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EFFECT OF FERTILIZATION AND STORAGE CONDITIONS ON THE QUALITY OF LETTUCE

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Abstract

This experiment was carried out in 2019, in the cold greenhouse, covered with polycarbonate, in the early culture, in the experimental field of the Faculty of Horticulture Bucharest, and the lettuce was stored in the Postharvest Technology Laboratory at the Research Center for Studies of Food Quality and Agricultural Products of the University of Agronomic Sciences and Veterinary Medicine Bucharest. F1 lettuce hybrids were used: Centore, Analena, Alanis, Shangore and Tizian, fertilized at planting with Best starter 200 kg/ha, K-sol 80 kg/ha, Novatec classic 300 kg/ha and Orgevit 3000 kg/ha. For storage only 2 hybrids, Tizian and Shangore, were used with 2 fertilizers, respectively, Best starter and K-sol. The storage conditions were: in the normal atmosphere at 1°C, 95% humidity and 20% oxygen and in the controlled atmosphere at 1°C, 95% humidity and 2% oxygen for 14 days. There were used 3 packaging variants: unpacked, packaged in food foil and packaged in food foil on cardboard. Plant growth and production were influenced by the fertilizer used, the best results being obtained by fertilizing with Best starter and K-sol, which is why these hybrids were chosen for storage. During the storage period it was observed that the greatest weight loss was in the unpackaged lettuce both in the normal and controlled atmosphere, regardless of the hybrid and the fertilization product used. The content in vitamin C was higher in hybrids fertilized with K-sol, but during the storage period there was a strong decrease especially for the lettuce from stored in controlled atmosphere, for all packaging variants. The acidity of the lettuce did not show major differences.

Key words*: fertilizer, humidity, oxygen, production, storage, temperature.*

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is one of the most important species amongst the green vegetables. The quality of the edible part depends on the culture system, the applied technology and the biological material used. Lettuce is little pretentious to atmosphere al factors, which makes it possible to cultivate these plants throughout the year, in Romania, in different culture systems to ensure fresh and qualitative lettuce to the consumer market from the national production. An important part in lettuce culture is played by the variety or the hybrid that is cultivated, which is why new hybrids, with superior characteristics regarding productivity and ability to adapt to the atmosphere, are more and more cultivated, especially within protected spaces (Neață et al., 2017). Applying certain products during the vegetation period, for some species, stimulates the growth of the root system and increase the capacity to absorb water and minerals (Helepciuc et al., 2019), while applying some stimulants during the vegetative growth period leads to intensifying some physiological processes, with effects on increasing production and quality (Dobrescu et al., 2017).
Lettuce contains a large variety of phyto-nutrients, fibres and other elements necessary to a proper functioning of the human body (Hoy et al., 2019) and it is included in the food diets along other vegetables and fruits. Lettuce leaves are rich in calcium, iron, magnesium, potassium, folic acid, vitamin K, vitamin C, lutein, beta-carotene, lycopene and other

elements essential for the human body. Consuming lettuce and other vegetables with green leaves reduces the incidence of some severe diseases, such as cardiovascular conditions (Pollock, 2016), strokes (Larsson, 2013), cancer (Sant et al., 2007) and others (Padayatty et al., 2003). Fresh products can represent means to transmit pathogens that lead to consumer diseases, which is why packing the products is necessary. Research conducted by Oliveira et al. (2010), on lettuce packed in different types of wrap, stored at 5°C and 25°C, and 10 days after at 5°C, showed that the populations of *E. coli* and *Salmonella* spp. Decreased, while the populations of *Listeria monocytogenes* increased. The 0°C temperature during lettuce storage ensured that the quality was maintained, compared to the temperature of 20°C, but is was also managed to store lettuce in a good condition at 20°C and relative humidity of 85-95% by applying a treatment with 0.2 µl/l 1-MCP (methylcyclopropene) or giberelic acid 0.1 mg/l GA (Tian et al., 2014).

Lettuce is a perishable lettuce, which is why it is recommended to be consumed fresh, but it can also be stored at 4-5°C for several days. Extending the storage period even in optimum conditions leads to an accelerated decrease in vitamin C content (Dewhirst et al., 2017). Reasearch conducted by Spinardi and Ferrante (2012) showed that for the lettuce stored at temperatures of 4 and 10°C the loss in vitamin C was very high, it actually almost disappeared after 5 days since storage, regardless of the temperature, stating that that could be a biochemical marker of the freshness of the lettuce. The lettuce chopped and packed in bags, stored at 2°C, kept its quality 2.5 times more than the one stored at 10°C, as per Bolin et al. (1977).

Manzocco et al. (2017) studied the evolution of some quality parameters of the packed lettuce, at 4°C, 8°C and 12°C, and noted that with the increase in temperature, there was no effect of lettuce firmness, no weight loss, but the colour changed, microbial infections appeared, which led to being impossible to capitalize the product. Increasing the temperature and the level of CO_2 in storage spaces determines the degradation of product quality by altering the content in some nutrients (Tilahun et al., 2017; Kapetanakou et al., 2019). The change in the green colour for some vegetable species, due to the alteration of the chlorophyll and accumulation of carotenoids and/or flavones, was also observed by Kulaj (2015). Applying organic fertilizers determines the increase of the productive yield and lettuce quality compared to the ones obtained by applying chemical fertilizers. Thus, Chen Bo-Ching et al. (2014), showed that fertilizing the lettuce with organic products, 200 kg/ha, led to obtaining lettuce plants with a lower content in nitrates and with a higher growth, compared to fertilizing the plants with the same quantity of chemical products. Hossain and Ryu (2018), showed that using organic fertilizers for lettuce determined an increase in production and its content in different nutrients, an increase the soil content in nitrogen and organic matter and a decrease in heavy metals content of the soil (cadmium and lead).

MATERIALS AND METHODS

Research was conducted within 2 experiments, the first one for producing lettuce and the second one for storing it.

Experiment 1

The lettuce culture was established in the experimental field of the Faculty of Horticulture of Bucharest, during 2018-2019, for the spring culture, within an unheated greenhouse, covered with double-layered polycarbonate and with protection against ultraviolet rays. The experiment had two factors, 5 hybrids and 4 products for soil fertilization were used, during the soil preparation for planting, as detailed below:

Factor A Hybrid	Factor B Fertilizer
a1- Tizian F1	b1 - Best Starter, 200 kg/ha
a2 - Shangore F1	b2 - K Sol, 80 kg/ha
a3 - Alanis F1	b3 - Novatec clasic, 300 kg/ha
a4 - Analena F1	b4 - Orgevit, 3000 kg/ha
a5 - Centore F1	

The purpose of the experiment was to determine the influence of the hybrid on lettuce production, the influence of the fertilizer on the growth of edible parts and the combined influence of the two factors on the growth and productive yield of the lettuce cultivated in

unheated greenhouse. The culture was established in the first decade of March, with 40-day-old seedlings. Planting was done at 40 cm between rows and 30 cm between plants on a row, resulting around 8 plants/m^2. The fertilization was made through dispersal and soil incorporation, on different variants. Specific maintenance works were applied to the culture. Harvesting of the lettuce was done 38 days after planting, moment in which physical-chemical measurements were made.

Experimental design

The experiment was organized into subdivided parcels, with 3 replications. Each replication had 5 plants for which measurements were made at harvest. Measurements regarding plant weight were made through weighing with the electronic scale WTB 2000, while for determining the root system volume the graded cylinder was used.

The interpretation of the results was made through variance analysis, the values being compared to the average of the experiment.

Experiment 2

It was conducted at the Research Center for Studies of Food Quality and Agricultural Products - Hortinvest from the USAMV Bucharest. Two hybrids were stored in controlled atmosphere, Shangore F1 and Tizian F1, respectively, obtained from a culture fertilized Best starter (BS) and K-sol (KS). The purpose was to establish the effect of storage conditions on lettuce quality. The lettuce was stored in normal atmosphere conditions (CR), at a temperature of 1°C, humidity of 95%, 20% oxygen level, and controlled atmosphere (CA), at a temperature of 1°C, humidity of 95%, 2% oxygen, for 14 days. The lettuce was individually packed in food wrap, food wrap + tray (cardboard plate for support) and unpacked.

Measurements made

Three measurements were made: the first at the beginning, immediately after harvest, when the lettuce was introduced to storage, and others after 7 and 14 days. The following were measured: vitamin C (Chanforan et al., 2012; Turmanidze et al., 2017), using the tool Agilent Technologies 1200 equipped with detector UV-DAD through column ZORBAX Eclipse XDB-C18 (4.6 x 50 mm, 1.8 pm id), and the data was recorded and processed using the software Agilent Chem Station B.04.03 (Agilent, USA); acidity was measured with the automatic titrator TitroLine easy. It was titrated with NaOH 0.1 N, until a pH value of 8.1 (Saad et al., 2014; AOAC Official Method, 942.15) and was calculated using the formulae:

Titrable acidity (%) = (V x N x C x 100)/m

V=volume of NaOH consumed; N=normality of NaOH; C=malic acid equivalent; m=sample mass; losses recorded during storage, through weighing; content in soluble dry matter using the refractive method with digital refractometer (Kruss DR301-95) and total dry matter by drying in the drying oven at 105°C.

RESULTS AND DISCUSSIONS

The influence of the hybrid and fertilizer on the growth of lettuce plants

The results obtained after interpreting the data recorded during the experiment showed that both the hybrids and the used fertilizers had a very good influence on lettuce growth and productivity (Table 1). The weight of the edible part was influenced by all used fertilizers, but the best results were recorded for the fertilizer K-sol with 4 of the hybrids: Tizian F1, 375.9 g, Centore F1, 384.4 g, Shangore F1, 405.4 g and Analena F1, 416.7 g. The weight of the non-edible part had values between 7.3 g for the hybrid Analena F1 fertilized with Best starter and 29 g for the hybrid Tizian F1 fertilized with K-sol, but without noticing a certain influence of the hybrid or the fertilizer used. The root system of lettuce plants had similar weight values for all studied hybrids, between 16.8 g and 19.2 g, except for the hybrid Centore F1 for which the roots had values between 11.7 g and 14.6 g. However, root volume was more uniform and no great variations were recorded amongst the studied variants. The lettuce production is similar to the production obtained in Romania (Horgos et al., 2001), in unheated spaces, and had values between 2.02 kg/m^2 for Alanis F1 fertilized with Novatec classic and 3.33 kg/m^2 for Analena F1 fertilized with K-sol. For the majority of the studied combinations, the largest productions were obtained as a result of the fertilization with Best starter and K-sol.

Table 1. Biometric characteristics of lettuce plants at harvest

Combination	Weight of edible part (g)	Weight of non-edible part (g)	Root		Production (kg/m^2)
			Root weight (g)	Root volume (cm^3)	
a1b1	368.8	28.5	16.8	22	2.95 N
a1b2	375.9	29.0	19.1	24	3.01**
a1b3	306.2	27.0	18.0	18	2.45^{000}
a1b4	339.5	17.5	19.2	20	2.72 N
a2b1	397.7	24.1	17.4	18	3.18***
a2b2	405.4	22.9	19.0	22	3.24 ***
a2b3	342.8	24.5	18.2	24	2.74 N
a2b4	344.1	21.7	19.2	16	2.75 N
a3b1	366.1	8.3	16.8	16	2.93 N
a3b2	256.7	8.2	17.4	22	2.05^{000}
a3b3	252.3	16.0	18.0	20	2.02 ^{000}
a3b4	362.3	12.3	19.2	18	2.90 N
a4b1	371.3	7.3	18.8	16	2.97*
a4b2	416.7	11.3	18.0	26	3.33***
a4b3	365.0	14.3	18.0	22	2.92 N
a4b4	347.3	9.7	18.4	20	2.78 N
a5b1	361.2	11.4	12.6	21	2.89 N
a5b2	384.4	17.8	14.6	22	3.08 ***
a5b3	364.6	12.3	13.8	19	2.92 N
a5b4	353.5	11.2	11.7	20	2.83 N
LSD 5%					0.12 kg/m^2
LSD 1%					0.16 kg/m^2
LSD 0.1%					0.22 kg/m^2

The influence of the packing variant and storage duration on lettuce quality in normal atmosphere

Lettuce is a highly perishable vegetable, which is why it is recommended for consumption immediately after harvest or for storage in certain conditions to maintain qualitative characteristics, except for vitamin C (Dewhirst et al., 2017). Regarding the content in vitamin C, it was observed that for the fertilization with K-sol, the obtained plants had a higher content in vitamin C (5.38-7.69 mg/100 g fresh lettuce) compared to the plants fertilized with Best starter (4.43-4.89 mg/100 g fresh lettuce). After 7 days, the content in vitamin C decreased more for the unpacked lettuce, fertilized with K-sol (41.08% for Tizian F1 and 58.00% for Shangore F1) compared to the one fertilized with Best starter, where the loss was of 13.70% for Tizian F1 and 20.31% for Shangore F1. For the lettuce packed in food wrap or food wrap+cardboard, the loss was generally higher than for the unpacked lettuce for both hybrids except for Shangore F1 fertilized with K-sol, packed in food wrap, for which the loss was of 50.59%. After 14 days, the greatest loss was recorded also for the packed variants. Packing the lettuce determined the highest loss in vitamin C, the values being between 74.49% for Shangore F1+BS and 92.85% for Shangore F1+KS (Table 2). These results are in according with other results from speciality literature (Spinardi and Ferrante 2012; Bolin et al., 1977).

Within the controlled atmosphere, the loss in vitamin C were larger after 7 days compared to the normal atmosphere, for all packing variants, for all experimental variants, with values between 71.98% for Tizian F1+BS, unpacked, and 90.9% for Shangore F1+KS, packed in food wrap + cardboard (Table 3).

Table 2. Vitamin C content of the lettuce stored in normal atmosphere

Hybrid + fertilizer									
Time of analysis (days)	Packing variant	Shangore F1+BS		Shangore F1+KS		Tizian F1+BS		Tizian F1+KS	
		mg/100 g	%	mg/100 g	%	mg/100 g	%	mg/100 g	%
0		4.43	0	7.69	0	4.89	0	5.38	0
7	N	3.53	20.31	3.23	58.00	4.22	13.70	3.17	41.08
	F	2.38	46.27	3.80	50.59	1.79	63.39	2.12	60.59
	F+C	2.14	51.69	1.56	79.71	1.75	64.21	1.37	74.54
14	N	2.03	54.17	2.40	68.80	4.78	20.25	3.14	41.64
	F	1.13	74.49	0.55	92.85	0.82	83.23	0.59	89.03
	F+C	0.66	85.10	0.55	92.84	0.57	88.34	0.79	85.31

After 14 days, the vitamin C loss was slightly higher than after 7 days, with values between 84.76% for Tizian F1+KS, unpacked, and 94.15% for Shangore F1+KS, packed in food wrap + cardboard, very high values compared to the when the lettuce was introduced to storage. The packing variant had a very low influence on the loss of vitamin C during storage.

Table 3. Vitamin C content of the lettuce stored in controlled atmosphere

Storage condi-tions	Hybrid + fertilizer								
	Time of analysis (days)	Pac-king variant	Shangore F1+BS		Shangore F1+KS		Tizian F1+BS		Tizian F1+KS	
			mg/100 g	%	mg/100 g	%	mg/100 g	%	mg/100 g	%
	0		4.43	0	7.69	0	4.89	0	5.38	0
CA	7	N	0.84	81.04	1.51	80.36	1.37	71.98	0.76	85.87
		F	0.73	83.52	0.75	90.25	0.77	84.25	1.13	79.00
		F+C	0.46	89.62	0.7	90.90	0.76	84.46	1.05	80.48
	14	N	0.64	85.55	0.57	92.59	0.55	88.75	0.82	84.76
		F	0.56	87.36	0.63	91.81	0.52	89.37	0.65	87.92
		F+C	0.50	88.71	0.45	94.15	0.52	89.37	0.44	91.82

Lettuce acidity had values of 0.07-0.08% malic acid when stored, the values slightly increasing as the storage duration increased, regardless of the packing variant and the storage conditions (Table 4). The highest value of acidity was recorded after 14 days of storage, for Shangore F1 with both fertilizers, for unpacked lettuce, 0.13-0.14%.

The lettuce content in soluble dry matter (Table 5) immediately after harvest had values between 1.97% and 3.00% for the hybrid Shangore F1 and 2.27-2.30 for the hybrid Tizian F1, with both fertilizers.

In normal atmosphere, for the unpacked lettuce, after 7 days of storage, the content in soluble dry matter increased compared to the initial moment, except for the hybrid Shangore F1+KS for which it decreased. After 14 days, the content decreased compared to the initial moment, except for the hybrid Shangore F1+BS for which it slightly increased (2.10%). For the packed lettuce, the content in soluble dry matter increased after 7 days for all studied variants compared to the initial moment, while after 14 days of storage it decreased below the initial value, except for the hybrid Shangore F1+BS for which it increased (2.50%).

In controlled atmosphere, for the unpacked lettuce, after 7 days of storage, the values increased for Shangore F1+BS and Tizian F1+KS and decreased for the other two variants. For the packed lettuce, no clear influence of the hybrid, storage duration or packing variant could be observed, the values for this parameter being somehow irregular.

The lettuce content in total dry matter (Table 6) recorded values between 4.17% and 5.11% at harvest and introduction to storage. After 7 days of storage, it was observed that the values increased to 6.53% for Shangore F1+BS, packed in food wrap + cardboard, and to 6.19% for Tizian F1+BS, unpacked. It was observed that for the unpacked lettuce, for the majority of the studied variants, the content in total dry matter was higher compared to the packed lettuce, for which the water loss through evapo-transpiration were lower. The lowest content in total dry matter was recorded for Shangore F1+BS, packed in food wrap, 3.38%, after 14 days of storage.

Table 4. Titrable acidity (% malic acid)

Storage conditions	Hybrid + fertilizer					
	Time of analysis (days)	Packing variant	Shangore F1+BS	Shangore F1+KS	Tizian F1+BS	Tizian F1+KS
	0		0.07	0.08	0.07	0.08
NA	7	N	0.11	0.1	0.11	0.1
		F	0.09	0.1	0.06	0.08
		F+C	0.09	0.09	0.08	0.08
	14	N	0.13	0.12	0.08	0.1
		F	0.1	0.08	0.11	0.09
		F+C	0.11	0.12	0.07	0.11
CA	7	N	0.1	0.08	0.07	0.07
		F	0.08	0.1	0.09	0.08
		F+C	0.09	0.08	0.08	0.09
	14	N	0.14	0.13	0.11	0.11
		F	0.09	0.1	0.08	0.1
		F+C	0.1	0.11	0.07	0.09

Table 5. Soluble dry matter content of the lettuce (%)

Storage conditions	Hybrid + fertilizer					
	Time of analysis (days)	Packing variant	Shangore F1+BS	Shangore F1+KS	Tizian F1+BS	Tizian F1+KS
	0		1.97	3.00	2.30	2.27
NA	7	N	2.43	2.23	2.63	2.90
		F	3.07	3.07	2.57	2.87
		F+C	3.10	3.27	3.20	2.83
	14	N	2.10	1.83	1.23	1.83
		F	1.63	1.67	2.00	1.67
		F+C	2.50	1.97	2.03	1.83
CA	7	N	2.47	2.70	1.40	2.37
		F	2.80	2.43	2.80	2.53
		F+C	2.27	2.45	2.53	2.67
	14	N	2.23	2.57	2.63	2.30
		F	2.13	2.50	1.83	1.43
		F+C	2.70	2.23	1.33	1.73

The weight loss of the salad, especially the packaged, kept at 4-12°C are very small, says Manzocco et al. (2017), but changes in color or microbial infections occur.

Analyzing the weight loss of the lettuce during storage (Table 7), it was noted that the highest loss was recorded for the unpacked lettuce, both for the storage in normal atmosphere and controlled atmosphere. The values of the weight loss for the unpacked lettuce stored within normal atmosphere was between 10.00% for Shangore F1+KS and 12.53% for Tizian F1+K-sol, and between 17.33% and 21.41% for the same hybrids, after 14 days of storage. In the case of unpacked storage within controlled atmosphere, after 7 days, the loss was between 7.96% for Shangore F1+Best starter and 9.99% for Tizian F1+K-sol, while after 14 days the loss had values between 14.63% and 21.94%, for the same hybrids. Smaller loss values (sub 0.7%) were recorded for the lettuce packed both in food wrap and food wrap + cardboard, for both storage conditions. Thus, after 7 days, for all studied variants, the weight loss was between 0.02% and 0.12%, while after 14 days it was between 0.04% and 0.64%. To reduce weight loss during storage, lettuce must be packed in order to maintain the water within the tissues.

Table 6. Total dry matter content (%)

Storage conditions	Hybrid + fertilizer					
	Time of analysis (days)	Packing variant	Shangore F1+BS	Shangore F1+KS	Tizian F1+BS	Tizian F1+KS
	0		5.11	5.06	4.17	5.11
NA	7	N	5.29	5.87	6.19	4.98
		F	4.02	4.47	4.40	4.72
		F+C	6.53	4.44	5.63	4.70
	14	N	4.41	4.51	4.15	3.60
		F	3.49	3.99	4.16	4.23
		F+C	3.96	4.04	4.15	4.05
CA	7	N	4.56	5.22	5.73	5.37
		F	4.71	4.28	4.73	4.81
		F+C	3.49	3.71	4.45	4.25
	14	N	4.00	5.16	5.30	5.07
		F	3.38	3.98	3.78	3.61
		F+C	3.61	3.67	3.83	3.84

Table 7. Lettuce weight loss during storage (g)

Storage conditions	Packing variant	Time of analysis (days)	Hybrid + fertilizer							
			Shangore F1+BS (g)	Losses (%)	Shangore F1+KS (g)	Losses (%)	Tizian F1+BS (g)	Losses (%)	Tizian F1+KS (g)	Losses (%)
NA	N	0	**327.88**	**0.00**	**351.15**	**0.00**	**317.64**	**0.00**	**354.39**	**0.00**
		7	294.95	10.04	316.05	10.00	283.94	10.61	310.00	12.53
		14	263.04	19.78	290.29	17.33	258.62	18.58	278.51	21.41
	F	0	**269.95**	**0.00**	**460.92**	**0.00**	**333.92**	**0.00**	**349.69**	**0.00**
		7	269.62	0.12	460.78	0.03	333.63	0.09	349.59	0.03
		14	268.92	0.38	459.92	0.19	331.50	0.64	348.99	0.20
	F+C	0	**331.04**	**0.00**	**434.53**	**0.00**	**292.35**	**0.00**	**348.14**	**0.00**
		7	330.90	0.04	434.44	0.02	292.28	0.02	347.86	0.08
		14	330.60	0.13	434.22	0.07	292.11	0.08	347.72	0.12
AC	N	0	**354.80**	**0.00**	**426.14**	**0.00**	**325.74**	**0.00**	**328.17**	**0.00**
		7	326.55	7.96	385.11	9.63	296.81	8.88	295.40	9.99
		14	302.90	14.63	354.12	16.90	261.45	19.74	256.17	21.94
	F	0	**341.43**	**0.00**	**433.68**	**0.00**	**255.88**	**0.00**	**429.50**	**0.00**
		7	341.33	0.03	433.57	0.03	255.79	0.04	428.21	0.30
		14	341.20	0.07	433.46	0.05	255.58	0.12	427.86	0.38
	F+C	0	**310.61**	**0.00**	**399.42**	**0.00**	**267.15**	**0.00**	**385.40**	**0.00**
		7	310.42	0.06	399.21	0.05	266.84	0.12	385.31	0.02
		14	310.33	0.09	399.03	0.10	266.76	0.15	385.23	0.04

CONCLUSIONS

As a result of the research conducted, it could be seen that in order to obtain vigorous plants and with a higher productive capacity both organic and chemical fertilizers can be used. The best results from this point of view were obtained by using the fertilizers Best starter and K-sol in the quantity recommended by the producer, for 3 of the studied hybrids, Shangore, Tizian and Analena, respectively. Packing the lettuce strongly reduced the weight loss during storage both within normal and controlled atmosphere, for 7 and 14 days, the loss being under 0.7%, which allows the storage of this species for 14 days with the studied atmosphere al conditions. For the unpacked lettuce, for both storage conditions, the weight loss was significantly larger, respectively 7.96 % after 7 days and 21.94 % after 14 days. Lettuce acidity increased slightly with the increase of the storage duration compared to the initial moment.

The level of vitamin C, within normal atmosphere, decreased significantly after 7 days, 58.00% for the unpacked lettuce, and 79.71% for the packed lettuce, respectively 20.25% for Tizian F1+BS and 92.8% for Shangore F1+KS, after 14 days. Within controlled atmosphere, the loss was more uniform and without large differences between the values after 7 days and after 14 days, but very large compared to the initial moment. This experiment showed that lettuce losses the greatest part of vitamin C during storage, regardless of the storage conditions and packing variants. The lettuce content in soluble dry matter and total dry matter recorded different values, without noticing a more significant influence of one of the factors.

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