Salinity stress enhances secondary metabolite production in *Fagonia indica*: Insights for climate-resilient medicinal plant resources in dryland ecosystems

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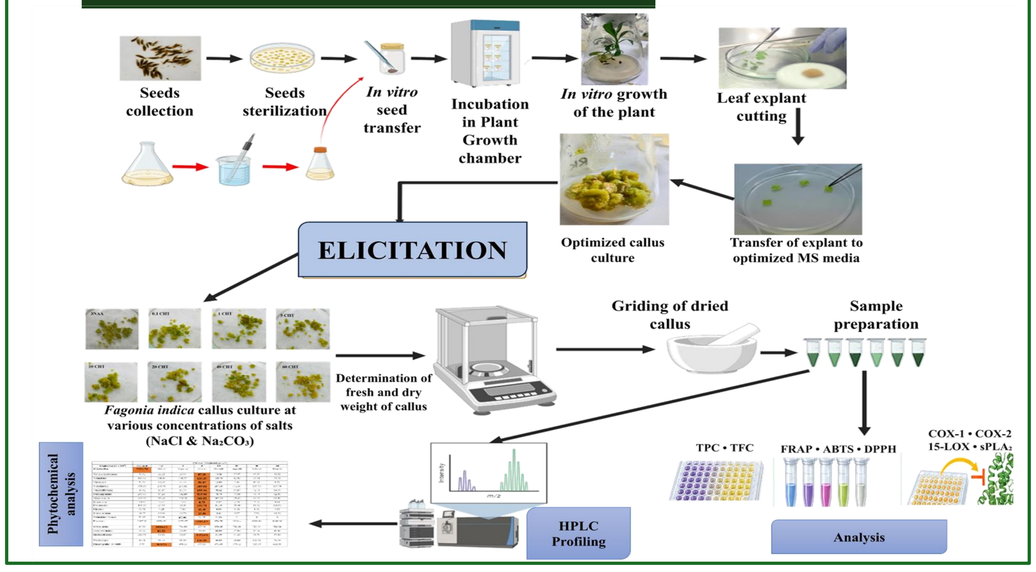
1. BACKGROUND & RATIONALE

- Soil salinization threatens dryland plant resources.
- *Fagonia indica* is adapted to arid and saline habitats.
- Callus cultures enable controlled study of salt-induced metabolites.

Aim: Evaluate how NaCl and Na_2CO_3 affect biomass, secondary metabolites, and bioactivity in *F. indica* callus cultures.

2. MATERIALS & METHODS



3. RESULTS: BIOMASS & PHYTOCHEMICALS

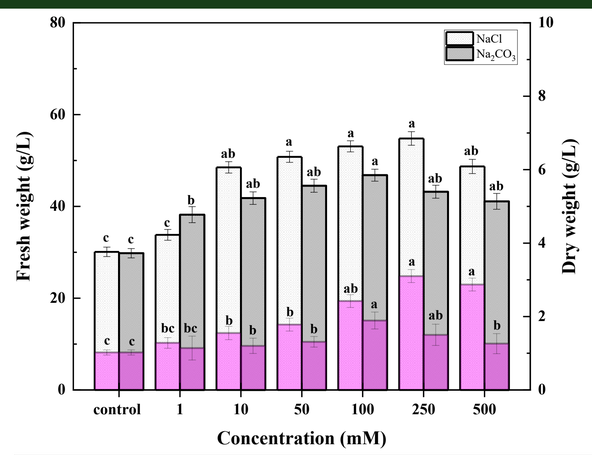


Figure 1: Effects of NaCl and Na_2CO_3 treatments on the fresh and dry biomass of *Fagonia indica* callus cultures. Values represent mean ± SE.

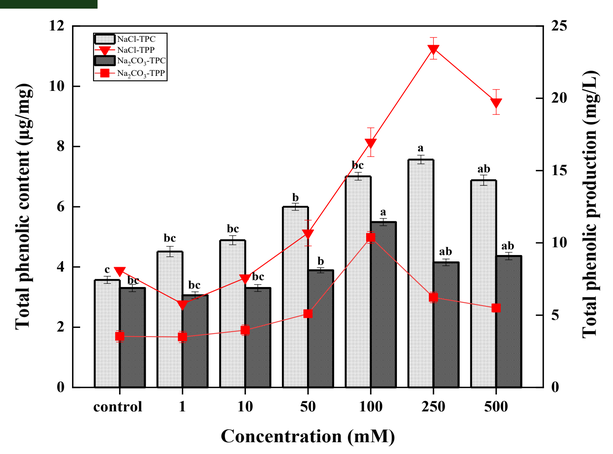


Figure 2: Effects of NaCl and Na_2CO_3 treatments on the total phenolic content in *Fagonia indica* callus cultures. Values represent mean ± SE.

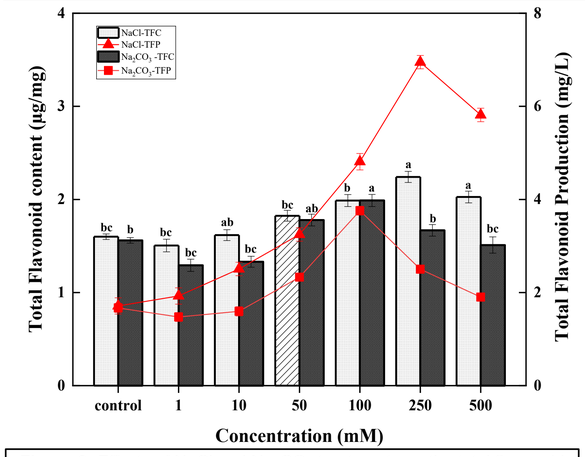


Figure 3: Effects of NaCl and Na_2CO_3 treatments on the total flavonoid content in *Fagonia indica* callus cultures. Values represent mean ± SE.

Key take-away:

NaCl at 250 mM significantly enhanced biomass, phenolics, and flavonoids compared to Na_2CO_3 treatments.

4. CALLUS CULTURE

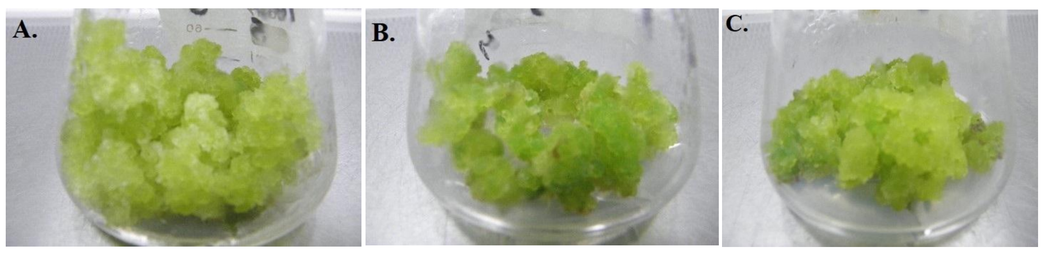


Figure 1. Callus induction in *Fagonia indica* Burm.f. at various Thidiazuron (TDZ) concentrations (**A**) Callus obtained on a medium with 1.0 mg/L TDZ (4.4 µM); (**B**) Callus obtained on a medium with 2.0 mg/L (9.08 µM); (**C**) Callus obtained on a medium with 3.0 mg/L (13.6 µM).

5. ANTIOXIDANT ACTIVITY

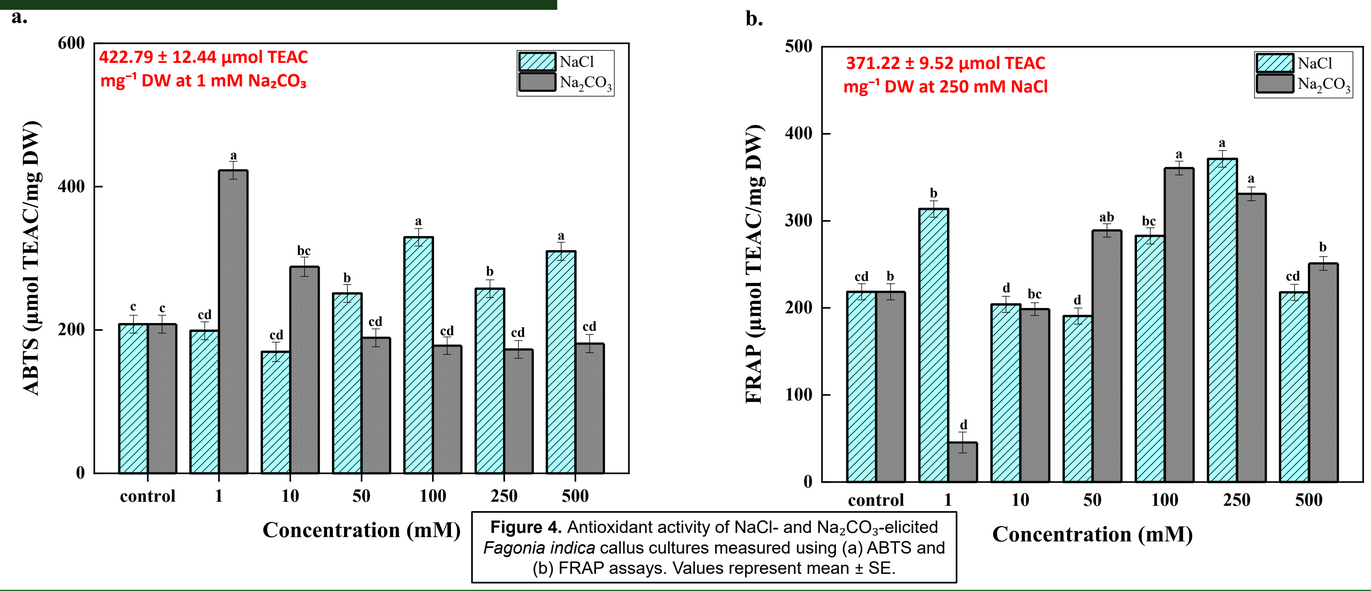


Figure 4. Antioxidant activity of NaCl- and Na_2CO_3-elicited *Fagonia indica* callus cultures measured using (a) ABTS and (b) FRAP assays. Values represent mean ± SE.

6. ANTI-INFLAMMATORY

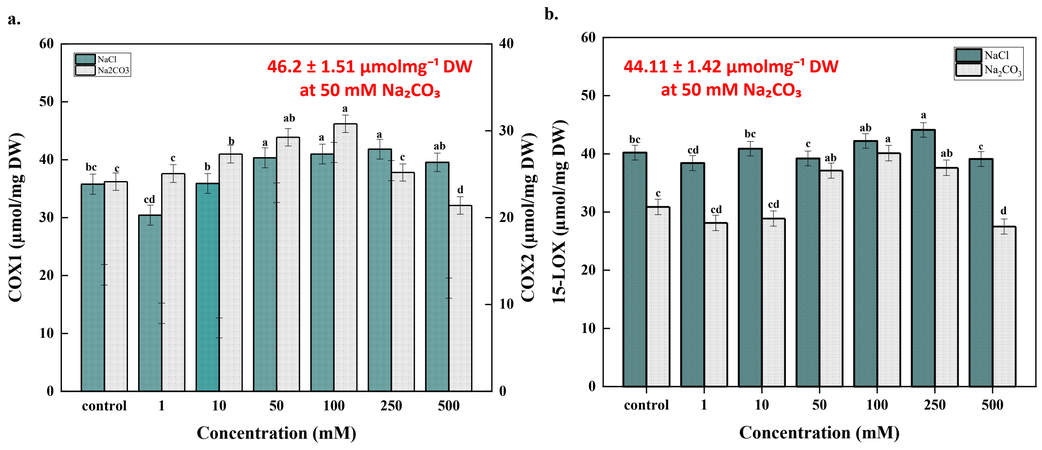


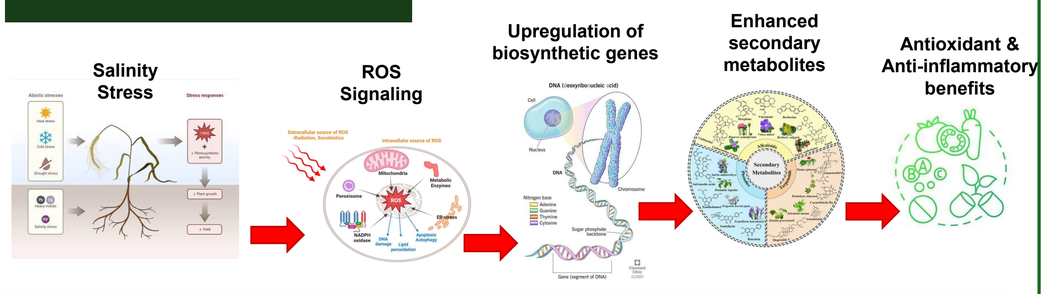
Figure 5. Anti-inflammatory activity of NaCl- and Na_2CO_3-elicited *Fagonia indica* callus cultures, determined using (a) COX-1 and (b) 15-LOX cell-free *in vitro* assays. Activities are expressed as percentage inhibition.

7. HPLC- Major Metabolites (mg g^{-1} DW)

Compound	Concentration (mg g^{-1} DW)											
	NaCl (mM)						Na_3CO_3 (mM)					
	1	10	50	100	250	500	1	10	50	100	250	500
Betulinic acid	206.28	541.03	828.64	1301.54	**1573.71**	1276.84	159.09	298.61	478.63	671.92	737.53	571.42
Apigenin	1.03	1.87	2.61	3.60	**4.62**	3.81	1.01	1.12	1.27	1.90	1.98	**1.44**
Nahagenin	61.07	110.88	133.53	163.18	**194.93**	163.31	54.19	56.31	62.52	67.43	71.43	58.40
Caffeic acid	3.60	4.90	6.14	7.43	**8.17**	7.61	3.04	3.57	4.46	4.66	5.09	4.57

Among the 11 metabolites analysed, individual compounds showed distinct responses to NaCl and Na_2CO_3 treatments, with key metabolites showing their highest accumulation at 250 mM NaCl.

8. INTERPRETATION



Salinity acts as a sustainable elicitor to enhance the production of high-value phytochemicals in *F. indica*, a climate-resilient species adapted to dryland ecosystems.

9. CONCLUSIONS

- **250 mM NaCl:** highest biomass, metabolites and antioxidant activity.
- **50 mM Na_2CO_3:** promising anti-inflammatory activity.
- Salt elicitation can enhance bioactive-compound production.

10. FUTURE WORK

- **Scale up production.**
- **Profile genes and metabolites.**
- **Test whole-plant salt tolerance.**
- **Assess production efficiency.**

ACKNOWLEDGMENT

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REFERENCES

Javed et al. (2026), Plant Biosystems 160:39.
DOI: 10.1007/s44473-025-00018-z

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