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Studies on Shankha Bhasma - III Studies on Micromeritic and Compressional Properties of Shankha Bhasma granules

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Shankha bhasma contains inorganic substances such as calcium oxide and possesses poor compressibility and flow properties. Granules of bhasma were prepared using different binders such as starch, PVP and gelatin. These granules were evaluated for their micromeritic, mechanical, and compressional properties. Starch granules have shown better flowability,mechanical strength and compressibility (low mean yield pressure) as compared to other granules but yielded compacts with very low tensile strength. The tensile strength of the compacts was high with gelatin granules. These results were discussed on the basis of nature of substances and their consolidation mechanisms. Thus, to strike a proper balance between the three properties the use of PVP as a binder is preferred.

BHASMA an Ayurvedic dosage form, is a powder of a substance obtained by calcination. It is applied to the metals, minerals or animal products which are by special processes calcined in closed crucibles in pits and cowdung cakes.[1] Bhasma suffers all the drawbacks of powder dosage form, as compared to which, the more popular dosage form, the tablet or Vati has several advantages such as increased shelf life, ease of handling and accuracy of dosage.

Most powders cannot be compressed directly in to tablets as they lack proper characteristics of binding or bonding together into a compact entity and they do not ordinarily possess the lubricating and disintegrating properties, flowability, compressibility required for tabletting. Hence, it is necessary to evaluate and manipulate the micromeritic and compressional properties of bhasma without affecting its therapeutic efficacy. In the present study an attempt has been made to evaluate the micromeritic and compressional properties of the bhasma granules prepared using different binders gelatin, starch and PVP K-30.

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MATERIALS AND METHODS

Shankha Bhasma which was prepared in our laboratory, Mercury, Starch, Gelatin, Polyvinylpyrrolidone were Pharmacopoeial grade obtained commercially. The instruments used include, Hydraulic press (SPECTALABS PUNE, Electronic balance (METTLER TOLEDO), Pfizer type hardness tester cadmach), Crushing strength apparatus (Seema Enterprises Pune), Ro-tap (LABTRONICS, PUNE).

Granules containing 10% w/w binders were prepared. The wet screening was carried out through granulating sieve. The wet granules were dried at 40° overnight.

Characterization of granules

1 Micromeritic properties

a) Particle size distribution:[2]

The particle size distribution of granules was established by sieve analysis on Ro-Tap sieve shaker.

Table 1
Effect of different Binders on micromeritic and mechanical properties of shankha bhasma granules

Binder	dg um	σg	Angle of repose (o)	Bulk density (g/cc)	Carr's Index	Hausner Ratio	Crushing Strength (g)
1. Gelatin	625	1.56	34.00 ±0.91	0.567	14.34	1.167	216.57 ±52.89
2. Starch	525	1.67	30.84 ±0.61	0.399	9.93	1.112	276.97 ±57.60
3. PVP	587	1.94	32.83 ±0.69	0.798	16.66	1.200	263.08 ±94.83

b) Angle of repose:[3]

The flowability of the granules was assessed using fixed funnel method. The angle of repose (θ) can be obtained from the following equation.

$$\tan(\theta) = h / 0.5\, d$$

Where h is the height of the cone and d is the diameter.

c) Bulk and tap density:

Bulk density and tap density were determined by Tapping Cylinder Method. This study was carried out using -16/+36 # granules. The final volume was measured after 50 tappings. The bulk and tapped densities were calculated. These results were used to determine Carr's Compressibility Index and Hausner Ratio.[4]

$$\text{Carr's Compressibility Index \%} = \frac{(\text{Tap Density} - \text{Fluff Density})\ 100}{\text{Tap Density}}$$

$$\text{Fluff density} = w/\text{ initial volume}$$

$$\text{Tap density} = w/\text{ volume after 50 taps}$$

$$\text{Hausner ratio} = \text{Tap density}/\text{ Fluff density}$$

2) Mechanical properties

Crushing strength of granules : Crushing strength of granules was determined using mercury load cell method as described by Jarosz and Parrot[5]. A minimum of 10 granules were tested and the average load in grams was taken as the crushing strength.

3) Compressional properties[6]

a) Heckel plot: The compressibility properties was studied using the Heckel Equation[7,8]. About 600 ± 5 mg of granules (-18/+36) were compressed on a hydraulic press (Spectralab) using a 13 mm. flat faced punch and die set, at pressures of 0.25, 0.5, 0.75, 1.0, 1.25, 1.5 and 2.0 tons for 10 sec. True density of the powder was determined by compression at 7.0 tons as described by Strickland **et al.**[9] The compacts were stored in an air tight container for 24 hours to enable elastic recovery to occur, and then the weight, diameter and thickness were determined. The data was processed using Heckel equation and the Mean Yield Pressure (Py) was obtained.

$$\ln(1/1-D) = kP + A$$

b) Tensile Strength: Hardness of the compact was determined using Pfizer type hardness tester and the values were converted to tensile strength (T) by using following equation[10]

$$T = 2P/\pi Dt$$

where,

P = compressional force (kg.),

D = diameter (cm.) and

t = thickness of compact (cm.)

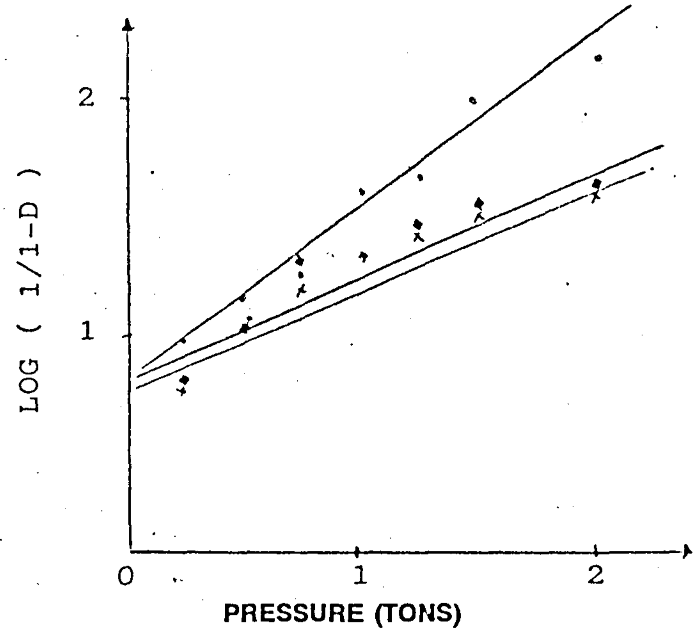
RESULTS AND DISCUSSION

Micromeritic Properties

It was observed that use of gelatin as a binder resulted in granules having larger size and higher value of angle of repose as compared to starch and PVP (Table 1). The size, bulk density and in turn the flowability of the granules are affected by a number of factors especially viscosity and surface tension of the binder solution. It was suggested that better wetting of the powder leads to the formation of granules having larger size and low friability.[11] Thus, PVP which exhibits lower surface tension[11] is apt to give larger granule size.

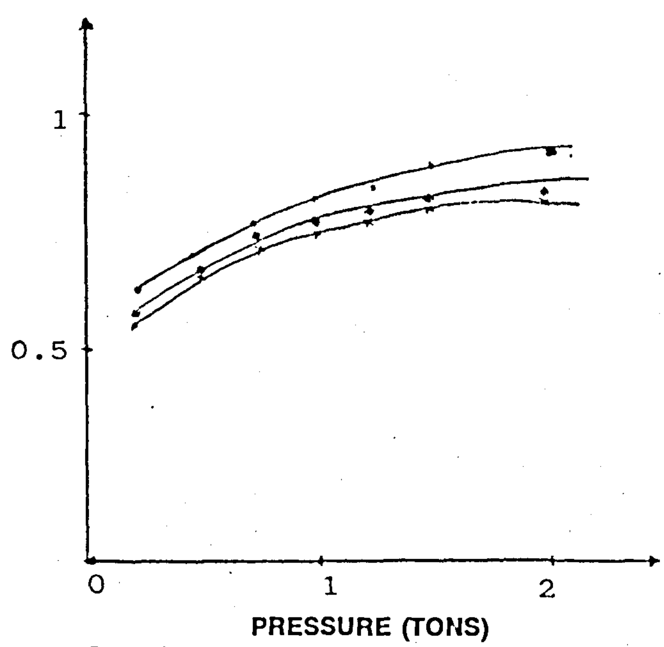
Shankha Bhasma when subjected to determination of angle of repose failed to flow through the funnel exhibiting poor flow properties which was well supported by higher values of Carr's Index (23.98) and Hausner Ratio (1.31). Comparison of flowability and compressibility of the granules with different binders on the basis of angle of repose, Carr's index and Hausner ratio values has shown that no significant difference existed in the properties imparted and exhibited in by PVP and gelatin, whereas, starch granules have superior properties. Granules containing starch have shown higher crushing strength indicating better strength during handling as compared to other two binders.

Compressional properties of the material can be evaluated using different equations, but Heckel equation[8] is widely used. The two parameters considered include, Mean Consolidation Pressure (Py), determined from the slope of the plot of Log (1/1-D) Vs P (Fig.1) and change in packing fraction with compression pressure. Granules obtained using starch as a binder have shown significantly low Py



• STARCH
♦ PVP
X GELATIN

Fig. 1: Heckel Plot of Shankha Bhasma Granules



• STARCH
♦ PVP
X GELATIN

Fig. 2: Plot of packing fraction Vs pressure of shanka bhasma granules

Table 2
Effect of different binders on compressional properties of shankha bhasma granules

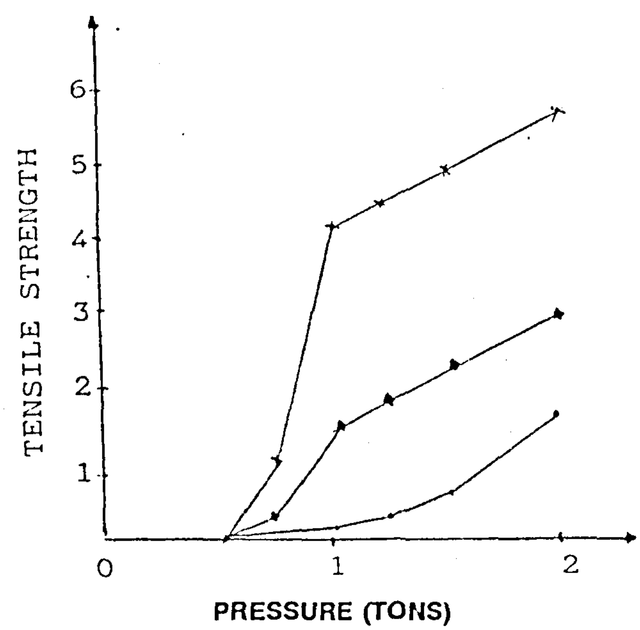
Binder	(Py)	Tensile Strength at P.F. 0.75
Gelatin	1.037	4.495
Starch	0.616	0.014
PVP	1.016	1.700
P	< 0.05	< 0.05

value (Table-2) and higher rate of change in packing fraction as compared to those obtained with the granules containing gelatin and PVP as binders (Fig. 2). Thus Heckel plot study also confirms that starch is more efficient for improvement of compressibility of shankha bhasma as compared to gelatin and PVP.

The tensile strength of the compacts was studied with respect to compression pressure (Fig. 3). It shows that tensile strength of compacts increases with increase in pressure this can be accounted by the fact that in addition to the elastic and plastic deformations at the points of contact between particles, there may occur asperity melting due to combinations to high pressure and temperature followed by resolidification to form welded bonds[12]. Tensile strength of compacts was also compared at same packing fraction (p.f. = 0.75) which also shows that the granules containing starch have resulted in the compacts with lower tensile strength, whereas, granules with gelatin have significantly high tensile strength.

Bhasmas consist of inorganic materials and such substances are hard and brittle and undergo consolidation by fragmentation.[13]

In a granule, the binder forms a coat on the powder material and the tensile strength of the compact formed is dependent on the plasticity, mechanical strength and durability of this cost. Starch and PVP are considered as softer and more readily compressible materials. Starch undergoes plastic deformation though this tendency is dependent on the source of starch and shape of the particles, while PVP is considered to be elastic in nature.[12] Gelatin possesses high elasticity, low plasticity and high tensile strength.[14]



• STARCH
♦ PVP
X GELATIN

Fig. 3: Plot of tensile strength Vs pressure of shankha bhasma granules

Thus, high plasticity of starch assists consolidation and is responsible for its low Py value. During consolidation, large surfaces are continually and freshly created due to fragmentation giving rise to a large number of contact points but with weaker bonds, thus leading to a weak compact similar to lactose.[15] In case of gelatin, low plasticity resists consolidation (high Py), and the high tensile strength of gelatin is responsible for the high tensile strength of compacts. Gelatin is brittle and due to this property, granules containing gelatin will be relatively friable, as indicated by their low crushing strength.

In conclusion, from the above discussion it is evident that starch is a superior binder respect to improvement of micromeritic, mechanical and compressional properties but will generate tablets with low tensile strength. Alongwith these factors the effect of binder on antacid efficacy of the bhasma must be studied which will allow selection of a suitable binder.

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