Obtaining granular fertilizers based on ashes from combustion of waste residues and ground bones using phosphorous solubilization with bacteria *Bacillus megaterium*.

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Products of functional properties containing nutrients obtained from natural resources and not being chemical synthesis products have become increasingly sought by customers [1,2].

Phosphate rock, which is non-renewable, constitutes the primary source of raw materials for phosphate fertilizers. In the environment, phosphorus is obtained from ore (phosphorites, apatite) and effectively scattered in agricultural management [3]. There is no substitute for phosphorous, however it does not disappear after being used and it can be recycled. Therefore, attempts to obtain phosphorous from renewable resources including wastage e.g. bone waste, fishbone, and ashes from biomass combustion from waste treatment plants became increasingly significant[4].

This paper presents results of semi-technical research on obtaining granulated phosphorous fertilizers. Bones from meat industry (with the content of 6,1 % mass P_2O_5) and ash from biomass combustion from waste treatment plants with tertiary treatment (with the content of 24,7 % mass P_2O_5) were used as raw materials. In order to activate phosphorous contained in raw materials, the obtained granulate underwent microbiological solubilization by application of suspension containing bacteria: *Bacillus megaterium*.

Mechanical granulation tests were conducted on granulation plate (drawing 1). Ground bones and ash were mixed with granulating additive (bentonite, gypsum, single superphosphate). Then, this mixture was being put onto granulation plate with a simultaneous dosing of hot water from hand sprayer in order to bond molecules into larger agglomerates. In case of tests with molasses and sodium lignosulphonate, these substances were dissolved and as hot solutions they were dosed onto the plate. The tests were continued until granulates with granules of 2-5 mm were obtained (drawing 1). The obtained granulates were dried and underwent physicochemical analyses. All of the obtained fertilizers were tested with regard to:

- the content of particular forms of P_2O_5,
- compression strength,
- abrasion resistance,
- effectiveness of granulation system.

Exemplary results of physicochemical analyses were presented in tables 1 and 2

Drawing 1. On the left: granulation plate used in semi-technical tests. On the right: granulate obtained in tests

Table 1. The content of particular P_2O_5 depending on granulating factor used and the type of granulation, in % mass.

Granulating factor	P_2O_5	
	Total	**Soluble in citrate**
Sodium lignosulphonate	21,0	10,6
bentonite	21,0	10,7
gypsum	20,6	10,4
superphosphate	21,8	11,1
molasses	20,9	10,3

Table 2. Compression strength and abrasion resistance and effectiveness of granulation

Granulating factor	Compression strength	Abrasion resistance	Effectivness of granulation
	N	**%mass.**	**%**
Sodium lingosulphonate	14,3	94,2	95
bentonite	9,2	66,8	10
gypsum	10,4	71,7	12
superphosphate	11,5	80,6	23
molasses	8,2	77,5	8

The obtained fertilizers are characteristic of a high content of total P_2O_5. The content of P_2O_5 soluble in neutral ammonium citrate is higher than it would be expected taking into account the content of the used raw materials. This demonstrates a positive influence of processes carried out on the assimilability of phosphorous compounds.

These tests proved that is possible to obtain granulated phosphorous fertilizers from waste product, with the use of solubilization of phosphorous compounds with bacteria *Bacillus megaterium*. These fertilizers allow for recycling of phosphorous compounds and will be particularly useful in countries without their own resources of typical phosphorous raw materials.

References:

1. Schroeder and Grzesiak (2014)
2. Fertilizer manual, IFDC/UNIDO, (1997)
3. Saeid *et al.* (2012)
4. Stamford, *et al (*2003)

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