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RESULTS OF EXTRA HIGH FREQUENCY RADIATION TREATMENT OF COTTON SEED

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Abstract

In a scientific article, it was determined that the free gossypol in the fry was significantly less changed when the cotton wool was treated with radiation power in the range of 100 to 300 W. In the control experiments (with industrial method), the material was treated with steam, the moisture content of the material was brought up to 13–15%, and the temperature was brought up to 60–65˚C, after that, the temperature of the roast was brought up to 100–105˚C during 60 minutes. When the oil was treated with 100 W high-frequency radiation, the color of the oil was observed to change after only 5 minutes, and it was found that the number of red units increased to 45 and the number of blue units increased to 2 by the end of the treatment after 30 minutes. Also, it has been proven that the peroxide value of oil obtained from cotton pulp treated with 300–600 W ultra-high frequency radiation with a frequency of 2450 MHz and a power of 300–600 W within 5–30 minutes is changed from 10 to 17 mmol/kg.

Keywords: *cotton seed, extra high frequency radiation, peroxide value of oil, oxidation of fatty acids*

Introduction

Oil production as an industry was established at the beginning of the last century. It is known from the sources that oil separators of the United States of America were initially attracted to our region (Kopeikovsky, V.M., Danilchuk, S.I., Garbuzova, T.I., Mosyan, 1982; Gavrilenko, I.V., 1939). However, this equipment did not allow to completely separate the oil contained in the raw material, and the amount of 4–5% of the seed mass remained in the raw material. Cotton lint is a multi-component material containing oil and mainly consists of petal-like pith and boll. According to the used technology, up to 5 percent of returnable goods, that is, fuza in the fuza tank and

sludge in the filter press, are included in the solution (Kopeikovsky, V.M., Danilchuk, S.I., Garbuzova, T.I., Mosyan, 1982).

The changes of gossypol during the industrial processing of cottonseed are divided into two types: changes of gossypol under the influence of heat and oxygen in the air; change as a result of interaction with substances included in the seed (Markman, A.L., Rzhekhin, V.P., 1965). The interaction reaction of gossypol with phosphatides in the presence of water has a definite temperature limit of 106–110˚C, outside of which the reaction rate increases sharply. It is known that the apparent speed of the reaction of gossypol in the oil environment starts at a temperature of 60˚C and its maximum speed is in the range of 80–120˚C (Markman, A.L., Rzhekhin, V.P., 1965). Analysis shows that the intense dark color of raw cottonseed oil is not given by gossypol itself, but by its transformation products and combinations with other substances contained in the seed. Gossypol, which does not contain free aldehyde groups and acidic hydroxyls, has a high ability to stain partial oxidation products, anhydration products, phosphatides, amino acids and products of interaction with diene fatty acids (Markman, A.L., Rzhekhin, V.P., 1965).

Ilyasov A.T. and his staff proposed to neutralize the gossypol in the solution with the help of urea (Ilyasov, A.T. 1996). Two amino groups of urea actively interact with aldehyde groups of native gossypol, eliminating similar chemical changes of gossypol with substances of the gel part of the solution. At the same time, conditions can be created to neutralize free gossypol and preserve proteins, free amino acids and phosphatides in their native state.

The authors (Ilyasov, A.T., Vahabova, D.Z., Urakov, R.M., 1993) purified cottonseed oil with a concentration of 250 g/l of alkali and 4 and 7 kg/t of caustic soda. In control studies, refined oil of the first and second grade standard in terms of color was obtained from forpress and extraction oils, respectively, with a caustic consumption of 7 kg/t, with a yield of 89.7–91.5 and 88.8–89.6%.

Rzhekhin V.P. and his staff studied the interaction of gossypol with protein substances, free amino acids, anthranilic acid, phosphatides and other reagents (Rzhekhin, V.P. and Preobrazhenskaya, I.S., 1961). It was found that free gossypol practically does not interact with the above-mentioned reagents and forms complex complexes, which are not completely removed from the oil even in the “hard” regimes of alkaline cleaning.

Therefore, the analysis of literary sources on the considered problem shows that the moisture-heat treatment process of cotton pulp occupies an important place in the technology of extracting plant, especially cotton oil. Switching this process to a “soft” mode will undoubtedly help to increase the technical and economic efficiency of the subsequent processing of oil and slag.

Materials and methods

In the scientific article, the results obtained from the use of cotton seed pulp processing, physico-chemical analysis of oil refining and its processing products, modern high-performance liquid chromatography, gas chromatography and other modern methods of physico-chemical analysis and the data obtained in laboratory and experimental-production conditions are reliable. The limit value of the interval is based on the correspondence to the theoretical results.

Press oil analysis was performed based on the following methods:

– cotton oil color is determined by Lovibond cotton color meter according to UzDSt 1199:2009 (O’zDSt 1199: 2009);

– the amount of free gossypol was determined by the method of high-performance liquid chromatography. An Agilent Technologies (USA) 1200 series liquid chromatograph was used, with a DAD detector. Column Ultropac Columen Lihroprep RP18, 5 μn, 2.6x100mm. Gossypol was added to 1.0––1.5 μn of acetonitrile and eluted from the column at room temperature in isocratic mode using a solution of 0.1% acetonitrile, phosphoric acid and water (80:20). Detection was carried out with 254 nm (Abou-Donia, S.A., Laches, J.M., Abou-Donia, M.B. 1981).

Also, in some studies, determination of the mass fraction of free gossypol in oil was carried out according to the methodology certified by the State Standard certificate No. 188 (TSh 88.06–27: 2011).

This method for measuring the mass fraction of free gossypol in oil applies to

unrefined cottonseed oil and to high-sipol crude cottonseed oil in the range of 0.50% to 1.5%, using the aniline method.

This method is based on the interaction reaction of gossypol with aniline and the formation of dianilinegossypol, which is insoluble in oil and some organic solvents.

– the acid number of oils was calculated according to UzDSt 1203, and a 1 percent alcohol solution of phenolphthalein was taken as an indicator (O'zDSt 1203: 2009). This method is based on the titration of an oil sample with an alkaline solution in the presence of a phenolphthalein indicator.

A neutralized solution of alcohol and diethyl ether was used as an oil solvent.

– mass fraction of moisture volatile substances calculated according to UzDSt 1193:2009 (O'zDSt 1193: 2009);

– the degree of oxidation of oils is measured according to UzDSt 1200:2009, depending on the peroxide value calculated by the iodometric method (N.S. Arutyunyan, E.A. Arisheva, L.I. Yanova, M.A. Kamyshan, 1983; O'zDSt 1200:2009).

Results

Currently, many scientists are conducting research on eliminating the above defects, reducing the cost of the processes, etc. Ultra-high frequency radiation is considered to be a new method of moisture-heat treatment of cotton wool, which has the ability to reduce the above defects. Normal microwave devices, based on their physical parameters, work only at 2450 MHz, their regulated parameters are radiation power (w, W) and processing time (t, min.) (Yulchiev, A.B., Abdurahimov, S.A., Serkaev, K.P. 2009).

Laboratory studies show that the free gossypol in the roast changes much less when the roast is treated with radiation power in the range of 100 to 300 W. This can be explained by the shorter processing time and lower temperature of the processed material, unlike the industrial method.

During moisture-heat treatment and frying, along with the changes mentioned above, the color of the oil also changes. Changes in the color of cottonseed oil depend on many factors, such as changes in the amount of dyes, gossypol, proteins, phospholipids, glucose, etc. (Yulchiev, A.B., Abdurahimov, S.A. Serkaev, K.P., 2011).

It is known that the degree of coloring of the oil depends on the method and duration of preparation of the oil for pressing. In contrast to the industrial method of roasting cotton, ultra-high-frequency processing is carried out with a rapid acceleration of the pressure of liquids in the processed material. To determine the change in the color of oil in ultra-high-frequency radiation, cotton wool was subjected to normal (industrial) method (control) and in laboratory equipment under ultra-high frequency (experience) processed.

In the control experiments (with industrial method), the material was treated with steam, the moisture content of the material was brought up to 13–15%, and the temperature was brought up to 60–65˚C, after that, the temperature of the roast was brought up to 100–105˚C during 60 minutes.

In the laboratory experiments, as in the control experiment, the material was first treated with steam, the moisture content of the material was raised to 13–15%, and the temperature was raised to 60–65˚C, and then it was treated with high-frequency radiation of various powers for 30 minutes. In both experiments, samples were extracted after every 5 minutes to press the oil and measure its color change. The results of the experiments are shown in table 1.

Table 1. *Variation of color of oil in frying depending on the method and duration of processing*

Processing method	Color of frying oil, Lovibond red(blue) units in 1 cm layer of the cuvette. Processing time, minutes							
	5	10	15	20	25	30	40	60
Color of frying oil, red(blue) units in 1 cm layer of cuvette according to Lovibond.								
Industrial style	20(3)	22(3)	26(3)	30(3)	35(2)	40(2)	49(1)	54(1)
Power of high-frequency radiation during processing:								
W=100 w	21(3)	26(3)	30(2)	36(2)	40(2)	45(2)	–	–

Processing method	Color of frying oil, Lovibond red(blue) units in 1 cm layer of the cuvette. Processing time, minutes							
	5	10	15	20	25	30	40	60
W=300 w	30(2)	34(2)	38(2)	43(2)	46(2)	48(2)	–	–
W=600 w	34(1)	42(1)	56(1)	68(1)	–	–	–	–

Discussion and Conclusion

It can be seen from Table 1 that when the material is treated in an industrial way, the color of the oil does not change much in the first 10–15 minutes, because this time of treatment is spent on raising the temperature. In the next 20–25 minutes, changes in gossypol, dyes, etc. occur, as a result, the color of the oil deteriorates sharply and the number of red cells increases from 30 to 54. When Yanchilma is treated with high-frequency radiation with a power of 100 W, the color of the oil begins to change after only 5 minutes, and after 30 minutes, until the end of the treatment, the number of red units increases to 45 and the number of blue units to 2.

The same changes are observed when the tissue is treated with 600 W high-frequency radiation. Only by increasing the processing power will the duration of changes be reduced. For example, when the material is treated with high-frequency radiation with a power of up to 600 W, the intense color change lasts up to 20 minutes, and then the material is excessively roasted and its color becomes invisible.

It is known that changes in blue units in cottonseed oil often mean changes in chlorophyll and its derivatives. It can be seen from the data in table 3.3 that in the industrial method of processing, blue units change after 25–30 minutes and at the end of processing, they decrease to 1/3 of the initial amount.

We have studied the changes in the peroxide number of oil extracted from cotton pulp treated for 5–30 minutes with 2450 MHz, 300–600 W ultra-high frequency radiation.

The analysis of the peroxide number of the oil was carried out according to the manual O'zDSt 1200:2009 "Calculation of the peroxide number of vegetable oils" (O'zDSt 1200:2009).

It was determined that the peroxide value of the press oil changes from 10 to 17 mmol/kg during the ultra-high frequency irradiation of the cotton pulp in the above regimes. At the same time, the peroxide value of the oil increases with the increase of the high frequency radiation power (from 300 to 600 W) and the microwave treatment time (from 5 to 30 minutes). At the same time, the peroxide value of the oil increases with the increase in strength (Yulchiev, A. B., 2015).

A comparison of the results of the analysis of the oils obtained as a result of the traditional methods and ultra-high frequency treatment of cotton ginning shows that microwave radiation helps to reduce the oxidation of fatty acids in trialglycerides.

Using ultra-high frequency heating instead of traditional convective roasting of cottonseed reduces the peroxide value of the oil, and this leads to an increase in the output of purified edible oil and a decrease in the costs of its processing.

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