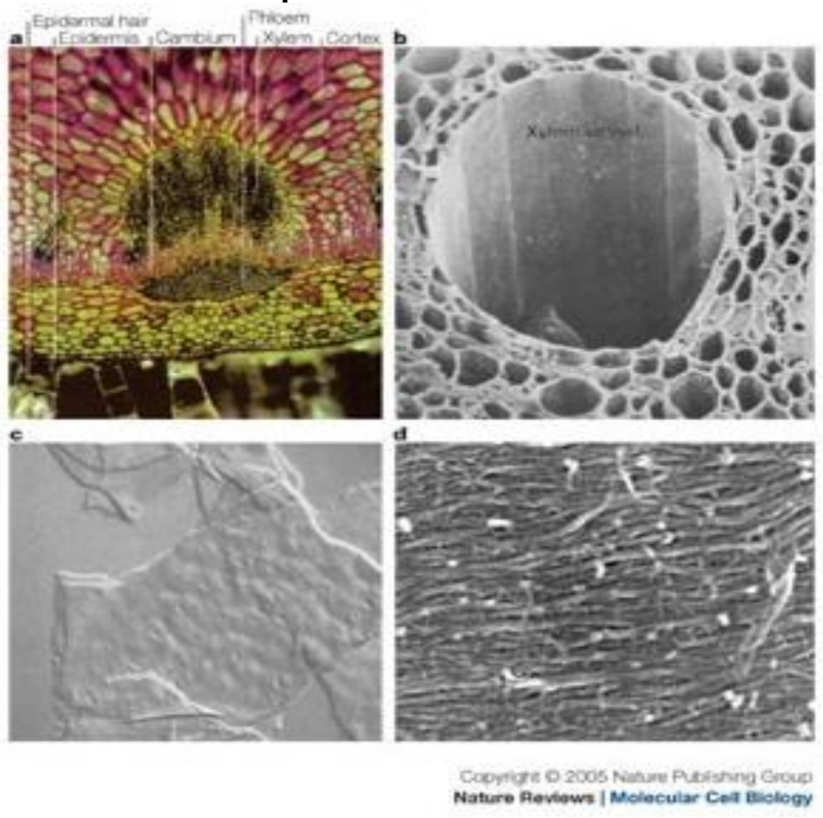
THE INFLUENCE OF CELLULOSE ON GRANULAR PRODUCT

Introduction

Cellulose microfibrils are insoluble cable-like structures that are typically composed of approximately 36 hydrogen-bonded chains containing from 500 to 14,000 β-1,4-linked glucose molecules. Cellulose microfibrils comprise the core component of the cell walls that surround each cell. The long inelastic, microfibrils wrap around cells in spatially oriented overlapping layers that provide resistance to osmotic pressures. The pressure of the plasma membrane against the cell wall rigidifies the cell walls, and allows plants to adopt an erect growth habit [1, 2].



Experimental

In order to determine the optimal parameters of the granular product (the composition of the raw material, the particle size, the moisture content) the microcrystalline cellulose suitable for production of high quality fertilizers, was used for granulation. Potassium dihydrogen phosphate was granulated in the laboratory drum-type granulator-dryer (Fig. 1) at 5 degrees of tilt angle and a constant (27 rpm) rotation speed. The raw materials were supplied to the granulator preheated up to 55–65 °C. For irrigation, tap water was used, which was being injected into the raw material mixture upstream of the drum-type granulator-dryer. Potassium phosphate granulation was investigated by changing the amount of water used for irrigation purposes as well as by adding a binder (two kind of cellulose). Pellet uniformity assessment was made by taking fertilizer photos while using optical and scanning electron microscopy techniques. The TA.XT plus Texture Analyzer from Stable Micro Systems Ltd (Godalming, UK) was used in order to characterize the stiffness and strength of the granules.

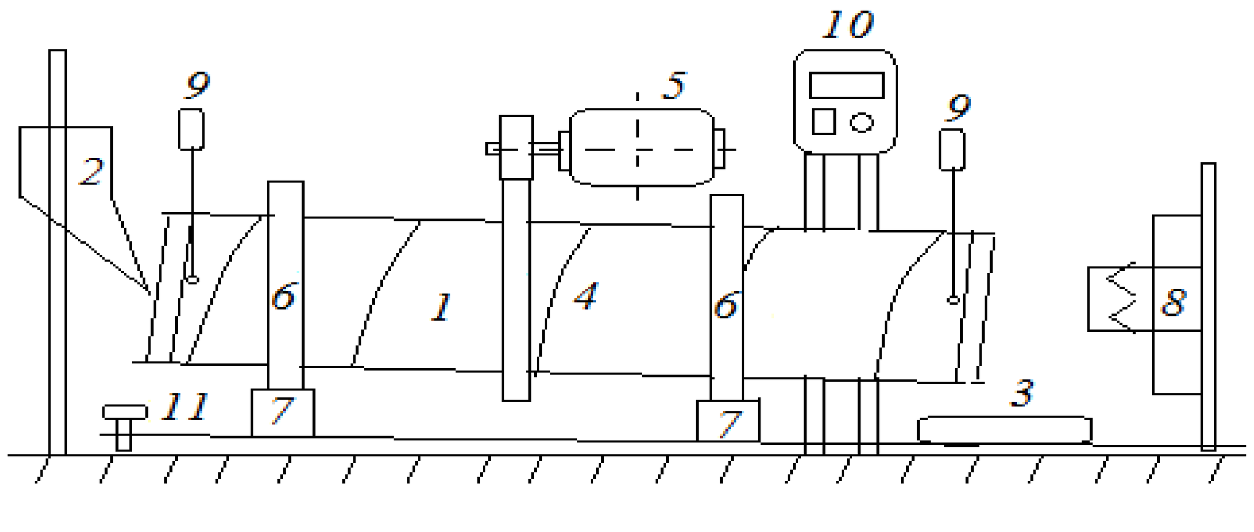


Fig. 1. Laboratory rotary drum-type granulator *1* - drum; *2* - supply of raw materials; *3* - product dropout; *4* - drum paddle; *5* - electric motor; *6* - cogwheel; *7* - bearing roll; *8* - supply of hot air; *9* - thermocouples; *10* - control unit; *11* - lock of drum inclination angle

Conclusions

It is evident that when cellulose was used for granulation, more spherical-shaped pellets were formed in comparison to the pellets formed when granulating with water only. It was determined that the best parameters of granular potassium dihydrogen phosphate (65 % marketable fractions, static strength of the granule – 8.73 N/gran.; moisture of the granule – 1.7 %) was obtained with the drum granulator when: the raw material mixture contained 5 % cellulose and 21 % humidity; the temperature was in the range of 55–65 °C; the rotation speed was 27 rpm.

Results and discussion

Pellet uniformity assessment was made by taking fertilizer photos while using optical and scanning electron microscopy techniques. The obtained photos are presented in Figure 2.

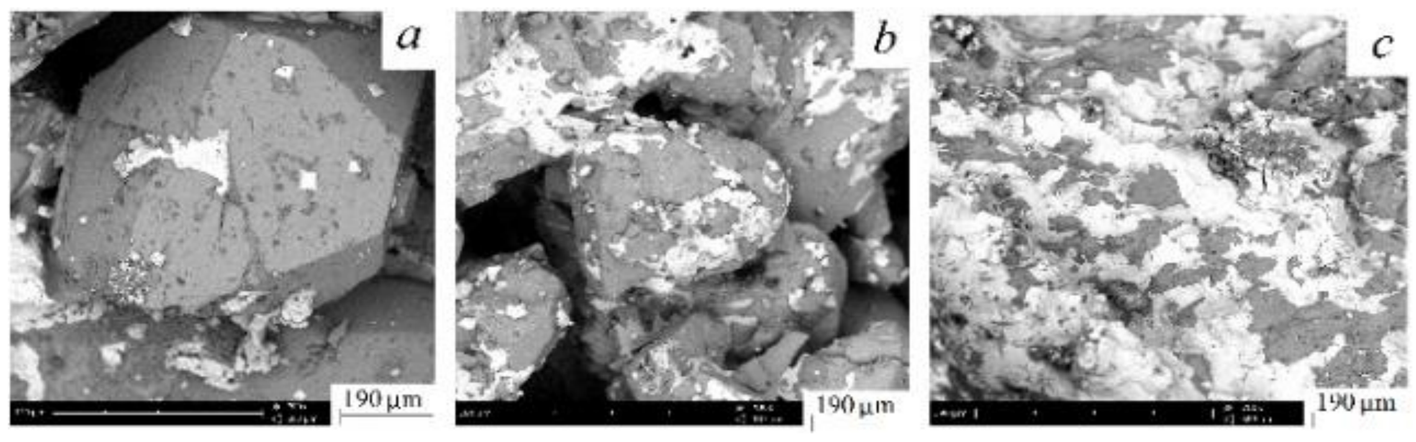


Fig. 2. SEM photos of a product, granulated only with water (no microcrystalline cellulose) with different magnifications: *a* – ×500; *b* – ×700; *c* – ×1000

The obtained results indicate that in order to obtain granulated potassium dihydrophosphate with optimal properties, the use of water does not suffice. Analysis of scientific publications on the binding materials used in the granulation technology suggests that if the objective is to obtain maximally pure potassium dihydrophosphate, cellulose should be chosen as the binder (Fig. 3).

Propetries of granulated potassium dihydrophosphate were determined and presented in Figure 4 and Figure 5.

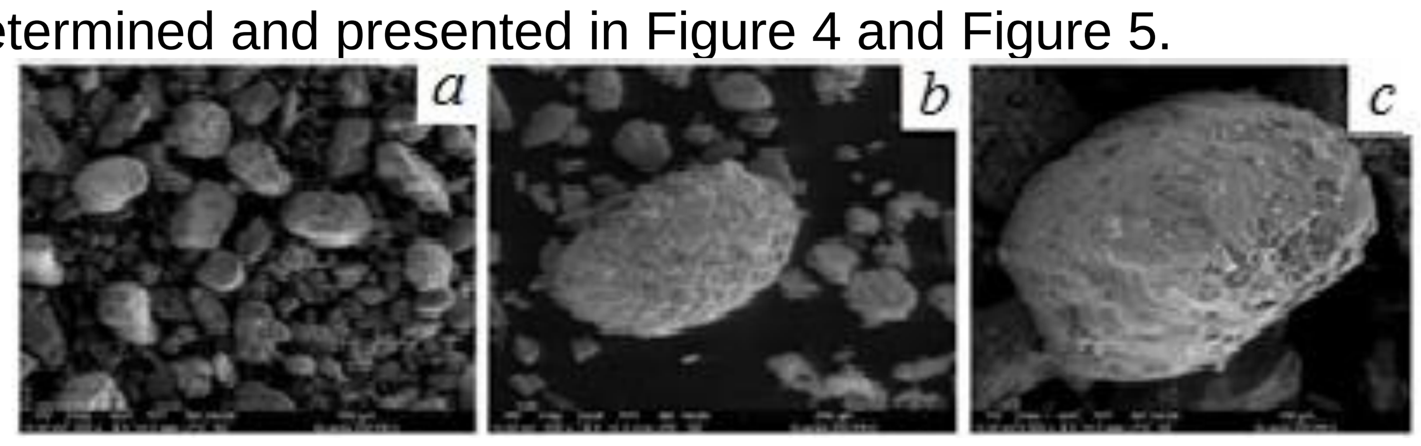
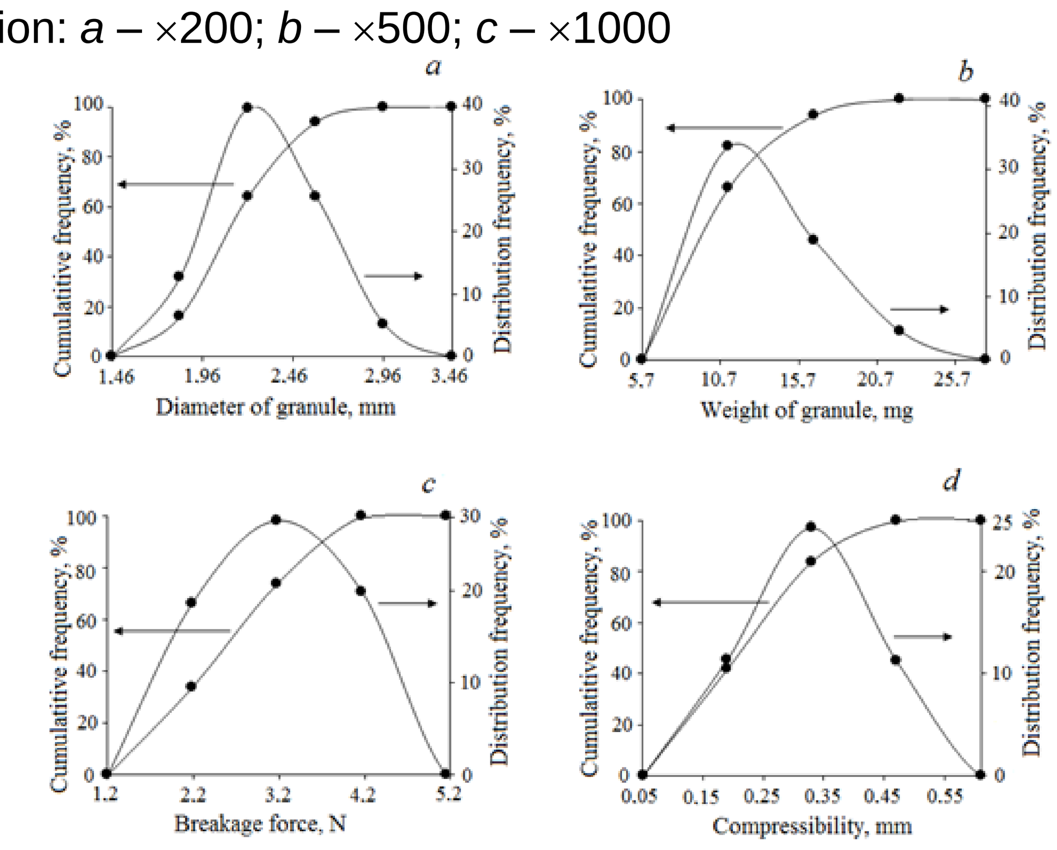


Fig. 3. SEM photos of product granulated with cellulose and water with different magnification: *a* – ×200; *b* – ×500; *c* – ×1000

Fig. 4. Properties of granules (2–3.15 mm) of the granulated product, which was obtained only by water potassium dihydrogen phosphate wetting. Distribution by: *a* – diameter; *b* – weight; *c* – breakage force; *d* – compressibility



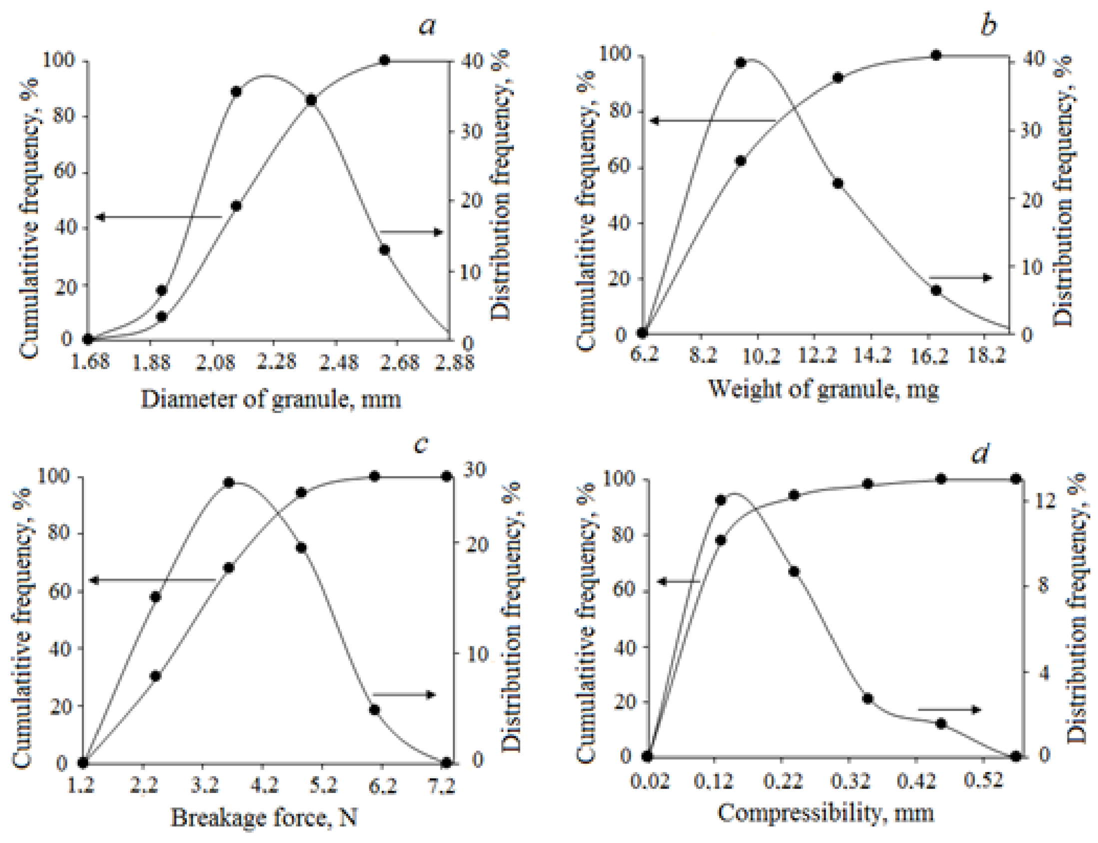


Fig. 5. Properties of the granules (2–3.15 mm) of the granular product which was obtained by wetting potassium dihydrogen phosphate with water and adding micro-crystalline cellulose. Distribution by: *a* – diameter; *b* – weight; *c* – breakage force; *d* – compressibility

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