Selected physical parameters and daily volume of silver birch sap collected from the cardinal directions of the tree trunk

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Potential of non-wood forest products?

- Growing fashion for a healthy lifestyle;
- the search for natural products coming from the least contaminated ecosystems;
- searching sources of income from forest management another than wood - one of the priorities mentioned by the European Union in the New Forest Strategy [Komunikat... 2013].

Use of birch sap - history

- Birch sap was used in Scandinavian countries, middle-eastern Europe, Balkans or Asia [Berg 1933; Sõukand 2015].
- In the Middle ages it was used in many countries as a fresh or fermented drink as well as in medicine and cosmetology [Gunda 1987; Haberland 1926; Kostroň 1974; Manninen 1931].
- Birch sap was boiled with rye flour and milk [Dekowski 1973] or evaporated to syrup consistency and use it to sweeten food [Chętnik 1936].
- In Poland in 1960s and 1970s around 30 - 50 tons a year of birch sap was obtained [Grochowski, 1990]; in Ukraine - around 3.000 tons a year [Orłow 1974].

Why birch sap?

- Birch sap is one of the most promising non-wood forest resources in Central Europe, with a very wide range of practical uses, including in the food and cosmetics industry [Zyryanova et al. 2010, Beck et al. 2016, Enescu 2017].

- Estonian research from 1970s reports, that the profit from selling birch sap is 6 time higher than profit from wood selling from the same forest area [Silm 1977].

- Grochowski [1990] and Kostroň [1974] state that the value of birch sap, which can be collected in 10 consecutive years, might be 18 times higher than the value of timber sales harvested from the same stand over the same time.

Aim of the study

- How the daily volume of collected silver birch sap and selected physical parameters of the sap change depending on the location of the boreholes in the tree trunk in relation to the cardinal directions (N-E-S-W).

Methods

- Sap was collected:
  - on April 2018 in Lubartów Forest District (eastern part of Poland);
  - in fresh broadleaved forest habitat;
  - in a stand with a dominant share of silver birch (*Betula pendula* Roth) trees of age approx. 100 years.
- The Hartig's method was used to designate 6 sample trees representing the stand *(method based on taking trees ordered by increasing DBH and categorizing them into three classes of the same cross-sectional area)*.

https://www.google.com/maps

Methods

- In every of the 6 selected trees, 4 holes were drilled at a height of 1 m, positioned according to the cardinal directions (N-E-S-W);
- sap was collected twice, one week apart, always after 24 hours of leak;
- samples for further testing were immediately frozen;
- all parameters (except daily leak volume) were measured in triplicate and then averages were calculated.

Photo: J. Misiurski

What physical parameters we tested?

- Electrolytic conductivity *(proving, among others, the content of pro-health mineral compounds)*;
- refractometric index *(proving the approximate content of sugar what is important for taste values)*;
- pH value *(corresponding to, inter alia, organic acid content)*;
- the percent of dry matter *(corresponding to, inter alia, the sugars content)*.

Equipment used for determination of physical properties

- electrolytic conductivity;
- pH value;

Conductometer and pH-meter HI 9811-5, HANNA
(https://hanna-polska.com)

Equipment used for determination of physical properties

- refractometric index

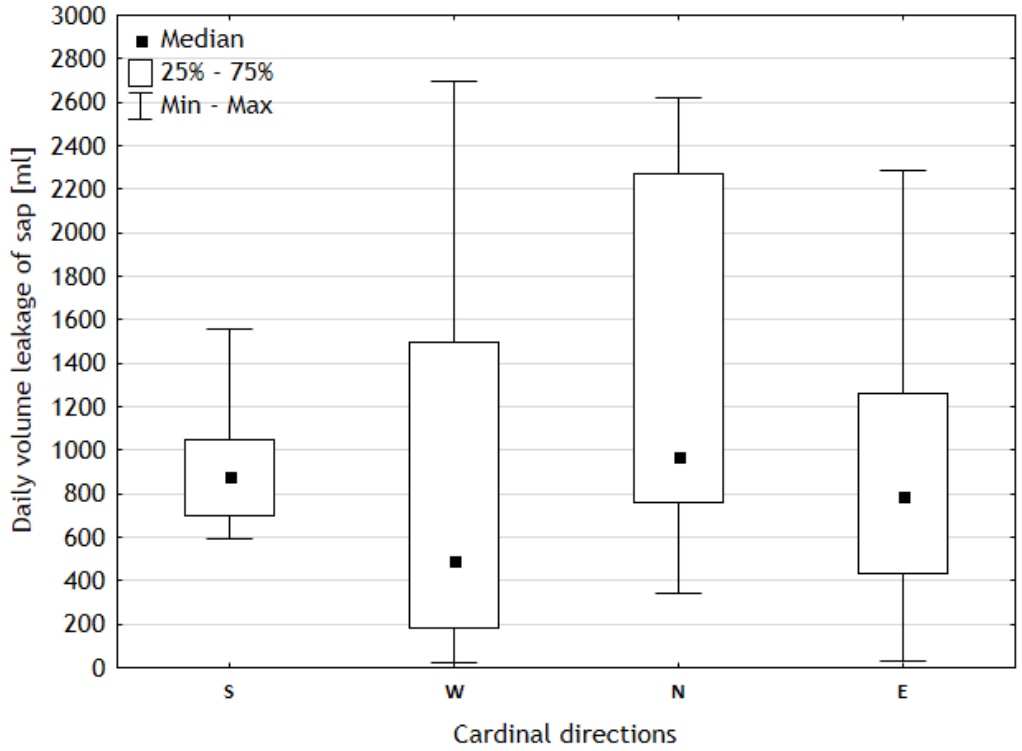
Refractometer HI 96801, HANNA
(https://hanna-polska.com)

Statistical analysis

- The impact of the location of the boreholes on the trunk (the cardinal direction) on daily leak volume, refractometric index, pH value, electrolytic conductivity and percentage of dry matter was checked using the Friedman test (Friedman One-Way Repeated Measure Analysis of Variance by Ranks).
- The multiple pairwise-comparison procedures were carried out with the use of Dunn's post-hoc test, investigating the significant differences in the mean values of the examined features (physical parameters of birch sap) for all combinations of pairs of the independent variable (cardinal directions).
- The relationship between various physical parameters of birch sap was investigated using the Spearman's rank correlation coefficient.

Results

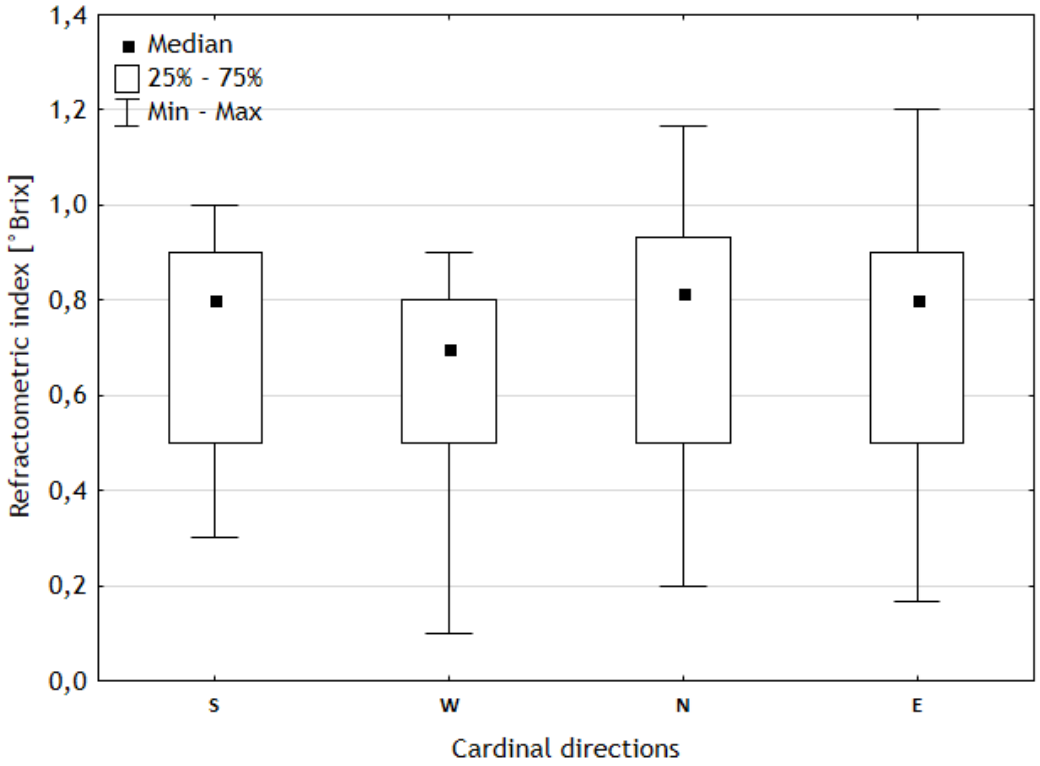
1. How the daily volume of sap change depending on the location of the holes in relation to the cardinal directions?



- A total amount of 49.281 dm^3 of birch sap was obtained (N - 16.766 dm^3, S - 10.970 dm^3, W - 10.567 dm^3, E - 10.978 dm^3).
- **No statistical significance** was found between the cardinal direction from which the sap was collected and the daily sap volume ($p = 0.334$), despite the observed differences in the volume of sap obtained.

Results

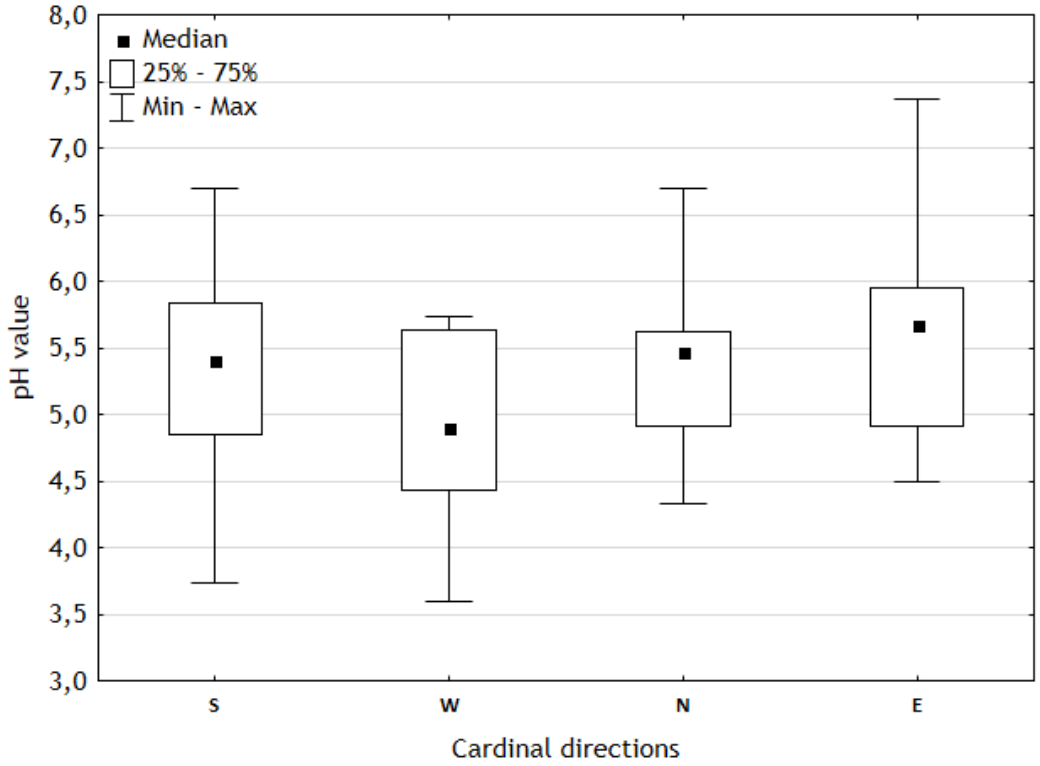
2. How the refractometric index change depending on the location of the holes in relation to the cardinal directions?



- **No statistical significance** was found between the cardinal direction from which the sap was collected and refractometric index (p=0.233).

Results

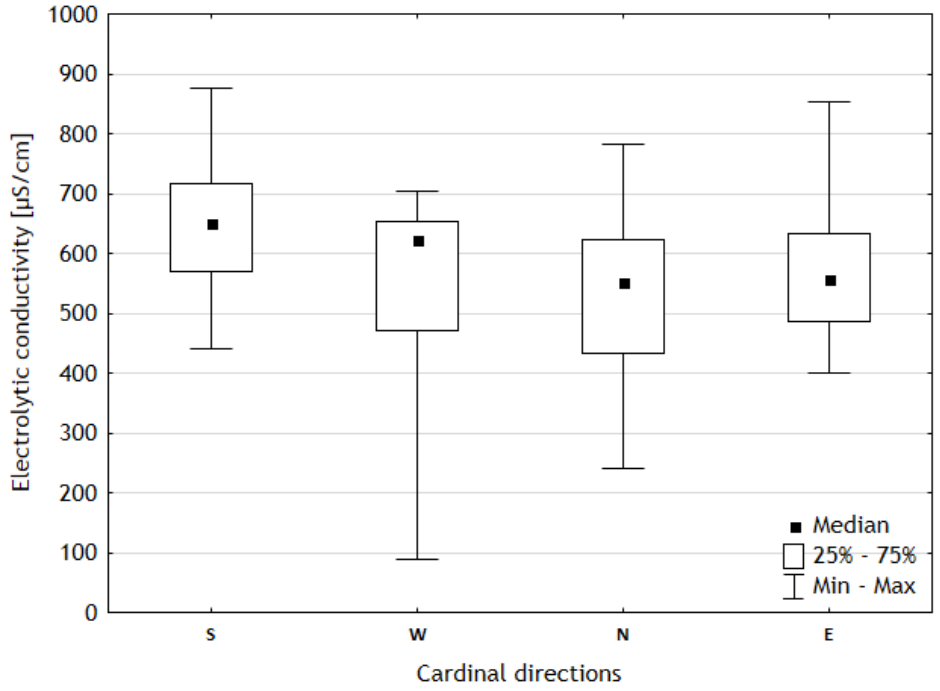
3. How the birch sap pH value change depending on the location of the holes in relation to the cardinal directions?



- **No statistical significance** was found between the cardinal direction from which the sap was collected and pH index (p=0.341).

Results

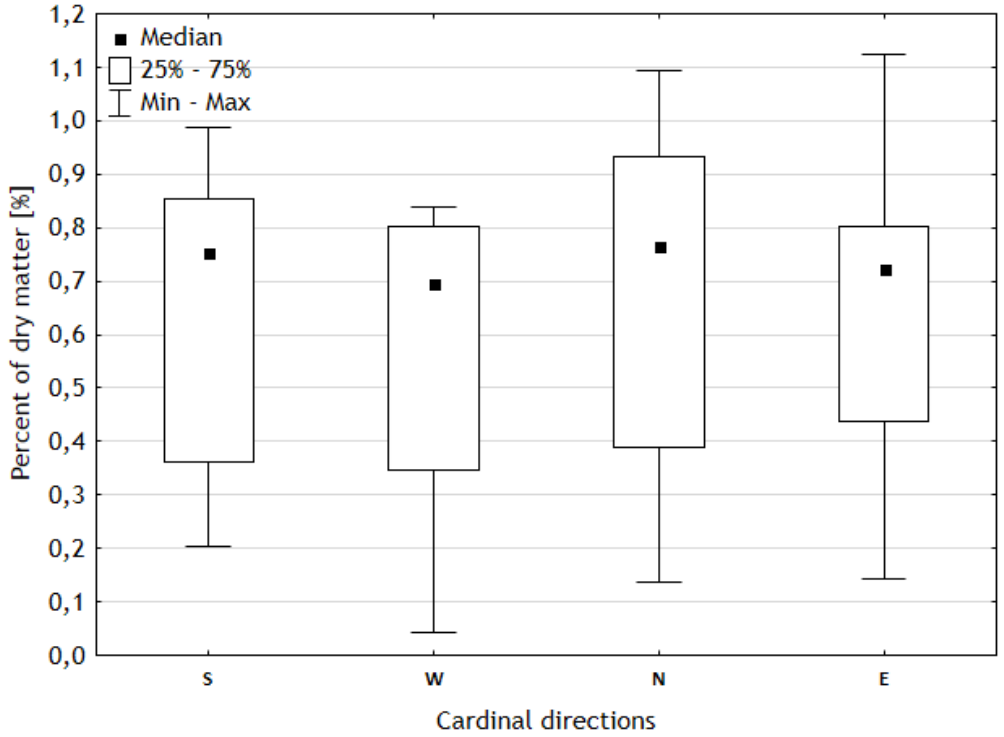
4. How the electrolytic conductivity change depending on the location of the holes in relation to the cardinal directions?



- **Statistical significance** was found between the cardinal direction from which the sap was collected and electrolytic conductivity (p=0.025).
- The arrangement of homogeneous groups showed two homogeneous groups and statistical differences exist between the N and S directions.

Results

5. How the percent of dry matter change in birch sap depending on the location of the holes in relation to the cardinal directions?



- **No statistical significance** was found between the cardinal direction from which the sap was collected and the percent of dry matter (p=0.873).

Results

- Correlation was found between:
  - the refractometric index and pH value (r=0.6350);
  - the refractometric index and electrolytic conductivity (r=0.3760);
  - the refractometric index and the percentage of dry matter (r=0.9588);
  - the percentage of dry matter and pH value (r=0.6499);
  - the percentage of dry matter and electrolytic conductivity (r=0.3096).

Conclusions

- The location of boreholes in the tree trunk in relation to the cardinal directions (N-E-S-W) does not affect the efficiency of the birch sap leak intensity.

- The location of boreholes in the tree trunk in relation to the cardinal directions has no influence on physical sap properties such as: refraction, pH value and percentage of dry matter; however, a slight effect on the electrolytic conductivity was found. Therefore it can be summarized that the cardinal directions does not affect the usefulness of the sap for the production of birch syrup, but may affect a nutritional value. To confirm it, research using instrumental analysis techniques must be applied, because not only the minerals content, but also organic acids and inorganic anions can affect the electrolytic conductivity.

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