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The prediction of Perilla frutescens L. Britton seeds viability in the relation to storage temperature and duration

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Abstract

Perilla (*Perilla frutescens* L. Britton) seeds is grown as an oil seed crop from Japan to northern India. The Perilla seeds are considered rich in minerals, vitamins, and especially on poly-unsaturated fatty acids. The oil comprises up to 51% of the seed's weight, it's a very rich source of the omega-3 fatty acid alpha-linolenic acid (ALA). About 50 to 60% of the oil consists of ALA. On the other hand, it's also contained other poly-unsaturated fatty acid derivatives; omega-6 and omega-9. However, the oil seed has a high deterioration rate under unsuitable storage temperature. The aim of the study was to evaluate the storability and develop an equation for predicting seeds viability in related to various storage temperature. The experiment was designed in factorial in complete randomized block design with 16 replications. Perilla seed was random stored in vacuum bag under various stored temperature; 4, 15, 25 and 40 °C for 12 weeks. Then, the physical qualities were tested. The perilla seed deteriorated fast when stored under the storage temperatures higher then 25 °C. The optimum temperatures to prolong perilla seed qualities were 4, 15 and 25 °C. These temperatures showed highest seed germination and vigor. The best 12 weeks predicting equation were $Y_1 = 19.00 - 5.53\ 10^{-14}\ X_2 + 16\ X_4$, $Y_2 = 60 + 8.95\ X_2 - 0.66\ X_1 + 4.61\ X_4$ and $Y_3 = 62.78 + 8.42\ X_3 - 1.74\ X_6 + 6.99\ X_4$ ($R^2 = 1.00$), when Y_1, Y_2 and Y_3 were predicting perilla seed germination storing under 4, 15 and 25 °C, respectively, X_1 = moisture content, X_2 = water activity, X_3 = electrical conductivity, X_4 = root length, X_5 = shoot length, X_6 = germination index to perilla seeds.

Keywords : Perilla, storage, seed quality, predicting equation, omega-3

Introduction

Perilla (*Perilla frutescens* L. Britton) is grown as an oil seed crop from Japan to northern India. Plants are erect to 3 feet (1 m) in height, with an equal spread. Leaves are broadly ovate to 5 inches (12.5 cm) long and deeply toothed. They are extremely fast growers. The leaves are used as a vegetable or flavoring in Asia (Pink A. 2004). Seeds are pressed for the edible oil. The perilla seeds are considered rich in minerals, vitamins, and especially on poly-unsaturated fatty acids. The oil comprises up to 51% of the seed's weight, it's a very rich source of the omega-3 fatty acid; alpha-linolenic acid (ALA), about 50 to 60% of the oil consists of ALA. On the other hand, it's also contained other poly-unsaturated fatty acid derivatives; omega-6 (lioleic acid) and omega-9 (oleic acid) (Gunstone, 1994). However, the oil crop seed has a high deterioration rate under undesirable storage conditions; storage temperature, and seed moisture content. Thus, the aim of the study was to evaluate the storability and develop an equation for predicting perilla seeds viability in related to various storage temperatures.

Materials and Methods

Accelerated aging test

Perilla seeds were multiplied as foundation seed at Mahongson Thailand. The experiment was designed in split - plot design with 20 replications. Seed sample was taken and each of the working samples was 20 g. The sample seeds were aging under various temperatures; 40, 50, 60, and 70 °C, for 48, 60, 72, 84, and 96 hrs at 100% RH. The effect of ageing was analysed with the following tests: standard germination test, germination index (GI), water activity (Aw), seedling dry weight (SDW), seedling growth rate (SGR), cold emergence test (Cold), electrical conductivity test (EC), and moisture content (MC) (ISTA, 2006).

The storage of perilla seeds

The factors were analysed in a complete randomized block design with 48 replications. 150 g of perilla seed was stored randomly in vacuum bags at various temperatures (4, 15, 25 and 40 °C) for 12 weeks. The physical quality was tested by standard germination tests, germination index (GI), water activity (Aw), seedling dry weight (SDW), seedling growth rate (SGR), cold emergence test (Cold), electrical conductivity test (EC), and moisture content (MC) (ISTA, 2006).

The data were explained in term of mean after analysis for least significant different (LSD) at $P \leq 0.05$. Then, the Pearson correlation was analyzed. Finally, a stepwise linear regression was applied to create an equation to [predict perilla seed quality during storage for 12 weeks under various storage temperatures (Figure 1). The statistical software; STATISTIX version released 8.0 (Analytical software, Tallahassee, USA) was used.

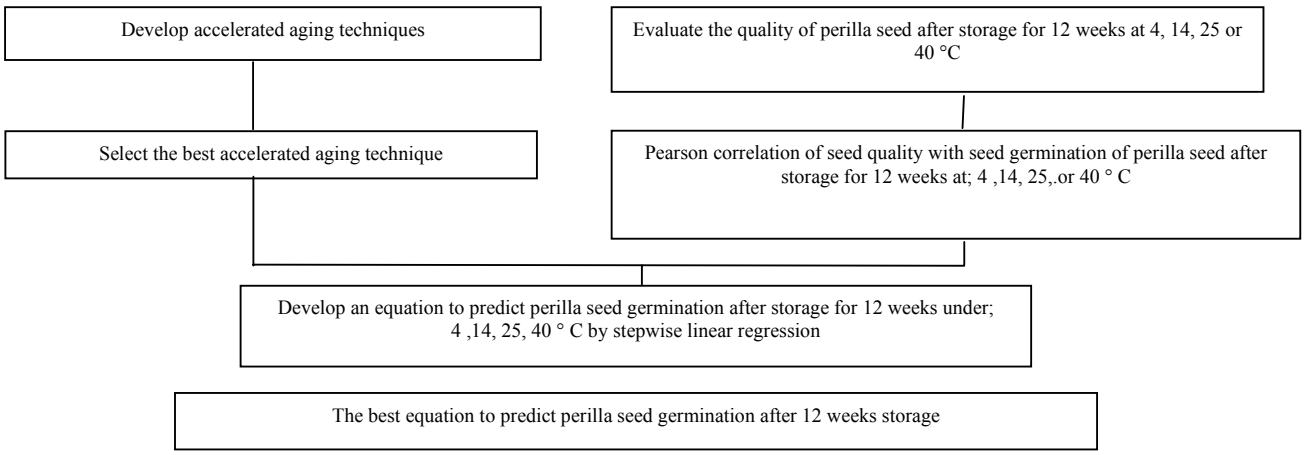

Figure 1: The development of an equation to predict perilla seed germination after 12 weeks storage.

Results and Discussion

The evaluation of accelerate aging techniques results showed that the best condition to aging the perilla seeds was at a temperature of 40 °C for 48 hrs (Table 1). This gave similar results as ageing perilla seeds by storage at 40 °C for 12 weeks. On the other hand, the other accelerate aging condition; the temperature higher than 40 °C, and longer than 48 hrs, was significantly decreased the seeds viability and vigor. Under those conditions, perilla seeds were completely dried (Table 1).

Table 1: Different physical quality of accelerated aging test of perilla seed.

Temperature	Time	MC	Aw	EC	Root	Shoot	SGR	SDW	Germ	GI
40	48	5.39	0.9229	1.245	5.75	3.75	2.68E-02	3.25E-03	2	0.1425
	60	5.743	0.9363	1.2625	1	0.75	1.63E-02	2.75E-04	0.5	0.0175
	72	5.823	0.9399	1.3425	1.5	1.25	7.65E-03	6.25E-04	1.25	0.0425
	84	9.325	0.9399	1.24	0	0	3.78E-03	0	0	0
	96	10.61	0.9483	1.155	0	0	0	0	0	0
50	48	28.707	0.9341	1.5525	0	0	0	0	0	0
	60	30.777	0.9395	1.4325	0	0	0	0	0	0
	72	31.51	0.9344	1.3575	0	0	0	0	0	0
	84	33.117	0.9411	1.38	0	0	0	0	0	0
	96	39.115	0.9506	1.3175	0	0	0	0	0	0
60	48	38.45	0.9365	3.505	0	0	0	0	0	0
	60	44.195	0.9348	3.4225	0	0	0	0	0	0
	72	47.078	0.9435	3.4	0	0	0	0	0	0
	84	46.847	0.946	3.4	0	0	0	0	0	0
	96	54.217	0.9495	3.21	0	0	0	0	0	0
70	48	39.708	0.9495	3.1325	0	0	0	0	0	0
	60	41.768	0.9475	3.2175	0	0	0	0	0	0
	72	45.69	0.9528	3.3	0	0	0	0	0	0
	84	45.925	0.9488	3.33	0	0	0	0	0	0
	96	44.908	0.9513	3.4475	0	0	0	0	0	0

Table 2: showed that, perilla seeds were completely dried when stored at 40 °C, while the viability and vigor did not decline when stored between 4 – 25 °C for 12 weeks. The results indicated that those conditions were not deteriorating to perilla seeds.
The Pearson correlation results showed that, at 4 °C, the germination of perilla seeds correlated with Aw, MC, root and shoot length (Table 3), at 14 °C s, the germination of perilla seeds correlated with GI, MC, shoot and root length (Table 4), and at 25 °C, the germination of perilla seeds correlated EC, SGR, SDW, shoot and root length, (Table 5).

Table 2: The effect of storage temperatures on perilla seed viability and vigor after stored for 12 weeks.

Temperature	MC	Aw	EC	Root	Shoot	SGR	SDW	Germ	GI
4	5.5975 b	0.6228 ab	1.3375 c	1.312 a	3.625 a	5.47E-03 a	0.0624 a	68 a	9.4425 a
15	7.3575 a	0.6667a	1.420 c	1.250 a	2.875 ab	4.43E-03 ab	0.0615 a	58.75 b	8.0175 a
25	7.940 a	0.6703 a	2.160 b	1.125 a	2.1875 b	1.57E-03 ab	0.0148 a	69.50 b	4.5325 b
40	3.200 c	0.5003 b	2.7175 a	0 b	0 c	0 b	0 a	0 c	0 c

Table 3: The Pearson correlation coefficients of perilla seeds stored at 4 °C for 12 weeks

	AW	EC	GERM	GI	MC	ROOT	SHOOT	SDW
EC	-0.567							
GERM	O.586	NS						
GL	NS	-0.869	NS					
MC	0.585	-0.607	0.922	0.633				
ROOT	0.62	-0.843	0.742	0.88	0.891			
SHOOT	0.549	-0.87	0.567	0.878	0.752	0.959		
SDW	NS	-0.603	NS	0.716	NS	0.561	0.689	
SGR	NS	-0.641	NS	NS	NS	0.518	0.661	0.708

NS: non- significant different at P ≤0.05

Table 4: The Pearson correlation coefficients of perilla seeds stored at 14 °C for 12 weeks.

	AW	EC	GERM	GI	MC	ROOT	SHOOT	SDW
EC	-0.536							
GERM	NS	NS						
GI	NS	-0.869	0.5318					
MC	0.585	-0.607	0.686	0.6332				
ROOT	0.62	-0.843	0.724	0.858	0.891			
SHOOT	0.549	-0.87	0.675	0.878	0.752	0.959		
SDW	NS	-0.603	NS	0.7168	NS	0.561	0.6897	
SGR	NS	-0.641	NS	NS	NS	0.518	0.661	0.708

NS: non- significant different at P ≤0.05

Table 5: The Pearson correlation coefficients of perilla seeds stored at 25 °C for 12 weeks.

	AW	EC	GERM	GI	MC	ROOT	SHOOT	SDW
EC	-0.5367							
GERM	NS	-0.8827						
GI	0.4872	-0.8693	0.7978					
MC	0.5858	-0.607	NS	0.6332				
ROOT	0.6204	-0.8437	0.5835	0.8584	0.891			
SHOOT	0.5491	-0.8704	0.6856	0.8788	0.7527	0.9597		
SDW	NS	-0.6036	0.6689	0.7168	NS	0.5617	0.6897	
SGR	NS	-0.6413	0.6022	NS	NS	0.5183	0.6617	0.7082

NS: non- significant different at $P \leq 0.05$

Table 6: The stepwise liner regression equation of perilla seeds after stored for 12 weeks under 4 (Y_1), 14 (Y_2), and 25 (Y_3) °C.

Prediction equation of seed germination of 12 week	**R^2**
$Y_1 = 19.00 – 5.53\ 10^{=14}\ X_2 + 16\ X_4$	1.000
$Y_2 = 60 + 8.95\ X_2 – 0.66\ X_1 + 4.61\ X_4$	1.000
$Y_3 = 62.78 + 8.42\ X_3 – 1.74\ X_6 + 6.99\ X_4$	1.000

X_1 = Moisture content, X_2 = Water activity, X_3 = Electrical conductivity, X_4 = Root length , X_5 = Shoot length, X_6 = Germination index.

Conclusions

The best equations to predict germination of perilla seeds after 12 weeks storage are the following:

$$Y_1 = 19.00 – 5.53\ 10^{-14}\ X_2 + 16\ X_4,$$
$$Y_2 = 60 + 8.95\ X_2 – 0.66\ X_1 + 4.61\ X_4,$$
$$Y_3 = 62.78 + 8.42\ X_3 – 1.74\ X_6 + 6.99\ X_4$$

Where: Y_1, Y_2 and Y_3 predict perilla seed germination upon storage at 4, 15, and 25 °C respectively.
X_1 = moisture content,
X_2 = water activity,
X_3 = electrical conductivity,
X_4 = root length,
X_5 = shoot length,
X_6 = germination index

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