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USING DUAL-FREQUENCY ULTRASOUND IN INTENSIFYING THE STAGE OF MINERALIZATION OF PLANT AND ANIMAL FOODS

Abstract. *A combined action of high and low frequencies ultrasound (US) for the intensification of wet mineralization of various foods has been studied. It is shown that the use of dual-frequency ultrasound can increase the degree of extraction and allows using one oxidizing agent for all foods. It allows creating a unified technique for the analysis of various alimentary products.*

Key words. *Dual frequency ultrasound, acid mineralization, metrological characteristics.*

Introduction. The most prolonged stage of food analysis is the sample preparation, in particular, its mineralization, which takes more than 90% of analysis time [1-5]. To intensify the wet mineralization processes, the use of ultrasound (US) with a frequency from 18 to 100 MHz has been studied. In this case the time for the mineralization reduced by 5-20 times [2].

We had studied a combined action of high and low frequency ultrasound on the destruction of organic compounds of common salt and brines before. It was shown that the use of dual-frequency ultrasound can reduce energy consumption and improve the analysis of metrological characteristics of the results [6-8].

Objective: to study a combined action of 3 high and low frequency ultrasound in order to intensify the wet mineralization processes of foods.

Materials and methods. To create low-frequency oscillations we used tubular magnetostriction radiators, inside which a test tube with the test solution was installed. The upper part of the tube was covered with a ring-shaped piezo-radiative of PZT-type 19 made of lead zirconate-titanium using fluoroplastic seals.

The unified method of determination of lead and cadmium in plant and animal foods.

An animal product weighing 0.50 g or plant one of 1.00 g is placed into a test tube and 5 ml of hydrogen peroxide (90%) is added. The tube

is placed into a magnetostriction radiator, and the US with the frequency of 22 kHz and 1 MHz with an intensity of 2.0 and 2.5 W / cm², respectively is used. Ultrasonic exposure time in analyzing plant products is 2 minutes, and in the analysis of animal ones it is 3 min.

To the mineralizer that we obtain, 1 ml of 0.01 mg / l of solution Pd(NO₃)₂ is added solved with bidistilled water until the volume is 10 ml and the content of lead and cadmium is determined by non-flame atomic absorption method using the time-temperature program given in [6].

Results and discussion. The analysis results are shown in the Table. The studies found that when using a combined action of ultrasound of high and low frequencies the degree of extraction of lead and cadmium was slightly higher (98-100%) than when using the low-frequency ultrasound alone (93-96%). We have found optimal parameters of the US: high frequency - 1 MHz low-frequency - 22 kHz, high intensity 2.0 W / cm², and the low-frequency - 2.5 W / cm², exposure time is 3 minutes.

The higher efficiency of the simultaneous action of ultrasound with high and low frequencies is due to the peculiarities of the formation and collapse of cavitation bubbles, in which most of (over 90%) small spherical cavitation bubbles are formed, the collapse of which leads to the most effective intensifying of

Table

The results of determination of lead and cadmium in foods

Sample name	Found, mg/kg; (n=6)							
	By using our method				By using the standard method [1, 9]			
	Pb	Sr	Cd	Sr	Pb	Sr	Cd	Sr
Meat (pork)	0,195	0,06	0,037	0,08	0,192	0,09	0,035	0,10
Milk, fat 2.5%	0,092	0,07	0,013	0,07	0,095	0,10	0,012	0,11
Milk, fat 3.2%	0,114	0,07	0,020	0,07	0,116	0,10	0,018	0,10
Cream fat 10 %	0,128	0,07	0,021	0,06	0,134	0,10	0,019	0,09
Cream fat 20 %	0,160	0,06	0,020	0,07	0,155	0,09	0,022	0,10
Wheat groats, s/q	0,150	0,07	0,014	0,08	0,153	0,10	0,013	0,09
pearl barley	0,066	0,07	0,041	0,07	0,061	0,10	0,036	0,09
buckwheat	0,085	0,07	0,053	0,06	0,081	0,10	0,048	0,10
bread «Donbass New»	0,159	0,08	0,035	0,08	0,153	0,10	0,030	0,11
Bun with jam	0,217	0,07	0,019	0,08	0,211	0,10	0,018	0,09
Instant coffee	0,114	0,06	0,029	0,08	0,114	0,09	0,027	0,09
Apples	0,157	0,06	0,014	0,08	0,153	0,09	0,012	0,10
Cabbages	0,084	0,07	0,007	0,08	0,085	0,09	0,008	0,10
Apricot juice	0,079	0,07	0,009	0,08	0,071	0,11	0,011	0,10
Beer Donetsk, 14%	0,129	0,07	0,019	0,08	0,122	0,09	0,021	0,10

sonochemical reactions underlying the accelerating processes of mineralization [8].

Conclusions. Thus, the use of a combined action of high and low frequencies ultrasound can increase the degree of extraction, allows using one oxidizing agent for all foods that allows you to create a unified technique for the analysis of alimentary products. We have developed a unified technique for determination of lead and cadmium in different foods. The technique correctness was checked by testing the same samples using the standard method.

Prospects for further research. We are planning a study on the use of dual-frequency ultrasound for dry mineralization, which has advantages over the wet one – there is no need in using solvents and the analysis is easy to perform.

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