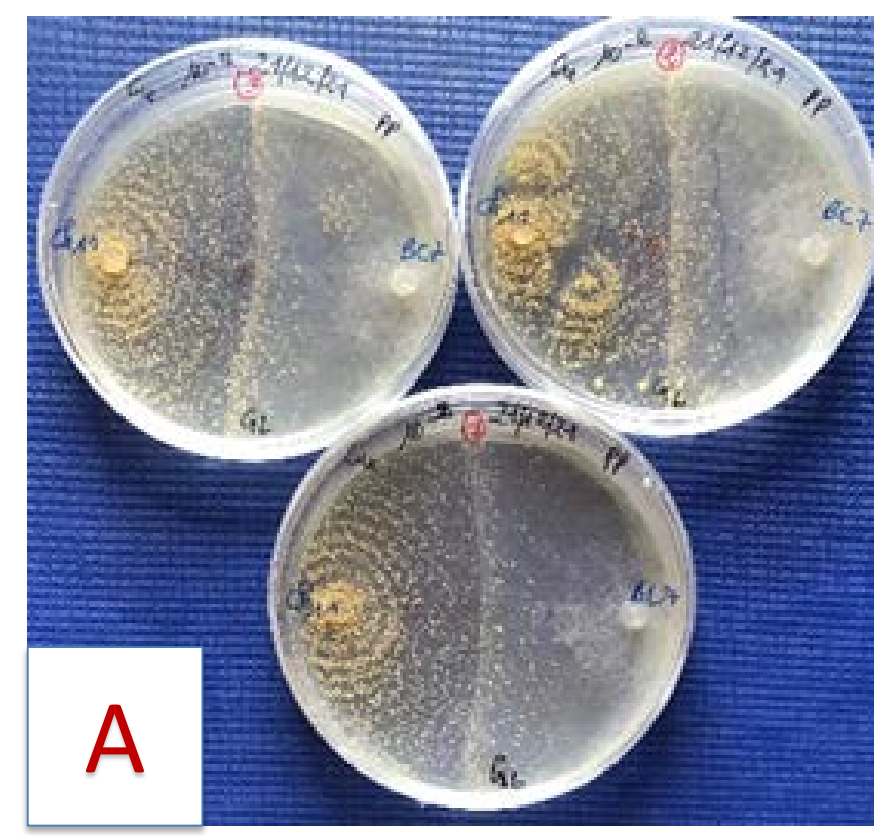


In vitro and in vivo screening and selection of microorganisms from five composts with antagonistic effects on *Phytophthora* spp., the causal agent of black rot of cocoa pods (*Theobroma cacao* L.) in Côte d'Ivoire



1- Introduction

Cocoa production in Côte d'Ivoire is threatened by black pod rot (BPR) due to *Phytophthora* spp. [1] as well as the decline in soil fertility [2]. The present study proposed to formulate five (5) composts using different ratios of poultry manure, cattle manure, sheep manure, cocoa hulls, rice bran and panicum, and to study the effect of the microorganisms they contain in the control of BPR of cocoa.



In vitro (A) & in vivo (B) tests to determine the antagonistic capacities of fungal isolates, obtained from the composts, on *Phytophthora* spp.

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2- Materials and Methods

Composts :

- The five composts were formulated with different ratios of the beforementioned constituents (see Table 1)
- After 8 months composts were analysed for their chemical characteristics (Table 1)

Isolation microorganisms :

- After 8 months, bacteria and fungi were isolated from the five composts
- A total of 296 bacterial and 55 fungal isolates were thus obtained

In vitro & vivo antagonism against *Phytophthora* spp.

- All 55 fungal isolates were used in dual culture to determine their potential for growth inhibition of *Phytophthora megakarya* and *P. palmivora*
- Arcsine transformed percentage inhibition data was used to analyse differences between composts and their inhibitory quality for both pathogens
- A detached pod test was used to determine the fungistatic or fungicidal nature of the 55 fungal isolates tested

Table 1 : Composition, and chemical characteristics of the five composts after eight months.

	Composition ¹	pH _{water}	C (%)	N (%)	C/N	P _{tot} (mg kg ⁻¹)	K (mg kg ⁻¹)	Ca (mg kg ⁻¹)	Mg (mg kg ⁻¹)	Mn (mg kg ⁻¹)	Fe (mg kg ⁻¹)	Cu (mg kg ⁻¹)	Na (mg kg ⁻¹)	Zn (mg kg ⁻¹)	Cd (mg kg ⁻¹)
Compost 1	CM 30%, BM 50%, PM 05%, CH 5%, RB 5%, P 5%	7.3	27.0	1.8	15.4	3700.0	44050.0	14530.0	9330.0	4.8	10.0	18.7	6.8	11.4	3.5
Compost 2	CM 45%, BM 10%, PM 20%, CH 10%, RB 5%, P 10%	7.9	29.2	1.9	15.4	3500.0	42860.0	14920.0	7230.0	2.9	11.1	20.9	7.6	11.0	3.9
Compost 3	CM 45%, BM 10%, PM 25%, CH 10%, RB 5%, P 5%	7.6	35.1	1.6	21.7	4100.0	47620.0	16210.0	7230.0	5.6	11.1	19.9	6.7	12.1	4.0
Compost 4	CM 45%, BM 10%, PM 05%, CH 30%, RB 0%, P 10%	8.7	26.8	1.5	18.1	2800.0	39290.0	15940.0	10730.0	0.8	8.9	18.7	8.4	10.3	2.9
Compost 5	CM 45%, BM 10%, PM 15%, CH 20%, RB 5%, P 5%	8.3	28.1	1.4	20.1	3100.0	41670.0	14510.0	9330.0	2.6	11.1	18.0	7.6	10.7	2.7

¹CM = Chicken manure, BM = Bovine manure, PM = Pig manure, CH = Cocoa husks, RB = Rice bran, P = *Panicum* sp

3- Results

- Composts showed differences in chemical composition, notably for N, P, & K. Noteworthy are the relatively high Cd contents of all composts.
- All composts contained fungal isolates able to inhibit *Phytophthora* growth.
- Isolates from compost C1 were most proficient in inhibiting growth of *P. palmivora* and *P. megakarya*, isolates from compost 3 were least proficient (Fig 1)

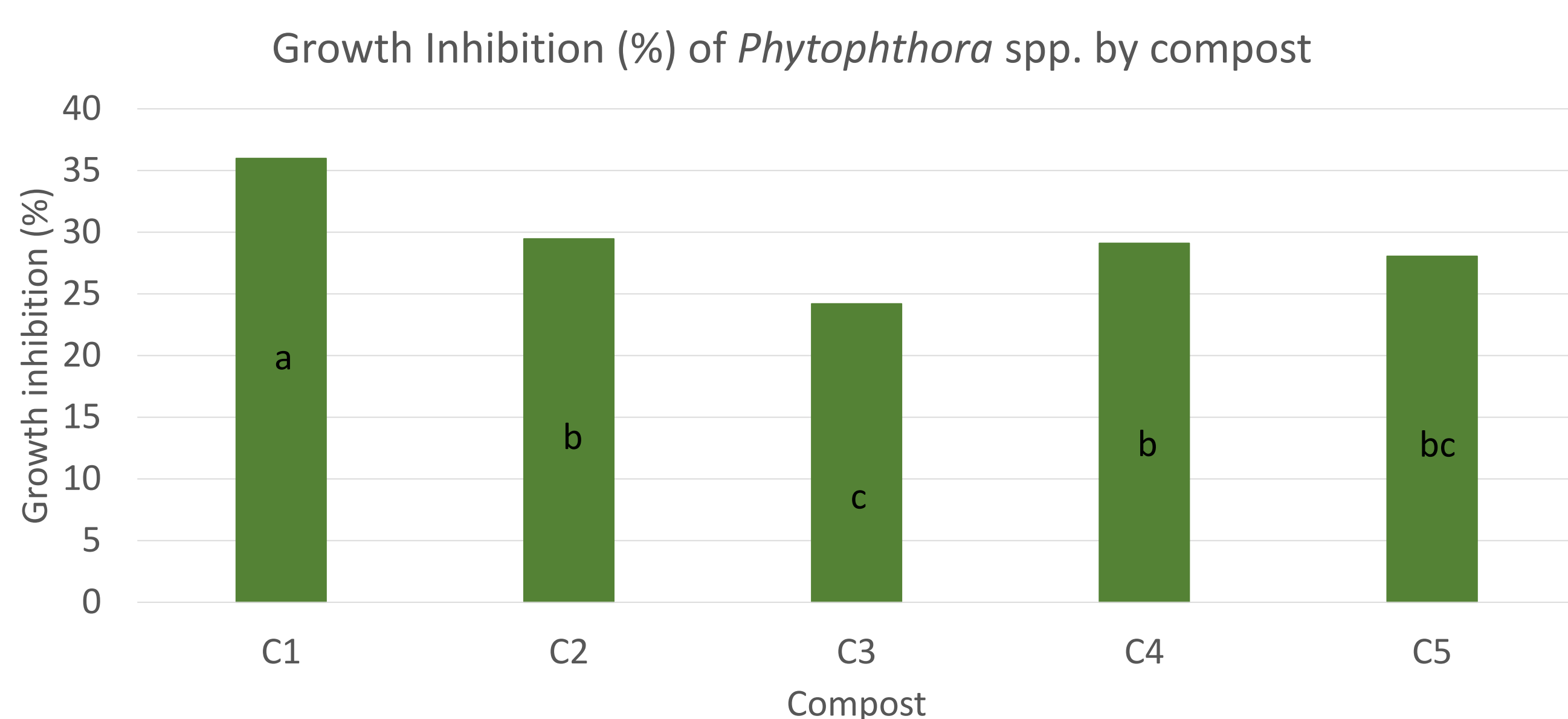


Figure 1: Average growth inhibition of *P. palmivora* and *P. megakarya* by fungal isolates obtained from the 5 different composts. Values with different letters are significantly different (ANOVA)

- The fungal isolates from the five different composts inhibited growth of *P. megakarya* significantly more than *P. palmivora* (Fig 2)

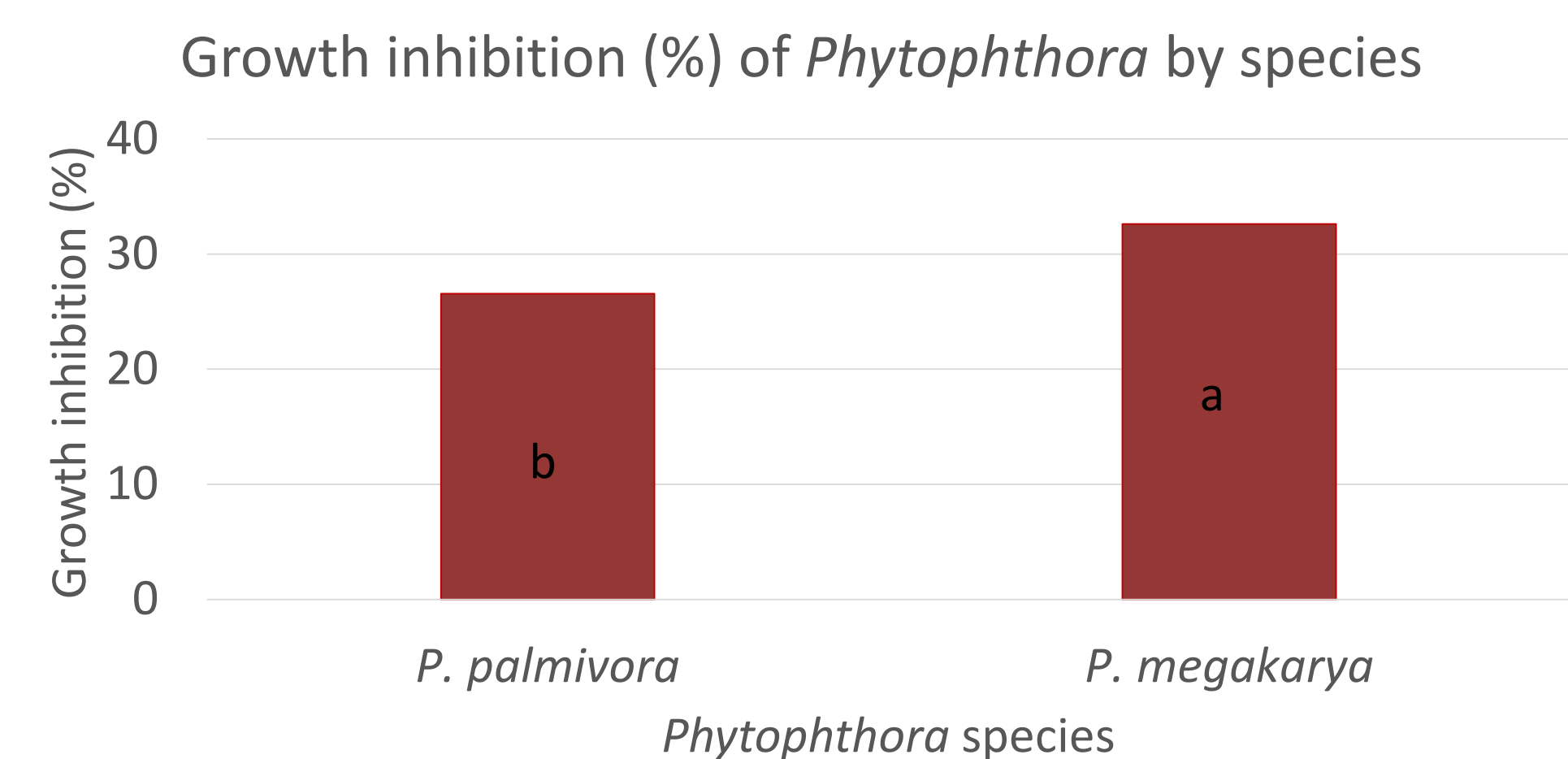


Figure 2: Average percentage growth inhibition of *P. megakarya* and *P. palmivora* due to the 55 fungal isolates obtained from the 5 different composts. Values with different letters are significantly different (Anova)

- Of all 55 fungal isolates, 8 displayed fungicidal capacities against *P. megakarya* and 2 against *P. palmivora*. No fungicidal isolates were obtained from compost 3.

4- Discussion

- The chemical composition shows differences in composts likely due to the original composition. Their effect on cocoa growth and productivity remains to be studied. The Cd content of all composts is of concern given the maximum residue levels for Cd in cocoa [3].
- All composts showed growth inhibition of both *Phytophthora* species. Interestingly differences were found in percentage growth inhibition and number of fungicidal isolates per compost. Whether these are actual differences and whether they will effect black pod disease remains to be tested under greenhouse and field conditions, trials which are underway.

This study does show that there is scope for the use of biofertilizers to enhance cocoa plant health and control of black pod disease

References

- [1] Coulibaly & al. 2018. DOI:10.18483/ijSci.1707
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