The Production and Function of Mucilage by Sweet Basil (*Ocimum basilicum* L.) Seeds

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ABSTRACT:

Sweet basil (*Ocimum basilicum* L.) seeds produce a thick layer of mucilage around the testa within minutes after hydration. Mucilage is most prevalent among plant species adapted to surviving in arid sandy soils, though its significance in determining ecological fitness is unclear. The mucilage produced is reported to be composed of cell-wall polysaccharides that are deposited in testa cells during development. In this study, sweet basil seeds were examined using light and environmental scanning electron microscopy. The mucilage of basil seeds is held together by columnar structures that unfolded from the pericarp and helped hold and stabilize the mucilage to the seed surface. The mucilage was removed using diluted hydrochloric acid to compare performance of seeds with and without mucilage. Mucilage removal did not significantly change germination percentages under ideal conditions in a laboratory, but seeds without mucilage took longer to germinate. The water content of intact seeds with mucilage was almost 4 times greater than seeds without mucilage. Mucilage enabled seeds to cling to an incline board set to a steeper angle than the seeds without mucilage. Germination testing of whole seeds on diverse growing media and native soils increased germination percentages and survival compared to seeds without mucilage over a 10 day period. Basil seed mucilage acts as a reservoir to hold loosely bound water at high water potential so it is available for seed germination and early seedling development.

INTRODUCTION:

Sweet basil (*Ocimum basilicum* L.) seeds produce mucilage after hydration. The production of hydrophilic mucilage by the seed coat or pericarp during hydration is a common adaptation in angiosperms, known as myxodiaspory. The mucilage is composed primarily of pectins and hemicelluloses that undergo substantive swelling upon hydration.

The production of seed mucilage occurs in a broad range of plant families, including Acanthaceae, Brassicaceae, Liaceae, and Plantaginaceae. While the fruit mucilage production occurs in the families of Asteraceae, Lamiaceae and Poaceae .

Mucilage production by seed dispersal units (seed coat or pericarp) has been proposed to play a number of roles, including facilitation of seed hydration, regulation of germination by affecting oxygen entry into seeds, and mediation of seed dispersal through adhesion to soil or animal vectors.

The sweet basil seed mucilage is mainly polysaccharides, resembles Arabidopsis mucilage, but contains arabinoxylan and glucomannan, and a minor fraction of glucan (Western, 2012).

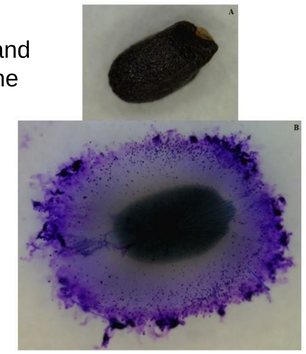

Fig 1. Basil intact and hydrated seed.

MATERIALS AND METHODS:

-Three sweet basil cultivars were tested:

1. 'Italian Large Leaf' ('ILL'): higher yields
2. 'Aroma 2': disease resistant 'Genovese' type
3. 'Genovese': traditional Italian basil

- Mucilage removal: mechanical (hand and sandpaper), chemical (33% concentrated HCl)

- Hydration and Dehydration Time Course

- 'ILL' and 'Aroma 2'
- Intact seeds with mucilage VS seeds without mucilage
- 4 replications of 50 seeds each at 22°C, 35% RH
- Hydration course stopped at radical emergence observed
- Dehydration course stopped at seed weight stable

- Microscopy:

- DinoXcope (Dino-Lite Digital Microscope)
- Light microscope (Olympus SZX16)

- Basil seed water relations:

- Germination test for 'Italian Large Leaf' and 'Aroma 2' with PEG: -0.25 MPa and -0.5 MPa
- Osmotic potential of sweet basil seed mucilage also measured by osmometry

- Hydrated Seeds Cling Test

- Hydrated seeds with and without mucilage were placed on an incline board.
- The angle of the incline board was increased, to observe the angle where seeds would slide.

Fig 2. To observe whether seed (with and without mucilage) could survive, seeds were germinated on clay, loamy clay, perlite, vermiculite and sand.

RESULTS:

Fig 3. Basil seed imbibition in water stained with toluidine blue.

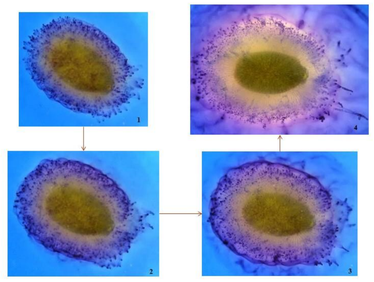

Fig 4. . Thin section of sweet basil seed in cross section viewed by light microscopy.

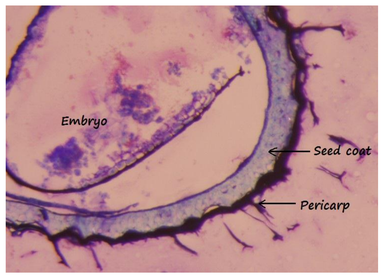

Fig 5. Seed after mucilage removal with HCl solution.

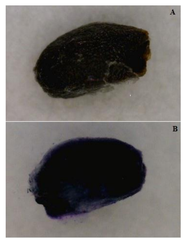

Fig 6. Effect of mucilage removal on weight of 'Aroma 2' and 'ILL' during seed hydration at 22°C, 35% RH.

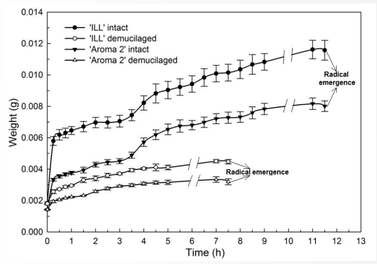

Fig 7. Effect of mucilage removal on weight of 'Aroma 2' and 'ILL' during dehydration at 22°C, 35% RH.

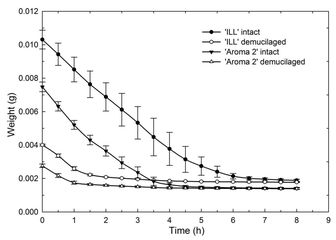

Table 1. Effect of mucilage removal using diluted HCl on germination of 'Genovese', 'Aroma 2' and 'Italian Large Leaf' sweet basil cultivars at 32°C in an incubator.

Genotype and treatment	Germination (%) †	MTG(days) ‡
'Genovese'		
intact	87 ± 1.5	1.20 ± 0.08
demucilaged	88 ± 2.0	1.54 ± 0.07
'Aroma 2'		
intact	95 ± 1.0	1.22 ± 0.05
demucilaged	93 ± 1.5	1.65 ± 0.08
'Italian Large Leaf'		
intact	96 ± 1.4	1.49 ± 0.11
demucilaged	94 ± 1.0	1.60 ± 0.11
	**	**

Table 2. Seed water content (dry weight basis).

Water Content (dry weight)	intact	demucilage
'Italian Large Leaf'	4.71 ± 0.43	1.28 ± 0.03
'Aroma 2'	4.35 ± 0.03	1.01± 0.02

Table 3. Water potential of the basil seed mucilage at 25°C.

Ψ (MPa)	20 min	40 min	120 min	150 min
'Ialian Large Leaf'	-0.076	-0.088	-0.106	-0.155
'Aroma 2'	-0.080	-0.094	-0.104	-0.155

Table 4. Media Test of the germination / survival percentage of intact and seeds without mucilage after 10 d at 25°C (3 replications of 10 seeds total).

Genotype and treatment			Germination	/ Survival	(%)	
Water (ml)	1	2	3	4	5	6
Clay						
intact				40 / 20	50 / 30	80 / 60
demucilaged				60 / 40	60 / 60	60 / 60
Loamy clay						
intact				10 / 0	70 / 50	90 / 60
demucilaged				0 / 0	70 / 50	90 / 60
Vermiculite						
intact	30 / 10	90 / 50	90 / 50	100 /60	100 / 80	100 / 80
demucilaged	30 / 0	90 / 80	90 / 70	80 / 60	80 / 70	100 / 80
Sand						
intact	60 / 0	70 / 60	100 / 70	100 / 70	100 / 70	100 / 70
demucilaged		60 / 0	80 / 40	70 / 50	80 / 60	80 / 60
Perlite						
intact	80 / 0	90 / 0	90 / 50	80 / 50	90 / 50	80 / 40
demucilaged	40 / 0	50 / 0	50 / 10	70 / 40	70 / 40	60/ 30

DISCUSSION AND CONCLUSION:

- The mucilage in basil seeds come from the fruit pericarp tissue and expands very rapidly in water during the first 20 minutes of hydration.
- The mucilage water potential of fully hydrated seeds approached 0 MPa, so the mucilage acts as a reservoir of loosely bound water that can ensure germination and drive expansive growth of young seedlings in dry environments.
- Intact basil seeds had almost 4 times greater water content than the seeds without mucilage so a primary function of the mucilage is as a water reservoir to help seeds to germinate and seedlings survive and grow.
- A secondary function may be to anchor seeds to a favorable location and prevent movement by flowing water.

REFERENCES:

Western, T. L., 2012. The sticky tale of seed coat mucilages: production, genetics, and role in seed germination and dispersal. Seed Science Research 22:1-25.

ACKNOWLEDGEMENTS:

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