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Experiments in Preserving and Revitalizing Pine, Onion, and Okra Seeds

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Introduction

In view of the somewhat contradictory reports on the preservation of seeds at low temperatures (1, 2, 3, 4, 9, 10, 11) and the agricultural importance of seed preservation and revitalization, the following study on seed preservation and revitalization was undertaken. This study, started in 1954, was designed to explore general conditions for preserving seeds of long leaf pine (*Pinus palustris* Mill.) which are extremely sensitive to adverse storage conditions; to increase germinability by breaking dormancy; and to revitalize aged seeds. The idea for the preservation of seeds was to apply Kaloyereas' dehydrofreezing method (6) on pine seeds, and his starch phosphate treatment against rancidity (7) on onion and okra seeds. For restoring loss of viability of aged seeds various treatments were tried, among which ultrasonic treatment and soaking in extracts from fresh seeds or pollen were more extensively used. In the application of dehydrofreezing method to seed preservation the correlation between the moisture content of the seeds and the preservation of their viability had to be investigated.

Experimental Methods

Fresh long leaf pine seeds of the same lot (original moisture 18%) were dried to various levels of moisture content and stored at temperatures ranging from room temperature to 0°F. Among those stored at room temperature were some in which the air surrounding the seeds was replaced by CO_2 or by CO_2 plus a small amount of ethylene oxide. The latter treatment has been satisfactory in rough rice storage experiments (8). This first attempt to use carbon dioxide with ethylene oxide in pine seed preservation was not intended for quantitative measurements and had only exploratory purpose. In the use of antioxidants for the preservation of viability, okra and onion seeds were dipped for one minute in 1% starch phosphate solution or 1% emulsion of tocopherol in water with some alginate salt added to it. The controls were dipped for the same length of time in water. The moisture content of seeds (treated and controls) was brought up to the original level by drying them in the dehumidifier at room temperature. The treatment of aged seeds with water extract of fresh seeds consisted in placing the seeds in the extract overnight at 45°F. The ultrasonic treatment lasted from 15-30 minutes in a magnetostriction oscillator of 9 kilocycles or in a model U-300 Ultrasonator (of Televiso Company) with a frequency as high as 457 kilocycles. For the determination of germinability the standard "sand flat germination test" and a "tetrazolium chloride technique" developed in our laboratory were used. Germinability was tested by Mr. W. Mann at the Alexandria Research Center and by Kaloyereas at the Food Preservation Laboratory of Louisiana State University (Baton Rouge) with excellent agreement. Both methods gave similar values but only

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the data obtained with the standard method are presented here. At the food preservation laboratory tests were performed on 50-100 seeds in wooden cases filled with sand and kept near a northern window of the laboratory. All seeds were practically under the same light and temperature conditions and data given in the tables were taken so as to be comparable.

TABLE I

PER CENT GERMINATION OF PINE SEEDS AFTER DEHYDRATION TREATMENT.

Storage temp.	% germination at the start		
	18% moisture	13.5% moisture	8% moisture
78° F	78.3	----	----
34° F		84.3	84.3
25° F		82.0	82.0
0° F		78.3	78.3

Discussion and Results

From the existing literature on the effect of higher temperatures on life and the subsequent development of the organisms, one might suspect that drying by the usual methods would affect the viability of seeds. Even when the drying temperature or the length of the heat treatment is not such as to affect the life of the seeds, it certainly results in decreasing their power of germination. This becomes more apparent in a long storage and therefore should be taken into consideration. In order to reduce the influence of this factor to the minimum, a desomatic dehumidifier was used to dry seeds at room temperature.

In a previous paper on the role of rancidity in the loss of viability of fatty seeds (7), it was found that rancidity development correlates closely with the loss of viability in the early stage of loss of viability. This was attributed to the destruction of tocopherols and other antioxidants present in seeds. Tocopherols and other antioxidants are known to be associated with fertility and longevity (5). Therefore, if the hypothesis is correct, treatment of seeds with a proper antioxidant should have some protective effect on viability.

The results of five years' storage of pine seeds with the dehydrofreezing treatments suggest that there is a relationship between moisture level in the seeds and the storage temperature for optimum preservation (Table I). In general an 8% moisture level in the seeds proved to be the best for both 25°F and 0°F, but for a shorter period of preservation a higher level of moisture content (13.5%) is also satisfactory. At 25°F some of the water present in the seeds remains in the bound form but not at 0°F or below. In Table II and Graph I data obtained from storage at 0°F, 25°F, and 34°F are summarized.

Seeds stored at temperatures below freezing germinated more rapidly than seeds stored at temperatures above freezing (Table III). The results of the treatment of okra and onion seeds with antioxidants such as starch phosphate and

TABLE II

GERMINATION AND PERCENTAGE LOSS OF GERMINATION DURING STORAGE OF PINE SEEDS.

	18% moisture		13.5% moisture		8% moisture		
	Germination	Loss %	Germination	Loss %	Germination	Loss %	
78° F	0.0	78.3	----	----	----	----	
25° F			65.2	20.3	63.2	21.7	After one year storage
0° F			66.2	15.4	63.7	18.8	
34° F			65.8	21.9	64.0	24.0	After two years' storage
0° F			66.2	14.1	66.7	14.7	
34° F			20.0	76.2	55.0	34.7	After five years' storage
25° F			45.0	45.1	60.0	26.8	
0° F			62.0	20.8	65.0	16.9	

GRAPH I

COMPARATIVE RESULTS OF TREATMENTS IN PRESERVING VIABILITY OF OKRA, PINE AND ONION SEEDS

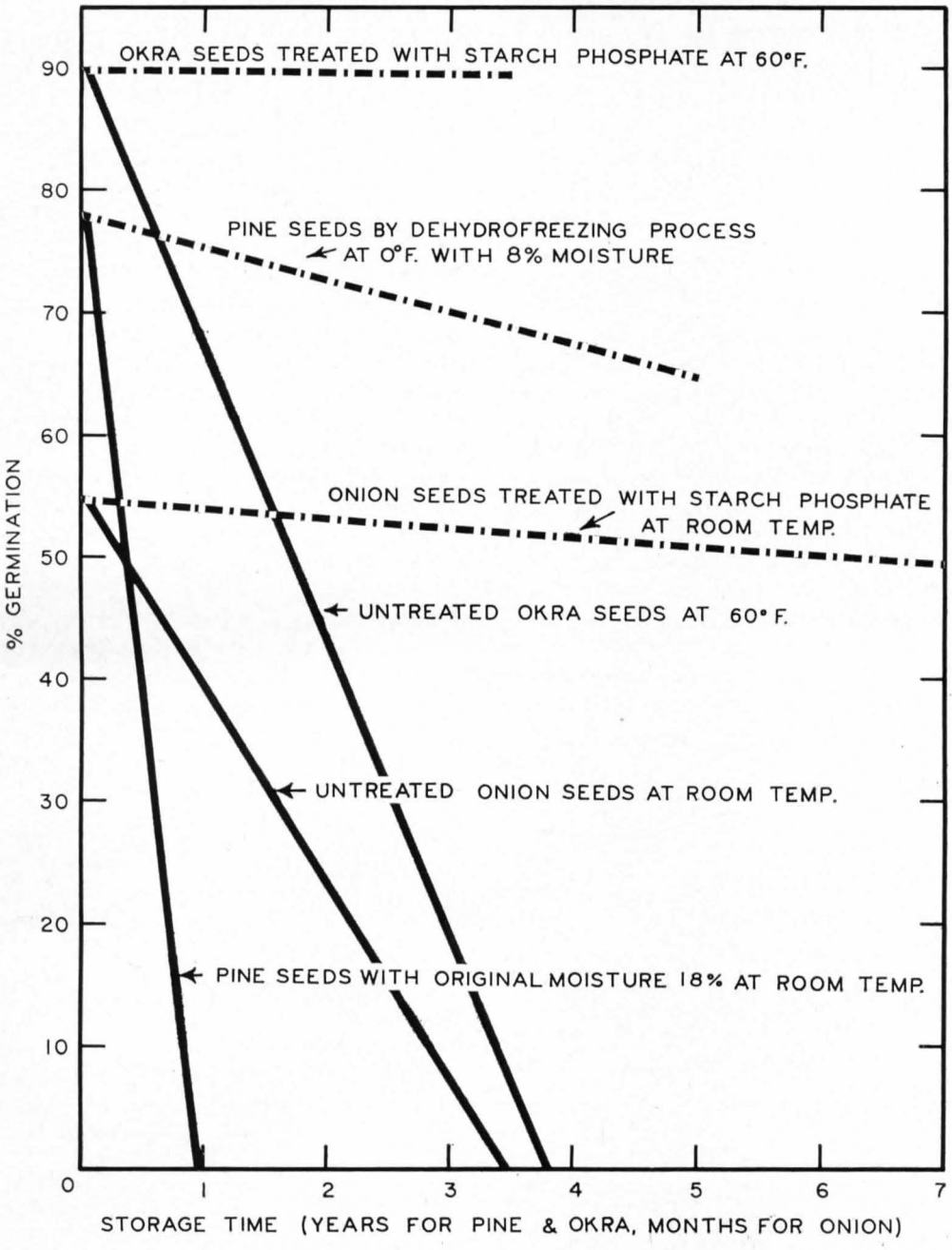

TABLE III

EFFECT OF FREEZING TREATMENT ON THE VIABILITY AND TIME OF GERMINATION FOR LONG LEAF PINE SEEDS.

Storage conditions and treatments	% moisture	% total germination	No. days required		
			To start germination	For 50% germination	To complete germination
Fresh seed	18.5	84.0	13	—	28
Fresh seed	10.0	81.0	12	—	28
Fresh seed	6.1	76.0	11	—	28
Stored seed					
45° F 1 year	18.5	48.0	14	16	30
Room temp. 1 year	5.5	18.0	16	20	33
0° F 1 month	18.5	94.2	5	7	20
25° F 1 month	18.5	94.0	5	7	20
25° F 1 year	12.9	32.0	10	11	14

α-tocopherol shown in Table IV support the proposed theory and demonstrate the beneficial effect of these treatments in the preservation of viability of onion and okra seeds.

Other results of this experiment are: (a) that pine seeds stored at temperatures below freezing germinate more rapidly than seeds stored at temperatures above freezing (Table III) and (b) that partial drying of seeds in a desomatic dehumidifier at a few degrees above room temperature had practically no effect on germination, (c) that the use of limited amounts of carbon dioxide with ethylene oxide for the preservation of viability in pine seeds would require a rather severe dehydration treatment to about 5% moisture, and (d) that carbon dioxide alone or even airtight containers improve the conditions of preserving viability of pine seeds at lower temperatures and lower levels of moisture content of the seeds.

Summary

Experiments on preserving seed viability showed that partial drying can extend the vitality of pine seed stored both above and below freezing temperatures. For long leaf pine seeds, drying to 8% moisture was beneficial in preserving viability at subfreezing temperatures; for

TABLE IV.

EFFECT OF TREATMENTS WITH STARCH PHOSPHATE AND α-TOCOPHEROL ON THE PRESERVATION OF VIABILITY OF OKRA AND ONION SEEDS.

A. Okra seeds ('Louisiana Market') stored at 60°F.

Treatments	Germination %			
	At the beginning	After 75 days	After 150 days	After 1270 days
1) Control	90	87	62	8
2) Treated with starch phosphate	90	97	88	92
3) Treated with *alpha*-tocopherol	90	72.5	—	—

B. Onion seeds ('Texas Grano') stored at room temp. (around 85°F) with and without treatment.

Treatments	Germination %				
	At the beginning	After 90 days	After 105 days	After 150 days	After 240 days
1) Control	55	37.0	0.0	0.0	0.0
2) Treated with starch phosphate	55	63.0	62.0	66.0	49.0
3) Treated with *alpha*-tocopherol	55	50.0	46.9	-----	-----

room temperature preservation, drying to 5% was preferable. A freezing treatment of pine seeds improves viability and also shortens the time needed for germination.

The viability of onion and okra seeds can be preserved for a long time at room temperatures by treating the seeds with starch phosphate; tocopherol treatment appears less beneficial.

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