Beeswax adulteration issue: *aspects of contamination and outcome*

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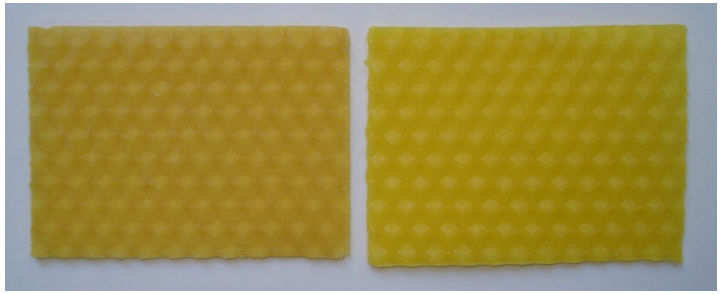
Beeswax adulteration issue

- long-present and **growing problem** worldwide
- uncontrolled contamination - **comb foundation** trade
- there are still **no** internationally standardized **analytical methods** for beeswax authenticity control
- current analytical methods (proposed by IHC):
  - beeswax composition criteria for routine testing based on classical physico-chemical parameters determined in accordance with EP
  - GC/MS analysis
  - sensory analysis
  - **analytical eligibility**: not reached

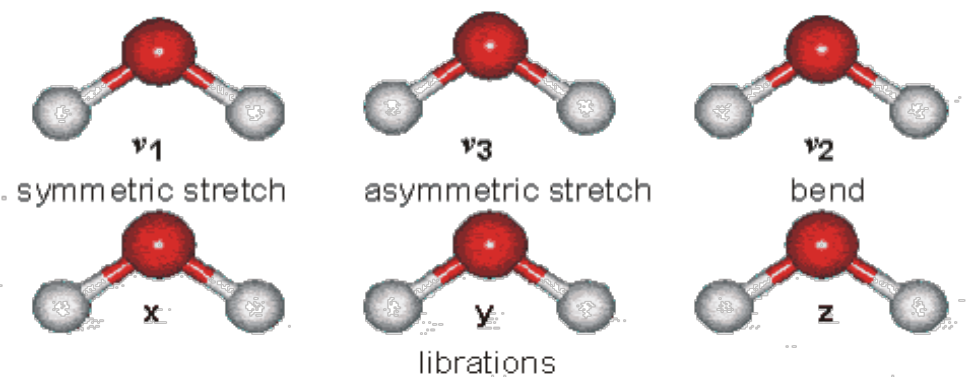


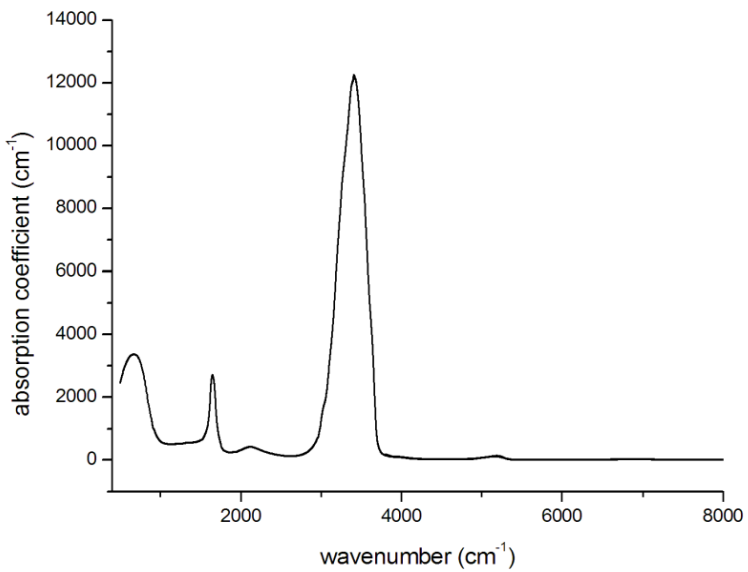
Pure comb foundation | Adulterated comb foundation

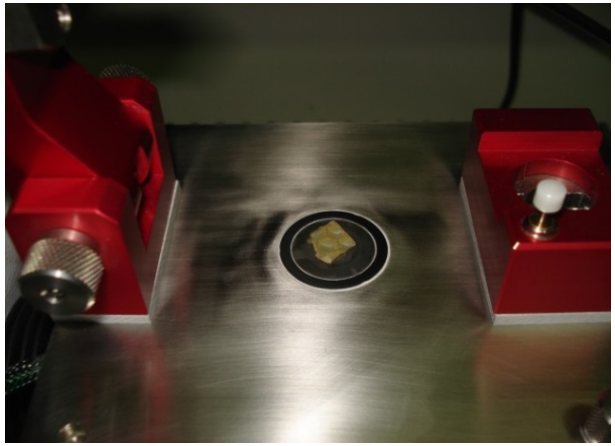
FTIR spectroscopy - basics, advantages and analytical procedure development

- development of an **analytical procedure** for reliable beeswax **adulteration detection** (Svečnjak et al., 2015)
- feasibility study - Maia et al. (2013) - good detection limits (5%)
- information on the **total chemical composition** of a sample
- detection of **functional group vibrations** - bands with specific position and intensity in IR spectrum
- **unique IR fingerprint** of a sample

H_2O molecule

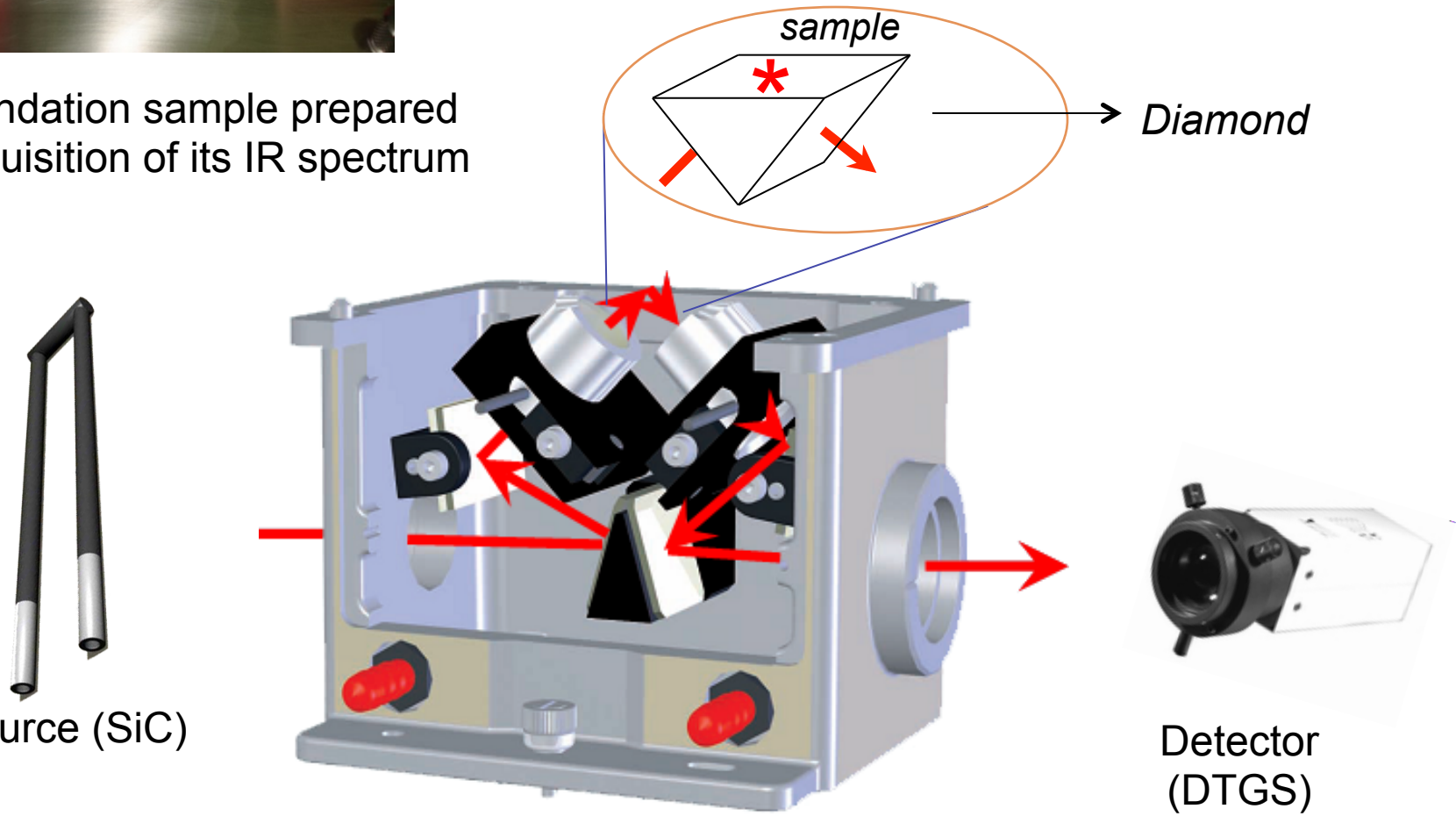






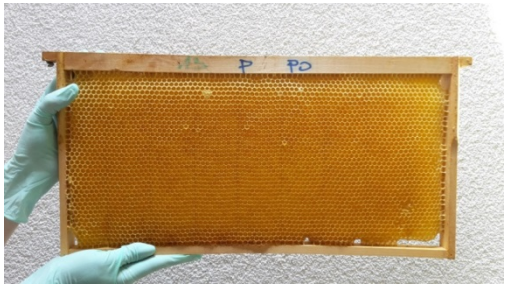
Comb foundation sample prepared for the acquisition of its IR spectrum

Fourier-transformed infrared (FT-IR) spectroscopy coupled with ATR (attenuated total reflectance) recording technique

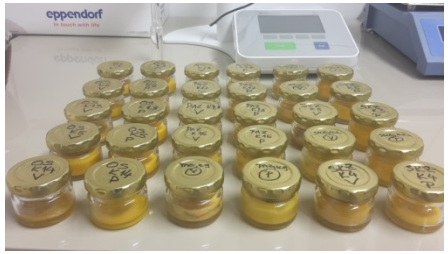


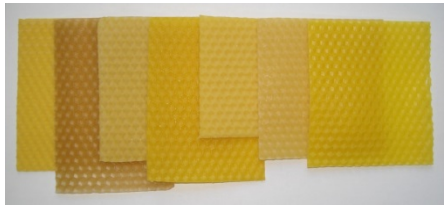
Materials and methods
Sampling and IR spectra acquisition

- comb foundations containing **90% of paraffin** placed in **15 *Apis mellifera* colonies** (1 frame / LR hive)
- left in the hives until full comb construction
- **honeyombs** constructed on experimental paraffin foundations **melted and recorded** by FTIR spectroscopy (separately)



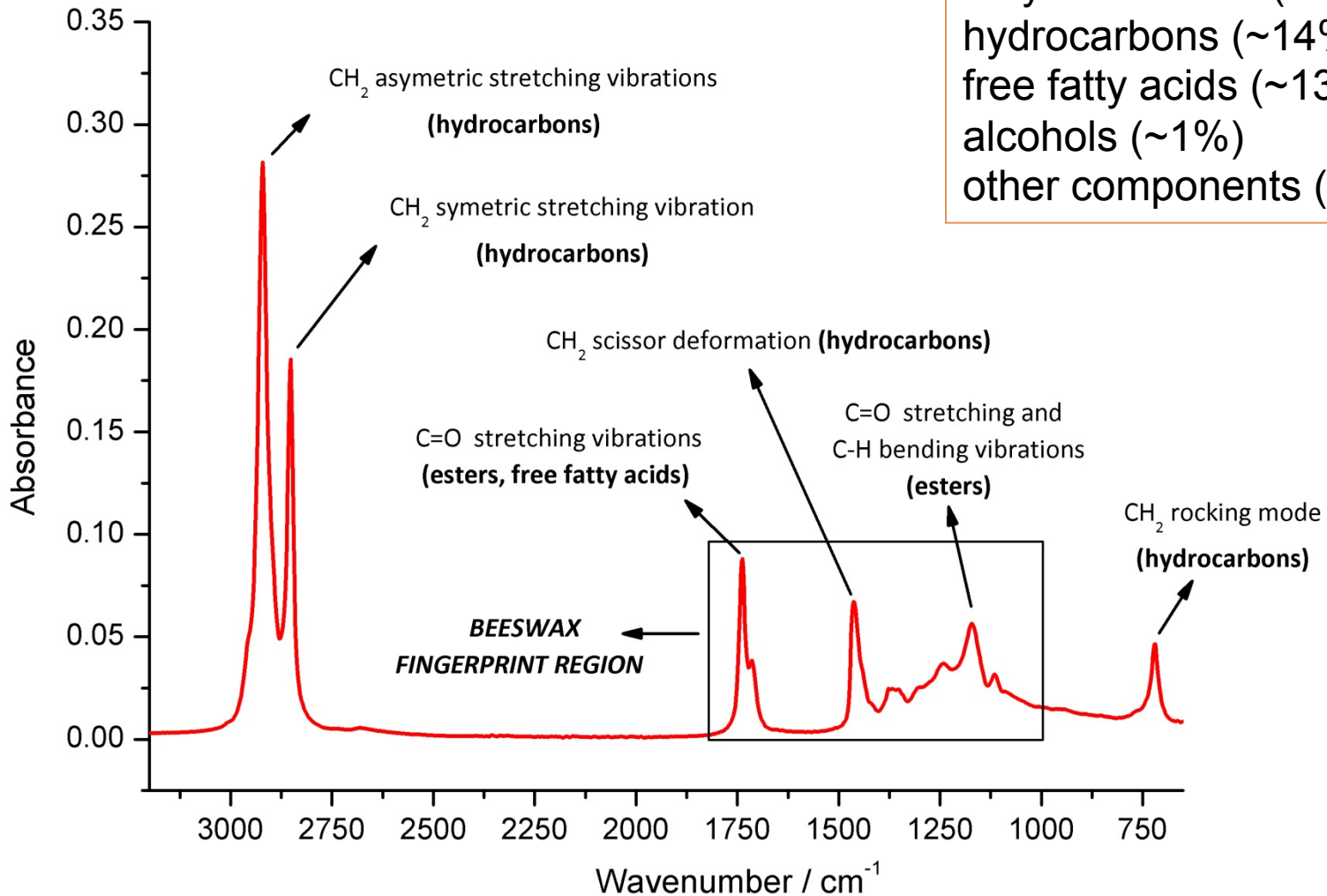
- **236 comb foundation** samples collected from 2014 to 2016 - manufacturers and/or specialized beekeeping shops - 14 European countries + 5 countries outside EU



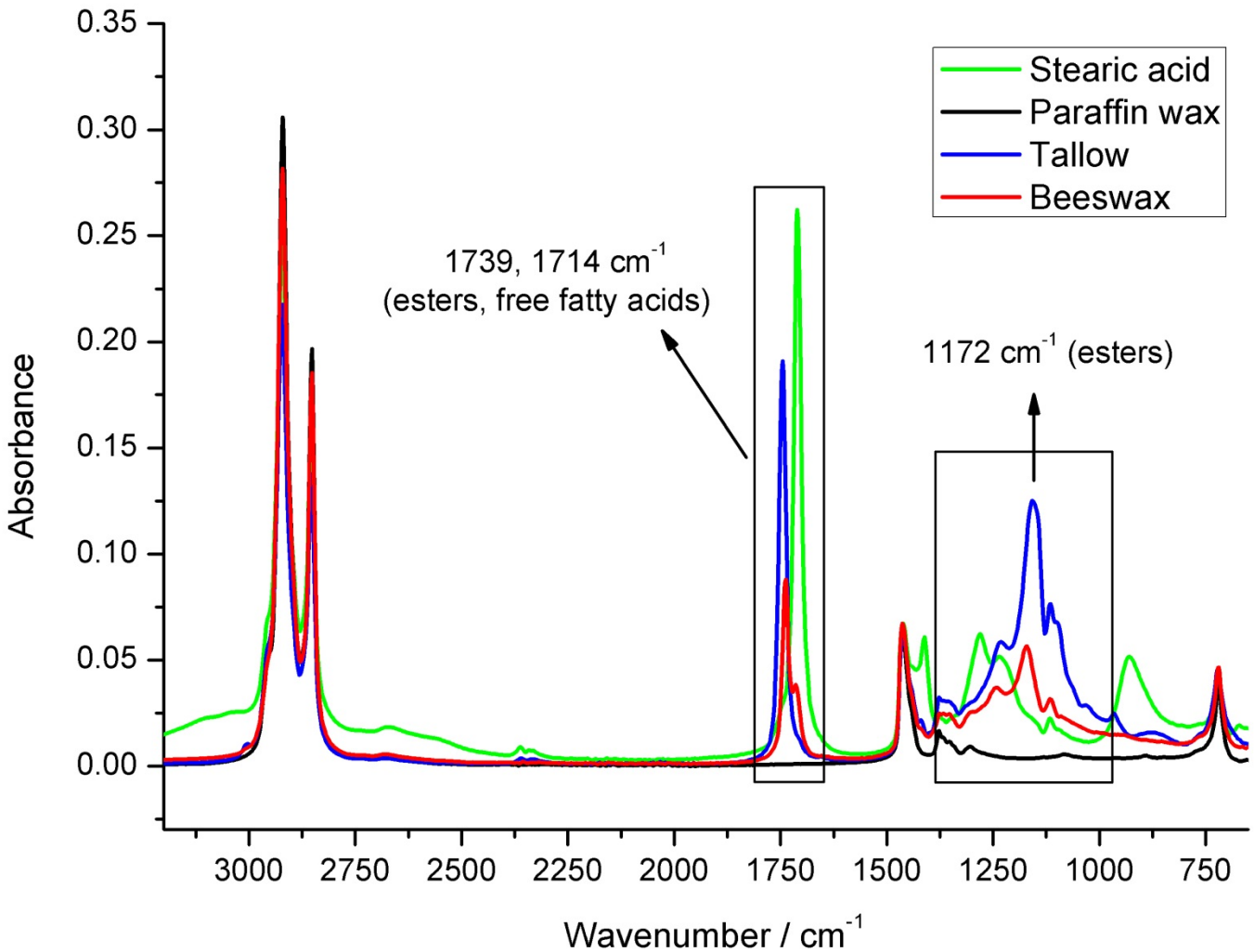


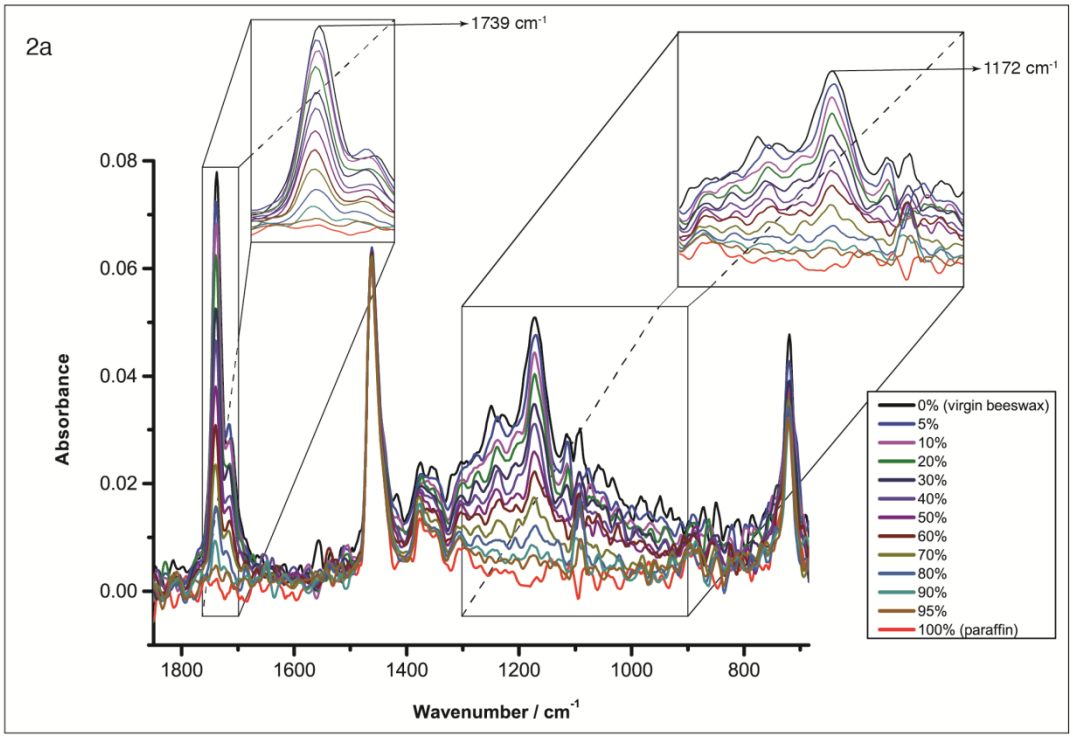
Characteristic FTIR-ATR spectrum of genuine beeswax and underlying molecular vibrations

Beeswax chemical composition:
fatty acid esters (~67%)
hydrocarbons (~14%)
free fatty acids (~13%)
alcohols (~1%)
other components (~5%)

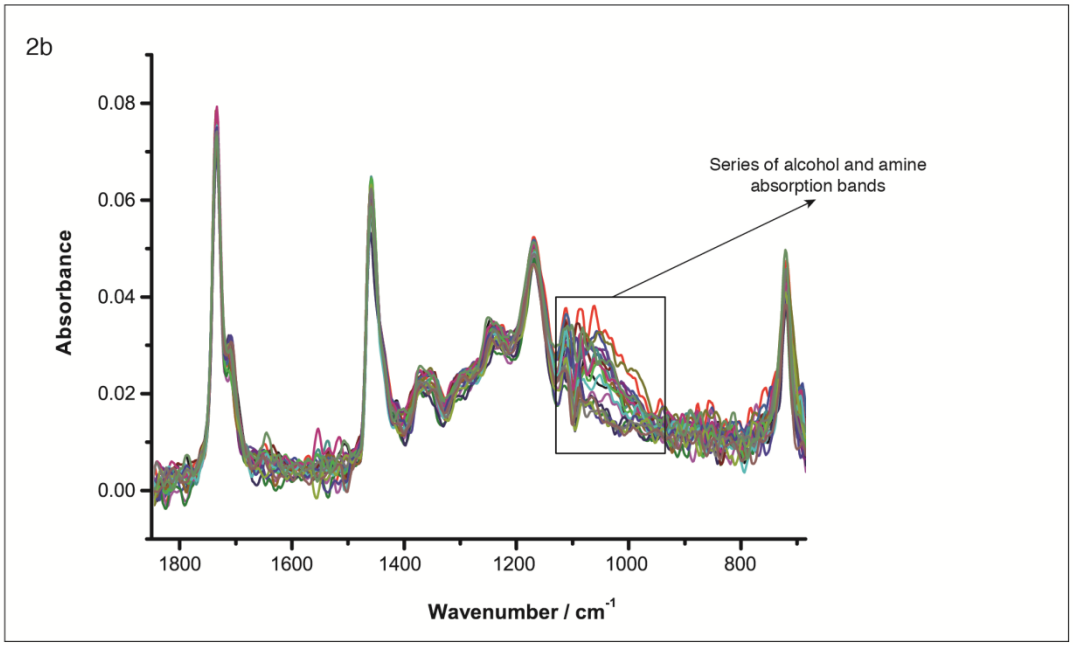


Comparison of typical FTIR-ATR spectrum of genuine beeswax and selected adulterants



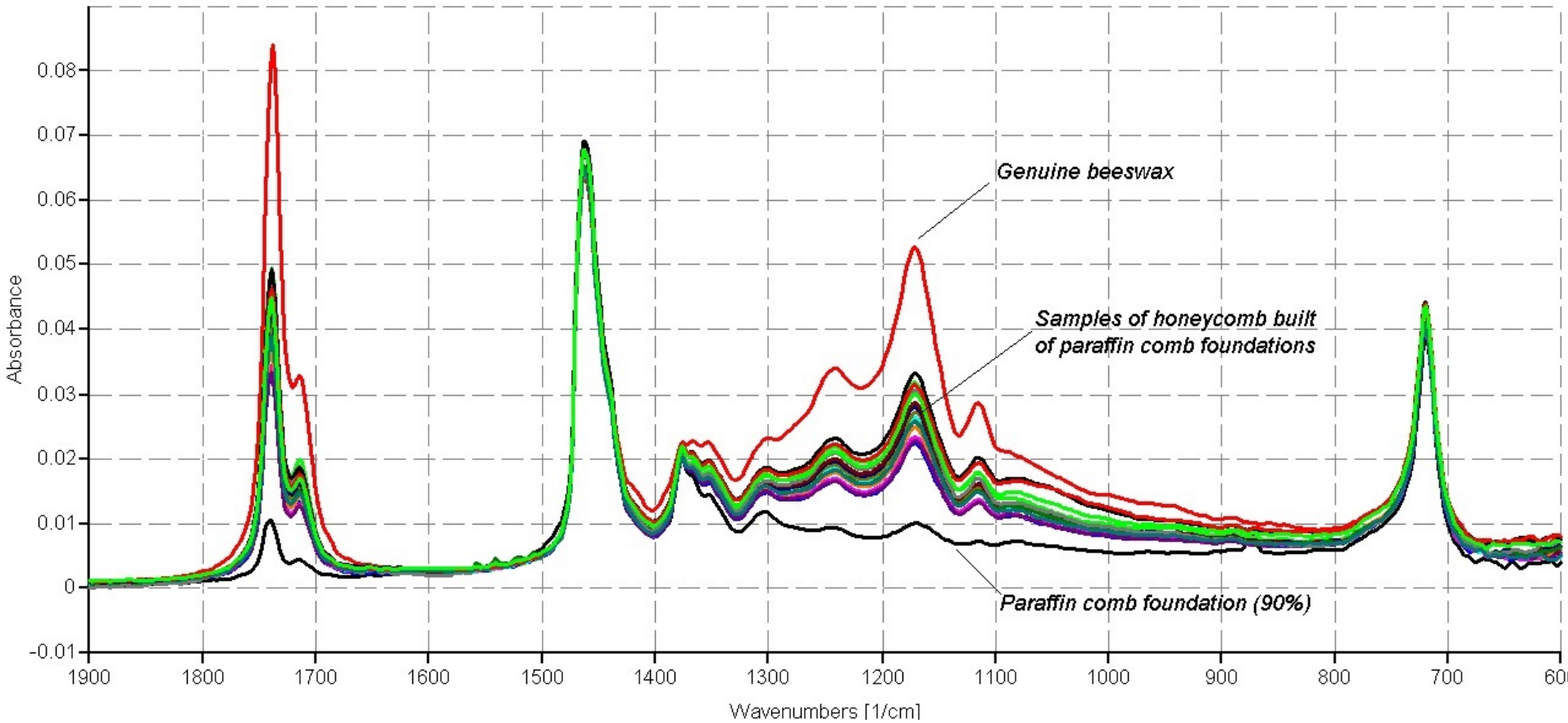


IR spectra of virgin beeswax, paraffin and prepared virgin beeswax-paraffin mixtures containing different proportion of paraffin (5-95%) (2a)



Spectral variations between different virgin beeswax samples (n=21) (2b)

Residual amount of paraffin in melted honeycomb samples



- in average **53.4 %** of **paraffin remains** in the newly built and melted raw wax material (44,6 - 63,2 %)

Categorization and distribution of analysed comb foundation samples (**n=61 / 2014**) by adulteration level (category)

Adulteration category	Paraffin share (%)	Samples (n)	Samples (%)
High level	*>70*	*12*	*19.7*
Higher middle level	*45-70*	*4*	*6.6*
Lower middle level	*20-45*	*6*	*9.8*
Low level	*5-20*	*28*	*45.9*
Genuine beeswax	*< 5*	*11*	***18.0***
Total		**61**	**100%**

- **82 %** samples **adulterated with paraffin**
- **up to 92.7 % of** paraffin
- no other adulterant traces found in comb foundations
- prevalence of the paraffin adulteration on the market

Categorization and distribution of analysed comb foundation samples (**n=64 / 2015**) by adulteration level (category)

Adulteration category	Paraffin share (%)	Samples (n)	Samples (%)
High level	*>70*	*7*	*11.3*
Higher middle level	*45-70*	*3*	*4.8*
Lower middle level	*20-45*	*6*	*9.7*
Low level	*5-20*	*32*	*51.6*
Genuine beeswax	*< 5*	*14*	***22.6***
Total		**62**	**100%**

- **77.4 %** samples **adulterated with paraffin**
- **up to 95 % of** paraffin
- other adulterants: **tallow** 10% (1 - B&H), **stearic acid** 15 % (1 - Poland)
- prevalence of the paraffin adulteration on the market

Categorization and distribution of analysed comb foundation samples (**n=111 / 2016**) by adulteration level (category)

Adulteration category	Paraffin share (%)	Samples (n)	Samples (%)
High level	*>70*	*8*	*7.6*
Higher middle level	*45-70*	*1*	*1*
Lower middle level	*20-45*	*7*	*6.7*
Low level	*5-20*	*58*	*55.2*
Genuine beeswax	*< 5*	*31*	***29.5***
Total		**105**	**100%**

- **70.5 %** samples **adulterated with paraffin**
- **up to 94.2 % of** paraffin
- **stearic acid** (20-35 %) found in 6 samples (Netherlands)
- prevalence of the paraffin adulteration on the market

Conclusions

- disconcerting situation on the comb foundation market indicated by the results obtained in this study implies **an urgent need** for routine **beeswax** **authenticity control**
- consequence of a larger-scale problem - general **deficit of beeswax** and **“chronic” accumulation and circulation** of the paraffin in comb foundation production process
- **lack of routine analytical tools** - contribute to this issue

Thank You For Attention

Importance of beeswax and its authenticity

- carbohydrate metabolism product
- wax scales - 3x3 mm, 0,1 mm thick
- **1100 to 1200 wax scales** - necessary to produce **1g of wax**
- **6-8 kg of honey** to produce **1kg of wax**
- negative effects of adulteration - destroyed comb, disrupted chemical communication and brood development, decreased honey production…