

Beeswax adulteration issue: *aspects of contamination and outcome*

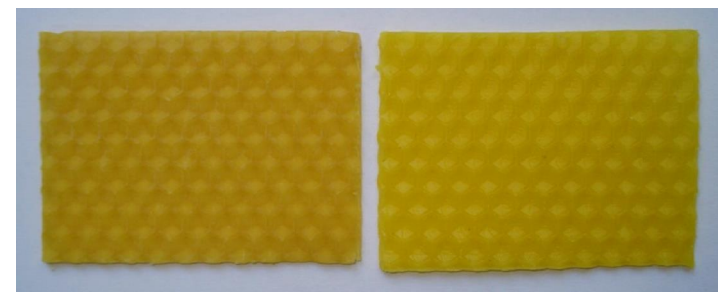
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Beeswax adulteration issue

- 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



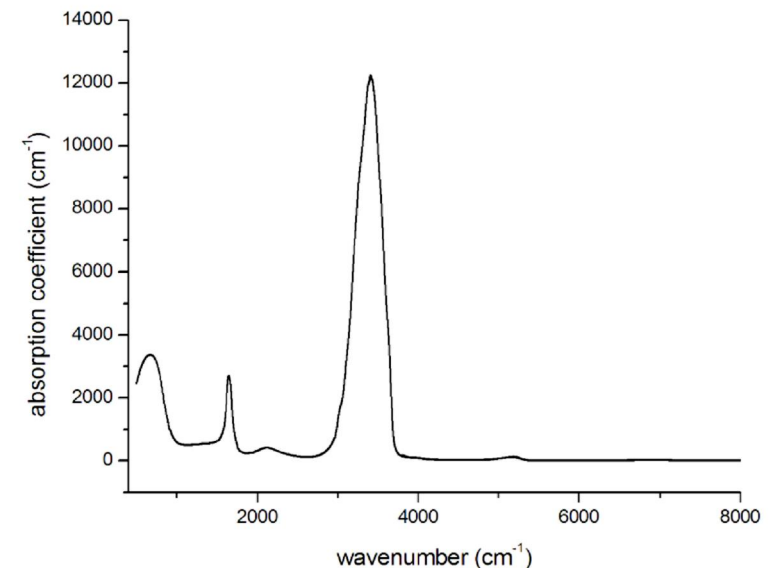
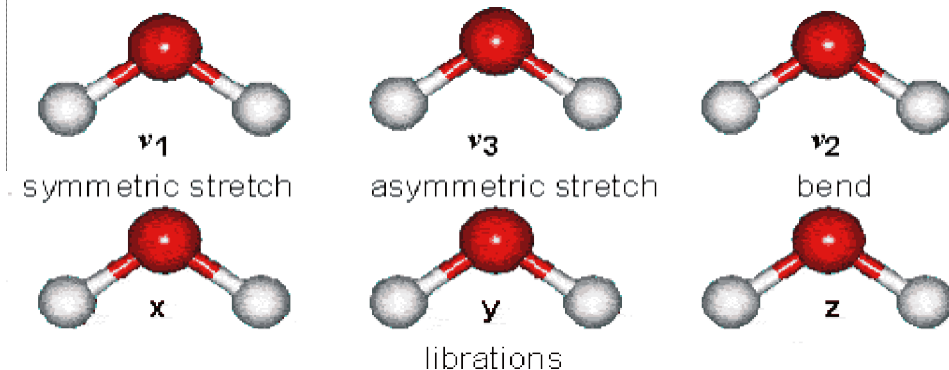
Pure comb
foundation

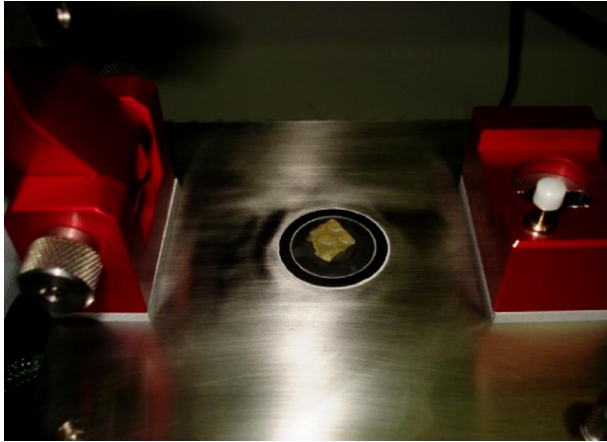
Adulterated
comb foundation

FTIR spectroscopy - basics, advantages and analytical procedure development

- development of an **analytical procedure** for reliable beeswax **adulteration detection** (Sve njak 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

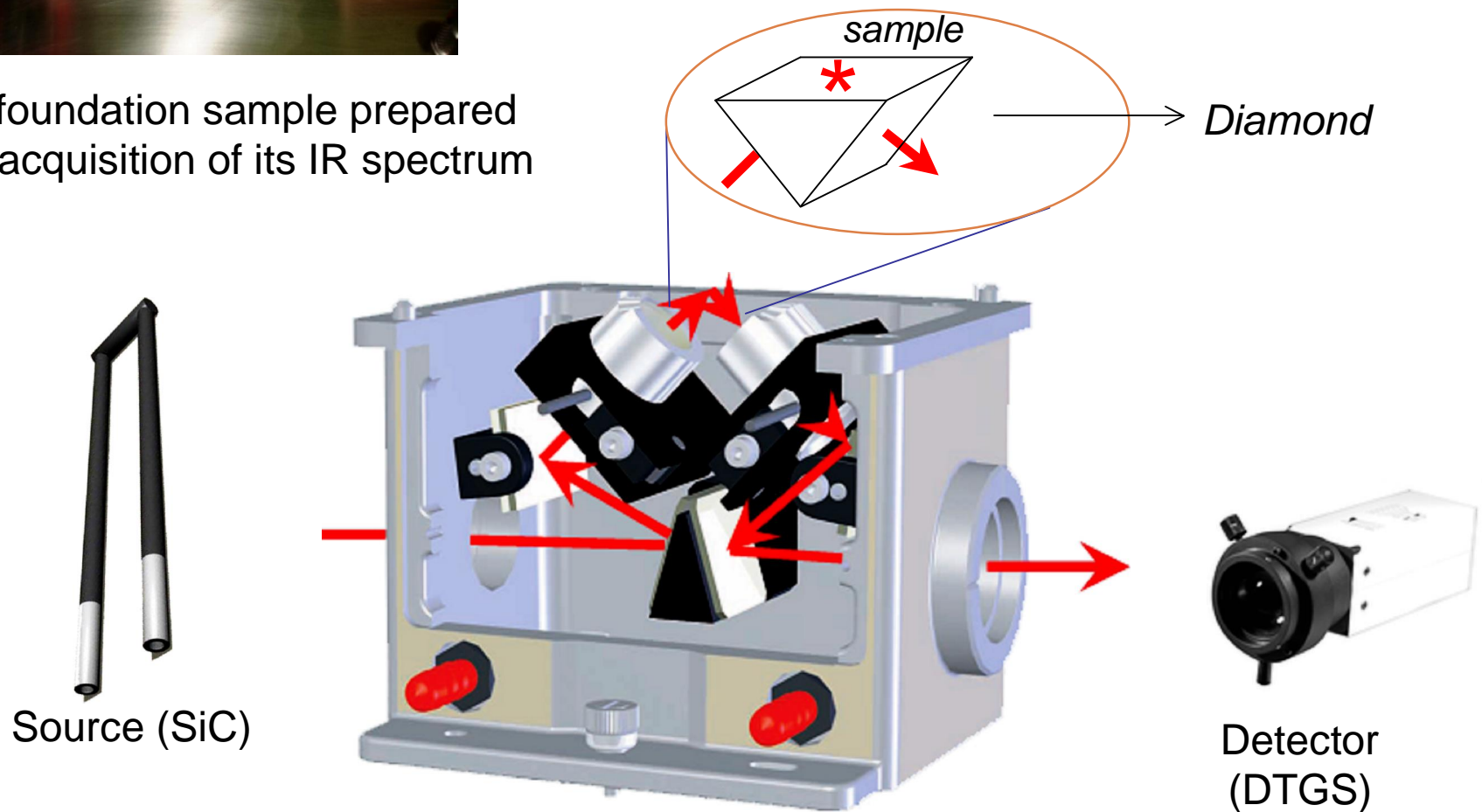
H₂O molecule





Comb foundation sample prepared for the acquisition of its IR spectrum

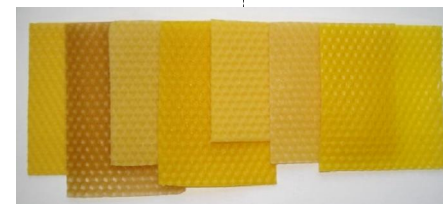
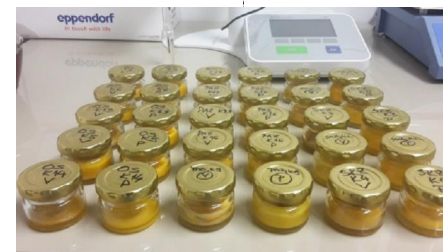
Fourier-transformed infrared (FT-IR) spectroscopy coupled with ATR (attenuated total reflectance) recording technique



Materials and methods

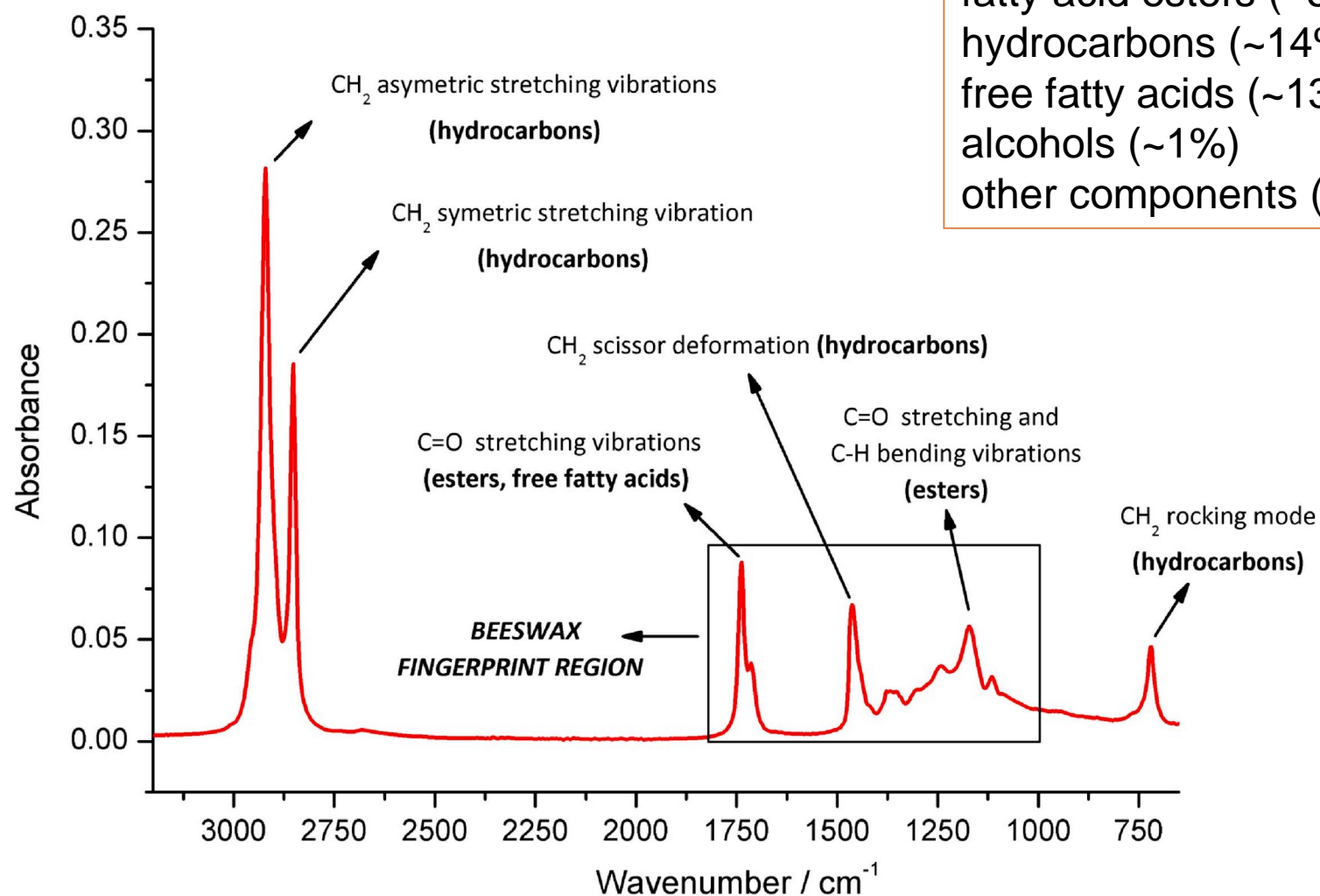
Sampling and IR spectra acquisition

- 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

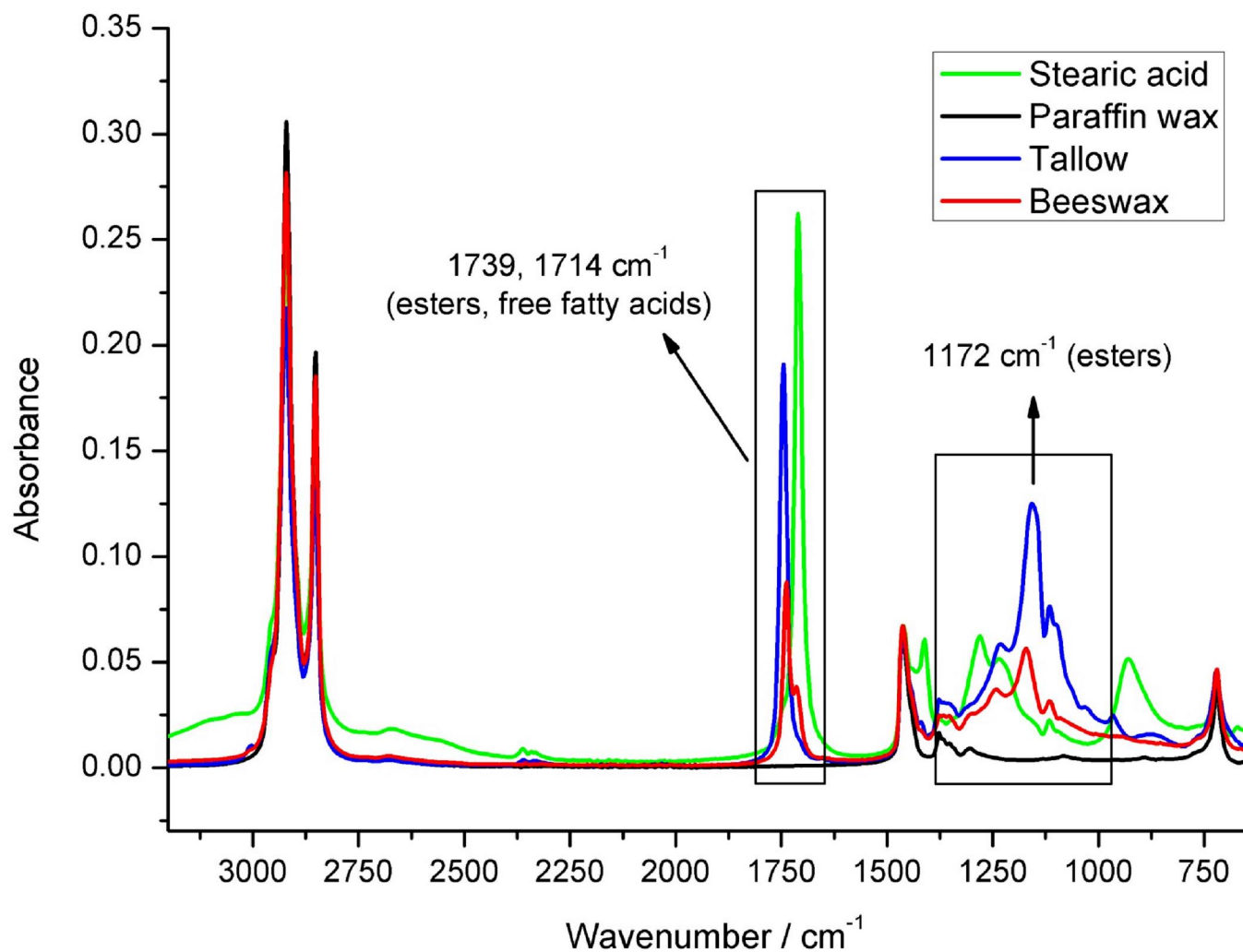


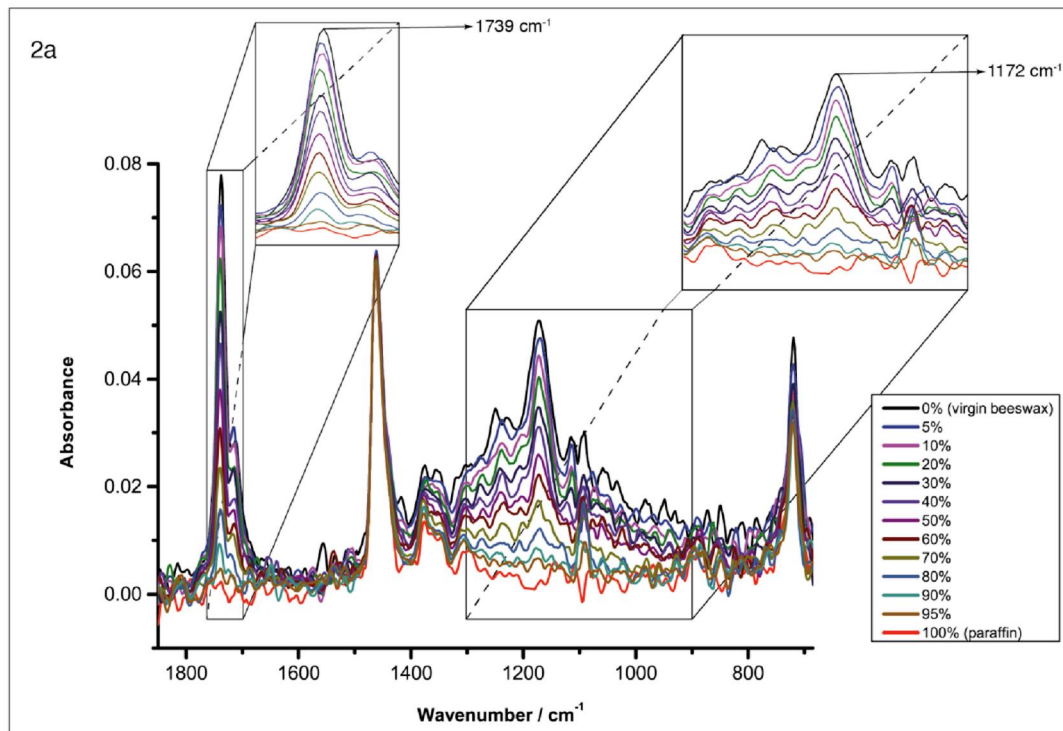
Characteristic FTIR-ATR spectrum of genuine beeswax and underlying molecular vibrations

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

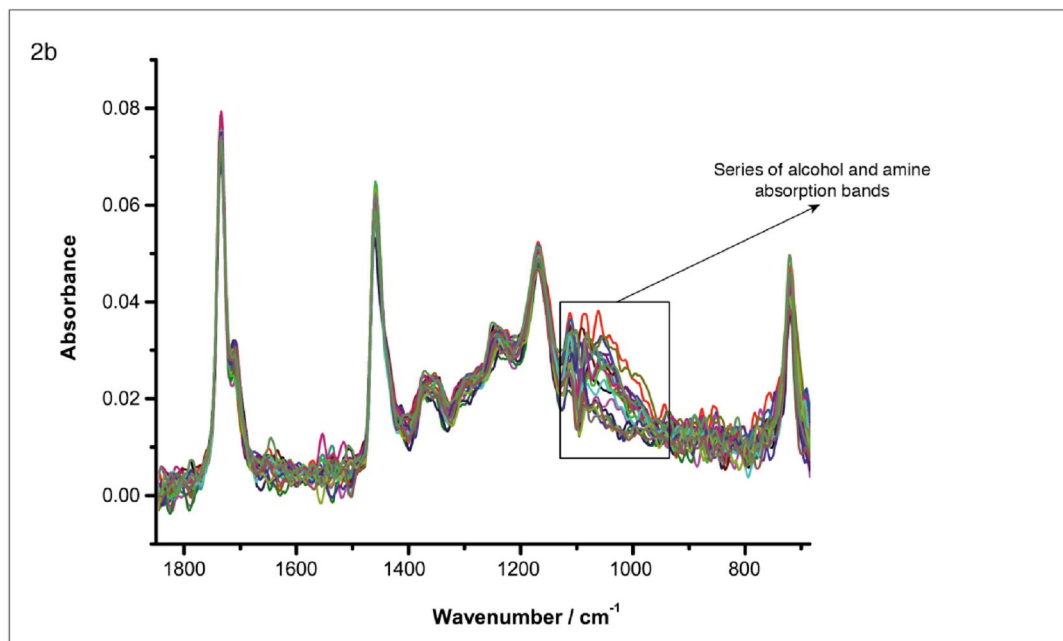


Comparison of typical FTIR-ATR spectrum of genuine beeswax and selected adulterants



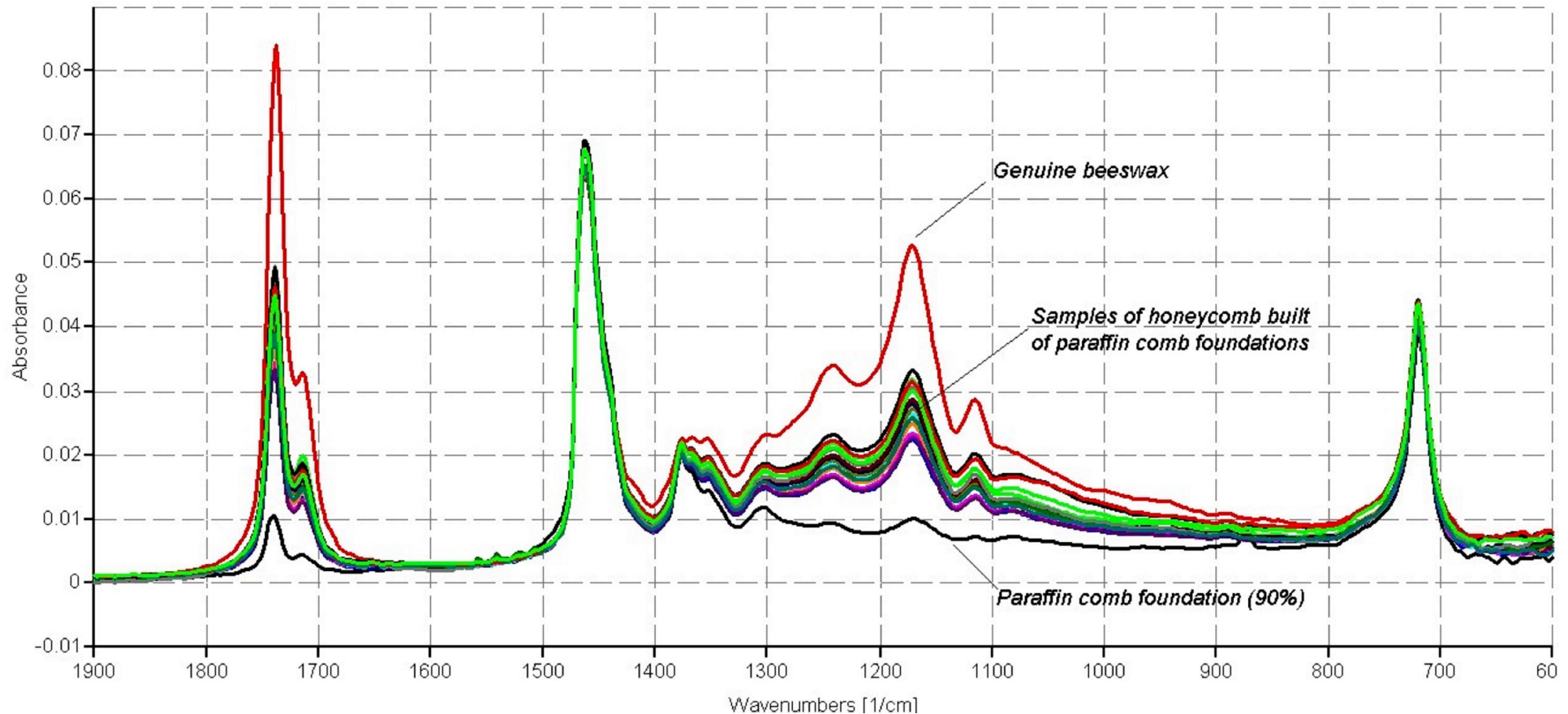


IR spectra of virgin beeswax, paraffin and prepared virgin beeswax-paraffin mixtures containing different proportion of paraffin (5-95%) (2a)



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 (%)
<i>High level</i>	>70	12	19.7
<i>Higher middle level</i>	45-70	4	6.6
<i>Lower middle level</i>	20-45	6	9.8
<i>Low level</i>	5-20	28	45.9
<i>Genuine beeswax</i>	< 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 (%)
<i>High level</i>	>70	7	11.3
<i>Higher middle level</i>	45-70	3	4.8
<i>Lower middle level</i>	20-45	6	9.7
<i>Low level</i>	5-20	32	51.6
<i>Genuine beeswax</i>	< 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 (%)
<i>High level</i>	>70	8	7.6
<i>Higher middle level</i>	45-70	1	1
<i>Lower middle level</i>	20-45	7	6.7
<i>Low level</i>	5-20	58	55.2
<i>Genuine beeswax</i>	< 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 **ÍchronicÎ 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

