Cassava, mandacaru, and glue as adhesive agents in the coating of heirloom fava bean seeds

ABSTRACT

The seed coating technique, while not recent, has garnered attention due to its commercial implications. This process has grown in significance and feasibility, imparting greater added value to seeds, particularly in an increasingly competitive and regulated market environment, notably within the realm of heirloom seeds. Thus, the objective of this study was to investigate the impacts caused by the use of adhesive agents, including mandacaru extract, polyvinyl acetate-based glue, and cassava gum, in the pelleting process of heirloom fava bean seeds with rock dust. The experiment was conducted in the Phytotechnics Laboratory, situated within the Campus of Engineering and Agricultural Sciences at the Federal University of Alagoas. In the coating process, MB-4 rock powder was employed. The analyzed parameters encompassed water content, thousand seed weight, first germination count, germination percentage, germination speed index, mean germination time, germination uncertainty, primary root length/aboveground portion, and seedling dry mass. Polyvinyl acetate (PVA) glue and cassava gum proved to be the most efficient adhesive agents in the pelleting of fava bean seeds with rock powder.

Keywords: Pelletizing, Traditional communities, Vigor, Seed, Germination.

1. INTRODUCTION

The concept of seed coating is not recent; the first patent related to the seed coating process dates back to the 19th century. However, its commercial functionality did not garner real interest until the 20th century (SANTOS, 2016). Researchers, motivated by the potential benefits of this process and the goal of producing and marketing coated seeds, established the first commercial company in 1946, formalizing the patent for this process with beet seeds (GIMÉNEZ-SAMPAIO and SAMPAIO, 2009). However, the social and low-cost technology transfer aspects were never taken into account.

From the outset, the materials and procedures for coating were originally developed for the pharmaceutical industry (TAYLOR et al., 2001). Seed coating has become a growing and thriving technology because it adds value to seeds and contributes to an increasingly competitive and stringent market, especially when it comes to heirloom seeds. Agents used as adhesives must have affinity with other ingredients, be readily soluble in water, operate at low concentrations, and not be hygroscopic, corrosive, or toxic. When it comes to grains, seed coating is still considered a recent technology in Brazil, especially for family farming, as it lacks information regarding the type of rock, adhesive material, and treatment strategies (MELO et al., 2020).

The preference for using heirloom seeds is primarily attributed to characteristics such as adaptability, preservation of customs, taste, and quality of traditional varieties, in addition to low production costs (PELWING et al., 2008). Therefore, to efficiently preserve the physiological potential of heirloom fava bean seeds during the off-season, the use of post-harvest seed treatments is necessary. Seed treatment is possibly the oldest, most cost-effective, and occasionally the safest measure that yields the best results in improving germination and vigor. The seed coating technique, while not recent, has garnered attention due to its commercial implications. This process has grown in significance and feasibility, imparting greater added value to seeds, particularly in an increasingly competitive and regulated market environment, notably within the realm of heirloom seeds.

Thus, the objective of this study was to investigate the impacts caused by the use of adhesive agents, including mandacaru extract, polyvinyl acetate-based glue, and cassava gum, in the pelleting process of heirloom fava bean (*Vicia faba*) seeds with rock dust.

2. MATERIAL AND METHODS

The experiment was conducted in the Phytotechnics Laboratory, situated within the Campus of Engineering and Agricultural Sciences at the Federal University of Alagoas, Brazil.

Activities conducted:

The adhesive agents used were: 1 - water (control), 2 - mandacaru extract, 3 - polyvinyl acetate-based glue, and 4 - cassava gum. Before the pelletization process, asepsis was carried out of the seeds by immersing them in 70% alcohol for 1 minute, followed by washing in running water. The seeds were placed inside a plastic container where the adhesive agent was added and gently shaken for uniform coating. For the coating, they were covered with the adhesive agent and placed in a plastic tray containing rock dust (MB-4), with the tray gently shaken until the seeds were perfectly covered.

At the end of the process, excess rock dust was removed through sieving, and the thousand-seed weight (TSW) and moisture content were measured to quantify possible changes after treatment. Subsequently, the treated seeds were placed for germination on roll-shaped paper towels moistened with distilled water in an amount equivalent to 2.5 times their weight, and then placed in a B.O.D. (Biochemical Oxygen Demand) germinator at a temperature of 20°C. Seeds that produced normal seedlings with all essential structures, showing potential for further development and the production of normal plants under favorable conditions (BRASIL, 2009), were considered and germinated. Daily counts of germinated seeds were performed at the same time for fourteen days. To determine the seed moisture content, the oven method at 105 ± 3 °C for 24 hours was used, following the Rules for Seed Analysis (BRASIL, 2009). This determination was made at the time of test installation, using four samples per treatment. At this stage, the thousand-seed weight was also determined by weighing eight replicates of 100 units, following RAS (BRASIL, 2009): TSW = SW x 100/N, where TSW = Thousand-seed weight (g); SW = Sample weight (g); N = Total number of seeds.

The following variables were analyzed:

Germination: gi = (Σki=1ni/N) x 100, where ni is the number of germinated seeds/emerged seedlings at time i, and N is the total number of seeds placed for germination (CARVALHO et al., 2005).

First germination count: It was performed concurrently with the germination test, counting the percentage of normal seedlings obtained from the fourth day after test installation.

Germination Speed Index: G1/N1 + G2/N2 + ... + Gn/Nn, where IVG = G1, G2, and Gn = number of germinated seeds counted in the first, second, and last count, and N_1, N_2, and N_n = number of days from sowing to the first, second, and last count (MAGUIRE, 1962).

Average germination time: $t = \sum_{i=1}^{k}(n_i t_i)/\sum_{i=1}^{k} n_i$, where t_i is the time from the start of the experiment to the ith observation (days or hours); n_i is the number of germinated seeds at time i (corresponding to the ith observation); k is the last day of germination (CZABATOR, 1962).

Uncertainty index: $U = -\sum_{i=1}^{k} F_i \log_2 F_i \asymp F_i = n_i/\sum_{i=1}^{k} n_i$, where F_i is the relative frequency of germination; n_i is the number of germinated seeds at time i (corresponding to the ith observation); k is the last day of germination (LABOURIAU, 1983).

Root and shoot length of seedlings: At the end of the germination test, the hypocotyl and primary root of normal seedlings from each sub-sample were measured using a graduated ruler, and the results were expressed in centimeters per seedling (MELO, 2011).

Dry mass of seedlings: After the germination test, normal seedlings from each replicate were placed in paper bags, then placed in a forced ventilation oven at 80°C for 24 hours. After this time, the samples were placed in desiccators with activated silica gel and weighed on an analytical balance with a precision of 0.0001g, with the result expressed in g/seedling (NAKAWAGA, 1999).

Statistical analysis: The experimental design used was completely randomized (CRD), with four replications of 50 seeds per treatment. The data were subjected to analysis of variance (ANOVA), and means were compared using the Tukey test and, when necessary, Dunnett's test. The analyses were conducted using the SISVAR 5.6 software (FERREIRA, 2011).

3. RESULTS AND DISCUSSION

Table 1 presents the results of the thousand-seed weight (TSW) analysis, demonstrating that the application of the proposed adhesive agents resulted in significant increases in the Thousand-Seed Weight (TSW) in all treatments, except for seeds treated with water as the adhesive agent. Regarding the Moisture Content (MC), the seeds exhibited similar values, with no statistically significant differences among them. This indicates that the adhesive agents employed in the coating process did not retain moisture, and the ambient temperature of 35°C was effective in promoting drying during the coating step. This pattern of results aligns with the research conducted by Melo *et al.* (2020) in the context of pelleting heirloom maize seeds.

Table 1. Thousand-Seed Weight (TSW) and Moisture Content (MC) of heirloom fava bean seeds subjected to adhesive agents for pelleting with rock dust.

Treatments	TSW (g)	MC (%)
Water	423,9 bz	10,4 az
Mandacaru Extract	447,1 ay	10,0 az
Cassava Gum	451,0 ay	11,9 az
Glue (PVA)	450,2 ay	11,6 az
	PMS = 423,0 z	TA = 11,5 z
CV (%)	10,00	9,20

Means followed by the same lowercase letter in the column do not differ at a 5% probability level according to the Tukey test.
Means followed by the same letter (z, y) between TSW and MC (control - no adhesive agents + rock dust) do not differ significantly at a 5% probability level according to the Dunnett test.

Analyzing the results obtained in Table 2, the parameters of first germination count (PCG), germination (GER), and germination speed index (IVG) evaluated did not differ statistically from each other.

The treatments performed exceptionally well in adhering to the seeds, meaning water, mandacaru extract, cassava gum, and polyvinyl acetate (PVA) glue effectively adhered the rock dust to the seeds and did not affect the germination process of fava bean seeds. Melo *et al.* (2023a), Melo *et al.* (2023b), and Melo *et al.* (2020) concluded in their respective studies (involving maize and beans) that the germination percentage of seeds is not reduced by pelleting, regardless of the material used, making it a valuable parameter in the execution of the process. These tests are of utmost importance as they assess germination speed, indicating that higher seed germination in the first count may imply greater seed vigor (KRZYZANOWSKI *et al.,* 2020).

Table 2. First germination count (PCG), germination (GER), and germination

speed index (IVG) of heirloom fava bean seeds subjected to adhesive agents for pelleting with rock dust.

Treatments	PCG (%)	GER (%)	IVG
Water	90 a	100 a	6,189 a
Mandacaru Extract	89 a	100 a	6,075 a
Cassava Gum	90 a	100 a	6,025 a
Glue (PVA)	90 a	100 a	6,003 a
CV (%)	11,2	9,00	8,30

Means followed by the same lowercase letter in the column do not differ at a 5% probability level according to the Tukey test.

Regarding the mean time (TM) and uncertainty (I) of germination for the studied seeds (Table 3), it was observed that polyvinyl acetate (PVA) glue demonstrated better efficacy compared to the other treatments. According to Melo *et al.* (2020), some materials allow for better diffusion of gases and water between the seed and the external environment. The remaining treatments did not differ statistically from each other.

Table 3. Mean time (TM) and uncertainty (I) of germination of heirloom fava bean seeds subjected to adhesive agents for pelleting with rock dust.

Treatments	TM (dias)	I (bit)
Water	4,2 b	0,150 b
Mandacaru Extract	4,5 b	0,165 b
Cassava Gum	4,5 b	0,160 b
Glue (PVA)	3,0 a	0,101 a
CV (%)	8,17	8,03

Means followed by the same lowercase letter in the column do not differ at a 5% probability level according to the Tukey test.

When evaluating the length and dry mass of the seedlings (Table 4), it was observed that the highest averages (12.40 cm, 11.20 cm and 1.303 g, respectively) were obtained when cassava gum was used, differing statistically from the others treatments. The application of cassava gum possibly favored the germination process with more efficient degradation of the reserves present in the seeds, which aided in the development of the radicles and aerial parts, consequently leading to dry mass accumulation. During this phase, all seedling development is attributed to the chemical composition of the seeds (MARCOS FILHO, 2015).

Table 4. Root length (RL), shoot length (SL) and dry mass (DM) of seedlings derived from heirloom fava bean seeds subjected to adhesive agents for pelleting with rock dust.

Treatments	RL (cm)	SL (cm)	DM (g)
Water	9,50 b	7,00 c	0,900 b
Mandacaru Extract	10,50 b	9,50 b	0,909 b
Cassava Gum	12,40 a	11,20 a	1,303 a
Glue (PVA)	10,10 b	9,00 b	0,892 b
CV (%)	9,90	7,55	15,02

Means followed by the same lowercase letter in the column do not differ at a 5% probability level according to the Tukey test.

4. CONCLUSIONS

Polyvinyl acetate (PVA) glue and cassava gum were the most efficient adhesive agents in the pelleting of heirloom fava bean seeds with rock dust.

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