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RESEARCH REGARDING THE TEMPERATURE AND HUMIDITY VARIATION IN A POTATOES WAREHOUSE WITHOUT AUTOMATIC CONTROL SYSTEM

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Abstract: *The warehouse in which the researches were done has no automatic adjustment systems for temperature, humidity or airflow speed. In the warehouse floor there are placed channels through which the atmospheric air is circulated. This is necessary to correct these parameters. Also there are some electric radiators and a heating source with solid fuel for warming the warehouse in critical moments. The weekly measured values of the climatic phenomenon, both inside and outside the warehouse were processed and applied to the biological evolution of the potatoes tubercles from five different varieties. For each variety there were monitored 20 tubercles displaced at different heights in storing box-pallets. There were found different biological evolutions which mean that each potato variety needs different storing conditions.*
Keywords: *biological evolution, climatic factors, potato, warehouse*

1. INTRODUCTION

ISO 9001:1994 norms regarding Quality system accord a special attention to storing, manipulation, conservation and delivery operations through 4.15 Clause. The porpoise of this clause is to assure the consumer proper products, conforming to its requests. That is way it becomes very important the integration of storing, manipulation, packing, conservation and delivery operations through agricultural products path, not only to satisfy the consumer requests, but also for this operations to take place efficiently [1], [2].
Temperature, light, oxygen moisture high variation or the lack of water vapors and natural enzyme, after a certain period of time, tend to deteriorate them.
Because potatoes are perishable products, their storage requires certain conditions, which will be considerate in elaboration of the quality policy. It is recommended to avoid: stacks to heavy; natural light impact over stored potatoes; high temperatures.
Potatoes expiration date will be permanent monitored thorough the actualization of the products input and output database. Periodically inspects will be done for evaluating the products health condition. If tubers had suffered qualitative deterioration they must be isolated immediately from the other products.
In Table 1 are presented the potatoes main physical and chemical characteristics, which must be verified periodic during storing [1], [4], [5].

Table 1: Potatoes physical and chemical characteristics

Characteristic	Value
Mass, *g* (limit)	30...300
Pieces/kg (limit)	3...33
Volumetric Mass, kg/m^3	650...700
Specific Heat, $Kcal/kg^{\cdot o}C$	0,82
Water content, *%*	75...80
Total sugar*, %*	0,40...3,40
Starch, *%*	12,1...20,6
Cellulose, *%*	0,7
Protides , *%*	2,00
Average content in mineral substances at 100g fresh substance, *%*	0,99

Carotene ,*mg*	0,02
Vitamin B_1,*μg*	130
Vitamin B_2,*μg*	60
Vitamin PP,*μg*	1200
Vitamin C1,*mg*	20...30

In a warehouse construction an important problem is that of thermal isolation, which must assure the protection of stored products from winter frost, but also from high temperatures from the other seasons, making possible the temperature maintenance in established limits, which for potatoes are between 2… 4^{o}C temperature and 85…90% humidity. On the other hand potatoes are living organisms with biological activity after which heat and water vapors are produced. In these conditions is necessary to adapt some efficient thermal isolation, protected by impermeable layers without discontinuities [5].

2. MATERIAL AND METHOD

Measurements were done in the warehouses of the National Institute of Research and Development for Potato and Sugar Beat- Brasov. These determinations were made during the moths of December 2010 - April 2011, every week at approximately the same hour. The porpoise was to determine the warehouse inside and outside climatic parameters effect over five potatoes varieties and to establish which of these varieties is more suitable for storage in warehouses without automatic adjustment systems.
The climatic factors determination were measured with a VT300-KIMO (fig. 1) thermo-anemometer to which was attached a LV 107 anemometer (fig. 3) which uses a Hall Effect sensor. With this anemometer, the temperature and the airflow speed which is introduced through the floor holes were determined.

Figure 1: VT 300 thermo-anemometer

Figure 2: Thermocouple penetration probe type SFP-K

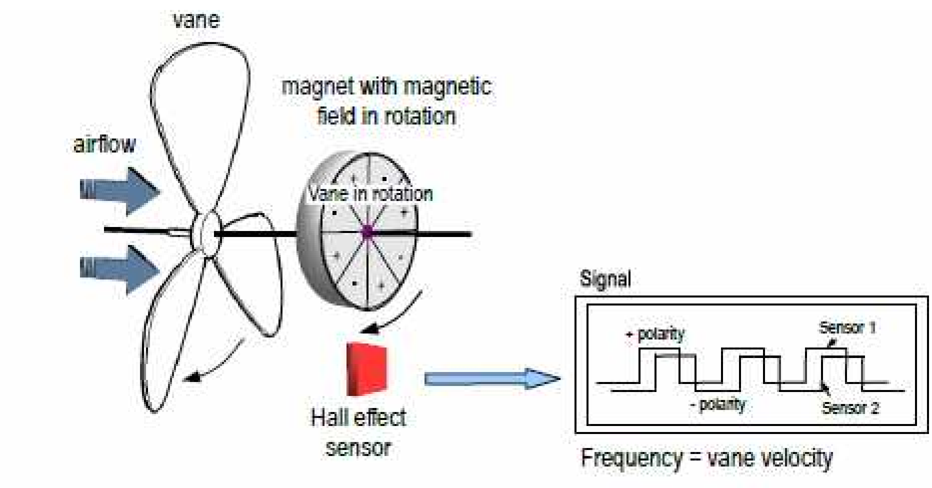

Figure 3: Anemometer type LV 107 working principle

To have correct data it was waited approximately two minutes until the mechanical ventilation installation routed the entire circuit at least one time and the ventilator engine reached the nominal power.
The interior and exterior temperatures of five tubers varieties were measured to observe how the climatic factors influence the storage duration. For a precise imagine from each variety were picked 20 potatoes, displaced at different heights. The exterior temperature was measured with the Fluke type 561 infrared thermometer and with the VT300-KIMO thermo-anemometer to which was attached the STP-K thermocouple penetration probe presented in figure 2, with which the internal temperatures were measured. Because the tubers exterior temperatures measured with the infrared thermometer were different to those measured with the thermo-anemometer it was realized a mediation between these two values for each measured potato [3], [6].

3. RESULTS AND DISCUSSIONS

In table 2 the temperature and airflow speed values are illustrated. The airflow is introduced into the warehouse through the perforated floor. The measurements started from the first ventilation hole and then every three meters for establishing the temperature and airflow speed variation regarding the distance from the ventilator.

Table2: Temperature and airflow variation

Measured parameter	Months in which measurements were done				
	December	January	February	March	April
I hole temp., ^oC	3.7	3.6	3.7	3.6	7.2
II hole temp., ^oC	3.9	3.5	3.7	3.6	7.2
III hole temp., ^oC	3.9	4.2	3.7	3.4	7
IV hole temp., ^oC	4	4.3	3.5	3.2	6.9
I hole airflow speed, m/s	1.4	1.6	1.3	1.2	1.3
II hole airflow speed, m/s	1.3	1.1	1	1	1.1
III hole airflow speed, m/s	1.1	1	0.9	0.9	1
IV hole airflow speed, m/s	0.8	0.7	0.7	0.6	0.8
Exterior temp., ^oC	2.1	1.4	2.2	3.1	8.6

In figure 4 the temperature and the airflow speed evolution, for each measured ventilation hole, are presented. It is observed that the airflow speed at different ventilation holes is approximately equal. Also, a very interesting fact is that although the exterior temperature is low these kind of mechanic ventilation which uses air from inside the warehouse combined with the outside air offers, during daytime, a optimal storage temperature.
When the exterior temperature is low there is tendencies of airflow temperature increase as the measurements are made further form the ventilator and when the exterior temperature is higher the airflow temperature decreases as the measurements are made further from the ventilator. Starting from April, when the exterior temperature increases considerably, the mechanic ventilation system becomes inefficient in assuring an optimal, constant storage temperature

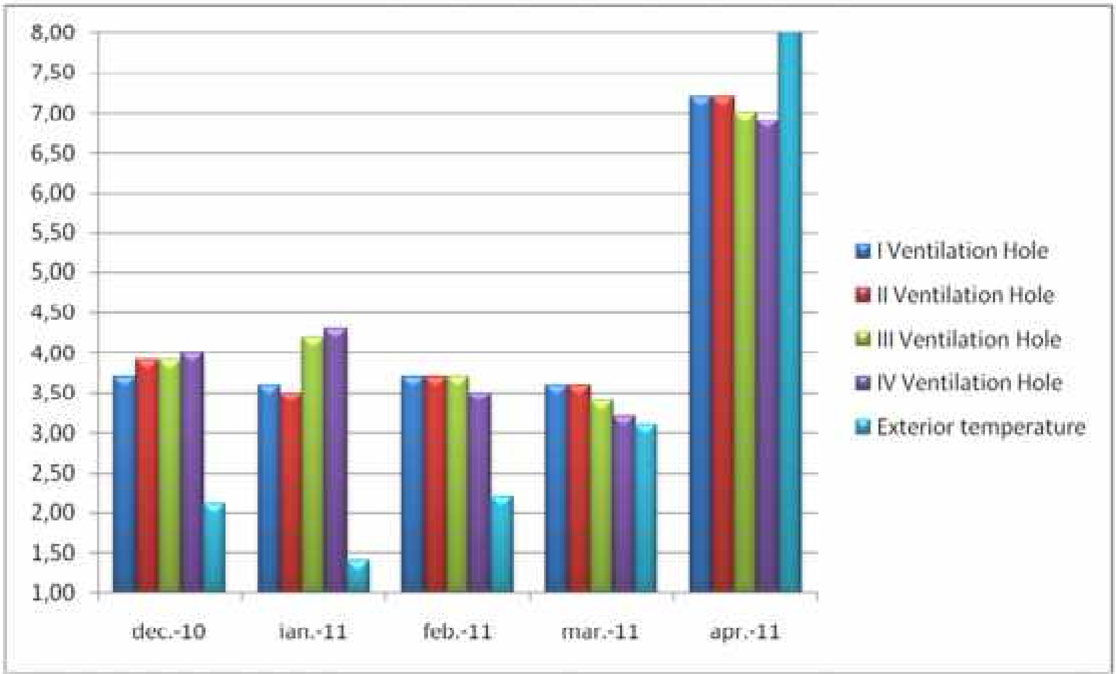

Figure 4: Temperature variation

In table 3 the exterior and the internal temperature of five potatoes varieties are presented. The measurements were made during five months. These values are the averages of 20 tubers from each variety, tubers placed at different heights.

Table 3: Potatoes internal and exterior temperature

Measured parameter	Months in which measurements were done				
	December	January	February	March	April
T. in Christian	3.2	3.3	2.1	2.2	8.2
T. in Tâmpa	3.7	3.7	2.2	2.4	9.1
T. in Alize	3.7	3.7	2.2	2.4	10
T. in Rustic	3.7	3.2	2.6	2.6	9.2
T. in Ostara	3.2	3.7	2.3	2.4	9.3
T. ext. Christian	3	4.7	2.6	2.8	9.7
T. ext Tâmpa	3.1	3.1	3.2	3.3	9.2
T. ext Alize	3.4	4	3.2	3.3	11.2
T. ext Rustic	3.1	4.2	3.2	3.3	9.6
T. ext Ostara	2.9	4.2	3.6	3.3	9.7

In figure 5 the exterior temperature of five potatoes variety during the months of December 2010 – April 2011 are presented and in figure 6 the internal temperature of the same potatoes variety in the same time period.

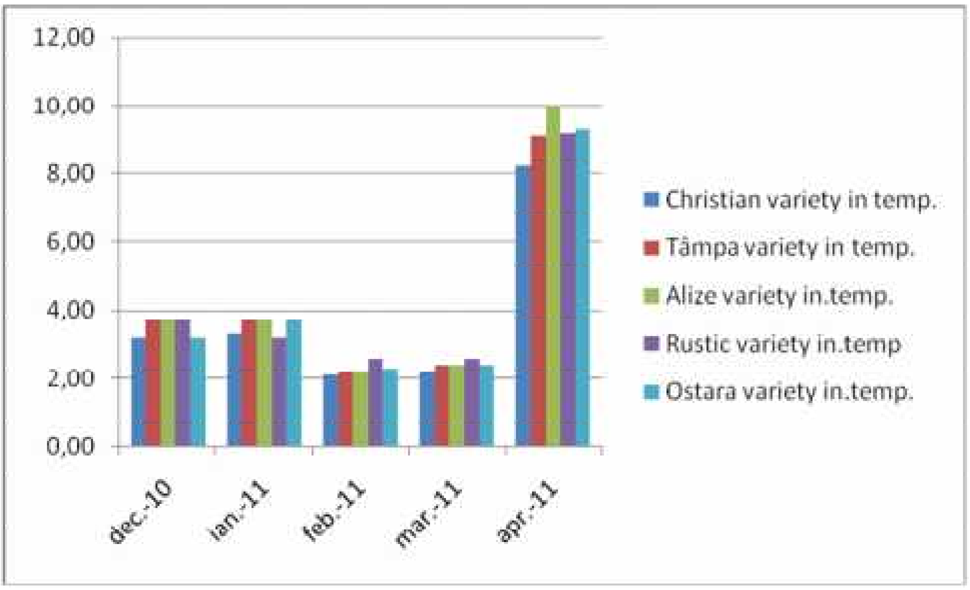

Figure 5: Potatoes internal temperature

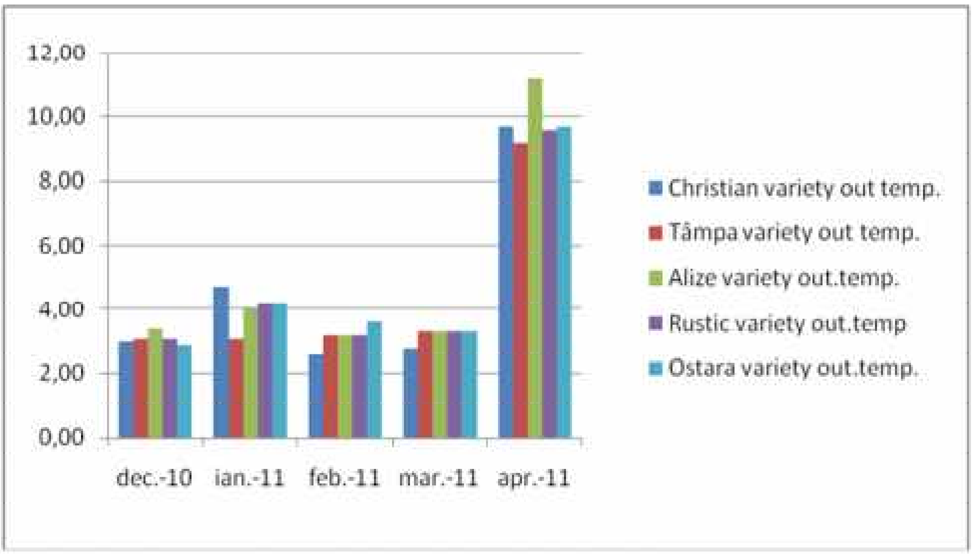

Figure 6: Potatoes exterior temperature

From these two figures it can be seen that during the winter months, when the outside temperature is small the internal and external potatoes temperature remains constant at an optimal value for storage. Christian variety has the biggest variation of the internal and external temperature, which makes it the most sensible studied tuber. Tampa and Alize varieties are suitable for long term storage in warehouses without automatic control systems because, as it can be seen, their temperature variation is small and remains in the optimal storage interval.

4. CONCLUSIONS

1. Due to the vegetative inactivity length period is a specific feature of the tuber variety and has no connection with the vegetative length period, an ineffective storage strategy can determine earlier exit from vegetative inactivity and may trigger sprouting.
2. As long as the exterior temperature does not exceed 7°C the mechanical ventilation system can assure an optimal storage temperature. Also these kinds of warehouses can be used in spring months for increasing the tuber seeds temperature before sowing.
3. To assure a constant speed of the airflow the ventilation holes should be smaller near the ventilator and as the distance from it increases so should increase the ventilation holes diameter.
4. Is recommended that before starting the ventilation system to read the exterior temperature and depending on its value the warehouse keeper may decide on the time the installation works and also on the exterior airflow volume.

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