SUSeeds: Biodegradable coatings for vegetable seeds

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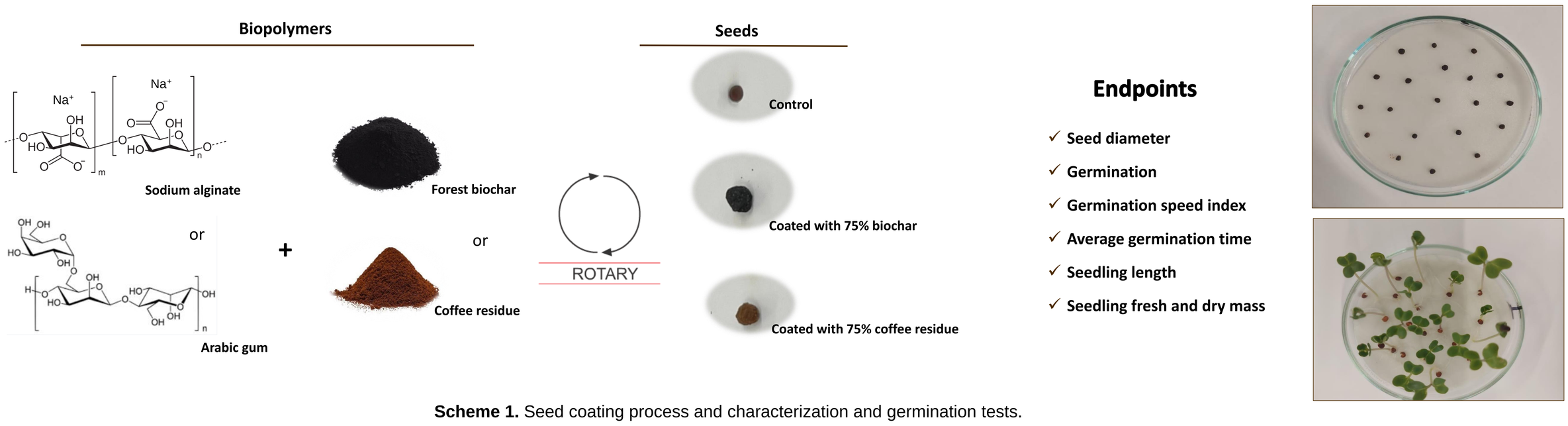
Introduction

Agricultural systems with intensive use have imposed high pressures on natural resources, with significant consequences on biodiversity, water scarcity, soil exhaustion, and the growth of emerging pathogenic species, which also compromise food security [1]. Transitioning to sustainable agriculture demands the development of high-productivity practices that utilize renewable resources. Agricultural innovations, such as implementing new farming technologies and introducing improved seeds and tools, are crucial to ensuring sustainability and increasing production [2]. To keep the balance between the food demand and the protection of the ecosystems, it is imperative that sustainable high-productivity methods can be adopted, using renewable resources and efficient practices. Using biopolymers in agriculture offers a promising alternative to petroleum-derived polymers [3]. Biopolymers and derived coating materials are attractive due to their low ecological footprint and inherent biodegradability by microorganisms or natural processes. Furthermore, these materials exhibit biocompatibility and possess additional functionalities like antibacterial and antifungal properties, potentially enhancing agricultural product quality. The present research focuses on designing new multifunctional films or capsules based on biodegradable biopolymers to coat the surface of different types of vegetable seeds.

Materials and methods

Tronchuda cabbage seeds (Sementes Vivas, Portugal) were sterilized with 2% (w/v) sodium hypochlorite solution (NaOCl) for 5 minutes and washed with distilled water. After they were immersed in a 5% (w/v) aqueous solution of sodium alginate (Panreac, Spain) or arabic gum (Fisher, Germany) and sieved (Ø 1 mm). Forest biochar and coffee residue [25, 50, and 75% (w/w)] were added and, to ensure uniformity, coated seeds were subjected to circular rotary at 120-150 rpm, for 10 minutes (Scheme 1). Seeds were dried at 30 °C for 24 h, physical characterized, and subjected to germination tests, an average of 18 °C, for nine days.



Scheme 1. Seed coating process and characterization and germination tests.

Results

Physical and germination results are presented in Table 1 and 2, respectively.

Table 1. Seed area (A), mass of 100 seeds (M), germination (G), germination speed index (GSI), and mean germination time (MGT) of uncoated (control) and coated cabbage seeds.

Factor	A (mm^2)	M (g)	G (%)	GSI (% day^{-1})	MGT (days)
Control	3.45 **	4.00 **	100 ^{ns}	9.80 **	1.00 **
Adhesive Material					
GA	4.82 a	4.93 a	95 a	9.12 a	1.10 a
ALG	4.76 a	4.91 a	92 a	7.87 b	1.51 b
Cementing Material					
Coffee	4.58 b	4.58 b	95 a	8.65 a	1.35 a
Biochar	5.01 a	5.26 a	92 a	8.34 a	1.26 a
Concentration					
25%	4.63 a	4.62 b	92 a	8.64 a	1.22 a
50%	4.85 a	5.07 a	95 a	8.23 a	1.43 b
75%	4.90 a	5.07 a	93 a	8.61 a	1.27 a
CV (%)	17.27	5.18	7.37	8.65	12.92

Table 2. Shoot Length (SL), Root Length (RL), Seedling Length (SLG), Fresh Mass (FM), and Dry Mass (DM) of uncoated (control) and coated cabbage seeds."

Factor	SL (cm)	RL (cm)	SLG (cm)	FM (g)	DM (g)
Control	4.06 **	7.25 *	11.31 **	1.08 **	0.06 *
Adhesive Material					
GA	4.07 a	6.98 a	11.05 a	1.23 a	0.07 a
ALG	3.68 b	6.39 b	10.07 b	1.17 b	0.07 a
Cementing Material					
Coffee	3.72 b	6.63 a	10.35 a	1.12 b	0.06 a
Biochar	4.03 a	6.75 a	10.78 a	1.28 a	0.08 a
Concentration					
25%	3.66 b	6.28 b	9.94 b	1.13 b	0.07 a
50%	3.95 a	6.85 ab	10.80 a	1.25 a	0.07 a
75%	4.02 a	6.92 a	10.94 a	1.22 a	0.07 a
CV (%)	16.52	24.02	17.29	2.27	38.14

Adhesive Material: GA = Gum Arabic; ALG = Sodium Alginate. ns – comparison between control and treatments, not significant by F-test at 5% level * - comparison between control and treatment, significant by F-test at 5% level. ** - comparison between control and treatment, significant by F-test at 1% level. Means followed by the same letter, in the column and within each factor, do not differ from each other by Tukey's test, at 5% probability level.

Conclusions

Seed coating is thought to be a more effective method than traditional spraying for protecting plants in their early stages of growth. Formulations containing sodium alginate and arabic gum combined with forest biochar and coffee residue, were applied to cabbage seeds, resulting in increased mass and diameter of the propagation unit. The coating had no significant effect on seed germination, but it did cause a slight delay in germination speed and time. The combination of gum arabic and biochar at a 75% concentration exhibited the best results in terms of physiological quality and seed vigor. Further research is now being conducted with tomato seeds and other natural cementation materials.

References

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SDG 2 directly addresses achieving food security and promoting sustainable agriculture and **SDG 13** proposes sustainable agricultural practices that reduce greenhouse gas emissions and protect ecosystems.