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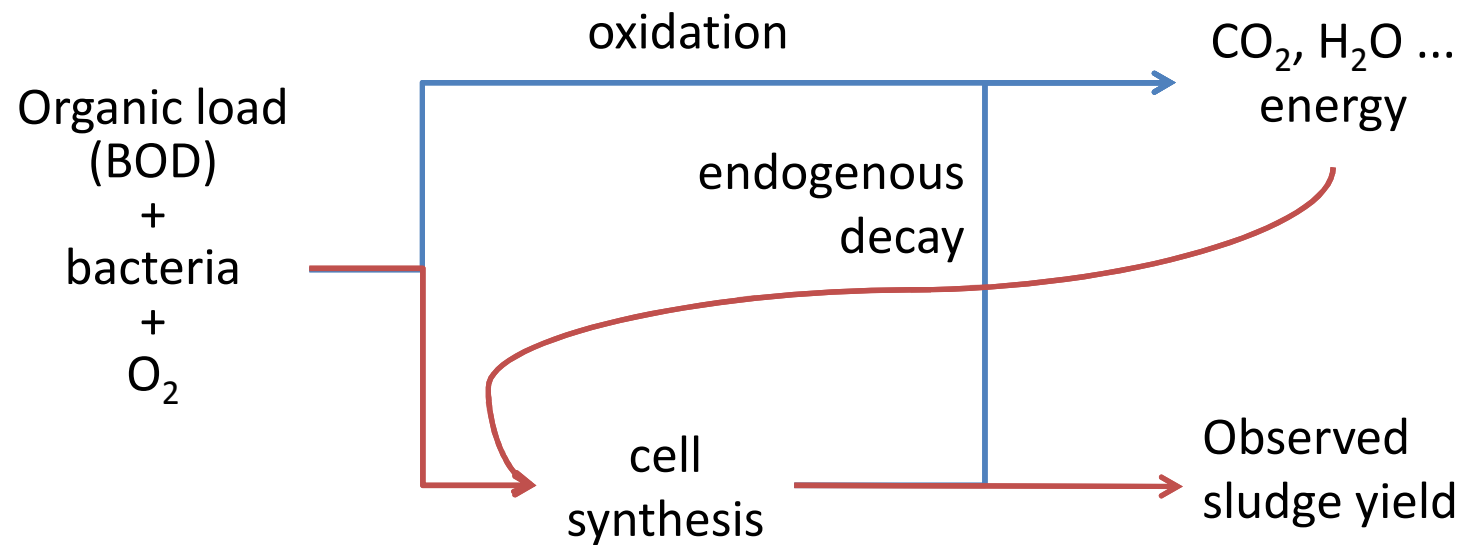


REDUCING PRODUCTION OF EXCESS ACTIVATED SLUDGE IN BLEACHED KRAFT PULP MILL EFFLUENT TREATMENT

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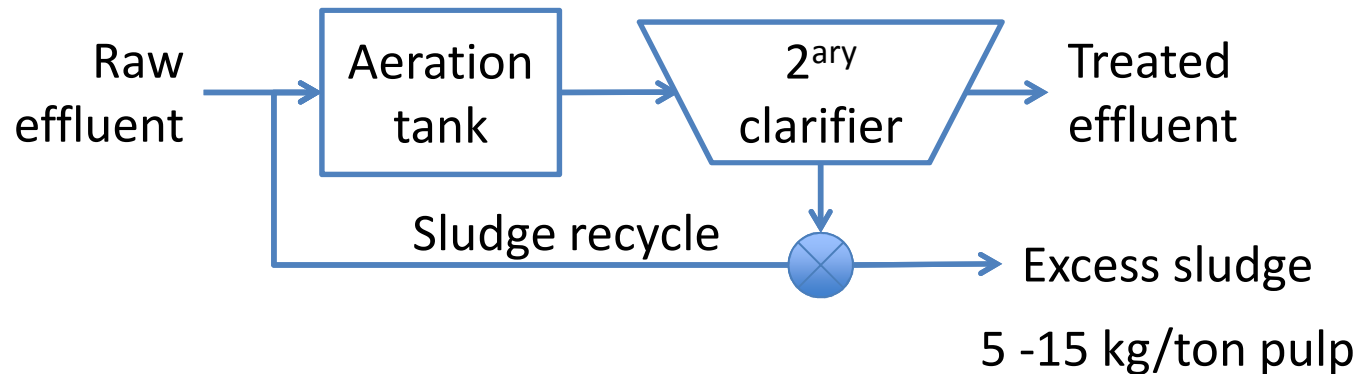


Aerobic biological effluent treatment





Activated sludge process



5 -15 kg/ton pulp

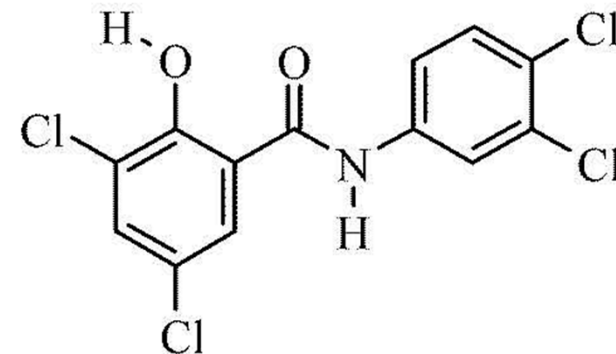
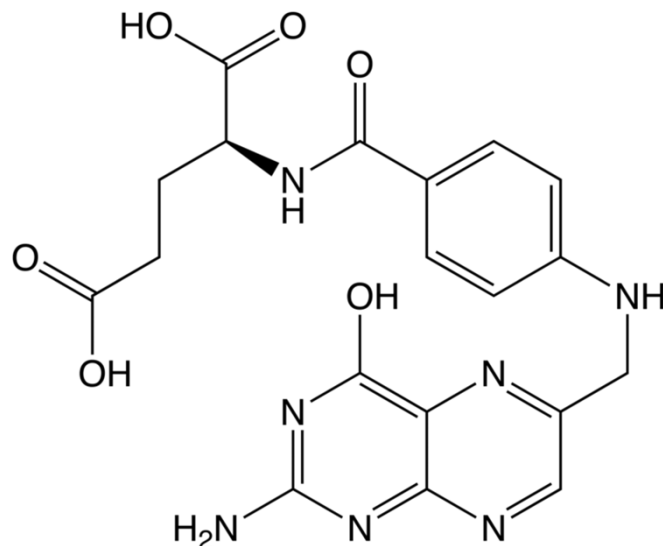
treatment & disposal = 30-60% WWTP operating costs

- Alternatives for sludge reduction
 - Increase sludge age
 - Degrade recycled sludge oxidatively or thermally
 - Modify microbial metabolism



Modifying microbial metabolism

- Folic acid (vitamin B9)
 - Accelerates metabolic processes leading to greater endogenous decay
- TCS (3,3',4',5- tetrachlorosalicylanilide)
 - Uncouples BOD oxidation from energy capture



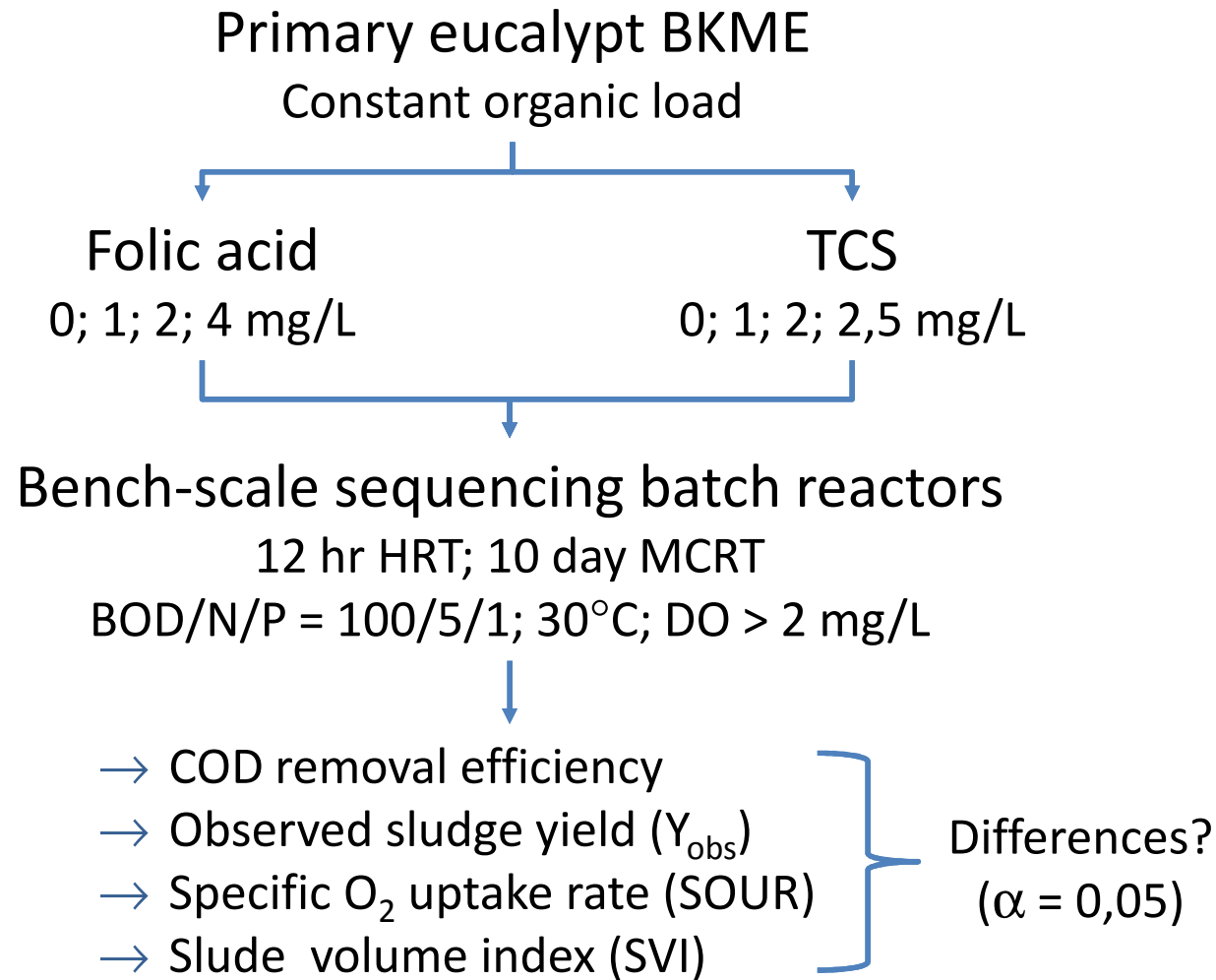


Objective

- Can folic acid and, or TCS reduce sludge production during activated sludge treatment of eucalypt bleached kraft pulp mill effluent (BKME) without harming treatment efficiency, sludge characteristics or effluent toxicity?



Preliminary study





Methods

- Observed sludge yield

$$Y_{\text{obs}} = \frac{\text{mgVSS}_{\text{produced}}}{\text{mgCOD}_{\text{removed}}}$$

- Specific O₂ uptake rate: microbial activity

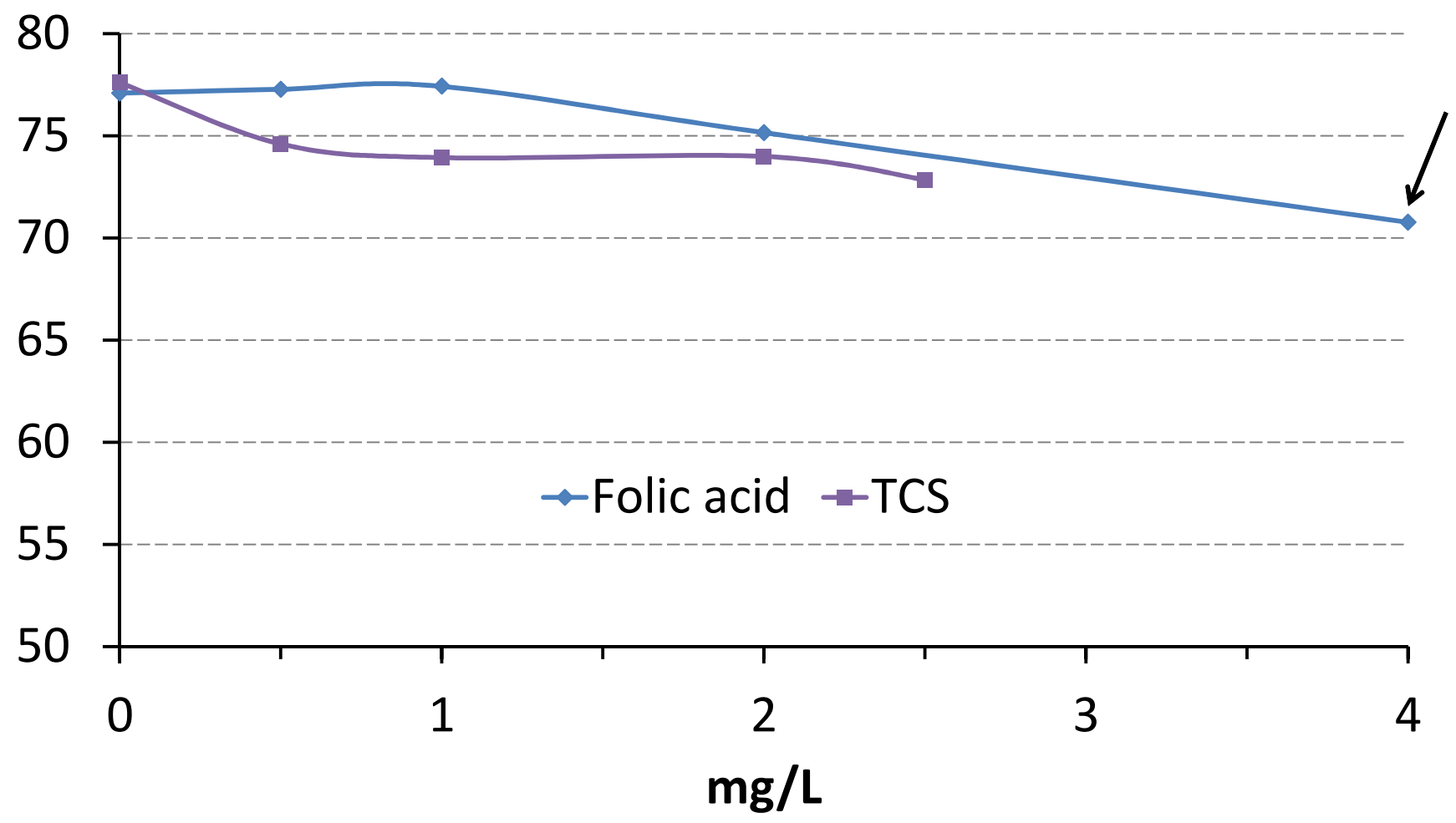
$$\text{SOUR} = \frac{\text{mgO}_2}{\text{gVSS.h}}$$

- Sludge volume index: sludge settleability

$$\text{SVI} = \frac{\text{mL}}{\text{gVSS}}$$

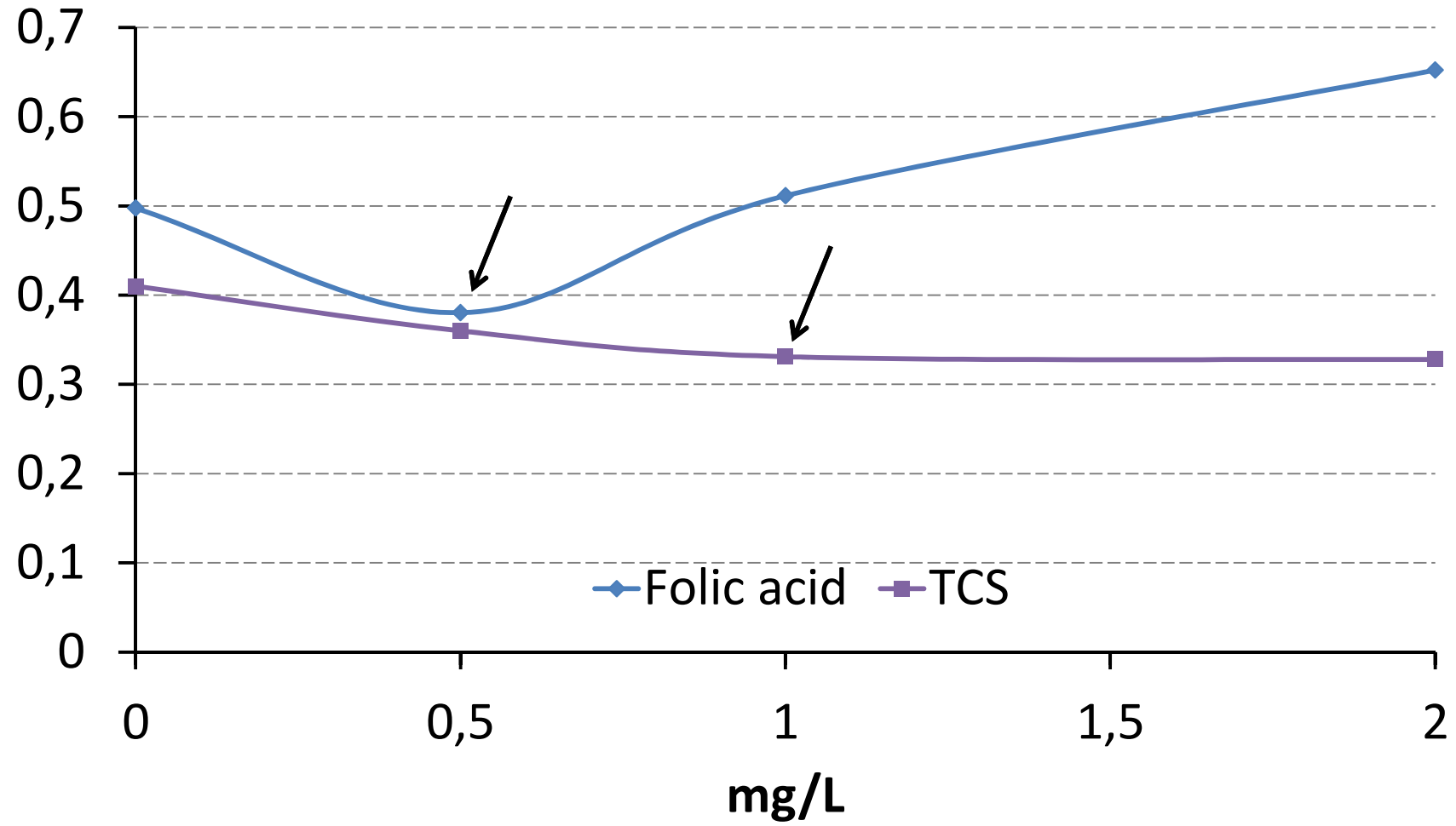


COD removal, %



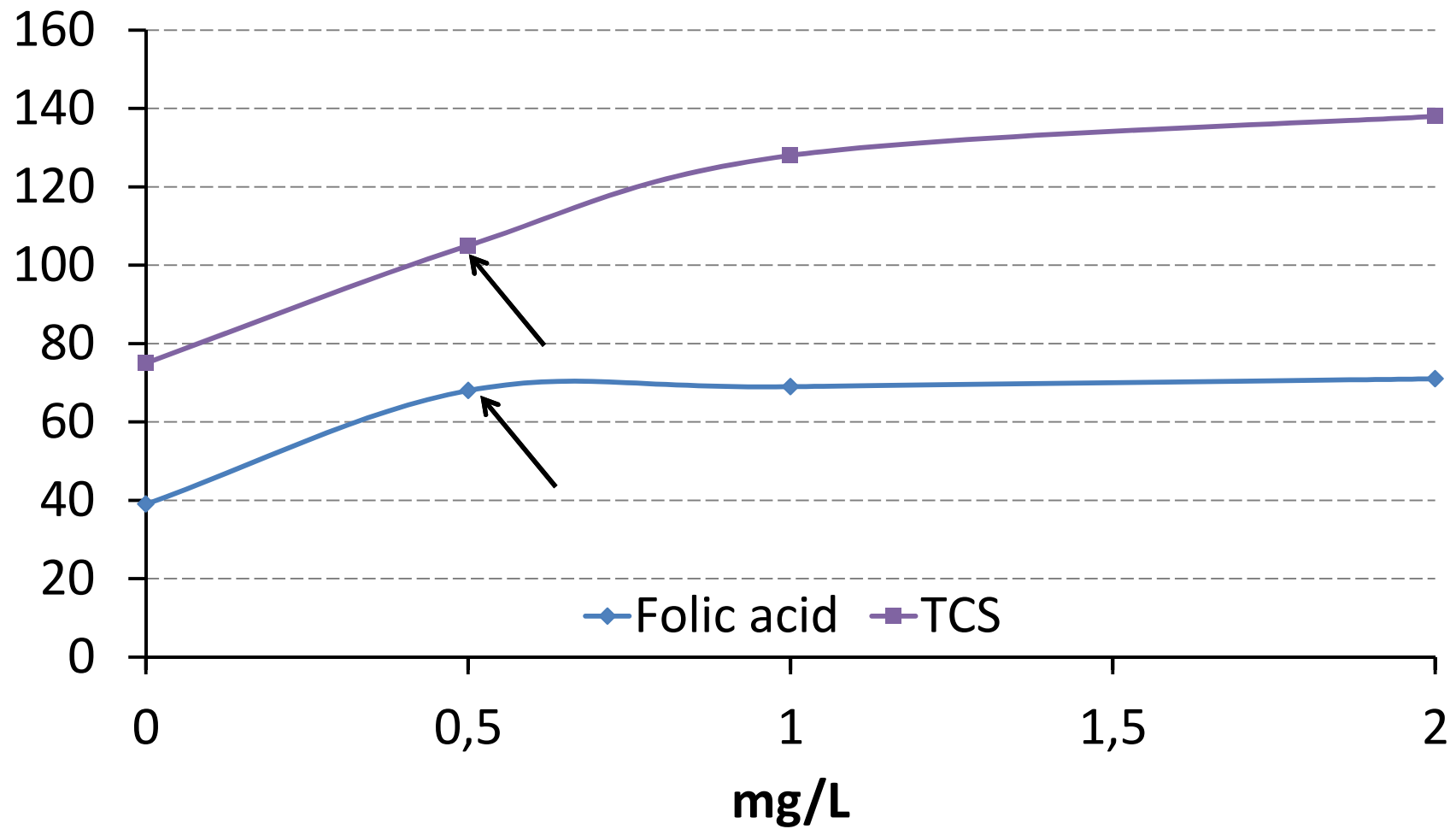


Y_{obs} , mgVSS/mgCOD



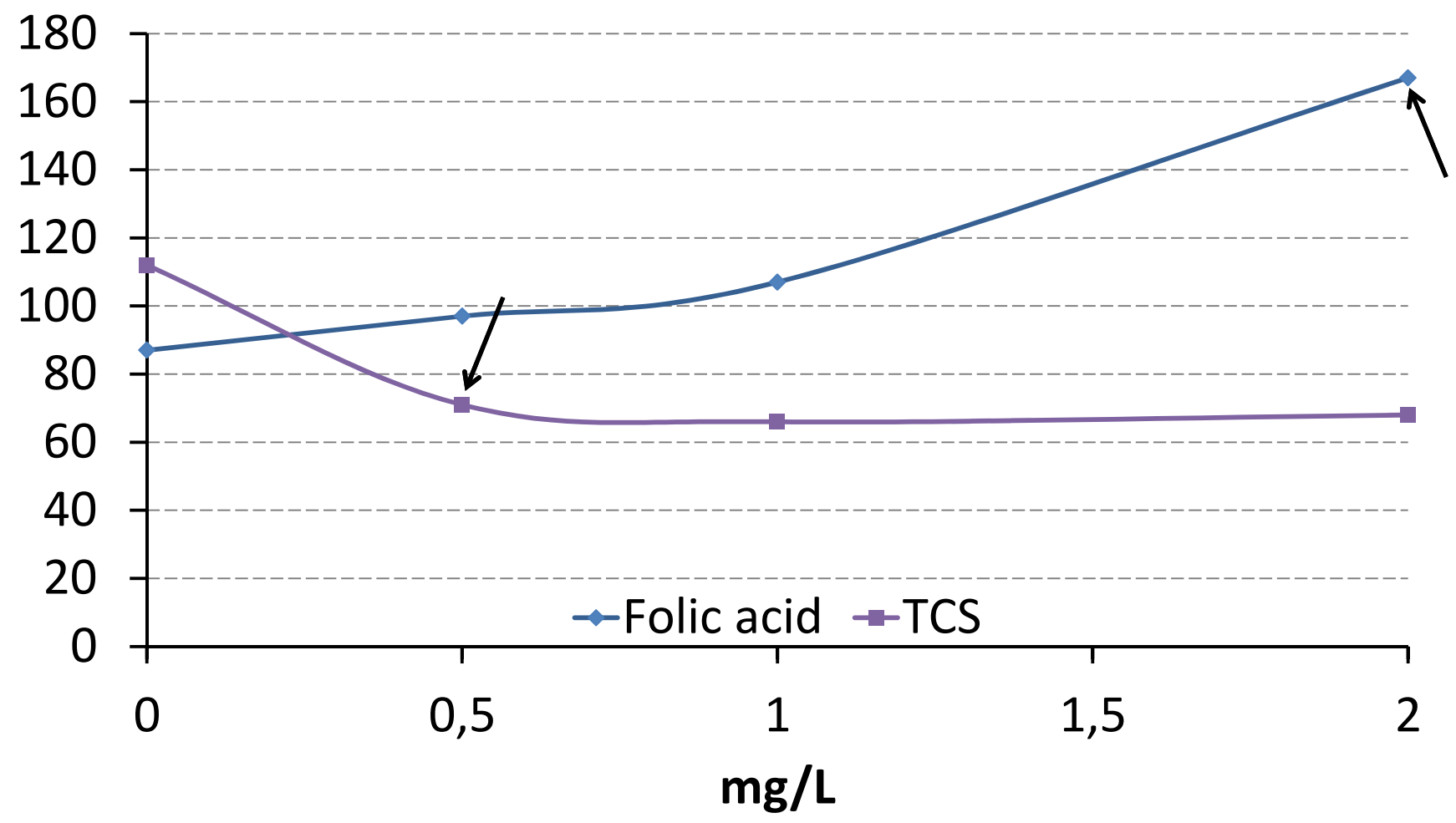


SOUR, $\text{mgO}_2/\text{gVSS.h}$





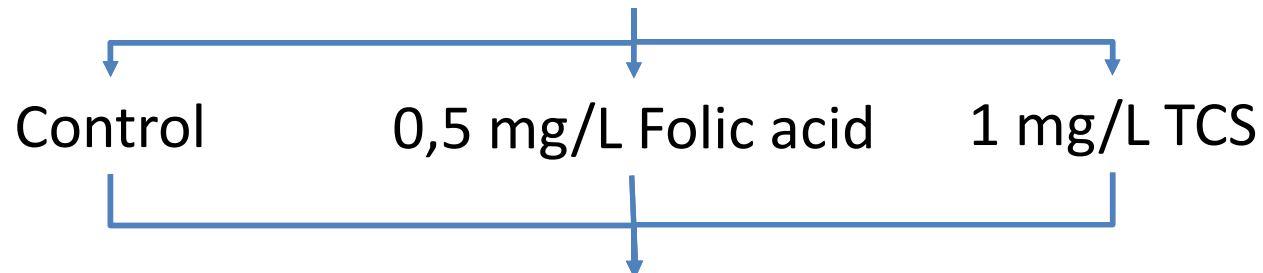
SVI, mL/gVSS





Second phase

Primary eucalypt BKME
Varying organic load



Bench-scale sequencing batch reactors

12 hr HRT; 10 day MCRT

BOD/N/P = 100/5/1; 30°C; DO > 2 mg/L

- COD removal efficiency
- Observed sludge yield (Y_{obs})
- Specific oxygen uptake rate (SOUR)
- Sludge volume index (SVI)
- Toxicity

Differences?
($\alpha = 0,05$)



Organic loading rates

Period	Duration, d	g DQO.d ⁻¹
1	14	2,1
2	10	3,5
3	14	7,2
4	10	4,2
5	12	1,8
6	10	3,8



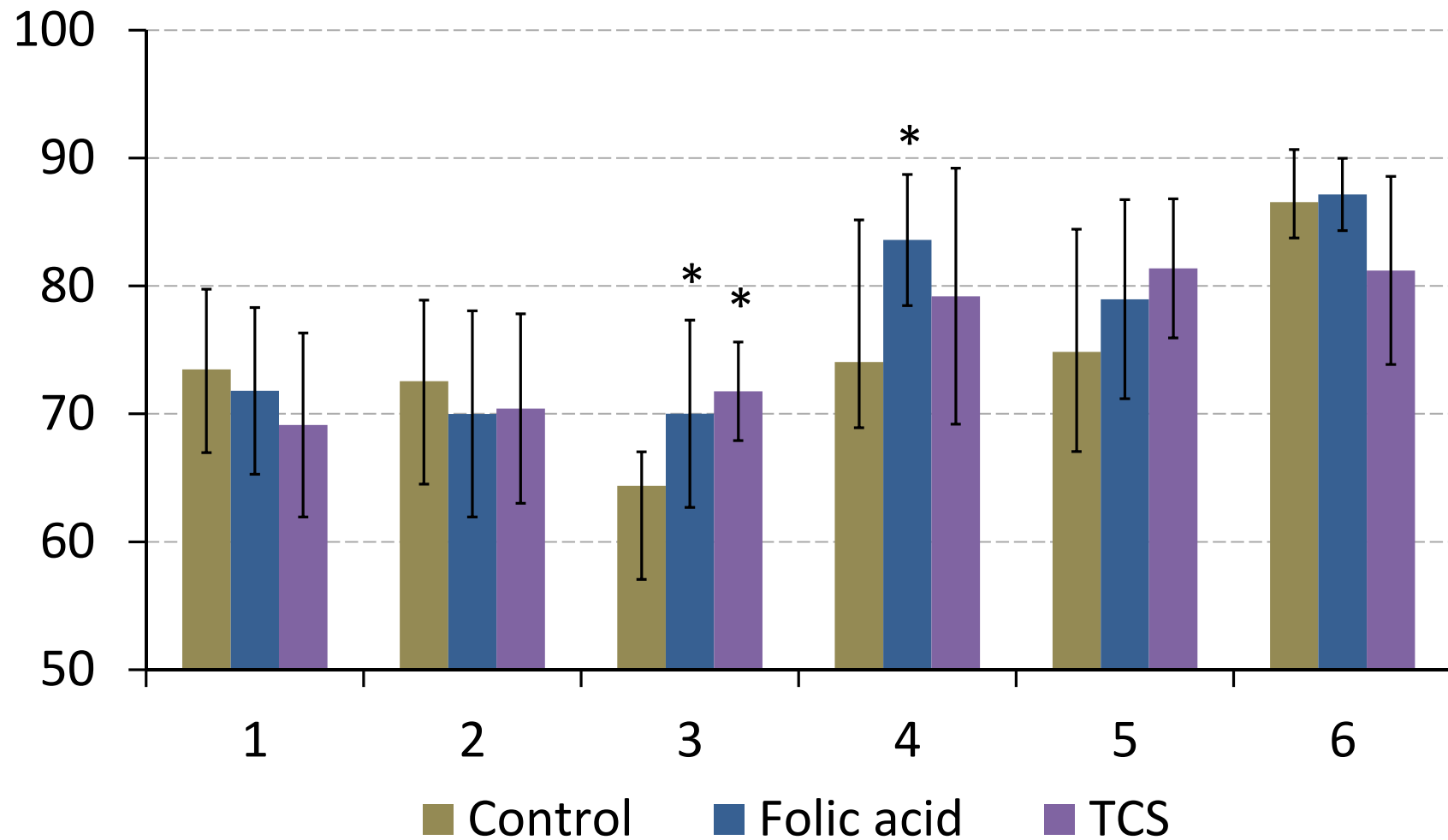
Methods

- Toxicity
 - acute *Daphnia* immobilization, 48 h
 - chronic algal growth inhibition, 96 h
 - results in toxic units

$$TU = \frac{100}{IC_{25}, \%}$$

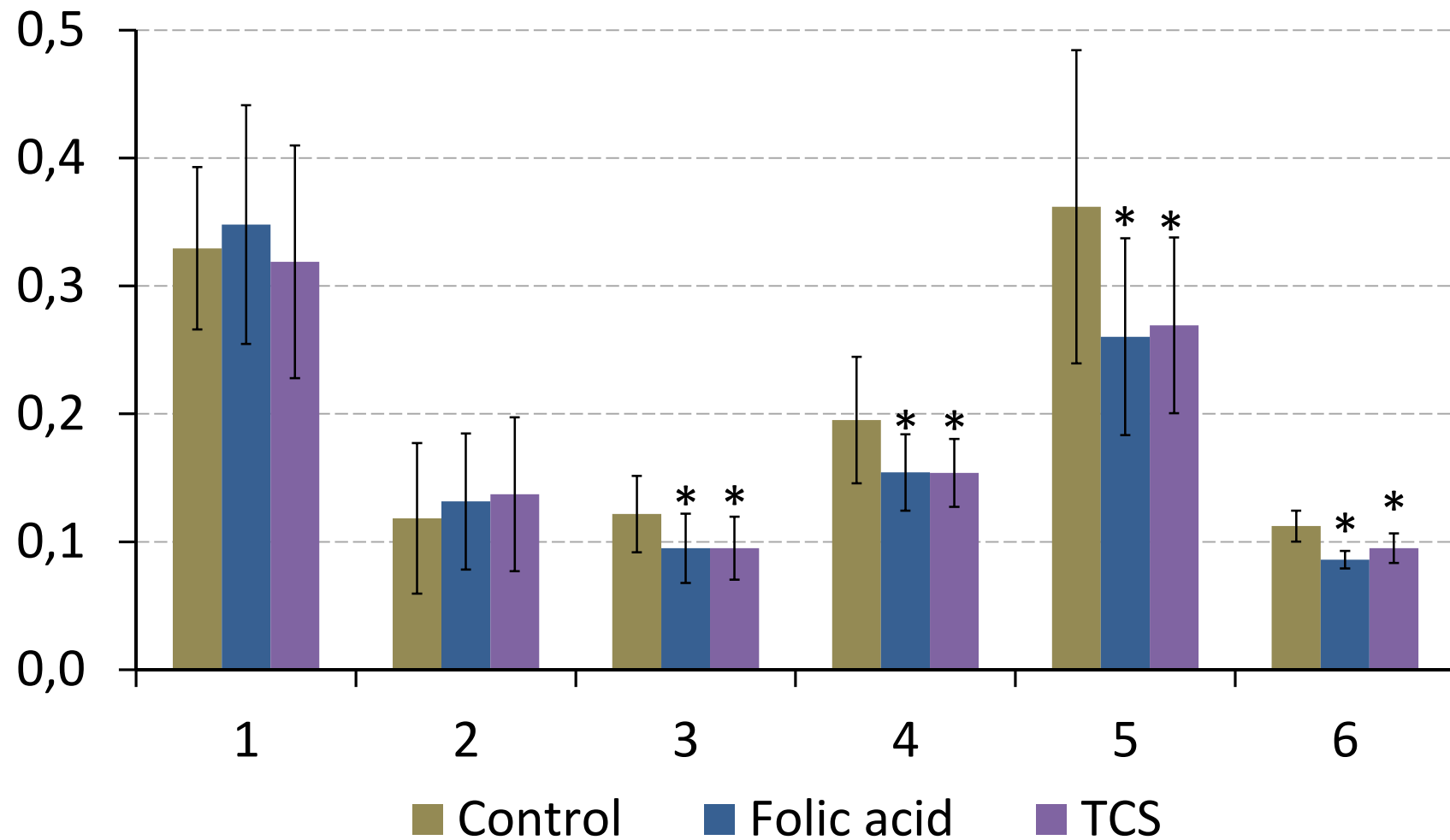


COD removal, %



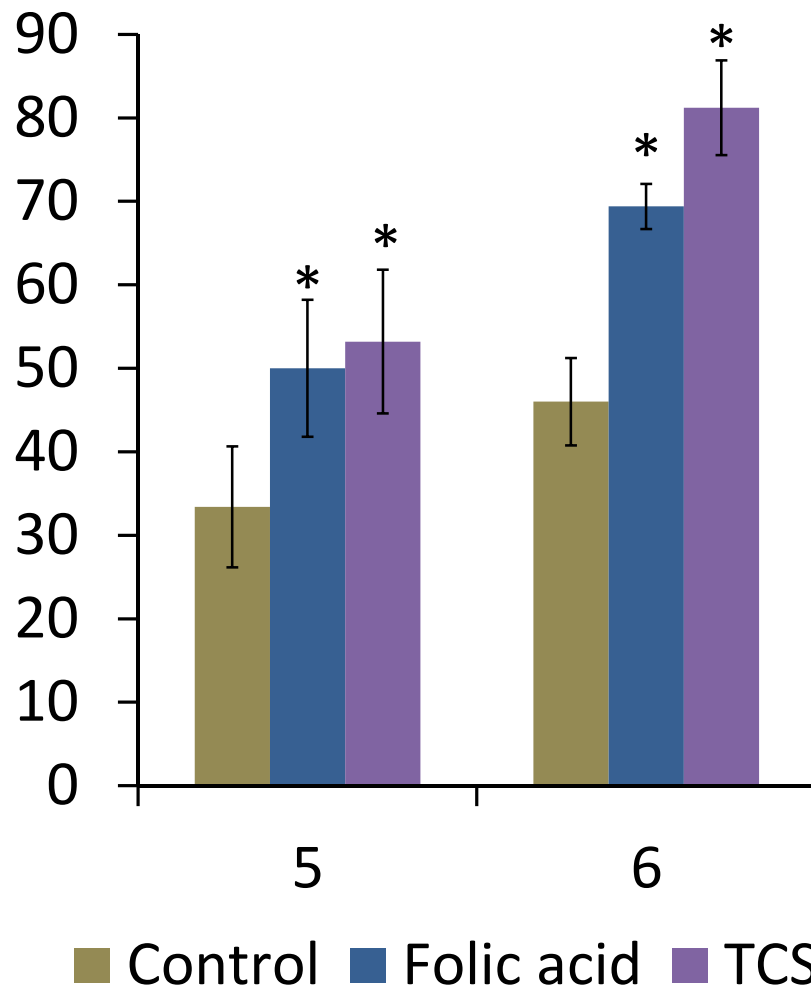


Y_{obs} , mgVSS/mgCOD

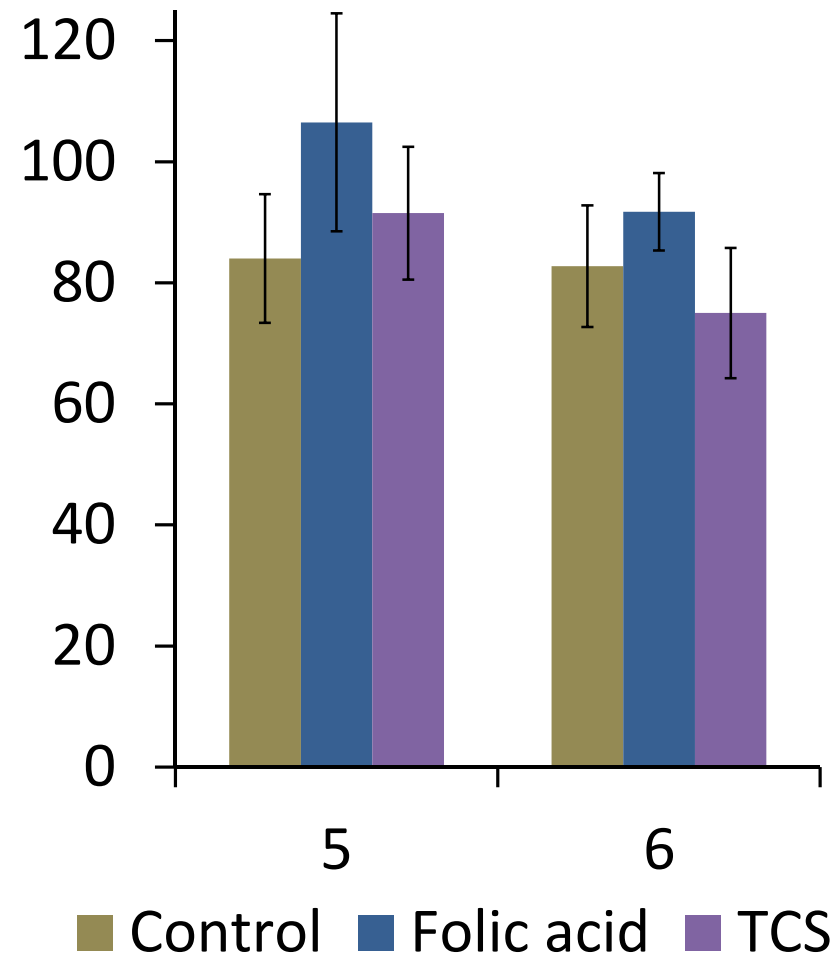




SOUR, mgO₂/gVSS.h

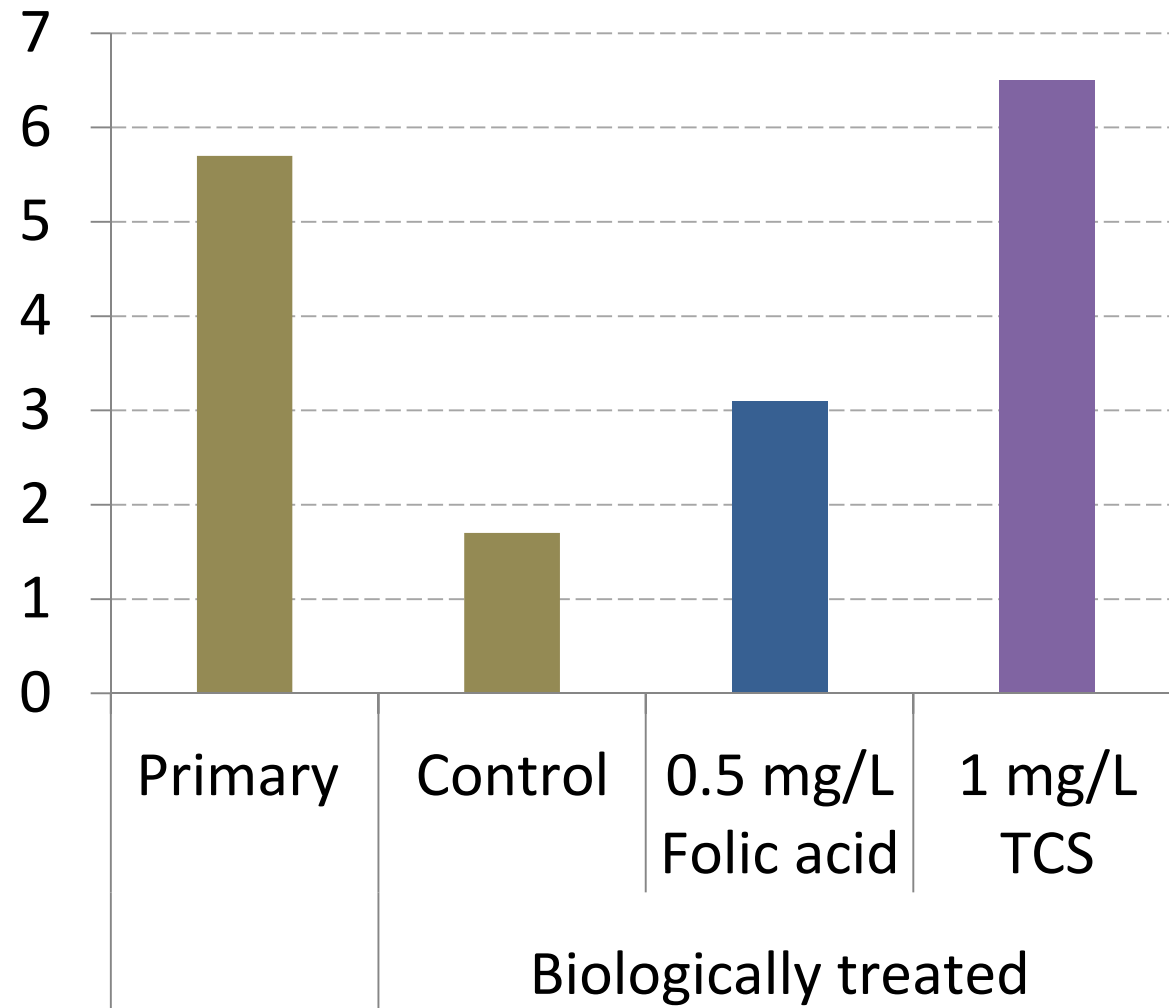


SVI, mL/gTSS





Algal growth inhibition, TU





Conclusions

- Folic acid (0.5 mg/L) and TCS (1.0 mg/L) reduced activated sludge production
 - COD removal efficiency maintained
 - Sludge settleability not impaired
 - Benefits at varying organic loading rates

...but...

 - Increased sludge specific oxygen uptake rates
 - Increased final effluent chronic toxicity
- Application requires evaluation of
 - Aeration system capacity
 - Degree of effluent dilution upon discharge to receiving waters



Acknowledgments

- Teynha Valverde Stoppa, *in memoriam*
- Lwarcel

