Influence of the application of alternating impulses of pressure on the quantitative sensory analysis of pure water, associated liquid aqueous systems and solutions

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Abstract

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Introduction. The purpose of research is to determine the effect of alternating impulses of pressure on the quantitative sensory analysis of samples of the pure water, associated liquid aqueous systems and solutions.

Materials and methods. Pure water and associated liquid aqueous systems and solutions were used for investigations and analyzing the change of their physical and chemical parameters and properties during the treatment and processing by the different methods and technological modes. Electrochemical analysis methods were used. A quantitative sensory analysis of the experimental liquid samples of pure water and associated liquid aqueous systems and solutions was performed.

Results and discussion. It is established that a great variety of methods of liquid systems and solutions treatment are widely used in different branches of food industry. The physical and chemical properties and parameters of water, and liquid mediums, such as: oxidation-reduction potential, pH value, dissolved oxygen and etc. may be changed by the physical methods of energy influence. As a result of the water treatment in the conditions of alternating impulses of pressure throughout 1s gave the opportunity to increase general score of a quantitative sensory analysis on 12,12%, the water treatment in the conditions of alternating impulses of pressure throughout 30s gave the opportunity to increase general score of a quantitative sensory analysis on 3%, the water treatment in the conditions of alternating impulses of pressure during 60s gave the opportunity to increase general score of a quantitative sensory analysis on 9%. It ought to be distinguished that the taste, odor, appearance, color of water has improved in comparison with the control liquid simple of water.

Conclusions. According to the results of organoleptic studies, it is established that water has a higher tasting score and improved organoleptic parameters, which has a positive effect on the quality of the finished product, as compared to the control samples, which obtained by the technology of the enterprise.

Introduction

At the present time organoleptic methods objectively, quickly and reliably give an overall assessment product quality. Touch control allows you to quickly and purposefully affect all stages of food production.

Intensification of agrarian sector and food technologies, application unconventional types of raw materials and new technologies lead to changes, usually negative flavoring properties, texture and other organoleptic food quality indicators.

It is allowing you to quickly and purposefully affect all stages and operations of food production.

Using of innovative technologies gives the possibilities to reduce the energy and recourses consumption of food production. The method of the alternating impulses of pressure may be suitable for technology of water treatment for food and foodstuff production.

The purpose of this scientific work is to investigate the influence of the application of alternating impulses of pressure throughout treatment in foodstuff production by the quantitative sensory analysis of samples of the pure water and associated liquid aqueous systems and solutions.

Materials and methods

Materials

Objects of research are different types of treatment and processing methods end modes of liquid water systems and solutions like as technological water for the application in food industry.

Subjects of study are the changing of the physical and chemical parameters and properties of liquid water systems and solutions which can form hydrogen bonds and associates of different variety [1].

Pure water and associated liquid aqueous systems and solutions were used for investigations and analyzing the change of their physical and chemical parameters and properties during the treatment and processing by the different methods and technological modes. [2]

Experimental installation

The object of this scientific research work was rotary pulsed apparatus in which liquid solutions treat by alternating impulses of pressure, the speeds of shift of a stream, pressures of shift of a stream. Rotary pulsed apparatus was the cylindrical type with the working parts «rotor-stator-rotor» [3].

Methods

General scientific methods and special methods, such as electrochemical analysis methods were used for the analyzing of the results of research work [4].

For the description of physical and chemical parameters of liquid samples of water and solutions which obtained throughout the experimental investigations, chemical methods described in singular literature are used [5]

A quantitative sensory analysis of the experimental liquid samples of pure water and associated liquid aqueous systems and solutions was performed [6].

For the reception related data, liquid samples of water and solutions were analyzed not less than three times with the following statistical processing [7].

Results and discussion

There are many methods of water treatment for changing chemical and physical properties and parameters. In recent years researches and technologists and engineers have turned their interest to employment of the innovative non-traditional technologies and methods in processing of the liquid mediums, solutions, systems, which consists of the water or water solutions.

The physical and chemical properties and parameters of pure water and associated liquid aqueous systems, solutions and mediums, such as: oxidation-reduction potential, pH value, dissolved oxygen and etc. may be changed by the physical methods of energy influence.

The application of sonication treatment using audible sound (20-75 Hz) showed to have a positive effect to improve the quality and consumer acceptability of carbonated water due to the effects of audible wavelengths which increase pressure within the bottle and, therefore, modifies bubble size during formation [8].

That's why hydrodynamic effects occur at water and water binary systems and different water mixtures and solutions treatment by physical and mechanical methods or so-called non reagent (reagentless).

The method of alternating impulses of pressure is one of physical methods of treatment with many hydrodynamic effects, such as power of pressure of shift, cavitations, the effect of explosive boiling, collective effects in assembly of vials, crossness of an interphase surface in gas-liquid bubbly medium, action of hydrodynamic oscillations, alternating impulses of pressure, effects which associated with acceleration of movement of a continuous phase.

The most important effects of the alternating impulses of pressure are allied with increase of velocity of association of a continuous phase of medium.

The method of alternating impulses of pressure can influence on structural and energy transformation in multifarious liquid mediums on micro- and nano- level and gives opportunity to begin physical and chemical alteration in these mediums.

The fundamental nature of alternating impulses of pressure consists in that preliminary permanently entered and any rank the energy distributed in working to accumulate in locally disconnected discrete points of system and further pulse to realise for achievement of necessary physical effects:

- Forcing and dumping of pressure;
- Adiabatic boiling;
- Hydraulic blow;
- Shock waves of pressure or depression;
- Pressure of shift, local turbulence;
- Cavitation and many other effects [9].

Three-dimensional and period concentration of energy gives the possibility to receive the big capacity of pulsation power accomplishment, to release internal energy of substance, to create active energetic processes which take place at microlevel and also at nanolevel.

The development of different microliquid devices for some last decades has caused growth of interest to microscale streams. Rotary pulse apparatus are characterised by small enough sizes of width of channels which gives the possibility to consider them as microchannels with effects of slippage a watercourse on walls and surfaces.

A number of heat and mass technological processes (structuring, crushing, dispersion, emulsification, homogenization, mixing, etc.) are spend in rotary pulse apparatus of cylindrical type which realise principles of alternating impulses of pressure.

Investigating of new methods, apparatus and industrial technologies are concentrating on raise of an overall presentation of procedure and an increase of processes in environments

which involves complex researches on learning of hydrodynamic conditions, modelling of processes in new devices.

In this context, research methods of analysis are very important since this is the main tool for obtaining data. One of the key positions belongs to the sensory analysis method.

The potential value of sensory analysis has often been undermined in the food industry and in foodstuff production. A great variety of forms of sensory-related work can provide an important investigative and informative function in a great number of different areas [10].

Specialized research techniques are available to measure, understand and optimize consumers' sensory experiences, so that products can be designed and marketed to meet consumers' sensory needs, thus reducing the risk of product failure. This scientific field is known as sensory evaluation [11].

It can be production of different types of products: drinks, beverages which include:

- Beer;
- Carbonated water;
- Carbonated soft drinks;
- Sparkling wine, among;
- Others, liquid food goods which can consist from dissimilar solutions.

Emerging technologies, based on the combination of robotics, computer vision, and machine learning as an approach to artificial intelligence, have been developed and applied for the assessment of beverages and beer and, to a lesser extent, sparkling wine [12].

Traditionally, sensory evaluation has often been associated with product experts and specialists, and afterward as a more passive member of the product development team.

Currently, the new challenges facing the food industry are progressively transforming sensory to a more proactive role, responsible for generating new product ideas based on unique sensory properties or unique consumer segments identified only through sensory behavior [13].

Choice of sensory method should be based on better methodological data on how methods perform and at what cost in resources. There is a need for more methodological research to establish the reliability and validity of sensory methods [14].

Nowadays for a continuous monitoring with fast response times and low cost, new measurements techniques have been developed through Electronic Noses (E-noses), given that they are an alternative instrumental measurement, replacing the conventional methods used for the detection and bacteria identification in different types of samples [15].

According to the investigations carried out during the last years about the electronic noses, it is important to mention that this equipment can be used for specific analysis, identification and recognition of complex smells and volatile organic compounds [15].

So authors can show after this sensory analysis and wine tasting that the anti-transpirant product does not affect the wine notes and their characteristic structure [16].

Sensory analysis gives the ability to generate sensory and chemical profiles of commercial wines, and to identify many sensory characteristics for wine: stone fruit, dried fruit, citrus, herbaceous, grassy, apple/pear, confectionary, vanilla, creamy, buttery, wood, and toasty [17].

The sensory analysis revealed a clear vintage, closure and glutathione effect on wines oxidative character after several years of bottle aging [18].

To address the issue of the role of vine water deficit in the overall quality of fine aged wines, a large set of wines from four Bordeaux appellations were subjected to sensory analysis [19].

Fermentation process parameters: pH, total acidity and yield of biomass; chemical composition: organic acids, total phenols and flavonoids and vitamin C content and sensory analysis indicated that SWE were more suitable substrates for successful fermentation [20].

Consequently, the measurement and monitoring of final product quality factors and features are critical for the production of all types of carbonated beverages and drink products.

Taste and odor problems in drinking water frequently occur because of many compounds present in the water [21]. Physical and chemical analysis helps determine this.

Quality control, mainly focused on the assessment of bubble and foam-related parameters, is critical in carbonated beverages, due to their relationship with the chemical components as well as their influence on sensory characteristics such as aroma release, mouthfeel, and perception of tastes and aromas [12].

Microorganisms in drinking water contribute largely to taste, and odor production and drinking water distribution systems are known to harbor biofilms and microorganisms in bulk water, even in the presence of a disinfectant [22]. Importantly, the understanding of types of these microbes and their taste, and odor compound-producing mechanisms is needed to prevent taste, and odor formation during drinking water distribution [22].

Also sulfide and polysulfides are strong nucleophiles and reducing agents that participate in many environmentally significant processes such as the formation of sulfide minerals and volatile organic sulfur compounds.

Their presence in drinking water distribution systems are of particular concern and need to be assessed, since these species consume disinfectants and dissolved oxygen, react with metal ions to produce insoluble metal sulfides, and cause taste and odor problems [23].

To identify the cause of off-odor in bottled water is necessary special methodology. For initial screening, sensory analysis and gas chromatography with mass spectrometry and olfactometric detector were used.

Selected compounds were then analyzed and quantified by selective ion monitoring. 2,4-decadienal, a fatty acid oxidation product, was identified as the source of off-odor [24].

Descriptive sensory analysis is conventionally conducted using a trained panel and has the purpose of developing the sensory profile of a product by evaluating the intensities of the major descriptors.

This category of sensory analysis is more often than not used in innovative product enlargement and to assess the quality of the same formulation in the unusual batches produced.

A quantitative sensory general score of water treated under alternating impulses of pressure depending on the processing time or the duration of treatment.

Comparative analysis of samples of the pure water and associated liquid aqueous systems and solutions was used for data processing.

Control liquid samples of water were used for comparative analysis. These were samples obtained according to the enterprise standard methodology.

The general score of control samples was 16,50 and the general score of water solutions which was treated in conditions of alternating impulses of pressure was 18,50 (Figure 1).

In general course an effect of the water treatment in the conditions of alternating impulses of pressure during uninterrupted mode throughout 1 second gave the opportunity to increase general score of a quantitative sensory analysis of water on 12,12%.

It ought to be distinguished that the taste, odor, appearance, color of water and water solutions has improved in comparison with the control liquid simple of water and water solutions.

As a result the general score of control samples was 18,00 and the general score of water which was treated in the conditions of alternating impulses of pressure was 18,5 (Figure 2).

Figure 1. Tasting evaluation of water samples with processing time 1s:
a – liquid samples of water which was treated in the conditions of alternating impulses of pressure;
b – control liquid samples of water

a

b

Figure 2. Tasting evaluation of water samples with processing time 30s:
a – liquid samples of water which was treated in the conditions of alternating impulses of pressure
b – control liquid samples of water

The results of research investigations demonstrate that the application of the water solution treatment in the conditions of alternating impulses of pressure throughout 30 seconds gave the opportunity to increase general score of a quantitative sensory analysis of water on 3%.

It ought to be distinguished that the taste of water and water solutions has improved in comparison with the control liquid simple of water without any treatment.

In wide-ranging course the general score of control samples was 17,00 and the general score of water solutions which was treated by alternating impulses of pressure was 18,5 (Figure 3).

a

b

Figure 3. Tasting evaluation of water samples with processing time 60s:
a – liquid samples of water which was treated in the conditions of alternating impulses of pressure
b – control liquid samples of water

During the scientific work the result of the water solutions treatment in the conditions of alternating impulses of pressure during 60 seconds gave the opportunity to increase general score of a quantitative sensory analysis and tasting of water and water solution on 9%.

It should be noted that the taste of water has improved in comparison with the control liquid simple of water.

The general score of control samples was 17,00 and the general score of water treated by alternating impulses of pressure was 18,5 (Figure 4).

The duration of the water treatment in the conditions of alternating impulses of pressure by 90s gave the possibility to increase general score of a quantitative sensory analysis on 9%.

It should be noted that the odor of water has improved in comparison with the control liquid simple of water.

It was established that no significant differences between treatments in the conditions of alternating impulses of pressure with the duration process time more than 600s.

The general score is not increase after such time of processing, but energy efficiency and efficiency of raw material using is decrease.

The method of the alternating impulses of pressure is innovative method of treatment to receive water with necessary physical and chemical parameters and properties for food production.

It was established that appliance of the alternating impulses of pressure for water solutions treatment give possibility:

- To decrease reduction-oxidation potential on 20–70%,
- To increase the potential of hydrogen on 13–17%,
- To decrease mass of the dissolved oxygen on 50–55% [2].

Further investigation is needed to better understanding of the change physical and chemical parameters of water systems and technological water solutions during treatment.

In order to obtain more reliable sensory data, the odor thresholds of eighty-four compounds previously characterized as key food odorants were re-evaluated and compared to literature results.

On the basis of a distinct protocol, also the aroma attributes of the odorants were evaluated in order to define an aroma language, which can be used for specific purposes [25].

It will give the possibilities to create and design new energy and power saving technologies, modes, equipment and apparatus of water treatment for foodstuff production.

The importance of the improvement and submission of innovative and emerging technologies in food and foodstuff production were proven by the research investigations.

The application of the emerging technologies for quality assessment of water on physical and chemical parameters would potentially allow their implementation in the industry to evaluate the products within the production line in real-time.

The full potential of sensory evaluation is realized when sensory, consumer and and/or instrumental analyses are combined.

The command of sensory evaluation is realized when these two elements are combined to reveal insights into the way in which sensory properties drive consumer acceptance.

A key challenge is to use a highly variable human ‘measuring instrument’ to gather robust, unbiased data [11].

The objective be obliged to be to accomplish a realistic and practical balance between sensory analysis methodology and instrumental methods and to administer the sensory process effectively, if consequences are to be carrying great weight for foodstuff production.

a

b

Figure 4. Tasting evaluation of water samples with processing time 90s:
a – liquid samples of water which was treated in the conditions of alternating impulses of pressure
b – control liquid samples of water

Conclusions

At the present time one of unique and new method and equipment that was used for improvement of water treatment process is the method of alternating impulses of pressure.

New experimental and theoretical studies and modeling have shown that the method of alternating impulses of pressure may possibly be suitable for processing in food industry and foodstuff production, where hydrodynamic effects are found to be an substitute to traditional methods and modes in technological lines, equipment and processes of water and water solutions treatment.

According to the general results of sensory analysis and organoleptic studies, it was established that water solutions has a higher general tasting score and improved organoleptic parameters, which has a positive effect on the quality of the finished product, as compared to the control samples, which obtained by the technology of the enterprise.

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