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Comparing between Germination Percentage in *Moringa peregrina* and *Moringa oleifera* under Laboratory Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study was carried out in February 2019 at the laboratory; Department of Biology, College of Taymaa, Tabuk University. The numbers of germinated seeds were recorded daily after Soaking for two days during 10th, 15th, 20th, 25th and 30th days and final percentage calculated at the end of germination period. Germination percentage, radical length and vigor index values were calculated for the two studied species. The two species (S) under study, days of germination (D) and interaction between them showed highly significant ($P < 0.01$) for seed germination. Despite germination percentages being slightly higher at the 10th day and 15th day for *M. oleifera* than *M. peregrina*, the germination percentages recorded higher values at the 20th, 25th and 30th days for *M. peregrina* than *M. oleifera*. The highest seed germinated number recorded at 20th day and 15th day for *M. peregrina* and *M. oleifera*, respectively with significant differences between the numbers of germinated seed in two species. Generally, germination %, radical length and vigor index of *M. peregrina* recorded a higher value compared to *M. oleifera*. A total value of germination percentage (80.33% and 65.33%) was recorded for *M. peregrina* and *M. oleifera* seed after 20 days from germinating time, respectively.

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1. INTRODUCTION

The genus *Moringa* (*M.*) family Moringaceae consist of 13 species. *M. arborea, M. borziana, M. concanensis, M. drouhardii, M. hildebrandtii, M. longituba, M. oleifera, M. ovalifolia, M. peregrina, M. pygmaea, M. rivae, M. ruspoliana, and M. stenopetala* [1]. They are distributed in the tropical and sub-tropical regions (Plate 1).

Historical proof showed that various civilizations viz., Indian, Greek, and Egyptian were using *Moringa* for thousands of years for several purposes. In India, the leaf extracts of Moringa was used as feed as it was believed that the decoction relieves them from the pain and stress incurred during the war, as well as it is drink provides added energy in the war field [2]. Edible oil with pleasant taste (Ben oil) from the seeds of *Moringa* was highly valued by the civilizations of ancient Greek, Roman, and Egyptian for protecting their skin and making perfume. Since the middle and old kingdoms (3000–2000 BC), the ben oil was used by the Egyptians [3]. Currently, *Moringa* is cultivated for multiple purposes because all its parts including seeds, stems, shoots, leaves, flowers, fruits and radicals are useful [4]. According to Fuglie [5] the many uses for *Moringa* include: it possess biomass production, animal forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed-cake), foliar nutrient (juice expressed from the leaves), green manure (from leaves), gum (from tree trunks), honey- and sugar cane juice-clarifier (powdered seeds), honey (flower nectar), medicinal (all the plant parts), ornamental germinations, bio-pesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tannin for tanning hides (bark and gum), water purification (powdered seeds). Among the 13 known species, *Moringa oleifera (M. oleifera)* Lam. and *Moringa peregrina* Forssk. Fiori (*M. peregrina*) are the most famous species of *Moringa*.

A native of the sub- Himalayan regions of northwest India, *M. oleifera* is also indigenous to many countries in Africa, Southeast Asia, the Pacific and Caribbean islands and South America [6]. Godino et al. [7] mentioned that, the species is present in Asia, Africa, North America, Central America, the Caribbean, South America and Oceania. While, *M. peregrina* was originated in Arabian Peninsula [8]. *M. peregrina* is widely grown in Saudi Arabia (South and North Hijaz), Iran, India, Djibouti, East Africa, Egypt, Ethiopia, Palestine, Jordan, North Africa, Oman, Somalia, Sudan, Syria, Uganda, Yemen [1, 9].

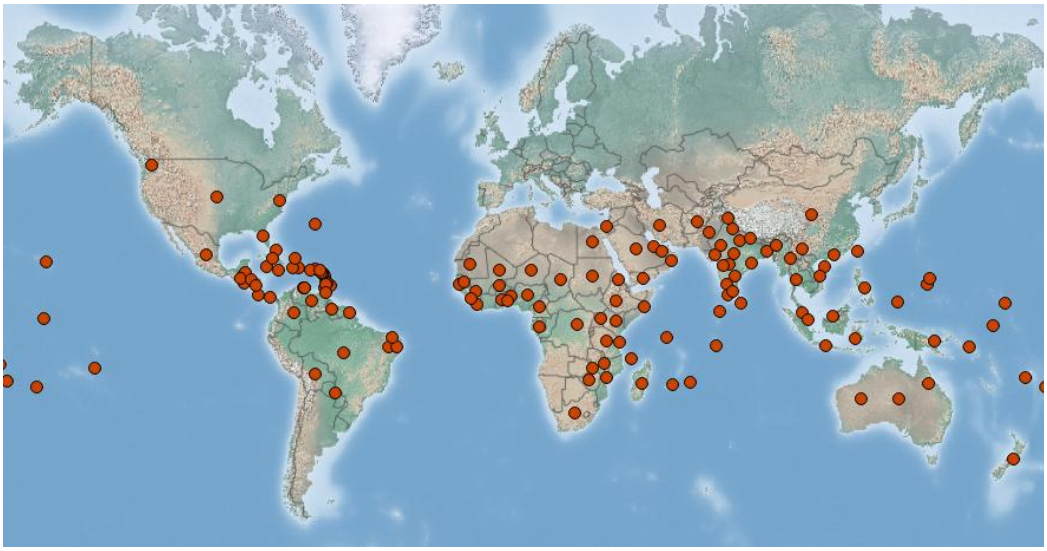

Plate 1. Distribution of moringa in World
source: USDA-ARS [10]

Preferred common name for *M. oleifera* is Horse Radish Tree. But there are other terms used for Moringa such as Drumstick Tree, and Ben Oil Tree [11]. While, common names for *M. peregrina* are Ben tree, Miracle tree, wispy-needled yasar tree, wild drum-stick tree (En). yusor tree, al-yasser, al-ban. We refer to this tree as Arabian moringa [12].

M. oleifera leaves, seeds, bark, radicals, sap, and flowers are widely used in traditional medicine, and the leaves and immature seed pods are used as food products in human nutrition, containing vitamins, minerals, amino acids, and fatty acids [13]. The leaves are reported to contain various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics, and carotenoids [14]. *Moringa* tree is even drought and salt tolerant and low nutrients requirements [5].

M. peregrine is growing in many regions of the Kingdom of Saudi Arabia. It is a fast growing tree [15]. It has a grayish green bark, long, alternate leaves, and yellowish white to pink, showy, fragrant flowers [16]. *M. peregrina* is one of the species which has wide range of traditional, nutritional, industrial, and medicinal values in many countries in Middle East. The plant parts are used in folk medicine for many human health care purposes including diabetes, wound healing, disinfectant, fever, constipation, muscle pains, slimness, burns, labor pain, hypertension, malaria, stomach disorder, asthma, skin problems, and to expel a retained placenta. In addition to medicinal value, *M. peregrina* has cultural, spiritual, and religious connections with the native people of Arabian [1]. It is proved a significant role as anti-cancer drug for colon and breast cancer cells [17].

Seed germination is one of the most important stages of the plant life cycle. The efficient progression of germination determines the nature of seedling establishment and the proper development of mature plants [18]. The term 'germination' properly refers to the physiological and developmental processes that resume in mature, non-dormant seeds when they are exposed to appropriate conditions of water availability, temperature and other physicochemical factors. In germination experiments, it is actually the completion of germination that is observed [19]. To initiate the array of complex processes that lead to the initiation of growth in the quiescent embryo in the seeds (germination), the condensed, insoluble stored substrates must first be hydrated and then hydrolyzed to their basic forms before they can be reprocessed. The processes necessary to hydrate and reactivate enzymes, cell membranes, and cell organelles require much more respiratory energy than is required to maintain the dry seed [20].

Germination experiments typically are conducted by placing groups of seeds on a moist substrate inside containers (e.g. filter paper or sand in Petri dishes), which are then placed randomly in an incubator under controlled temperature and light conditions. Seeds are checked for germination (operationally defined, usually as radicle emergence) on a sequence of observation days over a fixed period of time, typically chosen to be long enough so nearly all seeds germinate that are capable of doing so under the experimental conditions. On each observation day, seeds found to have germinated since the previous observation are counted and removed, yielding a temporal sequence of germination numbers [19].

The germination of *M. oleifera* reported to be low due to unfavorable environmental conditions i.e., change in soil chemistry and drought stress etc. [21]. Different techniques have been used to enhance the germination of *M. oleifera* since germination is low due to un-suitable soil and environmental conditions [22]. The percentage of germination of *M. peregrina* seeds that germinated at constant temperature increased significantly with the rise of temperature till 25°C which showed the highest germination of 83%, then decreased at 35°C (79.7%). No germination occurred at 5°C. So, among the constant temperature regimes tested, the germination of *M. peregrina* was restricted to the temperature range 15 to 35°C [23]. The main objective of this work, is comparing between germination percentage, radical length and vigor index in *M. peregrina* and *M. oleifera* under laboratory conditions.

2. MATERIALS AND METHODS

Moringa seeds were obtained from the Gold Tree Company, Riyadh, Saudi Arabia. In this study, we select seed for germination of the two species *M. oleifera* and *M. peregrine* (Plate 2) in February 2019 at the laboratory in Department of Biology, College of Taymaa, Tabuk University. The seed lots were sieved to remove debris and sorted based on their size and color. The seeds free from any deformity were handpicked from seed lot [21].

Plate 2. *M. peregrina* and *M. oleifera* seed

The seeds of both species were soaked in natural water for 48 hours. For each species, about 300 seeds were applied in 30 Petri dishes containing natural water and ten healthy seeds were soaked in each petri dish. The experimental units were distributed according to completely randomized design (CRD). The petri dishes with seeds were kept in laboratory un-illuminated at room temperature (the temperature ranged from 18 to 22 C°). Seeds were considered to be germinated with the emergence of the radicles. The initial counting was after 10 days of sowing seeds. Then, germination was monitored through the counting of germinated seed after every five days for a period of 25 days. Germination percentage was measured at 10, 15, 20, 25 and 30 days to germination after germination in both species. Germination percentage was calculated as the proportion of germinated seeds within a replicate. The length of radical of seeds picked at random from the germinated samples was measured by using a ruler at the end of germination period. This was done to record optimum germination. Germination percentage (G%) and vigor index (VI) were calculated with the following formula:

$$G\% = \frac{Seed\ germinated}{Total\ number\ of\ seeds} x100 \quad [24]$$

$$VI = G\%\ x\ root\ length\ of\ seeds\ germinated \quad [25]$$

According to Gomez and Gomez [26], the significance of differences between means (species and germination days) for germination % was measured at 0.05 and 0.01 significance level. The means were compared using the least significant difference test (LSD) at P ≤ 0.01 [27].

3. RESULTS AND DISCUSSION

A combined analysis of variance (Table 1) showed highly significant differences for germination percentage (G%) among the two

Table 1. Means values of germination percentage after 10, 15, 20, 25 and 30 days for *M. peregrina* and *M. oleifera*

Species (S)	Days(D)/ germination percentage				
	10	**15**	**20**	**25**	**30**
M. peregrina	3.67±0.34	27.33±0.67	67.00±1.00	77.00±0.89	80.33±0.97
M. oleifera	5.67±0.42	39.00±0.75	53.67±0.91	63.33±1.01	65.33±0.87
L.S.D at	**5%**			**1%**	
S	0.59			0.81	
D	0.94			1.29	
S x D	1.33			1.82	

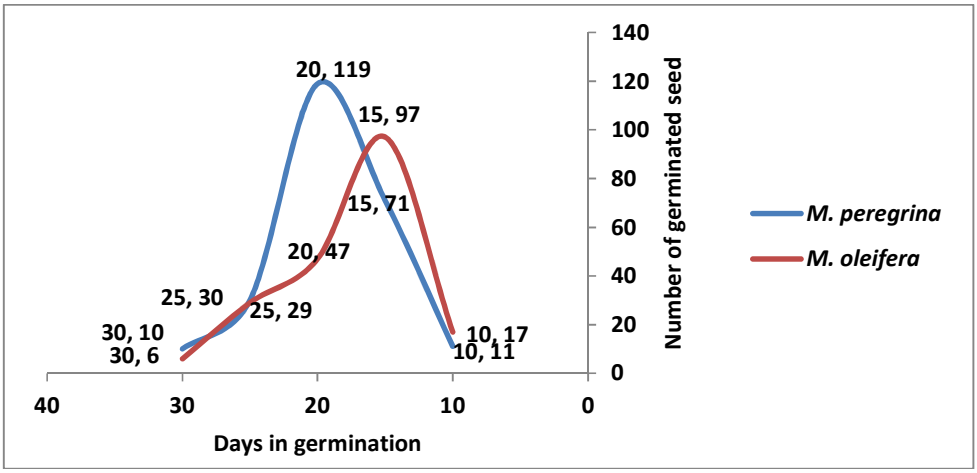

Fig. 1. Germination curve for *M. peregrina* and *M. oleifera* after 10, 15, 20, 25 and 30 days

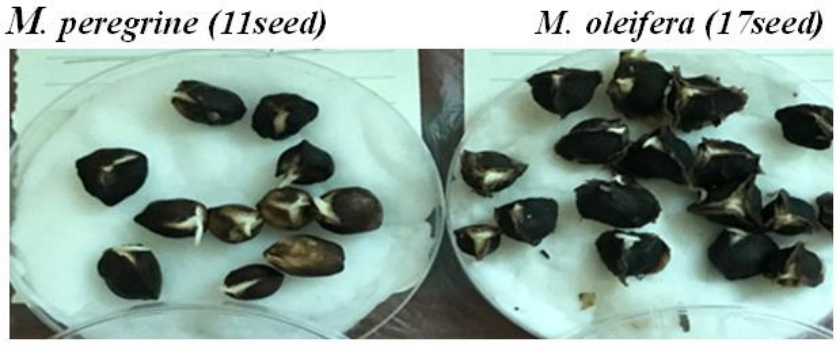

Plate 3. Number of germinated seed of *M. peregrine* and *M. oleifera* after 10 days

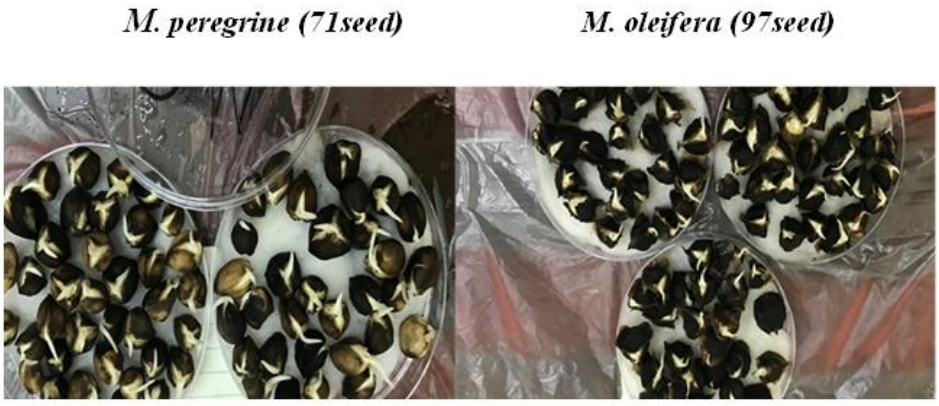

Plate 4. Number of germinated seed of *M. peregrine* and *M. oleifera* after 15 days

species (S), days of germination (D) and interaction between them. These results indicated that differences between *M. peregrina* and *M. oleifera* were found in relation to time required for germination. Padilla et al. [28] stated that the germination percentage of *M. oleifera* had significant during 11-15 day and 16-21 day after sowing in petri dishes. Seed germination was very high in all treatment combinations but significantly decreased over time in *M. peregrina* [29].

The values of germination percentage ranged from 3.67% to 80.33% for *M. peregrina*, while it is ranged from 5.67% to 65.33% for *M. oleifera* at 10th and 30th days, respectively (Table 1). Under lab. Conditions, a total 80.33% and 65.33% seeds were germinated after 20 days/at 30 days for *M. peregrina* and *M. oleifera*, respectively. Gomaa and Picó [29] mentioned that, the value of germination percentage was 97.3% after 21 days from germination time in *M. peregrina*. While, Alatar [23] reported that, the percentage of germination of *M. peregrina* seeds that

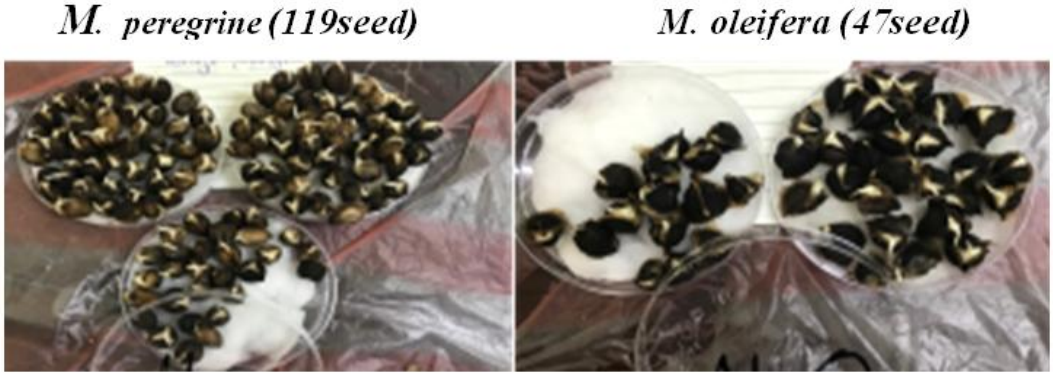

Plate 5. Number of germinated seed for *M. peregrine* and *M. oleifera* after 20 days

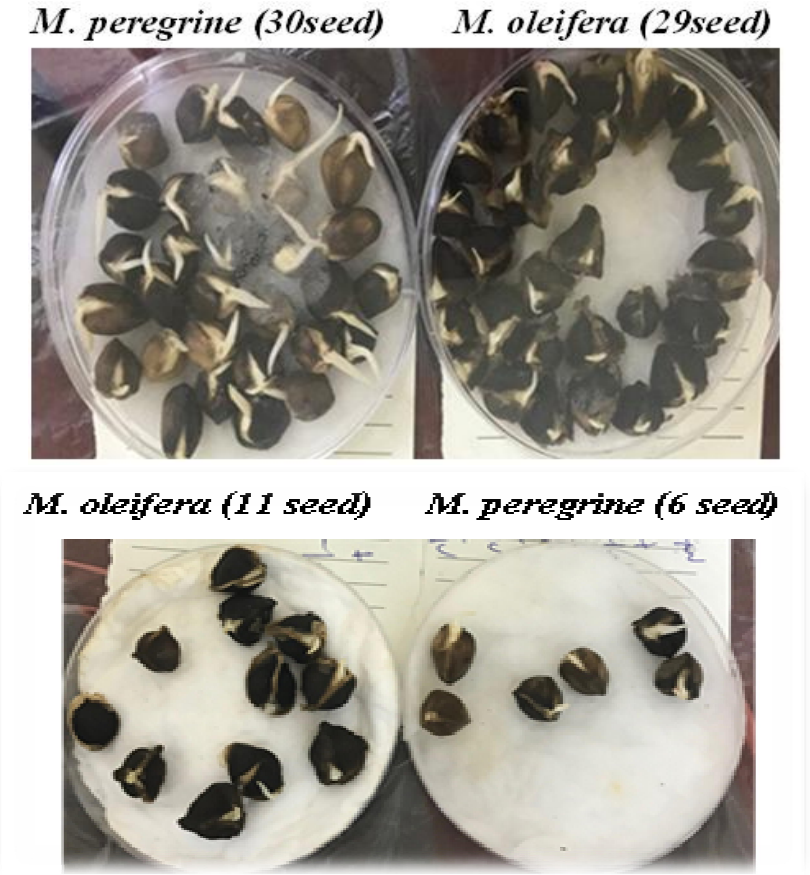

Plate 6. Number of germinated seed for M*. peregrine* and *M. oleifera* after 25 and 30 days respectively

germinated at constant temperature increased significantly into 83%. On the other hand, the germination percentage was determined to be 67%, 84 and 93 % for *M. oleifera* by Fotouo-M et al. [30], Bezerra et al. [31] and Madinur [32], respectively. Generally, the values of the standard errors ranged from 0.34 and 0.42 to 1.00 and 1.01 for the two studied species, respectively. These values indicates that there are low differences between each period of germination %.

Fig. 1 shows that the germination started on the 10th day (Plate 3) in both studied species at a small rate, then the germination curve began to increase until the 20th day (Plate 4) in the *M. peregrina* and the 15th day (Plate 5) of the *M. oleifera*, and then the germination decreased until stopped after the 30th day (Plate 6). Seed germination for *M. oleifera* had higher than *M. peregrina* at 10th and 15th days.

On the other hand, seed germination for *M. peregrina* was higher than *M. oleifera* during 20th, 25th (Plate 6) and 30th days. Generally in accord to the curve, the patterns of seeds behavior at 20th and 15th days show maximum increasing on germination for the *M. peregrine* and *M. oleifera*, respectively. The increase in the seed germination percentage is attributed to many physiological processes such as enzyme activation, hormones activation, starch hydrolysis and dormancy breaking in seed [33] in addition to hormonal interaction and environmental factors [34].

These results was confirm by Padilla et al. [28] reported that 86% of the germination for *M. oleífera* seeds occurred between the 11 and 15 days after the sown. Gomaa and Picó [29] stated that, *M. peregrina* seeds had significantly decreased germination rate over time. In any case, *M. peregrina* seeds maintain very high germination rates among populations over time.

Comparing between two species at 30th day, the germination % of *M. peregrina* was higher than *M. oleifera* with 15% (Fig. 2). The radical length also showed higher value for *M. peregrina* with 1.32 cm versus *M. oleifera* with 0.98 cm (Table 2).

Also in Table 2, it was observed that the vigor index had considerably higher in *M. peregrina* (105.99) than *M. oleifera* (64.07). Padilla et al. [28] mentioned that the total germination was 90% during the 20 day after soaking of *M. oleífera* seeds in petri dishes (Table 2).

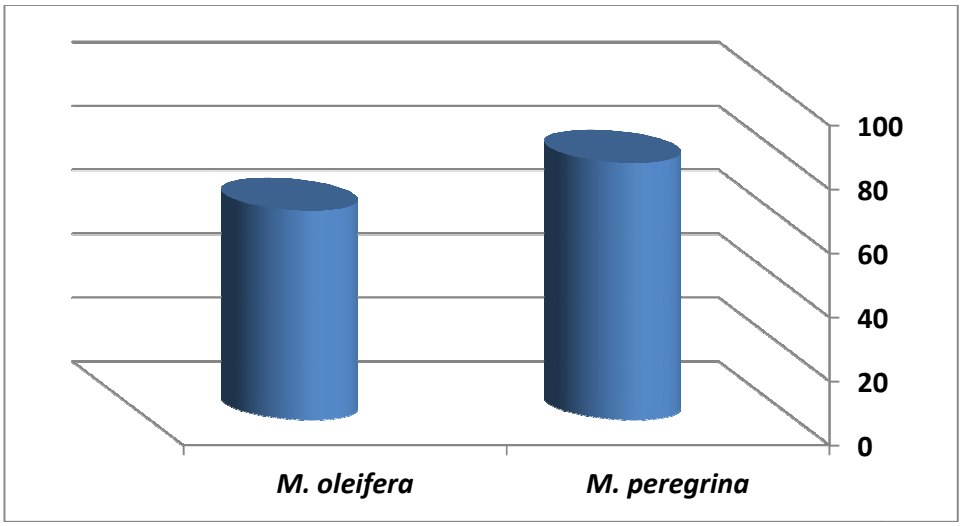

Fig. 2. Germination percentage for *M. peregrina* and *M. oleifera* after 30 day

Table 2. Mean values of radical length and vigor index after 30 days for *M. peregrina* and *M. oleifera*

Species /30 Days to Soaking (D)	Radical length (cm)	Vigor index
M. peregrina	1.32	105.99
M. oleifera	0.98	64.07

4. CONCLUSION

The days of germination, 10th, 15th, 20th, 25th and 30th had a statistically significant effects ($P < 0.01$) on germination percentage in both studied species. The 20th day and 15th day of soaking time gave the highest number of seeds germinated in *M. peregrina* and *M. oleifera*, respectively. Germination percentage, radical length and vigor index parameters were higher in *M. peregrina* when compared to that of *M. oleifera*. A total of 80.33% and 65.33% for *M. peregrina* and *M. oleifera* seeds germinated after 20 days from germination time, respectively.

5. RECOMMENDATION

Moringa sp. Which have a wide range of economic important in agriculture, health and industry fields. It is recommended to germinate under laboratory conditions (18 – 22°C) and must be propagated by further agriculture, seed bank or tissue culture.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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