3. Preparation of Samples

3.2 Dry matter and dry matter density

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For soils, percentage of dry matter is only determined, if for specific analyses, e.g. enzyme activity, weigh-in of wet matter is necessary. Otherwise, soil samples are air-dried or dried in an oven at 40 or 60 °C to accelerate drying.

For sediments, the elemental concentrations per dry matter are often only determined. However, it is recommended to note water and dry matter content as well as dry matter density for each sample and add them to elemental analyses. Thereby, different reference values can be selected.

A complete air-drying has to be done in a desiccator, as otherwise residual water would remain in the material depending on humidity. All dried or ashed samples have to cool down in the desiccator before weigh-out (Tab. 3.2-1).

Table 3.2-1 Overview of temperatures, applied for drying of samples

Dry matter		
Temperature °C	**Degree of Dryness**	**Material**
Lyophilisation		if sensitive organic compounds or P fractions have to be measured
ca. 20		soil
40 (60)		
60		seston
90		plant biomass
105	without crystal water	sediment

Protocol

- Empty mass[1] of crucible made of porcelain or aluminium trays, if they are further annealed
- *Permanent labelling*
  - Apply liquid cobalt salt solution (e.g. Co-nitrate) or Fe(III)-chloride with sharpened thin wood sticks (toothpick, shashlik skewer) on the crucible base and let dry.
  - Annealing at 550 °C; permanent black or rusty brown labels develop (Fig. 3.2-1 to 3.2-3).
- Weigh in some g of sediment in 1-4 crucibles or trays each.
- Weigh in dabbed biomass (estimation of amount in tab. 3.2-2).
- Following masses are noted: crucible empty, crucible with wet mass and crucible with dry mass
- Place crucibles for 10 - 16 hours (at listed temperature, tab. 3.2-1) in the drying oven
- Cool down in desiccator and weigh
- Before calculation of water content, calculate all masses without crucible mass (equation A and B)!
- In case of standard error > 5 % for water content: repeat determination.
- Minimum masses of ashes should not be lower than 1 g for sediments and 100 mg for tissue, to make sure that possible contamination or losses only have minimal effects on results (light ash flakes).

Fig. 3.2-1 Black labelling – often runny and barely readable

Fig. 3.2-2 rusty brown labelling – better readable

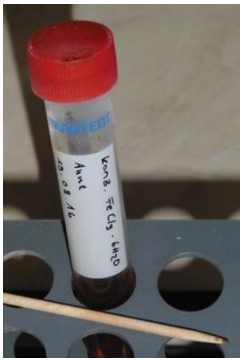

Fig. 3.2-3 solution of salt for labelling

[1] Mass or weight: All data in gram refer to the mass. This mass is also measured as weight force. For this reason, outside physics the mass is also called weight. Weight force can be calculated as a product from mass with gravity acceleration. However, the mass is an absolute physical measurand. Therefore, mass is the exact term.

Fig. 3.2-4 Sediment dry mass in porcelain crucibles from determination of dry matter density (miniature sedimentcore) and weighed in for determination of loss of ignition

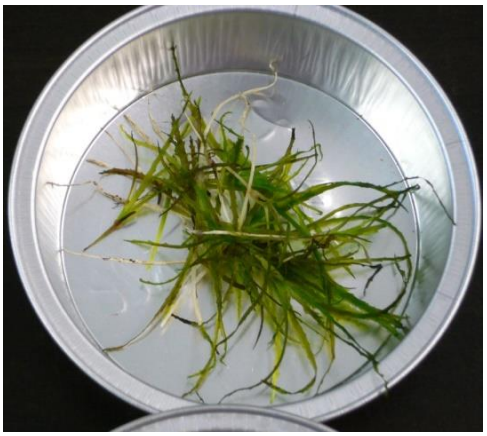

Fig. 3.2-5 Young plants of naiad (*Najas* spec.) in aluminium trays weighed in for drying

Fig. 3.2-6 Large dry matter in aluminium foil packed for ashing

Table 3.2-2 Common weigh-ins of wet mass for drying of material and for dry matter (DM) or ashes for determination of P concentration (at least 4 replicates)

	Drying		Digestion	
	Wet matter weigh-in (ca. g)	**Dry matter percentage (%)**	**Weigh-in per replicate (mg)**	**Volume of extract of digestion (ml)**
mineral soils	10	> 90	< 500 DM	50-100[3]
organic rich dry matter			100-200 DM	50-100[3]
sediment	3	20-90	50-100 Ash	10-15[2]
algae	1-2	10-30	3 Ash	10-15[2]
plants			< 10 DM	50-100[3]
animal tissues			< 10 DM	50-100[3]
bone char			< 50	50-100[3]

[2] Subboiling digestion
[3] Microwave Mars Xpress

Equation 3.2-1 Calculation of percentage of dry matter in % of wet matter

$$DMC = \frac{DM \times 100\ \%}{WM}$$

WM wet mass (g or mg without crucible mass)
DM dry matter (g or mg without crucible mass)
DMC dry matter content (%)

Synonyms for dry matter percentages are percentages of dry substances or suspended (filterable) material.

Equation 3.2-2 Calculation of water content in % of wet matter

$$WC = 100\ \% - DMC$$

WC Water content (%)

In contrast to density the dry matter density is calculated by dry matter and not by wet matter and volume (equation C). Very different water contents of sediments have a large influence on dry matter density (Fig. 2.2-1 and 3.2-8).

Fig. 3.2-7 As miniature-sampling tube prepared 20 ml syringe.

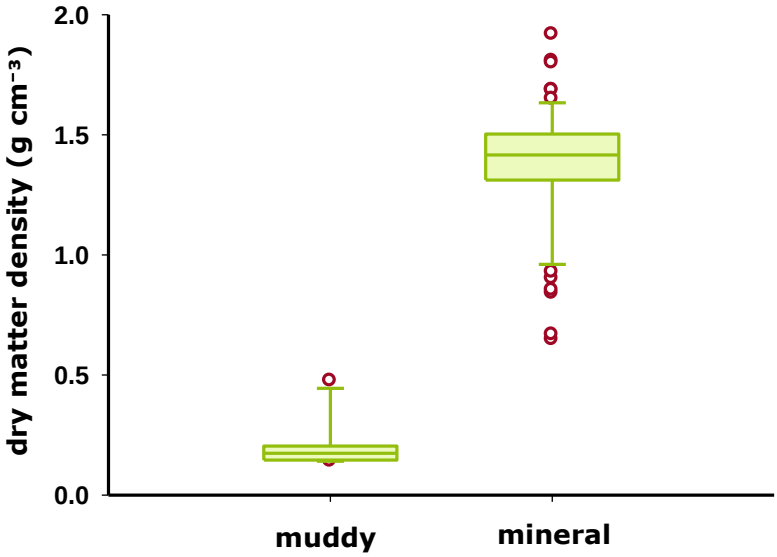

Fig. 3.2-8 Dry matter density of muddy (> 5 % loss of ignition, n = 11) and mineral sediments (< 5% loss of ignition, n = 65)

Protocol

- Take sediment sample with sampling tube (or box corer) as big as possible.
- Keep surface as undisturbed as possible.
- Push the sediment upward with a plunger until the overlaying water is drained.
- Prepare the syringe (Fig. 3.2-7)
  - Cut front side by scalpel
  - Mark 1 cm around
  - The volume of a 20 ml syringe (inner diameter 1,9 cm) is than 2,8 cm^3
- draw up syringe plunger to 1,5 - 2 cm
- prick syringe around 1 cm into sediment and pull out. In doing so, build up negative pressure with plunger.
- Press out sediment sample up to 1 cm, push away supernatant (horizon < 1 cm) with spatula (Fig. 3.2-4).
- Transfer punched sample completely into crucible, weigh wet matter, dry (see above) and determine dry matter.

Equation 3.2-3 Calculation of dry matter density in g DM cm^{-3}

$$DMD = \frac{DM}{V}$$

$$DMD = \frac{Cr_{out} - Cr_{empty}}{V} = \frac{27.389 - 21.367}{2.84} = 2.12$$

DMD dry matter density (g cm^{-3})
DM dry matter without crucible weigh (g)
V volume (cm^3)
Cr_{out} crucible weigh out after drying (g)
Cr_{empty} crucible empty mass (g)
with calculation example

Reference

Schlungbaum G (1979) Untersuchungen über die Sedimentqualität in den Gewässern der Darß- Zingster Boddenküste unter besonderer Berücksichtigung der Stoffaustauschprozesse zwischen Wasser und Sediment. Postdoctoral Thesis, University of Rostock

For citation: Zimmer D, Schumann R (*year of download*) Chapter 3.2 Dry matter and dry matter density (Version 1.1) in Zimmer D, Baumann K, Berthold M, Schumann R: Handbook on the Selection of Methods for Digestion and Determination of Total Phosphorus in Environmental Samples. DOI: 10.12754/misc-2020-0001