

EFFECT OF STORAGE TEMPERATURE AND SEED MOISTURE CONTENTS ON PAPAYA (*Carica papaya* L.) SEED VIABILITY AND GERMINATION

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Abstract: This experiment examined the suitable storage temperature and seed moisture content for seed storage of papaya (*Carica papaya* L.) cultivar of “sekaki”. The seeds were dried to 6%, 8% and 10% moisture contents using silica gel and stored at 0°C, 4°C and 28°C for three months. Seeds containing 6% moisture content and stored at 0°C gave higher percentage of germination, lower dormancy, lower seed death compared to the seed of the other storage conditions. The result suggested that such condition was the best condition for papaya seed storage. Seeds containing 10% moisture content and stored at 28°C is not recommended for papaya seed storage because seed deterioration rate under such condition is higher within three months of storage.

KEYWORDS: Papaya seed, temperature, moisture contents, storage

Introduction

Papaya (*Carica papaya* L.) from the family *Caricaceae* is a major dessert fruit crop in the tropics. In papaya, seeds are predominantly used for raising the plants. They are also used for evolving the new cultivars through hybridization as well as for the long-term conservation of the genetic diversity. Papaya seeds have been grouped as recalcitrant seed by Chin *et al.* (1984) and Hofmann and Steiner (1989) but more recently it was grouped as the intermediate seed (Ellis *et al.*, 1990).

Papaya seed has survive for a short period of time under the ambient conditions. The seeds show an orthodox storage behavior (Ellis, 1984) in which seeds withstand desiccation and extend longevity at lower temperatures. Papaya seeds are susceptible to chilling temperatures and are killed when stored at zero or subzero temperatures. Therefore, the seeds are considered intermediate between recalcitrant and orthodox attribute.

Seed moisture content is very crucial in papaya seed storage. Higher seed moisture

content injures the seed life and rapidly reduces seed viability during the storage. Harrington (1972) found that papaya seed longevity decreases by one-half for every one percent rise in seed moisture content, and that it well maintains at the range of 5% to 14% moisture content. Seed moisture of 5% to 7% is ideal for safe storage of papaya seeds. In general, the moisture content of seed increases with a rise in relative humidity level, and absorption also depends on the surrounding temperatures.

Papaya seeds deteriorate rapidly at higher storage temperatures and relative humidity. Fresh seeds give higher germination rate and seedling vigor that will decline with increasing the storage time. Understanding the effect of storage temperature and seed moisture content on seed deterioration could facilitate farmers to prolong the storage time of papaya seeds. Therefore, the objective of this study is to determine the suitable storage temperature and seed moisture content for maintaining the high germination and viability rate of papaya seed after three months storage.

Materials and Methods

Seed Material

Seeds from a single cultivar (Sekaki) of papaya (*Carica papaya* L.) was used in the study. The seeds were purchased from the Department of Agriculture Kota Bharu, Kelantan. They were previously dried out under the sunlight for three weeks until the moisture content reached 10%. The seeds were stored in a cool room at 4°C for two weeks before used.

Seed Moisture Content Determination

A total of 21,000 seeds with three levels of moisture content, 6%, 8% and 10% were used. The desired moisture content was obtained by storing the seeds in the desiccators containing silica gel. The desired moisture contents (%) were measured as follows:

$$\text{Weight of seed (g) at DCM\%} = \frac{(100 - \text{Initial MC \%}) \times \text{initial seed weight (g)}}{(100 - \text{DMC \%})}$$

DCM = Desired moisture content (%)

MC = Moisture content (%)

50 seeds of each moisture contents were kept in different polyethylene bags. The bags were sealed tightly to prevent moisture penetration, labeled and stored at 0°C, 4°C and 28°C.

Seed Germination Test

Polyethylene bags stored at different temperatures were retrieved for every month to test the germination rate. Seed from the bags were sown in moistured sands at 3cm depth in tray and kept in green house at 27°C - 30°C. The seeds were considered as germinated when the seedlings emerge from sand surface.

Seed Viability Test and Mean Germination Time (MGT)

Seeds that do not germinate were then examined by the tetrazolium test to determine the viability. The ungerminated seeds were longitudinally cut and completely immersed in 0.1% tetrazolium solution. After one hour, the seeds were observed for the appearance of the red color

which indicate the respiratory activity of the seed. The seeds that show the respiratory activity via the color change indicated the viable seed. The germinated seed and dormant seeds were recorded as a percentage of the total number of viable seed, while damaged seeds were calculated as a percentage of the total number of tested seeds used.

The mean germination time (MGT) was calculated using the method of Younsheng and Sziklai (1985) as follows:

$$\text{MGT} = \sum \text{nidi/n}$$

Where:

ni = number of seed germinated on day;

di = day during germination period

n = total number of seeds germinated during experimental period;

Statistical Analysis

Arcine square root transformations were performed for the data before being converted to two-way ANOVA. Means among the treatments were compared using the Tukey test at 5% significant level.

Results

Seed Germination

Figure 1 shows the changing in the percentage of papaya seeds germination with moisture contents of 6%, 8% and 10% stored at 0°C, 4°C and 28°C. The result of the present study shows that the accelerated deterioration in seed germination is associated with the storage time. Germination percentage of seeds with 6% moisture content were higher with an average of 97±4%, 85±4% and 54±7% in the first, second and third month of storage respectively as compared to the seed with the normal moisture content (Figure 1 A).

A significant trend toward higher reduction in the germination rate was observed for seeds stored at 4°C with 10% of moisture content which showed an average of 21±4%, 8±12% and 5±8% of germination after one, two and three months of storage respectively (Figure 1B). Seeds deterioration rate was higher at 28 °

C (Figure 1C). Seeds containing 10% moisture content failed to germinate starting from the third month of storage as compared with the first month ($16\pm 2\%$) and the second month ($3\pm 6\%$). Generally, germination rates were higher as seeds were dried to the lower moisture content irrespective of the temperature regimes (Figure 1).

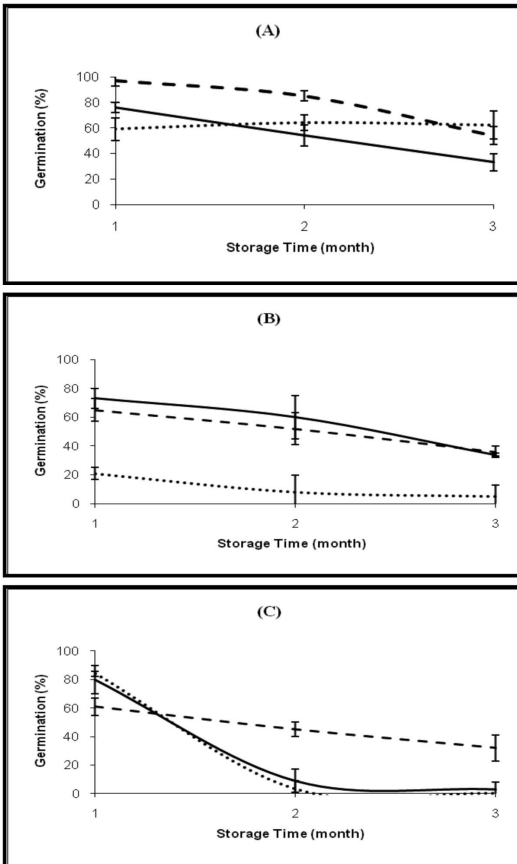


Figure 1: Changes in the percentage of germination of papaya seeds with moisture contents at 6% (- - -), 8% (—), 10% (·····) stored at 0°C (A), 4°C (B), and 28°C (C).

Seed Dormancy

Figure 2 shows the changing in the dormancy percentage of papaya seeds with 6%, 8% and 10% moisture contents and stored at 0°C, 4°C and 28°C. The influence of different moisture contents on seeds dormancy stored at 0, 4 and 28°C is shown in Figure 2. In general, there was a progressively increase in dormancy percentage

of the storage time for seed with all moisture contents levels regardless of storage temperature (Figure 2). Dormancy percentage increased when seeds were stored at 28°C with moisture content of 8% and 10%.

Storage at 4°C and 28°C allowed the dormancy percentage of papaya seeds with 10% moisture content progressively increase to about $79\pm 4\%$, $92\pm 12\%$, and $95\pm 8\%$ after one, two and three months storage (Figure 2A and Figure 2B).

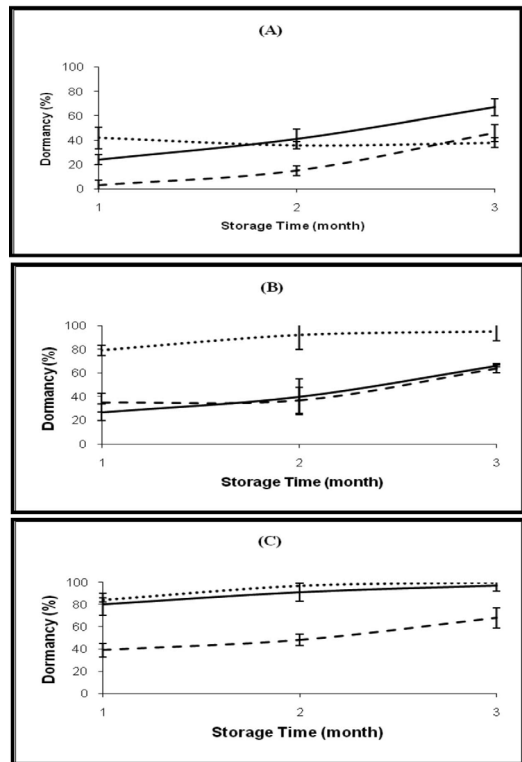


Figure 2: Changes in the percentage of dormancy of papaya seeds with moisture contents at 6% (- - -), 8% (—), 10% (·····) stored at 0°C (A), 4°C (B), and 28°C (C).

Seed Death

Figure 3 shows the changing of the seed death percentage of papaya seeds with moisture contents of 6%, 8% and 10% and stored at 0°C, 4°C and 28°C. There was a progressive increase in the seed death of seeds with 10% moisture content when stored at 28°C with about of $22\pm 7\%$, $68\pm 5\%$ and $69\pm 5\%$ at the first, second

and third month of storage, respectively. The increased in seed death percentage was the highest for seed containing the higher moisture contents (Figure 3C).

The second highest in seed death percentage was seeds containing 8% moisture content which stored at 28 ° C with about 16±0%, 36±5%, and 30±6% after one, two and three months storage, respectively (Figure 3C). Generally, the seed death percentage of papaya seeds increased after three months of storage at different temperatures and moisture contents. The death was greater in seeds stored at higher moisture content regardless of storage temperatures (Figure 3A and 3C).

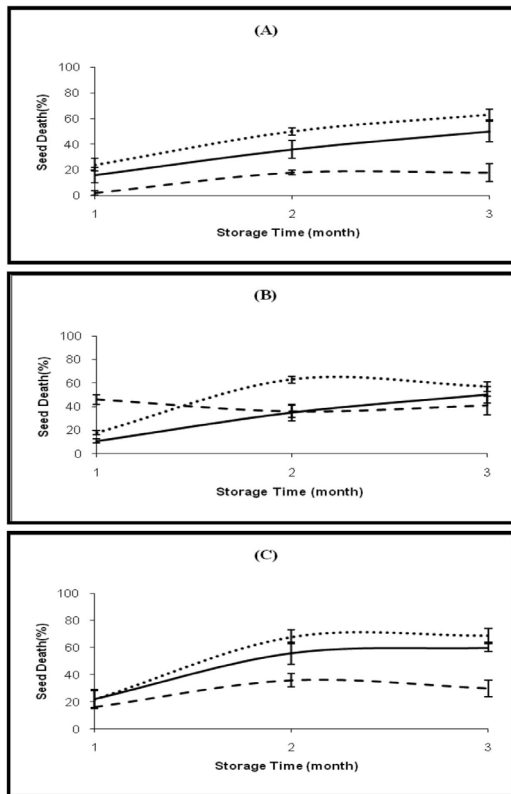


Figure 3: Changes in the percentage of seed death of papaya seeds with moisture contents at 6% (- - -), 8% (—), 10% (· · · · ·) stored at 0°C (A), 4 ° C (B) and 28 ° C (C).

Mean Time Germination (MTG)

Figure 4 shows the changing in the mean time germination (MTG) of papaya seeds with

moisture contents of 6%, 8% and 10% stored at 0°C, 4°C and 28°C. It was found that the MTG for seeds containing 10% moisture content with 28°C storage temperature was progressively reduced with increasing the storage time which were 22.21±0.54, 6.4±11.09 and 0.0±0.0 after one, two and three months of storage, respectively (Figure 4C). Seeds at 8% moisture content and stored at 28°C were 22.14±0.98, 13.65±11.83 and 6.98±12 MTG at one, two and three months storage respectively (Figure 4C).

Seeds with moisture content of 6% exhibited a constant rate of MTG with 23.38±0.56, 23.60±0.44 and 22.83±0.47mtg after one, two and three months storage respectively when stored at 0°C (Figure 4A). Generally, the rate of MTG decreased when the storage temperature was greater than 0°C (Figure 4A, 4B and 4C).

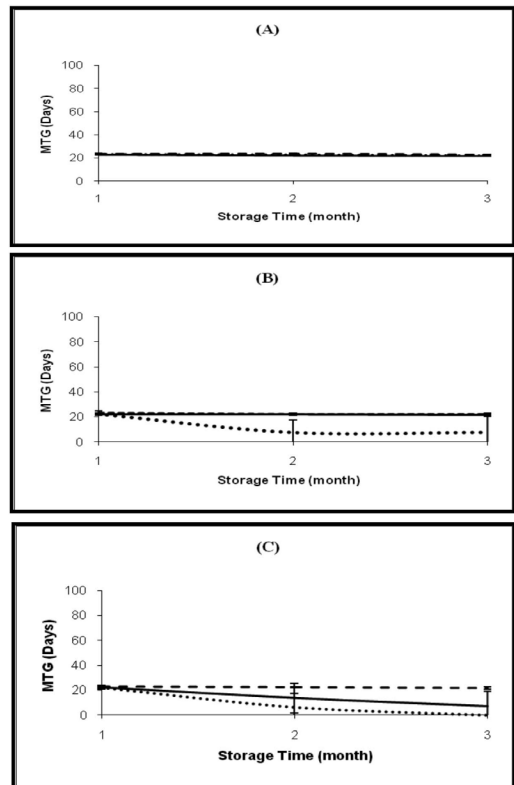


Figure 4: Changes in the mean time germination (MTG) of papaya seeds with moisture contents at 6% (- - -), 8% (—), 10% (· · · · ·) stored at 0°C (A), 4 ° C (B) and 28 ° C (C).

Table 1: Changes in the percentage of germination, dormancy, death and mean time germination (mtg) of papaya seeds with moisture contents at 6%, 8%, and 10% stored at 0°C, 4°C and 28°C after three months storage.

Temperature (°C)	Moisture contents (%)	Germination (%)	Dormancy (%)	Seed death (%)	Mgt (Day)
0	6	54±7 ^{a*}	46±7 ^c	18±7 ^c	22.83±0.47 ^a
	8	33±7 ^b	67±7 ^b	50±8 ^c	21.85±0.59 ^a
	10	62±11 ^a	38±11 ^c	63±4 ^{ab}	21.96±0.51 ^a
4	6	36±4 ^b	64±4 ^b	41±8 ^{cd}	22.28±0.74 ^a
	8	34±1 ^b	66±1 ^b	50±7 ^{bc}	21.69±0.34 ^a
	10	5±8 ^c	95±8 ^a	57±4 ^{abc}	7.44±12.89 ^a
28	6	32±9 ^b	68±9 ^b	30±6 ^c	21.76±0.77 ^a
	8	3±5 ^c	97±5 ^a	60±3 ^{ab}	6.98±12.10 ^a
	10	0.00±0.00 ^d	100±0 ^a	69±5 ^a	0.00±0.00 ^b

*Means with the same letter within the same column are not different at the 5% of significant level after determined by Tukey test.

Percentage of Germination, Dormancy, Death and MTG after Three Months Storage

Table 1 shows the changing in the percentage of germination, dormancy, death and mean time germination (MTG) of papaya seeds with moisture contents of 6%, 8% and 10% stored for three months at 0°C, 4°C and 28°C.

Discussion

Generally, papaya seeds containing 6% of moisture content and stored at 0°C gave higher germination percentage with 54±7% (Table 1). In the present study, the seed longevity is greatly influenced by storage conditions. Young and Young (1992) had also mentioned that cold moist storage conditions had commonly practiced as a method for short term storage when dealing with very dormant seeds. Oelke and Stanwood (1988) stated that the viability of intermediate seeds of temperate origin have also maintained well at cooler temperature of 5 to -20°C.

It was reported that papaya seeds stored at room temperature gave higher germination rate than seeds stored in a desiccator or refrigerator (Saito and Yamamota, 1965). Singh and Singh (1981) reported that papaya seeds remained viable for eight months at room temperature

when packed in sealed polyethylene bags. In the present study, seeds containing 6% moisture content and stored at 0°C also gave the lowest percentage of seed dormancy (46±7%) and seed death (18±7%) compared to seed stored at other temperatures with moisture conditions (Figure 1). The result of this study suggests that papaya seeds containing 6% moisture content and stored at 0°C is the most suitable conditions for the seed storage.

In the present study, seeds containing 6% moisture content when dried using silica gel gave the highest value in germination percentage and the lowest value in seed death percentage (Table 1). According to Doijode (1996), seed viability and vigor are maintained for four years in papaya seeds stored using silica gel. Moreover, Arumugam and Shanmugavalu (1977) claimed that viability decreased to 50% in papaya seeds without silica gel after nine month of storage.

Begum *et al.*, (1998) stated that the temperature below 23°C and above 44°C is detrimental to germination and viability of papaya seeds after three months storage under ambient temperatures. However, Bass (1975) stated that seeds of papaya with 9%-10% moisture contents can be stored up to 5 - 6 years without loss in viability. The result from this

experiment suggested that storage at 0°C with 6% seed moisture content is the best condition for storage of papaya seed. Meanwhile, storage at 28°C with seed moisture content of 10%, is not recommended for papaya seeds storage.

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