Drying Temperature and Storage Period and Their Relation to Stevia Leaf Chemical Composition

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ABSTRACT: Stevia *(Stevia Rebaudiana* Bertoni*)* is a herbal plant with increasing attention due to its high potency sweetener worldwide. Nevertheless**,** its leaves are highly moisten and are susceptible to rapid degrade. Therefore, two field experiments were carried out at the experimental farm, Sakha Agric. Res. Station in Kafr El-Sheikh-Governorate, Egypt in 2017 and 2018 seasons, to study the effect of drying temperatures (60, 70, 80 and 90 °C) in addition to shade drying and storage period (one, two, three and four months) compared to the control (after harvest directly) on quality of stevia leaves. All combination treatments were allocated in randomized complete block design (RCBD) in three replications, where one cut (one harvest) was taken after 5 months from planting to determine the *i. e.* stevioside%, rebaudioside% rebaudioside/ stevioside ratio, carbohydrate content and weight loss during storage (storability) as well as correlation coefficient during both seasons of 2017 and 2018. The most important results showed that Increasing drying temperature to 90 °C positively significantly affected;(p≤*0.05)* stevioside, rebaudioside and carbohydrate percentages. However decreased both the ratio between rebaudioside/stevioside and weight loss of leaves was obtained during both seasons. All storage times, significantly (p≤*0.05)* decreased values of all studied characters during storage up to four months during the both seasons. Correlation coefficients indicated significant positive correlation ones among stevioside and rebaudioside and ratio of rebaudioside/ stevioside and carbohydrate%; however, storability recorded negative significant correlation with other characters under study in the both seasons.

Key words: Stevia plant, stevioside %, rebaudioside A%, Carbohydrate %, stevia storability, dry leaves of stevia.

INTRODUCTION

Stevia plant (*Stevia rebaudiana* Bertoni) family Compositae as a herbal plant and modern crop from wild plants, which increased the recent demand for high potency sweeteners which helping the other sweeteners (sugar cane and sugar beet). In addition, it has been highlighted as it contains stevia glycosides that are 200-300 times sweetener than sugar (Goyal *et al*, 2010; Jackson *et al*., 2009). Stevia glycosides have no calories and are generally recognized as safe (GRAS) of the food and drug administration in the United States of America (FDA, 2008). In Europe, the European commission granted the authorization of the use of stevia glycosides as food sweetener in 2011 (EU, 2011).

Leaves containing a large amount of initial moisture are highly susceptible to rapid degradation (Chua and Chou, 2003). Drying is a very common practice to extend the shelf life of products since moisture reduce the growth of microorganism (Shen-Dun *et al*., 2011) and allows longer periods of storage maintaining quality and stability of product (Mondaca *et al*.,2015), and minimizes packing, transport, handling and distribution requirement's (Kwok *et al*.,2004).

Samsudin and Aziz (2013) dried stevia leaves at different temperatures *i.e.* 50, 60, and 70 °C to remove moisture content of stevia plant. They found that at temperatures from 50-60 °C; lead to better quality of dried leaves as sweeteners and nutrient content compared with drying at 70 °C. Using laboratory dryer for 5-6 h; brought about in moisture content reduction from 80% to 3-5% with keeping dried leaves with its stevioside, in addition, sugar content was 5-7 % Brix with a pH around 6.

Sadvatha (2010) compared drying stevia leaves at 40, 50, 60 and 70 °C on microwave oven with other methods of drying as (shade). He pointed out that drying at 50-60 °C was effective on quality and the dried leaves were better compared with drying at 70 °C.

Lakshmi and Vimala (2000) investigated amaranths, curry leaves and mint green vegetable powdered by dehydration technology. They reported that cabinet dried green leaves seemed to be better in terms of nutrition than sun-dried ones.

The storage of stevia leaves is very important step from harvest to use it with good quality without any losses. Kumar and Sreenarayanan(2000) concluded that storage and packing of stevia leaves had shelf-life up to three months with high quality when stored in foil laminate whereas, samples which stored in pages from high density polyethylene (HDPE) at accelerated conditions (38 °C with 90% R.H.) spanned storage time of a month only. Zakia *et al*. (1992) concluded that the balanced mushroom when stored at normal storage temperature (27 °C with 65% R.H.) in foil laminate had shelf-life up to 3 months compared to one month only with another pages (HDPE). Jasmin *et al*. (1996) dried garlic slices at 55-60 °C and stored it. They reported that the products maintained its quality up to 3 months.

Previous work, showed that either drying temperatures or storage were important to keep stevia leaves with high quality, therefore , the objective of this study was to assess the effect of different drying temperatures and storage times to extend shelf-life of stevia leaves with high composition of steviosides in *Stevia rebaudiana* Bertoni leaves.

MATERIALS AND METHODS

To study the effect of different temperatures and storage times on shelf-life of stevia leaves, two field experiments were conducted at Sakha Agric. Res. Station Farm in Kafr El-Sheikh Governorate, Egypt, during the two successive seasons of 2017 and 2018 to obtain healthy stevia leaves after harvesting the plants which planted in the first week of January in both seasons, until May. Spanti cultivar of stevia was seeded in a nursery and after 75 days from sowing the seedlings were transplanted to the open field in plots at the space area (6 m^2) on ridges wide 50 cm with 3 meter long and 20 cm between hills. Every hill contained one plant during both growing seasons. Plants were fertilized with nitrogen fertilizers (Urea 46% N) at rate of 30 kg N /fed/cut in two equal doses, the first dose was added just before the first irrigation, while the second half was applied before the second irrigation for every cut.

The first cut was harvested at the first of May (i.e. 1/5/2017) after 5 months from sowing (before flowering and decreasing steviosides percentage) where the plant had an average of 25 branches and 75 – 100 leaves and leaf fresh weight *ca.* 30 gram. Leaves of harvested plants were separated, washed and left under room conditions at 27°C for 72 h to dry. After air drying each sample was divided into three parts (replications) to grind to be fine and subjected to the following treatments:

Drying sample	Drying temperature
D1	Drying under room condition at 27°C (control) shade
D2	Drying at 60°C in an oven drier for 6 hours
D3	Drying at 70°C in an oven drier for 6 hours
D4	Drying at 80°C in an oven drier for 6 hours
D5	Drying at 90°C in an oven drier for 6 hours

Then, after drying every mentioned sample was divided to five parts for storing at 5 different times:

Stored sample	Stored times
S1	Not stored (control)
S2	Storage for one month
S3	Storage for two months
S4	Storage for three months
S5	Storage for four months

The four treated samples were stored in paper bags under room conditions at 27°C and 65% R.H. through the mentioned times while all analyses were done for all treatments included the control one also to determine the following characters:

1	**Stevioside %**
2	Rebaudioside %
3	Rebaudioside / stevioside ratio
4	Carbohydrate %
5	Weight loss during storage (storability) g / 1 kg f.w.
6	Correlation coefficient according to steel and Torrie(1980)

The first two characters were determined using high-performance liquid chromatography (HPLC). The determination of stevioside by HPLC was done according to Nishiyama *et al.* (1992). The HPLC system was a HP 1100 chromatograph (Agilent Technologies, Palo Alto, CA, USA) equipped with an auto-sampler, quaternary pump and a diode array detector, in the central laboratory of the Faculty of Science, Alexandria University during both seasons.
Carbohydrate percentage was determined as described by Nishiyama *et al.* (1991), and according to the equation:
TC= 7.56 + 0.96 (ST)
Where TC= total soluble carbohydrate ST= stevioside content (%)
Weight loss during storage (storability) was estimated using a digital scale
Correlation coefficient (*r*) simple correlation matrix was carried out for the two seasons to investigate the relationship between different factors under study on leaf chemical according to Steel and Torrie (1980)

Experimental design and statistical analysis:
Each experiment was laid out as a factorial experiment in randomized complete block designed (RCBD). With three replications, each replicate contained 25 treatments (5 Temp. x5 storage period) the obtained date were statistically analyzed and treatment effects were compared using revised least significant difference test (L.S.D. P<0.05) as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The obtained results will be presented and discussed as follows:

Stevioside percentage
Stevioside content is important factor in stevia leaves which cause the sweetness of stevia leaves. Results in Table (1) demonstrate that applied treatments exerted a significant (*p≤0.05)* effect on stevioside percentage values during both season. This result could be a consequence of drying temperatures. Increasing drying temperature from 60 °C to 90 °C may cause a significant increase in stevioside percentage content from 10.01 to 12.43% in the first season, *i.e.* from 6.87 to 10.52% in the second season. This increase could be taken place due to decrease moisture content with increasing degrees of temperature from 60 to 90 °C, compared with control treatment (drying on room temperature) which gave the lowest ones (8.66 and 6.29%) in both seasons, respectively.

These results are in agreement with the results were obtained by Rayagura and Khan (2008); Sadvatha (2010); Samsudin and Aziz (2013); Perich *et al.* (2015), and Mondaca *et al*. (2016); Results outlined in Table (1) declared a significant decrease in stevioside content due to increasing storage time until four months after harvest, *i.e.* from 12.66 to 6.52% and from 11.22 to 2.14% in both seasons, consecutively compared to control treatment. Similar, more or less results were obtained by Wills and Stuart (2000) they concluded that storage of ground roots of *Echinacea purpura*. Many investigators obtained a similar trend on some other crops (Tanko *et al.*, 2003; Uddin e*t al.*, 2006; Cartericoradi *et al.*, 2015).

Concerning the interaction between drying temperatures and storage times on stevioside % during both seasons, Results in Table (2) exhibit that the highest stevioside content in stevia leaves were obtained (22.35 and 16.69%) during both seasons because of drying leaves directly after harvesting at 90 °C. While the lowest values of stevioside% were recorded in both seasons (6.05 and 1.70%) owing to storage stevia leaves directly for 4 months without drying. This loss may be achieved due to high moisture content which encourage microorganism activities causing the deterioration of stevioside content. This result divulges the role of drying temperature on suppressing the biological activity of leaves during storage.

Table(1). Stevioside percentages in stevia leaves as affected by different drying temperatures and storage times in 2017 and 2018 seasons

Treatment	2017 season	2018 season
Drying temperature (°C) :		
control	8.66	6.29
60°C	10.01	6.87
70°C	10.93	8.23
80°C	11.89	8.78
90°C	12.43	10.52
L.S.D (0.05)	1.12	0.76
Storage times (month) :		
Not stored (control)	20.15	12.43
one Month	12.66	11.22
Two Months	7.53	9.10
Three Months	7.05	8.80
Four Months	6.82	2.14
L.S.D (0.05)	1.12	0.76
Interaction	*	*

Table (2). The interaction effect between drying temperatures and storage times on stevioside percentage of stevia leaves during 2017 and 2018 seasons

Treatment	2017				
	Storage time (month)				
	Control	One months	Two months	Three months	Four months
Control	16.31	8.45	6.37	6.12	6.05
60°C	18.45	11.97	6.85	6.58	6.20
70°C	21.71	12.19	7.49	6.82	6.43
80°C	21.94	14.81	8.39	7.83	6.50
90°C	22.35	15.90	8.57	7.88	7.44
L.S.D (0.05)	2.50				
	2018				
	Control	One months	Two months	Three months	Four months
Control	10.08	9.07	6.17	4.46	1.70
60°C	10.62	10.46	6.93	4.43	1.92
70°C	11.99	10.98	10.49	5.61	2.09
80°C	12.78	11.76	10.60	6.50	2.25
90°C	16.69	13.83	11.33	8.01	2.75
L.S.D (0.05)	1.70				

Rebaudioside percentage

Rebaudioside content is the second major content on stevia leaves which cause sweetens in leaves because it has from 300-450 sweet times more than sugar. So, this compound determined after affected by drying temperatures and storage times concerning to applying of drying temperatures on rebaudioside%, date in Table (3) showed that with increasing drying temperatures from 60 to 90 °C caused a significant increase in rebaudiana % from 2.11 to 3.22% in the first season and from 2.42 to 4.66% in the second season compared to control treatment (shad drying), which gave the lowest ones (1.84, 1.97%).

These results are in agreement with those found by Rayagura and khan (2008); Samsudin and Aziz (2013). Rebaudioside% percentage as affected by storage times during two growing seasons are shown in Table (3). Results obtained pointed out that this content was significantly affect by increasing storage time to 4 months. Significant decreases in values of rebaudioside were obtained in both seasons with increasing storage times from 6.10 to 1.21% and from 4.45 to 2.07% in both seasons respectively Tanko *et al*.(2003) reported that storage few leaves for 120 days at 24 °C, resulted in a decrease content of parthenolide in the leaves. Regarding interaction effect between drying temperatures and storage times on rebaudioside percentage in both seasons, Table(4) cleared that significant effect was found in the second season only. The highest value of rebaudioside% was obtained (5.90%) when stevia leaves were dried at 90 °C and stored for 4 months with compared to lowest values which obtained when leaves did not dry or dried at low degrees and stored for 4 months.

Table (3). Rebaudioside percentage in stevia leaves as affected by different drying temperatures and storage times in 2017 and 2018 seasons

Treatment	2017 season	2018 season
Drying temperature (°C)		
control	1.84	1.97
60°C	2.11	2.42
70°C	2.39	3.26
80°C	2.72	4.04
90°C	3.22	4.66
L.S.D (0.05)	0.28	1.19
Storage times (month)		
Not stored (control)	6.10	4.45
one Month	2.11	4.14
Two Months	1.50	3.18
Three Months	1.37	2.51
Four Months	1.21	2.07
L.S.D (0.05)	0.28	1.19
Interaction	N.S	**

Table (4). The interaction between different drying temperatures and storage times on rebaudioside percentage during 2018 season

Treatment Drying temperature °C	2018 season				
	Storage time (month)				
	Control	One month	Two months	Three months	Four months
control	2.67	2.30	1.80	1.53	1.57
60°C	3.70	3.20	2.00	1.90	1.30
70°C	4.80	4.60	3.10	2.00	1.80
80°C	5.20	5.10	4.10	3.30	2.50
90°C	5.90	5.50	4.90	3.80	3.20
L.S.D (0.05)	0.42				

Rebaudioside/stevioside ratio

Results in Tables (5 and 6) disclose the main effects of both studied independent variables (i.e., drying temperature, storage times and their interactions, each in turn) on stevia plant Rebaudioside/stevioside ratio through both growing seasons. Rebaudioside/stevioside ratio is very important factor because it is an indicator for sweetens of stevia leaves because of rebaudioside sweetens more than stevioside. Regarding the main effect of drying temperature on the above-mentioned character, results of Table (5) indicated, that the given values were increased significantly ($p \leq 0.05$) with increasing drying temperatures from 60 °C to 90 °C. This was true during both seasons. Tanaka (1988) reported that stevioside and rebaudioside-A are reasonable thermally stable under the elevated temperature used in food processing and do not undergo browning or caramelization when heated.

As for the main effect of storage periods on the given ratio in both seasons, the obtained results of Table (5) pointed out its significance ($p \leq 0.05$) effect on this character during the first season. Whereas, increasing storage times were associated with decreasing the given character from harvest time up to 4 months in storage. Whereas, in the second season opposite trend was found. This reverse effect related to rebaudioside values which increased in the second season more than in the first season. This result could be due to day length that affected this trait. This finding is in harmony with that obtained by Grammer and Kan (1986). The interaction between both factors under the study (Table 6) demonstrated a significant ($p \leq 0.05$) in the second season only on rebaudioside/stevioside ratio. The gained results revealed that the highest ratio (0.92) was obtained when stevia leaves were harvested and stored without drying compared to the control treatment (0.27). The lowest value may be taken place due to the high content of water or moisture of leaves.

Table (5). Rebaudioside / stevioside ratio of stevia leaves as affected by different drying temperatures and storage times in 2017 and 2018 seasons

Treatments	2017 season	2018 season
Drying temperatures (°C)		
control	0.18	0.42
60°C	0.19	0.41
70°C	0.21	0.47
80°C	0.22	0.57
90°C	0.26	0.57
L.S.D (0.05)	0.04	0.07
Storage times (month)		
Not stored (control)	0.31	0.36
one Month	0.20	0.37
Two Months	0.20	0.34
Three Months	0.18	0.43
Four Months	0.17	0.95
L.S.D (0.05)	0.04	0.07
Interaction	N.S	*

Table (6). The interaction effect between different drying temperature and storage times on rebaudioside / stevioside ratio during 2018 season

Treatment Drying temperature °C	2018 Season				
	Storage time (month)				
	Control	One month	Two months	Three months	Four months
control	0.27	0.27	0.29	0.35	0.92
60°C	0.35	0.32	0.29	0.43	0.68
70°C	0.40	0.43	0.29	0.35	0.86
80°C	0.41	0.44	0.39	0.51	1.11
90°C	0.35	0.40	0.43	0.49	1.17
L.S.D (0.05)			0.16		

Carbohydrate percentage

Results postulated in Tables (7 and 8) exhibit the main effects of both independent variables and their interaction on carbohydrate content during both growing seasons.

In terms of the main effect of drying temperatures on carbohydrate percentage, results presented in Table (7) revealed that increasing drying temperature of stevia leaves either after harvest (shade drying) or at any temperature raised from 60 to 90 °C; increased leaf carbohydrate percentage from 15.87 and 13.60% to 19.41 and 17.99% during both seasons, respectively. In this respect, Mondaca *et al*. (2016) reported that drying stevia leaves until 80 ºC increased leaf carbohydrate content in the both seasons.

Regarding the main effect of storage time, results of Table (7) denoted a significant ($p \leq 0.05$) effect of the given variable on carbohydrate content percentage during the second season only. There was an inverse relationship between the given factor and the studied trait, whereas storage time increased (control = 19.48), the studied decreased (one month = 9.61) proportionally. This result could be the consequence of biological changes during the prolonged storage time (*i.e.* 4 months).

Pertaining the first order interaction between both studied variables, results depicted in Table (8) disclose that the interaction between D5 (*i.e.* 90 °C) and control treatment (s1= not stored); brought about the highest percentage (23.58), and do both drying temperature and storage time increased ; the studied character decreased as presented due to the interaction between various levels of either independent variable levels (9.19 to 10.19%)

Table (7). Carbohydrate of stevia leaves as affected by different drying temperatures and storage times in 2017 and 2018 seasons

Treatments	2017 season	2018 season
Drying temperatures (°C)		
Control	15.87	13.60
60°C	16.39	14.14
70°C	16.97	15.46
80°C	18.80	15.99
90°C	19.41	17.99
L.S.D (0.05)	1.52	0.73
Storage times (month)		
Not stored (control)	25.86	19.48
one Month	18.79	18.33
Two Months	14.77	16.30
Three Months	14.22	13.13
Four Months	13.82	9.61
L.S.D (0.05)	1.52	0.73
Interaction	N.S	* *

Table (8). The interaction effect between different drying temperature and storage times on Carbohydrate % during 2018 season

Treatment Drying temperature °C	2018 Season				
	Storage time (month)				
	Control	One month	Two months	Three months	Four months
control	17.24	16.27	13.48	11.84	9.19
60°C	17.66	17.60	14.21	11.81	9.40
70°C	19.07	18.10	17.63	12.95	9.57
80°C	19.83	18.85	17.74	13.80	9.72
90°C	23.58	20.84	18.44	15.25	10.19
L.S.D (0.05)			1.62		

Storability

Results tabulated in Table (9) represent the main effect of both drying temperature, storage times and their interaction on stevia leaf storability in order to extend its shelf-life. With regard to the main effect of drying temperature, it exerts significant ($p \leq 0.05$) effect on storability during both seasons. There is an inverse relationship between the given trait and storability of stevia leaf during both seasons. On other words, as drying temperature increased, the tested character decreased. The control treatment (D1) exhibited the highest percent compere with at 90 °C (D5), in general.

Table (9). Leaf weight losses shelf-life (storability) (g /1 kg f. w.) as affected by drying temperatures °C, storage periods and their interactions during 2017 and 2018 seasons

Treatments	2017 season	2018 season
Drying temperatures (°C)		
control	382	595
60°C	330	583
70°C	325	570
80°C	315	550
90°C	305	522
L.S.D (0.05)	6.44	15.76
Storage times (month)		
Not stored (control)	343	582.6
one Month	333	576.6
Two Months	331	561.6
Three Months	328	555.6
Four Months	322	552.6
L.S.D (0.05)	6.44	15.76
Interaction	**	**

Result tabulated in Table (10) demonstrated that significant effects were found in both seasons. The obtained results revealed that drying stevia leaves at any temperatures (60, 70, 80 and 90°C) caused a stable in weight leaves during all storage periods (4 months) compared to the control treatment which stored for 4 months without drying after harvest that recorded a significant decrease in weight leaves with increasing storage period. This was true in the both seasons.

Table (10). The interaction effect between drying temperature and storage periods on storability of stevia plant leaves during 2017 and 2018 seasons

Treatment Drying temperature °C	2017				
	Storage times (month)				
	Control	One month	Two months	Three months	Four months
control	440	390	380	365	335
60°C	330	330	330	330	330
70°C	325	325	325	325	325
80°C	315	315	315	315	315
90°C	305	305	305	305	305
L.S.D (0.05)			14.29		
Treatment	2018				
	Control	One month	Two months	Three months	Four months
control	680	615	585	555	540
60°C	583	583	583	583	583
70°C	570	570	570	570	570
80°C	550	550	550	550	550
90°C	520	520	520	520	520
L.S.D (0.05)			35.25		

Correlation coefficient (r)

Correlation coefficient estimation was determined during the both seasons as presented in Table (11) and (12) for studied characters. A significant positive correlation was obtained among, stevioside%, rebaudioside%, the ratio between rebaudioside/stevioside, carbohydrate %, whereas, storability in the first season correlation was negatively affected owing to the factors under the study. Whereas, in the second season correlation was positively affected owing to storability with rebaudioside% and rebaudioside/ stevioside ratio.

Table (11). The correlation coefficient between studied characters in the 2017 season as affected by drying temperatures and storage period

Studied character	Rebaudioside	Carbohydrate	Rebaudioside/ stevioside ratio	Storability
Stevioside	0.0919**	0.972**	0.465**	-0.045-
Rebaudioside		0.904**	0.742**	-0.005-
Carbohydrate			0.461**	-0.031-
Rebaudioside/ stevioside ratio				-0.030-

**correlation is highly significant at 1% probability

Table (12). The correlation coefficient between studies characters at the 2018 season

Studied character	Rebaudioside	Carbohydrate	Rebaudioside/ stevioside ratio	Storability
Stevioside	0.827	1.000**	0.638**	-0.034-
Rebaudioside		0.827**	0.183	-0.376**
Carbohydrate			0.632**	-0.035
Rebaudioside/ stevioside ratio				-0.336**

**correlation is highly significant at 1% probability

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الملخص العربي

درجة حرارة التجفيف و فترات التخزين وعلاقتها بالتركيب الكيميائي لأوراق الاستيفيا

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الاستيفيا نبات عشبى ترجع اهميته لقوة التحلية التى يتميز بها اوراقة لما تحتوية من الاستيفيوسايدز. و تحتوى هذة الاوراق على نسبة عالية من الرطوبة التى تجعلها قابله للتدهور بسرعه . و لذا اجريت تجربتان حقليتان بالمزرعه البحثيه لمحطه بحوث سخا الزراعيه – كفر الشيخ خلال الموسمين الزراعيين ٢٠١٧ / ٢٠١٨ لدراسه تاثير درجات حراره تجفيف اوراق نبات الاستيفيا بعد الحصاد على درجات حرارة (٦٠ – ٧٠ – ٨٠ – ٩٠ م°) مقارنه بالكونترول (التجفيف فى الظل على درجة حرارة الغرفة) وكذلك فترات التخزين بعد الحصاد (شهر – ٢ شهر – ٣ شهور – ٤ شهور) مقارنه بالكونترول (بعد الحصاد مباشرة) على جودة اوراق نبات الاستيفيا

ويمكن تلخيص اهم النتائج المتحصل عليها فيما يلى:

كان لتجفيف الاوراق تجفيفا صناعيا على درجات حرارة (٩٠ °م) اثرا معنويا فى زيادة قيم كل الصفات التاليه فى كلا الموسمين .

١. نسبة الاستيفيوسيد المئوية – نسبه الريبودايوسيد – النسبة بين الاستيفيوسيد و الريبودايوسيد– نسبة الكربوهيدرات الذائبة الكلية – النقص فى الوزن خلال التخزين فى الاوراق المخزنة. اذا ما قورنت بالمعامله التى تم تجفيفها فى الظل على درجات حرارة الغرفة التى سجلت اقل قيمة لهذه الصفات خلال الموسمين.

٢. اذا ما زادت فترة تخزين الاوراق الى ٤ شهور بعد الحصاد ادى ذلك الى نقص معنوى فى قيم كل الصفات التى تحت الدراسه ماعدا صفة نسبه الريبودايوسيد الى الاستيفوسيد فى الموسم الثانى حيث زادت هذة الصفة نتيجة زيادة فترة التخزين من شهر الى ٤ شهور زيادة معنوية.

٣. ادى التفاعل بين عوامل الدراسة الى التأثير المعنوي على كل الصفات تحت الدراسة حيث ادت زيادة حرارة التجفيف الى ٩٠ °م لاعطاء اكبر قيمة بعد الحصاد و مباشرة و قبل التجفيف و اقل قيمة لها عند التجفيف على حرارة منخفضة و فترات تخزين اطول (٤ شهور)

٤. سجل معامل الارتباط بين عوامل الدراسه تفاعلا موجبا و معنويا فى الموسم الأول و اما الموسم الثانى كان التفاعل معنوى و سالبا مع صفة النسبة بين المكونين الرئيسية فى اوراق الاستيفيا وهما الريبيودايوسيدو الاستيفيوساید مع باقي الصفات التى كانت تحت الدراسة والبحث

تشير نتائج هذا البحث الى ان افضل معاملات بعد الحصاد يتم اتباعها و تطبيقها على اوراق نبات الاستيفيا المحلى الطبيعى للمحافظه على جوده هذه الاوراق ومحتوياتها هو التجفيف الحرارى لهذه الاوراق على حراره ٩٠ م ° وعدم اطاله او زياده فتره التخزين بعد التجفيف المباشر بعد الحصاد حيث انه كلما زادت فتره التخزين اثر معنويا بالنقص فى قيم الصفات التى تحت الدراسه .