Under the High Patronage of His Majesty King Mohammed VI

International Water Resources Association
IWRA

XIX WORLD WATER CONGRESS
International Water Resources Association (IWRA)
Marrakech, Morocco | 1 - 5 December 2025

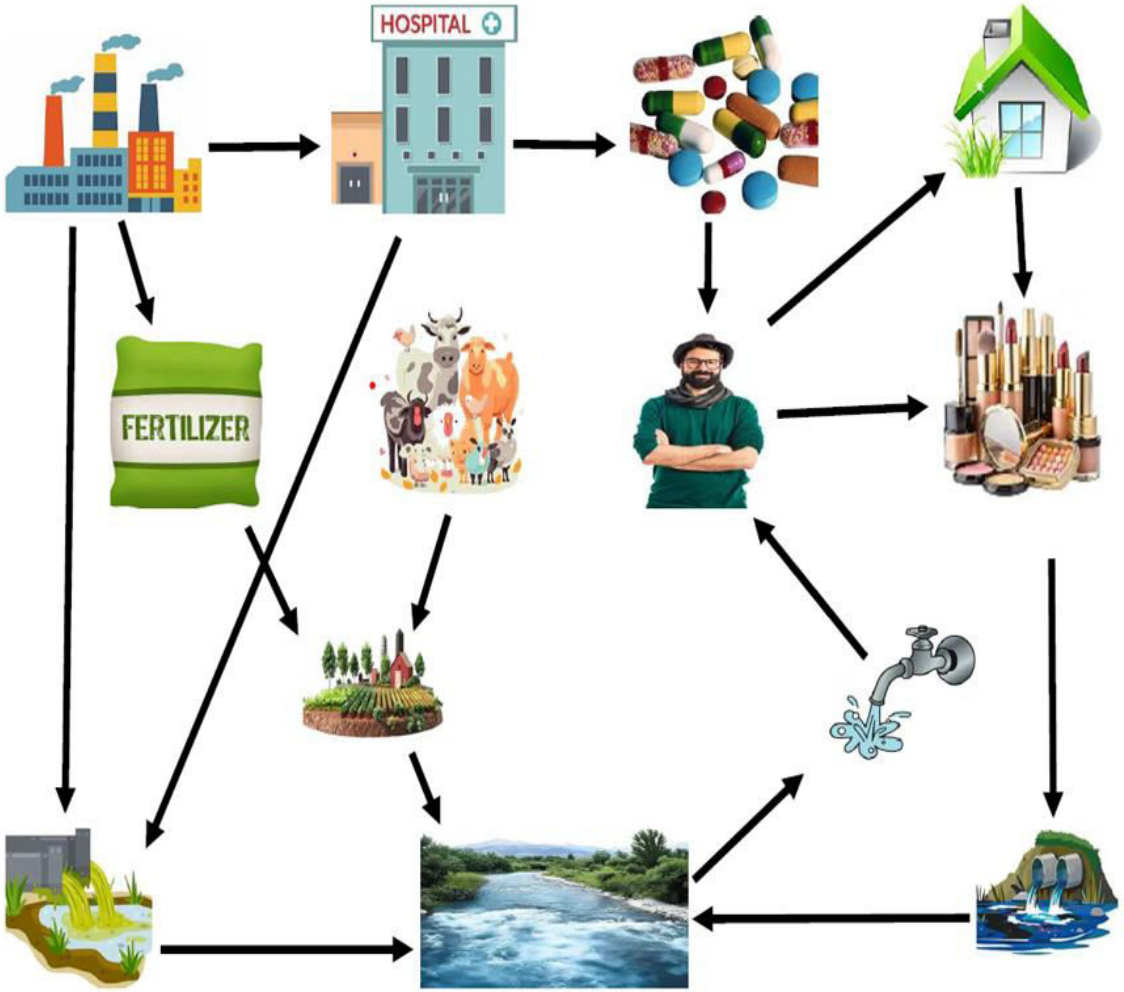
Kingdom of Morocco
Ministry of Equipment and Water

Comparison study of various powder activated carbon which can effectively remove contaminants of emerging concern from drinking water

Dr. P. I. Dikobe
Magalies Water
02 December 2025

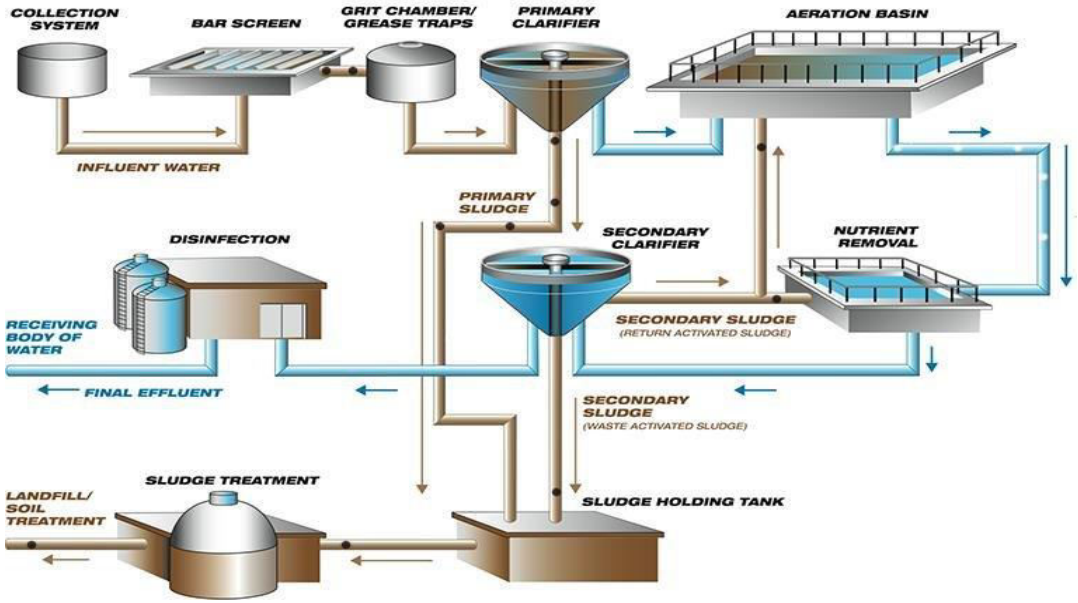
Table of content

Background



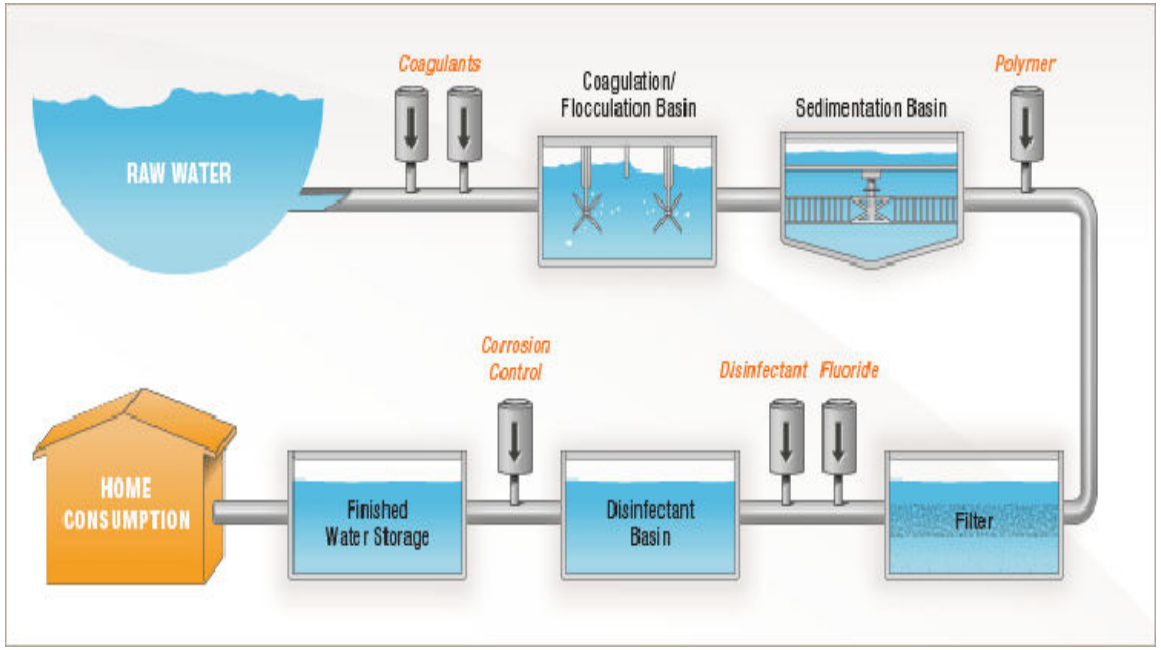
- What are Chemicals of Emerging Concern (CEC)?
- Where do they originate?
- How are they introduced to the aquatic systems?
- What are sources of the CEC?
- Are these compounds addressed in national standards or guidelines?
- What are the effects of the CEC in human and animals?

Background (cont.)



- Types of conventional water treatment plants.
- Unit processes employed during the water treatment plants.
- Purpose of the water treatment plants.

- Limitations of the conventional water treatment plants.
- Presence of CEC in discharged drinking water.
- Adsorption technique employed for removal of CEC (Absorbent - PAC).



Aim and objectives of the study

- The overall aim of this study is to compare various PAC which can effectively remove CEC from drinking water.

Objectives:

- To characterise selected CEC in treated water.
- To evaluate the percentage removal of selected CEC in treated water.
- To identified effective PAC material and optimum dosage that are suitable for drinking water treatment plant (DWTP).
- To compare the quality of treated water with South African National Standard 241 and other international standards.

Material and Method

Sampling:

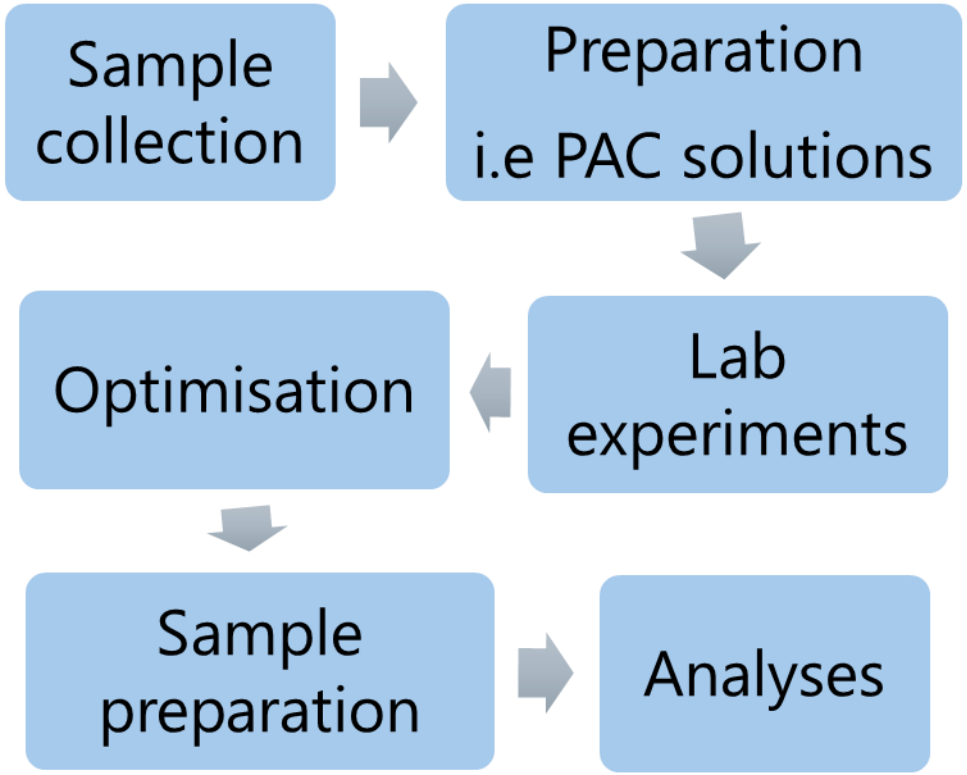
- 25 L raw water sample of the 12 ML/d DWTP in Pretoria, South Africa (11 November 2022 and 02 February 2023).
- Sampling done according to standard methods (APHA, 2017).

Preparation PAC solutions:

- Various concentrations/dosages of PAC solutions.

Lab experiments and optimisation:

- Jar Test stirrer.
- Same operational conditions of DWTP



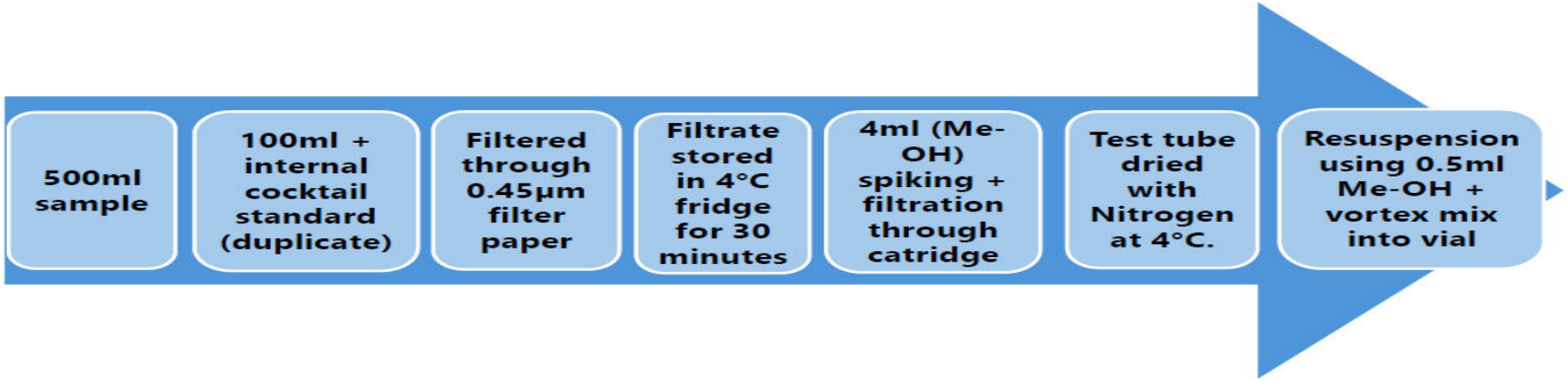
CECs	Abbreviation
Methamphetamine	MET
1,7 Dimethylxanthine	1,7 DXN
Benzoylecgonine	BZE
Caffeine	CAF
Acetaminophen	ACT
Diclofenac	DCF
Sulfamethoxazole	SMX
Trimethoprim	TMP
Emtricitabine	FTC
Efavirenz	EVZ
Tramadol	TMD
Venlafaxine	VFX
Cetirizine	CTZ
Carbamazepine	CBZ
Benzotriazole	BTA
Atrazine	ATZ
Methaqualone	MTQ

Material and Method (cont.):

XIX WORLD WATER CONGRESS
International Water Resources Association (IWRA)
Marrakech, Morocco | 1-5 December 2025

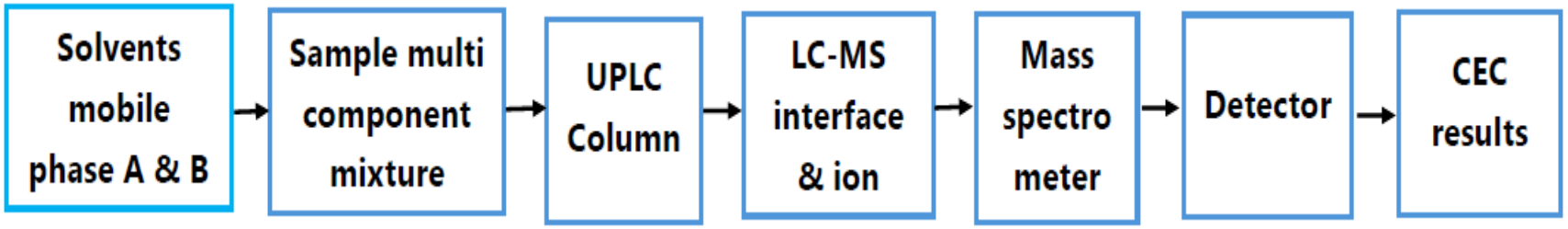
Sample preparations:

- Sample preparations was done by SPE method.



Characterisation of CEC:

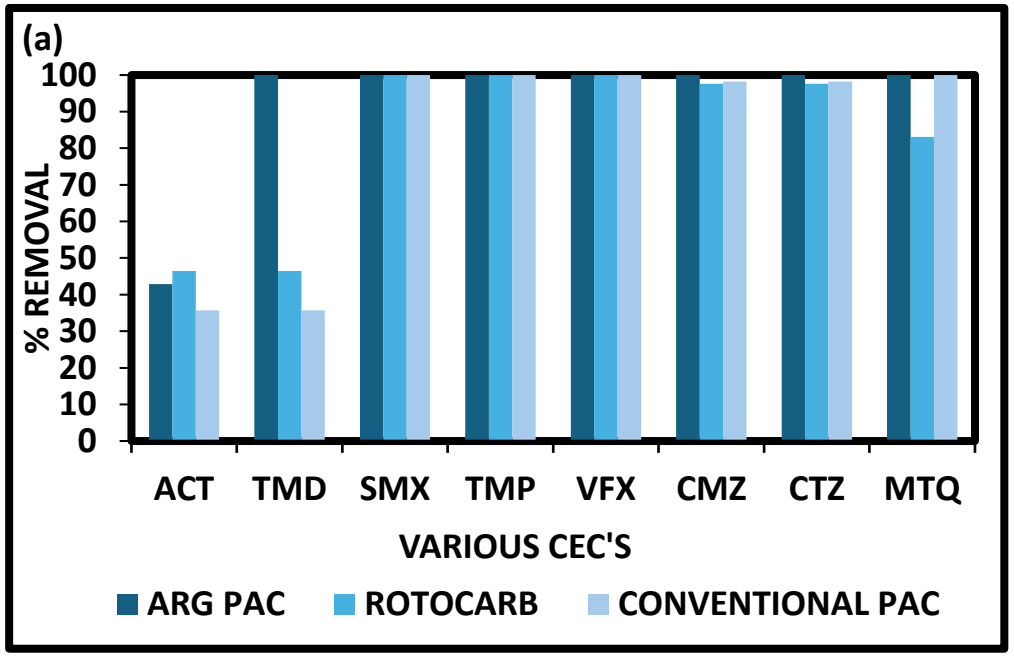
- The samples were characterised by UPLC-MS/MS.

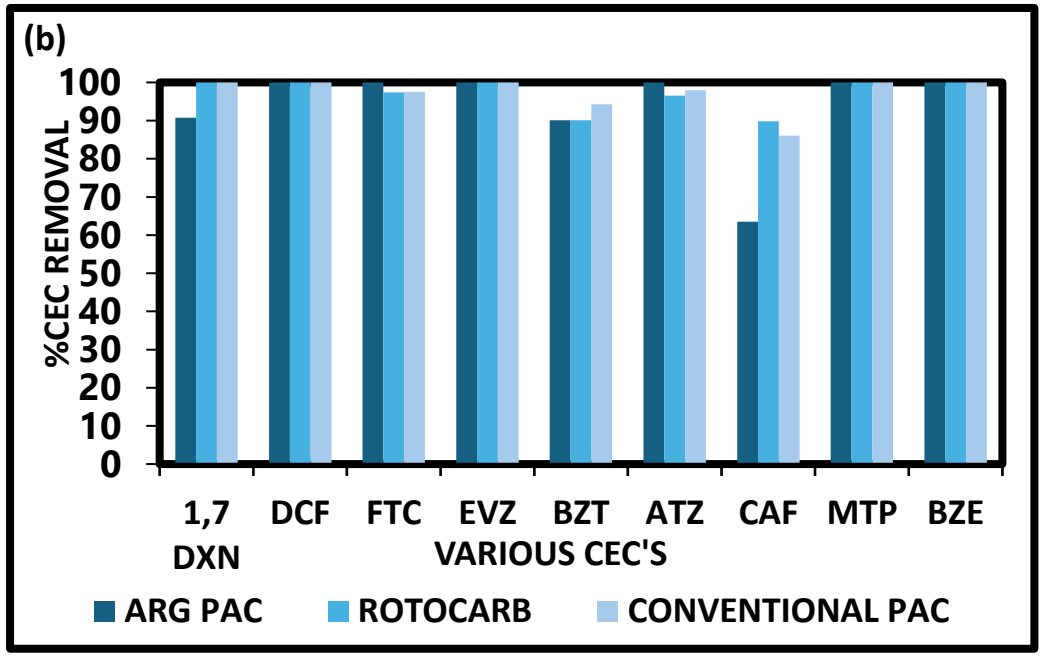


Results and discussion

Preliminary study:

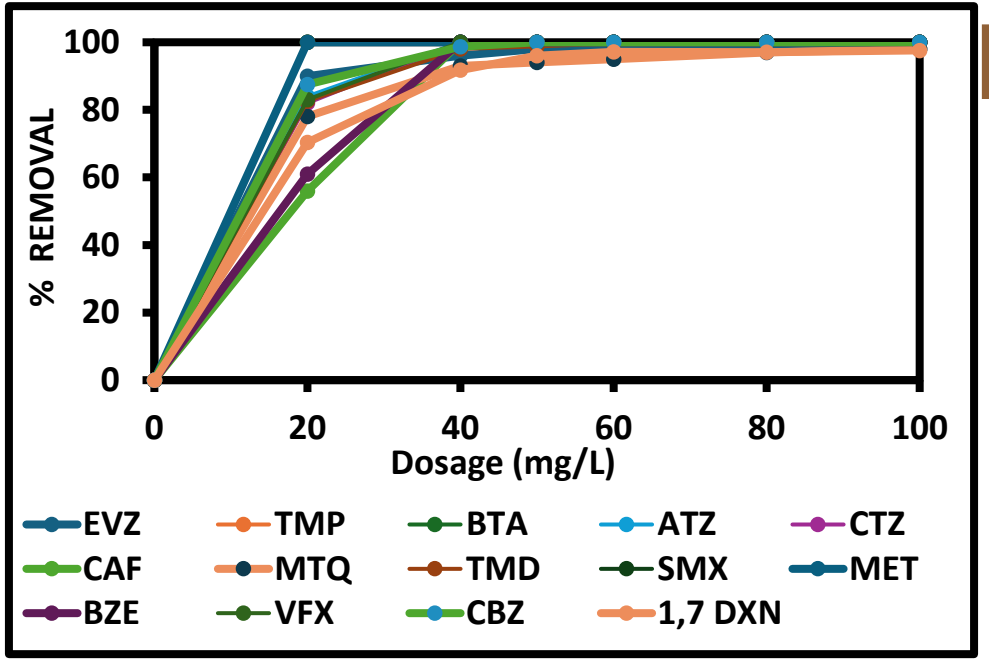
- 50mg/L dosage was employed with similar operational conditions of DWTP.

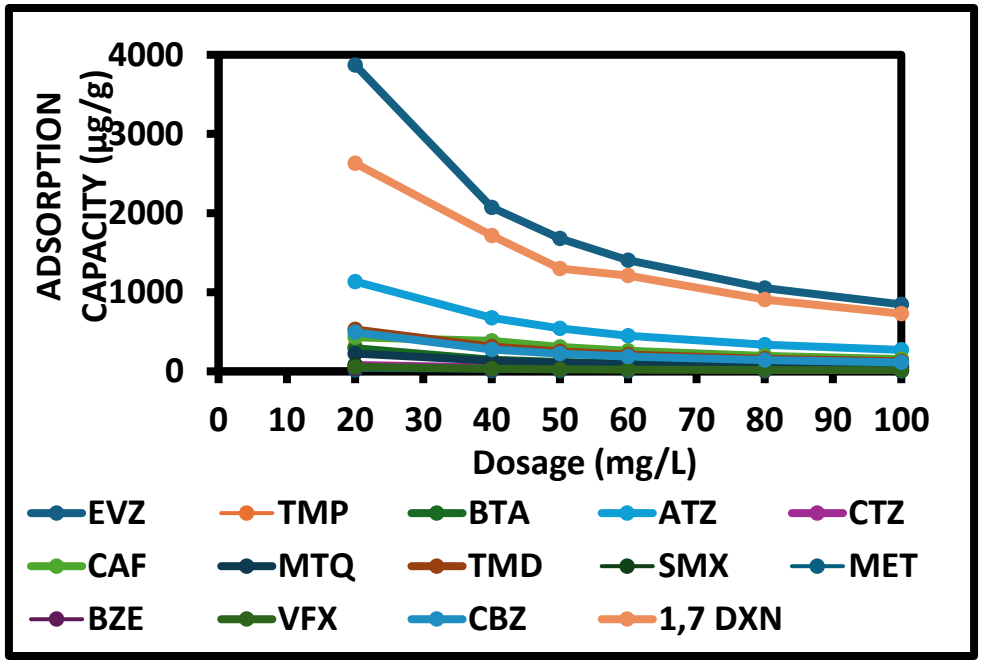




N.B MET was not detected

Results and discussion (cont.)





- Increase in % removal with an increase in dosage.
- Dosage (40.0 mg/L) >90% removal was achieved.
- Optimum dosage was observed at 40.0 mg/L.
- Not detected in raw water: ACT; DCF; NAP; FTC.
- Removed CECs: TMP; BTA; ATZ; CTZ; CAF; SMX; MET; BZE & VFX.
- Reduced CECs: EVZ; MTQ; TMD; CBZ & 1,7 DXN.
- Decreased adsorption capacity was observed with an increase in adsorbent dosage, hence denoting that the CECs are fast depleted with increasing PAC dosages due to high availability of adsorption sites. A steep reduction in the equilibrium adsorption capacity was observed up to 40 mg/L, and thereafter the decrease was much milder.

Results and discussion (cont.)

Comparisons of drinking water standards

CECs	Raw water (ng/L)	Treated water (ng/L)	Removal (%)	EU (EUROPE)	USEPA (USA)	SANS 241 (RSA)
TMD	148.00	6.50	95.60	NL*	NL	NL
SMX	114.50	0.00 (<MDL**)	100.00	NL	100	35.0
VFX	16.00	1.00	93.75	NL	10	NL
CBZ	142.80	1.00	99.30	2000	40	NL
1,7 DXN	476.00	28.00	94.12	NL	NL	NL
BZE	16.8	1.00	94.05	NL	NL	NL
TMP	84.30	0.00 (<MDL)	100.00	120	NL	NL
CTZ	28.80	1.50	94.79	NL	NL	NL
MET	47.6	0.00 (<MDL)	100.00	NL	NL	NL

Results and discussion (cont.)

Comparisons of drinking water standards

CECs	Raw water (ng/L)	Treated water (ng/L)	Removal (%)	EU (EUROPE)	USEPA (USA)	SANS 241 (RSA)
EVZ	1025.50	54.80	94.65	NL	NL	NL
BTA	58.30	1.00	98.28	NL	20	NL
ATZ	224.30	4.30	98.08	0.6	3	100
CAF	84.80	0.00 (<MDL)	100.00	NL	NL	NL
MTQ	70.80	2.30	96.75	NL	NL	NL
FTC	<MDL	0.00 (<MDL)	-	NL	NL	NL
NAP	<MDL	0.00 (<MDL)	-	NL	NL	NL
DCF	<MDL	0.00 (<MDL)	-	NL	NL	NL
ACT	(<MDL)	0.00 (<MDL)	-	NL	200	NL

Conclusions and Recommendation

- This study successfully demonstrated the use of ROTOCARBON PAC derived from macadamia nuts for the treatment of drinking water.
- Similar operational conditions from the DWTP were used and the optimum dosage was observed to be 40,0 mg/L.
- Most CECs are not regulated globally or listed on the SANS 241, however SMX and ATZ are listed and the obtained results were within the SANS 241 limits.
- Although the following CECs: TMP; BTA; ATZ; CTZ; CAF; SMX; MET; BZE & VFX were remove from drinking water, there are no standards regulating them. Other CECs (EVZ; MTQ; TMD; CBZ & 1,7 DXN) are not listed and were detected in treated water. Therefore, further research is required to shed light on the effects of CECs in drinking water, and this could underpin their effective regulation.
- Cocaine, Codeine and Ecstasy were analysed but were not detected throughout the whole sampling period, this might be due the fact that they easily dissolve in water and get diluted.

Conclusions and Recommendation

- Future studies should focus on the assessments of temporal migration and attenuation of CECs in unit operations or processes of the DWTP. The PAC should be employed as adsorption technique to remove the CECs.
- Finally, the employed PAC contains biological carbon that has undergone carbonisation and, therefore, by storing (e.g., landfilling) the spend PAC, opportunities for carbon dioxide removal (CDR) could be created and this merits further examination.
- The continual monitoring of CECs should be regulated in international and locally by regulatory bodies.

Under the High Patronage of His Majesty King Mohammed VI

XIX WORLD WATER CONGRESS
International Water Resources Association (IWRA)
Marrakech, Morocco | 1-5 December 2025

Thank you!

pakid@magalieswater.co.za
www.magalieswater.co.za
magalieswater

www.worldwatercongress.com

International Water Resources Association
IWRA

WWCongress | wwcongress | worldwatercongress

Kingdom of Morocco
Ministry of Equipment and Water