EFFECT OF SEED STORAGE PERIODS, CONDITIONS AND MATERIALS ON SEED QUALITY OF SOME SOYBEAN CULTIVARS

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Abstract- In order to examine the effect of storage period, storage conditions and storage materials on seed quality of some soybean cultivars. A Laboratory experiment was conducted in Agronomy Department, Fac. of Agric., Mansoura Univ., Egypt during 2011 and 2012. The results showed that acid number, peroxide number and electrical conductivity (dSm-1) were increased with the period of ageing were increased. The obtained results indicated that Giza 22 cultivar exceeded other cultivars in electrical conductivity and moisture percentage. Giza 35 cultivar exceeded the other cultivars in acid number and peroxide number. Crawford cultivar exceeded the other cultivars in oil percentage. Storage under refrigerator conditions at $10^{\circ}\text{C} \pm 1$ exceeded storage under ambient conditions in oil percentage and moisture percentage. Storage under ambient conditions exceeded storage under refrigerator conditions at $10^{\circ}\text{C} \pm 1$ in acid number, peroxide number and electrical conductivity. Acid number and peroxide number significantly affected by storage material. Storage soybean cultivars as seeds or pods in plastic bags recorded lowest values of peroxide and acid number compared with other package materials. Results clearly showed that oil percentage, moisture percentage, acid number, peroxide number and electrical conductivity significantly affected by the varies interactions.

Keywords- Soybean, cultivars, storage, viability, deterioration, seed vigor and periods

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Introduction

Both storage conditions and duration are important factors affecting soybean seed quality and the degree of biochemical changes in seed. In Egypt, soybean the most important crop and being the edible oil. Seed quality is an imperative parameter for commercialization and processing of the seed and can affect the value of the product and its derivatives [2]. Changes that occur in seed during ageing are significant in terms of seed quality among other things, also implies seed longevity [20]. Changes arising in seed during are very significant with regard to quality and longevity of seed. Characteristics of oily plants seed composition are related to specific processes occurring in seed during storage [14]. Seed quality during storage depend upon the initial quality of seed and the manner in which it is stored. The rapid seed deterioration of soybean is thought to be due to lipid peroxidation, subsequently resulting in loss of seed viability [27].

Changes in seed during ageing are significant in terms of seed quality, among other things, also implies seed longevity [20]. Balesevic-Tubicet, et al. [8] showed that defense of seed quality hang on ageing condition and duration. Khaliliaqdamet, et al. [19] suggested that variations occurred with the viability constants of a seed deterioration model between the soybean cultivars. Different periods of seed ageing, as well as storage conditions adversely affected the seed quality [30]. Similar inferences was reported by

Sharma, et al [26], Simic, et al [29] and Vijay, et al [35].

Differences in oil affected by storage longevity were significant among tested crops and genotypes within crops. Storage longevity was negatively related with oil percentage. At storage conditions at $12^{\circ}\text{C}/60\%$, decreasing of seed oil content than in storage conditions at $25^{\circ}\text{C}/75\%$ [28]. The amount of electrolytes in the soaked water increased as the period of time and the temperature of storage were increased. The temperature at which soybean seeds remain during storage may affect the amount of electrolytes in the soaked water and consequently the results of the electrical conductivity test [33]. Vijay, et al. [35] incubated soybean seeds at two different temperatures of 34°C and 40°C for varying times. They indicated that soybean viability decreased by increasing storage temperature.

A significant difference between soybean genotypes (Sb1, Sb2, Sb3, Sb4, Sb5 and Sb6) in oil percentage, acid number, peroxide number and moisture percentage. These differences between genotypes might be due to the genetic factors and seed chemical composition influence the expression of seed deterioration and vigor decline [30]. Khaliliaqdamet, et al. [19] reported that initial viability was same 100% among DPX and Sahar cultivars. Electrical conductivity had no significant difference between DPX and Sahar cultivars but in Shahar, were higher than DPX and EC in Sahar was lower. Similar conclusions were reported by Kalavathi, et al [18],

Simic, et al [29], Venkatareddy, et al [32].

In case of quality characters of soybean seed decreases all cases but the rate of deterioration is highest in cloth bag [22]. Seeds were stored in Metallized film bags and Aluminum foil bags observed highly standard quality and seed vigor, and keep water activity and seed moisture content in low level could delay seed quality deterioration followed by Polypropylene bags and woven bag [10]. Seeds were stored in aluminums foil bags observed highly seedling vigor and keep moisture content in low level could delay seed deterioration followed by polyethylene and wheat bags [31]. Sorghum seeds stored inside gene bank and freezer regardless of the packaging materials and type of accession retain their viability [24]. Similar results was obtained by [6,9,25]. Chuansin, et al. [10] found that soybean seeds were stored in Metallized film bags and Aluminum bafoil gs keep water activity and seed moisture content in low level could delay seed quality deterioration followed by Polypropylene bags and woven bag. The oil peroxide index differed significantly among samples due to the interaction between moisture content, temperature and storage period [3]. The objectives of this research were aimed to determine the effects of storage periods, storage conditions and materials on seed quality characters of some soybean cultivars.

Materials and Methods

A laboratory experiment was conducted at experimental seed testing laboratory of Agronomy Department, Faculty of Agriculture, Mansoura University, Egypt during 2011 and 2012. The objectives of this investigation were aimed to investigate the response of some soybean cultivars i.e. Giza 21, Giza 22, Giza 35, Giza 111 and Crawford to storage periods i.e. 3,6,9 and 12 months, storage conditions i.e. ambient conditions and refrigerator conditions at $10^{\circ}\text{C}\pm 1$ as well as storage materials i.e. seed with cloth bags, seed with plastic bags, pods with cloth bags and pods with plastic bags on seeds quality characters.

Treatments and Experimental Design

Treatments were arranged in factorial experimental in completely randomize design, consisted of totally 160 treatments combinations involving tow storage conditions i.e. ambient conditions and refrigerator conditions at $10^{\circ}\text{C}\pm 1$, four different kinds of package materials i.e. seed with cloth bags, seed with plastic bags, pods with cloth bags and pods with plastic bags of five soybean cultivars i.e. Giza21, Giza22, Giza35, Giza 111 and Crawford. Four storage periods i.e. 3,6,9 and 12 months were used. Soybean (*Glycine Max* L. Merr.) cultivars were harvested in October 2011, cleaned from dust and dirt then dried and processed for storage. Every three months, from a total 12 months of storage, electrical conductivity, acid number, peroxide number, oil percentage and moisture percentage were evaluated.

Studied Characteristics

The following seed quality characters were studied as following:

Oil Percentage (%)

Soxhelt apparatus was used for determination of ether extract percent, heating by electric heaters; cold water was used through the condenser. Petroleum ether ($60-80^{\circ}\text{C}$) was preferred for extractions which continued for not less than eight hours (rate of siphoning was 6-7 /hr.) according to AOAC [1]. Moreover, oil percentage was calculated by multiplying ether extract percent $\times$ yield of dry matter (g).

Acid Number

Acid value was determined according to AOAC [1]. A known weight of sample (g) was dissolved in 20 ml ethylalcohol then the contents of the flask were shaken for one minute, then titrated with aqueous potassium hydroxide (0.1N) in the presence of phenolphthalein as indicator. The acid value was calculated according to the following equation [Eq-1]:

$$\text{Acid Value (A.V.)} = \frac{V \times N \times 56.1}{W} \quad (1)$$

Where, V = volume of KOH required to neutralize the free fatty acids, N = normality of KOH and W = weight of sample.

Peroxide Number

Peroxide value was determined as reported by AOAC [1]. A known weight of oil sample (g) was dissolved in 30 ml of glacial acetic acid:

Chloroform mixture (2:1, v/v), then one ml of freshly prepared saturated potassium iodide solution was added. The content of the flask were allowed to stand with occasional shaking for exactly 1 min and 30 ml of distilled water were added.

The liberated iodine was titrated with sodium thiosulphate solution (0.1N) until the yellow color had almost disappeared. The titration was continued after adding 1 ml of 1% starch solution as an indicator until the blue color has just disappeared.

The following equation [Eq-2] was used for calculation of peroxide value expressed as mill equivalents of oxygen / g oil:

$$\text{Peroxide Value} = \frac{V \times N}{W} \times 1000 \quad (2)$$

Where, V = volume of sodium thiosulphate used for sample, N = normality of sodium thiosulphate solution and W = weight of oil sample.

Electrical Conductivity of Seed Leachate (dSm^{-1})

Five grams of seeds in four replications were surface sterilized with HgCl_2 1% solution and thoroughly washed in distilled water, later seeds were soaked in 25 ml distilled water and kept at $25\pm 1^{\circ}\text{C}$ for 24 hr. The leachate was decanted to another container and volume was made up to 25 ml by adding distilled water. The electrical conductivity of seed leachate was measured with electrical conductivity bridge and expressed in dSm^{-1} [16].

Moisture Percentage (%)

The moisture percentage of the seed was calculated according to the International Seed Testing Association (ISTA) rules [16] by hot air oven method maintaining $103^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for 17 hr. and then at 105°C till constant dry weight. The moisture content was calculated on wet basis and expressed in percentage by using the following formula [Eq-3]:

$$\text{Moisture Percentage (\%)} = \frac{(M2 - M3)}{(M2 - M1)} \times 100 \quad (3)$$

Where, M1 = Weight of empty moisture tin in (g), M2 = Weight of moisture tin and seed material before drying (g) and M3 = Weight of moisture tin and seed material after drying (g).

Result and Discussion

Storage Periods Effects

The results showed that oil percentage and moisture percentage

were decreased as storage periods were increased as shown in [Table-1]. While, acid number, peroxide number and electrical conductivity were increased as storage periods were increased. Before storage treatment significantly exceeded the other storage periods in oil percentage and moisture percentage followed by storage for 3 months. While, storage for 12 months recorded lowest oil percentage and moisture percentage. It could be concluded that increasing storage periods from 6 and 12 months decreased oil percentage by 12.99 and 17.58%, respectively compared with before storage treatment. Increasing storage periods from 3, 6, 9 and 12 months decreased moisture percentage by 0.42, 1.38, 0.95 and 2.45%, respectively compared with before storage treatment. Increasing storage periods from 3, 6, 9 and 12 months increased electrical conductivity by 7.28, 11.57, 13.96 and 18.%, respectively compared with before storage treatment. Increasing storage periods from 6 and 12 months increased acid number by 14.39 and 23.59%, respectively compared with before storage treatment. Increasing storage periods from 6 and 12 months increased peroxide number by 12.61 and 30.27%, respectively compared with before storage treatment. Decrease of seed quality is connected with biochemical changes in seeds of oil crops. These seeds had a rapid deterioration due to autoxidation of lipids and the increase of the content of free fatty acids during storage period. The longer seeds storage period increases intensity of seeds ageing [10]. These results are in good agreement with many researchers [5,7,12,13,15,17,19].

Storage Cultivars Effects

Results in [Table-1] revealed that Giza 35 cultivar surpassed other cultivars in acid number and peroxide number. Giza 21 cultivar recorded the lowest moisture percentage. Giza 22 cultivar recorded the lowest peroxide number and acid number. Giza 35 cultivar recorded the lowest oil percentage. Giza 35 cultivar surpassed Giza 21, Giza 22, Giza 111 and Crawford cultivars in acid number by 3.31, 18.96, 10.68 and 4.05%, respectively. Giza 35 cultivar surpassed Giza 21, Giza 22, Giza 111 and Crawford cultivars in peroxide number by 12.13, 25.10, 8.13 and 8.27%, respectively. In this respect, Tatic, et al [30] stated that there was significant differences between soybean genotypes (Sb1, Sb2, Sb3, Sb4, Sb5 and Sb6) in oil percentage, acid number, peroxide number and moisture percentage. These differences between genotypes might be due to the genetic factors and seed chemical composition influence the expression of seed deterioration and vigor decline. In addition, Doi-joide [11] stated that the storability of different soybean cultivars is also regulated by initial seed quality, physical and chemical composition of seed as different cultivars possess different physical structure and chemical composition which determine the quality of seed in storage. Moreover, Gupta and Aneja [4] indicated that decreases in oil content between soybean cultivars may be due to age induced depletion phenomenon, improper storage environments and higher activity of storage fungi. These results are in good accordance with those obtained by Balesevic-Tubic, et al [7], Chuansin, et al [10], Erandes, et al [13] Jamro, et al [17] Khaliliaqdam, et al [19] Tatic, et al [30].

Storage Conditions Effects

The results in [Table-1] showed that a significant effect of storage conditions on average of oil percentage, acid and peroxide number and electrical conductivity. Storage under refrigerator conditions at 10°C surpassed ambient conditions in oil percentage by 4.71, 5.85, 11.67, 7.77 and 2.92%, respectively. While, storage under ambient

conditions surpassed refrigerator conditions at 10°C in acid number, peroxide number and electrical conductivity by 26, 8.29 and 2.77%, respectively. In this regard, Arif [6] recorded that highest seed quality was in seed stored at 4°C than room temperature. Moreover, Vijay and Dadlani [35] incubated soybean seeds at two different temperatures of 34°C and 40°C for varying times. They indicated that soybean viability decreased by increasing storage temperature. These results are in good harmony with those obtained by Balesevic-Tubic, et al [7], Erandes, et al [13] Jamro, et al [17], Khaliliaqdam, et al [19], Mohammadi, et al [21], Vieira, et al [33].

Table 1- Averages of oil percentage (%), acid number, peroxide number, electrical conductivity (dSm⁻¹) and moisture percentage (%) as affected by storage periods, soybean cultivars, storage conditions, package materials and their interactions.

Treatments	Oil (%)	Acid Number	Peroxide Number	Electrical Conductivity (dSm ⁻¹)	Moisture (%)
S- Storage periods (months)					
Before storage	22.86	4.34	5.32	1.91	9.38
3 months	-	-	-	2.06	9.34
6 months	19.89	5.07	6.47	2.16	9.25
9 months	-	-	-	2.22	9.29
12 months	18.84	5.68	7.63	2.27	9.15
LSD 5%	0.19	0.04	0.08	0.01	0.12
V-Soybean cultivars					
Giza 21	20.69	5.25	6.37	1.99	9.17
Giza 22	20.37	4.4	5.43	2.24	9.42
Giza 35	20.35	5.43	7.25	2.11	9.18
Giza 111	20.41	4.85	6.66	2.1	9.34
Crawford	20.82	5.21	6.65	2.2	9.28
LSD 5%	0.25	0.05	0.1	0.01	0.12
C-Storage conditions					
Ambient conditions	20.22	5.16	6.75	2.16	9.24
Refrigerator conditions (10°C±1)	20.83	4.9	6.19	2.1	9.32
F- test	**	**	**	**	NS
P-Package materials					
Pods in plastic bags	20.42	4.99	6.49	2.12	9.35
Pods in cloth bags	20.61	5.16	6.53	2.12	9.26
Seed in plastic bags	20.57	4.89	6.49	2.13	9.29
Seed in cloth bags	20.52	5.08	6.38	2.13	9.22
LSD 5%	NS	0.08	0.09	NS	NS
F-test Interactions					
V×S	**	**	**	**	NS
S×C	**	**	**	**	**
V×C	**	NS	NS	**	NS
V×C×S	NS	NS	NS	*	NS
S×P	NS	**	*	NS	NS
V×P	NS	**	**	**	NS
V×S×P	NS	**	*	*	NS
C×P	NS	NS	NS	*	NS
S×C×P	NS	NS	NS	NS	NS
V×C×P	NS	NS	NS	NS	NS
V×C×S×P	NS	NS	NS	NS	NS

Storage Package Materials Effects

The results in [Table-1] showed that a significant effect of package materials on the average of acid number and peroxide number. The results showed that highest value of acid number was obtained from storage soybean pods or seed in cloth bags. However, lowest value of acid number was obtained from storage soybean cultivars pods or seeds in plastic bags. Highest value of peroxide number was obtained from storage soybean pods in cloth bags. However, lowest value of peroxide number was obtained from storage soy-

bean cultivars seeds in cloth bags. In this regard, Chuansin, et al [10] showed that seeds were stored in Metallized film bags and Aluminum foil bags observed highly standard quality and seed vigor, and keep water activity and seed moisture content in low level could delay seed quality deterioration followed by Polypropylene bags and woven bag. Moreover, Tatipata [31] stated that seeds were stored in aluminums foil bags observed highly seedling vigor and keep moisture content in low level could delay seed deterioration followed by polyethylene and wheat bags. These results are in harmony with those reported by Arefi and Abdi [5], Erandes, et al [13], Khaliliaqdam, et al [19], Tatipata [31].

Interaction Effects

Interaction between Soybean Cultivars and Storage Periods

Highest electrical conductivity was obtained from storage Giza 22 and Crawford cultivars for 12 months without significant differences between them. Lowest values of electrical conductivity were recorded from Giza 35 and Giza 21 cultivars before storage without significant differences between them [Fig-1]. The results clearly indicated that highest oil percentage was obtained from Giza 21 cultivar before storage followed by Giza 21 cultivar storage for 6 months. While, lowest oil percentage were recorded from storage Giza 21 and Giza 22 cultivar storage for 12 months without significant between them [Fig-2].

Fig. 1- Averages of electrical conductivity (dSm^{-1}) as affected by the interaction between soybean cultivars and storage periods

Fig. 2- Averages of oil percentage (%) as affected by the interaction between storage periods and soybean cultivars

The results clearly indicated that highest acid number was obtained from storage Giza 21 and Giza 35 cultivars for 12 months without significant differences between them. While, lowest acid number were recorded from Giza 22 before storage [Fig-3]. The results clearly indicated that highest peroxide number was obtained from

storage Giza 21 and Crawford cultivars for 12 months without significant differences between them. While, the lowest peroxide number were recorded from before storage of Giza 22 [Fig-4]. These results in agreement with those reported by Arefi and Abdi [5], Balesevic-Tubic, et al [8], Chuansin, et al [10], Khaliliaqdam, et al [19], Muhammad [23], Tatipata [31].

Fig. 3- Averages of acid number as affected by the interaction between storage periods and soybean cultivars.

Fig. 4- Averages of peroxide number as affected by the interaction between storage periods and soybean cultivars.

Interaction between Storage Periods and Storage Conditions Effects

The results clearly showed that pre storage treatment recorded the lowest electrical conductivity followed by storage after 3 months under refrigerator conditions at 10°C [Fig-5]. Highest electrical conductivity was recorded from storage for 12 months under ambient conditions. The results clearly showed that pre storage treatment recorded highest moisture percentage followed by storage for 3 months under refrigerator conditions at 10°C [Fig-6]. Storage under ambient conditions for 12 months recorded the lowest moisture percentage. Pre storage treatment recorded highest oil percentage followed by storage after 3 months under refrigerator conditions at 10°C [Fig-7].

Storage under ambient conditions for 12 months recorded lowest oil percentage. The results clearly showed that pre storage treatment recorded lowest acid number followed by storage for 3 months under refrigerator conditions at 10°C [Fig-8]. Storage under ambient conditions for 12 months recorded highest acid number. The results clearly indicated that pre storage treatment recorded lowest peroxide number followed by storage for 3 months under refrigerator conditions at 10°C [Fig-9].

Fig. 5- Averages of electrical conductivity (dSm^{-1}) as affected by the interaction between storage conditions and storage periods

Fig. 9- Averages of peroxide number as affected by the interaction between storage periods and storage conditions

Fig. 6- Averages of moisture percentage (%) as affected by the interaction between storage conditions and storage periods.

Fig. 7- Averages of oil percentage(%) as affected by the interaction between storage periods and storage conditions.

Fig. 8- Averages of acid number as affected by the interaction between storage periods and storage conditions.

Storage under ambient conditions for 12 months recorded the highest peroxide number. The amount of electrolytes in the soaked water increased as the period of time and the temperature of storage were increased. In this respect Vieira, et al [33] showed that the temperature at which soybean seeds remain during storage may affect the amount of electrolytes in the soaked water and consequently the results of the electrical conductivity test. Moreover, Vijay, et al [35] incubated soybean seeds at two different temperatures of 34°C and 40°C for varying times. They indicated that soybean viability decreased by increasing storage temperature. These results are in conformity with those reported by Balesevic-Tubic, et al [7], Erandes, et al [13], Jamro, et al [17], Khaliliaqdam, et al [19], Mohammadi, et al [21], Vieira, et al [34].

Interaction between Soybean Cultivars and Storage Conditions Effects

Electrical conductivity significantly affected due to the interaction between soybean cultivars and storage conditions. Highest electrical conductivity was obtained from storage Crawford cultivar under ambient conditions. The lowest electrical conductivity was obtained from storage Giza 21 cultivar under refrigerator conditions at 10°C [Fig-10].

Fig. 10- Averages of electrical conductivity (dSm^{-1}) as affected by the interaction between soybean cultivars and storage conditions.

The results clearly indicated that highest oil percentage was obtained from storage Crawford cultivar under refrigerator conditions (10°C±1). The lowest oil percentage was obtained from storage Giza 21 and Giza 35 cultivars under ambient conditions without significant differences between them [Fig-11]. In this trend, Khaliliaqdam, et al [19] reported that initial viability was same 100% among DPX and Sahar cultivars. Electrical conductivity had no significant

difference between DPX and Sahar cultivars but in Sahar, were higher than DPX and EC in Sahar was lower. These results are in conformity with those reported by Arefi and Abdi [5], Chuansin, et al [10], Erandes, et al [13], Khaliliaqdam, et al [19], Tatipata [31].

Fig. 11- Averages of oil percentage (%) as affected by the interaction between soybean cultivars and storage conditions.

Interaction between Storage Periods, Soybean Cultivars and Storage Conditions

The results clearly showed that highest electrical conductivity was obtained from storage Giza 22 and Giza 111 cultivars under ambient conditions for 12 months. The lowest electrical conductivity was obtained from pre storage of Giza 21 and Giza 35 cultivars [Fig-12]. In this regard, Tatic, et al [30] noticed that a significant differences between soybean genotypes (Sb1, Sb2, Sb3, Sb4, Sb5 and Sb6) in oil percentage, acid number, peroxide number and moisture percentage. These differences between genotypes might be due to the genetic factors and seed chemical composition influence the expression of seed deterioration and vigor decline. These results are in good agreement with those reported by Balesevic-Tubic, et al [7], Erandes, et al [13], Jamro, et al [17], Khaliliaqdam, et al [19], Mohammadi, et al [21], Vieira, et al [34].

Fig. 12- Averages of electrical conductivity (dSm^{-1}) as affected by the interaction between storage periods, soybean cultivars and storage conditions.

Interaction between Storage Periods and Package Materials

Acid and peroxide numbers significantly affected due to the interaction between storage periods and package materials.

The results clearly showed that pre storage treatment recorded the lowest acid number followed by storage for 3 months [Fig-13]. The highest acid number was recorded from storage soybean cultivars for 12 months seeds in cloth bags. Pre storage treatment recorded the lowest peroxide number followed by storage for 3 months [Fig-

14]. The highest acid number was recorded from storage soybean cultivars for 12 months seeds in plastic bags. The oil peroxide index differed significantly among samples due to the interaction between moisture content, temperature and storage period [3]. These results are in conformity with those reported by Khaliliaqdam, et al [19], Muhammad [23].

Fig. 13- Averages of acid number as affected by the interaction between storage periods and package materials.

Fig. 14- Averages of peroxide number as affected by the interaction between storage periods and package materials.

Interaction between Soybean Cultivars and Package Materials

Highest electrical conductivity was obtained from storage Giza 22 cultivar pods storage in cloth bags or seeds in plastic bags. While, lowest values of electrical conductivity was obtained from Giza 21 cultivar storage as pods in plastic or cloth bags [Fig-15].

Fig. 15- Averages of electrical conductivity (dSm^{-1}) as affected by the interaction between soybean cultivars and package materials.

The results clearly showed that the highest acid number were produced from storage Giza 35 cultivars pods or seeds in cloth bags

[Fig-16]. The lowest acid number was obtained from storage Giza 22cultivar seeds in plastic or cloth bags without significant differences between them. Highest peroxide number was produced from storage Giza 35cultivar pods in plastic or cloth bags [Fig-17]. The lowest peroxide number was obtained from storage Giza 22cultivar seed in cloth bags. These results are in conformity with those reported by Balesevic-Tubic, et al [7], Erandes, et al [13], Jamro, et al [17], Khaliliaqdam, et al [19], Mohammadi, et al [21].

Fig. 16- Averages of acid number as affected by the interaction between soybean cultivars and package materials.

Fig. 17- Averages of peroxide number as affected by the interaction between soybean cultivars and package materials.

Interaction between Storage Periods, Soybean Cultivars and Package Materials

The results clearly showed that highest electrical conductivity was obtained from storage Giza 22cultivar seed in plastic bags for 12 months.

Fig. 18- Averages of electrical conductivity (dSm-1) as affected by the interaction between soybean cultivars, package materials and storage periods.

The lowest electrical conductivity was obtained from pre storage of Giza 21 and Giza 35 cultivars [Fig-18]. The results clearly showed that highest acid number was produced from storage Giza 35 cultivar as pods or seeds in cloth bags for 12 months [Fig-19]. The lowest acid number was obtained from pre storage of Giza 22 cultivar. The results clearly showed that highest peroxide number were produced from storage Giza 35 cultivar as seed in cloth bags for 12 months [Fig-20]. The lowest peroxide number was obtained from pre storage of Giza 35 cultivar. These results are in good agreement with those reported by Balesevic-Tubic, et al [7], Erandes, et al [13], Jamro, et al [17], Khaliliaqdam, et al [19], Mohammadi, et al [21], Vieira, et al [34].

Fig. 19- Averages of acid number as affected by the interaction between storage periods, soybean cultivars and package materials.

Fig. 20- Averages of peroxide number as affected by the interaction between storage periods, soybean cultivars and package materials

Interaction between Storage Conditions and Package Materials

The results clearly showed that highest electrical conductivity was obtained from storage soybean cultivars as pods in cloth bags under refrigerator conditions ($10^{\circ}\text{C}\pm 1$). The lowest electrical conductivity was obtained from storage soybean cultivars pods in cloth bags under ambient conditions [Fig-21].

In this respect, Chuansin, et al [10] found that soybean seeds were stored in Metallized film bags and Aluminum foil bags keep water activity and seed moisture content in low level could delay seed quality deterioration followed by Polypropylene bags and woven bag. The oil peroxide index differed significantly among samples due to the interaction between moisture content, temperature and storage period [3]. These results in good harmony with those reported by Balesevic-Tubic, et al [7], Erandes, et al [13], Jamro, et al [17], Khaliliaqdam, et al [19], Mohammadi, et al [21].

Fig. 21- Averages of electrical conductivity (dSm-1) as affected by the interaction between storage conditions and package materials

Conclusion

The results indicated that for maximizing soybean seed quality, it could be storage Giza 111 cultivar under refrigerator conditions ($10^{\circ}\text{C}\pm 1$) as pods or seeds in cloth bags for 3 months.

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