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INTERRELATION OF THE CRITERIA OF BEER WORT COLOR GRADE AND BARLEY GRAIN CONTAMINATION RATE

Abstract. There is an interconnection between grain color grade and contamination rate. The purpose of this work is to research the influence of ion-ozonic explosive cavitation on barley grain contamination and wort color grade. It has been revealed that brewing barley grains without any treatment have the first degree of contamination, and the wort received from epy malt of these grains does not correspond to the quality regarding indicators of transparency and color grade. Meanwhile, the treated samples had no degree of contamination and the wort conformed to the requirements of the standard.

Keywords: grain, barley, wort, contamination, transparency, color grade, ion-ozonic explosive cavitation.

Introduction. The main thing in barley grain production is high-quality treatment, receiving an environmentally friendly product, high-quality storage, barley seed processing into malt and beer with prevention of distribution and activity of the corresponding microorganisms in them [1]. Mites are the most widespread pest of brewing barley which sizes do not exceed 1 mm. Mites like heat and moisture, favorable temperature for their reproduction is 18-30 °C. For brewing, only the first class of contamination is admissible, and they try to use such grain as soon as possible.

Also, the weevil that eats the inside of the grain is very dangerous to barley, and any degree of contamination evidences about unfitness of barley for malting [2]. Body length of weevils together with the proboscis is from 3 to 5 mm. The linear sizes of grain microflora (viruses, yeast, bacteria, mold fungi) are from 100 nanometers (nm) and above. The sizes of insect pests make from 1 000 000 to 10 000 000 nm [3].

Historically, bactericidal treatment at processing enterprises generally is carried out by chemical reagents [4]. For example, an antioxidant – ascorbic acid, which slows down the growth of grain pathogens, is used as a chemical reagent [5].

Using such substances often makes an undesirable impact on the product; its taste, pH and other parameters change; it can be followed by emergence of cancerogenic compounds. For a long time there was no alternative to use of chemicals [4].

Now the modern science and practice has a wide range of ways of treatment. One of such ways is the use of radiation. Different sources of radiation are used for radiation of foodstuff: radioisotopes (cobalt-60 or caesium-137) and accelerators of electrons. Radiation leads to suppression of activity or death of insects and pathogenic microorganisms, and that gives the chance to increase safety of products and to increase the storage periods of substances [6-8].

Modern methods of grain disinfecting during malting also include the promising method of processing in an ultrahigh frequency electromagnetic field [9].

The research in the field of microbiology should be also noted: scientists from Germany have suggested using lactic bacteria as a starting culture for improvement of biological and technological properties of barley malt. All treated barley samples have shown considerable decrease in aerobic bacteria

(by 99,8 %) and stimulation of growth of yeast in comparison with untreated control [10]. In Thailand, Bacillus megaterium powder, which is dried up by dispersion, is intended for fight against the diseases affecting rice. Powdered skim milk which is a part of this powder keeps viability of cells, protecting the cells from a sharp loss of free water and a change of temperature during storage [11].

Formation of beer mash color grade is closely connected with the degree of contamination of barley grain. Color grade is one of the most important parameters of brewing malt quality [12]. Color grade of wort indicates the quality of malt from the perspective of its suitability for production of light beer. In the «color grade» concept, not only the characteristic shade is important, but also transparency, existence or lack of color range [2].

Ion-ozonic explosive cavitation is a new step to effective, environmentally friendly, reliable production free from chemical disinfectants.

Death of bacteria happens due to oxidation of proteinaceous and lipidic structures, and also other inclusions of colloidal appearances which form the external cover and the cytoplasmatic membrane. Charged particles, getting in a biological cell of a bacterium, break the cell's energy balance, i.e. doom the bacterium to unproductive activity, and the bacterium perishes.

Death of viruses during ion-ozonic explosive cavitation happens due to oxidation of the protective protein coat of nucleic acids which form living cells of viruses [13].

Objects and methods of research. We have investigated the brewing barley of Sanshain grade, German selection, but which had been grown up in Kazakhstan and used for production of malt. Sampling and laboratory analyses were carried out according to the requirements of State standard:

1) barley for brewing in accordance with State standard 5060-86 «Barley for brewing. Specifications» [14];

2) light barley malt in accordance with State standard 29294-92 «Brewing barley malt. Specifications» [15].

Contamination by pests in accordance with State standard 13586-4-83 «Grain. Methods for determination of infested grain and its damage» [16], using the corresponding screen set (the top screen with openings of 2,5 mm, the lower one – with openings of 1,5 mm). 1 kg of barley was screened using the screens during 2 minutes. If grain temperature was lower than 5 °C, the received screenings and the undersize were warmed up to the temperature of 25-30 °C, until insects begun to move, then counted the number of weevils and mites [17].

Also, the degree of contamination was controlled by means of the Indicator of grain and grain products contamination by pests of IZS type representing «Lozar» set of special traps and bars for their immersion. In the store of traps, they placed a food bait for insects who, in turn, attracted by the smell of baits, got through openings to the store and remained in it. Then, after a certain period of time, they took the traps out from the bulk-grain and defined the number and the species composition of insects [18].

Color grade and transparency of wort were determined with the use of a spectrophotometer. Measurement of optical density was made at 430 nm, and color grade in ABS units was received by multiplication of optical density by the known coefficient. The wort was clarified before the analysis. If wort turbidity was higher than 1 ABS unit, it was filtered to full transparency. To define whether the studied sample is transparent enough, they measured its optical density at 700 and 430 nm (A_{700} and A_{430}). If $A_{700} \leq 0{,}039\ A_{430}$, then the sample was considered transparent. Color grade was defined by measuring optical density at 430±0,5 nm in relation to water in ditches 5 or 10 mm thick.

Wort was diluted so that optical density would be within the linear dependence field «optical density – malt concentration» (value to 0,8). Preliminarily, they checked optical density on water in the spectrophotometer which had to make 0,00.

Color grade (C, in ABC units) was calculated using the following formula:

$$C = A_{430} F \cdot 25,$$

where A_{430} – light absorption at 430 nm in a 10 mm thick ditch; 25 – coefficient; F – dilution factor [19].

Barley was treated using an ion-ozonic explosive cavitation installation. Input parameters were as follows: ozone concentration 2, 4, 6 mg/m^3, ion concentration – 500±20, 50250±250, 100000±25 un/cm^3 (ion-ozonic mix), explosive cavitation – 2, 4, 6 at, exposure of 5, 10, 15 minutes.

The accepted plan of active planning of the experiment has allowed to receive the influence of three factors on grain disinfecting under eight options of experience. Data processing was made by means of Mathcad 140 program.

Results and their discussion. Grain contamination is important as it can result in possible risks for health in cases of consumption of polluted grain in human foodstuff [20]. The purpose of comprehensive protection of plants is to consider all available methods which suppress the development of harmful organisms. Many methods of indirect protection can be more effective and cheap than use of pesticides [21]. Ion-ozonic explosive cavitation treatment has shown its efficiency during our research.

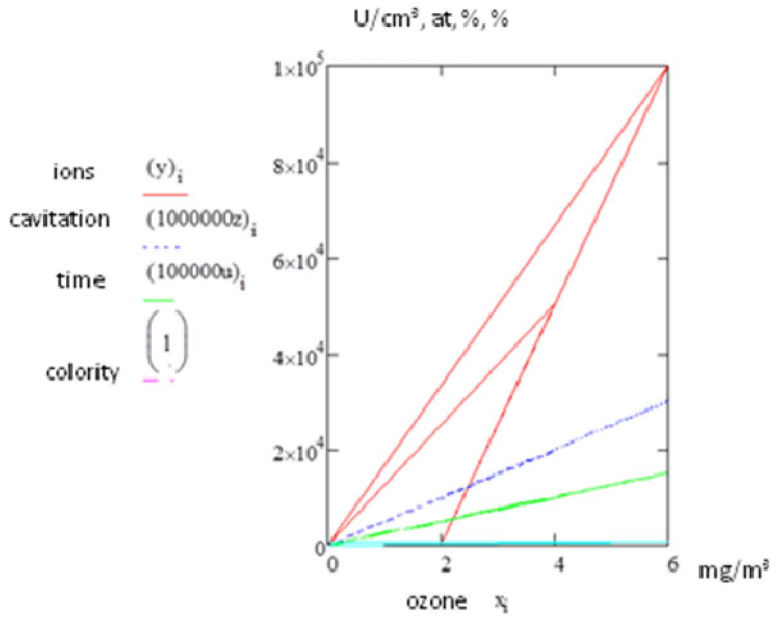
When studying barley contamination by insect pests, it has been revealed that the number of mites and weevils after grain treatment by ion-ozonic explosive cavitation equals to zero, while the control sample had the first degree of contamination (2 weevils and 15 mites) [22].

It should be noted that scientists from China investigated the influence of high hydrostatic pressure treatment on physical-chemical and sensory characteristics of wheat beer during which its impact on microorganisms has been studied. It has been revealed that an alternative to heat treatment is high hydrostatic pressure treatment which can effectively lead to destruction of microorganisms in order to increase safety and to extend storage periods of foodstuff [23].

The color grade indicator of laboratory wort can also characterize the quality of soluble malt. During investigation of wort color grade (l) with the use of Mathcad 140 program, it has been revealed that the entered parameters allowed receiving a mathematical functional dependence of this indicator with the analytical expression describing this criterion [24]:

$$ffl(w):=d_0 + d_1w^2 + d_2w^3 + d_3w^3 + d_4w^4 + d_5w^5 + d_6w^6 + d_7w^7$$

As a result, we received a schedule (figure) constructed on experimental points: $l:=l$.



The diagram, constructed on experimental points by determination of color grade criterion

Measurement of color of the wort received from malt is one of the most important quality parameters which are subject to control [25]. Superior quality light malt has to have color grade no more than 0,18 ABS. According to our research, color grade of the laboratory wort control sample makes 1,687 ABS; that of test samples processed at high parameters – 0,200-0,240, and that of samples with low parameters of processing – 0,028-0,075 ABS. As this research has shown, ion-ozonic explosive cavitation exerts positive impact not only on the color grade of laboratory wort, but also on its transparency. The wort prepared from processed malt samples was transparent, unlike the control sample which had slight opalescence.

It can be connected with the fact that, the control sample had the first degree of infection during determination of contamination by pests. It is known that wort transparency depends on microbiological quality of barley. Pollution of barley by fungi, insects, and bacteria results in turbidity of the initial wort [25].

Conclusion. The received results show that, within the range of the set processing parameters (ozone concentration of 2, 4, 6 mg/m^3, that of ion – 500±20, 50250±250, 100000±25 un/cm^3, explosive cavitation – 2, 4, 6 at, time – 5, 10, 15 minutes), insect pests, their larvae, various viruses and bacteria perish.

It is necessary to emphasize that molecular ions of air oxygen are activated, and atomic ions are suppressed, i.e. a weak or sick cell is affected. Therefore there is an increase in epy biological value of grain products. Ozone is a powerful oxidizer – it is the strongest disinfectant in nature. Ozonization destroys everything, including pathogenic bacteria, viruses and microorganisms. Ozone dissolved in water has a preserving effect. Thus, comprehensive ion-ozonic processing of grain in the cavitation zone has a disinfecting effect, destroys insect pests, increases the product's biological value, increases stability against external influences, promotes improvement of viability, and reduces humidity by 2-3 %. Cavitation itself strengthens the positive influence of ion-ozonic processing on grain properties [26].

Theoretical justification of experimental studies shows also that, as a result of destruction (oxidation) of coloring agents, the criterion of color grade has changed to the norm – from 1,687 to 0,028 %.

The research results have shown that, as a result of treatment, the best concentration of ozone when determining the criterion of color grade was 2 mg/m^3, that of molecular ions – 500 un/cm^3, excessive pressure during cavitation corresponded to 2 at, the best exposure time – 5 minutes.

Ion-ozonic explosive cavitation, having an efficient sterilizing effect, allows reducing expenses on disinfecting substances, reduces consumption of energy resources, promotes obtaining social benefit and profit arising due to creation of a qualitative, safe and environmentally friendly ready-made product of increased biological value [27].

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АРПА ДӘНДЕРІНІҢ ЗАРЯДТАЛУ ДӘРЕЖЕСІ МЕН СЫРА АШЫТҚЫСЫНЫҢ ТҮСТІЛІКТЕРІ КРИТЕРИЙЛЕРІНІҢ ӨЗАРА БАЙЛАНЫСЫ

Аннотация. Дәндердің түстілігі мен зарядтылығы арасында байланыс болады. Осы жұмыстың мақсаты болып арпа дәні мен сыра ашытқысының зарядтылығына иондыозондық жарылыстыкавитациялық әсерін зерттеу табылады. Сыра қайнататын арпа дәнінің қандай да бір өңдеусіз зарядтылықтың бірінші дәрежесінде болатындығы, ал осы дәннің уытынан алынған сыра ашытқысы сапа жағынан түстілік пен мөлдірлік көрсеткіштеріне сәйкес келмейтіндігі анықталды. Ал өңделген үлгілерде зарядтылықтың дәрежесі болмаған және сыра ашытқысы стандарт талаптарына сәйкес келеді.

Түйін сөздер: астық, арпа, сыра ашытқысы, зарядтылық, мөлдірлік, түстілік, иондыозондық жарылыстыкавитациялық.

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ВЗАИМОСВЯЗЬ КРИТЕРИЕВ ЦВЕТНОСТИ ПИВНОГО СУСЛА СО СТЕПЕНЬЮ ЗАРАЖЕННОСТИ ЗЕРНА ЯЧМЕНЯ

Аннотация. Существует связь между цветностью и зараженностью зерна. Целью данной работы являлось исследование влияния ионоозонной взрывокавитации на зараженность зерна ячменя и цветность сусла. Выявлено, что зерно пивоваренного ячменя без какой-либо обработки имеет первую степень заражения, а сусло, полученное из солода данного зерна, не соответствует качеству по показателям прозрачности и цветности. В то время как обработанные образцы не имели степени заражения и сусло соответствовало требованиям стандарта.

Ключевые слова: зерно, ячмень, сусло, зараженность, прозрачность, цветность, ионоозонная взрывокавитация.

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