# Chemical and microbiological characterization of Cambisols, Luvisols and Stagnosols

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**ABSTRACT**

Cambisols, Luvisols and Stagnosols are main soil taxonomical units covering 78% of the total area of the Czech Republic. In the period 2001–2008 soil samples from 13 arable and 2 grassed localities were collected and tested. Microbial biomass carbon (MBC) was determined using microwave irradiation method (MW), chloroform fumigation extraction method (FE) and re-hydration technique (RHD). Soil samples were moistened, according to the content of organic carbon ($C_{org}$), by deionized water addition (%$C_{org}$ × 0.19 ml/g DM – dry mass of soil) immediately before MBC determination. Microwave sterilization (800 J/g DM = 600 W, 2 × 67 s, 100 g DM (10 soil samples) and microwave soil extracts digestion (800 J/ml = 250 W, 77 s, 24 ml) give the lowest values of MBC (204 ± 67 mg/kg DM; 100%) in comparison with FE (236 ± 57 mg/kg DM; 116%) and RHD (478 ± 138 mg/kg DM; 235%), respectively. High significant correlation ($r$ = 0.9713) was found between TC (total carbon; 1.36 ± 0.29%) and TN (total nitrogen; 0.15 ± 0.03%) determined by CNS analyzer. Furthermore, high significant correlations were found between MBC-MW and MBC-RHD ($r$ = 0.8965) as well as MBC-FE and DHA (dehydrogenase activity; $r$ = 0.8094), respectively. DHA in studied soils reached 147 ± 68 mg of triphenylformazan/kg DM/24 h. $C_{org}$ formed 96% of TC and total Kjeldahl nitrogen 97% of TN, respectively. According our results MW is fully acceptable for MBC determination.

**Keywords**: microbial biomass; total carbon and nitrogen; $K_2SO_4$ extractable carbon; dehydrogenase; Cambisols; Luvisols; Inceptisols; Alfisols

What are ecologically important soil characteristics suitable for soil biological evaluation? Hofman and Dušek (2003) preferred three well-known parameters (microbial biomass carbon (MBC), basal respiration (BR), metabolic coefficient ($qCO_2$ = BR/MBC) and five other parameters (potential with glucose respiration (GR), ratio of potential and basal respiration (GR/BR), biomass specific potential respiration (GR/MBC), available organic carbon (C-$K_2SO_4$) and biomass specific available organic carbon (C-$K_2SO_4$/MBC). Růžek et al. (2006) evaluated Cambisols (Inceptisols) and Luvisols (Alfisols) according to six biological criteria (MBC and five ratios: MBC/$C_{org}$, C-$K_2SO_4$/MBC, GR/BR, potential with peptone/control ammonification (PA/CA), potential with $(NH_4)_2SO_4$/control nitrification (PN/CN). Wojewoda and Russel (2003) tested the impact of shelter-belts on soil properties and microbial activity through five criteria (MBC, BR, MBC/$C_{org}$, dehydrogenase activity, PA/CA). Majority of described soil microbial parameters were closely connected with nitrogen inputs to soil (Šimon 2005, Haberle et al. 2008, Mikanová et al. 2009).

Yakovchenko and Sikora (1998) analyzed MBC using fumigation extraction (FE) method and rehydration (RHD) technique. Their results for MBC content were in the range of 110–440 mg C/kg DM (dry mass of soil) for FE and 150–570 mg C/kg DM for RHD method. Růžek et al. (2006)

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Table 1. Crops on 13 arable Luvisol, Albeluvisol, Cambisol and Stagnosol localities of Czech Republic (2001–2008)

| Crop | Proportion (%) | Fertilization |
|---|---|---|
| Winter cereals (wheat, barley) | 44 | |
| Spring cereals (barley, triticale, wheat, oats) | 22 | |
| Winter oilseed rape | 11 | |
| Maize for silage | 8 | standard, mineral and organic |
| Pea | 6 | |
| Trifolium | 6 | |
| Sugar beet | 3 | |

presented at arable and grassed Luvisols (Alfisols) for RHD method 388 ± 92 mg/kg DM and 489 ± 140 mg/kg DM for arable and grassed Cambisols (Inceptisols), respectively.

The aim of this study is the evaluation of relationship among soil organic matter and individual soil biological characteristics in three main soil taxonomical units (Cambisols, Luvisols and Stagnosols) in the Czech Republic.

## MATERIAL AND METHODS

Cambisols (58.02%), Luvisols and Albeluvisols (10.48%) and Stagnosols (9.22%) altogether cover 78% of the total area of the Czech Republic. Altitude of experimental localities ranges from 248 m (Nechanice; arable Luvisol) to 625 m (Červený Potok; grassed Cambisol). Basic characteristics are presented in Tables 1–5. The soil samples (210) were collected in the years 2001–2008 twice a year (March and October except March 2001 and October 2004) from the profile (0–200 mm) using the Eijkelkamp sampler; they were transported in the cooling box (temperature 6–12°C), adjusted, sieved (mesh 2 mm) and stored in refrigerator (4–6°C). 24 h prior to biological analyses the samples were pre-incubated at the room temperature (22 ± 2°C).

The list of the methods used for soil samples analyses:

– Texture (sand, silt, clay content, (ISO 11277) was determined by the pipette method.

– pH ($H_2O$): 25 ml of deionized water (DW) and 10 g of air-dried soil sample was shaken (15 min) and pH was determined after over night sedimentation with amplified electrode by Hanna (Czech Republic).

– Total Kjeldahl Nitrogen (TKN) – European Standard EN 13342.

– Soil organic carbon ($C_{org}$) – colorimetric determination in 600 nm (Sims and Haby 1971) after (over night) sedimentation; 1 g of air-dried soil sample was shaken with 5 ml of 0.34 mol/l $K_2Cr_2O_7$, followed by injection of 5 ml conc. $H_2SO_4$ and a digestion (25 min) in forced-air ventilation oven at 125°C. After cooling, 20 ml DW was added to this mixture. After overnight sedimentation and immediately before colorimetric C-determination a 5 ml of this mixture was repeatedly diluted by 20 ml DW.

– Humus quality (A400/A600) was determined using ratio of absorbances of soil sodium pyrophosphate extract at the wavelengths of 400 and 600 nm according to Pospíšil (1981); 1 g of air-dried soil sample was horizontally shaken (60 min; 250 rpm) with 20 ml of reagent (0.05 mol/l $Na_4P_2O_7 \cdot 10\ H_2O$ with conc. NaOH; pH = 12) at the room temperature (22 ± 2°C). Shaking (60 min; 250 rpm) was repeated after 24 h. The injection of 10 ml 0.5 mol/l $Na_2SO_4 \cdot 10\ H_2O$ and three-day sedimentation followed. Immediately before colorimetric determination 5 ml were repeatedly diluted by 20 ml of reagent.

– Microbial biomass carbon (MBC) – All soil samples were moistened according to the content of organic carbon ($C_{org}$) by DW addition (%$C_{org}$ × 0.19 ml/g DM – dry mass of soil) immediately before MBC determination.

MBC-MW is microwave irradiation method (Islam and Weil 1998; K = 21.3%) comprised colorimetric C determination at 590 nm both in microwaved soil samples (C-$K_2SO_4$-MW) and in none sterilized soil samples (C-$K_2SO_4$). Microwave soil sterilisation (800 J/g DM = 600 W, 2 × 67 s, 100 g DM (10 soil samples) were carried out in microwave oven Panasonic NE-9051. Calibration comprised pipette 0.0–1.0 ml of 0.5 mol/l $K_2SO_4$ (4.357 g $K_2SO_4$ dissolved in 50 ml DW) to '25 ml' glass beakers + 1.0–0.0 ml of sucrose solution

Table 2. Characteristic of Luvisols and Albeluvisols of Czech Republic

| Soil taxonomical unit (land use) | Locality | Sand[a] (%) > 0.063 mm | Silt[a] (%) > 0.002 mm | Clay[a] (%) < 0.002 mm | pH ($H_2O$) | $A_{400}/A_{600}$ ratio[b] | $C_{org}$[c] (%) | TKN[d] (%) | MBC[e] (MW) | MBC[e] (FE) | MBC[e] (RHD) | DHA[f] | C-$K_2SO_4$[g] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Luvisol (arable) | Filipov | 8.50 | 63.11 | 28.29 | 6.37 | 4.54 (0.40)[h] | 1.31 (0.12) | 0.15 | 155.7 (21.7) | 194.6 (38.8) | 358.8 (50.3) | 66.7 (18.2) | 21.7 (8.5) |
| Luvisol (arable) | Jarov | 13.71 | 65.38 | 20.92 | 6.30 | 6.33 (0.32) | 1.52 (0.13) | 0.19 | 215.6 (23.4) | 340.2 (75.1) | 588.0 (63.8) | 181.2 (42.3) | 27.4 (6.2) |
| Luvisol (arable) | Mostek 123 | 13.41 | 74.39 | 12.20 | 6.71 | 5.22 (0.29) | 1.28 (0.14) | 0.15 | 239.6 (37.8) | 223.5 (48.4) | 457.7 (75.2) | 149.5 (59.3) | 30.1 (13.7) |
| Luvisol (arable) | Nechanice | 23.35 | 53.11 | 23.54 | 6.92 | 6.02 (0.41) | 1.00 (0.08) | 0.12 | 137.7 (21.2) | 203.2 (39.1) | 323.6 (50.5) | 91.7 (33.8) | 21.1 (5.1) |
| Albeluvisol (arable) | Nový Dům | 20.12 | 62.73 | 17.15 | 5.78 | 6.85 (0.44) | 1.30 (0.11) | 0.14 | 233.6 (36.8) | 210.7 (70.6) | 521.4 (83.1) | 142.3 (48.6) | 31.8 (9.6) |
| Albeluvisol (arable) | Sloupnice | 16.94 | 66.06 | 17.00 | 6.86 | 7.72 (0.20) | 1.09 (0.10) | 0.13 | 203.6 (40.5) | 203.5 (37.4) | 378.9 (79.7) | 120.0 (39.0) | 23.9 (13.9) |

[a]ISO 11277; [b]ratio of absorbances of soil sodium pyrophosphate extract at the wavelengths of 400 and 600 nm as the indicator of humus quality; [c]colorimetrically; [d]TKN – total Kjeldahl nitrogen (European Standard EN 13342); [e]MBC – microbial biomass carbon (mg C/kg DM); DM – dry mass of soil; MW – microwave irradiation method; FE – fumigation extraction method; RHD – re-hydration technique; [f]DHA – dehydrogenase activity (mg TPF/kg DM/24 h); [g]C-$K_2SO_4$ – 0.5 mol/l $K_2SO_4$ extractable carbon (mg C/kg DM); [h]Standard Deviation; TPF – triphenylformazan

Table 3. Characteristics of Cambisols of Czech Republic

| Soil taxonomical unit (land use) | Locality | Sand[a] (%) > 0.063 mm | Silt[a] (%) > 0.002 mm | Clay[a] (%) < 0.002 mm | pH ($H_2O$) | $A_{400}/A_{600}$ ratio[b] | $C_{org}$[c] (%) | TKN[d] (%) | MBC[e] (MW) | MBC[e] (FE) | MBC[e] (RHD) | DHA[f] | C-$K_2SO_4$[g] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cambisol (grassed) | Červený Potok | 26.41 | 61.33 | 12.27 | 6.13 | 7.38 (0.32)[h] | 1.73 (0.12) | 0.20 | 329.4 (81.9) | 359.9 (115.0) | 765.0 (198.2) | 341.5 (151.9) | 38.8 (11.8) |
| Cambisol (arable) | Hradec n. Svitavou | 45.29 | 39.09 | 15.62 | 6.68 | 6.47 (0.37) | 0.96 (0.09) | 0.11 | 119.8 (15.9) | 173.5 (28.8) | 339.6 (45.6) | 127.5 (31.7) | 27.0 (9.8) |
| Cambisol (arable) | Maskovice | 32.21 | 44.03 | 23.76 | 6.52 | 7.18 (0.99) | 0.97 (0.11) | 0.11 | 131.8 (25.3) | 233.0 (40.2) | 334.1 (65.4) | 157.6 (42.8) | 22.9 (10.3) |
| Cambisol (arable) | Zderaz | 29.18 | 52.73 | 18.09 | 6.48 | 6.31 (0.26) | 1.30 (0.14) | 0.16 | 239.6 (36.5) | 222.1 (33.1) | 507.3 (82.6) | 71.6 (38.6) | 25.5 (8.2) |

[a]ISO 11277; [b]ratio of absorbances of soil sodium pyrophosphate extract at the wavelengths of 400 and 600 nm as the indicator of humus quality; [c]colorimetrically; [d]TKN – total Kjeldahl nitrogen (European Standard EN 13342); [e]MBC – microbial biomass carbon (mg C/kg DM); DM – dry mass of soil; MW – microwave irradiation method; FE – fumigation extraction method; RHD – re-hydration technique; [f]DHA – dehydrogenase activity (mg TPF/kg DM/24 h); [g]C-$K_2SO_4$ – 0.5 mol/l $K_2SO_4$ extractable carbon (mg C/kg DM); [h]Standard Deviation; TPF – triphenylformazan

Table 4. Characteristics of Luvic and Cambic Stagnosols of Czech Republic

| Soil taxonomical unit (land use) | Locality | Sand[a] (%) > 0.063 mm | Silt[a] (%) > 0.002 mm | Clay[a] (%) < 0.002 mm | pH ($H_2O$) | $A_{400}/A_{600}$ ratio[b] | $C_{org}$ [c] (%) | TKN[d] (%) | MBC[e] (MW) | MBC[e] (FE) | MBC[e] (RHD) | DHA[f] | C-$K_2SO_4$[g] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Luvic Stagnosol (arable) | Horšov | 36.05 | 41.61 | 22.34 | 7.02 | 7.92 (0.66)[h] | 1.19 (0.11) | 0.12 | 113.8 (17.7) | 206.0 (39.8) | 333.3 (52.5) | 111.9 (38.1) | 23.1 (5.4) |
| Luvic Stagnosol (arable) | Mostek 140 | 26.99 | 56.52 | 16.49 | 5.80 | 8.39 (0.70) | 1.12 (0.11) | 0.13 | 191.6 (35.3) | 200.5 (37.5) | 424.8 (84.0) | 129.1 (28.9) | 22.7 (15.1) |
| Luvic Stagnosol (arable) | Spytice | 9.60 | 65.85 | 24.54 | 6.38 | 6.80 (0.53) | 1.27 (0.16) | 0.15 | 269.5 (25.4) | 264.8 (46.7) | 484.1 (46.3) | 110.6 (43.4) | 22.0 (8.6) |
| Cambic Stagnosol (arable) | Červená Voda 7443 | 16.51 | 68.76 | 14.73 | 6.73 | 7.31 (0.31) | 1.47 (0.14) | 0.16 | 173.7 (30.3) | 241.1 (47.2) | 504.3 (91.4) | 167.6 (49.0) | 23.9 (9.5) |
| Cambic Stagnosol (grassed) | Červená Voda 7449 | 16.56 | 67.57 | 15.87 | 5.52 | 6.09 (0.23) | 1.86 (0.14) | 0.19 | 311.4 (59.7) | 324.5 (82.4) | 649.4 (130.7) | 229.0 (100.4) | 24.6 (11.8) |

[a]ISO 11277; [b]ratio of absorbances of soil sodium pyrophosphate extract at the wavelengths of 400 and 600 nm as the indicator of humus quality; [c]colorimetrically; [d]TKN – total Kjeldahl nitrogen (European Standard EN 13342); [e]MBC – microbial biomass carbon (mg C/kg DM); DM – dry mass of soil; MW – microwave irradiation method; FE – fumigation extraction method; RHD – re-hydration technique; [f]DHA – dehydrogenase activity (mg TPF/kg DM/24 h); [g]C-$K_2SO_4$ – 0.5 mol/l $K_2SO_4$ extractable carbon (mg C/kg DM); [h]Standard Deviation; TPF – triphenylformazan

(29.686 mg $C_{12}H_{22}O_{11}$ p.a. dissolved in 50 ml DW) + 12 × 1 ml of mixture (M): 400 mg $K_2Cr_2O_7$ in 10 ml DW, 50 ml conc. $H_2SO_4$ and 20 ml conc. $H_3PO_4$. Afterwards, microwave digestion followed dilution with 10 ml DW and colorimetric C determination at 590 nm.

MBC-FE is fumigation extraction method (K = 37.8%) by Vance et al. (1987);

MBC-RHD is re-hydration technique (Blagodatskiy et al. 1987), 64°C (forced-air ventilation oven) and 24 h (K = 25.0%) with colorimetric C determination at 590 nm.

– Extractable (available) organic carbon has been extracted by 0.5 mol/l $K_2SO_4$ (Vance et al. 1987) from fresh and moistened soil samples both from none sterilized (C-$K_2SO_4$) and microwaved 2 × 67 s (C-$K_2SO_4$-MW), 24 h fumigated (C-$K_2SO_4$-FE) and 24 h heated at 64°C (C-$K_2SO_4$-RHD). In all cases 10 g DM was inserted into 50 ml polypropylene DigiTUBEs vials (SCP SCIENCE), moistened by DW (%$C_{org}$ × 0.19 ml/g DM) and horizontally shaken (60 min; 250 rpm) with 20 ml of reagent at the room temperature (22 ± 2°C). Than followed sedimentation (a few minutes), centrifugation (2 ml, 3 min; 14 000 rpm), microwave soil extracts digestion (800 J/ml = 250 W, 77 s, 24 ml) in the M (soil extract (1 ml) and M (1 ml)) were carried out in microwave oven Panasonic NE-9051. After microwave digestion soil extracts were diluted with 10 ml DW before colorimetric C determination (spectrophotometer SPEKOL 221) using equation:

μg C = 0.6378 × absorbance – 0.192).

– Total carbon (TC) was determined by Vario MAX CNS analyzer (ELEMENTAR).

– Total nitrogen (TN) was determined by Vario MAX CNS analyzer (ELEMENTAR).

– Dehydrogenase activity (DHA) was determined by Öhlinger (1995).

Following characteristics were calculated:

MBC-MW = (C-$K_2SO_4$-MW – C-$K_2SO_4$)/0.213 (Islam and Weil 1998);

MBC-FE = (C-$K_2SO_4$-FE – C-$K_2SO_4$)/0.378 (Vance et al. 1987);

MBC-RHD = (C-$K_2SO_4$-RHD – C-$K_2SO_4$)/0.250 (Blagodatskiy et al. 1987);

($MBC/C_{org}$) × 100;

(C-$K_2SO_4$/MBC) × 100.

Statistical evaluation and correlations were computed by the Statgraphic Centurion XV software.

## RESULTS AND DISCUSSION

**Microbial biomass carbon**. MBC was determined by three method (MW, FE and RHD) in main soil

Table 5. Characteristics of main soil taxonomical units of Czech Republic

| Soil taxonomical unit | MBC-MW[a,b] 100% | MBC-FE[a,c] 116% | MBC-RHD[a,d] 235% | DHA[e] | TC[f,h] (%) | TN[g,h] (%) | A400/A600 ratio[i] |
|---|---|---|---|---|---|---|---|
| Luvisols and Albeluvisols | 197.6 (41.8)[j] | 223.3 (68.3) | 445.8 (113.7) | 125.2 (41.4) | 1.34 (0.26) | 0.15 (0.02) | 6.11 (1.10) |
| Cambisols | 205.1 (98.8) | 243.1 (91.4) | 505.6 (222.6) | 174.6 (112.8) | 1.32 (0.42) | 0.15 (0.04) | 6.84 (0.70) |
| Luvic and Cambic Stagnosols | 212.0 (78.6) | 246.0 (70.2) | 495.8 (145.4) | 149.6 (50.0) | 1.42 (0.38) | 0.16 (0.03) | 7.30 (0.91) |

[a]MBC – microbial biomass carbon (mg C/kg DM); DM – dry mass of soil; [b]MW – microwave irradiation method; [c]FE – fumigation extraction method; [d]RHD – re-hydration technique; [e]DHA – dehydrogenase activity (mg TPF/kg DM/24 h); TPF – triphenylformazan; [f]TC – total carbon; [g]TN – total nitrogen; [h]vario MAX CNS analyzer (ELE MENTAR); [i]ratio of absorbances of soil sodium pyrophosphate extract at the wavelengths of 400 and 600 nm as the indicator of humus quality; [j]Standard Deviation

taxonomical units of the Czech Republic (Tables 2 to 5) in the profile of 0–200 mm. MW values (Islam and Weil 1998; K = 21.3%) varied from 113.8 to 329.4 mg C/kg DM, RHD values (Blagodatskiy et al. 1987; K = 25.0%) from 208.6 to 1103.9 mg C/kg DM and FE values (Vance et al. 1987; K = 37.8%) from 112.9 to 522.2 mg C/kg DM respectively. Among the methods (MW, FE and RHD) a significant correlation was found, the strongest ($r$ = 0.8965; Table 6) was confirmed between MW and RHD methods. Vance et al. (1987), during the verification of their new method, found at Broadbalk Continuous Wheat Experiment values of 551 mg C/kg by fumigation-incubation (FI) method (K = 45.0%) and 396 mg C/kg by new FE method (K = 37.8%), both in alkaline soil (pH 7.6). Kiem and Kandeler (1997) studied MBC using FE method on 35 locations where Chernozems predominated (12), and Cambisols (5) and Anthroposols (5) were also represented. After eliminating results of two extreme locations, they reached a very similar result of 128–515 mg C/kg.

The strongest highly significant correlation was found for TN and MBC-FE ($r$ = 0.8551; $n$ = 210; Table 6). Generally, a strong significant relationship exists among DHA and MBC (MW, FE and RHD); the strongest correlation was found between DHA and MBC-FE ($r$ = 0.8062; $n$ = 210; Table 6).

**Soil organic carbon**. $C_{org}$ provides us with basic information (Table 2–4) on the supply of non-humic and humic substances ($C_{org}$ × 1.724), thus also on potential energy sources for microbial communities. It is an extraordinarily stable criterion, which shows year-on-year non-measurable variation on soils without human interference. A better look at the level and degree of condensation of soil organic matter is given by parallel determination of the quality of extractable hu-

Table 6. Correlation in Luvisols, Albeluvisols, Cambisols, Luvic and Cambic Stagnosols of Czech Republic

| | TKN | $C_{org}$ | TN | TC | DHA | MBC-RHD | MBC-FE | MBC-MW |
|---|---|---|---|---|---|---|---|---|
| MBC-MW[a,b] | 0.8362*** | 0.7856*** | 0.8239*** | 0.7445** | 0.6161* | 0.8965*** | 0.7543** | x |
| MBC-FE[a,c] | 0.8830*** | 0.8476*** | 0.8749*** | 0.8235*** | 0.8094*** | 0.8694*** | x | |
| MBC-RHD[a,d] | 0.9305*** | 0.9025*** | 0.9039*** | 0.8768*** | 0.7929*** | x | | |
| DHA[e] | 0.6635** | 0.6916** | 0.6455** | 0.6767** | x | | | |
| TC [f,h] | 0.9400*** | 0.9869*** | 0.9713*** | x | | | | |
| TN[g,h] | 0.9795*** | 0.9758*** | x | | | | | |
| $C_{org}$ [i] | 0.9416*** | x | | | | | | |
| TKN[j] | x | | | | | | | |

Correlation: ***$P$ < 0.001; **$P$ < 0.01; *$P$ < 0.05. [a]MBC – microbial biomass carbon (mg C/kg DM); DM – dry mass of soil; [b]MW – microwave irradiation method; [c]FE – fumigation extraction method; [d]RHD – re-hydration technique; [e]DHA – dehydrogenase activity (mg TPF/kg DM/24 h); TPF – triphenylformazan; [f]TC – total carbon; [g]TN – total nitrogen; [h]vario MAX CNS analyzer (ELEMENTAR); [i]colorimetrically; [j]TKN – total Kjeldahl nitrogen (European Standard EN 13342)

mic compounds – ratio of absorbances of soil sodium pyrophosphate extract at the wavelengths of 400 and 600 nm (A400/A600 nm; Tables 2 to 5). The lowest value (high quality) is typical for Luvisols and Albeluvisols (6.11 ± 1.10) and there is a highly significant difference (ANOVA; Scheffe's Test) from Cambisols (6.84 ± 0.70) and Stagnosols (7.30 ± 0.91). A ratio $C_{humic\ acids}/C_{fulvic\ acids}$ is a next suitable criterion. The highest level of $C_{org}$ (1.67 ± 0.25) is typical for Cambic Stagnosols and the lowest one for Albeluvisols (1.19 ± 0.15). Růžek et al. (2006) presented very similar values of $C_{org}$ – for Cambic Stagnosols 1.54 ± 0.37 and for Albeluvisols 1.03 ± 0.15.

**Ratio C-$K_2SO_4$/MBC**. Biomass specific available organic carbon (ratio C-$K_2SO_4$/MBC; Hofman and Dušek 2003) is another criterion for the evaluation of microbial associations in soil (Růžek et al. 2006). This ratio maps a C-$K_2SO_4$ accumulation out of the microbial cells against carbon immobilization into microbial cells. In other words, it maps the ability of soil microbial communities to utilize their own extracellular metabolites. A complex microbial community (that is not exposed to the stress) uses these trophically valuable and unstable substances C-$K_2SO_4$ and so maintains their level low. Růžek et al. (2006) present the lowest values of this ratio (6.5 ± 2.6) for Cambic Stagnosols and the highest values (15.2 ± 6.4) for Regosols. In this study the lowest values (4.1 ± 2.1) characterize Cambic Stagnosols and the highest values (6.2 ± 5.1) characterize Albeluvisols.

**Ratio MBC-RHD/$C_{org}$**. Ratio expresses portion of the metabolic active carbon (immobilized in living microbial cells) in the carbon of soil organic matter. Several authors indicate this output as a more important characteristic of soil biological status than solitary MBC. Usual level for arable soils is 2.5–3% (Insam and Domsch 1988). Our results are higher: the lowest one at Luvisols 3.3 ± 0.8%, Cambic Stagnosols 3.4 ± 0.8%, Luvic Stagnosols 3.4 ± 0.9%, Albeluvisols 3.7 ± 0.9% and the highest at Cambisols 3.8 ± 1.1%. Růžek et al. (2006) present the lowest values for Chernozems (3.0 ± 0.7%) and the highest ones for Albeluvisols (4.4 ± 0.8%).

**Ratio TC/TN**. Ratio TC/TN belongs among often used soil characteristics with high stability. There is no difference among arable Cambisols (8.65 ± 0.74), Stagnosols (8.77 ± 0.98) and Luvisols (8.87 ± 0.81). We determined a highly significant difference between arable soils (8.79) and grassed soils (9.51).

**Dehydrogenase activity (DHA)**. Mikanová et al. (2006) studied dehydrogenase activity of soil with conventional and protective tillage. The highest dehydrogenase activity (1500 μg TPF/100 ml = 250 mg TPF/kg) was found at protective tillage with pea crop residues and the lowest values at conventional tillage (1050 μg TPF/100 ml = 175 mg TPF/kg). In this study, the highest values were determined in Cambic Stagnosols (198.3 ± 83.5 mg TPF/kg DM/24 h) and the lowest ones in Luvic Stagnosols (117.2 ± 37.3 mg TPF/kg DM/24 h). The correlation coefficients between MBC and dehydrogenase activity are presented in Table 6. The high significant correlation ($r$ = 0.8094) was found only between DHA and MBC-FE. Dedourge et al. (2004) informed about significant correlation between dehydrogenase activity and MBC in Cambisols, Luvisols and Stagnosols too. Also other authors described the links between enzyme activities and MBC depending on soil treatment, indicating differences in microbial community composition.

**Total Kjeldahl nitrogen (TKN)**. Content of TKN roughly corresponded with one tenth of the $C_{org}$ (Table 2–4). Ratio $C_{org}$ /TKN (6–8) is typical for soils in 47% of the total area of Czech Republic (Růžek et al. 2006). It is a basic chemical parameter that is in a direct connection with the results of mentioned biological parameters. TKN proved to be in a high significant correlation with several biological parameters (Table 6), for instance with MBC-RHD ($r$ = 0.9305), MBC-FE ($r$ = 8830) and MBC-MW ($r$ = 0.8362). This high significant correlation is stronger in comparison with $C_{org}$ and stressed out the high informative value of TKN.

Newly adopted MW method for microbial biomass carbon determination in absolute data is much closer to widely used FE method with acceptable correlation coefficient (0.7543; Table 6). It means that it can substitute FE method, especially to exclude the use of chloroform. The aim of article to give the information on chemical and microbiological parameters of some typical arable and grassed soils in the Czech Republic was reached. Two grassed localities (Tables 3 and 4) were characterized with higher chemical and biological characteristics ($C_{org}$, TKN, MBC-all three methods and DHA). To have more complex data about these important soil units in the Czech Republic the monitoring will continue.

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