



Evaluation of indigenous nitrogen-fixing bacteria from Bambara groundnut for tolerance to pH and saline conditions

Gugu Maseko; Zakheleni Dube; Elizabeth Kola; Siphesihle Mthombeni, Thobile Mkhwanazi, Rivoningo Ubisi



Introduction

- Underutilized crop (Khan *et al.*, 2021).
- Bambara groundnut in South Africa (Majola *et al.*, 2021).
- Symbiotic relationship with nitrogen-fixing bacteria (Zenabou *et al.*, 2022).
- Lack of information on Bambara groundnut rhizobia (Fwanyanga *et al.*, 2022).



Figure 1: Bambara groundnut.

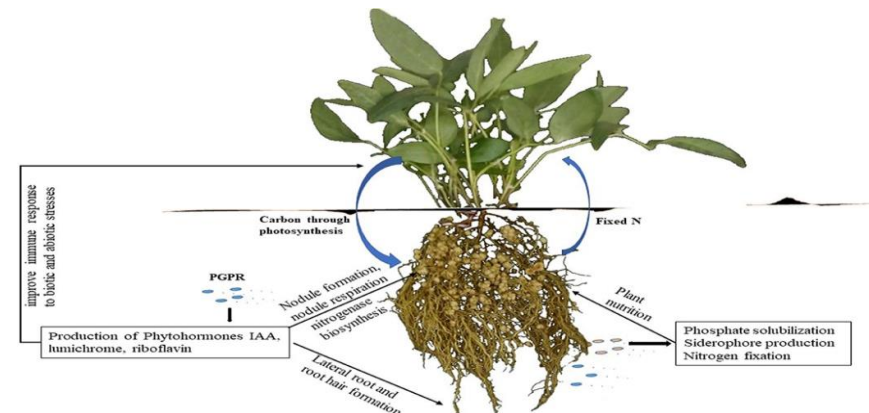


Figure 2: Plant growth-promoting activities in the rhizosphere.



Introduction



Figure 3: Nitrogen-fixing bacteria.

- Low population of beneficial microorganisms and nutritional status (Khan *et al.*, 2021).
- High soil salinity and fluctuating soil pH (Torabian *et al.*, 2019).
- Indigenous strain inoculant formation (Sanchez-Navarro *et al.*, 2020)



Materials and methods

Study location

- University of Mpumalanga (UMP) (25°27'06.18"S and 30°58'5.21"E), Mbombela campus, South Africa under laboratory conditions.

Experimental treatments

- Completely Randomized Design (CRD), replicated 3 times.
- 10 isolated bacteria Bambara indigenous (*Sphingobacterium faecium*, *Proteus columbae*, *Mammaliococcus sciuri*, *Bacillus pumilus*, *Stenotrophomus pavanii*, *Bacillus pumilus*, *Kaistella daneshvariae*, *Enterobacter asburiae*, *Stenotrophomonas maltophilia*, and *Cellulosimicrobium cullulans*).



Figure 4: University of Mpumalanga Laboratory.



Materials and methods



Figure 5: E-SP 1100-UV-P spectrophotometer .

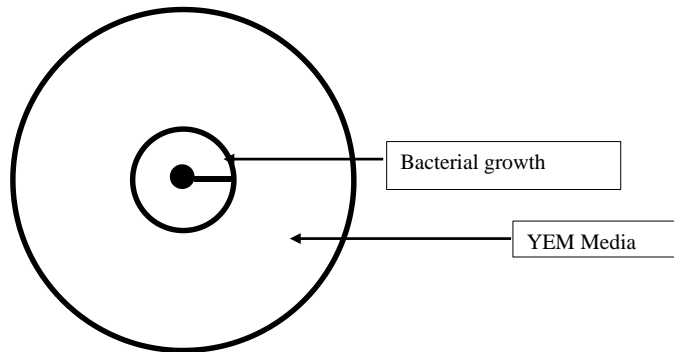


Figure 6: Illustration of bacterial isolate radial growth in a YEM media plate.

- 15ml nutrient broth tubes with pre-adjusting the pH to 3.5, 4.5, 5.5 with HCl or NaOH.
- 6.9 Nutrient broth pH
- Incubated at 28°C and kept at 120 revolutions per minute (rpm) in an incubator shaker for 5 days.
- Two independent experiments were conducted separately.
- Absorbance at 470nm using E-SP 1100-UV-P spectrophotometer at 470 nm.
- Eight treatments, namely 2, 4, 8, 16, 32, 64, and 128 NaCl + CaCl₂ mM/m³ at a 3:1 ratio were impregnated in the YEM medium.
- Plates will be incubated for 7 day at 28°C.
- 300 mm ruler from the center to the colony edge



Results and discussions

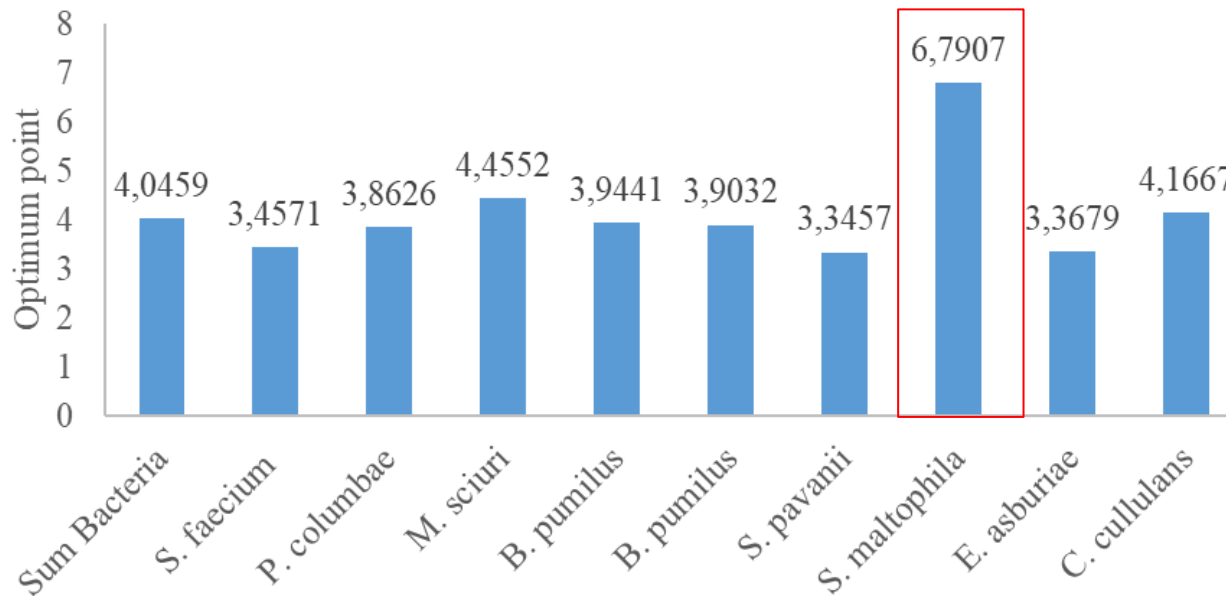
Table 1: Effect of Bacteria and pH levels on absorbance of Bambara groundnut nitrogen-fixing bacteria isolates

Bacteria	Absorbance			
	pH			
	3.5	4.5	5.5	6.9
<i>Sphingobacterium faecium</i>	0.022 ^{qr} (0.052)	0.061 ^{l-r} (0.170)	0.091 ^{j-r} (0.256)	0.110 ^{i-o} (0.291)
<i>Proteus columbae</i>	0.036 ^{n-r} (0.086)	0.158 ^{f-j} (0.446)	0.113 ⁱ⁻ⁿ (0.296)	0.267 ^{ab} (0.868)
<i>Mammaliococcus sciuri</i>	0.017 ^r (0.039)	0.028 ^{opqr} (0.065)	0.108 ^{i-p} (0.283)	0.249 ^{abcd} (0.817)
<i>Bacillus pumilus</i>	0.061 ^{k-r} (0.179)	0.241 ^{abcd} (0.778)	0.114 ⁱ⁻ⁿ (0.301)	0.111 ^{i-o} (0.292)
<i>Bacillus pumilus</i>	0.038 ^{n-r} (0.093)	0.177 ^{c-j} (0.503)	0.171 ^{d-j} (0.485)	0.153 ^{f-k} (0.427)
<i>Stenotrophomus pavanii</i>	0.048 ^{l-r} (0.118)	0.215 ^{b-f} (0.641)	0.308 ^a (1.040)	0.243 ^{a-e} (0.762)
<i>Kaistella daneshvariae</i>	0.021 ^{o-r} (0.071)	0.161 ^{e-j} (0.466)	0.249 ^{abcd} (0.791)	0.126 ^{h-m} (0.340)
<i>Stenotrophomonas maltophila</i>	0.027 ^{pqr} (0.065)	0.146 ^{f-k} (0.405)	0.149 ^{f-k} (0.411)	0.249 ^{abcd} (0.828)
<i>Enterobacter asburiae</i>	0.046 ^{m-r} (0.112)	0.199 ^{b-h} (0.595)	0.181 ^{b-l} (0.561)	0.130 ^{g-l} (0.352)
<i>Cellulosimicrobium cullulans</i>	0.047 ^{m-r} (0.114)	0.102 ^{i-q} (0.278)	0.258 ^{abc} (0.819)	0.211 ^{b-g} (0.629)
F-value	3.850			
P-value	0.000*			
LSD _{0.05}	0.083			

*Highly significant ($P \leq 0.01$); Means in columns followed by the same letters are not statistically different ($P \leq 0.05$); Values found in brackets are untransformed means [$\text{Log}_{10}(x+1)$].



Results and discussions



Individual and sum of indigenous Bambara groundnut bacteria

Figure 7: Optimum turning point of Individual and sum of indigenous nitrogen-fixing Bambara groundnut bacteria.



Conclusions and recommendations

- *Bacillus pumilus* performed well in low pH levels of 3.5 and 4.5
- *Stenotrophomus pavanii* at pH level 5.5 and *Proteus columbae* at 6.9.
- All Bambara groundnut nitrogen-fixing bacteria strains survived well in low salinity levels.
- *Stenotrophomonas maltophila* survived well in high and low salinity levels.
- *Stenotrophomonas maltophila* can be recommended to farmers who want to produce Bambara groundnut in high-saline soil conditions.



References

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Thank you for your attention!

Gugu Maseko

Mobil: +27 60 940 0629

E-mail: gcmaseko22@gmail.com

Address: Cnr R40 & D725 Roads, Mbombela,
1200, South Africa



December 4-6, 2024, București



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