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Influence of Ionic, Ozone, Ion-Ozone and Ion-Ozone Cavitational Treatment on Safety of the Leguminous Plants and Oil-Bearing Crops at the Storage

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Abstract: The given research is investigated the influences of ionic, ozone, ion-ozone and ion-ozone cavitational treatment on safety of the leguminous plants and oil-bearing crops, such as: peas, chick-pea, colza. During the research, it was revealed that for the leguminous plants, all types of treatment are positive and the processed cultures are preserved for a long time, than the control (non processed) samples. And for oil-bearing crops it is optimum an ionic treatment as ozone is oxidized fats of the oil-bearing crops. The ion-ozone and ion-ozone cavitational technology of grain treatment is used for the purpose of improvement of quality and providing of safety at storage of leguminous plants and oil-bearing crops, taking into account their efficiency.

Key words: Control sample, ionic treatment, ozone treatment, ion-ozone treatment, ion-ozone cavitational treatment, storage, leguminous plants and oil-bearing crops, peas, chick-pea, colza

INTRODUCTION

A grain is physiologically quite stable after harvesting and this stability as well as its viability should be preserved in a good storage method. Under natural conditions however, stored grain undergoes chemical changes within itself. Its further deterioration is caused by external living organisms, such as insects, microorganisms, molds, fungi, mites and rodents. The stored grain in bulk is a system in which deterioration results from interactions among physical, chemical, physiological and biological variables. Some of the variables are temperature; moisture; oxygen; storage structure; physical, chemical and biological properties of grain bulks; microorganisms; and insects, mites, rodents and birds (Chakraverty and Singh, 2004).

During of the long storage process there are taken place continuously the physiological processes with formation of the spontaneous heating centers as a result of ripening of freshly harvested grain, respiration of the grain mass and germination at casual ingress of moisture. All above-mentioned processes are increased development of microbiological processes: there are destroyed carbohydrate and albuminous, lipid connections and are reduced storage stability of leguminous plants and oil-bearing crops. Timely use of treating and improving ion-ozone cavitational treatment will lead to the end of development of undesirable processes at storage of grain crops (Mayemerov *et al*., 2011.

It is known a set of ways of postharvest grain treatment: disinsection, hydrothermal, ultrasonic, laser, drying, etc. Given work is presented the use of universal ion-ozone cavitational technology which provides a long storage safety of grain crops. Ionic, ozone, ion-ozone and ion-ozone cavitational treatment of grain allows to disinfect and destroy grain insects, at the same time, accelerates the redox processes and also on the basis of quantum-physical processes increases seed, technological, biochemical properties and in general a nutrition value of a product that promotes its effective use in a process. For increase of the preservation and grain quality at short-term and long storage it is most effective the line ion-ozone treatment in the cavitation zone, increasing intensity of technological processes that reduces expenses considerably and time for treatment of grain raw materials (Mayemerov *et al*., 2011; Iztaev *et al*., 2013).

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MATERIALS AND METHODS

Technique: We were conducted laboratory researches of the physical and chemical, biochemical, technological indicators and physiological processes, proceeding at storage of leguminous plants and oil-bearing crops: "Aksay usaty" peas, "Ekarda Elite" chick-pea, "Lipetsk" colza.

Sampling and laboratory analyses were made by the determination of the qualitative characteristics according to the requirements of Interstate standards before and after treatment of stored consignment of peas and also chick-pea, colza; State Standard 10858-77 "Seeds of oil-bearing crops". Industrial raw materials. Methods for determining the acid number of the oil, State Standard 10846-91 "Grain". Method of albumen determination, State Standard 10968-88 "Grain". Methods of determination of germination energy and ability of germination, State Standard 12038-84 "Agricultural seeds". Methods of determination of germinability. There was used the "Analyzer-AM 5100" device (Perten Instruments AB, Sweden) for determination of test value and grains humidity.

RESULTS AND DISCUSSION

Main part: Legumes such as soybean, peas, field beans and peanuts produce seeds that are naturally high in protein. These protein crops are an important source of protein in many parts of the world. Nonlegumes can also be used for seed protein production and include quinoa, cotton and sunflowers. Many crop species produce oil-rich seeds that can be processed for their oil. Oil crops produce oils that contain fatty acids that vary in saturation. Oil crops include soybean, flax, sunflowers, canola, peanuts and cotton. Soybean accounts for half of edible oil production (Sheaffer and Moncada, 2012).

Condition of the grain mass is physical and chemical characteristics connected with a ripeness and freshness of the main grain, humidity value, degree and character of dockage of grain, strain, temperature, a pest infestation, consequences of the field sickness and strain of spontaneous heating , grain drying. The greatest value has humidity from all conditions. Temperature, freshness of grain, pest infestation and also grain quality are depended from it. Depending on humidity, grain can be carried to one of the four groups: dry, average dryness, damp and humid (Yukish and Ilyina, 2009). Seeds humidity is very important indicator. Breath of seeds increases dramatically if the humidity is above the critical norm, they are spontaneous heated and contaminated, losing germinability. Conditioning humidity of grain crops and leguminous plants in the southern and dry areas makes 14%, oil-bearing crops is even lower: flax and colza of 8%. Seeds with conditioning humidity are well stored (Gataulina *et al*., 1995).

Use of electrophysical methods in food technologies allows lowering energy consumption and labor expenditures, water consumption, to reduce extent of pollution of external environment, to improve quality and to raise yield. The special attention is drawn by biological effects of electrophysical factors among which the most significant are antimicrobic and anti-fermental. Effect of electric and magnetic fields provides the expressed inhibition of microorganisms and also decrease of enzymatic activity in muscular tissue (Sagitov *et al*., 2012). In the medical institutions it is used the aeroionization method, providing suppression of bacteria activity, microscopic funguses, viruses and protozoan. For increasing of efficiency of grain use, the Kazakhstan scientists were developed the various electrophysical methods of treatment, storage and treatment of grain products: ionic, ozone and ion-ozone treatments of grain which are promoted to an improvement of quality and safety of grain. Adjustable impact on the biological environment of ion-ozone-air intermixture with use of ion-ozone cavitation allows to bubble intensively with activization and stimulation of biological grain environments and also to inhibit viruses, bacteria, cryptogamic formations with inhibition of processes of physiological and physical and chemical processes with suppression of their infectious activity (Mayemerov *et al*., 2011).

There were conducted the laboratory researches of indicators, characterizing biochemical, physiological and microbiological processes of leguminous plants and oil-bearing crops. The influences of factors on regime parameters of storage of leguminous cultures (peas and chick-pea) and oil-bearing crops (colza) with use of ozone, ionic, ion-ozone treatment without and with cavitation were experimentally proved. The humidity condition and the dockage of grain in many respects dictate the process of technological storage. Experimental study on humidity conditions were investigated separately:

- For peas and chick-pea: dry to 14.0%, average dryness >14.0-16.0%, damp >16.0-18.0%, humid >18.0%
- For colza: dry to 8.0%, average dryness >8.0-10.0%, damp >10.0-12.0%, humid >12.0%

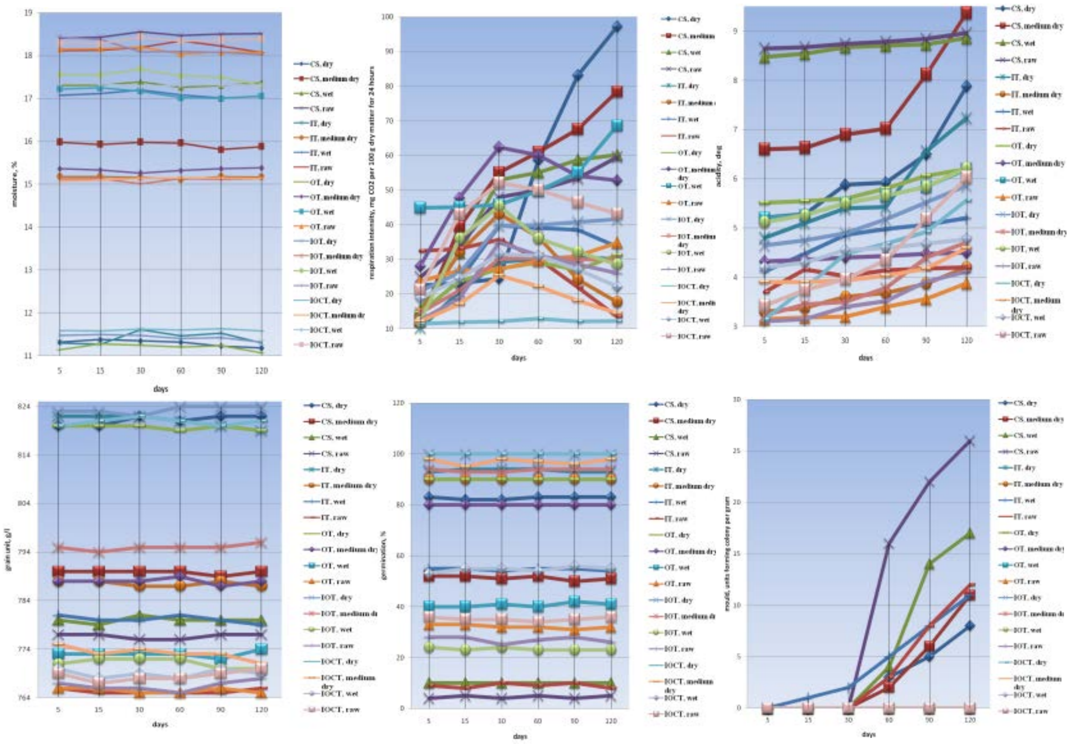

Fig. 1: Dynamics of change of moisture content, intensity of breath, acidity, test value, germinability and mold growth at different types of ion-ozone treatment of various condition of peas "Aksay usaty" grade in room temperatures of storage (T, °C = 18÷25)

Each humidity condition are separately processed by ion-air, ozone-air and ion-ozone-air streams with average regime parameters: treatment duration 20 min.; concentration of molecular ions 15000 U cm^{-3}, ozone concentration 2.0 mg m^{-3} and concentration of ion-ozone intermixture of 1.4 mg m^{-3} of ozone and 30000 U cm^{-3} of molecular ions in the ion-ozone-air environment.

At ion-ozone-air cavitational treatment, the pressure of ion-ozone-air intermixture was 3 atm. There were made on each culture 16 experiments and at cavitational treatment the number of experiences were made to 20.

After treatment by ions, ozone and ion-ozone streams without and with cavitation, the samples were put on storages into the room with a temperature over 18°C up to 25°C. Figure 1-3, there are given the results of a pilot study. Types of treatment and control samples in figures are reduced as follows: Control Sample (CS), Ionic Treatment (IT), Ozone Treatment (OT), Ion-Ozone Treatment (IOT) and Ion-Ozone Cavitational Treatment (IOCT).

It is followed, according to Fig. 1-3 that the special change of humidity in all groups and in all examples of oil-bearing crops and leguminous plants weren't observed.

Intensity of seed breath in control samples of leguminous cultures is increased from 3-8 times, than the treated samples. Protein content is increased from 0.5-1.5% at ion-ozone and ion-ozone cavitational treatment. Acidity in control samples is increased from 0.3-2.8° and at ozone, ion-ozone and ion-ozone cavitational treatment is increased from 0.1-2.6°, it means that the treatments, listed above, are reduced an grain acidity and prolongs their periods of storage. Test value is not changed and cultures of an average and dry, damp and crude condition are less than in dry samples. The samples, treated by ionic, ion-ozone and ion-ozone cavitational streams aren't exposed to molding. Formation of a mold is revealed in control samples in 60 days and in damp and crude grain, treated by ions, in 15 and 60 days respectively. Ion-ozone and ion-ozone cavitational treatment increases germinability of leguminous cultures. Germinability of samples of a dry condition, treated by these streams, was reached up to 100%. Also germinability of an average and dry, damp, crude condition in 2-3 times is higher than at control samples.
Storage of oil-bearing crops is difficult technological process which is created with low moisture content and high content of vegetable oil and in particular with the

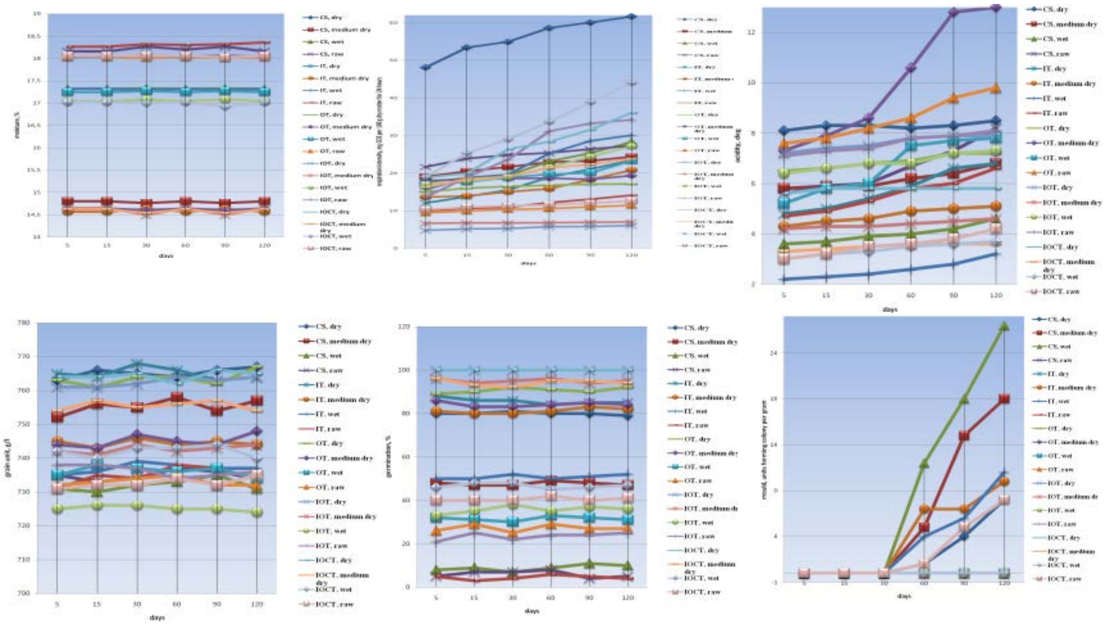

Fig. 2: Dynamics of change of moisture content, intensity of breath, acidity, test value, germinability and mold growth at different types of ion-ozone treatment of various condition of chick-pea "Ekarda elite" grade in room temperatures of storage (T, °C = 18÷25)

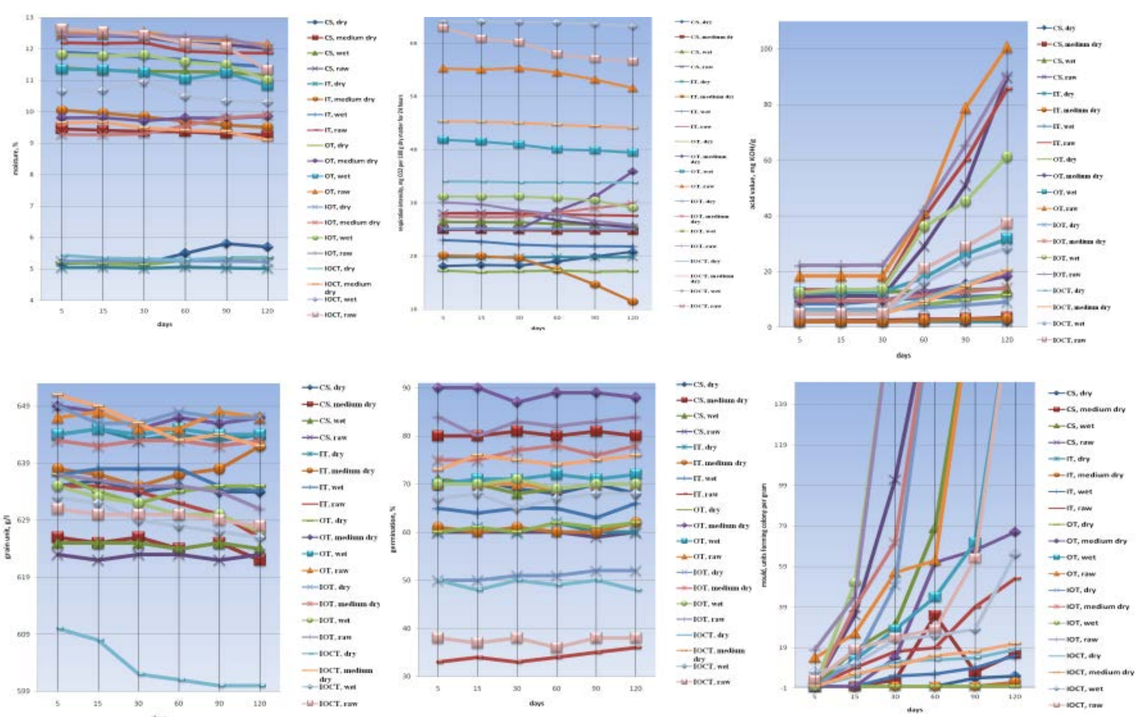

Fig. 3: Dynamics of change of moisture content, intensity of breath, acidity, test value, germinability and mold growth at different types of ion-ozone treatment of various condition of colza "Lipetsk" grade in room temperatures of storage (T, °C = 18÷25)

presence of unsaturated fatty acids. The analysis of data on a colza grade "Lipetsk" after 5, 15, 30, 60, 90, 120 days of storage are shown in Fig. 3. Control sample of a dry condition with increase of periods of storage on moisture content absorbs moisture from air and increases by 0.52%, also a sample of average dryness treated by ozone stream for 0.05%, a sample treated an ion-ozone stream is increased by 0.62% and moisture content isn't changed in the control and treated samples of a dry condition. Moisture content decreases from 0.1-1.5% in other examples of average dryness, a damp and crude condition. Intensity of colza breath is changed depending on moisture. Ionic treatment is more favorable for decrease in acidity of oil-bearing crops. Intensity of colza breath is changed depending on moisture. Ionic treatment is more favorable for decrease in acidity of oil-bearing crops. In comparison with a control sample an acidity of the treated tests by ionic streams is reduced on: 0.21 mg KON; 0.43 mg KON in a sample of average dryness; 2.61 mg KON in a sample of damp condition and in a sample of crude condition on 4.21 mg KON. With increasing of acidity, there is created a molding of grain of colza grades and it is reached the continuous growth of molds that is unacceptable at storage of oil-bearing crops. Only at ionic treatment of dry, average and dry condition, a mold is appeared in 120 days that is made 2 CFU g^{-1} and in damp sample in 30 days, in a sample a crude condition in 15 days. Test value of colza is remained without changes that are any treatments aren't influenced on safety of quality of oil-bearing crops. And germinability of the treated tests is increased in comparison with control test. Thus, the analysis of experimental data of Fig. 3 are shown that change of intensity of breath, acidity and on formation of a mold-ozone, ion-ozone and ion-ozone cavitational treatment isn't effective for extension of their period of storage. Only ionic treatment makes more favorable impact of not long-term storages of oil-bearing crops.

Storage is the difficult interconnected complex which behavior is based on regularity of change of physiological, biochemical and microbiological processes which in turn, define a qualitative condition of seed and technological properties of leguminous plants and oil-bearing crops. As a result of research, it is revealed that, during of ion-ozone cavitational treatment of leguminous cultures, ion-ozone mixture has negative polarity and leguminous cultures-positive, therefore according to the law of physics ion-ozone mixture and leguminous cultures interact more intensively, at the same time there is raised their physical and chemical, biochemical, seed and technological properties. As a result of research of leguminous cultures, it is revealed that high degree of seed safety, physiological and microbiological properties of leguminous cultures it is typical for, first of all, ion-ozone cavitational treatment, further ion-ozone, ozone treatment and to a lesser degree-ionic treatment. And also, it is revealed that for oil-bearing crops it is impossible to use ion-ozone treatment, this is because of at treatment, so oilseeds are oxidized and will lose the seed properties.

CONCLUSION

As a result of research it is established that ionic treatment is effective to a lesser degree for leguminous cultures, in comparison with other treatments. Ionic treatment is recommended to use for oil-bearing crops, it provides constancy of acidity level within three months in comparison with control and samples aren't exposed to a molding.

Ozone treatment is effective for extension of storage period of leguminous cultures but is undesirable for treatment of oil-bearing crops. Results of research of seed and physiological properties were shown stability at storage. Ozone treatment at certain modes increases seed properties of leguminous cultures and the mold isn't formed at dry, average dryness; it isn't found in a damp and crude condition within observed four months.

Ion-ozone treatment is influenced differentially on seed and physiological properties of leguminous plants and oil-bearing crops. At the same time, about two months it is possible to use it equally but further storage negatively influences on the storage indicators of oil-bearing crops that is acidity sharply increases and there is observed a formation of a mold.

It is established that ion-ozone cavitational treatment is the most effective way for extension of storage period of leguminous cultures, to improvement of microbiological purity and stabilization of seed and physiological properties at long storage and for oil-bearing crops it is necessary to use ionic cavitational treatment.

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