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COMPACTION BEHAVIOR OF PARACETAMOL POWDERS OF DIFFERENT CRYSTAL SHAPES

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ABSTRACT

The powder technology characteristics of 3 kinds of Paracetamol powders from different manufacturer were investigated. Their crystal lattices, crystal shapes and the shape coefficients were measured. The compression behaviors were shown that the needle-shaped crystals have greater extent of capping and lamination than that of other crystals because of its typical Mohr body compression behavior.

INTRODUCTION

Paracetamol powder is a poorly compressible material. Usually unsatisfactory tablets are yielded, even capping or lamination, when tableted. It is generally accepted that compression characteristics of powders depend on their physical properties mainly being related to plasto-elasticity and compaction behaviors of materials used during compression. The properties can be affected by the different crystal shapes of the particles used. Kregiel and Foss investigated the role of crystal system in the formation of tablets and reported that substances

belonging to the cubic crystal system presented no difficulty for direct compression(1). The other reporter suggested that physical properies may be associated with crystal forms(2).The effects of the crystal habit and particle shape on the properties of cubic and endritic crystals of sodium chloride and the tablets produced from these crystals were previously examined(3).

EXPERIMENTAL

Materials

3 kinds of Paracetamol powders of different crystal shapes were used. (Huai-nan Pharmaceutidal Factory;Jin-zhou Pharmaceutical Factory; Shen-yang Pharmaceutical Factory). A vibratory sieving machine was used to obtain -100 ~ +120 mesh the Paracetamol crystals which were dried at 60℃ for 24h and then to store in wax-sealed capped jars.

Cystal lattice analysis and crystal shapes observation

Crystallogams of the Paracetamol powders in different crystal shapes above were obtained by X-ray diffractometer(D/max-YA12KAW,U.S.A.). Scanning electron photomicrographs of Paracetamol powders from electron microscope (AMRAY-1000B, U.S.A.) showed the different crystal shapes.

Measurement of shape coefficient

Different shape coefficients of the Paracetamol powders above were obtained from IBAS-KAT Image Process System (Kontron, German) . The circle factor (FC = the ratio of circumference of a circle equaling to the area of a particle to real permeter of a particle) and shape factor (FS =the ratio of min length of a particle to max length of a particle) of the crystals in milled and unmilled condition were measured in order to investigate the change of the crystal shape after milling.

Measurement of compression cycles

Compaction was carried out in an instrumented single punch tablet machine with a set of 10 mm diameter die and flat-faced punches. Top and bottom punch pressures were monitored with a set of strain

gauges and die wall pressures were measured by a cut-away die boned with strain gauges(4). Strain gauges output was amplified with a strain meter(Shanghai Huadong electron meter factroy,YD-15). A displacement transducer (CIL-1-10) was employed to monitor top punch displacement. All signals were fed into a multi-channel UV recorder (Shang- hai electric meter factory ,SC-16).The die wall and the upper and lower punch surfaces were lubricated with a 2% suspension of magnesium stearate in acetone before each compression. Compacts of 300 mg were compacted under compression speed of 0.5cm/sec, while various compression data during compressing were recorded.

RESULTS AND DISCUSSION

Investigation of the nature of these crystals

The results from crystallograms (omitted) showed that all crystals were the same crystal lattice. But different crystal shapes of the powders used were observed from scanning electron photomicrographs.They belonged to cube-shped, layer-shpape and needle-shaped crystal systems which are illustrated in Fig 1 .

The values of shape coefficient for the 3 kinds of crystals in milled and unmilled condition are presented in Table 1 .

Comparing the statistics values of FC and FS of a kind of crystal in milled with that in unmilled the results shown no significant change ,i.e. a crystal shape of materals is also a inherent habit of crystals.

Compression behavior of the crystals

The compression cycle plots for the different crystals are illustrated in Fig. 2. Recordings for pressure applied to the top punch and the corresponding pressure exerted on the die wall were recorded continuously during the down and up strokes of the top punch by a X-Y recorder to obtain the pressure cycle directly. The shapes of the plots have the same general form and seem to indicate that the crytals behave similarly to a Mohrbody(5), because none of the crystals was given a pressure cycle similar to that of a body with constant shear yield stress.But the shape of the cycles from different shaped crystals

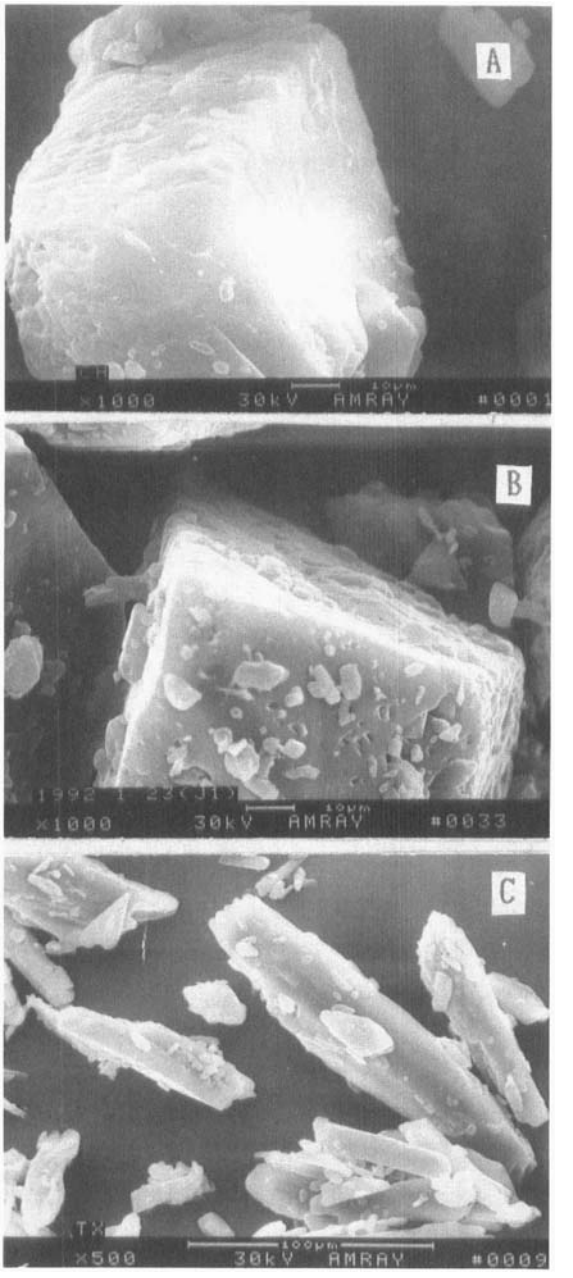

FIGURE 1
Scanning electron photomicrographs of the crystals. A: the cube-shaped crystal, B: the layer-shaped crystal, C: the needle-shaped crystal.

TABLE 1
Staistics values of FC and FS of crystals in milled and unmilled

Crystal shapes		the values of FC median	mean	s.d.	the values of FS median	mean	s.d.
Cube-shaped	(unmilled)	0.686	0.672	0.150	0.736	0.700	0.121
	(milled)	0.665	0.658	0.133	0.673	0.613	0.178
Layer-shaped	(unmilled)	0.612	0.617	0.148	0.552	0.547	0.167
	(milled)	0.659	0.654	0.131	0.672	0.621	0.165
Niddie-shaped	(unmilled)	0.624	0.617	0.161	0.661	0.603	0.182
	(milled)	0.671	0.663	0.137	0.684	0.619	0.176

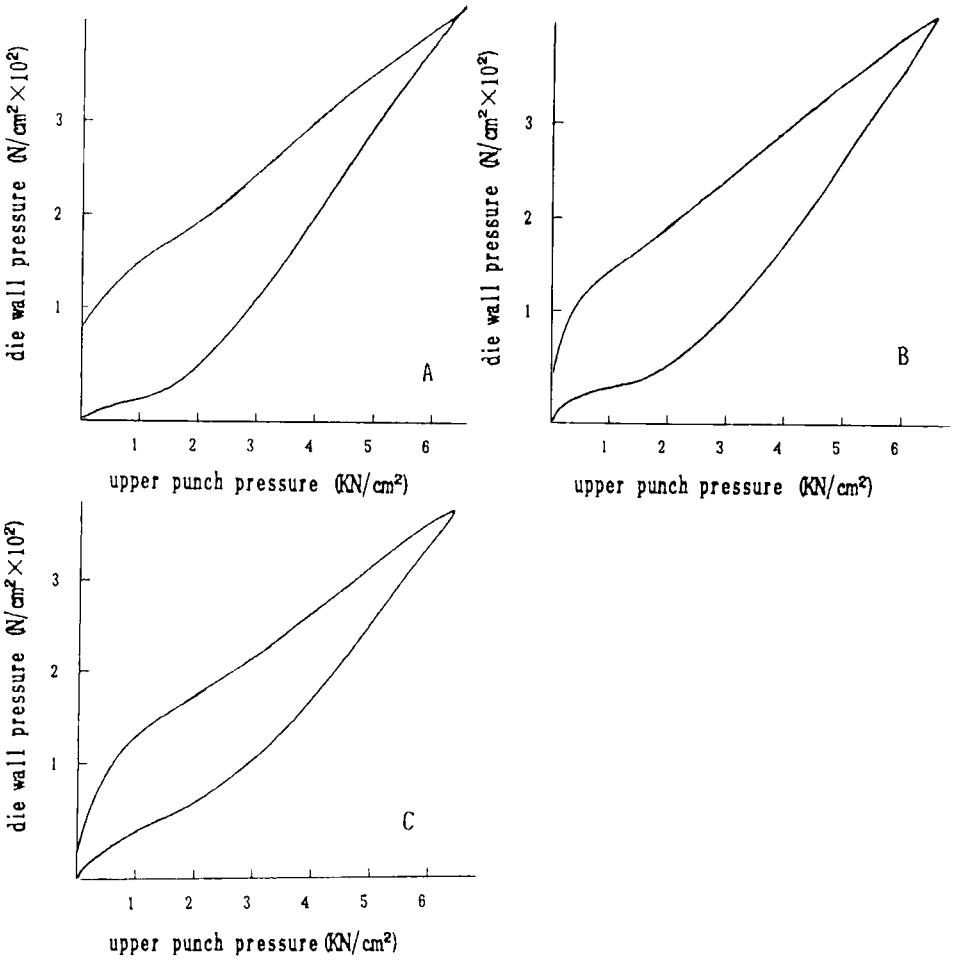

FIGURE 2
Pressure cycles of the crystals. A: the cube-shaped crystal, B: the layer-shaped crystal, C: the needle-shaped crystal.

differed in some respects. The residual pressure on the die wall in the needle-shaped crystal was lower than that of the others after the axial pressure returned to zero. The result shown the compression property of needle-shaped crystal was more alike to be an elastic body and has even poorer compressibility than that of the others.

The better compression property of the Paracetamol powder with cube-shaped crystals was probably due to easier rearrangement encountered by the crystals under pressure. Thus larger true contact areas were established among the crystals, and stronger bonds were formed than that of the others.

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