Safflower (Carthamus Tinctorius L.) and Sesame (Sesamum Indicum L.) Seeds were Given an Invigoration Treatment Prior to, during, and after Storage to Increase their Storability and Productivity

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Abstract

In May 1986, India launched the Technology Mission on Oilseeds (TMO), which has had a profound impact on the country's oil seeds business. In a decade, from 1985 to 1996, the nation was able to achieve food independence by more than tripling its oilseeds production. However, in the last several years, oilseed output has almost plummeted, with just 18.2 million tonnes produced. This is the lowest production in the preceding decade. In the 1980s, oilseeds expanded in area, yield, and productivity at far greater rates than other crops, but this trend rapidly decreased in the 1990s. To improve their capacity to withstand and benefit from storage, researchers in this publication studied the effects of an invigoration therapy applied before, during, and after storage on safflower (carthamus tinctorius l.) and sesame (sesamum indicum l.) seeds.

Keywords: *Safflower, Sesame, Invigoration Therapy, Oilseed, Crops.*

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1. Introduction

When Indian farmers began cultivating crops for profit, one of the first things they planted was oilseed. These days, oilseeds may be found in fields all across the globe. Countries including India, Africa, China, Argentina, Canada, France, Nigeria, North Central America, the United States of America, and Western Europe all play important roles in the oilseeds position. Approximately 14% of the oilseed area and 8% of the oilseed output come from India, making it one of the world's biggest vegetable oil economy. Safflower, sesame, castor, and niger are produced at a higher rate than in any other nation, while groundnut and rape seed-mustard come in as a close second. [1]

With a yearly revenue ofRs. 60,000 crores, the edible oil business is one of the most lucrative in India's agricultural economy. Consumption of vegetable oils in the nation is on the rise and has reached a new high in the previous few years, at around 12.4 kg per person, per year. This is still under the global average of 17.8 kg and the consumption in nearby countries like Pakistan of

16.1 kg. The average annual intake in the industrialised western world is between 44 and 48 kilogrammes. Predictions of Food Oil Demand The annual demand for oil seed in West Bengal is estimated to be around 12.5 million metric tonnes, although the state only produces 6.3 million metric tonnes. More oil seeds, such as safflower and sesame, need to be cultivated in West Bengal to make up for the state's severe shortage of the commodity.[2-3]

Because of the increasing demand for its cholesterol-free oil, safflower has emerged as a leading oil seed crop. The linoleic acid content of traditional varieties is high (78%), which is linked to a lower blood cholesterol level. In addition, safflower varieties cultivated to be rich in oleic acid have become more important as a source of cooking oil in recent years.[4-6]

A number of useful compounds, including a-tocopherol and carthamin, are derived from or produced using safflower. Oil may be extracted well from the spiny types. Between 20% and 36% of a safflower seed's weight is oil. The oil has several applications, including culinary usage, candle making, and soap making. [7-8]

While it spans over 0.59 million ha throughout India and yields about 0.13 million t, it only occupies about 60 ha in West Bengal and yields about 19 t. Since ancient times, Indians have tended sesame fields for the seeds' usage in Hindu rituals. Sesame is grown on a massive scale in Africa, Asia, China, and South America. [9-10]

2. Material And Methods

The measurement of water content

The ISTA technique was used to determine the moisture content. A glass vial containing five grammes of seed from each storage container was quickly put in an electrically heated air oven with proper ventilation and thermostatic control. Drying was performed at a constant temperature of 103 + 2°C for 17 + 1 hours in the ovCn.

Germination test

Samples of seeds were taken from each of the four different types of storage containers every a month to be tested for germination using a modified version of the procedure.

Natural ageing : Both treated and untreated seeds were aged for different amounts of time in ambient circumstances to determine the impact of the treatments on the seeds' capacity to germinate.

Accelerated ageing : In order to determine the efficacy of the treatments, treated and untreated seeds were both aged prematurely in artificially controlled regimes of varied relative humidities and temperature after the allotted time had passed. Perforated paper packets containing treated and untreated seeds (of equivalent weight) were exposed to accelerated ageing at 98% RH and

40°C, 93% RH and 40°C, and 80% RH and 40°C, respectively.

Mid storage

Five-month-old safllower seed of medium vigour was subjected to dry and moist treatments in the middle of storage. As with the previous experiment, the seeds were treated both dry and wet with the identical amounts of pharmaceuticals, chemicals, and raw plant material. Both the germination test and the ageing process were previously detailed.

Post-storage

Post-storage (pre-sowing) dry and wet treatments were given to 8 month old saRlower seeds which were stored in the rubber stoppered glass bottles inside the natural environment. Following treatment, a germination test was conducted using a modified version of the procedure. Both the pre-storage and mid-storage seed invigoration treatment protocols specified in the previous experiment were followed. To prepare seeds for planting in the field after wet treatment, they were soaked in water for 2 hours before being lightly air-dried.

Physiological and Biochemical studies

Permeability of membranes

Leaching of electrolytes, sugars, and amino acids from seeds may provide a measure of membrane function.

Assay of dehydrogenase activity

Instantaneously after treatment and after 90 days of natural ageing under ambient circumstances, the dehydrogenase enzyme activity of the treated and untreated seeds was evaluated using the technique.

Calculating Lipid Oxidation Rates

Thiobarbituric acid (TBA) colour reaction was used to examine lipid peroxide generation immediately after treatment (i.e., before ageing) and after natural ageing under ambient circumstances for 90 days, following the general guidelines established by Bernheim eI al. (1948) with some slight alterations.

Volatile aldehyde concentration predictions

Minor adjustments were made to the procedures of Harman et al. (1982), Wilson and McDonald (1986a), and Sur and Basu (1990b) for the determination of volatile aldehydes released during germination of treated and untreated seeds.

Statistical Analysis

The effects of seed invigoration treatments on germination and yield were assessed using analysis of variance applied to data collected from laboratory germination tests and biochemical research. Data on germination rates were converted to angles, and measurements of root and shoot lengths were similarly processed. Seed germination rate multiplied by seedling length yields a vigour index.

3. Results

Safflower (Carthamus tinctorius L.)

The newly collected safllower seeds were separated into three lots, one for pre-storage, one for mid-storage, and one for post-storage (pre-sowing) seed invigoration treatments. The seeds were then placed in glass jars with rubber stoppers and kept at room temperature until treatment.

Chemicals (bleaching powder, iodinated calcium carbonate, calcium carbonate, potassium nitrate), pharmaceutical formulations, and raw plant material were added to the safflower seeds in the glass bottles with rubber stoppers and left at room temperature for a few days before the harvest. In addition to dry treatments, wet treatments (soaking-drying) were also performed.

Similar dry and moist treatments were applied to seeds midway through storage and again after storage had concluded. Before and during storage, seeds were given special care before being returned to airtight, rubber-capped glass vials. Just before planting, post-storage treatments were performed.

Analysis of the rate of deterioration in vigour and viability of safflower seeds kept in a variety of containers at room temperature

500 grammes of freshly harvested safflower seeds were sorted into four separate containers and left to dry in the sun until they reached a safe moisture content of 8.7 percent. Seeds were taken from several containers on a monthly basis to examine how they fared in the germination test. Six days into germination at 28 + 1°C, we collected data on the germination % and the length of the resulting seedlings.

Table displays the proportion of safflower (cv. Tara) seeds that germinated and the average height of their seedlings after being kept in four different containers from April to November. After the rains, safflower seed was much less healthy and productive than before. Cloth bags, which allow a lot of moisture to pass through, are not ideal for storing seeds since they soak up a lot of moisture from the humid air during the monsoon month, reducing the germination percentage and, by extension, the seed's vigour when it comes time to plant them in November. The proportion of seeds that germinate and the duration of their seedlings show that seeds kept in moisture-proof containers like polythene packets, glass bottles, and metal tins have a longer lifespan than those kept in unsealed containers like cloth bags. Seeds kept in glass bottles had a greater germination rate (78%) and produced more robust seedlings when planted in November. This made glass bottles the best option for preserving safflower seeds. The months of July, August, and September were the most perilous times for seed degradation at room temperature and humidity. As a result, it's important to take precautions against seed degeneration during storage before the onset of the monsoon.

Table 1. Storage of safflower seed (cv. Tara) under ambient conditions at Lucknow causes a decline in vitality and viability

Containers Months	Cloth bag		Polythene packet		Metal tin		Glass bottle	
	Germi-nation	Seedling length	Germi-nation	Seedling length	Germi-nation	Seedling length	Germination	Seedling length
April	95	151	95	156	90	152	94	154
May	95	149	93	152	94	151	92	152
June	90	146	92	153	93	149	90	149
July	80	130	85	144	90	141	88	147
August	72	92	80	127	86	138	85	145
September	60	60	60	112	80	110	82	140
October	40	42	52	88	75	91	80	137
November	25	35	50	75	64	82	78	133

Following collecting, 500 g of clean, sun-dried seeds were separated into various containers and kept at room temperature until storage. 'Samples were taken from each container once a month to check for germination.

Maintaining safflower's germination and field performance after storage: the impact of seed invigoration treatments

Pharmaceutical formulation, chemicals, and crude plant material were mixed with freshly harvested (high-vigor) seeds and stored in glass bottles with rubber stoppers. In addition to the dry treatments, the wet therapy (soaking-drying) was also administered.

Using a modified version of the procedure described by Punjabi and Basu (1982), we tested the efficacy of seed invigoration treatments by measuring germination rates before (i.e., without) and after (i.e., after) accelerated and natural ageing.

There was no difference in the capacity of treated and untreated seeds to germinate when the test was performed immediately after treatment. Table shows that only a handful of the dry treatments, like Catharanthu5 leaf powder, aspirin, ibucon, etc., significantly increased seedling vigour in comparison to the control. However, majority of the pre-storage dry treatments exhibited substantially superior outcomes in improving germinability than untreated control following accelerated ageing at 98% RH and 40°C for 10 days. Table demonstrates that as compared to untreated controls, seedlings growing from dry-treated seeds are noticeably more vigourous due to increased root and branch length. Most of the dry treated seed also had a greater vigour index than the control when germination percentage was multiplied by seedling length. Table shows that the storability of safflower seed is improved by the addition of aspirin, bleaching powder, iodinated calcium carbonate, and potassium nitrate to the dry treatments. There was a little increase in germination rates after using a moist treatment, such as soaking-drying, compared to the control.

Table 2: Immediate dry and wet physiological treatments on the germination of safflower (cv. Tara) seeds

Treatments	**Germination**		**Mean root length** (mm)	**Mean shoot length** (mm)	**Vigour index (G% x Seedling** length)
	(%)	**Are-sin value**			
Control	95	77.08	100	52	14440
Aspirin	90	71.56	106	57	14670
Ibucon	93	74.66	106	60	15438
Celin	99	84.26	102	57	15741
Bleaching powder	94	75.82	101	60	15134
Calcium carbonate	90	71.56	103	56	14310

lodinated calcium carbonate	98	81.87	103	55	15484
Potassium nitrate	92	73.57	99	53	13984
Red chilli powder	91	72.54	103	56	14469
Catharanthus leaf powder	95	77.08	108	55	15485
Soaking-drying (water)	93	74.66	105	55	14880
LSD at 0.05 P	-	NS	NS	NS	-
LSD at 0.01 P	-	NS	NS	NS	-

Table 3. Germination rates of safflower (cv. Tara) seeds held for 10 days at 98% RH and 40°C were compared before and after receiving various seed invigoration treatments.

Treatments	Germination		Mean root length (mm)	Mean shoot length (mm)	Vigour index (G% x Seedling length)
	(%)	Arc-sin value			
Control	55	47.87	73	35	5940
Aspirin	69	56.17	97	45	9798
Ibucon	56	48.45	85	39	6944
Celin	59	50.18	86	40	7434
Bleaching powder	66	54.33	95	45	9240
Calcium carbonate	57	49.02	71	39	6270
lodinated calcium carbonate	70	56.79	85	40	8750
Potassium nitrate	65	53.73	90	40	8450
Red chilli powder	60	50.77	75	40	6900
Catharanthus leaf powder	54	47.29	69	37	5724
Soaking-drying (water)	49	44.43	75	37	5488
LSD at 0.05 P	-	4:99	4	2	-
LSD at 0.01 P	-	6.81	5	3	-

Most dry treatments considerably slowed down seed degradation compared to control in germination tests done before to planting in the field. When it comes to prolonging the shelf life of safflower seeds, dry treatments like celin and iodinated calcium carbonate have shown to be the most effective.

The effectiveness of dry and moist seed invigoration treatments for maintaining saffower's vitality, viability, and production during mid-storage.

Dry dressings of pharmaceuticals (aspirin, celin, and ibucon), chemicals (bleaching powder, calcium carbonate, iodinated calcium carbonate, and potassium nitrates), and crude plant material (red chilli powder, CathaFanthus leaf powder) were applied to five-month-old (medium-vigor) safflower seeds in glass bottles with rubber stoppers and stored at room temperature. Both dry and wet (or soaking and drying) procedures were carried out. After processing, seeds were kept in amber glass jars with rubber stoppers at room temperature and humidity until use.

Treatment efficacy was determined by comparing treated and untreated seedlings' germination rates before and after undergoing accelerated and natural ageing.

After treatment in the middle of storage, treated seeds did not perform better than untreated control in a germination test. However, soaking-drying (wet) therapy significantly improved vitality and viability above untreated control following accelerated ageing at 93% RH and 40°C temperature for 14 days. Table shows that the safflower seed's storage life was prolonged by certain dry treatments compared to the control. Mid-storage wet treatment (soaking-drying) has shown more effective than mid-storage dry treatments for enhancing storability.

Table 4: The effect of mid-storage seed invigoration treatments on the germination of safflower (cv. Tara) seeds that were aged in a glasshouse at 93% relative humidity and 40 degrees Celsius for 14 days.

Treatments	**Germination**		**Meanroot length (mm)**	**Mean shoot length (mm)**	**Vigour index (G% x Seedling lengths**
	(%)	Arc-sin value			
Control	47	43.28	79	45	5828
Aspirin	58	49.60	91	48	8062
Ibucon	57	49.02	87	48	7695
Celin	56	48.45	90	44	7504

Bleaching powder	58	49.60	99	51	8700
Calcium carbonate	58	49.60	100	47	8526
lodinated calciuin carbonate	59	50.18	98	47	8555
Potassium nitrate	67	54.94	73	46	7973
Red chilli powder	66	54.33	100	46	9636
Catharanthus leaf powder	49	44.43	74	49	6027
Soaking-drying (water)	71	57.42	104	53	11147
LSD at 0.05 P	-	7.49	9	2	-
LSD at 0.01 P	-	NS	11	3	-

Improving the field performance of stored salflower with the use of seed invigoration treatments applied after storage (prmsowing)

Eight-month-old safflower seeds (previously stored) were given seed invigoration treatments before being sown in the field. The vitality and strength of treated and untreated seeds were not significantly different in a germination test performed immediately after treatment. The only treatment that demonstrated any improvement in strength over controls was soaking followed by gentle air-drying.

Research on the physiology and biochemistry of keeping safflower healthy and productive

To further understand how pre-storage seed invigoration treatments (dry and wet) work to preserve vigour and viability, a number of physiological and biochemical experiments were conducted. Dry dressings of aspirin, bleach, red chilli powder, and Catharanthus leaf powder were applied to newly harvested safflower (cv. Tara) seeds. In addition, a soaking-drying process was used to collect young, vigourous safllower seed.

The results of an instant germination test after dry and wet pre-storage treatments showed that treated seeds did not significantly outperform the untreated control in terms of germination percentage or seedling vigour. There was also no statistically significant difference between treated and untreated seeds in terms of membrane integrity, the leaching of sugar, amino acids, and the activity of enzymes like dehydrogenase, volatile aldehyde production, or lipid peroxide formation .

The electrical conductance, sugar, and amino acid leaching were all reduced in the pre-storage soaking-drying treatments of safflower, despite the fact that the germination % was lower. When seeds were treated by soaking them in water for two hours, the seeds lost electrolytes, sugar, and amino acids. Because of this, electrical conductance, sugar, and amino acid levels were all reduced in soaking-drying treatments compared to the control. Both the pre-storage soaking-drying treatment and the untreated control yielded almost identical levels of germinability.

Table 5: The immediate post-treatment (i.e. pre-aging) effect of safflower seed invigoration treatments on membrane function, dehydrogenase enzyme activity, volatile aldehyde generation, and lipid peroxide creation.

Treatments	Germination		Seedling length (mm)	Eleectrical conductance (dsm"')	Leaching of sugar (pg-glucose e i	Leaching of amino acid (pg-glycine equiv./ m1)	Dehydrogenase activity (O.D.)	Lipid peroxidation (O.D.)	Volatile aldehyde (O.D.)
	(%)	Arc-sin value							
Control	92	73.57	187	0.*166*	8.2	23.5	0.466	0.225	0.052
Aspirin	95	77.08	186	0.163	8.6	22.0	0.442	0.254	0.057
Bleaching powder	95	77.08	193	0.148	7.4	24.0	0.485	0.225	0.055
Red chilli Powder	92	73.57	188	0.153	8.1	22.9	0.537	0.260	0.061
Catharanthus leaf powder	90	71.56	187	0.151	8.2	24.2	0.514	0.249	0.058
Soaking-drying	92	73.57	184	0.047	2.2	24.3	0.477	0.244	0.056

(water)									
L.S.D. at 0.05 P	-	NS	NS	0.021	0.7	NS	NS	NS	NS
L.S.D. at 0.01 P	-	NS	NS	0.052	1.0	NS	NS	NS	NS

decreasing the generation of lipid peroxides and volatile aldehydes compared to the control. Dehydrogenase enzyme activity was higher in the pre-storage dry treatments, but volatile aldehyde generation and lipid peroxide creation were reduced.

Five-month-old (medium-vigor) seeds were dry treated with aspirin, bleaching powder, red chilli powder, and Catharanthus leaf powder as part of a mid-storage therapy. In addition, safflower seed that was 5 months old (medium vigour) was subjected to wet (soaking-drying) treatments. Dry treated seeds did not differ significantly from untreated control seeds in terms of germinability, membrane function (electrical conductance of seed steep water, leaching of sugar and amino acids), dehydrogenase enzyme activity, volatile aldehyde production, or lipid peroxide formation immediately following mid-storage treatment.

Table 6: Seed membrane function, dehydrogenase enzyme activity, lipid peroxide creation, and volatile aldehyde production in safllower seeds immediately after mid-storage seed invigoration treatments, i.e., under non-aged conditions.

/ Treatments	Germination (%)	Germination Arc-sin value	Seedling length (mm)	Electrical conductance (dsm"')	Leaching of sugar (pg-glucose equiv./ m1)	Leaching of amino acid (Jig-glycine e uiv./ mI)	Dehydrogenase activity (O.D.)	Lipid peroxidation (O.D.)	Volatile aldehyde (O.D.)
Control	84	d6.42	162	0.186	8.6	30.2	0.348	0.218	0.044
Aspirin	82	64.90	164	0.184	8.8	32.4	0.352	0.228	0.047

Bleaching powder	84	66.42	171	0.169	8.4	32.6	0.341	0.222	0.038
Red chilli	85	67.21	168	0.175	8.5	28.7	0.339	0.218	0.032
Powder									
Catharanthus leaf powder	80	63.44	165	0.172	8.3	30.5	0.338	0.211	0.039
Soaking-drying (water)	82	64.90	166	0.069	5.4	31.5	0.347	0.239	0.042
L.S.D. at 0.05 P	-	NS	NS	0.018	0.9	NS	NS	NS	NS
L.S.D. at 0.01 P	-	NS	NS	0.054	1.4	NS	NS	NS	NS

Sesamum *psesamum indicum* L.)

Analysis of the deterioration of sesamum seeds kept in a variety of containers at room temperature

Sesame seeds were kept in cloth bags, polythene packets, metal tins, and glass bottles at room temperature and humidity after being sun-dried to a moisture content of 8.9%. Seeds were taken from various pots once a month to determine how well they germinated.

According to Table, high humidity and high temperature accelerate the decay of seed kept in a cotton bag during the monsoon season . Polythene packets, metal tins, and glass bottles are all good options for storing seeds since they prevent moisture from seeping in, hence prolonging their shelf life. In February, when the seeds were sown, the germination rate for those kept in a cloth bag had risen to 34%. Germination rates for seeds kept in glass bottles were above 80% . Seeds kept in glass bottles germinated at a higher rate than those kept in other containers.

Table 7: Storage conditions and the germination of sesame seeds (cv. NIC 8296) in Lucknow

Months	Cloth bag		Polythene packet		Metal tin		Glass bottle	
	Germina -tion (%)	Seedling length (=<)	Germiaa -tion (%3	Seedling length (<)	Germina -tion t%)	Seedling length (<<)	Geriniaa -tion (%)	Seedling length I =)
June	95	157	95	157	95	160	100	163
July	95	.152	97	155	95	153	98	157
August	85	137	92	150	95	154	95	158
September	75	128	90	142	94	152	94	157
October	72	121	88	140	92	148	90	155
November	55	102	85	135	88	144	90	152
December	50	93	82	133	85	149	88	150
January	46	90	78	121	83	135	84	142
February	34	84	75	119	80	132	82	138

After harvesting, the seeds were sorted, washed, and dried to a moisture content of 8.9% before being stored in a variety of containers at Laboratory, Lucknow. Samples were taken from each container every a month to check germination greater rates of germination and the development of robust seedlings are achieved by planting in the months of February and March.

Pre-storage seed invigoration treatments' influence on sesame's capacity to retain its germination rate and field performance

The red chilli powder, Catharanthus leaf powder, and Trigonella seed powder, along with the finely powdered pharmaceutical formulations (aspirin, ascorbic acid), chemicals (bleaching powder, iodinated calcium carbonate, calcium carbonate, and potassium nitrate), and crude plant materials, were dry dressed onto the harvest fresh (high vigour) sesamum seeds in the glass bottles with rubber stoppers. At the time of the dry treatment, the same seed lot was also subjected to hydration-dehydration (soaking-drying) treatments. After processing, seeds were returned to their original glass containers with rubber stoppers and kept at room temperature and humidity until needed.

The germination percentage, root length, and shoot length of the seedlings of treated and untreated seeds were not significantly different in an immediate post-treatment germination test.

Most of the pre-storage dry physiological treatments improved germination percentage and seedling vigour as measured by root and shoot length significantly more than the untreated control after accelerated ageing at 93% RH and 40°C temperature for 20 days and 98% RH and 40°C temperature for 16 days and slow ageing at 36% RH and 40°C temperature for 160 days. Sesamum seed germinability was marginally improved by pre-storage soaking-drying treatments compared to the control, most likely as a result of soaking damage in harvest fresh seed. For the best results in preserving the vitality and viability of stored sesamum seeds, choose for dry treatments such bleaching powder, iodinated calcium carbonate, and red chilli powder. Dry treated seeds had a significantly greater vigour index than the control group.

Table 8: Sesame (cv. NIC 8296) seed viability for germination just after pre-storage seed invigoration treatments, before ageing occurs.

Treatments	**Germination**		**Mean root length** (mm)	**Mean shoot length** (mm)	**Vigour index (G% x Seedling** length)
	(%)	**Arc-sin** value			
Control	91	72.54	98	46	13104
Aspirin	91	72.54	97	49	13286
Ascorbic acid	97	80.02	95	47	13774
Bleaching powder	97	80.02	98	47	14065
Calcium carbonate	90	71.56	94	47	12690
Iodinated calcium carbonate	86	68.03	98	49	12642
Potassium nitrate	91	72.54	93	49	12922
Red chilli powder	95	77.08	102	46	14060
Catharanthus leaf powder	91	72.54	99	49	13468
Trigonella seed powder	91	72.54	101	49	13650
Soaking-drying (water)	91	72.54	98	46	13104
LSD at 0.05 P	-	NS	NS	US	-

LSD at 0.01 P	-	NS	NS	NS	

Table 9: Sesamum (cv. NIC 8296) seed viability was studied before and after accelerated ageing for 20 days at 93% RH and 40°C temperature.

Treatments	Germination		Meanroot length (mm)	Mean shoot length (mm)	Vigour index (G% x Seedling length)
	(%)	Arc-sin value			
Control	58	49.60	60	34	5452
Aspirin	61	51.35	68	39	6527
Ascorbic acid	71	57.42	78	41	8449
Bleaching powder	79	62.72	75	41	9164
Calcium carbonate	70	56.79	76	39	8050
Iodinated calcium carbonate	74	59.34	83	39	9028
Potassium nitrate	73	58.69	79	42	8833
Red chilli powder	75	60.00	80	43	9225
Catharanthus leaf powder	73	58.69	82	43	9125
Trigonella seed powder	73	58.69	89	43	9636
Soaking-drying (water)	56	48.45	65	35	5600
LSD at 0.05 P	-	4.50	9	3	-
LSD at 0.01 P	-	6.15	13	4	-

Table 10: Sesame seed vitality and viability were preserved over a 160-day slow-aging period at 36% RH and 40°C temperature, thanks to pre-storage seed invigoration treatments.

Treatments	**Germination**		**Mean root length (mm)**	**Mean shoot length (mm)**	**Vigour index(G% xseedling length)**
	(%)	**Are-sin value**			
Control	68	55.55	71	37	7344
Aspirin	81	64.16	78	42	9720

Ascorbic acid	83	65.65	81	42	10209
Bleaching powder	86	68.03	81	45	10578
Calcium carbonate	82	64.90	85	45	10660
Iodinated calcium carbonate	82	64.90	84	47	10742
Potassium nitrate	82	64.90	87	48	11070
Red chilli powder	84	66.42	83	44	10668
Catharanthus leaf powder	85	67.21	85	48	11305
Trigonella seed powder	85	67.21	82	46	10880
Soaking-drying (water)	73	58.69	73	39	8176
LSD at 0.05 P	-	5.06	5	3	
LSD at 0.01 P	-	6.91	7	5	

4. Conclusion

Aspirin (active ingredient, ort/jo-acetylsalicylic acid) @ 50 mg/kg ofseed; chemicals such as bleaching powder (active ingredient, calcium hypochlorite) @ 2 g/kg ofseed; and crude plant materials i.e. red chilli powder (@ 1 g/kg of seed) and Trigonella seed powder (@ 2 g/kg of seed) were recommended for pre-storage dry dressing treatments of high-vigor Mid-storage hydration-dehydration (soakingdrying) treatments are recommended to increase safflower and sesame seed germinability and yield in the case of medium-vigor seed. Safflower and sesame seeds, which have poor vigour, may benefit from a post-storage (pre-sowing) wet treatment (soaking, then light air drying) to boost their performance and yield in the field. It has been pointed out that ordinarily the most vigourous and viable seed would not need any invigoration treatments. Most seed lots available for planting have either medium or low vigour, thus a proper pre-sowing treatment is essential for better field results.

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