Süleyman Demirel Üniversitesi
Fen Bilimleri Enstitüsü Dergisi
Cilt 22, Özel Sayı, 330-338, 2018

Süleyman Demirel University
Journal of Natural and Applied Sciences
Volume 22, Special Issue, 330-338, 2018

DOI: 10.19113/sdufbed.37514

Change in Some Nutritional Value of Potato Under Different Storage Conditions

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(Alınış / Received: 07.01.2018, Kabul / Accepted: 20.07.2018, Online Yayınlanma / Published Online: 06.09.2018)

Keywords
Potato,
Storage,
Starch,
Sucrose,
Reducing sugar,
Phenolic compound

Abstract: Potato (*Solanum tuberosum L.*) is a widely consumed food in the world.To ensure that potatoes produced the season are consumption throughout during the year, storing in a home environment it is preferred in Turkey.This leads to some nutrient losses in potatoes. Agria, which has been widely produced in Turkey for use in this study and which is preferred by producers due to its commercial value; Bettina that is resistant to bacteria, fungi, harmful potato viruses were preferred. These varieties were obtained in October 2014 through the 'Niğde Potato Research Station' from Niğde where the potatoes were extensively cultivated. The aim of our study is to examine some physical and chemical changes that occur in these varieties under different storage conditions. We stored cultivars of Agria and Bettina potatoes in four different household storage conditions (indirect sunlight, fluorescent light, dark rooms and dark refrigerators) for eight weeks. Samples were taken at the beginning and on the 2nd week, the 4th week and the 8th week to measure tuber weight, color (L*,a*,b*), protein, phenolic substance, starch, sucrose and reducing sugar levels. Especially in the Bettina variety stored in fluorescent light, the amount of reducing sugar increased from 0.02 mg/100g fw to 0.91 mg/100g fw. The amount of sucrose in the Bettina variety stored in the indirect sunlight rose from 0.13 mg/100g fw to 0.79 mg/100g fw.

Farklı Depolama Koşullarında Patatesteki Bazı Besin Değeri Değişimleri

Anahtar Kelimeler
Patates,
Depolama,
Nişasta,
Sakaroz,
İndirgen şeker,
Fenolik madde

Özet: Patates (*Solanum tuberosum L.*) dünyada yaygın olarak tüketilen bir gıdadır. Mevsiminde üretilen patateslerin yıl boyunca bulunabiliriğini sağlamak için Türkiye'de ev ortamında depolanması tercih edilmektedir. Bu durum bazı besin kayıplarına neden olmaktadır. Çalışmamızda kullanılmak için Türkiye'de çok yaygın bir şekilde üretimi yapılan ve ticari değeri nedeniyle üreticiler tarafından çok tercih edilen Agria; bakterilere, mantarlara, zararlılara karşı özelliklede patates virüslerine karşı dirençli olan Bettina patates çeşitleri tercih edildi. Bu çeşitler patatesin yoğun olarak yetiştirildiği Niğde'den 'Niğde Patates Araştırma İstasyonu' aracılığıyla 2014 yılı Ekim ayında hasattan bir hafta sonra temin edildi. Farklı depolama koşullarında bu çeşitlerde meydana gelen bazı fiziksel ve kimyasal değişimleri incelendi.Çalışmamızda, Agria ve Bettina patates çeşitleri, sekiz hafta boyunca dört farklı evsel depolama koşulunda (dolaylı güneş ışığı, floresan ışığı, karanlık odalar ve karanlık buzdolapları) muhafaza edildi. Yumrulardan başlangıçta, 2., 4., ve 8. haftalarda örnekler alındı. Bu örneklerde ağırlık değişimi, renk (L*,a*,b*), protein, fenolik madde, nişasta, sakaroz ve indirgen şeker seviyeleri ölçüldü. Özellikle floresan ışıkta depolanan Bettina çeşinde indirgen şeker miktarı 0.02 mg/100 g'dan 0.91 mg/100 g'a yükseldi. Dolaylı güneş ışığında depolanan Bettina çeşidinde sakaroz miktarı 0.13 mg/100 g'dan 0.79 mg/100 g'a yükseldi.

1. Introduction

Potato (*Solanum tuberosum L.*) is one of the most important food crop of the world with rice, wheat and corn because it is cheap and a good source of energy (starch) and has good quality protein content [1-4]. The annual consumption of potatoes per capita in the world is 34.17 kg [5]. The potato needs to be stored until it is consumed or processed. Storage of potatoes in inappropriate conditions can cause significant changes and loss of nutrient content [6,7] For example, sugar accumulation in the pathway is

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largely dependent on storage conditions and storage temperature. Sugar accumulation occurs at the fastest rate in cold weather conditions [8]. For this reason, the color is browned during frying of potatoes stored in cold weather conditions. On the other hand, higher storage temperatures will lead to further loss of quality and increased respiratory activity and hence lower shelf life [9]. For this reason, studies aiming to determine the extent of nutrient changes under different storage regimes are valuable to minimize the negative impact of storage on product quality. The purpose of this study is to reveal the change in nutrient content in potatoes stored in different storage regimes.

2. Material and Method

2.1. Material

Agria and Bettina potato varieties supplied from Niğde Potato Research Institute were used in the study. The tubers were provided one week later after harvest. Potato tubers were cleaned by washing and individually wiped with a rag. For each batch (80 units) medium sized (average weight 95 ± 7 g) tubers were selected. Subsequently, the tubers were stored indirect sunlight (21-22 ˚C, 335-1061 lux, 35-43% humidity), fluorescent light (22-23˚C, 300-1036 lux, 33-47% humidity), dark room (20-21 ˚C , 55-83% humidity) and in the dark refrigerator (4-6 ° C, 22-39% humidity) for 8 weeks.

The tubers stored in indirect sunlight were exposed to this condition for 10 h per 24 h period, while the other tubers were permanently exposed to the other three conditions. The potatoes were shelved in a row, they were not stacked on top of each other. The potato tubers stored in the light were turned daily to allow all directions to be exposed to light. Potato tubers that fresh and stored to different conditions weight loss, total dry matter, color, total phenolic compound, crude protein, starch, sucrose and reducing sugar analyzes were performed. Analyzes were carried out at the begining, on the 2nd week, the 4th week and the 8th week of storage. Two replicate runs were performed for each sample.

2.2. Method

Weight Change: Variations in the weight of Agria and Bettina varieties during their storage in different conditions were calculated by weighing each part individually.

Total Color Change: The color reproduction was carried out by peeling the shells of the potato tubers stored in fresh and different conditions very thinly. X-Rite ci62 color measurement spectrophotometer was used in determinations made at regular intervals. Total color change (TRD) was used as an informative model. TRD is calculated by the following formula [10].

$$\mathrm{TRD} = \sqrt{(L_0 - L)^2 + (a_0 - a)^2 + (b_0 - b)^2} \qquad (1)$$

L_0, a_0, b_0 = Reference values in fresh potato tubers

Total Phenolic Compound: 1 g of the sample was homogenized (11000 rpm) in 70% methanol. The homogenate was centrifuged at 4000 rpm. Phenolic compounds were then obtained by means of a rotary evaporator. 25 mL of methanol was added and filtered. A tube of the methanolic solution, distilled water, Folin Ciocalteu reagent and Na_2CO_3 were added and vortexed. It was kept in a water bath for 1 hour at 25 ° C. Later on the spectrophotometer was read at 765 nm. The results were determined using the gallic acid calibration curve [11].

Protein Determination: The Leco FP-528 instrument was used to determine the crude protein by Dumas incineration method. The calculated value was multiplied by 6.25 to calculate the % Raw Protein ratio [12].

Starch Determination: The peels of the tubers were peeled and grated. Samples were weighed 2.5 g. The sample and 50 ml of 1,128 N HCl were added to the balloon flask and allowed to stand in boiling water for 15 minutes. After 15 minutes, 30 ml of water was added and cooled. 5 ml of Carrez 1 and 5 ml of Carrez 2 solution were added in succession. Subsequently, 10 ml of purified water was added and the mixture in the flask was filled to 100 ml. It was then filtered. The filtrate, which was filled into the polarimeter tube, was read with Atago automatic AP-300 branded polarimeter [13].

Sucrose and Reducing Sugar Determination: Two-step extractions were performed in this analysis. 1 gr sample was weighed into a falcon tube and 9 ml, 70 ° C pure water, 0.5 ml Carrez 1, 0.5 ml Carrez 2 solution was added and it was mixed with a vortex. Mixture centrifuged at 6000 rpm for 7 min. 10 ml of water were added at 70°C on the remaining falcon tube from the first extraction. The mixture was vortexed for 3 minutes and centrifuged at 6000 rpm for 7 minutes. Both extracts were mixed with vortex and eppendorf tubes were taken and centrifugation was carried out at 10,000 rpm for 10 minutes. 20µL of the supernatant was injected into HPLC. SH-1011 (Shodex, 8 × 300 mm) was used as a separating column on HPLC, and a refractive index detector with a wavelength of 265 nm was used as a detector. 0.01 N H_2SO_4 was used as the mobile phase. The flow rate of the mobile phase was set at 0.7 ml/min [14].

Statistical analysis: Data were subjected to Analysis of Variance (ANOVA) with SPSS. Sources of variation were storage time (days), cultivar and storage type. Duncan test was used for binary comparison of experimental results.

3. Results

3.1. Weight change

The following fresh weights of the varieties of Agria and Bettina potatoes used in the study and the weight changes after they were subjected to different storage conditions are given in table 1. During eight weeks of storage, dramatic reductions in tuber weights were statistically significant ($P<0.01$).

The average weight loss of the Agria variety at the end of 8 weeks storage was 9.94%, while the average weight loss of the Bettina variety was 13.29% under the same storage conditions. The percentages weight change of the varieties is given in figures 1 and 2.

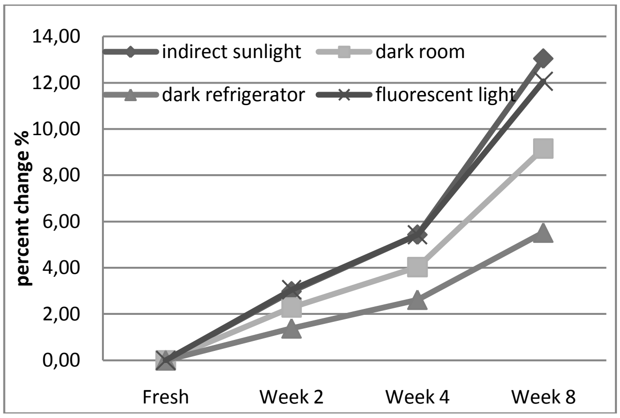

Figure 1. Percentage weight loss in the order of different storage conditions in the Agria variety

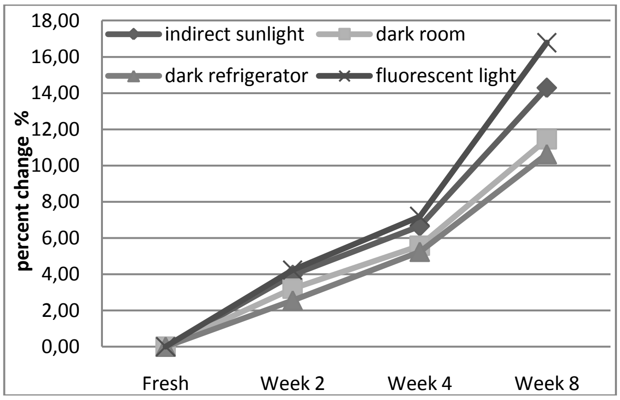

Figure 2. Percentage weight loss in the order of different storage conditions in the Bettina variety

3.2. Total color change

(L *) values ranged from 71.30 to 67.58 in the Agria, and 72.31 to 56.38 in the Bettina.

At the end of storage, the storage (L *) values of Agria decreased by 3.74% in indirect sunlight, 1.99% in darkroom, 1.89% in dark refrigerator and 5.21% in fluorescent light. Bettina (L *) values decreased by 14.92% in indirect sunlight, 5.66% in darkroom, 3.97% in dark refrigerator and 22.03% in fluorescent light. (a *) values ranged from 2.12 to (-1,64) in the Agria variety and from 0.02 to (-9.28) in the Bettina variety. (b *) values ranged from 39.79 to 44.37 in the Agria variety and from 38.20 to 44.39 in the Bettina variety.

As can be seen from Table 2, the highest total color change (TCC) value in the Agria variety was calculated to be 5.33 in the case of stored in indirect sunlight, while the highest TCC value in the Bettina variety was calculated to be 18.38 in the stored fluorescent light.

In Table 3 can see the interplay of the time * storage regime on TRD values. As can be seen from Table 3, time progressed in the darkroom and in the stored tubers in the dark refrigerator conditions, significant changes were observed and group differences emerged. However, there were no group differences in the tubers stored under indirect sunlight and fluorescent light.

3.3. Total phenolic compound

The total phenolic compound values of fresh Agria and Bettina potato varieties and the subsequent total phenolic compound values after subjecting to different storage conditions are shown in Table 4. When the total amount of phenolic compound in week 2 decreased in all conditions, partial decreases and increases were observed in the 4th week of storage. But at the end of the 8th week, the total amount of phenolic compound in all varieties and conditions increased.

In Table 5 can see the interplay of the time * storage regime on total phenolic compounds.

As can be seen from Table 5, significant changes were observed in the total phenolic compounds of the tubers stored in indirect sunlight and fluorescent light, and group differences emerged.

3.4. Protein content

The level of change, during the period of storage, of the levels of protein of Agria and Bettina stored in different storage conditions are given in Table 6. In Table 7, can see the interplay of the time * storage regime on total protein content.

As seen in Table 6, both types of crude protein fractions showed a decrease in the second week compared to fresh in all other storage conditions except storage in the dark refrigerator condition. A rising trend is observed in the following weeks. At the end of 8th week of Bettina variety, crude protein fractions are higher than fresh material but lower in Agria variety.

At the end of storage, the increase in the percentage of crude protein of Bettina variety was 15.13% on average in all storage conditions; The decrease in the percentage of crude protein of the Agria variety is 25.09% on average in all storage conditions. As can see table 7, Changes in protein percentage values of indirect sunlight and fluorescent light stored tubers were observed and group differences appeared.

3.5. Starch, Sucrose and Reducing Sugar Content

The level of change, during the period of storage, of the levels of starch, reducing sugar, and sucrose of Agria and Bettina stored in different storage conditions are given in Table 8, 10, 12. In Table 9, 11, 13 can see the interplay of the time * storage regime respectively on reducing sugar, and sucrose. As can be seen from Table 8, the highest starch increase in the potatoes is observed in stored tubers at room temperatures.

Table 1. Changes in weight that occur in the tubers in different storage regimes

Storage Regimes	Agria				Bettina			
	Fresh	2ndweek	4nd week	8nd week	Fresh	2nd week	4nd week	8nd week
Indirect Sunlight	736 g	714 g	696 g	640 g	706 g	678 g	659 g	605 g
Dark Room	743 g	726 g	713 g	675 g	716 g	693 g	676 g	634 g
Dark Refrigerator	724 g	714 g	705 g	684 g	705 g	687 g	668 g	630 g
Fluorescent Light	754 g	731 g	713 g	663 g	709 g	679 g	658 g	590 g

Table 2. Changes in total color of tubers in different storage regimes

Storage Regimes	Agria				Bettina			
	Fresh	2nd week	4nd week	8nd week	Fresh	2nd week	4nd week	8nd week
Indirect Sunlight	0.00	4.63	4.27	5.33	0.00	6.49	12.77	15.38
Dark Room	0.00	1.05	2.07	3.15	0.00	1.65	2.38	5.27
Dark Refrigerator	0.00	1.75	1.91	4.78	0.00	3.13	4.02	6.13
Fluorescent Light	0.00	3.94	5.37	5.22	0.00	10.40	9.92	18.38

Table 3. Total color change in storage time x storage regime variation

Storage TimexRegimes	Fresh	2ndweek	4ndweek	8ndweek	Anova
Indirect Sunlight	0,0000a	5,5600a	8,5200a	10,3550a	p>0,05
Dark Room	0,0000a	1,3500a	2,2250ab	4,2100b	p<0,05
Dark Refrigerator	0,0000a	2,4400ab	2,9650bc	5,4550c	p<0,05
Fluorescent Light	0,0000a	7,1700a	7,6450a	11,8000a	p>0,05

According to the letters, Duncan multiple comparison tests shows the difference between the periods for the same storage conditions (p <0.05).

Table 4. Changes in total phenolic compound in tubers for different storage regimes (mg/kg)

Storage Regimes	Agria				Bettina			
	Fresh	2nd week	4nd week	8nd week	Fresh	2nd week	4nd week	8nd week
Indirect Sunlight	390.25	377.27	299.84	562.82	461.02	425.75	301.01	628.60
Dark Room	390.25	307.94	394.32	403.86	461.02	451.39	590.97	596.50
Dark Refrigerator	390.25	331.23	402.82	446.40	461.02	258.23	570.44	582.68
Fluorescent Light	390.25	265.71	346.01	696.15	461.02	424.99	522.82	817.36

Table 5. Total phenolic compound change in storage time x storage regime variation

Storage TimexRegimes	Fresh	2ndweek	4ndweek	8ndweek	Anova
Indirect Sunlight	425,6350b	401,5100ab	300,4250a	595,7100c	p<0,01
Dark Room	425,6350a	379,6650a	492,6450a	500,1800a	p>0,05
Dark Refrigerator	425,6350a	294,7300a	486,6300a	514,5400a	p>0,05
Fluorescent Light	425,6350a	345,3500a	434,4150a	756,7550b	p<0,05

According to the letters, Duncan multiple comparison tests shows the difference between the periods for the same storage conditions (p <0.05).

Table 6. Changes in protein (Nx6.25) in tubers for different storage regimes, (%)

Storage Regimes	Agria				Bettina			
	Fresh	2nd week	4nd week	8nd week	Fresh	2nd week	4nd week	8nd week
Indirect Sunlight	3.03	1.64	2.03	2.27	2.28	1.22	2.32	2.59
Dark Room	3.03	1.55	1.69	2.16	2.28	2.03	2.20	2.53
Dark Refrigerator	3.03	2.06	2.01	2.10	2.28	2.51	2.32	2.44
Fluorescent Light	3.03	1.27	2.31	2.55	2.28	1.40	2.12	2.94

Table 7. Total protein change in storage time x storage regime variation

Storage TimexRegimes	Fresh	2ndweek	4ndweek	8ndweek	Anova
Indirect Sunlight	2,6550a	1,4300b	2,1750ab	2,4300a	p>0,05
Dark Room	2,6550a	1,7900a	1,9450a	2,3450a	p>0,05
Dark Refrigerator	2,6550a	2,2850a	2,1650a	2,2700a	p>0,05
Fluorescent Light	2,6550b	1,3350a	2,2150b	2,7450b	p<0,05

According to the letters, Duncan multiple comparison tests shows the difference between the periods for the same storage conditions (p <0.05).

This is because thought to be due to moisture loss. The highest starch increase for the Bettina was observed stored under fluorescent light, while the highest starch increase for the Agria was observed tubers in stored under indirect sunlight. The lowest starch increase for both varieties was observed in refrigerated stores. As can see Table 9, Starch percent values of tubers stored in indirect sunlight and fluorescent light were significant changes were observed and group differences emerged. Fructose, glucose, galactose and maltose changes in the storage order of the Agria and Bettina potato varieties are given in table 14-15.

Table 8. Changes in starch in tubers for different storage regimes(n=16), (%)

Storage Regimes	Agria				Bettina			
	Fresh	2^{nd} week	4^{nd} week	8^{nd} week	Fresh	2^{nd} week	4^{nd} week	8^{nd} week
Indirect Sunlight	13.81	15.35	17.91	17.09	15.45	16.63	18.21	18.11
Dark Room	13.81	15.04	14.87	16.17	15.45	15.55	18.11	17.40
Dark Refrigerator	13.81	14.43	16.88	13.92	15.45	16.17	15.96	16.60
Fluorescent Light	13.81	18.11	16.68	16.58	15.45	19.65	18.89	18.27

Table 9. Starch change in storage time x storage regime variation

Storage TimexRegimes	Fresh	2^{nd}week	4^{nd}week	8^{nd}week	Anova
Indirect Sunlight	14,6300a	15,9900ab	18,0600b	17,6000b	p<0,05
Dark Room	14,6300a	15,2950a	16,4900a	16,7850a	p>0,05
Dark Refrigerator	14,6300a	15,3000a	16,4200a	15,2600a	p>0,05
Fluorescent Light	14,6300a	18,8800b	17,7850ab	17,4250ab	p>0,05

According to the letters, Duncan multiple comparison tests shows the difference between the periods for the same storage conditions (p <0.05).

Table 10. Changes in reducing sugar in tubers for different storage regimes (%)

Storage Regimes	Agria				Bettina			
	Fresh	2^{nd} week	4^{nd} week	8^{nd} week	Fresh	2^{nd} week	4^{nd} week	8^{nd} week
Indirect Sunlight	0.20	0.18	0.41	0.22	0.02	0.19	0.16	0.27
Dark Room	0.20	0.22	0.18	0.32	0.02	0.41	0.27	0.54
Dark Refrigerator	0.20	0.16	0.23	0.28	0.02	0.72	0.25	0.79
Fluorescent Light	0.20	0.11	0.13	0.26	0.02	0.4	0.2	0.91

Table 11. Reducing sugar change in storage time x storage regime variation

Storage TimexRegimes	Fresh	2^{nd}week	4^{nd}week	8^{nd}week	Anova
Indirect Sunlight	0,1100a	0,1850a	0,2850a	0,2450a	p>0,05
Dark Room	0,1100a	0,3150a	0,2250a	0,4300a	p>0,05
Dark Refrigerator	0,1100a	0,4400a	0,2400a	0,5350a	p>0,05
Fluorescent Light	0,1100a	0,2550a	0,1650a	0,5850a	p>0,05

According to the letters, Duncan multiple comparison tests shows the difference between the periods for the same storage conditions (p <0.05).

Table 12. Changes in sucrose in tubers for different storage regimes(n=16), (%)

Storage Regimes	Agria				Bettina			
	Fresh	2^{nd} week	4^{nd} week	8^{nd} week	Fresh	2^{nd} week	4^{nd} week	8^{nd} week
Indirect Sunlight	0.25	0.28	0.18	0.45	0.13	0.27	0.2	0.79
Dark Room	0.25	0.25	0.41	0.01	0.13	0.29	0.36	0.23
Dark Refrigerator	0.25	0.37	0.16	0.61	0,13	0.86	0.32	0.71
Fluorescent Light	0.25	0.26	0.12	0.10	0.13	0.41	0.84	0.69

Table 13. Sucrose change in storage time x storage regime variation

Storage TimexRegimes	Fresh	2^{nd}week	4^{nd}week	8^{nd}week	Anova
Indirect Sunlight	0,1900a	0,2750ab	0,1900a	0,6200b	p>0,05
Dark Room	0,1900ab	0,2700ab	0,3850b	0,1200a	p>0,05
Dark Refrigerator	0,1900a	0,6150a	0,2400a	0,6600a	p>0,05
Fluorescent Light	0,1900a	0,3350a	0,4800a	0,3950a	p>0,05

According to the letters, Duncan multiple comparison tests shows the difference between the periods for the same storage conditions (p <0.05).

Table 14. Fructose, glucose, galactose and maltose levels (mg/100 g FW) in the Agria cultivar under different storage conditions

AGRİA	Indirect Sunlight				Fluorescent Light				Dark Room				Dark Refrigerator			
	Fresh	Week 2	Week 4	Week 8	Fresh	Week 2	Week 4	Week 8	Fresh	Week 2	Week 4	Week 8	Fresh	Week 2	Week 4	Week 8
Fructose	0,10	0,08	0,09	0,02	0,10	0,00	0,03	0,03	0,10	0,11	0,05	0,05	0,10	0,00	0,06	0,05
Glucose	0,10	0,10	0,26	0,05	0,10	0,11	0,06	0,06	0,10	0,11	0,06	0,11	0,10	0,16	0,09	0,08
Galactose	0,00	0,00	0,02	0,10	0,00	0,00	0,00	0,12	0,00	0,00	0,03	0,12	0,00	0,00	0,02	0,11
Maltose	0,00	0,00	0,04	0,05	0,00	0,00	0,04	0,05	0,00	0,00	0,04	0,04	0,00	0,00	0,06	0,04

Table 15. Fructose, glucose, galactose and maltose levels (mg/100 g FW) in the Bettina cultivar under different storage conditions

BETTİNA	Indirect Sunlight				Fluorescent Light				Dark Room				Dark Refrigerator			
	Fresh	Week 2	Week 4	Week 8	Fresh	Week 2	Week 4	Week 8	Fresh	Week 2	Week 4	Week 8	Fresh	Week 2	Week 4	Week 8
Fructose	0,02	0,19	0,04	0,06	0,02	0,18	0,10	0,39	0,02	0,21	0,10	0,22	0,02	0,32	0,13	0,37
Glucose	0,00	0,00	0,08	0,10	0,00	0,22	0,06	0,39	0,00	0,20	0,12	0,22	0,00	0,40	0,09	0,35
Galactose	0,00	0,00	0,00	0,07	0,00	0,00	0,00	0,10	0,00	0,00	0,00	0,10	0,00	0,00	0,00	0,07
Maltose	0,00	0,00	0,04	0,04	0,00	0,00	0,04	0,03	0,00	0,00	0,05	0,00	0,00	0,00	0,03	0,00

At the end of storage, the highest increase in reducing sugar observed in Agria tubers was observed in dark room conditions. It was followed by the tubers stored in the dark refrigerator conditions. The highest reducing sugar increase seen in the Bettina variety was observed in the tubers stored in fluorescent light. Again, it was followed by the tubers stored in the dark refrigerator conditions. At the end of storage, the amounts of sucrose in Agria tubers increased during storage in indirect sunlight and dark refrigerator conditions, while fluorescent light and dark room conditions decreased during storage. The maximum increase in sucrose at the end of storage for the Agria varieties was observed in the refrigerator stored tubers, with the greatest decrease being observed in dark room conditions. At the end of storage, the amount of sucrose in Bettina tubers increased in all storage conditions. The increase in the highest amount of sucrose at the end of storage is seen in the tubers stored under indirect sunlight, followed by the increase in dark refrigerator conditions. The smallest increase in the amount of sucrose was observed in the tubers stored in dark room conditions.

4. Discussion and Conclusion

Tubers stored in light environments lose more weight than those stored in the dark. For this reason, it is thought that the light is the end result of increasing the germination on the soft. In addition, the percentage of loss of weight in the tubers of both types stored in the dark refrigerator conditions is lower than that of the tubers stored in room conditions. This is due to the lowering of the respiratory rate of the ovules at low temperatures. Nourian et al. [15] have shown that respiratory rate is lower at the refrigerator temperature of 4 ° C, while respiratory rate increases as the temperature increases. Afek et al. [16] reported weight loss in stored potatoes as 2%, 7%, and 12%, respectively. Kara [17] stored 20 potato varieties at 4-10 ° C at 70-80 % relative humidity conditions. Weight loss of varieties varied from 5.78% to 13.49%.

Especially in the case of stored tubers under the light, there was a further decrease compared to those stored in other conditions. Nourian et al. [9] report that the values (L *) in potatoes stored at different temperatures decrease with time compared to the initial values and that the decrease rate in the value of (L *) is higher as the temperature increases. Nourian et al. [15] report that as time passes (L *) values decrease in cooked potatoes, there is a further decrease in storage at higher temperatures. Grace et al. [18] investigated the effect of storage on sweet potato varieties; found that the amount of β-carotene in some varieties increased during storage. Lachman et al. [19] have shown that the amount of anthocyanin increases with storage in some potato varieties. The increase of anthocyanin may increase the (a *) value. Edwards [20] examined some change parameters by storing potato tubers for 8 days under 12 μmol photons at different temperatures. The chlorophyll/carotene ratio, one of these parameters, increased at different temperatures (5 ° C, 10 ° C, 20 ° C, 25 ° C) due to the increase in chlorophyll content between the 2nd and 5th day of all the stored tubers. However, a further increase was observed between 5th and 8th days in the tubers stored at 10 ° C, whereas a decrease was observed in the tubers stored at 5 ° C. . In fresh samples at the beginning and at the end of the 8th week stored in all storage conditions, (b *) values were higher in the Agria variety than in the Bettina variety. Knutsen et al. [21] Saturna and Peik potato varieties were stored at 4 and 8 ° C. They found that the average (b *) values in the Peik variety decreased at both 4°C and 8°C at the end of 6 and 27-week storage. However, at both storage temperatures in the Saturna variety, average (b *) values increased in the first 6 weeks and decreased at the end of 27 weeks. Nourian et al. [9] showed that TCC value was correlated with storage temperature and TCC is high in potatoes stored at high temperatures. But the TCC values of both species at 4 ° C stored in the dark were higher than at 20 ° C stored in the dark. It is believed that this is caused by the increase in the amount of reducing sugar that causes browning at low temperatures. In Table 3 can see the interplay of the time * storage regime on TRD values.

While the average total phenolic compound increase in the Agria variety is 35.12%, the average total phenolic compound increase in the Bettina variety is 42.35%. The highest total phenolic compound increase in the Agria variety was observed in the stored tubers under fluorescent light, while the lowest total phenolic compound increase was observed in the stored tubers in dark room conditions. While the highest total phenolic compound increase in Bettina was observed in the tubers stored under fluorescent light, the lowest total phenolic compound increase was observed in the tubers stored in dark refrigerator conditions.Mehta et al. [22] examined total phenolic compounds changes in potato varieties that they stored for 90 days under four different conditions. The average amount of total phenolic compounds in the first day of the varieties was 41.4 mg / 100g. The average total phenolic compound of varieties during the 90th day was reported 62.3 mg / 100g at 2-4 ° C; 51,4 mg/100g at 10-12 °C; 67.6 mg/100g at heap conditions (17-31 ° C - 54-91% relative humidity); 64.4 mg/100g at bit conditions (17-27 ° C - 67-95% relative humidity). Al-Weshahy et al. [23] Penta and Marcy stored potato varieties at different temperatures for 8 weeks. During the 2nd and 4th weeks of storage, the total amount of phenolic compound decreased in the potato peel while it increased at the 8th week.

The increase in the percentage of total dry matter resulting from dehydration in the tubers is thought to be one of the reasons for protein increase after 2 weeks in all storage conditions. The increase in the percentage of protein in Bettina variety tubers stored in the refrigerator was lower than those stored in the room conditions. In the Agria variety, the biggest drop was in the tubers stored in refrigerator conditions. This shows that as the temperature increases, the percentage of crude protein increases due to loss of moisture. In the Agria variety, there was a decrease in protein with the storage period, while in the Bettina variety, the protein increase was observed. In the light of the data, while the Agria variety seemed more suitable for domestic consumption, it was determined that Bettina variety is industrial potato type. Şengül [24] investigated changes in the protein level by storing the potato varieties of Marfona and Granola for six months. During the storage period, Marfona's 0.20 – 3.72%; it has been found that Granola contains between 0.26 and 2.00% crude protein. It was observed that the percentage of crude protein increased during storage.

The lowest starch increase for both varieties was observed in refrigerated stores. This is due to the loss of moisture and the formation of shoots. Hydrolysis and degradation are seen in the starch molecule when potato tuber form shoots. This degradation of starch provides energy for growth and development of the shoot. Therefore, it is expected that the amount of starch will decrease especially in intense light and at high temperatures, because of increase shoot formation. However, the loss of water resulting from sweating in the tubers causes an increase in the percentage of starch [25]. Murniece et al. [26] have stored for 6 months at the temperature at 5-8 ° C of 80 ± 5 % RH of the varieties of Zile, Brasla, Madara, Lenora and Imanta potatoes. The amounts of starch determined freshly and after storage in g / 100 g are as follows: Zile 14.36-18.72; Brasla 17.09-18.72; Madara 13.20-15.69; Lenora 12.84-14.83; Imanta 17.24-17.79. Kaaber et al. Kaaber et al. [27] reported the exchange of starch by storing potato tubers at two different temperatures. Potato tubers stored at 4 ° C for 25 weeks, the percentage of starch in dry weight decreased from 72.05 to 68.82. Potato tubers stored at 8 ° C for 25 weeks, the percentage of starch in dry weight increased from 72.20 to 72.30. Copp et al. [28] examined changes in starch and sugar content in Snowden, Novachip, and Norwis potato varieties that they stored in the dark at 12 ° C with 95% relative humidity. They have reported that the starch content increases as a result of slight water loss in the potato tubers, but did not result in a direct correlation between the sugar content and the starch content.

The increase in the highest amount of sucrose at the end of storage is seen in the tubers stored under indirect sunlight, followed by the increase in dark refrigerator conditions. The smallest increase in the amount of sucrose was observed in the tubers stored in dark room conditions. Murniece et al. [26], the amount of reducing sugars increased in 3 of 5 different potato varieties they had stored for 6 months, while the amount of reducing sugars in the Brasla variety decreased. Zile variety has not changed. However, at the end of storage, the amount of sucrose was reduced in all varieties. On the whole of the same varieties harvested in the next period, both sucrose and reducing sugar increased with storage. Şengül et al. [29] have shown that the amount of sucrose and reducing sugars increased in all the tubers stored under different storage conditions, while the amount of sucrose decreased in the tubers stored only in the dark refrigerator.

Potatoes are widely consumed in the world. They must be stored for consumption in winter months. Unconscious storage made on domestic conditions adversely affects the nutritional value of the potatoes. Potatoes should not be stored at room temperature and under direct light. Otherwise, the nutritional value may decrease due to the formation of shoots. Cool environments should be preferred for storage of potatoes. However, very low temperatures can cause the conversion of starch to reducing sugar. The storage temperature should not fall below 4 ° C in order not to increase the amount of reducing sugar. Because reducing sugar formation leads to Maillard reaction, it causes undesirable colors and quality loss in the process.

Acknowledgment

This paper is a part of Cemal KASNAK's Ph.D. thesis. We thank TUBITAK Scientific Support Department for 2211-PhD Scholarship program financial support.

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