Interreg Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

NovelBaltic

Traceability and Authentication of Natural products

NovelBaltic project
Emmi Alakärppä, University of Oulu

Webinar 10th June 2020

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Why traceability and authentication are important?

- Food fraud happens for financial gain, especially with products of high price
- Food fraud can be a significant risk for public health and may destabilize consumers' confidence towards food products
- A growing number of food fraud cases have been reported today because of the complex and globalized food supply chains, which offer a greater possibility for fraud across them (McGrath et al. 2018)
- Some of the most recent food adulteration incidents:
  - Chinese milk scandal in 2008 affected more than 300 000 infants
  - Horsemeat scandal in 2013 in Europe had considerable economic impacts and impacted consumers' confidence towards the meat industry

Why traceability and authentication are important?

- Natural products are highly valued, and thus they are also linked to a high risk of adulteration
- Besides safety issues, the use of indications on origin and product traceability may tell of product quality and can allow producers to sell their products at premium price

Food fraud

- Different types of food fraud

Four criteria of food fraud:

- Violation of EU rules
- Deception of customers
- Undue advantage
- Intention

https://ec.europa.eu/food/safety/food-fraud/what-does-it-mean_en

Traceability

- EU General Food Law defines traceability as **the ability to trace and follow food, feed, and ingredients through all stages of production, processing, and distribution** (EU 2002)
- Additional cues, such as the “Hyvää Suomesta” (good from Finland) and “NYT Norge” (enjoy Norway) labels have been devised in order to inform consumers that raw materials are of certain origin

Traceability review of natural products

Background

- We studied what happens in the early stages, how the material is marked, and whether the information on exact origin is retained all the way till the end products.
- The review forms a basis for the development of authenticity methodology in the NovelBaltic project
- Information was gathered from a total of 19 enterprises :
  - 9 from Finland, 5 from Latvia, 2 from Lithuania, and 3 from Norway (micro/small enterprises, also a few medium-sized enterprises)
  - companies deal mostly with wild berries, but also with herbaceous species and material harvested from trees, and mushrooms

Traceability review

Results

Raw material acquisition:	Own collection	32 %
	Supplied	68 %
Batch no. for raw material origin:	Yes	74 %
	No	26 %
Traceability level:	Exact location	42 %
	Municipality	42 %
	Country	16 %
Origin information on packaging	Country	58 %
	Local	5 %
	None	37 %
Raw material batches mixed:	Yes	79 %
	No	21 %
Mixed batches traceable separately:	Yes	73 %
	No	27 %
Time of traceability data storage:	Less than two years	21 %
	Two to four years	32 %
	Five years or more	47 %

Traceability review

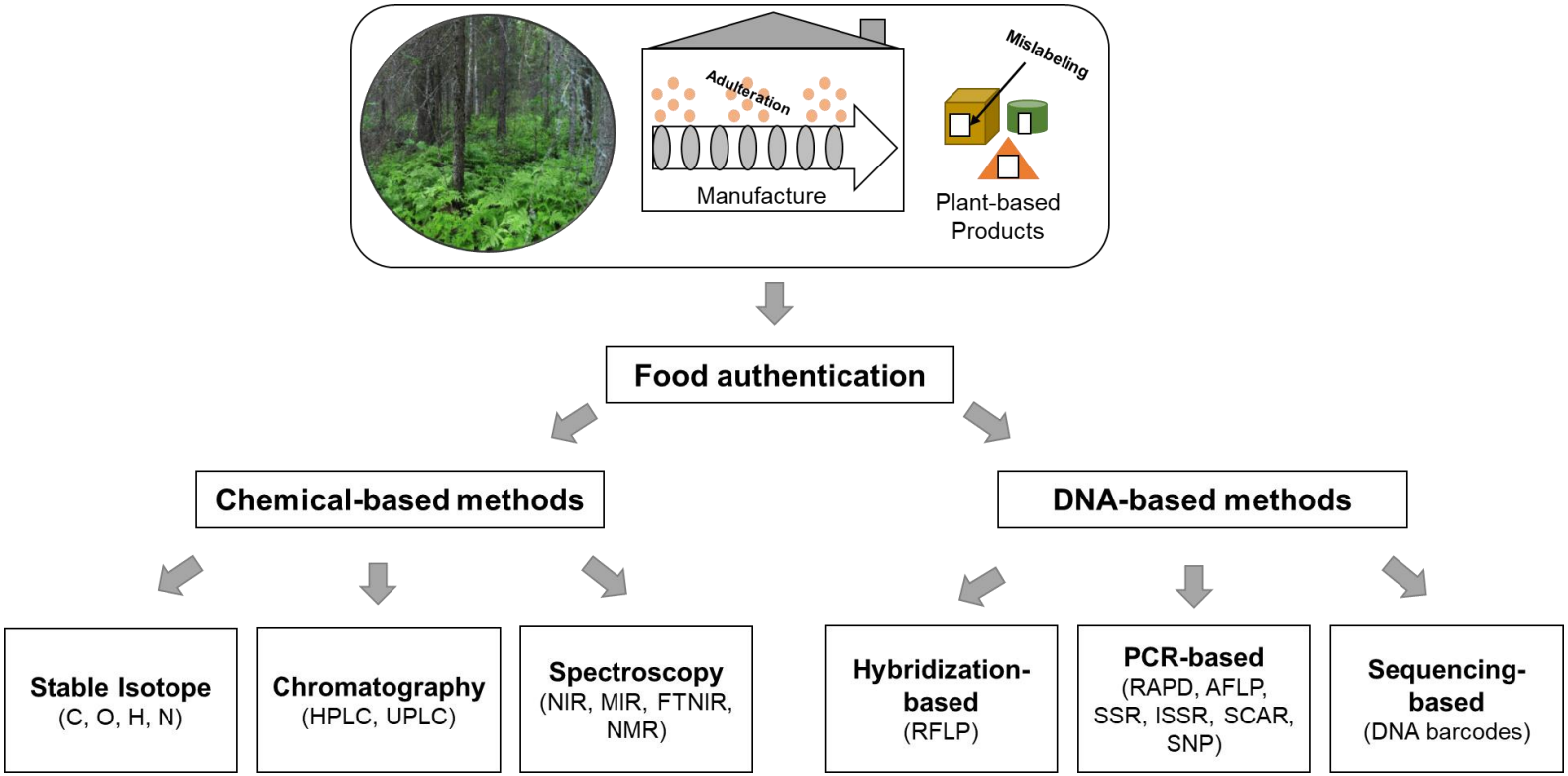
Conclusions

- The traceability of raw materials through the chain of production is according to the EU legislation, and follows the 'one step forward – one step back principle'
- Even though the EU legislation is quite definitive, it doesn't include information on what exactly is traced and how traceability is implemented in practice

-> The traceability information on the origin of raw materials ranged from exact location to seriously limited

- Even if the information on exact origin would be available, it may not be marked on product packaging, and thus not fully utilized in marketing
- Also, the country of origin may indicate only the country in which the last major stage of processing has occurred
- The review can be downloaded from NovelBaltic website (centria.fi/novelbaltic)

Authentication methods for plant-based products



Nguyen et al. 2020 manuscript

Development of authenticity analyses in NovelBaltic project

Background

- The aim is to develop authenticity analyses for NTFPs important for trade in Baltic sea region and emerging markets in South east Asia and China
- We focus on user-friendly & fast authentication methods
- Both DNA-based and chemical methods are developed
- The results presented here are preliminary results

-> Development of the methods continues through 2020

Development of authenticity analyses

University of Oulu

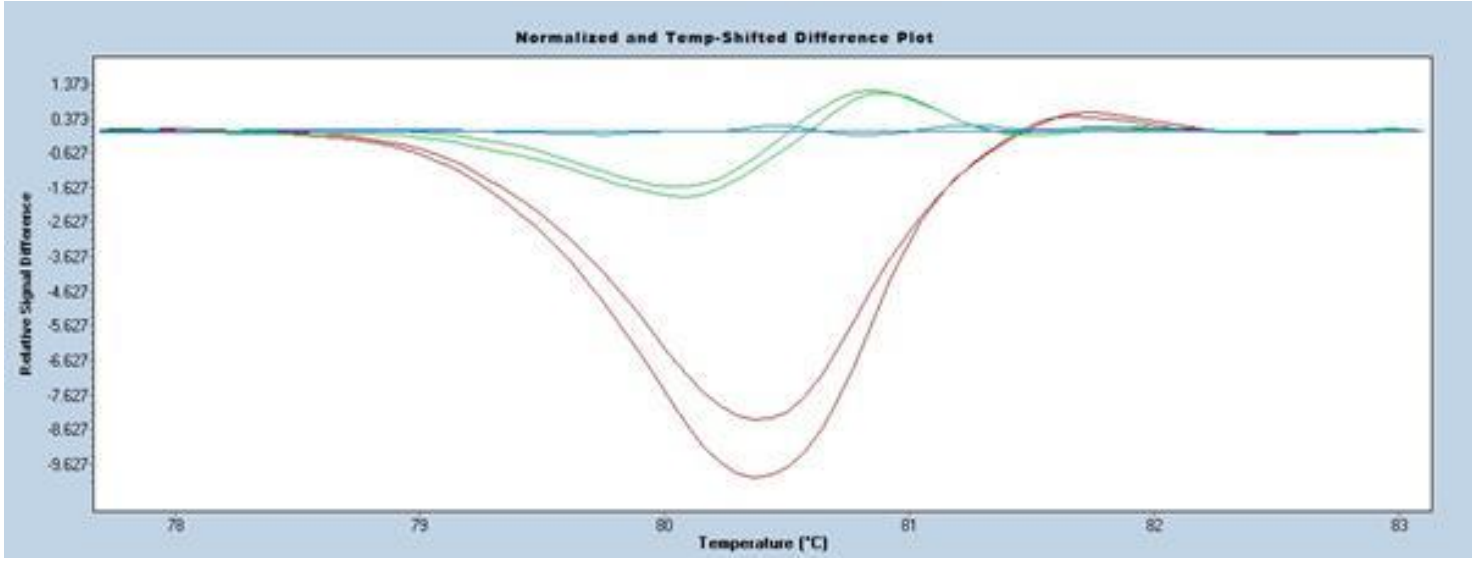
- DNA barcoding and high-resolution melting combined = Bar-HRM
- Fast and cheap method
- Can be used to identify species based on DNA samples
- Difficult to find DNA regions with enough variability to use this method on intraspecies level

Development of authenticity analyses

University of Oulu

- Bar-HRM method has been succesfully applied to detect interspecies difference
- DNA extracted from frozen berries:

red=bilberry, green=lingonberry, blue=cranberry



Development of authenticity analyses

University of Latvia

Maris Klavins, Agnese Kukela, Linards Klavins

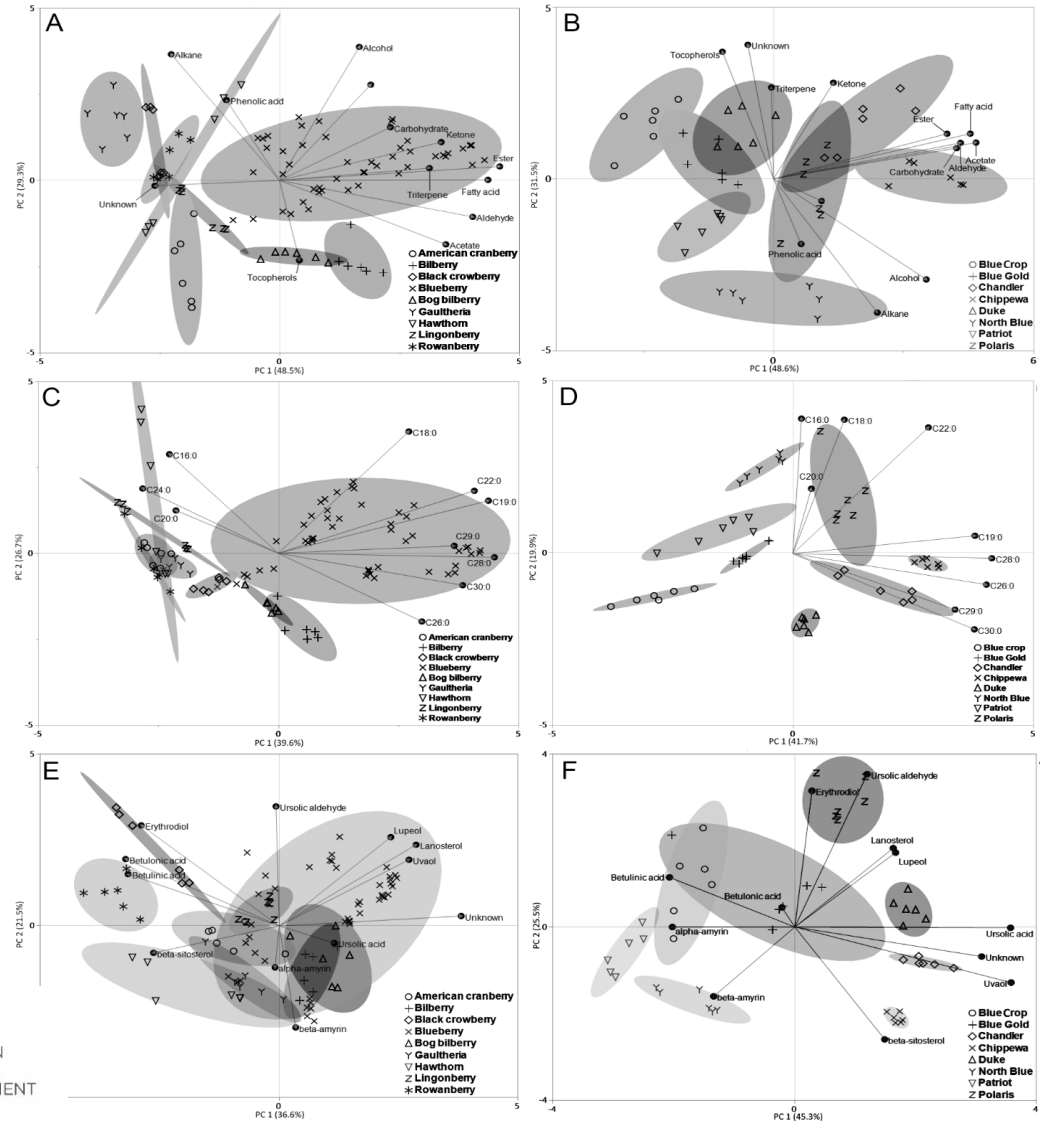
- Three methods are under development:
  1. Analysis of lipid profiles to distinguish between berries and their place of origin
  2. Stable isotope ratio analysis to show geographical differences between bilberries from Norway, Finland, Lithuania and Latvia
  3. Analysis of elemental composition in bilberry samples gathered in Latvia
- Different chemical methods can be applied but, in most cases, extensive sampling is required to reduce uncertainties.
- Databases of samples have to be made
- Mathematical treatment of the obtained data is required

Development of authenticity analyses

Univeristy of Latvia

1. Analysis of lipid profiles distinguish between berries and their place of origin

Principal components analysis (PCA) using lipid quantitative analysis of tested berry species and varieties. (A) and (B) show the PCA scores and loadings plot of different compound groups found in the lipid extracts of tested berry species (A) and the different varieties of blueberries (B). (C) and (D) show the PCA scores and loadings plot of the fatty acids found in the lipid extracts of tested berry species (C) and the different varieties of blueberries (D). (E) and (F) show the PCA scores and loadings plot of the fatty acids found in the lipid extracts of tested berry species (E) and the different varieties of blueberries (F). Berries of the same species or variety are grouped by 95% confidence ellipses.



https://www.mdpi.com/2304-8158/9/5/587; **https://doi.org/10.3390/foods9050587**

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Development of authenticity analyses

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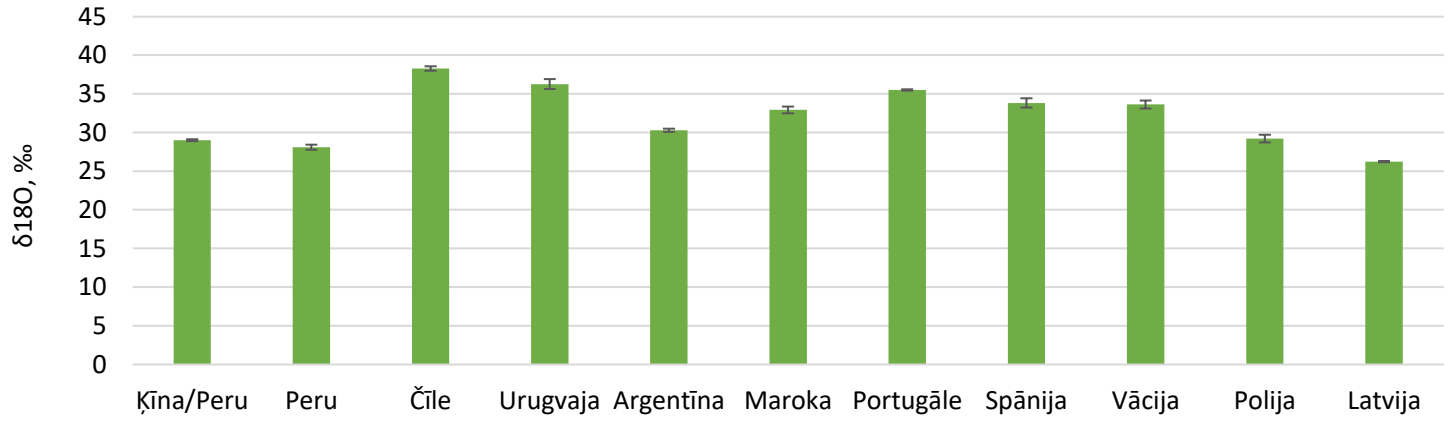
2. Use of stable, light isotope ratio analysis

- Isotope $^{2}H/^{1}H$, $^{13}C/^{12}C$, $^{15}N/^{14}N$, $^{18}O/^{16}O$ ratios $\delta^{18}O$, $\delta^{13}C$, $\delta^{15}N$ determined using Isotope Ratio Mass Spectrometry (IRMS) is a versatile tool for authenticity testing of food articles

$\delta^{18}O$ in commercially available bilberries from different countries



Development of authenticity analyses

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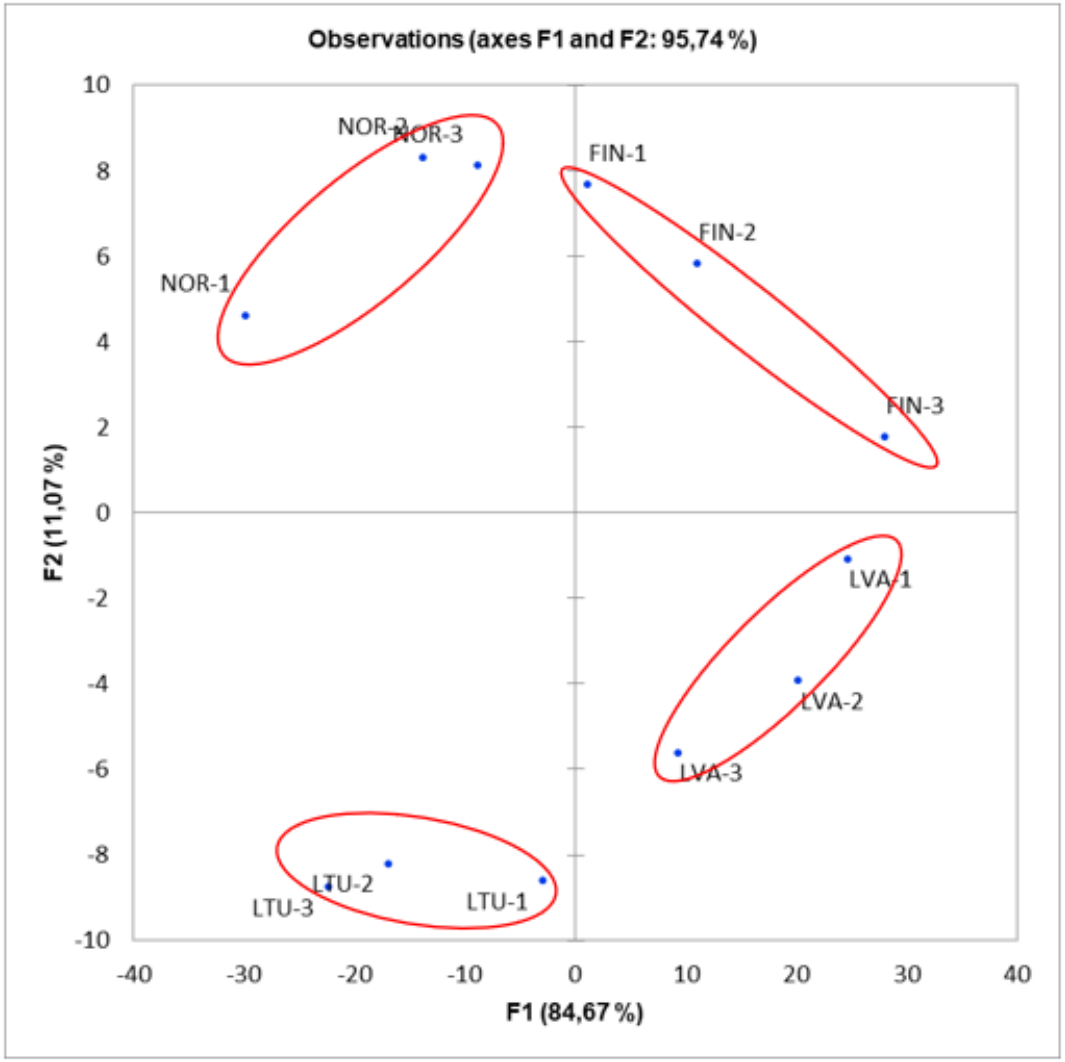
3. Analysis of elemental composition in bilberry samples gathered in Latvia

Development of authenticity analyses

LAMMC Institute of Horticulture



Principal component analysis (PCA) of Fourier transform near-infrared spectroscopy (FT-NIR) results: Bilberry

Prof. P. Viškelis

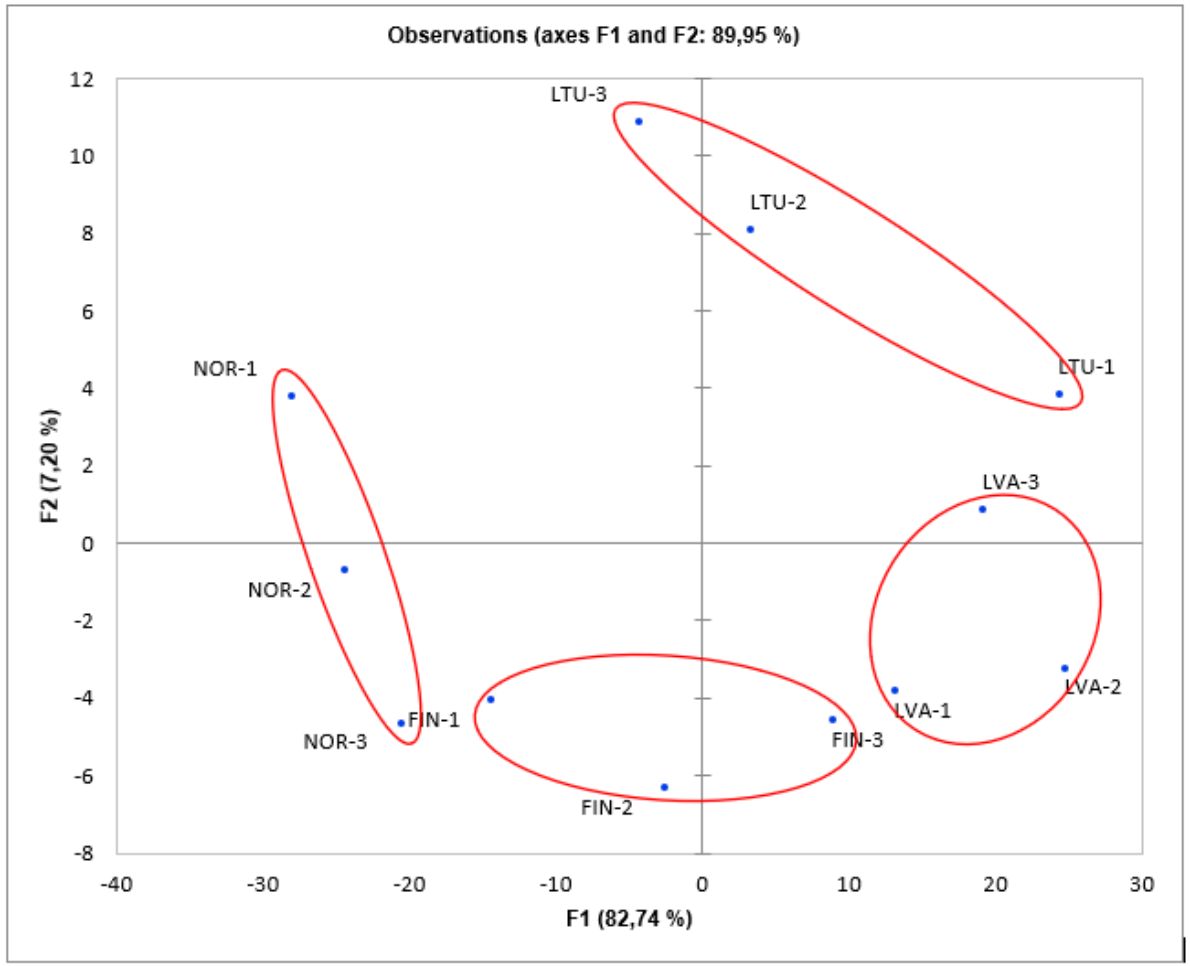
Dr. Č. Bobinais

Dr. J. Viškelis

Dr. R. Bobinaitė

Development of authenticity analyses

LAMMC Institute of Horticulture



FT-NIR PCA: Lingonberry

Development of authenticity analyses

Kaunas University of Technology

Authentication of frozen bilberries and lingonberries by SERS (surface enhanced Raman spectroscopy)

- SERS measurements were performed for frozen bilberries and lingonberries obtained from 3 regions in Lithuania, Latvia, Finland and Norway
- PCA analysis shows that the SERS method is appropriate for evaluation of authenticity

Team:
Prof. Dr. Habil Valentinas SNITKA and Dr. Lina TRAKSELE

Development of authenticity analyses

Kaunas University of Technology

An example of the analyses, frozen bilberries (3 regions, LT)

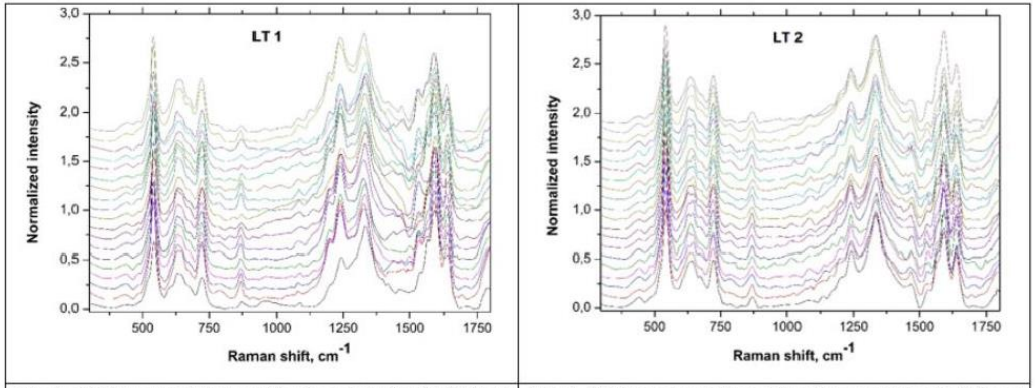


Fig. A. SERS spectra of frozen bilberries recorded at 20 different point of the sample. Bilberries were collected in Lithuania, location 1.

Fig. B. SERS spectra of frozen bilberries recorded at 20 different point of the sample. Bilberries were collected in Lithuania, location 2.

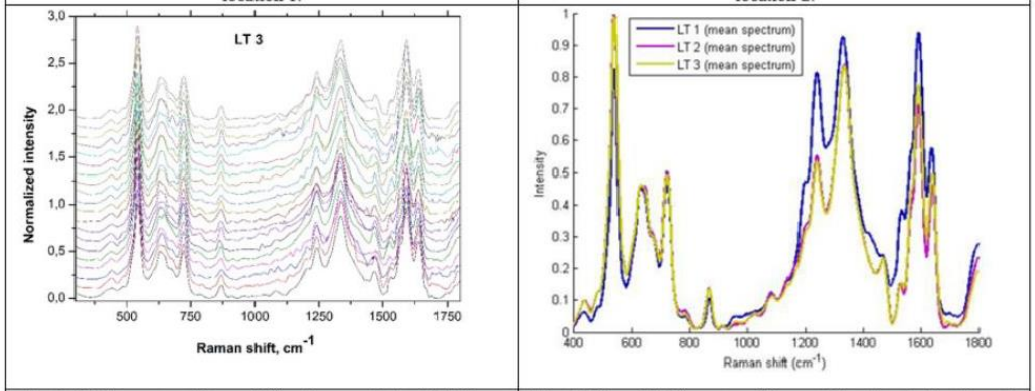


Fig. C. SERS spectra of frozen bilberries recorded at 20 different point of the sample. Bilberries were collected in Lithuania, location 3.

Fig. D. Mean SERS spectra of frozen bilberries obtained from 3 locations in Lithuania.

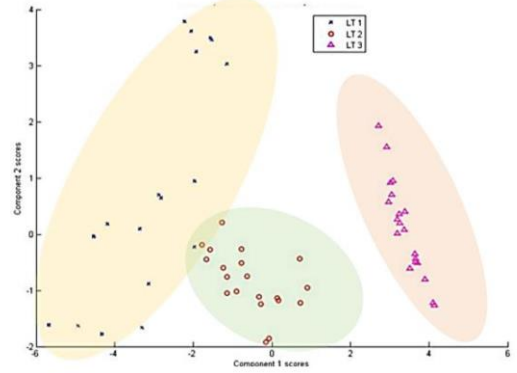


Fig. 1. PCA analysis of frozen bilberries obtained from 3 different regions in Lithuania

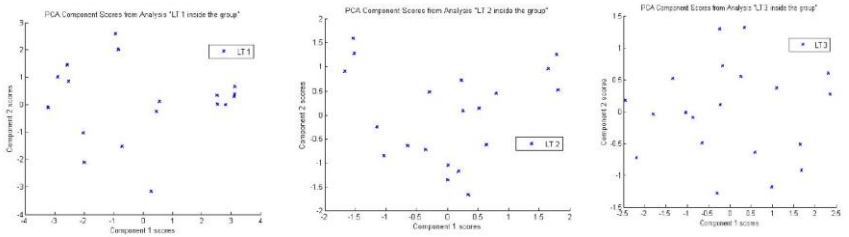


Fig. 2. Result of PCA analysis carried out inside the group and showing no significant difference between spectral data. The target group – frozen bilberries collected at 3 different regions in Lithuania

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