Selcuk Journal of Agriculture and Food Sciences

http://sjafs.selcuk.edu.tr/sjafs/index

Research Article

SJAFS

(2022) 36 (2), 187-196

e-ISSN: 2458-8377

DOI:10.15316/SJAFS.2022.024

Evaluation of Physical and Quality Traits of Local Potato Breeding Lines During Long Term Storage

Nursel ÇÖL KESKİN[1,*], Rahim ADA[1]

[1]Selcuk University, Faculty of Agriculture, Department of Field Crops, Konya, Türkiye

ARTICLE INFO

Article history:
Received date: 25.05.2022
Accepted date: 06.06.2022

Keywords:
Dry matter
Potato line
Selection
Solanum tuberosum L.
Storage

ABSTRACT

This study aimed to determine the potato breeding lines that show superior storage traits and can be candidate variety by selection. The storage study was carried out in the first year according to The Randomized Plots Trial Design and the second year according to The Randomized Plots in Factorial Trial Design with four replications. In the study, 20 potato breeding lines developed by Selcuk University, Faculty of Agriculture, Department of Field Crops and 18 registered varieties as plant material were used in the first year. In the second year, the study continued with 7 breeding lines and 8 registered varieties that selected in the first year. The varieties and lines were done harvest in the fields and then the genotypes were evaluated according to physical and quality traits with storage trials (+ 4 °C, 6 months). In the study; ratio of dry matter (%), yield of leaf chips (%), yield of French fries (%), quality of leaf chips (1-5 scale), quality of French fries (0-4 scale), blackening (1-5 scale), storage weight loss (%), the first shoot formation time (day) parameters were examined. The ratio of dry matter, yield of leaf chips, and French fries values increased compared to the pre-storage period. Among the promising lines in terms of dry matter ratio changes; T7LA8 (20.9 %-24.8 % in 2019,19.0 %-21.1 % in 2020 according to the genotype average values), PAG5 (22.6 %-20.5 % in 2019, 20.0 %-19.0 % in 2020 according to the genotype average values), GAF4 (18.7 %-21.6 % in 2019, 18.4 %-20.7 % in 2020 according to the genotype average values) can be counted. As a result of the study, T7LA8, PAG5 and GAF4 lines with high ratio of dry matter, yields of chips and French fries were determined as promising lines.

1. Introduction

The potato consumption market is divided into seven main groups. These are fresh consumption, frozen potato products, potatoes for chips and French fries, dried potatoes, starch, seeds and other industrial groups. Since it is so essential in human nutrition, the development of potato varieties with high field performance, resistance to disease, pests and storage is gradually increasing (Bond, 2014).

Potato breeding objectives can be summarized as yield, tuber quality, resistance to biotic and abiotic environmental restrictions. As for the quality parameters, they can be restricted into two categories. The first is the visible features of the tuber (size, shell color, tuber length, shape and depth of the eye). This group targets consumer desires, in other words, fresh consumption. The second category is the internal properties of the tuber (nutritional content, cooking, processing properties). They are closely related to the content of dry matter, taste, sugar, protein content, starch quality and the amount of glycoalcoholoids (Carputo and Frusciante, 2011).

The selection criteria continue after the field in potato breeding. Because potato tubers contain a high percentage of water, they should be stored in healthy storage conditions. The main factor restricting the processing capacities of potato tubers is the rate of sugar accumulation, which decreases during storage. The durability of storage is one of the most critical breeding objectives for the healthy continuation of the breeding program (Hoopes and Plaisted, 1987; Richardson et al, 1990).

The quality and storage time of potatoes are reduced by moisture loss, decay and physiological deterioration of the tuber. These losses are related to the storage temperature, relative humidity, ventilation and gas compo-

* Corresponding author email: *nurselcol@selcuk.edu.tr*; It is the summary of a part of Nursel Çöl Keskin's Doctorate Thesis

sition. Since potatoes are living organism, it needs an effective storage system. Potatoes are stored in modern storage structures, cellars, storerooms, earthen silos, and storages made of volcanic rocks (Ozturk, 2010; Sanli, 2012).

After harvesting, the tubers remain in their dormant natural state for 1-15 weeks (Wiltshire and Cobb, 1996). Potato tubers should be placed in storage with an equal distribution of piles after harvesting with the conditions of air circulation is provided, the temperature is maintained at a 15 ° C and relative humidity is between 90-95 % provided. Then, the storage temperature should be kept at 10-12 °C for two weeks to ensure the healing and hardening of the tuber shells (curing period). After this period, the storage temperature should be determined according to the intended use of the tubers (Shetty, 2010).

One month after harvesting, the increased elevated storage temperatures should be reduced to a minimum of 5-6 ° C. Lowering it to temperatures below this temperature increases the respiratory rate of tubers. The high increase in respiratory rate is due to the breaking of dormancy and the extension of exiles. While the formed exiles give off heat to the outside, the sproutings are increasing. As a result, the storage system is negatively affected and this situation sets the stage for product losses (Pringle et al., 2009). Storage weight losses amount to about 10% of the total weight loss over a storage period of 6-8 months (Wustman and Struik, 2007).

Storage requirements vary depending on the purpose of consumption of tubers. Tubers to be used for seed purposes should be stored in storage to give exiles sufficient give exiles with sufficient height and characteristics without losing their exile capabilities in the time until the next planting season. Potatoes that will be consumed as food in the coming times should also be stored in storages that will prevent the development of exiles from preventing spoilage, softening, and some other undesirable conditions. Moreover, the tubers in the industry should be stored in storage that will ensure the preservation of the starch-sugar ratio associated with technological quality (Sanli, 2012).

This study aimed to evaluate the storage performance of some trade registered potato varieties and promising variety lines selected as 5th field generation in the breeding program by Associate Professor Rahim Ada and determine the lines that can be variety candidates by making an intended selection.

2. Materials and Methods

In the first year of study, 20 promising potato lines developed by Associate Professor Rahim ADA and 18 standard potato varieties were used. In the second year, the performances of 7 promising potato lines and 8 standard potato varieties that were selected from the first year were evaluated in storage parameters. The breeding lines were selected as crossbreed seeds that were developed to 5th field generation by selection. The information about these lines and varieties were shown in the Table 1.

In the storage procedure, all genotypes produced and harvested in Konya for the first year and both in Konya and Karaman-Akçaşehir locations for the second year at 2019-2020 vegetation periods. Field studies were conducted at Selcuk University Faculty of Agriculture Abdulkadir Akcin Trial Field in Konya, and Karaman-Akcasehir farmer field. Exactly 5 kg per each was taken from the potato tubers harvested as starting material and they were put into a store at which temperature + 4 °C and store humidity at 90-98 %. Total storage period was 6 months. At the end of the storage periods, 30 tubers were randomly selected from all genotypes and the physical and chemical properties of tubers were determined.

The storage study was carried out in the first year according to the 'The Randomized Plots Trial Design' and the second year according to 'The Randomized Plots in Factorial Trial Design' with four replications. In the study; ratio of dry matter (%), yield of leaf chips (%), yield of French fries (%), quality of leaf chips (1-5 scale), quality of french fries (0-4 scale), blackening (1-5 scale), storage weight loss (%), the first shoot formation time (day) parameters were examined. The parameters of the varieties and lines examined in the storage conditions were determined before and after the storage.

The data were analyzed using technique of analysis of variance (JUMP) and treatment means were separated by Least Significant Differences (LSD) at 1 % probability level by using MSTAT-C as described by Nissen (1989).

Below methods were used for analyses of tuber samples taken from potato genotypes.

-Ratio of dry matter (%): The tuber samples belonging to the genotypes were first washed before and after storage, then dried and sliced. 100 g sample was taken from each and dried under the laboratory conditions. Then 24 hours in the drying chamber set up to 105 °C, reweighted and dry matter ratios were calculated by proportioning their fresh weights (Kacar, 1972). The data obtained were recorded as pre-storage and post-storage separately.

-Yield of leaf chips (%): After the potato tubers were washed and sliced with chips slicer (at the thickness of 1.0-1.5 mm), 100 g per each was weighted, washed in cold water and dewatered between two towels. Then the slices at the weight of 100 g were fried at 190 °C for 2 minutes and after cooling, all the samples were weighted and their values were calculated before and after storage as percentage of fresh weight (Senol, 1973). Obtained values were recorded as pre-storage and post-storage separately.

-Yield of French fries (%): After the potato tubers were washed and sliced with chips slicer (at the thickness of 1.0 cm), 100 g per each was weighted, washed in cold water and dewatered between two towels. Then the slices at the weight of 100 g were fried at 190 °C for

3 minutes and after cooling, the all samples were weighted and their values were calculated before and after storage as a percentage of fresh weight (Ross ve Porter, 1969). Obtained values were recorded as pre-storage and post-storage separately.

- Quality of leaf chips (1-5 scale): The samples used for chips yield were recorded according to grouping as pre-storage and post-storage separately (1 = No chips, 2 = Risky, 3 = Medium, 4 = Good, 5 = Very good) (Anonymous, 2001).

-Quality of french fries (0-4 scale): The samples used for French-fries yield were recorded according to grouping as pre-storage and post-storage seperately (0 = Very good, 1 = Good, 2 = Fair – good, 3 = Medium (max 30%), 4 = Low (max 10%)) (Anonymous, 2001).

-Blackening (1-5 scale): 5 tubers taken randomly from each plot were washed, divided into 3 lengthwise and after waiting for 30 minutes, evaluation was made according to the grouping as pre-storage and post-storage seperately (1 = V-shaped darkening, 2 = Significant darkening, 3 = Slight darkening, 4 = Local darkening, 5 = No darkening) (Anonymous, 2001).

-Storage weight loss (%): 5 kg of available tubers of all varieties and breeding lines were weighed and stored. These stored tubers were weighed again at the beginning and after the storage (6 months), and the difference was expressed as weight loss in % by proportioning to the first weighing (Ozturk et al., 2016).

-The first shoot formation time (day): The first shoot formation time of 5 kg tubers of each variety and breeding line used to determine storage weight change was checked at 15-day intervals and recorded per day.

Table 1
Information on potato varieties and breeding lines used in the study

Varieties	Usage	Varieties	Usage	Lines	Usage	Lines	Usage
VR 808	Chips	Marabel	Cooking	AFAG-C	Chips	ELAF-10	Cooking
Brooke	Chips	Agata	Cooking	HEAF-5	Chips	ELAF-11	Cooking
Doruk	Chips	Madeleine	Cooking	T7LA-8	French fry	T3AG-14	Cooking
Russet Burbank (R.B.)	French fry	Melody	Cooking	PA-9	French fry	T1AG-14	Cooking
Lady Olimpia (L.O.)	French fry	Zirve	Cooking	AFLA-9	French fry	T2AG-13	Cooking
Innovator	French fry	Çağlı	Cooking	AFLA-20	French fry	T3PO-13	Cooking
Kutup	French fry	Leventbey	Cooking	AFHE-11	French fry	T3LA-8	Cooking
Agria	Cooking-Chips	Muratbey	Cooking	MK-2	Cooking	PAG-5	Cooking
Jelly	Cooking-Chips			AFK-3	Cooking	AFBR-4	Cooking
Challenger	Cooking-Chips			GAF-4	Cooking	AFAG-12	Cooking

3. Results and Discussion

The variance sources and their statistical significance are shown in Table 2 and 3 for the physical and quality traits. Data of variance analysis in Table 2 showed that the effect of the genotypes on all parameters, both pre-storage and post-storage were statistically significant at 1 % probability level. Data of variance analysis in Table 3 showed that locations, genotypes, and location x genotype interactions on all both pre-storage and post-storage parameters were statistically significant at 1 % probability level.

According to ratio of dry matter from storage tubers in the first year, while average pre-storage ratio of dry matter was 18.8 %, this rate was recorded as 19.5 % after storage and increased. When ratios of dry matter before storage were examined; T3PO13 with 22.8 %, PAG5 with 22.6 % and VR808 with 22.5 % were recorded as the highest values and were in the group (a). The lowest ratio of dry matter of 13.9 % was determined in Agata variety and classified in (r) group. The highest ratio of dry matter after storage; It was determined in the T7LA8 line with 24.8 % and with this value it was included in group (a). The lowest ratio of dry matter was determined from the AFRR4 line with 16.1 % and formed the (u) group. Storage changes; Although there was a decrease in some varieties and lines, it was generally in the direction of increase (Table 4).

According to ratio of dry matter from storaged tubers in the second year; While the trial average before storage was 19.1 %, it was recorded as 19.5 % after storage. There was a relative increase. When the pre-storage data was examined, Konya location surpassed Karaman location (18.9 %) with 19.4 % in terms of location. According to the genotype averages; While Doruk variety with 22.9 % was in group (a), the lowest ratio of dry matter was determined in Melody variety with 14.3 % and was recorded in group (i). When the post-storage values were examined, a higher value was recorded in the Konya location with 20.1 % than in the Karaman location (18.9 %). According to the genotype averages; Brooke variety was found (a) group with 22.4 %, Melody variety was recorded (k) group with 15.8 %. Although there were fluctuations, the general trend was towards increasing the post-storage data (Table 5).

The starch content largely determines the ratio of dry matter in potato tubers. Starch content is significant for the processing industry and the fresh market as it affects the texture of the potato. The variation of dry matter ratio is closely related to the genetics of the variety, growing conditions, growing season, and storage temperature. A higher dry matter ratio was determined during the growing season in potato tubers grown in the spring. In addition, the ratio of dry matter differences between varieties is closely related to the vegetation period. Early maturing potato varieties have less dry matter accumulation than late maturing ones (de Freitas et al., 2006; Jansky, 2009; Kawchuk et al., 2008). High dry matter ratio; It increases the yield of chips, provides a crispy consistency in the mouth and less oil extraction during frying (Pedreschi et al., 2005; Rommens et al., 2010).

In this study, according to both 2019 and 2020 data; There was a general increase in storage change. This increasing trend might be due to weight loss of tubers through respiration and transpiration. Because, as is known, tubers, which are alive right after harvest, lose weight by dehydration through respiration (Er and Uranbey, 1998; Ozturk and Polat, 2016). Similar to this result, it was reported in many studies that dry matter and dry matter constituents increased relatively in potato tubers during storage (Kara, 1996; Haase et al., 2007; Sanli, 2012; Broćić et al., 2016).

Table 2
Results of variance analysis of the physical and quality traits in the study conducted in 2019

Source of Variation	df	Means square					
		Ratio of Dry Matter (%)		Yield of leaf chips (%)		Yield of French fries (%)	
		Pre-storage	Post-storage	Pre-storage	Post-storage	Pre-storage	Post-storage
Recurrence	3	0.03	0.03	0.08	0.05	0.40	0.14
Genotypes	37	19.13**	18.27**	109.40**	149.37**	78.42**	10.93**
Error	111	0.03	0.03	0.04	0.38	0.69	0.09

Source of Variation	df	Storage weight loss (%)	The first shoot formation time (day)
Recurrence	3	0.03	0.36
Genotypes	37	27.75**	854.59**
Error	111	0.04	1.64

*P < 0.05, **P < 0.01

Table 3
Results of variance analysis of the physical and quality traits in the study conducted in 2020

Source of Variation	df	Means square					
		Ratio of Dry Matter (%)		Yield of leaf chips (%)		Yield of French fries (%)	
		Pre-storage	Post-storage	Pre-storage	Post-storage	Pre-storage	Post-storage
Location	1	6.63**	47.38**	84.84**	139.96**	74.89**	27.08**
Recurrence [L]	6	0.17	0.03	0.52	0.68	0.06	0.49
Genotype	14	37.78**	30.12**	183.60**	362.90**	222.40**	332.00**
L x G	14	8.08**	4.41**	83.37**	59.57**	29.29**	50.96**
Error	84	0.16	0.03	0.31	0.68	0.17	0.31

Source of Variation	df	Storage weight loss (%)	The first shoot formation time (day)
Location	1	518.34**	6049.20**
Recurrence [L]	6	0.01	9.58
Genotype	14	38.95**	2034.95**
L x G	14	29.59**	1687.58**
Error	84	0.03	9.12

*P < 0.05, **P < 0.01

Table 4
Means of physical and quality traits of 38 potato genotypes in storage conditions in 2019 year.

Genotypes	Ratio of Dry Matter (%)		Yield of leaf chips (%)		Yield of French fries (%)		Storage weight loss (%)	The first shoot formation time (day)
	Pre-storage	Post-storage	Pre-storage	Post-storage	Pre-storage	Post-storage		
Agata	13.9 r	17.3 qr	32.7 w	50.8 m	47.5 o-q	52.9 v	7.8 g	37 q
Agria	18.1 l	17.4 pq	33.2 v	37.0 r	55.5 c	51.7 w	5.6 jk	76 ıj
Brooke	22.8 q	24.3 b	50.3 g	58.0 c-e	53.1 e-g	58.7 b	13.3 b	86 d
Challenger	18.7 jk	17.8 no	39.6 t	44.1 q	58.8 b	55.3 n-q	6.5 ı	74 jk
Çağlı	19.0 ıj	20.9 d	42.3 r	43.2 q	50.8 ı-k	53.6 u	4.3 no	61 m
Doruk	18.9 ı-k	20.7 de	46.7 j	54.7 hı	49.4 k-n	56.2 h-l	7.1 h	60 m
Innovator	20.8 d	19.8 g-j	45.8 l	49.2 n	49.2 l-n	56.2 h-l	3.6 p	76 ıj
Jelly	18.0 l	16.6 t	46.3 k	51.1 m	49.1 l-n	55.8 k-n	6.6 ı	53 op
Kutup	18.6 k	17.8 no	51.2 f	56.2 fg	48.8 m-o	54.6 rs	5.7jk	59 mn
L.O.	19.1 hı	19.6 ı-l	47.1 ı	49.2 n	54.1 c-f	55.6 m-o	8.3 f	54 o
Leventbey	18.1 l	16.6 t	54.6 b	62.2 b	54.5 c-e	57.3 de	7.1 h	69 l
Madeleine	16.1 op	17.0 rs	44.7 n	52.8 kl	44.8 st	54.7 rs	4.8 m	57 n
Marabel	17.3 m	19.7 h-k	40.7 s	53.0 j-l	57.7 b	55.6 m-o	5.4 kl	53 op
Melody	16.1 op	20.1 fg	44.9 mn	57.3 d-f	43.8 t	55.0 p-r	7.6 g	84 de
Muratbey	16.3 no	17.7 op	39.5 t	43.2 q	51.2 h-j	52.6 v	7.1 h	51 p

Table 4 (continued)
Means of physical and quality traits of 38 potato genotypes in storage conditions in 2019 year.

R.B.	19.5 fg	19.2 m	52.4 e	46.2 p	66.3 a	55.5 m-p	8.3 f	85 d
VR808	22.5 a	21.5 c	49.0 h	54.9 h	52.7 f-h	57.4 de	14.0 a	91 c
Zirve	21.4 b	20.9 d	50.0 g	57.3 d-f	49.9 j-m	56.3 h-k	10.1 d	80 fg
AFAG12	17.2 m	18.0 no	43.0 q	46.5 p	47.9 n-q	55.7 l-n	3.4 p	99 a
AFAG-C	18.0 l	21.3 c	46.1 kl	56.9 ef	51.2 h-j	56.6 f-h	1.5 q	81 fg
AFBR4	15.9 pq	16.1 u	47.0 ıj	57.2 d-f	47.2 pq	55.1 o-r	7.6 g	96 b
AFHER 11	21.2 bc	19.3 lm	55.4 a	54.7 hı	47.0 q	59.5 a	6.7 ı	59 mn
AFK3	17.8 l	16.8 st	44.6 n	52.4 l	53.5 ef	57.0 ef	10.8 c	77 hı
AFLA20	19.9 e	19.5 j-m	46.7 j	62.2 b	53.6 ef	58.1 c	4.3 no	84 de
AFLA9	19.8 ef	20.7 de	47.0 ıj	53.2 j-l	51.3 h-j	56.9 e-g	4.1 no	52 op
ELAF10	20.8 d	19.9 g-ı	53.1 d	62.0 b	54.3 c-e	54.4 st	7.1 h	80 fg
ELAF11	19.2 g-ı	20.5 e	42.4 r	58.1 cd	50.4 ı-l	56.5 f-ı	9.3 e	74 jk
GAF4	18.7 jk	21.6 c	43.3 q	50.7 m	55.2 cd	57.6 cd	8.6 f	72 k
HEAF5	21.2 bc	19.4 k-m	50.3 g	58.6 c	55.5 c	55.8 k-n	7.9 g	54 o
MK2	15.7 q	18.1 n	36.8 u	46.4 p	45.4 rs	54.8 q-s	7.6 g	72 k
PAG5	22.6 a	20.5 e	53.7 c	64.7 a	50.4 ı-l	56.0 ı-m	8.4 f	85 d
PAG9	19.4 gh	20.0 gh	44.0 op	45.9 p	49.9 j-m	54.6 rs	4.0 o	85 d
T1AG14	16.6 n	20.4 ef	43.1 q	47.8 o	46.7 qr	53.9 tu	7.2 h	78 gh
T2AG13	18.6 k	20.1 fg	45.2 m	48.0 o	53.9 d-f	55.9 j-m	5.1 lm	74 jk
T3AG14	16.3 no	17.0 rs	43.7 p	55.2 gh	44.4 st	53.9 tu	11.0 c	59 mn
T3LA8	17.9 l	19.8 g-j	43.1 q	53.7 ı-k	51.6 g-ı	57.4 de	4.4 n	82 ef
T3PO13	22.8 a	24.4 b	44.8 n	57.0 d-f	48.7 m-p	56.4 g-j	5.7 jk	53 op
T7LA8	20.9 cd	24.8 a	44.1 o	54.1 h-j	47.9 n-q	54.3 st	5.8 j	82 ef
Mean	18.8	19.5	45.5	52.8	51.1	55.7	6.9	71
Lsd genotype pre-storage (0.01)	0.32		0.37		1.54		0.38	2.37
Lsd genotype post-storage (0.01)	0.32		1.14		0.56			

While the leaf chips yield of tubers harvested in 2019 was 45.5 % before storage, this rate was 52.8 % after storage, and although the leaf chips yield of tubers fluctuated after storage, the general trend was to increase. Looking at the pre-storage data; While AFHER11 line was included in group (a) with 55.4 %, Agata variety represented (w) group with 32.7 %. After the storage; PAG5 line with 64.7 % was in the first group (a), Agria variety was in the last group (r) with 37.0 % (Table 4). While the leaf chips yield of tubers harvested in 2020 was 51.1 % in the analysis made before they were put into storage, this rate increased slightly by 53.9 % after storage. When the pre-storage values were examined, Konya location was in group (a) with 51.9 %, Karaman location was in group (b) with

50.2 %. After the storage, Konya location was determined with 55.0 % in group (a), and Karaman location with 52.9 % in group (b). According to genotype averages, PAG5 line was determined with 59.2 % before storage and Brooke variety (a) with 61.6 % after storage. The lowest leaf chips yield value was determined in the GAF4 line with 41.3 % before the storage and this value was in the (i) group, while it was determined on the same line with 41.2 % after the storage and was recorded in the (k) group. Although there were fluctuations, the general trend was that the yield values of leaf chips increase after storage (Table 5). In the study conducted by Kara (1996), an increase in chips yield was determined due to the decrease in storage weight losses in tuber. It was reported that the leaf chips yield of varieties with high dry matter ratios increased at that rate (Das et al., 2001). As a result of this study, the result determined as the increase in the post-storage values of dry matter ratios was in harmony with the information of these researches.

Table 5
Means of physical and quality traits of 15 potato genotypes in storage conditions in 2020 year.

Genotypes	Ratio of Dry Matter (%)			Ratio of Dry Matter (%)			Yield of leaf chips (%)		
	Pre-storage			Post-storage			Pre-storage		
	Konya	Karaman	Mean	Konya	Karaman	Mean	Konya	Karaman	Mean
Agria	20.6 g	16.9 mn	18.8 ef	19.4 kl	19.2 l	19.3 e	48.4 k	42.8 m	45.6 h
Brooke	21.4 a	23.2 a	22.3 b	21.8 c	23.0 a	22.4 a	55.3 cd	58.7 b	57.0 b
Doruk	24.1 b-d	21.7 bc	22.9 a	22.5 b	21.4 de	21.9 b	58.8 b	50.1 hı	54.4 c
Kutup	22.3 c-e	22.1 b	22.2 b	22.4 b	21.2 e	21.8 b	49.5 ıj	58.4 b	53.9 c
L.O.	17.3 lm	20.8 d-f	19.0 de	19.7 k	17.3 o	18.5 g	42.3 m	48.8 jk	45.5 h
Melody	13.3 op	15.3 p	14.3 ı	15.7 r	15.9 r	15.8 k	54.4 de	42.4 m	48.4 f
R.B.	19.3 no	17.1 l-n	18.2 g	19.7 k	16.5 q	18.1 h	49.3 ı-k	45.9 l	47.6 g
Zirve	16.7 ı-k	16.9 mn	16.8 h	17.4 o	18.1 n	17.8 ı	50.0 hı	58.0 b	54.0 c
AFAG-C	18.7 k-m	17.8 j-l	18.3 fg	21.1 ef	17.4 o	19.3 e	53.5 ef	50.8 gh	52.2 e
AFBR4	20.3 mn	17.2 l-n	18.7 e-g	16.9 p	16.7 pq	16.8 j	52.5 f	52.7 f	52.6 de

Table 5 (continued)
Means of physical and quality traits of 15 potato genotypes in storage conditions in 2020 year.

ELAF10	18.3 f	19.3 g	18.8 ef	21.7 cd	20.2 ıj	20.9 cd	52.9 f	53.0 f	53.0 d
ELAF11	19.6 g-ı	19.3 g	19.5 cd	20.4 h-j	18.7 m	19.5 e	56.1 c	49.8 h-j	52.9 de
GAF 4	18.3 ef	18.4 h-j	18.4 fg	20.8 fg	20.5 g-ı	20.7 d	40.8 n	41.9 m	41.3 ı
PAG 5	21.0 lm	19.0 gh	20.0 c	20.7 gh	17.3 o	19.0 f	64.0 a	54.4 de	59.2 a
T7LA8	19.4 f	18.7 g-ı	19.0 de	22.0 c	20.1 j	21.1 c	51.2 g	46.1 l	48.7 f
Mean	19.4 a	18.9 b	19.1	20.1 a	18.9 b	19.5	51.9 a	50.2 b	51.1
Lsd genotype (0.01) = 0.53				Lsd genotype (0.01) = 0.23			Lsd genotype (0.01) = 0.73		
Lsd locationx genotype (0.01) = 0.75				Lsd locationx genotype (0.01) = 0.32			Lsd locationx genotype (0.01) = 1.04		
Genotypes	Yield of leaf chips (%)			Yield of French fries (%)			Yield of French fries (%)		
	Post-storage			Pre-storage			Post-storage		
	Konya	Karaman	Mean	Konya	Karaman	Mean	Konya	Karaman	Mean
Agria	49.4 m	42.1 o	45.7 ı	51.6 g	49.7 h	50.7 e	60.9 b	50.9 jk	55.9 c
Brooke	61.4 cd	61.8 cd	61.6 a	52.2 g	50.1 h	51.1 e	51.9 ıj	53.2 gh	52.6 ef
Doruk	63.4 b	56.9 gh	60.2 bc	48.3 ı	53.0 f	50.7 e	52.7 hı	51.9 ıj	52.3 f
Kutup	51.3 l	58.2 fg	54.7 e	56.9 b	58.0 a	57.5 a	56.8 d-f	57.0 de	56.9 b
L.O.	48.6 m	48.9 m	48.7 h	52.2 g	53.0 f	52.6 c	51.8 ıj	57.5 d	54.6 d
Melody	51.3 l	55.9 hı	53.6 f	45.8 j	37.6 o	41.7 ı	38.6 r	37.7 r	38.1 l
R.B.	42.8 o	46.0 n	44.4 j	58.3 a	55.6 c	57.0 a	64.3 a	59.3 c	61.8 a
Zirve	61.7 cd	60.7 de	61.2 ab	45.2 j	45.8 j	45.5 h	46.4 mn	56.0 ef	51.2 g
AFAG-C	49.9 lm	54.5 ı-k	52.2 g	51.9 g	54.8 d	53.3 b	54.1 g	52.0 ı	53.1 e
AFBR4	62.1 b-d	53.6 jk	57.8 d	48.9 ı	44.1 k	46.5 g	46.8 m	40.5 q	43.7 j
ELAF10	62.4 bc	57.6 g	60.0 c	43.5 k	40.5 m	42.0 ı	48.5 l	53.2 gh	50.8 g
ELAF11	59.4 ef	56.8 gh	58.1 d	50.4 h	44.1 k	47.3 f	50.1 k	43.7 o	46.9 h
GAF 4	42.6 o	39.9 p	41.2 k	41.4 l	39.5 n	40.5 j	46.1 mn	45.4 n	45.7 ı
PAG 5	65.8 a	54.9 ıj	60.4 bc	50.4 h	53.9 e	52.1 cd	58.8 c	55.8 f	57.3 b
T7LA8	53.0 k	45.2 n	49.1 h	55.0 cd	48.5 ı	51.8 d	42.3 p	41.7 p	42.0 k
Mean	55.0 a	52.9 b	53.9	50.1 a	48.5 b	49.3	51.3 a	50.4 b	50.9
Lsd genotype (0.01) = 1.09				Lsd genotype (0.01) = 0.54			Lsd genotype (0.01) = 0.73		
Lsd locationx genotype (0.01) = 1.54				Lsd locationx genotype (0.01) = 0.77			Lsd locationx genotype (0.01) = 1.04		

While the yield of French fries before storage of tubers harvested in 2019 was 51.1 %, this rate was 55.7 % after storage, and the yield of French fries after storage increased despite fluctuations. Looking at the pre-storage data; While Russet Burbank variety was in the (a) group with 66.3 %, the Melody variety represented the (t) group with 43.8 %. After the storage; AFHER11 line took the lead with 59.5 % in (a) group, while Agria was determined in the last group

(w) with 51.7 %. Although there were exceptions, the general trend was towards an increase after storage (Table 4). In the pre-storage analysis in 2020, the yield of French fries was 49.3 %, while this rate increased by 50.9 % after the storage. When the pre-storage values were examined, Konya location was ahead of Karaman location (48.5 %) with 50.1 %. After storage similarly, Konya location surpassed.

Karaman location (50.4 %) with 51.3 %. According to the genotype averages, the highest French fries yield rates were 57.5 % for Kutup variety and 57.0 % for Russet Burbank variety in pre-storage conditions. After storage, the highest French fries yield value was 61.8 % in the Russet Burbank variety. The lowest French fries yields were recorded in the GAF4 line with 40.5 % before storage, and the Melody variety with 38.1 % after storage. Although there were fluctuations, the general trend was that the yield values of French fries increased after storage (Table 5).

French fries yield is related to dry matter ratio, and genotypes with high dry matter yields are also high. In this study, French fries yield of genotypes with high dry matter content (Table 4 and Table 5) was also high. Karadoğan (1994a) reported a positive relationship between chips, French fries yields, specific gravity and dry matter, and a negative relationship between protein and fat absorption rates. It was determined that the results of this research show similarity with the results of the studies (Senol, 1970; Sanli, 2012), which reported that the yields of French fries increase in parallel as the moisture losses in the tuber decrease.

The tuber weight loss values after storage in 2019 were examined; the trial average was determined as 6.9 %. The genotype that lost the most weight after storage was VR808 variety with 14.0 %, and the least weight loss was detected in the AFAGC line with 1.5 %. Loss rates recorded above the trial average were determined in AFAG12, AFHER11, AFLA20, AFLA9, PAG9, T2AG13, T3LA8, T3PO13 and T7LA8 lines. In standard varieties; It was detected in Agria, Challenger, Çağlı, Innovator, Jelly, Kutup, Madeleine and Marabel cultivars (Table 4).

When the storage losses of tubers in 2020 were examined, the trial average was 6.7 %. According to the locations, higher losses were detected in the Konya location (8.8 %), and almost 50 % fewer losses were detected in the Karaman location (4.7 %). According to the average of genotypes, Russet Burbank variety was determined as the highest weight loss with 10.3 %. The least weight loss was detected in the AFAGC line with 1.8 %. According to the location x genotype interactions, Konya x Brooke was the highest with 14.6 %, and Karaman x AFAGC was the interaction with the lowest weight loss with 1.5 %. AFAG-C line showed high storage resistance after both growing seasons (Table 6).

Potato tubers are living organisms that breathe, even after harvest. The high moisture content and metabolic activity of potato tubers cause weight and nutrient losses during storage. These losses occur due to respiration, transpiration and shoot growth (Burton, 1978; Gottschalk and Ezekiel, 2006). The difference in weight loss in genotypes varies with respiration, transpiration and shoot formation (Kolbe et al., 1995).

Weight changes determined as storage weight losses were found close to the findings of Kara (2004) (5.8 - 13.5%) and Okur (2008) (7.2-9.5%). The values related to storage weight losses in the study were determined to be well above the limits found by Ozcan (2019) (1.27-4.81%) and Ozturk et al. (2016) (1.32 - 2.74%).

The trial average of the first shoot formation time of tubers in 2019 was determined as 71 days. The earliest shoot forming genotype was Agata variety with 37 days, the latest shoot forming genotype was AFAG12 line with 99 days (Table 4).

When the first shoot formation time of the tubers in 2020 was examined, it was determined that while the first shoot formation time was 95 days in Karaman location, this period was 81 days for the Konya location. According to the genotype averages, the AFAGC line was determined as 113 days and classified in group (a). The earliest shooted line was ELAF10 with 55 days (Table 6).

Sprouting can be prevented by reducing the storage temperature to 2-4 °C followed by a constant temperature and 85-90 % relative humidity after harvest (Hartmans et al., 1995). However, shoot growth is inhibited in tubers stored at these temperatures for a long time. As a result, the quality of chips is negatively affected as the presence of reducing sugar increases (Kumar et al., 2007). In this study, although the first shoot formation period differed, it was parallel with the weight loss of tubers. The values determined as a result of the study were compatible with the results reported by (Kara, 2000) and (Kara, 1996).

When the quality of leaf chips before storage was examined in 2019, AFAG-C, AFBR4, AFHER11, GAF4, ELAF10, PAG9, T3AG14, T3PO13 were included in the “5” scale. Brooke, Agria, Kutup, Doruk, VR808, Zirve gave the best results in standard varieties. Only MK2 was determined as the line that cannot be used for chips, and among the standard varieties; Agata, Melody, Marabel, Madeleine were determined on a “1” scale. Except for the exceptions (AFK3, AFLA20, AFLA9, ELAF11, Çağlı, Jelly), no difference was observed in the pre- and post-storage changes (Table 7). When the leaf chips quality scale values were examined in 2020, the color scale values before and after storage were the same. Melody variety is the only genotype in the “1” scale in Konya and Karaman locations. The perfect color was detected in all genotypes except for Lady Olympia and GAF4 (Table 8). Chips quality; tuber size, shape, eye depth, specific gravity, dry matter and reducing sugar levels. These factors depend on cultural practices, environmental conditions, and genotype. However, the genetic component has the most decisive influence on inherited traits (Abong et al., 2012).

Table 6
Means of physical and quality traits of 15 potato genotypes in storage conditions in 2020 year.

Genotypes	Storage weight loss (%)			The first shoot formation time (day) (kg)		
	Konya	Karaman	Mean	Konya	Karaman	Mean
Agria	6.6 k	4.5 l	5.6 hı	77 h-j	124 a	100 c
Brooke	14.6 a	2.6 p	8.6 c	89 ef	92 e	90 f
Doruk	11.0 c	3.6 n	7.3 f	83 f-h	111 bc	97 cd
Kutup	8.7 f	3.0 o	5.8 h	81 g-ı	116 b	98 c
L.O.	7.4 hı	4.1 m	5.8 h	60 k	103 d	82 g
Melody	6.6 k	3.0 o	4.8 j	71 j	113 bc	92 ef
R.B.	8.1 g	12.5 b	10.3 a	104 d	53 lm	79 g
Zirve	10.4 d	4.8 l	7.6 e	84 fg	117 b	100 c
AFAG-C	2.1 q	1.5 r	1.8 k	116 b	111 bc	113 a
AFBR4	8.7 f	2.1 q	5.4 ı	76 ıj	112 bc	94 de
ELAF10	12.5 b	7.1 ıj	9.8 b	59 kl	51 m	55 ı
ELAF11	9.5 e	7.0 j	8.2 d	62 k	73 j	67 h
GAF 4	10.4 d	3.3 no	6.8 g	64 k	93 e	79 g
PAG 5	8.4 fg	8.7 f	8.5 c	85 fg	53 lm	69 h
T7LA8	7.5 h	2.4 pq	5.0 j	103 d	108 cd	105 b
Mean	8.8 a	4.7 b	6.7	81 b	95 a	88
Lsd $_{genotype (0.01)}$ = 0.23				Lsd $_{genotype (0.01)}$ = 3.98		
Lsd $_{locationx genotype (0.01)}$ = 0.33				Lsd $_{locationx genotype (0.01)}$ = 6.50		

Table 7
Quality of leaf chips (1-5 scale)[A], quality of french fries (0-4 scale)[B], blackening (1-5 scale) [C] scale values of the study conducted in 2019*

Varieties	A1	A2	B1	B2	C1	C2	Lines	A1	A2	B1	B2	C1	C2
Agata	1	1	4	4	3	3	AFAG12	2	2	2	2	3	3
Agria	5	5	0	0	5	5	AFAG-C	5	5	0	0	5	5
Brooke	5	5	0	0	5	5	AFBR4	5	5	0	0	5	5
Challenger	4	4	1	1	3	3	AFHER 11	5	5	0	0	3	3
Çağlı	2	4	4	3	5	5	AFK3	3	4	3	3	2	2
Doruk	5	5	0	0	5	5	AFLA20	3	4	3	3	4	4
Innovator	4	4	0	0	3	3	AFLA9	3	4	3	3	5	5
Jelly	3	4	3	3	2	2	ELAF10	5	5	0	0	5	5
Kutup	5	5	0	0	5	5	ELAF11	3	4	2	2	5	5
L.O.	4	4	1	1	3	3	GAF4	5	5	2	2	3	3
Leventbey	3	3	3	3	3	3	HEAF5	4	4	1	1	3	3
Madeleine	1	1	4	4	3	3	MK2	1	1	4	4	3	3
Marabel	1	1	4	4	3	3	PAG5	4	4	1	1	5	5
Melody	1	1	4	4	3	3	PAG9	5	5	0	0	4	4
Muratbey	2	2	3	3	3	3	T1AG14	4	4	1	1	3	3
R.B.	4	4	0	0	4	4	T2AG13	3	3	3	3	5	5
Vr808	5	5	0	0	3	3	T3AG14	5	5	0	0	2	2
Zirve	5	5	0	0	5	5	T3LA8	2	2	2	2	4	4
							T3PO13	5	5	0	0	4	4
							T7LA8	4	4	1	1	5	5

*1: Pre-storage; 2: Post-storage

Depending on the variety, potatoes begin to accumulate reducing sugar, which gives a sweet taste during and after storage and causes an undesirable brown color in chips and french fries. These reducing sugars have a negative effect on the technological processing of potatoes (Schwimmer et al., 1957). When the colors of the chips are evaluated, the chips colors of the varieties with low, reducing sugar content give better results (Das et al., 2001).

The potato used industrially should have a high yield of French fries (fried potatoes) and chips. In addition, the fact that they absorb less oil during frying is a desirable feature in terms of both health and low cost. The most important feature is the color of chips and French fries. Chips and fried potatoes should show a golden yellow and uniform color (Karadogan, 1994b). This study determined the desired color scale values for all selected lines in 2020.

Table 8
Quality of leaf chips (1-5 scale)[A], quality of french fries (0-4 scale)[B], blackening (1-5 scale) [C] scale values of the study conducted in 2020*

Genotypes	A1		A2		B1		B2		C1		C2	
	a	b	a	b	a	b	a	b	a	b	a	b
Agria	5	5	5	5	0	0	0	0	5	5	5	5
Brooke	5	5	5	5	0	0	0	0	5	5	5	5
Doruk	5	5	5	5	0	0	0	0	5	5	5	5
Kutup	5	5	5	5	0	0	0	0	5	5	5	5
L.O.	4	4	4	4	0	0	0	0	5	5	5	5
Melody	1	1	1	1	4	4	4	4	5	5	5	5
R.B.	5	5	5	5	0	0	0	0	4	3	4	3
Zirve	5	5	5	5	0	0	0	0	5	5	5	5
AFAG-C	5	5	5	5	0	0	0	0	5	5	5	5
AFBR4	5	5	5	5	0	0	0	0	4	5	4	5
ELAF10	5	5	5	5	1	1	1	1	5	5	5	5
ELAF11	5	5	5	5	1	1	1	1	5	5	5	5
GAF4	4	4	4	4	1	1	1	1	5	5	5	5
PAG5	5	5	5	5	0	0	0	0	5	5	5	5
T7LA8	5	5	5	5	0	0	0	0	5	5	5	5

*1: Pre-storage; 2: Post-storage; a: Konya, b: Karaman

When the color scale values of French fries before the storage were examined in 2019, AFAG-C, AFBR4, AFHER 11, ELAF10, PAG9, T3AG14, and T3PO13 were included in the "0" scale. In terms of standard cultivars, Brooke, Agria, Innovator, Kutup, Russet Burbank, Doruk, VR808, Zirve varieties gave the best results. Only MK2 was determined as the line that cannot be French fries. Among the standard varieties; Agata, Çağlı, Melody, Marabel, and Madeleine were determined on the 4 scale (Table 7).

When the color scale values of French fries before storage were examined in 2020, 0 and 1 values, which are determined as very good and good scale definitions, are seen in all genotypes except for Melody variety. Color values did not change after storage (Table 8).

The amount of starch in the tuber affects the color of chips and French fries. Sugar, amino acids and other compounds in potato slices exposed to high temperatures during the frying process combine, causing a dark color and a burnt taste. Potato varieties with high sugar content cause consumers not to prefer them because of this color status during frying (Stark, 2003). The amount of reducing sugar and phenol content in the tuber must be low so that the chips and French fries do not turn brown and have a bitter taste (Wiltshire and Cobb, 1996; Wang-Pruski and Nowak, 2004). Browning after frying is caused by reducing sugar content and the interaction with the amino acid sucrose (Shallenberger et al., 1959). The type of oil used while frying, the frying temperature, the frying time, and the type of frying affect the color change (Pringle et al., 2009). The MK2 line was subjected to negative selection, and the breeding lines in the "0" scale were examined in terms of other breeding criteria.

When the pre-storage blackening color scale values were examined in 2019, the genotypes on the 5 scale were determined as AFAG-C, AFBR4, AFLA9, Agria, Brooke, Çağlı, Doruk, ELAF10, ELAF11, Kutup, Zirve, T7LA8, T2AG13, PAG5. No change was observed after storage, either (Table 7). When the color scale values of the year 2020 were examined, it was observed that almost all genotypes gave a positive result in darkening, and no change was detected after storage. The Russet Burbank variety detected more significant blackening than the others (Table 8).

4. Coclusion

The healthy storage of tubers is as important as the cultivation of potatoes. For this reason, the main objectives are to prevent the development of shoots, adjust the storage temperatures and have the least loss of physical and quality properties of the tubers in the storage. In this study, significant changes occurred in all values compared to the pre-storage parameters of the tubers, which were exposed to excessive shoot growth and moisture loss. Dry matter content was in parallel with the yield of leaf chips and French fries, increasing after storage. As a result of the study, T7LA8, PAG5 and GAF4 lines with high ratio of dry matter, yields of chips and French fries were determined as promising lines.

5. Acknowledgements

The study was supported by OYP allowances numbered as 2018-OYP-007; and also, we would like to thank the authorities and our coordinator who provided us this opportunity.

6. References

Abong GO, Okoth MW, Karuri EG, Kabira JN, Mathooko FM (2012). Levels of reducing sugars in eight Kenyan potato cultivars as influenced by stage of maturity and storage conditions.

Anonymous (2001). Seed Registration Certification Central Directorate, Agricultural Values Measurement and Evaluation Instruction (Potato), https://www.tarimorman.gov.tr/BUGEM/TTSM/Belgeler/Tescil/Teknik%20Talimatlar/End%C3%BCstri%20Bitkileri/pates.pdf: [Visit Date: 10.04.2021]

Bond JK (2014). Potato utilization and markets, *The Potato: Botany, Production and Uses; CABI: Wallingford, UK*, 29-44.,

Broćić Z, Dolijanović Ž, Poštić D, Milošević D, Savić J (2016). Yield, tuber quality and weight losses during storage of ten potato cultivars grown at three sites in Serbia, *Potato Research*, 59 (1), 21-34.

Burton W (1978). The physics and physiology of storage, In: The Potato Crop, Eds: Springer, p. 545-606.

Carputo D, Frusciante L (2011). Classical Genetics and Traditional Breeding, In: Genetics, genomics and breeding of potato, Eds, p. 20-40.,

Das M, Ezekiel R, Sekhawat G (2001). Quality of dehydrated potato chips produced from fresh and heap stored tubers, *J. Indian Potato Assoc*, 28 (1), 174-175.

de Freitas ST, Bisognin DA, Gómez ACS, Sautter CK, da Costa LC, Rampelotto MV (2006). Processing quality of potato clones during spring and autumn grown conditions of Rio Grande do Sul.

Er C, Uranbey S (1998). Nişasta Şeker Bitkileri, *Starch Sugar Crops, AU Faculty of Agriculture Publication* (1504).

Gottschalk K, Ezekiel R (2006). Storage In "Handbook of Potato Production, Improvement, and Postharvest Management", *Food Products Press, an imprint of the Haworth Press, Inc., Binghamton, NY, USA*.

Haase T, Schüler C, Haase N, Heß J (2007). Suitability of organic potatoes for industrial processing: effect of agronomical measures on selected quality parameters at harvest and after storage, *Potato Research*, 50 (2), 115-141.

Hartmans KJ, Diepenhorst P, Bakker W, Gorris LG (1995). The use of carvone in agriculture: sprout suppression of potatoes and antifungal activity against potato tuber and other plant diseases, *Industrial Crops and Products*, 4 (1), 3-13.

Hoopes R, Plaisted R (1987). Potato (Chapter eleven), *Princeples of Cultivar Development*, 2.

Jansky S (2009). Breeding, genetics, and cultivar development, In: Advances in potato chemistry and technology, Eds: Elsevier, p. 27-62.

Kacar B (1972). Chemical Analysis of Plant and Soil II. Plant Analysis.

Kara K (1996). An Investigation on Some Charecteristics of Certain of Potato Varieties Stored for Different Periods, *The Journal of Food*, 21 (3).

Kara K (2000). The Effects of Storage Periods on Some Quality Features of Various-Sized Potato Varieties, *Turkish Journal of Agriculture and Forestry*, 24 (5), 561-569.

Kara K (2004). Investigation of Quality and Physiological Properties of Some Potato Varities After Storage, *The Journal of Food,* 29 (1), 63-71.

Karadoğan T (1994a). A Study on Chips and French-Fried Quality of Potato Cultivars. Ataturk *University Journal of Agricultural Faculty,* 25 (1).

Karadoğan T (1994b). The Effects of Different Nitrogen Sources and Application Times on Potato Yield and Yield Components, *Tr. J. of Agriculture and Foresty*, 19, 417-421.

Kawchuk L, Lynch D, Yada R, Bizimungu B, Lynn J (2008). Marker assisted selection of potato clones that process with light chip color, *American Journal of Potato Research*, 85 (3), 227-231.

Kolbe H, Hippe J, Olteanu G, Mueller K (1995). Relations between nitrogen, phosphorus and potassium concentrations at harvest time and changes in weight loss and chemical composition of potato tubers during long-term storage at 4 degrees C, *Agribiological research (Germany)*.

Kumar S, Khade H, Dhokane V, Behere A, Sharma A (2007). Irradiation in combination with higher storage temperatures maintains chip-making quality of potato, *Journal of Food Science*, 72 (6), S402-S406.

Nissen O (1989). MSTAT-C a Micro Computer Programme Design, Management and Analysis of Agronomic Research Projects. Michigan State University, East Lansing, Michigan, USA.

Okur H (2008). Effects of haulm killing on yield quality and storage properties in potato (*Solanum tuberosum* L.) cultivars. Master Thesis, *Gaziosmanpasa University, Graduate School of Natural and Applied Sciences Department of Agronomy*, Tokat.

Ozcan S (2019). Determination of storage responses and quality changes of some potato (*Solanum tuberosum* L.) cultivars during storage, Master Thesis, *Isparta University of Applied Sciences The Institute of Graduate Education Department of Field Crops*, Isparta.

Ozturk T (2010). The potato storage in the volcanic tuff storages in Turkey. *Journal of Agricultural Faculty of Gaziosmanpasa University*, 2010, 27(2), 113-120.

Ozturk E, Polat T (2016). The effect of long term storage on physical and chemical properties of potato, *Turk J Field Crops*, 21 (2), 218-223.

Ozturk E, Polat T, Tarakci S (2016). Effect of Storage on the Physical Properties of the some Potato (*Solanum tuberosum* L.) Cultivars, Ataturk *University Journal of Agricultural Faculty*, 47 (2), 89-94.

Pedreschi F, Moyano P, Kaack K, Granby K (2005). Color changes and acrylamide formation in fried potato slices, *Food Research International*, 38 (1), 1-9.

Pringle B, Pringle R, Bishop C, Clayton R (2009). Potatoes postharvest, CABI.

Richardson D, Davies H, Ross H (1990). Potato tuber sugar content during development and storage (10 C): possible predictors of storage potential and the role of sucrose in storage hexose accumulation, *Potato Research*, 33 (2), 241-245.

Rommens CM, Shakya R, Heap M, Fessenden K (2010). Tastier and healthier alternatives to French Fries, *Journal of Food Science*, 75 (4), H109-H115.

Ross L, Porter W (1969). Objective measurements of French fried potato quality. Laboratory techniques for research use, *American Potato Journal*, 46 (6), 192-200.

Sanli A (2012). Effects of volatile oils containing carvone on sprouting of potato (Solanum tuberosum L.) tubers at storage conditions, Doctorate thesis, *Suleyman Demirel University Graduate School of Applied and Natural Sciences Department of Field Crops*, Isparta.

Senol S (1970). The effect of plant density and seed weight on yield and some other properties of potatoes in Erzurum conditions, *Ayyıldız printing press,* Ankara.

Senol S (1973). The effect of temperature, duration, tuber specific gravity and variety characteristics on sugar, dry matter and chips quality in tuber in potato storage, Ataturk *University Broadcating*, 159

Schwimmer S, Hendel C, Harrington W, Olson R (1957). Interrelation among measurements of browning of processed potatoes and sugar components, *American Potato Journal*, 34 (5), 119-132.

Shallenberger R, Smith O, Treadway R (1959). Food color changes, role of the sugars in the browning reaction in potato chips, *Journal of agricultural and food chemistry*, 7 (4), 274-277.

Shetty K (2010). Potato storage management for disease control, *Potato Storage Research*, *University of Idaho*, 3806.

Stark JC, Thornton M, Nolte P (Eds) (2020). *Potato production systems*. Springer Nature.

Wang-Pruski G, Nowak J (2004). Potato after-cooking darkening, *American Journal of Potato Research*, 81 (1), 7-16.

Wiltshire J, Cobb A (1996). A review of the physiology of potato tuber dormancy, *Annals of Applied Biology*, 129 (3), 553-569.

Wustman R, Struik P (2007). The canon of potato science: 35. Seed and ware potato storage, *Potato Research*, 50 (3-4), 351-355.