



UNIVERSITY OF CHEMISTRY AND TECHNOLOGY, PRAGUE
Faculty of Food and Biochemical Technology
Department of Food Analysis and Nutrition

Transfer of phytocannabinoids from dried plant to aqueous infusions: Is cannabis 'tea' safe?



Matej Maly, Frantisek Benes, Zuzana Binova, Jana Hajslova*

25.4.2023



2nd ISO-FOOD Symposium
Portorož, Slovenia
April 24 – 26, 2023

**ISO-FOOD FROM
FOOD SOURCE TO HEALTH**



Phytocannabinoids



Phytocannabinoids

- Unique compounds characteristic for *cannabis* plants
 - **Over 120 identified** ¹
 - Binding to the endocannabinoids receptors in body ¹



¹ Morales P, Hurst DP, Reggio PH. Molecular Targets of the Phytocannabinoids: A Complex Picture. Prog Chem Org Nat Prod. 2017;103:103-131. doi: 10.1007/978-3-319-45541-9_4. PMID: 28120232; PMCID: PMC5345356.

Phytocannabinoids

- Unique compounds characteristic for *cannabis* plants
 - **Over 120 identified** ¹
 - Binding to the endocannabinoids receptors in body ¹
 - **CBD – cannabidiol**



¹ Morales P, Hurst DP, Reggio PH. Molecular Targets of the Phytocannabinoids: A Complex Picture. Prog Chem Org Nat Prod. 2017;103:103-131. doi: 10.1007/978-3-319-45541-9_4. PMID: 28120232; PMCID: PMC5345356.

Phytocannabinoids



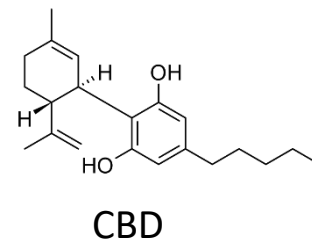
- Unique compounds characteristic for *cannabis* plants
 - **Over 120 identified** ¹
 - Binding to the endocannabinoids receptors in body ¹
 - **CBD – cannabidiol**
 - High pharmaceutical potential, **non-psychoactive**
 - Mostly used in **food industry** – CBD oil, tincture, ointment, tea...
 - Precursor is cannabidiolic acid (**CBDA**)

¹ Morales P, Hurst DP, Reggio PH. Molecular Targets of the Phytocannabinoids: A Complex Picture. Prog Chem Org Nat Prod. 2017;103:103-131. doi: 10.1007/978-3-319-45541-9_4. PMID: 28120232; PMCID: PMC5345356.

Phytocannabinoids



- Unique compounds characteristic for *cannabis* plants
 - **Over 120 identified** ¹
 - Binding to the endocannabinoids receptors in body ¹
 - **CBD – cannabidiol**
 - High pharmaceutical potential, **non-psychootropic**
 - Mostly used in **food industry** – CBD oil, tincture, ointment, tea...
 - Precursor is cannabidiolic acid (**CBDA**)

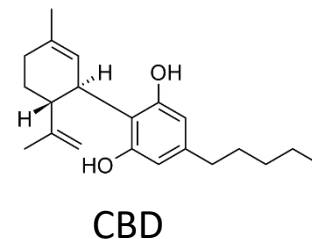


¹ Morales P, Hurst DP, Reggio PH. Molecular Targets of the Phytocannabinoids: A Complex Picture. Prog Chem Org Nat Prod. 2017;103:103-131. doi: 10.1007/978-3-319-45541-9_4. PMID: 28120232; PMCID: PMC5345356.

Phytocannabinoids



- Unique compounds characteristic for *cannabis* plants
 - **Over 120 identified** ¹
 - Binding to the endocannabinoids receptors in body ¹
 - **CBD – cannabidiol**
 - High pharmaceutical potential, **non-psychoactive**
 - Mostly used in **food industry** – CBD oil, tincture, ointment, tea...
 - Precursor is cannabidiolic acid (**CBDA**)
 - **Δ⁹-THC – delta-9-tetrahydrocannabinol**
 - **Psychoactive**
 - Analgesic properties, neuroprotective – medical use
 - Precursor is delta-9-tetrahydrocannabinolic acid (**Δ⁹-THCA**)

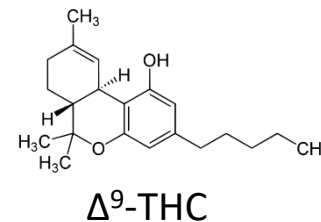
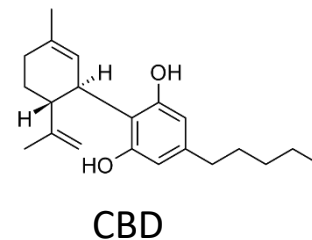


¹ Morales P, Hurst DP, Reggio PH. Molecular Targets of the Phytocannabinoids: A Complex Picture. Prog Chem Org Nat Prod. 2017;103:103-131. doi: 10.1007/978-3-319-45541-9_4. PMID: 28120232; PMCID: PMC5345356.

Phytocannabinoids



- Unique compounds characteristic for *cannabis* plants
 - **Over 120 identified** ¹
 - Binding to the endocannabinoids receptors in body ¹
 - **CBD – cannabidiol**
 - High pharmaceutical potential, **non-psychoactive**
 - Mostly used in **food industry** – CBD oil, tincture, ointment, tea...
 - Precursor is cannabidiolic acid (**CBDA**)
 - **Δ^9 -THC – delta-9-tetrahydrocannabinol**
 - **Psychoactive**
 - Analgesic properties, neuroprotective – medical use
 - Precursor is delta-9-tetrahydrocannabinolic acid (**Δ^9 -THCA**)

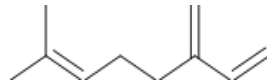


¹ Morales P, Hurst DP, Reggio PH. Molecular Targets of the Phytocannabinoids: A Complex Picture. Prog Chem Org Nat Prod. 2017;103:103-131. doi: 10.1007/978-3-319-45541-9_4. PMID: 28120232; PMCID: PMC5345356.

Other bioactive compounds in *cannabis*

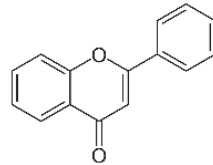
Terpenes / terpenoids

- α -pinene, D-limonene, ...



Flavonoids

- Vitexin, cannflavin A, ...



Non-cannabinoids phenols

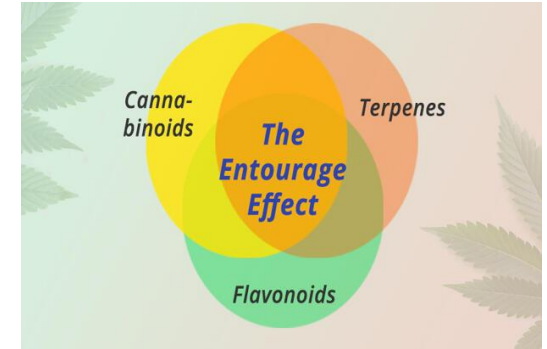
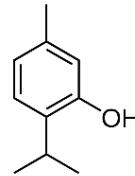
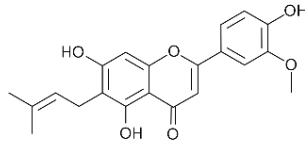
- Luteolin, ...

Alkaloids

- Cannabisativin, ...

Others

- Cannabisin A, B, ...



Discussion about „entourage effect“ in *cannabis* is ongoing...

PAIN MANAGEMENT, VOL. 11, NO. 4 | REVIEW

Open Access

Cannabis-based medicines and pain: a review of potential synergistic and entourage effects

Uma Anand , Barbara Pacchetti, Praveen Anand & Mikael Hans Sodergren

[Front Plant Sci.](#) 2016; 7: 19.

Published online 2016 Feb 4. doi: [10.3389/fpls.2016.00019](https://doi.org/10.3389/fpls.2016.00019)

PMCID: PMC4740396

PMID: [26870049](https://pubmed.ncbi.nlm.nih.gov/26870049/)

Cannabis sativa: The Plant of the Thousand and One Molecules

Christelle M. Andre,* Jean-Francois Hausman, and Gea Guerriero

Terpenoids From Cannabis Do Not Mediate an Entourage Effect by Acting at Cannabinoid Receptors

David B. Finlay*, Kathleen J. Sircombe*, Mhairi Nimick*, Callum Jones* and Michelle Glass*

Cannabis 'tea'

- Cannabis infused drink prepared by steeping dry or fresh cannabis plant (flowers and leaves) in hot water



Cannabis 'tea'

- *Cannabis* infused drink prepared by steeping dry or fresh cannabis plant (flowers and leaves) in hot water
- Alternative way of *cannabis* consumption



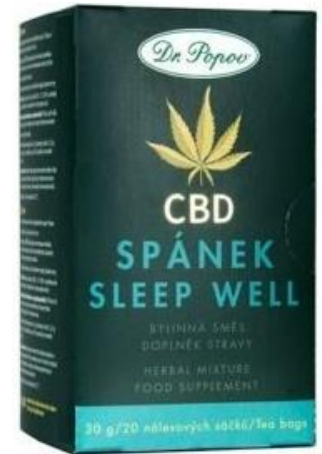
Cannabis 'tea'

- *Cannabis* infused drink prepared by steeping dry or fresh cannabis plant (flowers and leaves) in hot water
- Alternative way of *cannabis* consumption
- Traditionally used in Jamaica




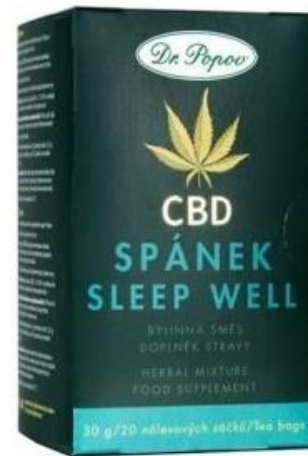
Cannabis 'tea'

- Cannabis infused drink prepared by steeping dry or fresh cannabis plant (flowers and leaves) in hot water
- Alternative way of *cannabis* consumption
- Traditionally used in Jamaica
- A growing trend in Europe



Cannabis 'tea'

- Cannabis infused drink prepared by steeping dry or fresh cannabis plant (flowers and leaves) in hot water
- Alternative way of *cannabis* consumption
- Traditionally used in Jamaica
- A growing trend in Europe 



The aim of the study



SAMPLES: 4 dried *cannabis* cultivars – CBD 1, CBD 2, CBG and THC

The aim of the study



SAMPLES: 4 dried *cannabis* cultivars – CBD 1, CBD 2, CBG and THC



The aim of the study



SAMPLES: 4 dried *cannabis* cultivars – CBD 1, CBD 2, CBG and THC

- **Target analysis:** determination of 41 phytocannabinoids transferred from herb to aqueous infusions by UHPLC-HRMS

The aim of the study



SAMPLES: 4 dried *cannabis* cultivars – CBD 1, CBD 2, CBG and THC

- **Target analysis:** determination of 41 phytocannabinoids transferred from herb to aqueous infusions by UHPLC-HRMS
 - **ISO 17025 ACCREDITED METHODS**

The aim of the study



SAMPLES: 4 dried *cannabis* cultivars – CBD 1, CBD 2, CBG and THC

- **Target analysis:** determination of 41 phytocannabinoids transferred from herb to aqueous infusions by UHPLC-HRMS
 - **ISO 17025 ACCREDITED METHODS**



The aim of the study



SAMPLES: 4 dried *cannabis* cultivars – CBD 1, CBD 2, CBG and THC

- **Target analysis:** determination of 41 phytocannabinoids transferred from herb to aqueous infusions by UHPLC-HRMS
 - ISO 17025 ACCREDITED METHODS
- **Target screening:** detection of other *cannabis* bioactive compounds transferred from herb to aqueous solutions by UHPLC-HRMS



The aim of the study



SAMPLES: 4 dried *cannabis* cultivars – CBD 1, CBD 2, CBG and THC

- **Target analysis:** determination of 41 phytocannabinoids transferred from herb to aqueous infusions by UHPLC-HRMS
 - ISO 17025 ACCREDITED METHODS
- **Target screening:** detection of other *cannabis* bioactive compounds transferred from herb to aqueous solutions by UHPLC-HRMS



The aim of the study



SAMPLES: 4 dried *cannabis* cultivars – CBD 1, CBD 2, CBG and THC

- **Target analysis:** determination of 41 phytocannabinoids transferred from herb to aqueous infusions by UHPLC-HRMS
 - ISO 17025 ACCREDITED METHODS
- **Target screening:** detection of other *cannabis* bioactive compounds transferred from herb to aqueous solutions by UHPLC-HRMS

Screening against in-house spectral library based on literature, currently: 745 compounds involved including 281 minor phytocannabinoids and 464 other compounds



Experimental part



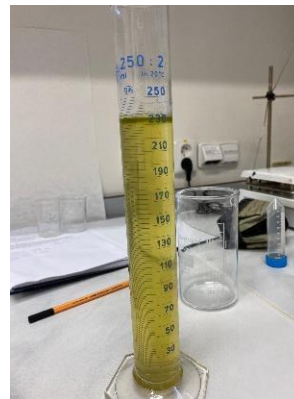
1 g of homogenised cannabis herb



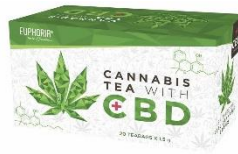
250 ml of water



Boiling for 10 min



Filtration of solid particles – aqueous solution

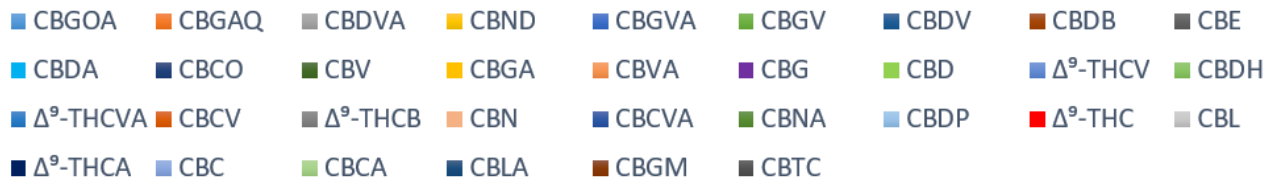
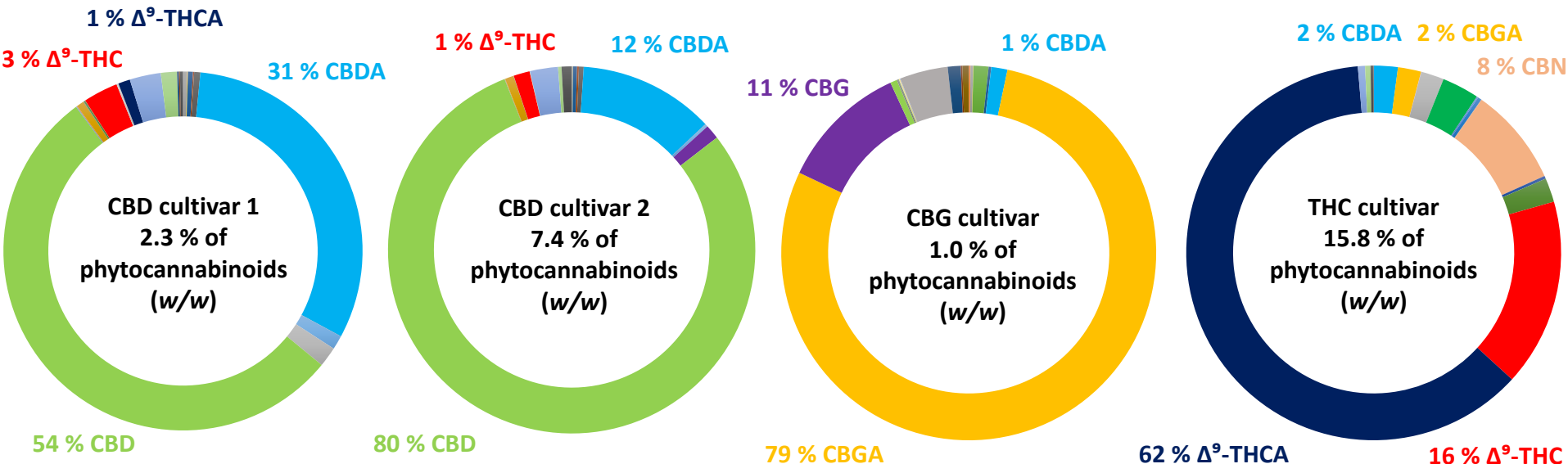


UHPLC-HRMS analysis



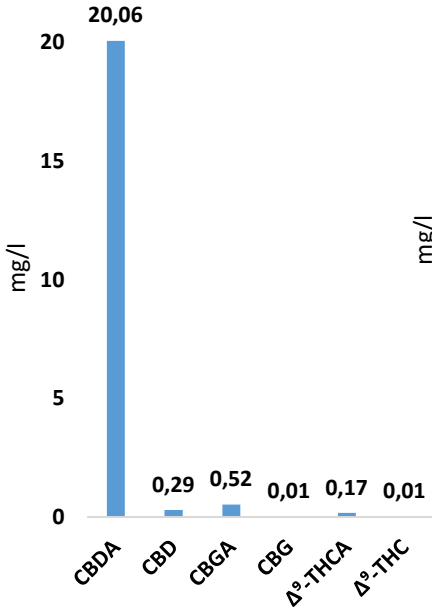
RESULTS AND DISCUSSION

Characterization of 4 dry cannabis cultivars by UHPLC-HRMS target analysis

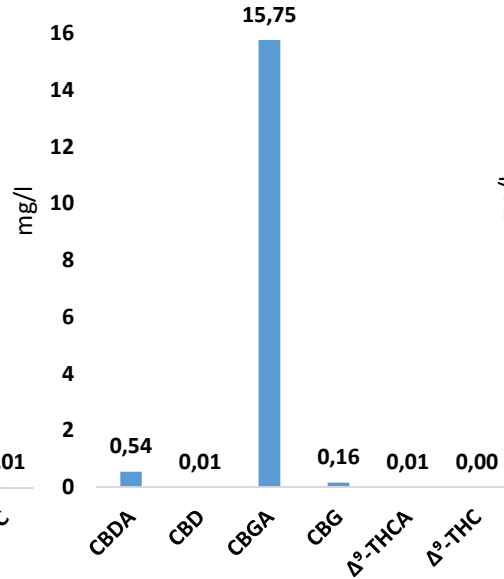


Concentration of 6 main phytocannabinoids in 1 l of aqueous infusions

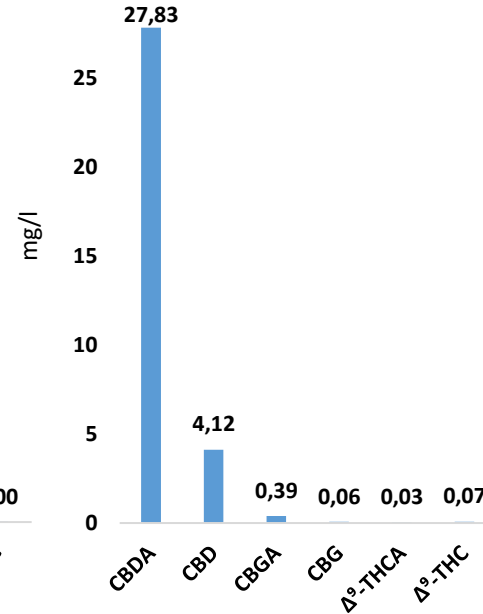
CBD cultivar 1



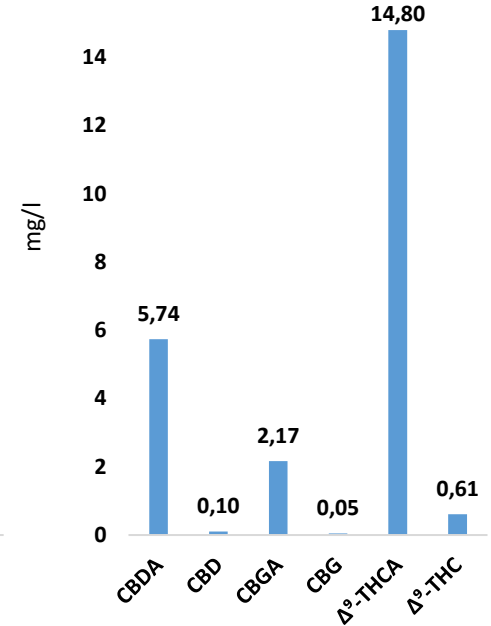
CBG cultivar



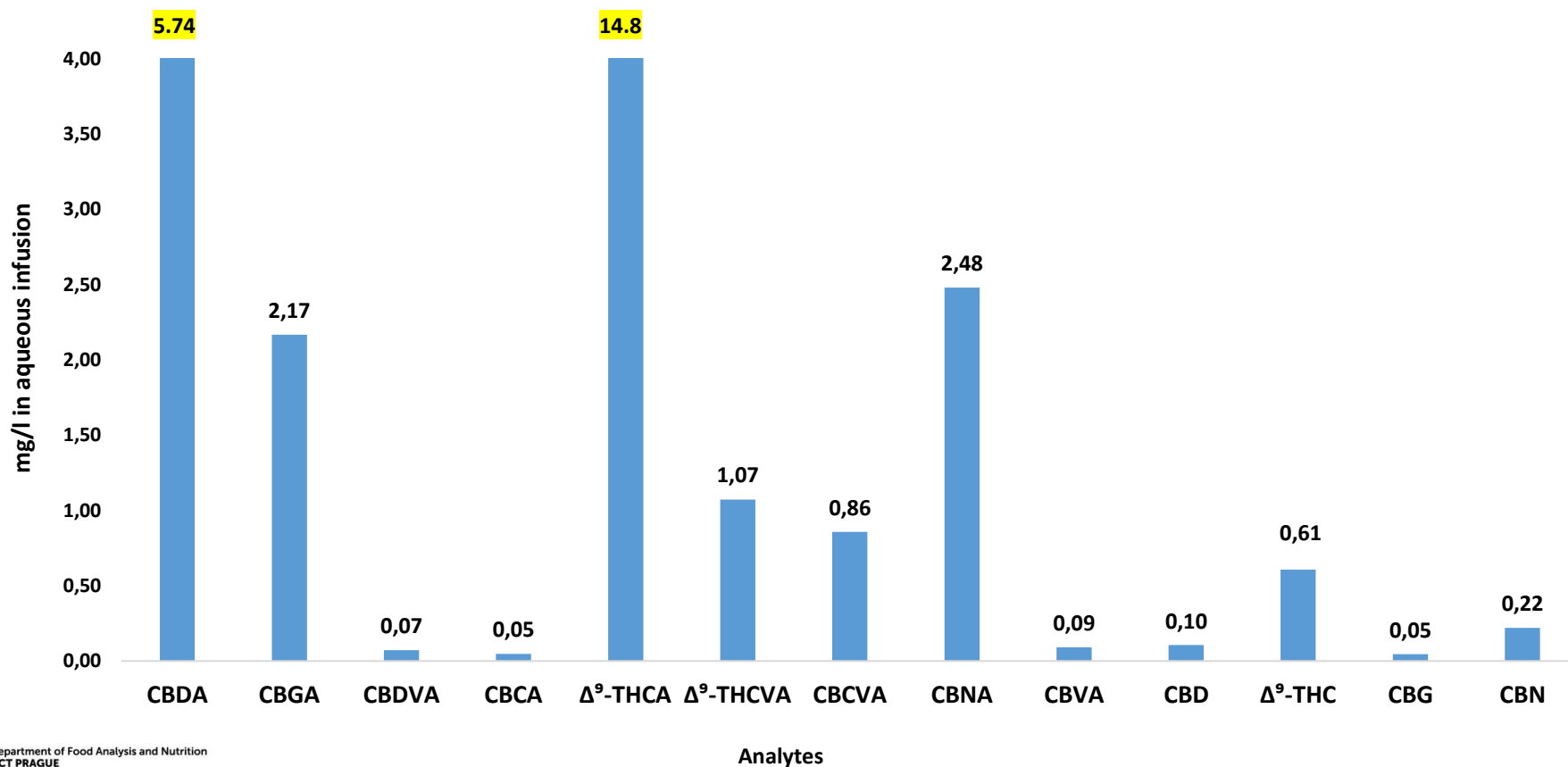
CBD cultivar 2



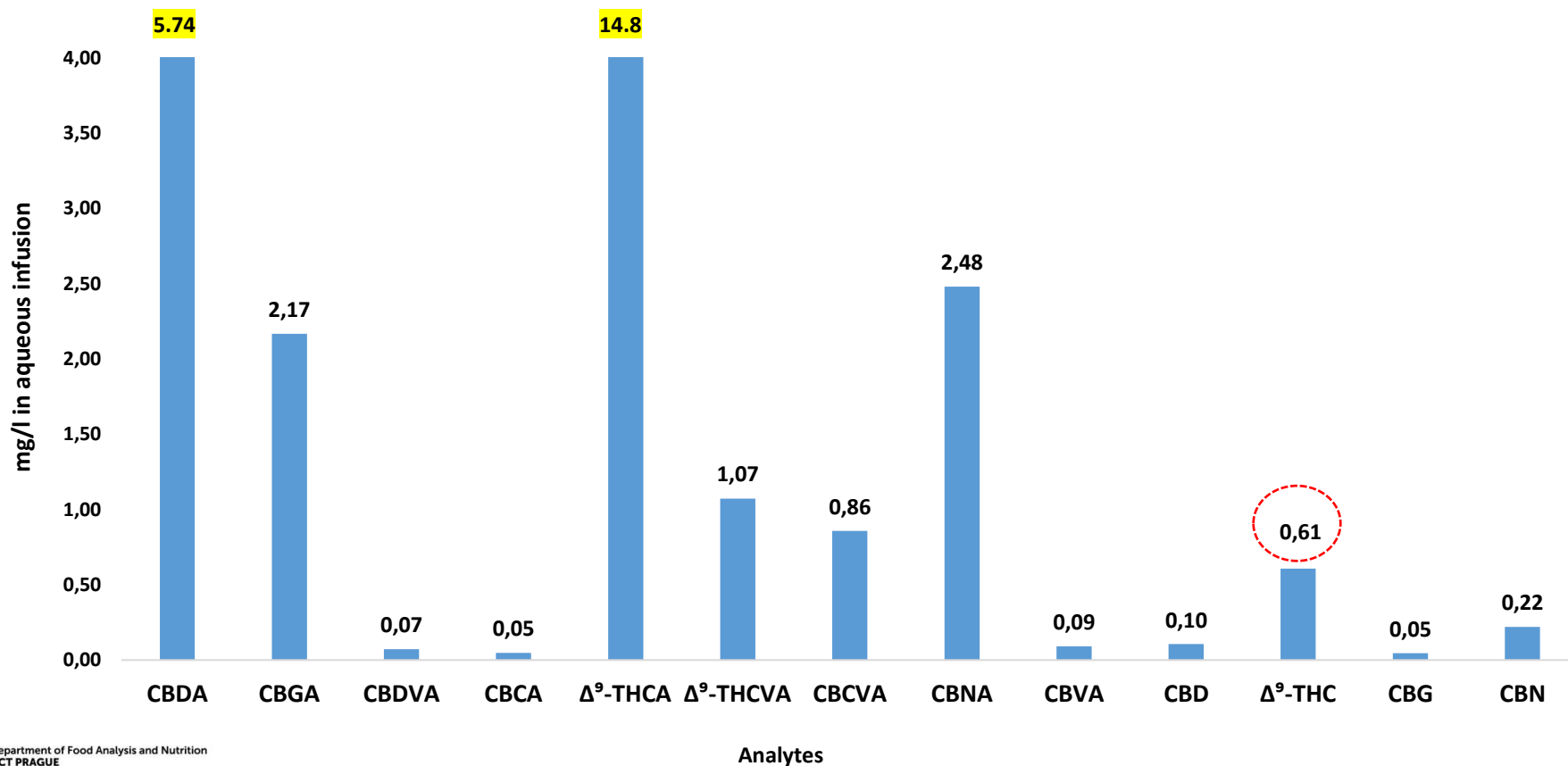
THC cultivar



High THC cultivar - concentration of phytocannabinoids (mg/l) in aqueous infusion

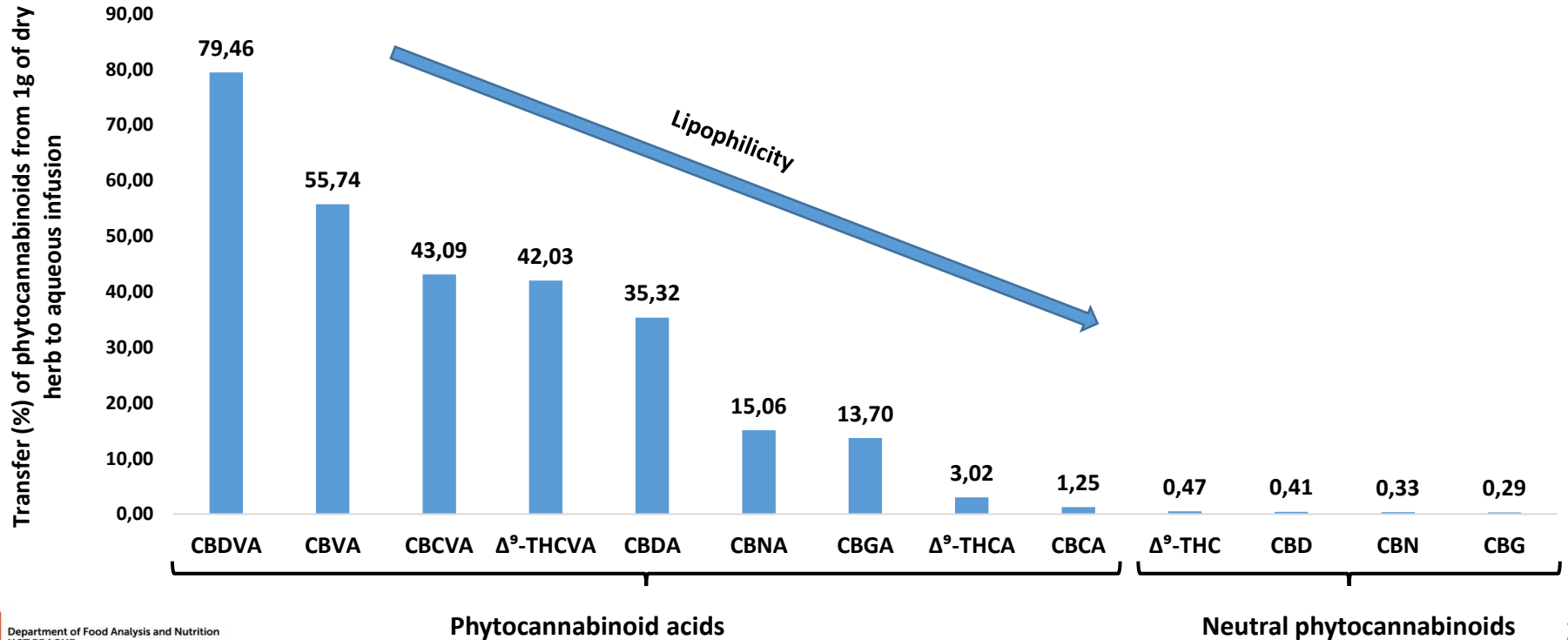


High THC cultivar - concentration of phytocannabinoids (mg/l) in aqueous infusion



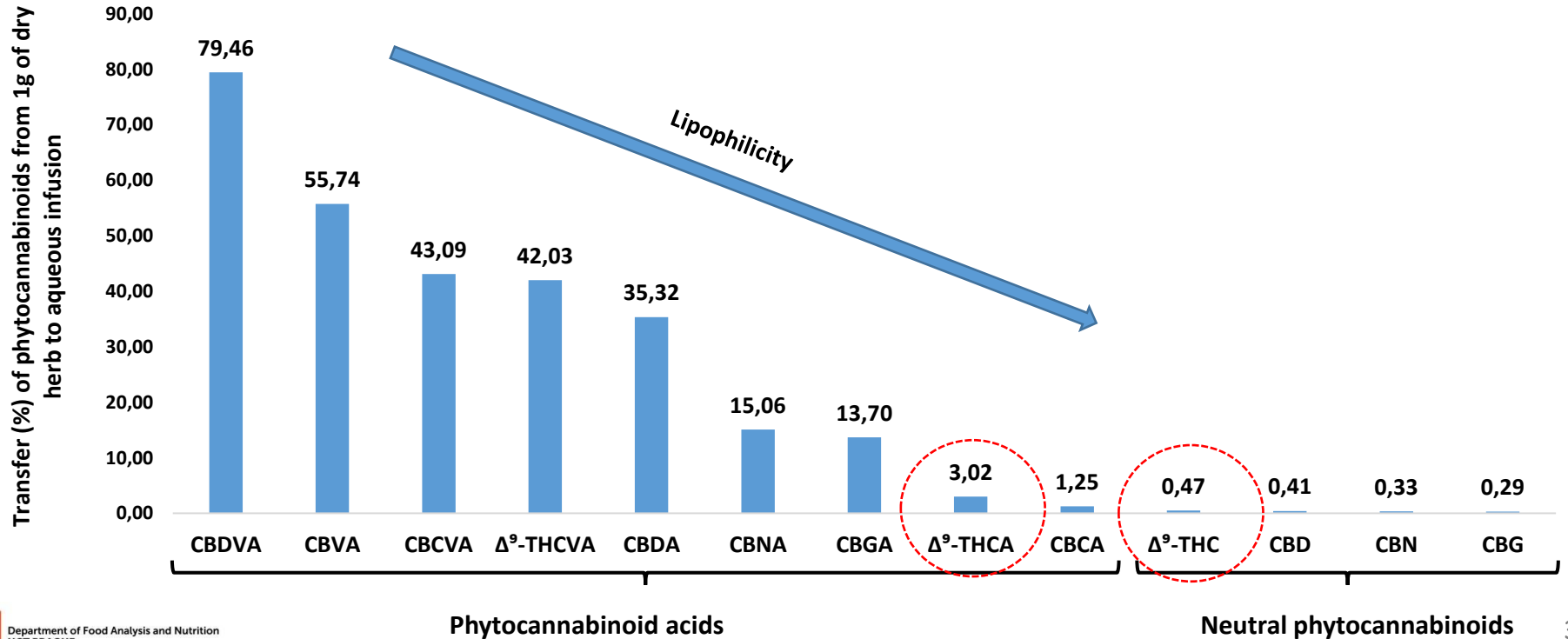
Phytocannabinoids transfer to aqueous infusion

Transfer (%) of phytocannabinoids from 1g of dry THC cultivar to 200 ml of aqueous infusion



Phytocannabinoids transfer to aqueous infusion

Transfer (%) of phytocannabinoids from 1g of dry THC cultivar to 200 ml of aqueous infusion



Transfer of Δ^9 -THC – Is cannabis tea safe?

- Acute reference dose ARfD for Δ^9 -THC – **1 $\mu\text{g}/\text{kg}$ body weight** defined by EFSA (2015)

Transfer of Δ^9 -THC – Is cannabis tea safe?

- Acute reference dose ARfD for Δ^9 -THC – **1 $\mu\text{g}/\text{kg}$ body weight** defined by EFSA (2015)
- How many ml of cannabis tea would a 70 kg person have to drink to fulfill the ARfD?

Transfer of Δ^9 -THC – Is cannabis tea safe?

- Acute reference dose ARfD for Δ^9 -THC – **1 $\mu\text{g}/\text{kg}$ body weight** defined by EFSA (2015)
- How many ml of cannabis tea would a 70 kg person have to drink to fulfill the ARfD?




Transfer of Δ^9 -THC – Is cannabis tea safe?

- Acute reference dose ARfD for Δ^9 -THC – **1 $\mu\text{g}/\text{kg}$ body weight** defined by EFSA (2015)
- How many ml of cannabis tea would a 70 kg person have to drink to fulfill the ARfD?
 - Sample 1 (CBD cultivar 1) – 7.5 l




Transfer of Δ^9 -THC – Is cannabis tea safe?

- Acute reference dose ARfD for Δ^9 -THC – **1 $\mu\text{g}/\text{kg}$ body weight** defined by EFSA (2015)
- How many ml of cannabis tea would a 70 kg person have to drink to fulfill the ARfD?
 - Sample 1 (CBD cultivar 1) – 7.5 l 



Transfer of Δ^9 -THC – Is cannabis tea safe?

- Acute reference dose ARfD for Δ^9 -THC – **1 $\mu\text{g}/\text{kg}$ body weight** defined by EFSA (2015)
- How many ml of cannabis tea would a 70 kg person have to drink to fulfill the ARfD?
 - Sample 1 (CBD cultivar 1) – 7.5 l 
 - Sample 2 (CBG cultivar) – 22 l



Transfer of Δ^9 -THC – Is cannabis tea safe?

- Acute reference dose ARfD for Δ^9 -THC – **1 $\mu\text{g}/\text{kg}$ body weight** defined by EFSA (2015)
- How many ml of cannabis tea would a 70 kg person have to drink to fulfill the ARfD?
 - Sample 1 (CBD cultivar 1) – 7.5 l ✓
 - Sample 2 (CBG cultivar) – 22 l ✓



Transfer of Δ^9 -THC – Is cannabis tea safe?

- Acute reference dose ARfD for Δ^9 -THC – **1 $\mu\text{g}/\text{kg}$ body weight** defined by EFSA (2015)
- How many ml of cannabis tea would a 70 kg person have to drink to fulfill the ARfD?
 - Sample 1 (CBD cultivar 1) – 7.5 l ✓
 - Sample 2 (CBG cultivar) – 22 l ✓
 - Sample 3 (CBD cultivar 2) – 0.980 l



Transfer of Δ^9 -THC – Is cannabis tea safe?

- Acute reference dose ARfD for Δ^9 -THC – **1 $\mu\text{g}/\text{kg}$ body weight** defined by EFSA (2015)
- How many ml of cannabis tea would a 70 kg person has to drink to fullfill the ARfD?
 - Sample 1 (CBD cultivar 1) – 7.5 l ✓
 - Sample 2 (CBG cultivar) – 22 l ✓
 - Sample 3 (CBD cultivar 2) – 0.980 l ⚠








Transfer of Δ^9 -THC – Is cannabis tea safe?

- Acute reference dose ARfD for Δ^9 -THC – **1 $\mu\text{g}/\text{kg}$ body weight** defined by EFSA (2015)
- How many ml of cannabis tea would a 70 kg person has to drink to fulfill the ARfD?
 - Sample 1 (CBD cultivar 1) – 7.5 l ✓
 - Sample 2 (CBG cultivar) – 22 l ✓
 - Sample 3 (CBD cultivar 2) – 0.980 l ⚠
 - Sample 4 (THC cultivar) – 0.115 l



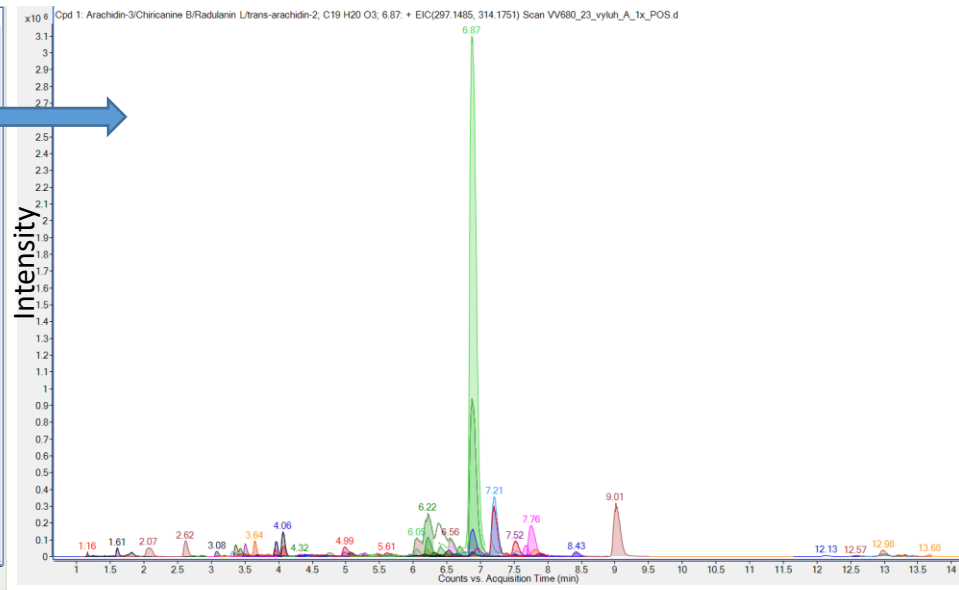
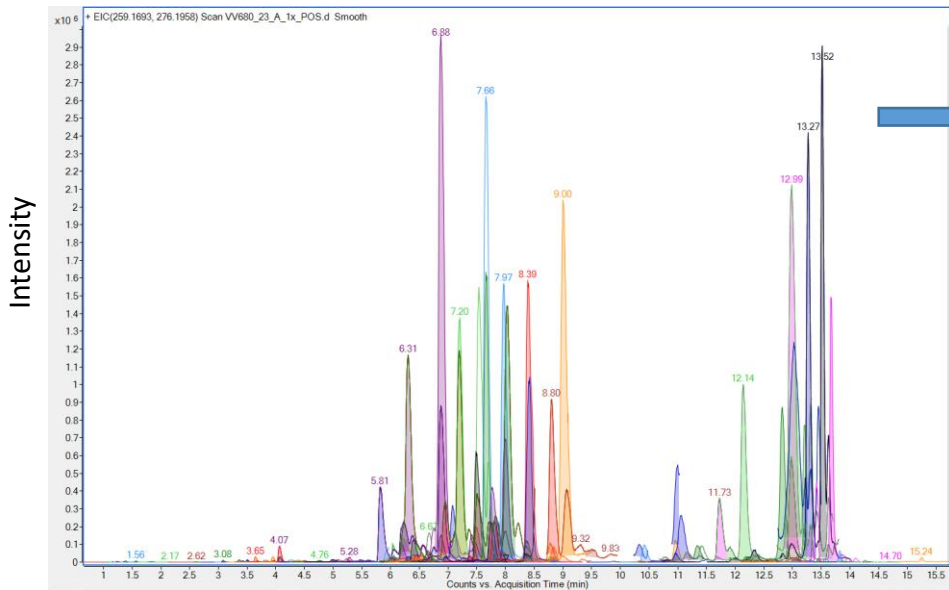
Transfer of Δ^9 -THC – Is cannabis tea safe?

- Acute reference dose ARfD for Δ^9 -THC – **1 $\mu\text{g}/\text{kg}$ body weight** defined by EFSA (2015)
- How many ml of cannabis tea would a 70 kg person has to drink to fullfill the ARfD?
 - Sample 1 (CBD cultivar 1) – 7.5 l 
 - Sample 2 (CBG cultivar) – 22 l 
 - Sample 3 (CBD cultivar 2) – 0.980 l 
 - Sample 4 (THC cultivar) – 0.115 l  



What about other bioactive compounds in *cannabis* tea?

XICs (ESI+) ; UHPLC – HRMS analysis

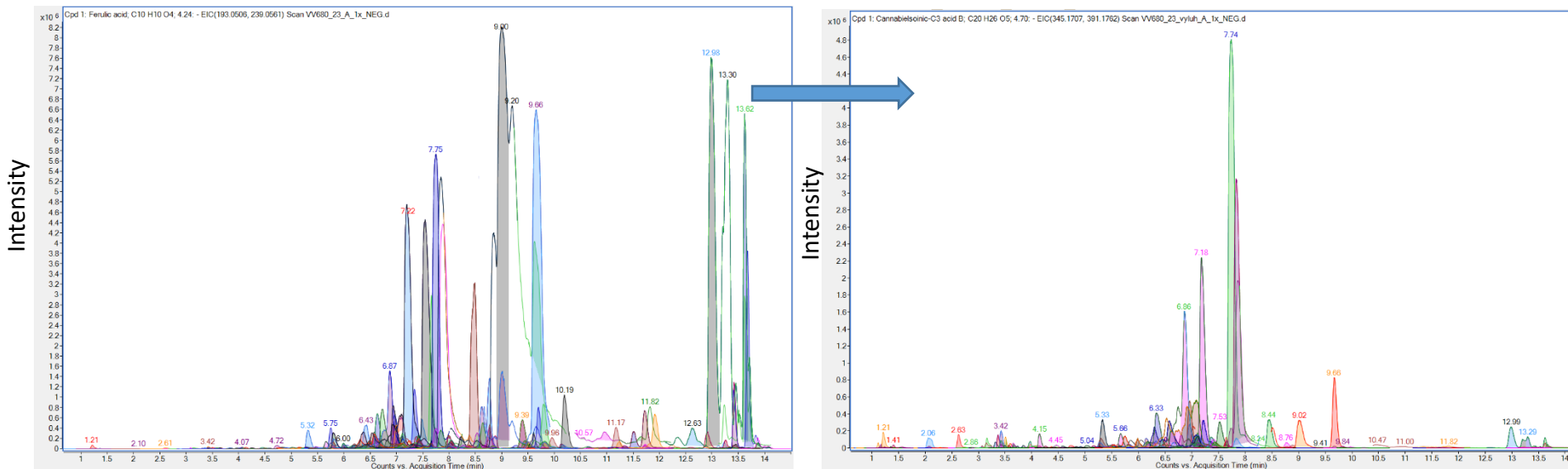


Dry *cannabis* THC cultivar:
99 minor cannabinoids and 91 other
compounds detected

Cannabis aqueous infusion:
Transfer of 51 cannabinoids (52 %)
and 63 other compounds (69 %)

How about other bioactive compounds in *cannabis* tea?

XICs (ESI-) ; UHPLC – HRMS analysis



Dry *cannabis* herb:
222 minor cannabinoids and 124 other
compounds detected



Cannabis aqueous infusion:
Transfer of 142 cannabinoids (64 %)
and 112 other compounds (90 %)

Conclusions



11

Conclusions

- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars



11

Conclusions



- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars
- The transfer of **acidic phytocannabinoids** to aqueous infusion >>> the transfer of **neutral phytocannabinoids**

11

Conclusions



- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars
- The transfer of **acidic phytocannabinoids** to aqueous infusion >>> the transfer of **neutral phytocannabinoids**

11



Conclusions



- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars
 - The transfer of **acidic phytocannabinoids** to aqueous infusion >>> the transfer of **neutral phytocannabinoids**
- Unique way of cannabis intake – limited decarboxylation step, specific extraction of **more polar compounds**

11

Conclusions



- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars
- The transfer of **acidic phytocannabinoids** to aqueous infusion >>> the transfer of **neutral phytocannabinoids**
- ↳ Unique way of cannabis intake – limited decarboxylation step, specific extraction of **more polar compounds**
- Transfer of Δ^9 -THC into infusion under experimental conditions – **only 0.47 %**

11

Conclusions



- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars
- The transfer of **acidic phytocannabinoids** to aqueous infusion >>> the transfer of **neutral phytocannabinoids**
- ↳ Unique way of cannabis intake – limited decarboxylation step, specific extraction of **more polar compounds**
- Transfer of **Δ^9 -THC** into infusion under experimental conditions – **only 0.47 %**
- In case of varieties with higher phytocannabinoid content, it is relatively easy to exceed the EFSA acute reference dose for Δ^9 -THC (by drinking 980 and 115 ml of tea, respectively)

11

Conclusions



- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars
- The transfer of **acidic phytocannabinoids** to aqueous infusion >>> the transfer of **neutral phytocannabinoids**
- ↳ Unique way of cannabis intake – limited decarboxylation step, specific extraction of **more polar compounds**
- Transfer of **Δ^9 -THC** into infusion under experimental conditions – **only 0.47 %**
- In case of varieties with higher phytocannabinoid content, it is relatively easy to exceed the EFSA acute reference dose for Δ^9 -THC (by drinking 980 and 115 ml of tea, respectively)
- *Cannabis* 'tea' contains many potentially beneficial compounds

11

Conclusions



- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars
- The transfer of **acidic phytocannabinoids** to aqueous infusion >>> the transfer of **neutral phytocannabinoids**
- ↳ Unique way of cannabis intake – limited decarboxylation step, specific extraction of **more polar compounds**
- Transfer of **Δ^9 -THC** into infusion under experimental conditions – **only 0.47 %**
- In case of varieties with higher phytocannabinoid content, it is relatively easy to exceed the EFSA acute reference dose for Δ^9 -THC (by drinking 980 and 115 ml of tea, respectively)
- ↳ *Cannabis* 'tea' contains many potentially beneficial compounds

11

Conclusions



- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars
- The transfer of **acidic phytocannabinoids** to aqueous infusion >>> the transfer of **neutral phytocannabinoids**
- Unique way of cannabis intake – limited decarboxylation step, specific extraction of **more polar compounds**
- Transfer of Δ^9 -THC into infusion under experimental conditions – **only 0.47 %**
- In case of varieties with higher phytocannabinoid content, it is relatively easy to exceed the EFSA acute reference dose for Δ^9 -THC (by drinking 980 and 115 ml of tea, respectively)
- *Cannabis* 'tea' contains many potentially beneficial compounds
- transfer > 50 % of minor phytocannabinoids and > 70 % of other bioactive compounds from dry cannabis herb to aqueous infusion

11

Conclusions



- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars
- The transfer of **acidic phytocannabinoids** to aqueous infusion >>> the transfer of **neutral phytocannabinoids**
- Unique way of cannabis intake – limited decarboxylation step, specific extraction of **more polar compounds**
- Transfer of **Δ^9 -THC** into infusion under experimental conditions – **only 0.47 %**
- In case of varieties with higher phytocannabinoid content, it is relatively easy to exceed the EFSA acute reference dose for Δ^9 -THC (by drinking 980 and 115 ml of tea, respectively)
- *Cannabis* 'tea' contains many potentially beneficial compounds
- transfer > 50 % of minor phytocannabinoids and > 70 % of other bioactive compounds from dry cannabis herb to aqueous infusion

Plans for future:

Conclusions



- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars
- The transfer of **acidic phytocannabinoids** to aqueous infusion >>> the transfer of **neutral phytocannabinoids**
- Unique way of cannabis intake – limited decarboxylation step, specific extraction of **more polar compounds**
- Transfer of **Δ^9 -THC** into infusion under experimental conditions – **only 0.47 %**
- In case of varieties with higher phytocannabinoid content, it is relatively easy to exceed the EFSA acute reference dose for Δ^9 -THC (by drinking 980 and 115 ml of tea, respectively)
- *Cannabis* 'tea' contains many potentially beneficial compounds
- transfer > 50 % of minor phytocannabinoids and > 70 % of other bioactive compounds from dry cannabis herb to aqueous infusion

Plans for future:

- Correlation of biological activity of cannabis infusions with their chemical composition

Conclusions



- UHPLC-HRMS analysis showed a **completely different profile** of the 4 cannabis cultivars
- The transfer of **acidic phytocannabinoids** to aqueous infusion >>> the transfer of **neutral phytocannabinoids**
- Unique way of cannabis intake – limited decarboxylation step, specific extraction of **more polar compounds**
- Transfer of Δ^9 -THC into infusion under experimental conditions – **only 0.47 %**
- In case of varieties with higher phytocannabinoid content, it is relatively easy to exceed the EFSA acute reference dose for Δ^9 -THC (by drinking 980 and 115 ml of tea, respectively)
- *Cannabis* 'tea' contains many potentially beneficial compounds
- transfer > 50 % of minor phytocannabinoids and > 70 % of other bioactive compounds from dry cannabis herb to aqueous infusion

Plans for future:

- Correlation of biological activity of cannabis infusions with their chemical composition
- Adding of a cream to water infusion



Thank you very much for your kind attention...



Department of Food Analysis and Nutrition
UCT PRAGUE



Prof. Jana Hajšlová



Ing. František Beneš



Ing. Zuzana Bínová



Dr. Marie Zlechovcová

