

Investigating Water Functionality



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There are many 'waters' in the world



What functional effect do they have?



What Does Water do for You?

- Forms saliva (digestion)
- Keeps mucousal membranes moist
- Allows body's cells to grow, reproduce and survive
- Flushes body waste, mainly in urine
- Lubricates joints
- Water is the major component of most body parts
- Needed by the brain to manufacture hormones and neurotransmitters
- Regulates body temperature (sweating and respiration)
- Acts as a shock absorber for brain and spinal cord
- Converts food to components needed for survival - digestion
- Helps deliver oxygen all over the body

There is a need for...

...**differentiating** waters by functionality

...personalized **advice** to consumers

...**informing** water providers

Knowing that water is dynamic and open!!



Aim is to

- 1 • scientifically investigate **functional effects** of water
- 2 • design a **reproducible** method to measure water functionality
- 3 • (be able to) explain **why** water behaves in a certain functional way
- 4 • (be able to) **inform** consumers and providers

First step to investigate functional effect of Esenca water vitalizing device



Tap water before going through Esenca device
(Control)

Hypothesized that Esenca water:

- Improves resilience, has a good effect on health
- Is open to natural rhythms, but undisturbed by unnatural influences
- Has properties for a long time (stable)



4 Esenca devices in greenhouse



Tap water after going through Esenca device
(Activated)

Experiments to measure effects of Control and Activated water on agricultural products

5 years biological observations



Results were indicative of hypothesized functionality, however:
These tests are time consuming, external factors influence results, such as season, weather, sunlight, soil condition, diversity within the species, etc.

Experiments to measure effects of Control and Activated water on agricultural products

4 years spectral data (UV/VIS, Raman, NIR, delayed luminescence)

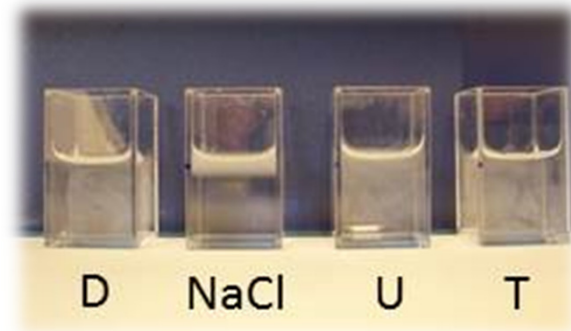


Results showed differences between Activated and Control grown vegetables, but more spectra and analysis required for statistical significant conclusions.

Experiments to measure differences between Control and Activated water directly in the lab

physical tests

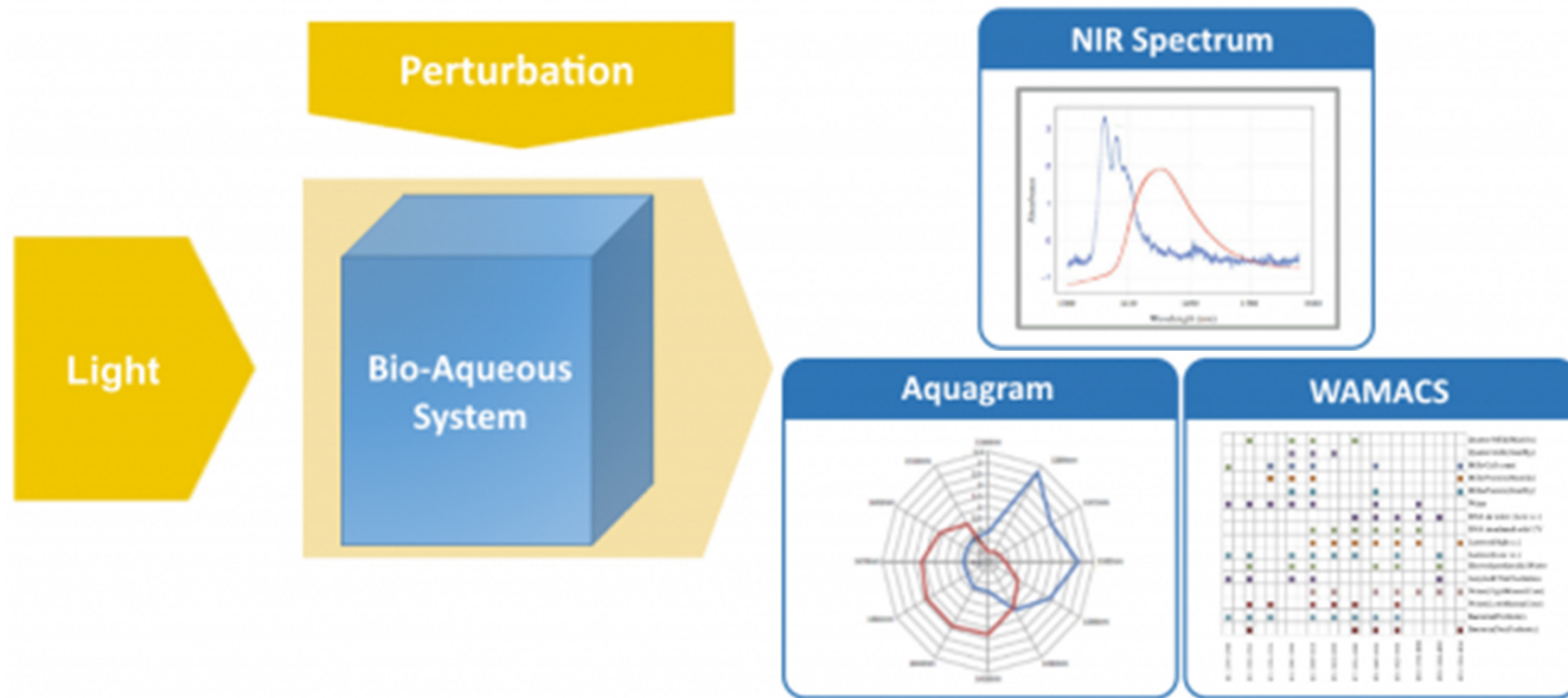
- Diffusion of substances
- Diffusion of waters on filter paper
- Exclusion zone size
- pH level
- Redox level
- Conductivity



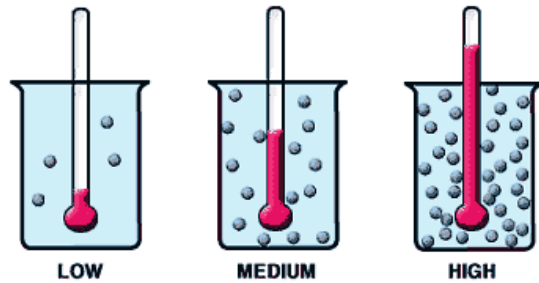
Results were inconclusive and some tests were very difficult to perform accurately.

Experiments to measure differences between Control and Activated water directly in the lab

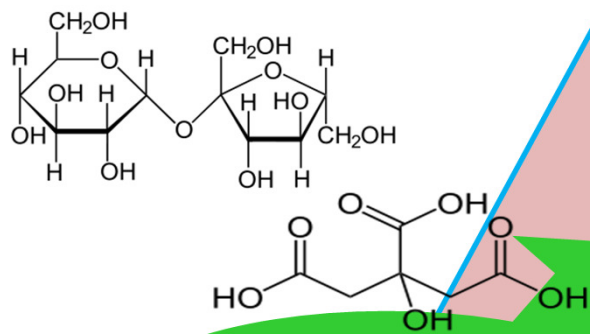
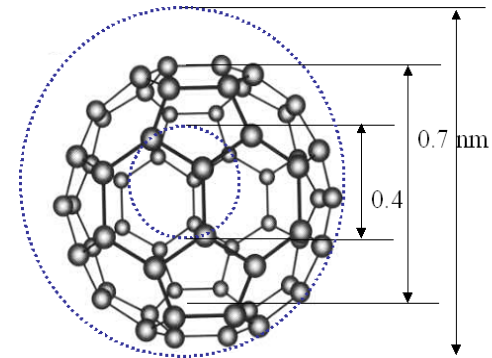
Near-infrared spectroscopy with **aquaphotomics** approach



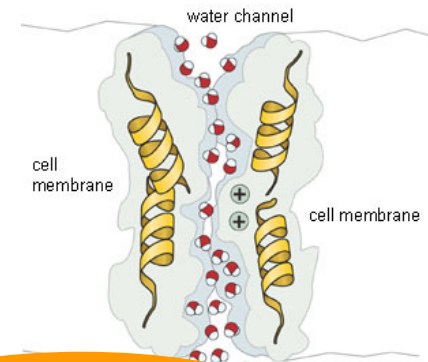
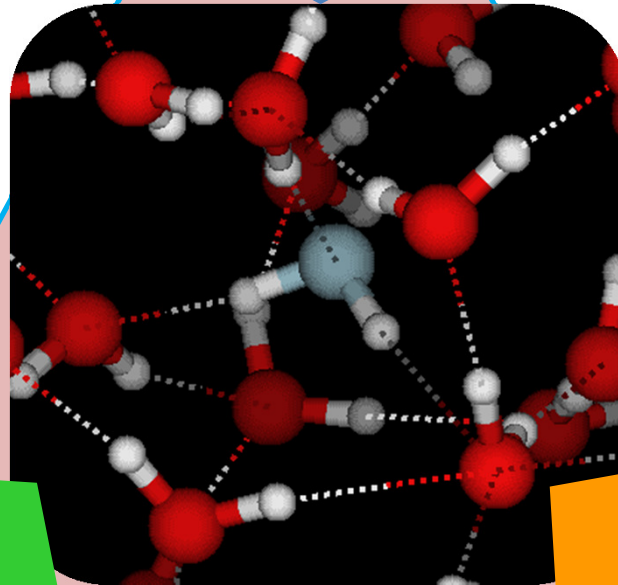
Water absorption spectrum changes in bio systems under various perturbations



Physical



Chemical



Biological

Introduce perturbations deliberately to investigate water

Probe/tickle/challenge/perturb water

- To measure behavior/reaction of water
- To overrule external factors influencing the experiment



Hypothesis determines ‘choice of perturbation’ and what can be found.

There is much more to water than what can be measured in one experiment.

Hypotheses for Esenca water

- Improves resilience, has good effect on health
- Is open to natural rhythms, but undisturbed by unnatural influences
- Has properties for a long time (stable)

- Assume effect of device is of **physical** nature
- Goal to find a **reproducible/stable** property

Our first choice was to introduce **temperature** perturbations

Measurement protocol

1. Filter with 0,2 μm filter
 2. Cool to 2°C (wait 8 minutes)
 3. Increase temperature stepwise to 50°C (per step 4 minutes and 80 spectra)
 4. Decrease temperature stepwise to 2°C (per step 6 minutes and 120 spectra)
- Shutter of halogen lamp is closed after every spectrum
 - One spectrum is average of 64 scans
 - One scan has integration time of 23ms
 - One measurement takes ~3hours



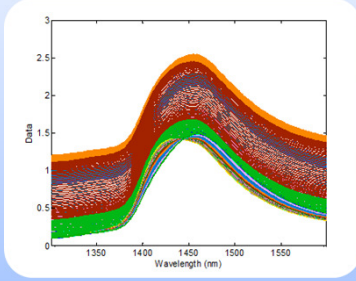
Experiments



Exp. #	Experiment Date	Water tapping Date
1	09-04-2015	07-04-2015
2	10-04-2015	07-04-2015
3	23-04-2015	07-04-2015
4	24-04-2015	07-04-2015
5	20-05-2015	18-05-2015
6	21-05-2015	18-05-2015
7	27-05-2015	18-05-2015
8	28-05-2015	18-05-2015
9	15-06-2015	09-09-2014
10	16-06-2015	09-09-2014

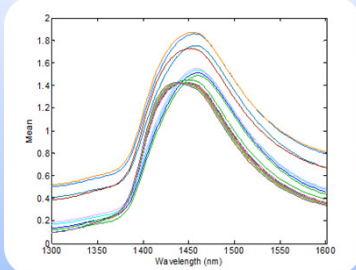
- Stability during
 - Day
 - Month
 - Year
- Stability for different tapping dates

Results visualized in aquagrams



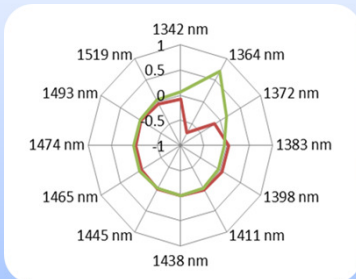
Raw spectra (1300-1600nm)

- 10^{-4} nm differences are relevant
- High accuracy and stable measurement set up required



Process spectra

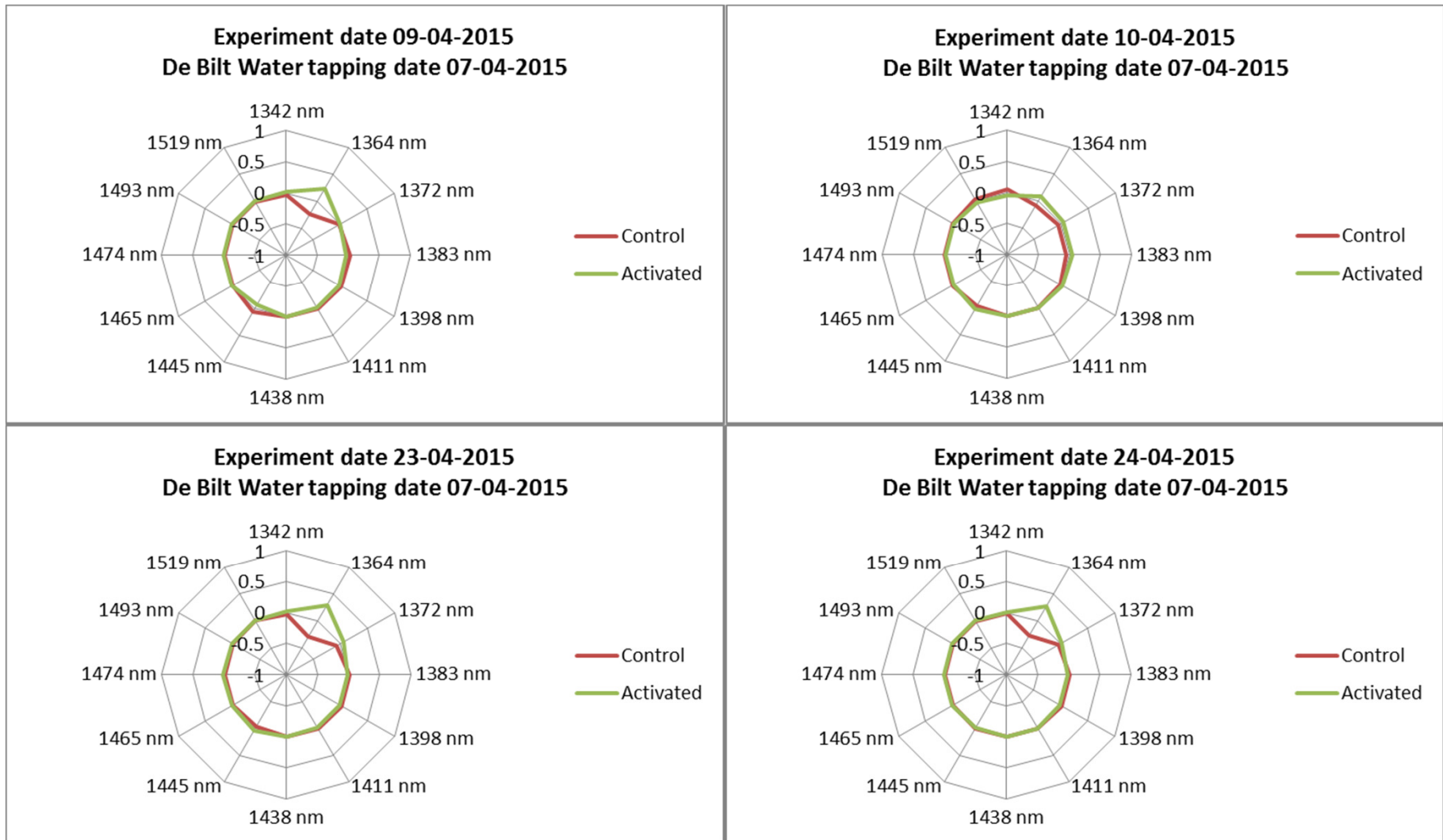
- Smoothing
- Extended multiplicative scatter correction



Calculate aquagrams at 12 main WAMACS

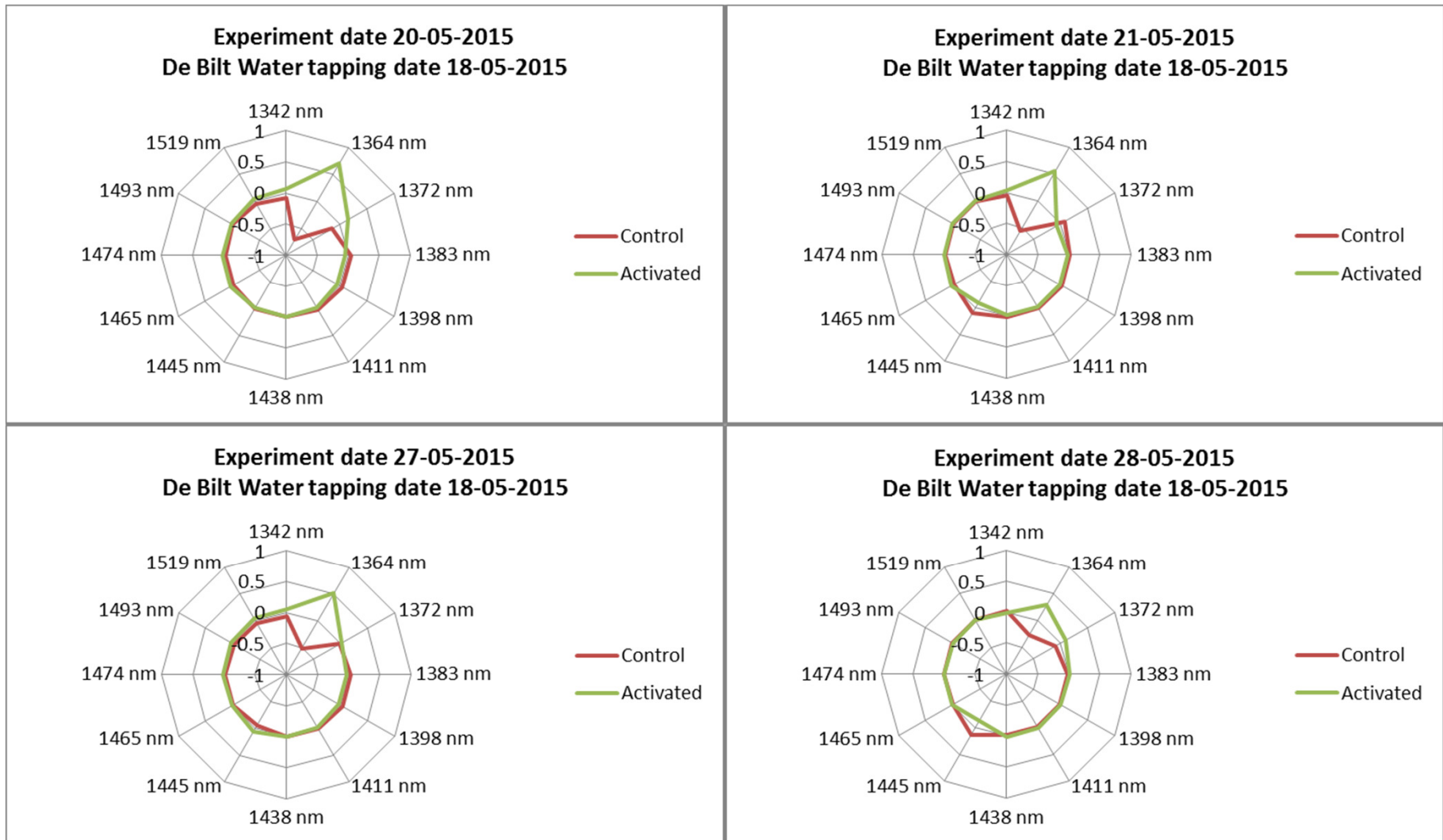
- $(\text{Control})_{\lambda} = ((\text{AVG Control})_{\lambda} - (\text{AVG all})_{\lambda}) / (\text{SD all})_{\lambda}$
- $(\text{Activated})_{\lambda} = ((\text{AVG Activated})_{\lambda} - (\text{AVG all})_{\lambda}) / (\text{SD all})_{\lambda}$

Control and Activated water of same tapping date 1



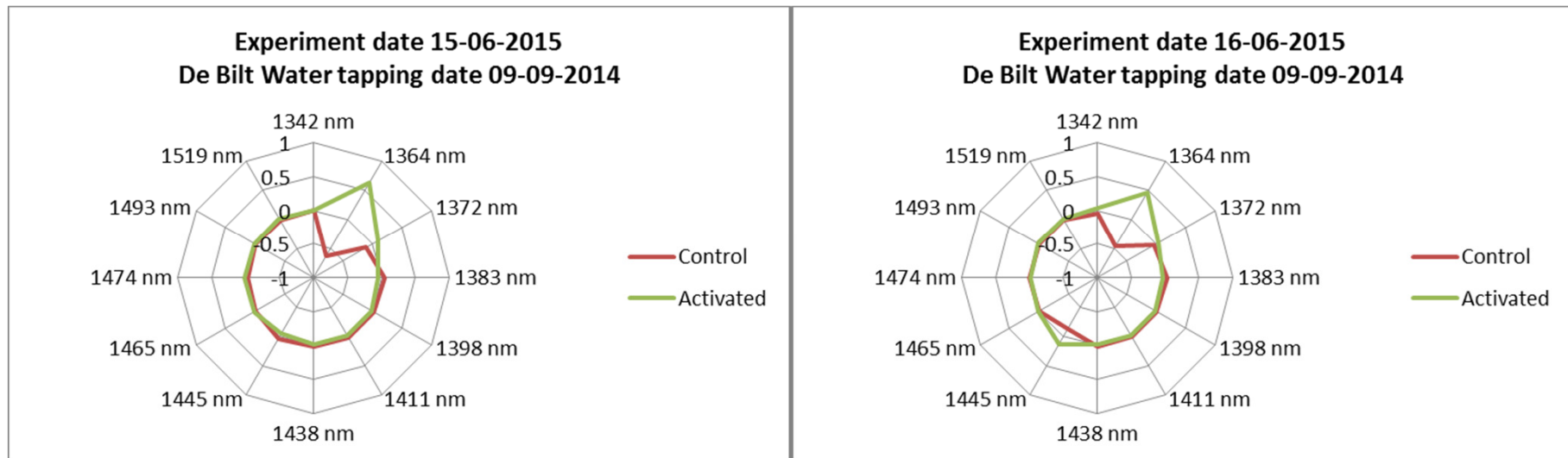
show repeatable differences during day and month

Control and Activated water of same tapping date 2



show repeatable differences during day and month

9 months old Control and Activated water



show the same differences
indicating that the effect is 'stable' for a long time

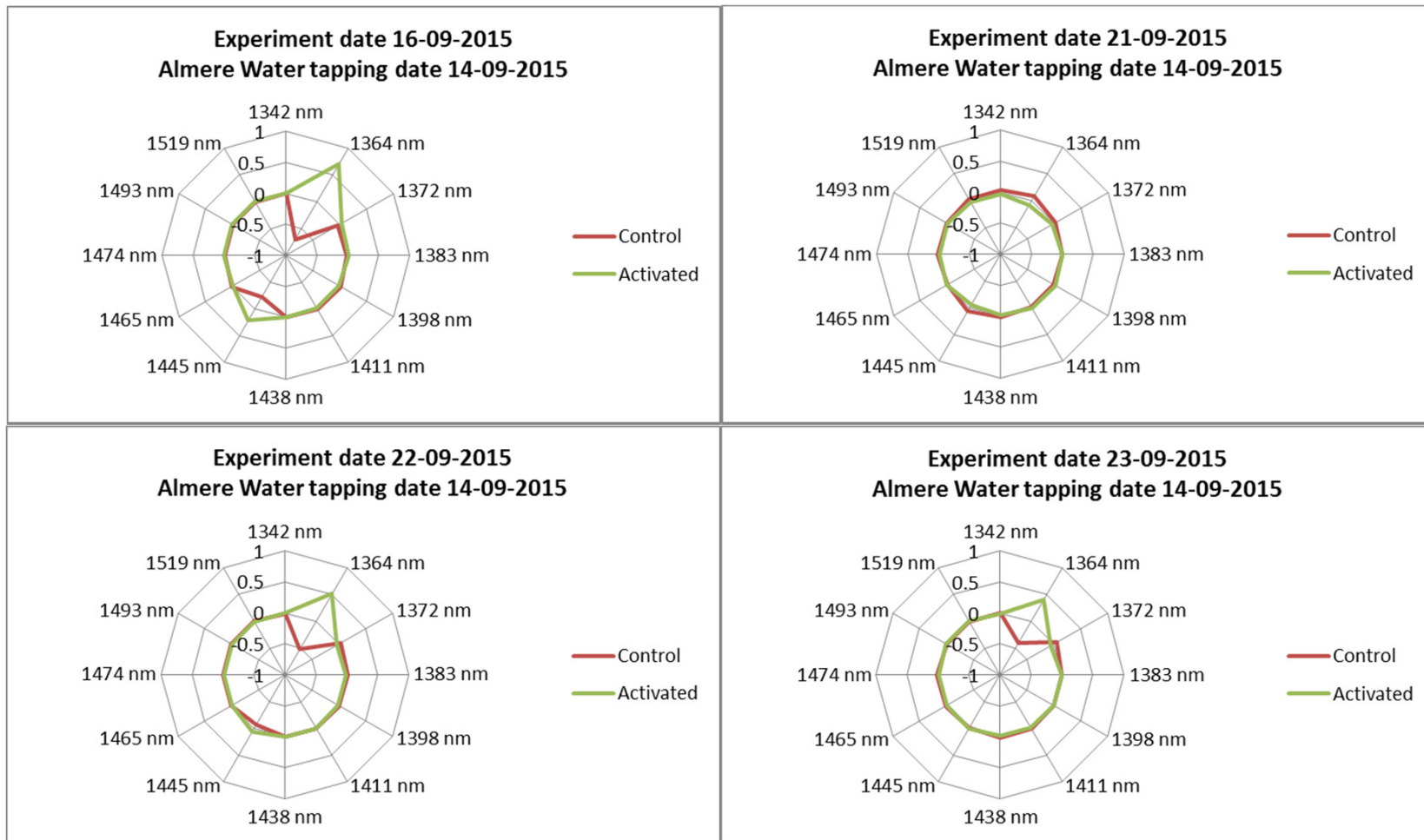
More experiments



Exp. #	Experiment Date	Water tapping Date
1	16-09-2015	14-09-2015
2	21-09-2015	14-09-2015
3	22-09-2015	14-09-2015
4	23-09-2015	14-09-2015
5	15-09-2015	14-09-2015
6	24-09-2015	14-09-2015
7	25-09-2015	24-09-2015
8	28-09-2015	24-09-2015

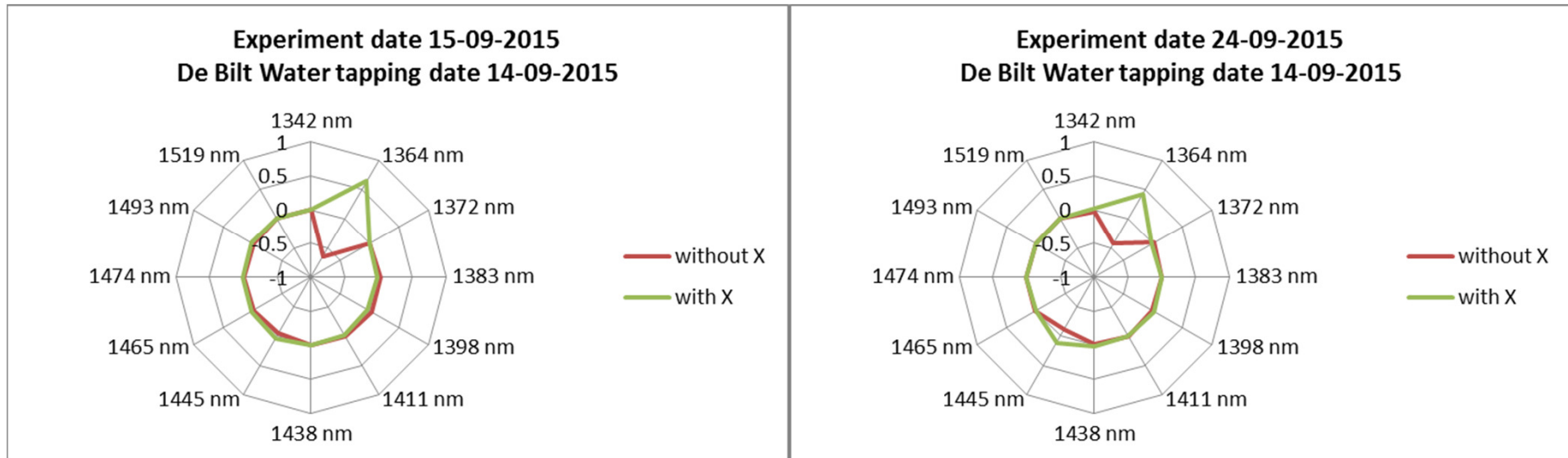
- Different incoming tap water effect?
- Effect of components inside device?
 - Component X out
 - Component Y out (Y inside X)

Other tap water shows the same results



Indicating that the effect is **independent** of incoming tap water

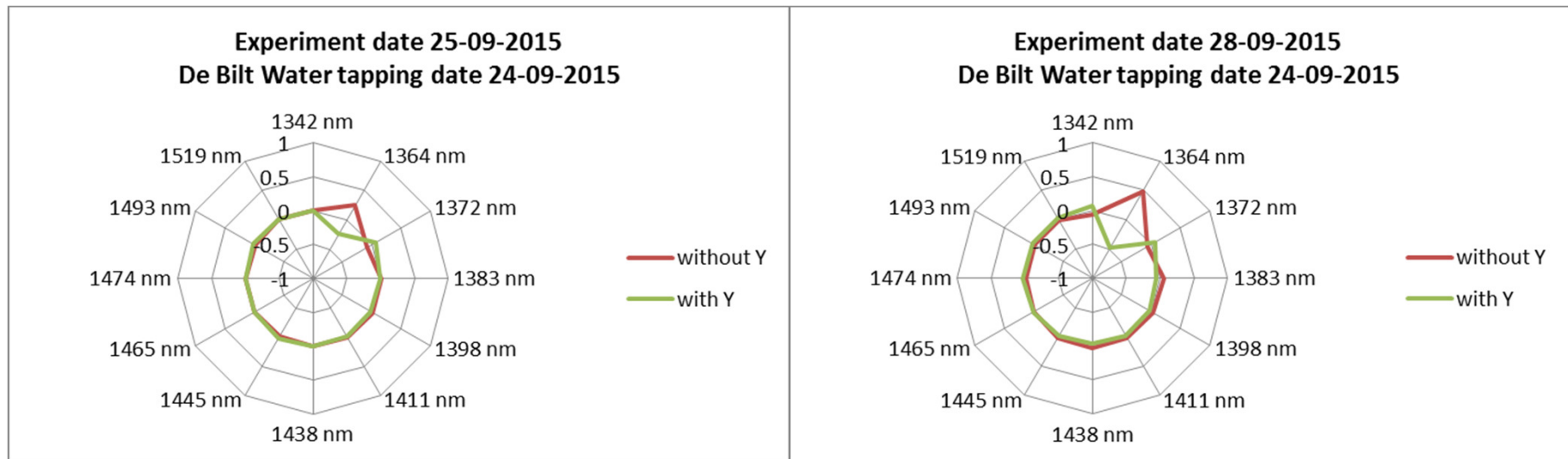
Comparing effect of water activation with and without component X



Component X seems to play a major role in the earlier presented device effect

Aquaphotomics protocol aids in device design

Comparing effect of water activation with and without component Y (component Y is inside component X)



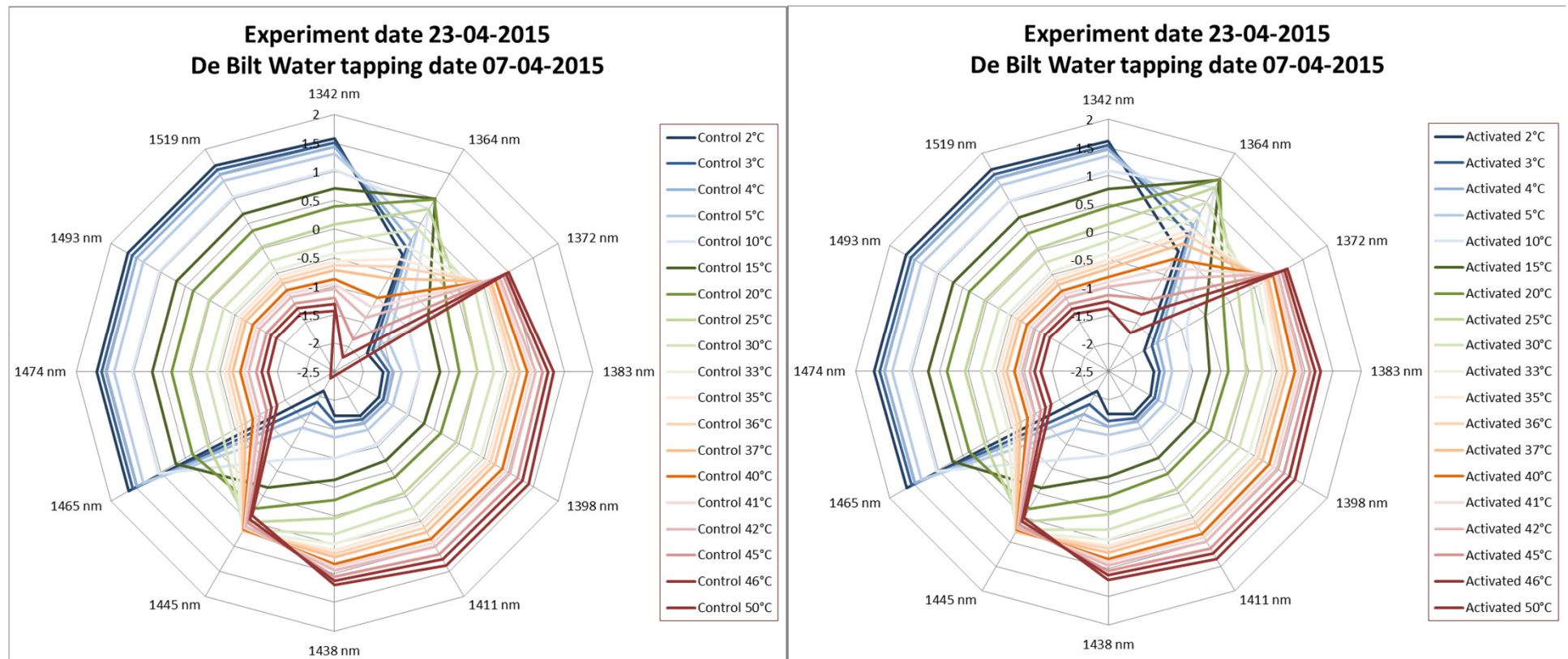
Component Y seems to play an opposite role in the earlier presented device effect

Aquaphotomics protocol aids in device design

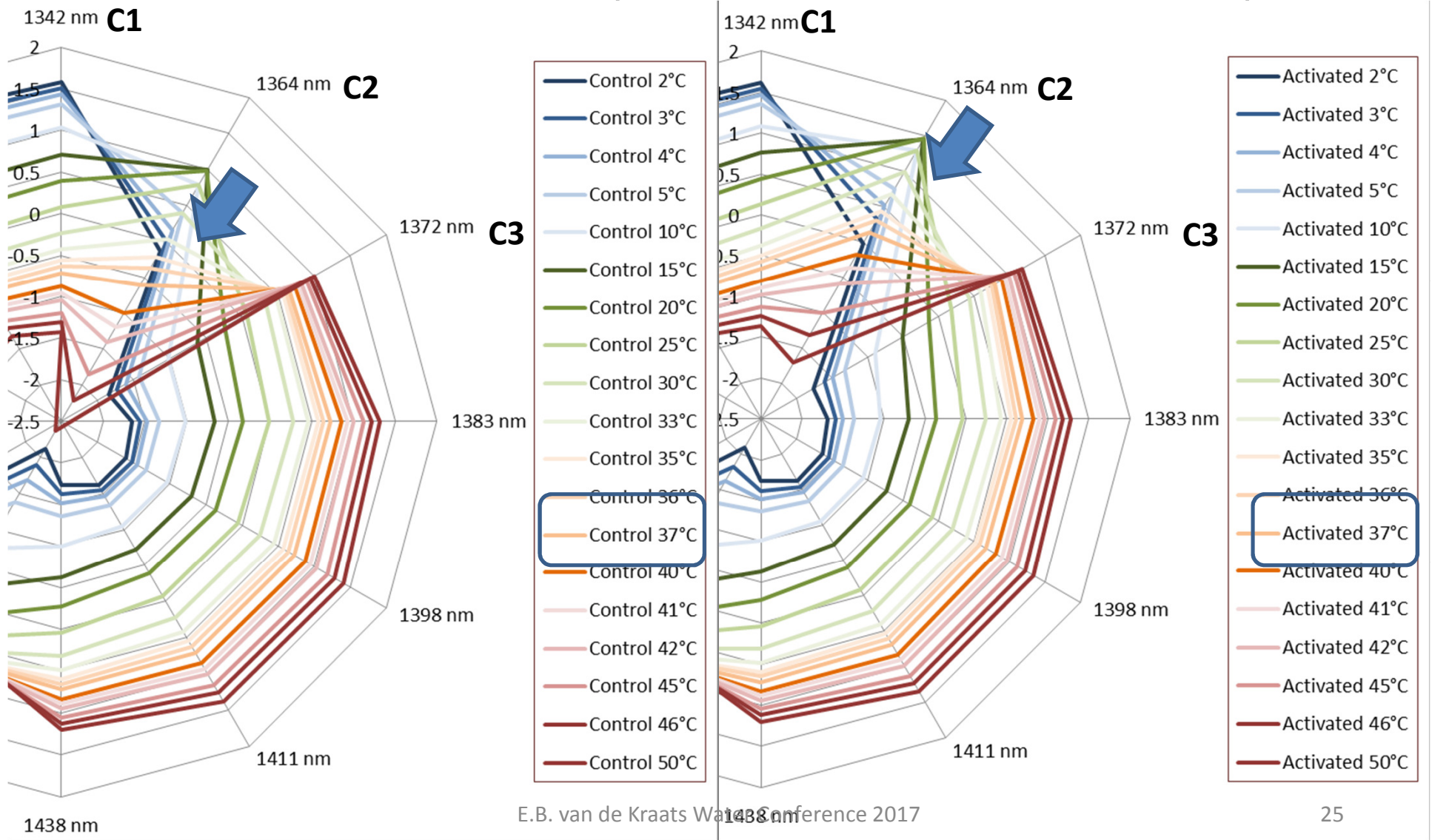
Current WAMACS assignments based on water molecular structure

WAMACS	Spectral range (nm)	Contemporary Assignment	References
C1	1336–1348	2v3	Ozaki 2002
C2	1360–1366	WS_{1,2,4}	Robertson et al. 2003
C3	1370–1376	v1+v3	Ozaki 2002
C4	1380–1388	WS _{1,4} , SOX ₄	Robertson et al. 2003; Weber et al. 2000
C5	1410–1418	S ₀	Maeda et al. 1995; Ozaki 2002; Buijs and Choppin 1963; Luck 1998
C6	1421–1430	H-OH bend, O-H··O	Robertson et al. 2003; Weber et al. 2000
C7	1432–1444	S ₁	Buijs and Choppin 1963; Luck 1998
C8	1448–1454	WS _{4,5}	Robertson et al. 2003
C9	1458–1468	S ₂	Buijs and Choppin 1963; Luck 1998
C10	1472–1482	S ₃	Buijs and Choppin 1963; Luck 1998
C11	1482–1495	S ₄	Franks 1973; Maeda et al. 1995; Ozaki 2002; Buijs and Choppin 1963; Luck 1998
C12	1506–1518	v1, v3, strongly bonded water	Osborne et al. 1993
Legend: WS_n : (OH)·(H₂O)_n water solvation shell			
SOX _n : (O ₂)·(H ₂ O) _n super oxides			
S _i : water molecules with i hydrogen bonds			

Control and Activated water show different reaction at specific temperature steps

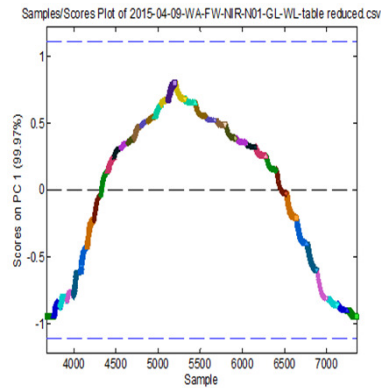


Control and Activated water show different reaction at ~37°C (look at ratio C1:C2:C3)

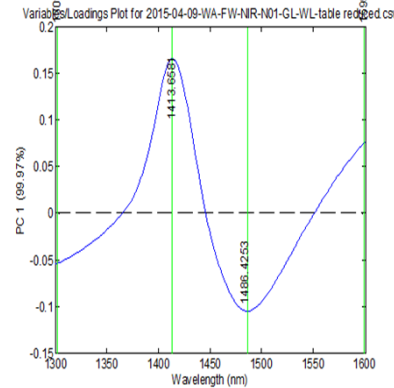


In-depth statistical analysis to find specific WAMACS and WASPs

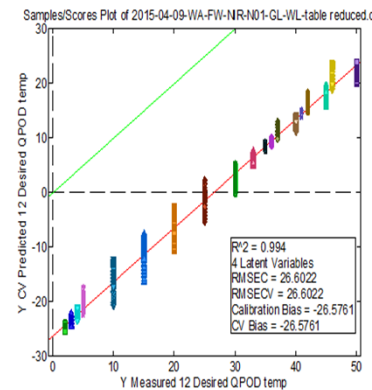
Scores on PC1 for Activated



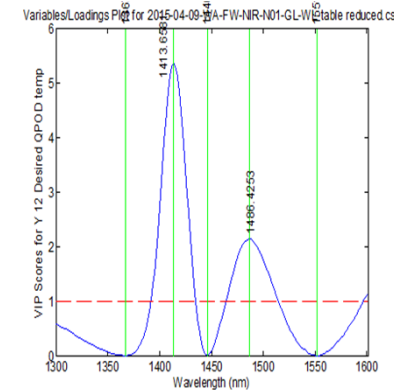
PC1 regression vector for Activated



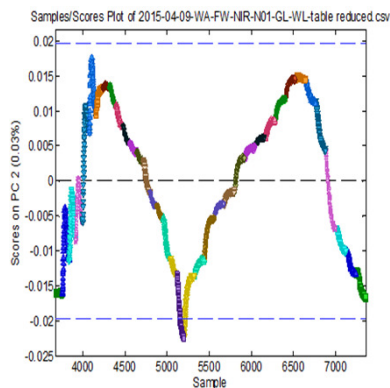
PLS temperature predicted Activated



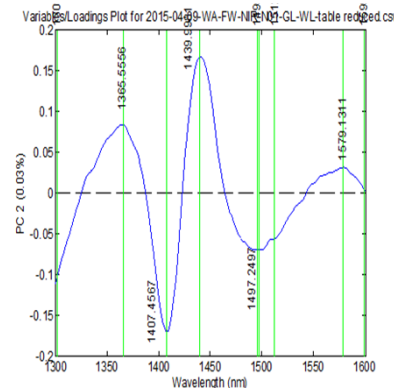
PLS temperature scores Activated



Scores on PC2 for Activated



PC2 regression vector for Activated



In-depth analysis methods

- PCA principle component analysis (left)
- PLS partial least squares (above)
- ICA independent component analysis
- Subtraction spectra

WAMACS Water Matrix Coordinates
 WASP Water Spectral Pattern

Relating to water functionality

Steps to interpret aquagram	Esenca water
Find differences in water spectral pattern (WASP)	Main difference at 1364nm
Assignment to water molecular structure and bonds between molecules (from references in literature) Open for other theories to assign WAMACS!	Assigned to water solvation shell 'organized' water around molecules, free protons and electrons available for reactions outside this shell
Finally confirm functionality with reference data	Check if results of biological experiments can be related to water solvation shell differences

Overview of biological tests



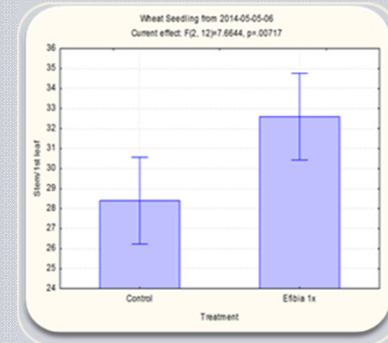
Germination rate of Activated Asian salad seems to be higher



Resistance to water stress of Activated Asian Salad seems to be better (3/4 exp, 30 plants each)

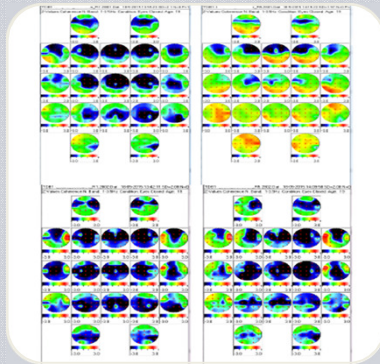


Number of rhizobia (representative of synergy with soil microbes) of Activated Saxa bean roots seems to be higher

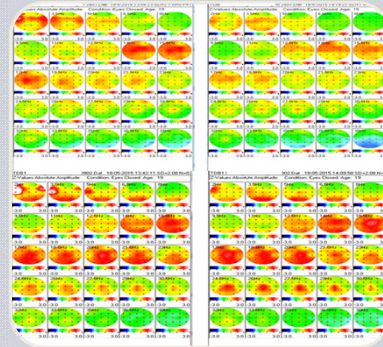


Growth under light stress is more for Activated wheat seedlings (4/6 exp, 10 seeds each)

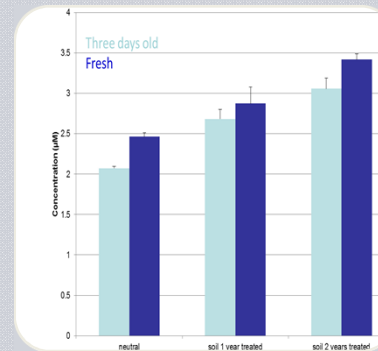
Overview of biological tests



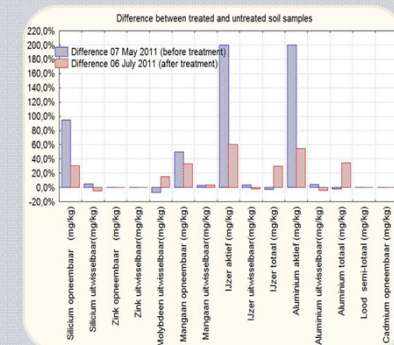
Positive effect on Delta coherence in QEEG when drinking Activated water (above) vs. Control water (below)



Positive effect on power of frequency spectra in QEEG when drinking Activated water (above) vs. Control water (below)



More ATP in carrots (3 days old/fresh) grown in 'Activated' soil
From left to right: Control, 1y Activated, 2y Activated



Effects on Soil composition
Nutrient content
Probiotic growth
and more...

Conclusions

1

- Functional effects of water have been scientifically investigated

2

- Presented aquaphotomics protocol is promising measurement tool for investigating water functionality

3

- Current WAMACS assignments give a good indication for explaining why water behaves in a certain way

4

- To be able to inform: need to measure more waters, gather reference data and expand aquagram interpretation

Vision to inform consumers and providers



- ‘Water-marking’ waters with aquagrams
- Building database with reference data and experiences
- Understanding and explaining functionality
- Advising on stability and storage

And match water to consumer.



Aquaphotomics Society

- Share knowledge
 - Standardize protocols and analysis
 - Build up database
 - Collaborate with experts from multiple disciplines to interpret results
 - Acquire reference data
-
- Develop monitoring, diagnostic and research applications based on aquaphotomics



Please join us on aquaphotomics.com

Thank you very much for your attention.
&
Looking forward to collaborate!



Take care of your bodily water!

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