THE ACTIVITY OF SOIL CATALASE, DEPENDING ON THE SOIL GRANULOMETRIC FRACTIONS AND SOIL DEPTH FOR EXAMPLE DRY POLDER BESA (SLOVAKIA)

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Abstract

Microorganisms of soil lives in the microenvironment and between the soil particles, therefore the soil structure affect their activity. Soil structure considerably affects the biological activity of the soil. In this work the relation of various soil granulometric fractions to microbial activity of soil enzymes was studied. The research was realized between 2012 and 2014 years in the East Slovak Lowland on four soil profile, from which three profiles were under perennial grass stands and one was under arable land. Soil samples for determine of selected parameters were taken from soil profile 0.0 – 0.6 m, from each 0.2 m. Activity of catalase is one from most stable microbial soil parameters, and so its activity was determined. Experimental data were evaluated by statistical methods. In soil profile the values of catalase activity were determined in the range 0.356-1.891 ml O_2.g.min^{-1}. From statistical testing result the dependence of enzymatic catalase activity on size of soil particles.

Key words: *activity of catalase, size of soil particles, soil*

1. INTRODUCTION

The aggregation of primary particles of soil is a key factor in the structure of soil. Soil structure is strongly influenced by climate, biological activity, density and land management practices. It is less likely to soil which is heavily textured have a well-defined structure and less porous structured space than soil with high clay content (Fulajtár 2006; Igaz 2009; Kondrlová 2013). Composition of soil granulometric fractions always reflect only the content of mechanical particles of mineral origin which are characterized by various shapes and sizes. Mineral soil particles of defined size are grouped into groups who received the name of granulometric fractions. The activity of enzymes is necessary for the operation of all bio-transformation in the soil, and therefore the enzyme activity used as a sensitive indicator of biological activity of the soil. The quantity of factors influence the activity of soil enzymes therefore it is necessary measured values given in relation to the physical, chemical and biological characteristics of the soil. Measurements of soil enzymes are relevant to the determination condition of the soil or the environment. Stemmer (1998) and Drazkiewicz (2008) showed on the relationships between the size of soil aggregates and biomass and activity of soil microorganisms, which may be associated with different intensity of adsorption of enzymes on the surface of soil particles and the different impact of inhibition. Catalase is an antioxidant enzyme that is released into the soil in order to hydrogen peroxide decomposes. To prevent damage to cells, its effects are detoxification, thereby organisms protecting. Microbial activity is influenced by many factors, one of which is soil texture. The aim of the present paper was to determine dependence enzymatic activity of catalase with different proportion of the soil particles in granulometric fractions.

2. MATERIAL AND METHODS

Global climate change is also reflected increasingly occurring extreme climatic phenomena such as torrential rains, floods, extreme drought lasting longer term (Špánik et al., 2002; Bárek et al. 2008). Due to retention high water are built so polders, which are only exceptionally impregnated in case of special flood situations. On the East Slovakian lowland (VSN) was built dry Besa polder, which retention the major water the river basin Bodrog.

The task we addressed from 2012 to 2014 in the territory of the dry polder Besa (Fig. 1). Polder of Besa is the dry reservoir, created under the village of Besa on the right side of the river of Latorica and the left side of the river of Laborec above its inflow into the river of Latorica in the former inundation space. Its construction was necessitated by the flood situations on the rivers of the Eastern lowlands.

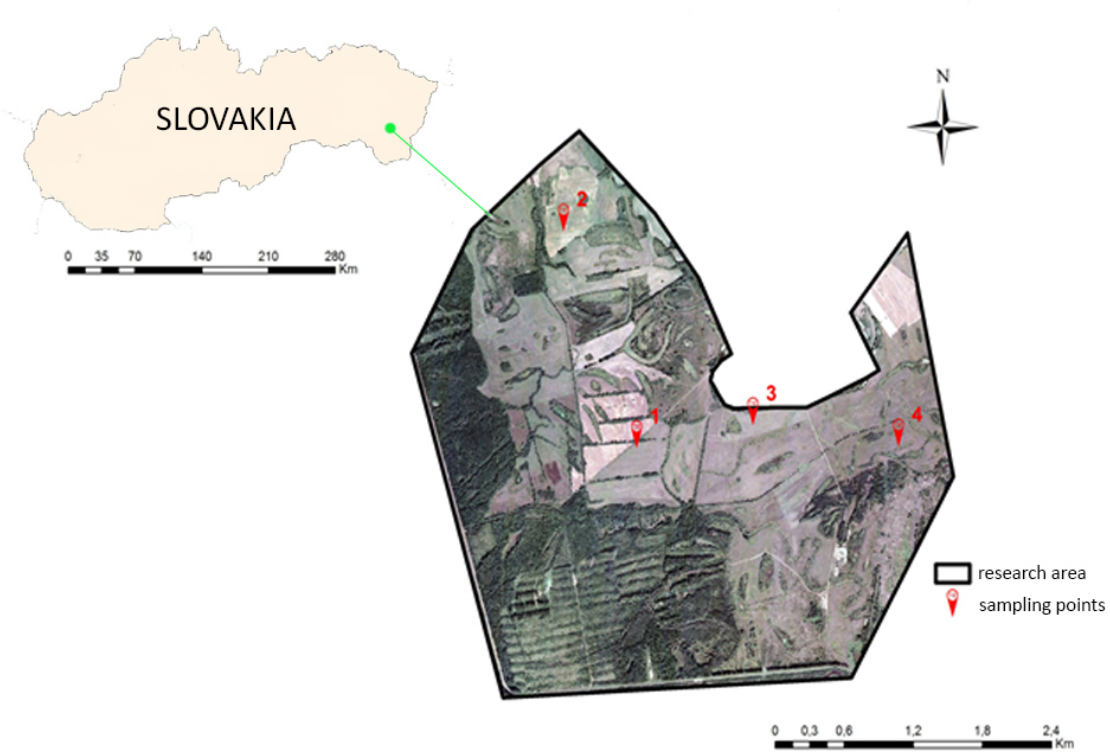


Fig. 1. Sampling profiles in dry polder Beša (VUPOP).

The field survey was realized on four soil profiles which represent more extended soil textures in the polder. Soil samples for determination of the physical and biological soil properties were taken from the depth 0.0 – 0.2; 0.2-0.4; 0.4-0.6 meter in four soil profiles the spring (Tab. 1). For the determination grain composition of the damaged samples collected from each soil profile and three depths. By pipette method, were determined following grain size fractions: 1 fraction - clay, <0.001 mm; 2 fraction - medium and fine dust, 0.001 to 0.01 mm; 3 fraction - coarse dust, 0.01 to 0.05 mm; 4 fraction - fine sand, 0.05 to 0.25 mm; 5 fraction - medium sand, 0.25 to 2.00 mm; Category I - clayey particles <0.01 mm. From the biological properties, the activity of catalase was investigated. The activity of catalase was determined by CHAZIJEV (1976) on Jankov vápnomer measuring the volume of oxygen, which is released after 10 min. from 10 g of the soil sample after the addition of 20 ml of 3% of H_2O_2.

The results were evaluated by mathematical - statistical methods by using the statistical program STATISTICA 10.

Table 1. Characteristics of sampling profiles in dry polder Besa.

profiles	**description of profiles**	**position data**	
		lattitude N	**longitude E**
1. – 4002/1	arable land	48°31'43"N	21°56'08"E
2. – 4204/1	grassland, northern part	48°32'39"N	21°55'34"E
3. – 1304/1	permanent grasssland, easterrn part	48°31'50"N	21°56'57"E
4. – 3202/1	permanent grassland, western part	48°31'46"N	21°57'59"E

3. RESULTS AND DISCUSSION

Difficult to geological conditions on East Slovak lowland (VSN) cause great soil heterogeneity. According to the latest data update observed Research Institute of Soil Science and Soil Protection in terms of grain composition in the Eastern lowlands occurs light soils 3.2%, 54.1% medium heavy soils, heavy soils 22.1% and 20.6% very heavy soils (Vilček 1998, 2005). For the territory is characterized by different soil types alternate on very short distances.

The choice of monitored profiles depends on the necessary representation of all types of soil, which is located in a particular area. It is characterized by four basic categories of soil particle size: Category I - clayey particles II. Category - dust, III. Category - powdery sand, IV. Category - sand. Taking into account the content of clay particles (<0.01 mm), the soil is divided into soil types, which are based on rating scale of Novak category of granularity (Fulajtár 2006; Zaujec et al., 2009). For each category is typical different particle diameter of. The average size of granulometric fractions of soil profiles in the dry polder Besa is shown in Table 2.

Table 2. The average size of granulometric fractions in the study area.

profile	Ø particles [mm]						types of soil
	< 0.001 clay	0.001–0.01 medium and fine dust	0.01–0.05 coarse dust	0.05–0.25 fine sand	0.25–2.00 medium sand	< 0.01 I.cat. clayly particles	
1.	12.60	11.55	19.03	38.44	17.71	24.10	sandy-loam
2.	26.72	29.56	25.74	16.03	1.96	56.28	clay-loam
3.	36.24	32.65	19.58	9.45	2.07	68.89	clayey
4.	48.98	28.06	14.71	7.14	1.09	77.05	clay

Of grain composition studied soil profiles shows that the clay content (fraction 1) at a depth of 0.0 to 0.6 meters is within the range from 10.67 to 56.71%. The content of fine dust and medium dust (fraction 2) at a depth of 0.0 to 0.6 m reached 8.60 to 37.17%. Coarse dust (fraction 3) in all evaluated soil samples ranged from 6.46 to 28.58%. The content of fine sand (fraction 4) ranged from 1.28 to 48.14%. Medium sand (fraction 5) ranged from 0.24% to 22.74%. Size distribution is the result of prolonged pedogenic process, and therefore during the observed period there wasn´t changes in the proportions of granulometric fractions. During the years, the contents of each grain-size fractions in the studied soil profiles not change significantly. Found small differences seem to be more a result of the spatial heterogeneity of the observed area than the influence of flooding polder area.

The average values of catalase activity during the reporting period were in the range 0.45 to 1.27 ml O_2.g.min^{-1} on locality 1 and locality 2 from 0.62 - 1.13 ml^{-1} O_2.g.min^{-1} , the locality 3 from 0.13 - 0.76 ml O_2.g.min^{-1}, and locality 4 from 0.2 -1.2 O_2.g.min^{-1}. Kruskal-Wallis test showed that the different locations, there is a statistically significant difference in the activity of catalase (Fig. 2), (x2 (2) = 64.7106, p = 5.784-14). On locality 1 which represented arable land with sandy loam types of soil we recorded values catalase activity of all monitored highest. On locality 3 with clayey soil was recorded value the lowest. The decrease in catalase activity was recorded also with increasing depth.

Kruskal-Wallis test showed that the differential depths there is a statistically significant difference in the microbial activity (Fig. 3), (x2 (2) = 74.9541, p = <2.2e-16th). These findings may be caused by a decrease in the biological activity of lower soil profiles, which is consistent with the published data the authors Dick et al. (1996), Javoreková et al. (2008). Kruskal-Wallis test showed that the various fractions, there was a statistically significant difference in the size of the soil particles, X2 (4) = 72.7843, p <5.859-15th (Fig.4).

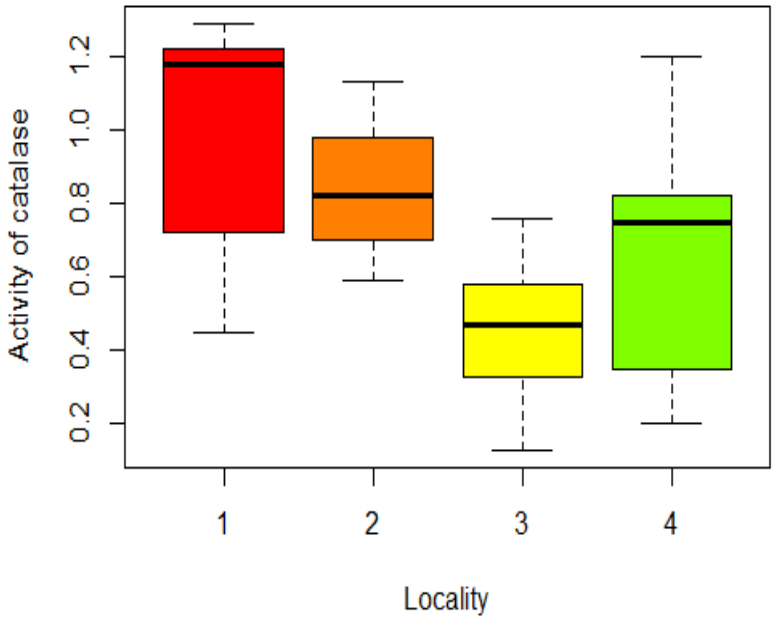


Fig. 2. The activity of catalase in different profiles.

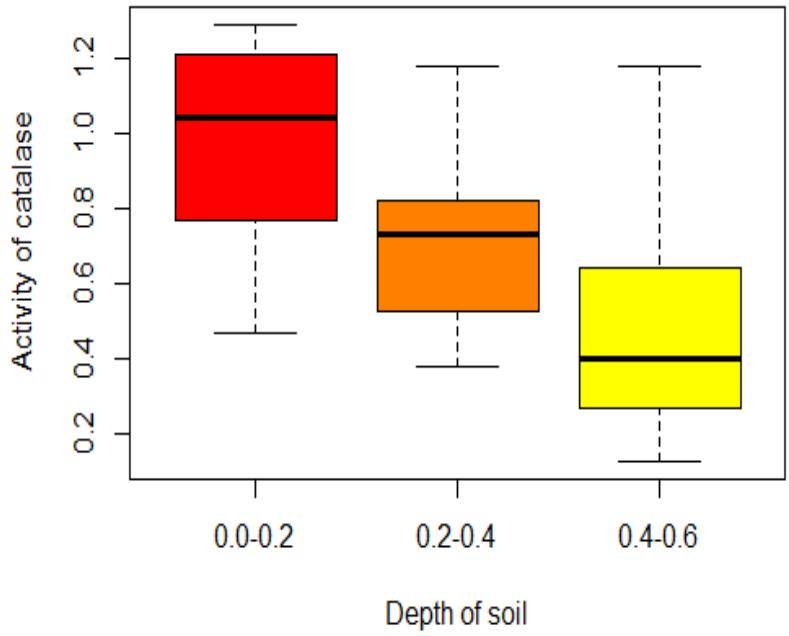


Fig. 3. The activity of catalase at different depths.

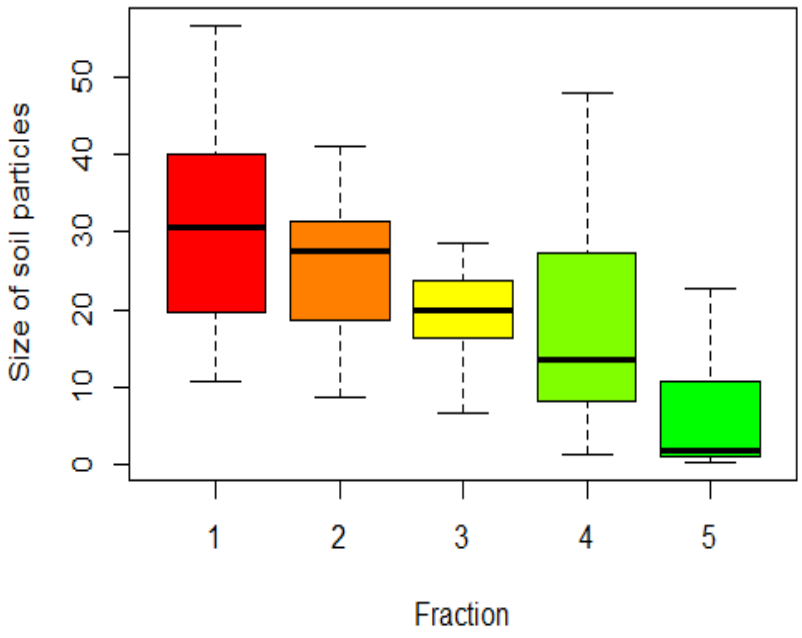


Fig. 4. The activity of catalase in each fractions.

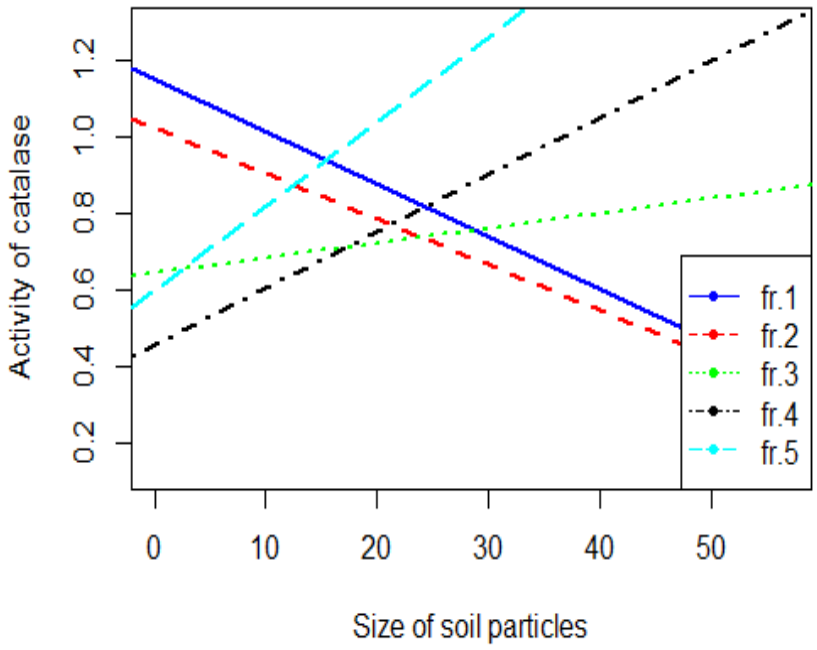


Fig.5. The activity catalase and proportion of particles.

The analysis we studied the relationship catalase activity and the proportion of particles of various fractions, we found interesting results. The diagrams (Fig. 5) indicated that the catalase activity was increased with the proportion of particles in granulometric fractions as confirmed by the results of studies Gömöryová (2011). The relationship between the activity of catalase and particles of type 4, and 5 fractions, has been confirmed as statistically significant (Tab. 3). Listed thus suggests increasing activities with the proportion of particles in each granulometric fraction.

Table 3. The relationship between fractions and proportion of particles size.

fraction	F	p
1	20.29	7.47e-05
2	3.8962	0.05656
3	0.1402	0.7104
4	19.281	**0.0001042 ***
5	10.661	**0.0025 ***

* significant dependence

4. CONCLUSIONS

Based on the research results for reporting period 2012 - 2014, we came to the following conclusions:

- the results of the field survey confirmed the high spatial heterogeneity of soil within the area. The presence of different types of soil - sandy-loam soil, clay-loam soil, loamy and clay pointed to the diversity of soils;
- measuring catalase activity confirmed that, with increasing depth of its activity decrease. The different fractions of soil microbial activity confirmed the increase with the increasing of particles in individual fractions.

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