a free-flowing and highly compressible starch, uniquely suitable for use as a directly compressible filler during continuous manufacturing. Use of StarTab can potentially eliminate the need for superdisintegrant and glidant in a tablet formulation, simplifying the formulation and number of feeders required for continuous manufacturing. The feeders can be assembled into several combinations of in-line unit equipment such as blenders, tablet press and tablet coater for directly compressible formulation, and are often designated to match tablet outputs between 25 to 200 kg/h. Feeder speed and feeder elements can have a large impact on the material characteristics and are known to be the most stressful operation on material, prior to tablet compression. Hence, it is important to understand if directly compressible filler can retain powder flow and compression characteristics after passing through the feeder. The purpose of this work was to characterize StarTab for loss in weight feeder used in a continuous manufacturing line.

Methods

The feeding study was carried out using a twin screw, loss-in-weight (LIW) feeder (Compact Feeder, GEA). Feeder characterization experiments were performed using a gain-in-weight catch scale (Mettler Toledo LL, USA) to record the weight of powder dispensed by the feeder every one second for all tests. The experimental setup of the feeder is shown in **Figure 1**. The powder was subjected to various conditions such as (1) 3 kg/h up to 24.5 kg/h feeder rate; (2) use of fine concave screw and coarse concave screw and (3) single feed and multiple feeds. Feeder profiles were generated for all the conditions and relative standard deviation (RSD) and relative difference from the mean (RTM) were calculated. Pre- and post- feeder StarTab powders were evaluated for powder characteristics and tablet compression properties. The powders were evaluated for bulk and tapped density (Varian, USA), loss on drying (Sartorius Moisture Analyzer MA35, Sartorius AG, Germany), surface morphology via scanning electron microscopy (SEM) (Phenom XL, USA) and particle size distribution (Malvern Instruments Ltd., UK). All powders were separately lubricated with 0.25% w/w magnesium stearate (previously screened through 60# mesh sieve) and subjected to rotary tablet compression (4-station, Piccola B/D 370 press, USA) fitted with 10 mm round flat-faced B-tooling at 50 rpm turret speed. Tablets were compressed to a target weight of 400 mg with compression forces ranging from 10 to 30 kN. Powder paddle feeder was used on the turret. All tablets were evaluated for tablet weight uniformity, hardness and thickness (Multicheck V, Erweka, Germany), friability (Varian, USA), and disintegration in 900 mL of DI water at 37°C (Erweka ZT 224, Erweka, Germany).

Results

StarTab exhibited uniform flow from the feeder using coarse concave, as well as fine concave screws (**Figure 2A and 2B**). Catch scale data were collected every second, with a moving average of 5 seconds calculated and shown against the feed rate set point. The feed rate was varied between 3 kg/h to 24.5 kg/h to indicate low or very high incorporation of StarTab as directly compressible excipient. **Figure 3** shows the consistency of StarTab refill in the feeder for 3 kg/h and 24.5 kg/h. Performance of StarTab at different feed rate, using different screw elements, was determined by using actual feed rate and its relative standard deviation (RSD) and relative distance from the mean (RDM) as shown in **Table 1**. Typically, when values for both the RSD and RDM are below 5%, that indicates uniform flow of the material through the feeder.[2] All the feeder profiles showed very low RSD and RDM values indicating that StarTab is freely flowable and could be used as a filler in continuous manufacturing line, which could provide easy material transfer from loss-in-weight feeder.

Figure 1. Experimental Set-up for StarTab Evaluation using LIW Feeder

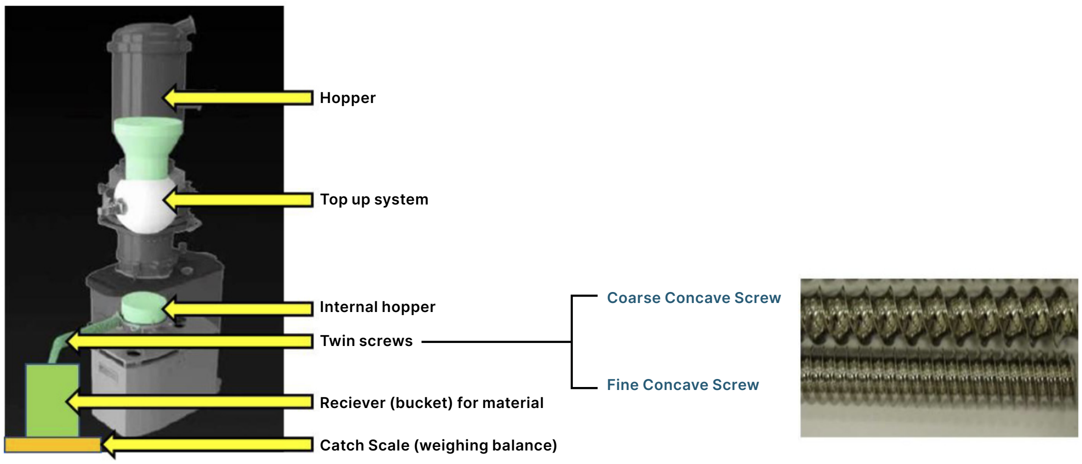


Figure 2. Mass Flow Rate of in LIW Feeder Fitted with (A) Fine Concave Screws and (B) Coarse Concave Screws, Both at Feed Rate of 3 kg/h and 7 kg/h

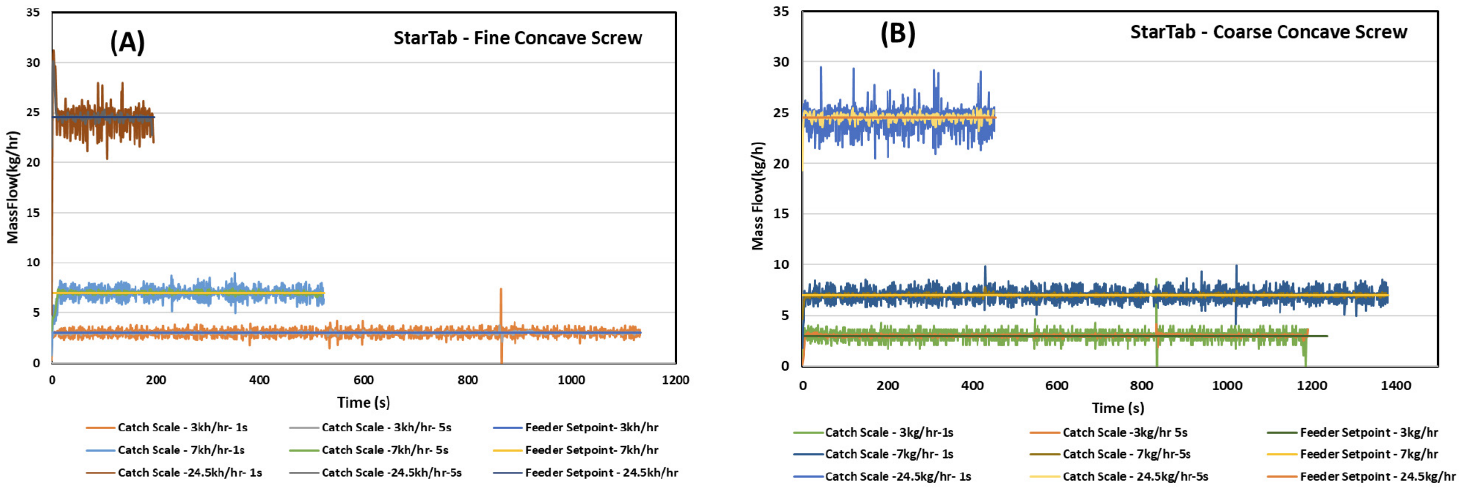


Figure 3. Refill Data for StarTab in LIW Feeder with Coarse Concave Screws set up at Feed Rate of 3.0 and 24.5 kg/h

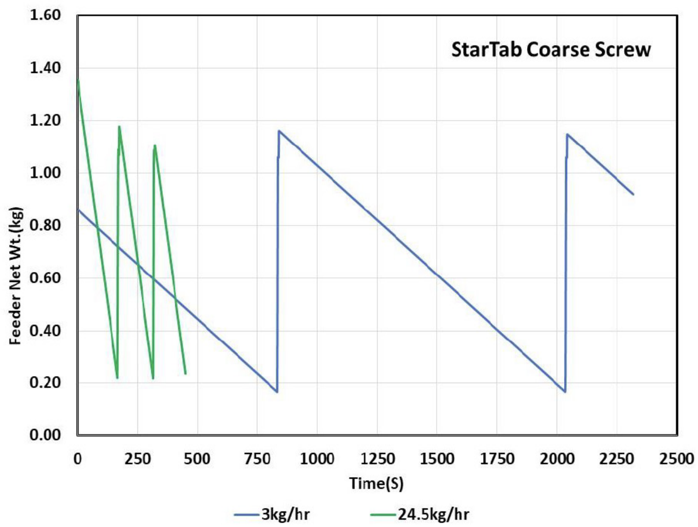


Table 1. Performance of StarTab in LIW Feeder using Different Feed Rate and Feed Screw

Screw Type	Feed Rate Set Point (kg/h)	Average Screw Speed (rpm)	Mass Flow Actual Mean (kg/h)	Feed Factor (g/rev)	RSD (5%)	RDM (%)
Coarse	3.0	16	2.98	2.96	3.76	0.57
Coarse	7.0	37	7.00	3.21	2.54	0.02
Coarse	15.0	76	15.01	3.28	2.00	0.09
Coarse	21.0	104	20.99	3.34	2.78	0.06
Coarse	24.5	123	24.51	3.30	1.64	0.02
Fine	3.0	38	3.00	1.34	3.03	0.09
Fine	7.0	76	7.00	1.53	2.00	0.08
Fine	24.5	270	24.53	1.65	3.43	0.39

RSD is relative standard deviation; RDM is relative difference from the mean 2

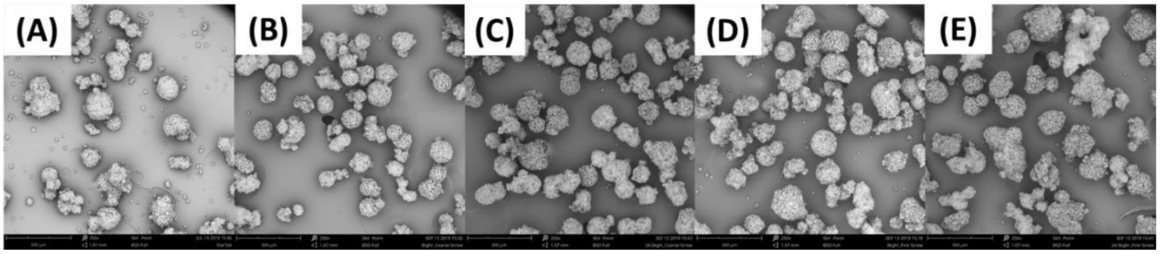
Powder Properties After LIW Feeder Study

StarTab has an optimized particle size and morphology that attributes to excellent flow properties for the material. All the powder samples, pre and post feeding, demonstrated similar and excellent powder flow properties as shown in **Table 2**. The density and particle size distribution were unaffected, indicating that use of different screw configurations or feed rates did not generate excess fines or impact the product's morphology in the feeder. This is further exemplified by SEM images comparing the pre and post feeding powders at 250x magnification (**Figure 4A-E**).

Table 2. Powder Flow Properties

Powder Flow Testing	StarTab (Initial)	StarTab Powder Feed (Coarse Screw)		StarTab Powder Feed (Fine Screw)	
Feeder Output Set Point (kg/h)	**None (0)**	**3.00**	**24.50**	**3.00**	**24.50**
Bulk Density (g/mL)	0.59	0.63	0.58	0.59	0.58
Tapped Density (g/mL)	0.70	0.71	0.71	0.72	0.70
Hausner Ratio	1.19	1.14	1.22	1.22	1.20
Compressibility Index (%)	16.00	19.00	18.00	18.00	16.00
Loss on Drying (%)	11.59	11.33	11.39	11.30	11.74
Particle Size, d10 (µm)	31.12	33.55	32.40	28.52	37.03
Particle Size, d50 (µm)	84.24	84.75	85.78	79.95	90.14
Particle Size, d90 (µm)	165.45	162.45	166.11	156.07	172.63
Particle Size, d4,3 (µm)	92.28	92.23	93.56	87.21	98.31

Figure 4. SEM Images of Initial StarTab (A); Coarse Concave Screw Feed at 3 kg/h (B) and 24.5 kg/h (C); Fine Concave Screw Feed at 3 kg/h (D) and 24.5 kg/h (E) at 250x magnification



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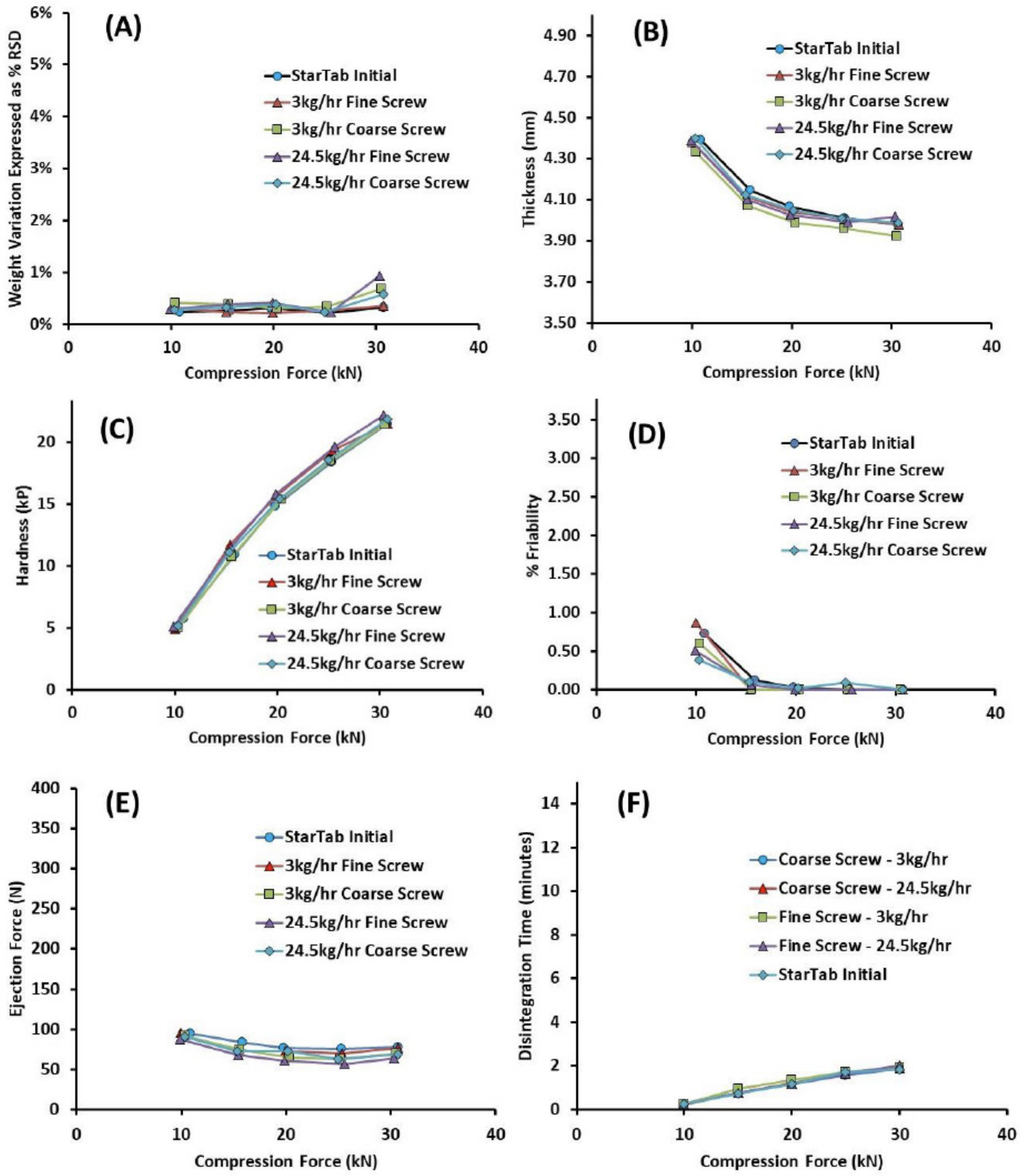
Rotary Tablet Compression

All the pre- and post- fed StarTab powder from the feeder, at extreme feed rates of 3 kg/h and 24.5 kg/h, were lubricated with 0.25% w/w magnesium stearate then subjected to rotary tablet compression using powder paddle feeder. All the blends of StarTab demonstrated excellent flow and compressibility on rotary tablet press, with uniform die fill, characterized by low weight and thickness variation, high hardness and low friability (**Figure 5**). All tablets demonstrated low ejection force (between 50 to 90 N) and fast disintegration time of < 3 minutes in water irrespective of compression force. Overall, all samples had similar tableting performance which indicated that StarTab retained its powder flow and compression properties after being subjected to a variety of feed rates and screw configurations on the feeder.

Figure 5. Effect of Compression Force on Placebo Tablets (A) Weight Variation, (B) Thickness, (C) Hardness, (D) Friability, (E) Ejection Force and (F) Disintegration Time of StarTab Before and After LIW Feeder Study



Conclusions

StarTab, Directly Compressible Starch, showed excellent powder flow properties and compression properties. Loss-in-weight feeder study indicated that StarTab is an excellent excipient for direct compression in continuous manufacturing. StarTab demonstrated the ability to withstand a variety of feed rates and screw configurations without affecting either powder flow or compression properties. Together with its flow, compressibility and excellent disintegration properties, StarTab is designed to simplify the formulation for direct compression and eliminates the need for superdisintegrant and glidant.

References

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