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RESEARCH ON THE BEHAVIOUR DURING THE STORAGE OF SOME APPLE VARIETIES FROM THE GROWN ASSORTMENTS IN THE SOUTH-EAST AREA OF ROMANIA

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Abstract

Keeping the fruits in the best conditions, for a long period of time and with the least quantitative and qualitative depreciations can be done if a whole complex of factors is taken into account. The research carried out aimed at the evaluation of the behaviour at the storage and of some physico-chemical characteristics of some varieties of apples from the assortment grown within Moara Domnească fruit farm. In order to achieve the objectives, 4 varieties of apples (Goldspur. Generos, Idared, Florina) were studied. Physical-chemical analyzes were performed which consisted in determining the mass losses and by damaging the fruits, their firmness and determining some chemical components (soluble SU, titrable acidity). Mass losses were recorded in all 4 varieties analyzed. The best varieties for storage were found to be Idared variety and Florina variety which recorded the lowest losses, generally below 10%.

Key words**:** *apples, losses, physical-chemical analyzes, storage, varieties*

INTRODUCTION

Apple is one of the most popular fruits [14]. The apple crop is so widespread, on the one hand, due to the nutritional and therapeutic value of the fruits, and on the other hand, to the high economic value [13]. Apples have special biological characteristics, being among the few fruits that keep their freshness for a long time, can be transported over long distances and consumed at any time of the year. It contains a lot of essential nutrients that are necessary for the normal growth and development of the body [6]. Keeping the fruits in the best conditions, for as long a period of time and with as little quantitative and qualitative depreciation as possible, can be done if a whole complex of factors is taken into account [7]. In Romania, the recommended apple assortment is very rich, comprising both varieties created within the research units from all over the country, as well as varieties introduced from abroad, which were tested and proved to be adapted to the pedoclimatic conditions from us. However, the base of apple production is provided by a relatively small number of varieties, already become traditional, such as: Jonathan, Golden Delicious, Red Delicious, Idared or Starkrimson. The first step to a successful storage is a harvest made correctly, according to each variety and its characteristics [8]. If the fruit is harvested too late or too early, there is a greater risk of disease-related loss during storage [3]. The disadvantages of too early harvesting: weight loss, so a reduction in harvest, because the fruits have not fully grown, have not reached their normal size [5]. Weight loss is also great for storage, as the water evaporation from the fruit is more intense; lack of qualitative properties such as taste and pleasant aroma; the coloration is weak and the colour does not become bright enough during storage; predisposition to some physiological disorders, such as: soft opaque, intense browning and bitter stains etc; The disadvantages of delayed harvesting are: harvesting losses due to anticipated fruit fall; increasing the degree of mechanical damage during transport and handling; reducing the storage time, because the fruit left on the tree

for a long time becomes very ripe, overripe and no longer suitable for storage, and should be used immediately; predisposition to some physiological diseases and disorders such as gray rot, monilioosis, internal browning and stoicity [1]. Keeping the fruits in the best conditions, for a long period of time and with the least quantitative and qualitative depreciations can be done if a whole complex of factors is taken into account [2]. These factors that influence the preservation can be divided into several groups, namely: the group of factors that contribute to the formation and growth of fruit in plantations; the group of factors and conditions for harvesting, handling and transporting fruits; the group of environment factors of fruit preservation. The success of storing fruits in storage is conditioned and depends to a large extent on the factors belonging to the first two groups. It is absolutely necessary to know the main factors that we must take into account in order to introduce only fruits corresponding to this purpose in the storage [11]. These factors specific to the first two groups are: ecological factors, natural from the region where trees and fruits grow; agrotechnical factors, represented by the crop technology; the biological particularities of the growth and development of trees and fruits; the conditions under which the fruits were harvested; the conditions of handling, conditioning and transport of the fruits from the place of production to the warehouse [4].

The duration of fruit preservation, following treatments with some insectofungicides, is generally negatively influenced. Thus, some substances reduce the life of apples [9]. Other products, applied before harvesting, with respect to the break time, have determined a good protection after harvesting against the storage diseases that can compromise the fruit [15]. These diseases are bitter rot (*Gloeosporium* spp.), wet rot (*Penicillium* spp.), Gray rot (*Botrytis* spp.) and bitter rot (*Alternaria*) [12]. The best conditions for storing apples are in warehouses with temperature and humidity controlled. The standard storage conditions are: a temperature of 3-4°C, and a relative humidity of air between 85-95%. The storage life can be up to 7 months.

MATERIALS AND METHODS

The research carried out aimed at the evaluation of the behaviour at the storage and of some physico-chemical characteristics of some varieties of apples from the assortment grown within Moara Domnească fruit farm [10]. They were stored in the freezing cells of the specialized storehouse within Moara Domnească. The analyzed fruits come from the harvest of 2019. In order to achieve the objectives, 4 varieties of apples (Goldspur. Generos, Idared, Florina) were studied and 20 pieces were analyzed from each variety. Within 2 days after harvesting, physical and chemical analyzes were performed, which consisted in determining the mass losses and by destroying the fruits, their firmness and the determination of chemical components (soluble SU, titrable acidity). After a period of 125 days from storage, assessments were made regarding the losses registered by destruction. The harvesting was done on 5th September. The last phytosanitary treatment was performed with Captan 80 WDG fungicide at a dose of 0.15%. The pause time of 14 days until harvest was observed.

Testing these varieties allows appreciation of the best variants suitable for competitive products. The experiences were organized in 3 variants, with 3 repetitions per variant. Physico-chemical analyzes were performed, consisting of the following determinations:

Determination of the average mass and the structural textural firmness of the apples. The determinations were made on a sample of 20 fruits for each variant, the average sample consisting of apples representative regarding size, degree of ripe and coloration. Structurally textural firmness was effected with the Effe-gi manual penetrometer, by penetrating at 4 points in the equatorial area, after the local removal of the epidermis.

Determination of solubility and titratable acidity. This operation was performed on samples of 3 kg of fruit from each variant, using standardized laboratory methods. The soluble dry matter was determined by the

refractometric method, using the ABBE mass refractometer, expressing the results in percentages. The content in acidity was determined by the titrimetric method with the expression of the results in percent malic acid.
During storage the daily control of the thermo-hydric factors in the cold room was carried out, in order to ensure the optimum conditions for maintaining the quality [2] (temperature 3-4°C and 90% RH). Also, the ability to maintain the quality of the fruits was evaluated by finding out about the changes in appearance that occurred regarding dehydration, the appearance and evolution of the different storage diseases. After removing the apples from the storage space, determinations were made regarding the level of the quantitative and qualitative losses recorded by the fruits, the modification of the fruit firmness (determined by penetration), the evolution of the content of soluble dry matter and the titrable acidity and the appreciation of the firmness of the fruits after storage.
The determination of mass losses and breakdowns produced during the storage period was made by weighing the resulting fruit samples, respectively of the depreciated (diseased) fruits, in comparison with the initial quantities stored.

RESULTS AND DISCUSSIONS

It can be seen from the data presented in Table 1 that the varieties had a different behavior regarding the losses registered during the storage. All have registered changes materialized in mass losses and through destruction. The lowest percentage of depreciation but also of losses through weight loss was observed in Idared variety, which had a percentage of 1.60% loss by breakdown and 3.70%, weight loss. The most significant losses were determined in Goldspur variety, 34.21% losses by damage caused by the attack of *Gloeosporium* ssp. and 20.31% mass losses by dehydration (Photo 1).
The variety Florina has withstood satisfactory for the duration of the storage having losses through damage and losses of mass of less than 10% (Photo 2).
Generous variety recorded losses by breaking down by more than 10% and by mass below 10%, the depreciation starting to appear after approx. 90 days of storage.

Photo 1. *Gloeosporium* ssp. to Goldspur variety
Source: own determination.

Photo 2. *Alternaria* to Florina variety
Source: own determination.

The best varieties for storage were found to be Idared variety and Florina variety which recorded the lowest losses, generally below 10%. The mass losses were registered in all 4 varieties analyzed (Fig. 1).
The fruit firmness registered a decrease during storage, to all studied varieties, being in the interval of 3.88-5.18 kgf/cm^2. The most significant decrease was remarked in Generos variety, 16% and the lowest, in Idared variety, 0.67% (Table 2).

Table 1. Losses registered during the apple's storage

Variety	Losses (%)			Remarks
	Total	Mass	Broken	
Generos	20.29	9.80	10.49	Start of depreciation by dehydration and breaking after 15.12.2019
Idared	5.30	3.70	1.60	Good looking fruit with freshness, little depreciation.
Florina	14.16	5.88	8.28	Fruits were stored well, with attractive aspect with beginning of *Alternaria* atack.
Goldspur	54.52	20.31	34.21	Depreciations caused by dehydration and tart of *Gloeosporium ssp.* attack

Source: own determination.

Table 2. Evolution of apples firmness during storage Penetration value (kgf/cm²)

Variety	Initial	Final	Differences %
Generos	4.75	3.99	-16.0
Idared	4.47	4.44	-0.67
Florina	6.14	5.18	-15.6
Goldspur	4.37	3.88	-11.2

Source: own determination.

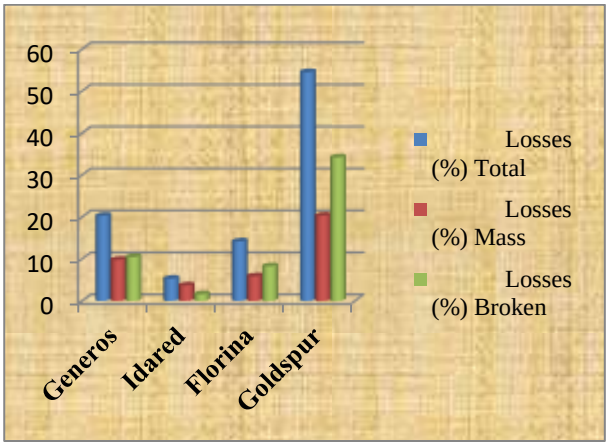

Fig. 1. Losses registered during the apples storage
Source: own determination.

The soluble SU content had both increases and decreases, this aspect being shown in Table 3.

Table 3. Evolution of soluble SU content during the apples storage

Variety	Soluble SU (%)		
	Initial	Final	Differences %
Generos	12.41	15.80	+27.3
Idared	13.16	12.70	-3.5
Florina	14.06	14.50	+3.1
Goldspur	12.06	13.90	+15.2

Source: own determination.

At Idared variety the soluble SU content registered a decrease of 3.5%. The other analyzed varieties had increases of SU solubility during storage, the values being from 3.1%, to Florina variety, to 27.3%, to Generos variety. In conclusion, soluble SU values increase as the storage period increases (Fig. 2).

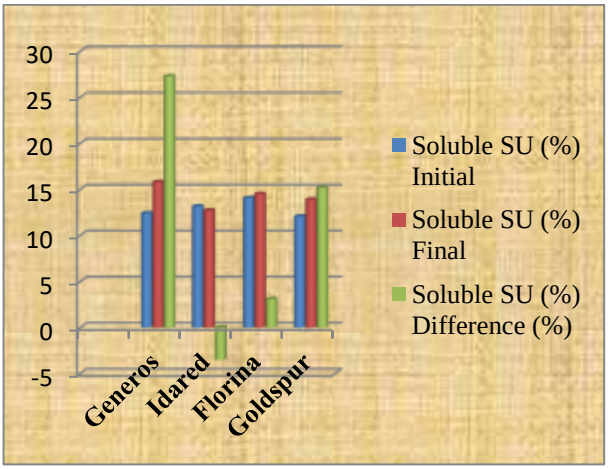

Fig. 2. Evolution of soluble SU content during the apples storage
Source: own determination.

Table 4. Evolution of titrable acidity content during the apples storage

Variety	Titrable acidity (%)		
	Initial	Final	Differences %
Generos	0.44	0.30	-31.8
Idared	0.59	0.70	+18.6
Florina	0.63	0.40	-36.5
Goldspur	0.49	0.30	-38.7

Source: own determination.

As shown in Table 4, the values of the titrable acidity registered, in the case of the majority of the studied varieties, decreases. Except for Idared variety, where there was an increase of the values of the titrable acidity following the storage, of 18.6%, in the other varieties there were determined decreases that exceeded

30.0%. The most significant decrease was observed in Goldspur variety, of 38.7%.

CONCLUSIONS

Mass losses were registered in all 4 varieties analyzed. The best varieties for storage were found to be Idared variety and Florina variety which registered the lowest losses, generally below 10%. The analyzed varieties had increases of SU Solubility during storage, the values being from 3.1%, to Florina variety, to 27.3%, to Generos variety. In conclusion, soluble SU values increase as the storage period increases. Fruit firmness decreased during storage, for all studied varieties, falling within the range 3.88-5.18 kgf / cm^2. Decreases of titrable acidity were determined in Generos, Florina and Goldspur varieties, which exceeded 30.0%. The most significant decrease was observed in Goldspur variety, of 38.7%. By analyzing the behavior of these varieties in storage and the changes that occur after storage, we were able to determine the varieties that are suitable for storage for long periods and that do not undergo significant changes, being compliant for sale.

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