RESEARCH ABOUT CONSUME OF ENERGY AND QUALITY OF PRODUCTS FOR COLD PRESERVATION OF CEREALS

CERCETARI PRIVIND CONSUMUL DE ENERGIE SI CALITATEA PRODUSELOR LA CONSERVAREA PRIN REFRIGERARE A CEREALELOR

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***Abstract**: In this paper we studied the possibilities of changing the technology of preservation of cereal by dryers with technology preservation by cold storage. It were made measurements to determinate the consume of electrical energy and ecological implication and also for determinate of quality parameters preserved by using of these two methods.*

***Rezumat**: In această lucrare este studiată posibilitatea înlocuirii tehnologie de conditionare a cerealelor prin uscare cu tehnologia de depozitare la rece. Au fost efectuate măsuratori privind consumurile de energie electrică şi implicaţiile ecologice precum şi pentru determinarea calităţii cerealelor condiţionate utilizînd cele două metode.*

Key words: *cold preservation of cereals, reducing of electrical energy consumed for cereals preservation, increasing of quality of cereals, environmental protection*
***Cuvinte cheie**: conservarea prin refrigerare a cerealelor, reducerea consumului electric utilizat la conditionarea cerealelor, cresterea calitatii cerealelor, protejarea mediului*

INTRODUCTION

The problem of storage of cereals without lost, or with minimal lost, eventually with increasing of quality parameters during the storage time, and with a higher reducing of cost per mass unit was issue of many research programs in the countries witch are cereals producers.

The main preoccupations for storage of cereals are to prevent the self-heating phenomena. Have been made propose different preventives measures, among them, after cleaning of cereals, in top is placed the reducing of moisture content of cereals under critical level, and cooling of cereals bulk. These operations are destined, not only to prevent self-heating, but also to create an unpropitious medium for growing and multiplication of harmful microorganisms.

For these purpose have been experimented the storage of cereals in controlled atmosphere with CO_2 or without air, and also in contact with some substances destined to reduce the activity of the microorganisms. Although these methods have good results, they could not be generalized in agricultural practice, which instead have adopted as basic method the dry-aeration. The porosity of bulk of cereals, the properties absorption and low thermal conductibility permits that by introducing the air at a some level of temperature and humidity through the cereals, these could be not only cooled by also dried.

In the last decades, after generalized of harvest of cereals using harvest combine, the artificial drying of cereals before storage in silo became increasing necessary.

Recently the accent is increasing in the guaranty of the food safety of cereals consume and also in increasing of quality of products (increasing of gluten content of the wheat). In that way was proceeding at utilizations of cooling equipments for cereals for preservation and for control of post-harvest process.

MATERIALS AND METHOD

The experiments have been made in Calarasi county in 2007 year. Have been analyzed a lot of winter wheat, Dropia variety, which have been harvested from one parcel who have applied a unitary, standard technology for winter wheat crop.

The harvest has been made in one day for all quantity, and has not register differences of the analyzed indicators at the harvest time. After that the quantity of winter wheat, have been divided into two lots at 162 t each.

The grains of first lot have been dried using a mobile dryer tip Riela model GTR 1500 up to the moisture content of 14% and after that have been stored into a cell with dimensions: length 9 m, width 6 m and height 4 m. The grains of second lot have been stored directly into a similar cell as first lot and cooled down using a mobile Granifrigor model KK140 device.

After 3-month storage time has been remade the laboratory analyzes about the quality of winter wheat and has noted the differences.

The measurements of moisture contents is make using a hygrometer SINAR AP, with an error of 0,1%. Is effectuate 20 measurements for each lots and is calculate the average. The difference among different measurements is covered statistically by error margins.

For measurement of consume of the electrical energy is used an electrical meter.

For humid gluten content measurement is used the method presented by Gh. V. ROMAN AND ALL. (2003).

The quantity of dry matter lost by post-harvest respiration process is calculated using mathematical equations of indirect method JOUIN (1964) modified by KOLB (2005).

Any storage of cereals involves a biological decay of the substance. In the mean while exist the risk of developments of harmfully insects. The both processes could be reduce by decreasing of temperature of storage, and could be eliminate by using temperatures below 8 ^{0}C. For these propose into the cereals bulk is blowing fresh refrigerated air. Using refrigerator device GRANIFRIGOR, the cereals are cooled down immediately after harvest (after introduce into the storage place), regardless of climacteric condition. That efficient method prevents depreciation of cereals newly harvested, which could self-heated due to self-respiration process. Into self-respiration process is eliminate carbon dioxide, water and heating – with important consequences: lost of dry matter, development of insects into cereals bulk, growing of fungus and microbial activity. Self-heating depends by moisture content and temperatures of cereals stored. Self-heating of cereals is causing often important havoc. The consequents norms of hygiene and the necessity of eliminate chemical treatments of cereals for food purposes are requests, which shall be fulfilled.

The blast-engines of cooling device GRANIFRIGOR exhaust the outside air. A refrigeration device cools down this air up to necessary temperature. The HYGROMAT device coupled after refrigeration device re-heated the air full automat mode. In that way is obtained a reduction of relative humidity of air and adaptation of air parameters to the bulk cereal condition. Is not allowed increasing of moisture content of air blow into the cereals bulk that could be extremely dangerous. This cool and dry air is compressed into cereals bulk using the funs. From windows made in the roof, the warm air charge by moisture content from cereals bulk is evacuated into atmosphere. Should not be using the environmental air for blowing into cereals bulk due to the hygroscopic property of cereals grain. These means that between the moisture content of grain and relative humidity of air is equilibrium due to temperature. In that way could appear increasing of moisture content of grain, if the humid air is blow into dry grain, and has as result depreciation of them. From these reasons, the dry-aerations depend highly by climacterics condition. Although, during harvest season, the ambient temperature of air is, in many times, to higher for these purpose.

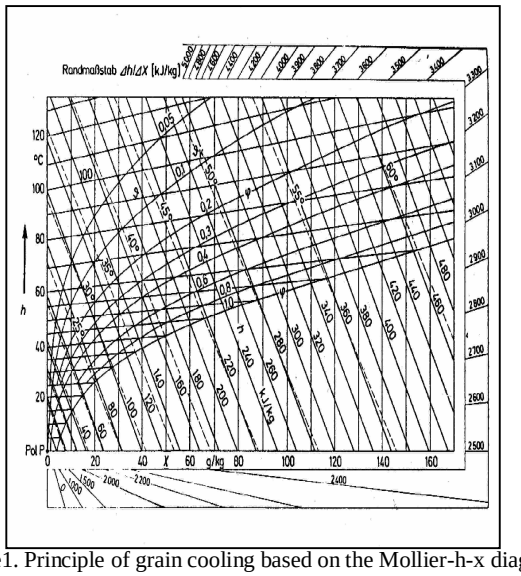

Figure1. Principle of grain cooling based on the Mollier-h-x diagram

The grain of cereals is alive, has respiration also after harvesting. By respiration process is consummated Oxygen, that oxidize the carbon hydrates from grain. It is eliminate Carbon Dioxide, water, and heating.

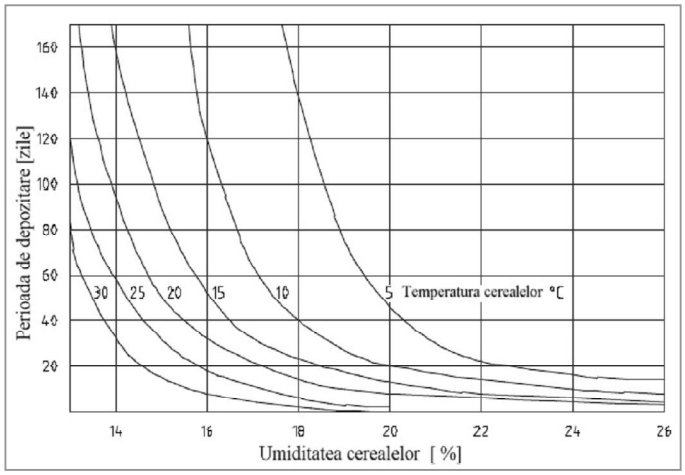

Figure2. Storage time of wheat at different moisture content and temperatures of grain (AGENA 1961)

Due to these process the dry matter is disintegrate and provoke weighing lost to cereals. The respiratory process increase with increasing of temperature and moisture content of cereals grain. The heating and moistures produced by respiration process of grain amplify the respiration process, which conduct to increasing of weight lost. Concomitantly is created

favourable conditions for developments of insects, fungus and bacteria, that conduct to increase of the risk of cereals degradation (BRUNNER, 1989).

$$C_{12}H_{22}O_{11} + 12O_2 \Rightarrow 12CO_2 + 11H_2O + 1.567x10^{-3}\ kWh \quad \text{(Kolb, 2005)}$$

RESULTS AND DISCUSSION

The results obtained during experiments are showed into Table 1. The storage at low temperature of winter wheat showed an increasing of humid gluten content, due to post-harvest phenomena, and consequently an increasing of quality of wheat for breading. In the meanwhile due to the respiration process of grain was registered a decreasing of quantity of dried cereals, stored in normal condition with 64 t from initially 10.000 t stored, and, for low temperature storage technology due to respiratory process the decreasing of quantity is only 18 t from initially 10.000 t stored.

Could be observed that by cooling process is decreasing the moisture content of cereals with 1%, without any supplementary costs. The grain dried by using the vertically dryer tip Riela Model GTR 1500, necessity an supplementary transport using screw conveyors electrically powered to the storage cell. These has a results increasing of electrical energy consume necessary to preserve the winter wheat using drying method, and to increase the cost of preservation.

Table 1

Results of parameters analysed in experiments

Parameters	Method	
	Drying	Cooling
Moisture content at harvest time %	17	17
Moisture content at storage beginning (after drying or after cooling) %	14	16
Humid Gluten content of cereals at storage beginning %	24	24
Moisture content of wheat after 3 month storage %	14	15.7
Humid Gluten content of cereals after 3 month of storage %	24	25.5
Lost of substance (dry matter) after 3 month storage %	0.64	0.18
Electrical energy consumed for preserve 1t of grain kWh/t	8	5
Electrical energy consumed for transport of grain after drying using belt conveyors kWh/t	1.5	0

In the bulk of cereals could be found pest that deteriorate the grain and cause big havoc. Some of those pest have adapted to condition of life from storehouses and silos and thrive only in grain bulk (grain weevil), others grows and attack the cereals into the storehouses and also into the field crop (Angoumois grain moth), and an other group of pest are growing in the field, infested the grain in field and continues their life into storehouse places. In springtime, the adult left the storehouses place, fly to the field crop, and re-infested the grain (THIERER AND ALL. 1971).

Infestation with pest of stored products has as results the quantity and very important quality lost, which conduct to exclusion of these grain from human been consumption. Therefore, prevent of infestation and fighting against insects and pest animals represent an important issue as part of preservation technology of agricultural products. (GH.V. ROMAN and all. 2003).

After harvesting, when agricultural product are stored, is necessary a periodically control of storage places and disinsection, due to the permanent risk of infestation with storage pests: insects (Lesser rice weevil - *Sitophilus oryzae*, Lessergrain borer - *Rhyzopertha dominica*, Confused flour beetle - *Tribolium comfusum, Tribolium castaneum*, Grain weevil - *Sitphilus granarius*, Cigarette beetle - *Lasioderma serricorne*, Saw-toothed grain beetle - *Oryzaephilus surinamensis*, Indian-meal moth - *Plodia interpunctella*, Dried bean weevil - *Achanthoscelites obsoletus* s. a.), spiders (Flour mite - *Acarus siro*).

The pest produces considerable damages to the stored products, by weight loosing, reducing of germination of seeds, modification of composition, aspect, and reducing of safety of alimentary use.

Using refrigeration of cereals at temperature below 10 ^{0}C is eliminating the necessity of chemical treatments of the stored cereals, and as results decreasing of risk from safety of alimentary use point of view.

Growing of microorganisms is accelerated by increasing of temperature. Is estimated an increasing from two to five times at the number of population of microorganisms for increasing of temperature with 10 ^{o}C above isotherm of 13 ^{o}C. Is many species of moulds from storage, with the optimum temperature for growing between 23 and 40 ^{o}C. The heat results in a respiration process of cereals has as results increasing of temperatures into cereals bulk, that conducts to accelerate growing of microorganisms, and accelerate depreciation of quality and quantity of cereals products.

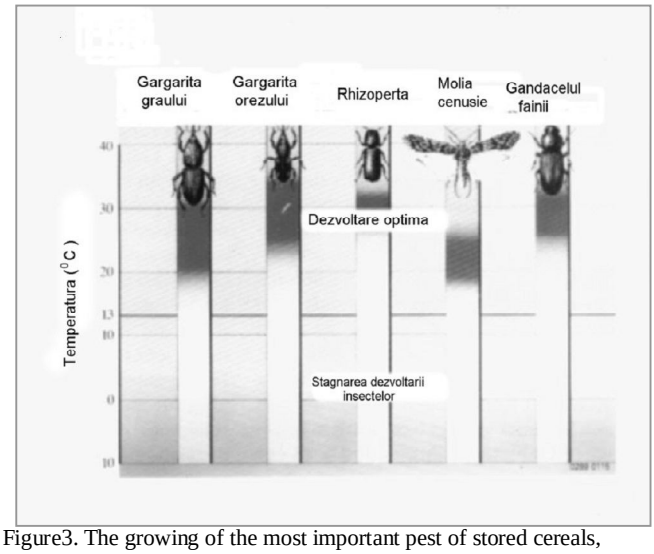

Figure3. The growing of the most important pest of stored cereals, due to ambient temperature *(Brunner, 1989)*

CONCLUSIONS

Experimental research showed the following advantage for using cooling of cereals against of drying of cereals: protection of cereals against of insects and spiders; increasing of safety alimentary consume by reducing using of chemicals; increasing of quality of grain by increasing of gluten content.

The consume of electrical energy used in cooling technology represent 52,60% of energy used in drying technology. That has as result decreasing by 50% of CO_2 emissions from producing of electrical energy in conventional power plant.

By changing the technology of conditioning of cereals from drying to cooling only for 1 million tones of cereals could be save 4.5 million kWh per year, at national level, which could have as results in reducing of CO_2 with 2,205 tones emissions from fossil fuels used in electrical power plant. That could be considerate also as an efficient environmental protection method and in the same time as a Good Agricultural Practice or a Good Environmental Practice.

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