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Shoirakhon Isroilova *

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Article

Prospects of Technology for Producing Non-Traditional Functional Oils

Shoirakhon Isroilova [1,*], Kamar Serkaev [2], Jasur Farmonov [3] Samandar Sodikov [4]

1 Trainee researcher of the Department of Food Technology, Tashkent Institute of Chemical Technology, Tashkent, 100000, Uzbekistan ; sherliverpool.211@gmail.com
2 Doctor of Technical Sciences, Professor of the Department of Food Technology, Tashkent Institute of Chemical Technology, Tashkent, 100000, Uzbekistan ; serkayev@mail.ru
3 Ph.D., Associate Professor of the Department of Food Technology Karshi Engineering and Economic Institute, Karshi, 180100, Uzbekistan; j.farmonov@mail.ru
4 Lecturer of the Department of Food Technology, Tashkent Institute of Chemical Technology, Tashkent, 100000, Uzbekistan; sodiqov12.samandar@gmail.com
* Correspondence: sherliverpool.211@gmail.com

Abstract: Background: to develop a technology for hydrothermal processing of oilseeds and primary pressed cake in order to obtain functional vegetable oils from non-traditional oilseeds (melon and watermelon seeds). **Methods:** Analyses of mint, pulp, oils and cakes obtained from them were carried out in accordance with the methodology described in the "Manual on research Methods, technochemical control and accounting of production in the fat and oil industry". **Results:** Technological parameters of hydrothermal treatment of crushed oilseeds from melon and watermelon seeds before primary and final pressing are investigated. **Conclusions:** An advanced double pressing technology has been developed, which provides grinding of seeds without separating the husk up to 60when passing through a sieve with a diameter of 1 mm, humidification with steam condensate up to 11and heat treatment at a temperature of 80°C for 50 minutes before pre-pressing and grinding up to 60of the patency of the pre-pressed cake, moistening the material to a humidity of 12steam at a temperature of 120 ° C and a pressure of 0.5 MPa for 30 minutes before distillation.

Keywords: oil seeds; functional oils; pressing; essential fatty acids omega3 and omega6; melon seeds; watermelon seeds

1. Introduction

As you know, vegetable oils have a high biological value and are a source of essential polyunsaturated fatty acids, vitamins and trace elements. They are a structural part of all body tissues, favorably affect many of its systems and functions, as well as contribute to proper metabolism. In this regard, vegetable oils are widely used in medicine, cosmetology and perfumery, the food industry and dietary nutrition. And such a wide use of them leads to the need to obtain environmentally friendly oils with a maximum content of biologically active substances. In this regard, an urgent task is to develop methods for deep processing of oil-containing raw materials to obtain environmentally friendly fat products. Deep (complex) processing implies the creation and application of technologies that allow the waste-free use of all components of raw materials and the production of functional products [1][pp.171–177pp.]. This report presents the results of work on the development of technology for the production of functional oils from melon and watermelon seeds, which are rich in mono- and disunsaturated fatty acids.

2. Materials and Methods

Dried melon and watermelon seeds were used as objects in the research. The subjects are the processes of obtaining oils from the above-mentioned melon seeds by double pressing, with hydrothermal treatment and microwave radiation. Analyses of the obtained pressed oil were carried out according to the following methods: - chromaticity of oils on the Lovibond color meter according

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to O'ZDST 1199 [2] [11p.]; - the acid number of oils was determined by O'ZDST 1203 and a 1alcohol solution of phenolphthalein was used as an indicator [3][10 p.]. The method is based on titration of an oil sample with an alkali solution in the presence of a phenolphthalein indicator. A neutralized mixture of alcohol with diethyl ether was used as a solvent for the oil. 3-5 g of oil was weighed into the flask on analytical scales, poured 50 ml of a neutralized mixture of diethyl ether and ethyl alcohol and dissolved oil. 3-5 drops of 1The resulting solution, with constant stirring, was titrated from a burette with 0.1 n alcoholic solution of caustic alkali until a slightly pink color appeared, which did not disappear for 30 s . k.h. (in mg KOH / g) was calculated by the formula: k.h. = 5,611 · a· k /m where: 5,611 is the titer to 0.1 n of caustic potassium solution, ml; a - the amount of 0.1 n caustic alkali solution consumed for titration, ml; k - titer correction; m - the mass of the analyzed oil, g - the mass fraction of moisture and volatile substances was determined by O'ZDST 1193 [4][11 p.]; - the degree of oxidation of oils was estimated by the peroxide number determined by the iodometric method according to the O'zdst 1200 standard [5,6] [152 p; 9 p.]; - the oil content in the processed materials was determined by exhaustive extraction in the apparatus Naaba [7][661 p]; - the moisture content of oil-containing materials and the concentration of miscella were analyzed by the weight method [8][18 p.]; - the content of crude protein and its soluble fractions in cakes was determined by the Kjeldahl macromethod [9][302 p.].

3. Literary Review

In industry, vegetable oils are extracted from the seeds of oilseeds by pressing (cold or hot) or organic solvents. Also, a combined method is used, including pressing followed by extraction of oil from the cake with a liquid solvent. Cold pressing is one of the pressing methods without heating or at low temperature. After cold pressing, the oil temperature and the acidity coefficient are low. Cold pressed oil (except cotton) usually does not require refining and after precipitation and filtration, the finished oil is obtained [10,11][88-96pp.; 40-51pp.]. There is a special screw press, called a cold press, where the supply temperature of oilseeds is below 80 ° C and they are not fried before the press. The features of the cold pressing method are that: 1. The finished oil is transparent. If the color requirements of the standard for oil are strict, it is recommended to choose cold pressing. 2. The quality of the cake is excellent. Due to the absence of a high-temperature process, the protein in the cake retains its original quality and does not change even after the press. Thus, the cake still has a high nutritional value. Hot pressing takes place by feeding the oilseed material into the press at a temperature above 80 C. As a rule, there is a brazier in front of the press, the function of which mainly consists in regulating the temperature and moisture content in the oilseed material, with the optimal choice of which the final oil yield increases. Features of the hot pressing method: 1. Relatively high oil yield. 2. Due to the high temperature of the brazier, the finished oil smells and has good taste properties. 3. Low oil residue in the cake. Since each oilseed crop has its own unique properties, each oilseed crop needs an appropriate method of extraction. Usually, long-term high-temperature treatment before pressing is used to obtain vegetable oil (for 20-50 minutes at 100-120 ° C). This method destroys the useful substances contained in the kernels of oilseeds, primarily vitamin E and carotene. The first slows down the aging process and prevents the development of cancer. The second (provitamin A) is responsible for vision and growth. In addition, with prolonged temperature and mechanical processing, many harmful substances pass into the oil. It is for their removal that refining and chemical treatment are required, in which the remaining vitamins and proteins are destroyed, as well as the oil's resistance to oxidation during storage is reduced. Unrefined oil obtained by "cold" pressing is better absorbed, retains more vitamins and nutrients than the same oil obtained by hot pressing and even more refined. However, according to the oil content, the seeds of many crops (amaranth, etc.) belong to low-oil crops, with an oil content of no more than 13-14and the complexity of the pressing process consists in the qualitative preparation of raw materials for subsequent oil extraction. In most cases, the presses are designed to extract oil from raw materials with an oil content of at least 15which makes them unsuitable for pressing low-oil raw materials. The main reason for this is a violation of the technological

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process of forming pellets from cake and removing them through the holes of the die from the working area of the press. In addition, it is known that for the normal formation of granules, the cake must contain at least 6-8fat [12][85-89pp.]. Therefore, to ensure the operability of the "cold-pressed" oil press due to the stable formation and withdrawal of cake granules from the pressing zone, an improved technological process is proposed, consisting in the fact that low-oil raw materials are pressed in a mixture with other oil-containing raw materials with their total oil content of more than 15When pressed together, the oil extracted from them is mixed and the quantitative composition is sufficient to form granules, as well as output through the holes of the die. This also ensures the operability of the "cold-pressed" oil press [13] [64-71pp.]. The necessary and sufficient amount of oil in the cake, for the stable formation of granules, is ensured by the fact that the mass fractions of the mixed raw components must contain more than 15fat. The latter is also a condition for the operability of oil-pressing presses. The moisture content of the material plays an important role in the production of vegetable oil. A group of scientists determined the influence of humidity and the size of sunflower seeds on the process of collapse. It was revealed that the maximum number of collapsed seeds on the proposed design of the centrifugal crusher was obtained at an initial humidity of W =5.9[14][152-156pp.]. With conventional oil production technology, the raw material is subjected to significant repeated heating. A technological scheme for processing ginger seeds by preliminary moisture-heat treatment in an extruder and single pressing has been developed, so that the oil content in the cake after pressing was 12-14It has a longer shelf life, has good fluidity, and is easily refined [15][27-29pp.]. The effect of the duration of heat treatment at 40 and 75 ° C on the oxidation resistance of a mixture of sunflower-rapeseed oils (55:45), as well as the effect of natural antioxidants on this process [16][92-95pp.], was studied. A method for obtaining vegetable oil and cake from melon seeds has been developed, including drying of seeds, cleaning from weed impurities, grinding, moisture-heat treatment of mint, pre-pressing to obtain oil and cake, grinding of cake and final extraction of oil from pre-pressed cake and primary oil purification to obtain high-protein cake with a crude protein fraction of at least 42.5in terms of on an absolutely dry substance [17][No. 2567745]. A method of moisture-heat treatment of oilseed flakes before oil extraction is proposed, which provides for grinding and moisture-heat treatment. To form granules, the flakes are passed through the drying zone, followed by cooling and feeding for oil extraction [18][22-23pp.]. A method of moisture-heat treatment of mint with microwave radiation has been developed, which contributes to a deeper disclosure of spherosomes and globules, as well as gossypol glands, which favorably affects the dissolution of gossypol in the extracted oil. The optimal technological modes of microwave processing of cotton mint have been identified, which are the radiation power - 300 W, the humidity of cotton mint - 15and the time of microwave radiation - 15 min [19][20-22pp.]. Usually, preliminary hydrothermal treatment is carried out by hot steam or dry heating of oilseeds [20–22][1073-1079pp.;195-1998pp.; 1169-1176pp.]. The method of pretreatment using microwaves was developed to improve the oil extraction process and the quality of oil storage at oil production facilities[23–27][1211-1215pp.; 168-171pp.; 207-214pp.; 867-871pp.; 164-167pp.]. As described above, it is possible that hydrothermal treatment of seeds causes the desired changes in physicochemical, functional and taste properties. Before testing the effect of hydrothermal treatment on these properties of seeds, it is necessary to study how hydrothermal treatment affects the main components of the oilseed material in order to obtain useful fundamental data for food processing, leading to further improvement of the quality and wider use of processed beans as food products. However, there have been few reports of hydrothermal treatment of seeds in low humidity conditions, whereas the effect of hydrothermal treatment on soybeans in high humidity conditions, that is, after sufficient water adsorption, has been studied very well [28–30][112-116pp.; 1164-1171pp.; 86-89pp.]. Based on the relevance of the above tasks, we conducted experimental studies to develop an acceptable method for obtaining oil from melon and watermelon seeds, which will ensure the production of oils and cakes for further processing for food purposes.

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4. Results

The aim of our experimental studies was to increase the efficiency of extracting functional vegetable oils from non-traditional sources by double pressing. The meaning of the word "Functional nutrition" is today accepted as "More healthy food", i.e. obtaining the necessary vitamins, minerals and amino acids is possible from products that are called functional. This term appeared quite recently, but has already gained popularity among fans of healthy eating [31][180p.]. Modern food, with all its abundance, is extremely poor in nutrients. And this is what caused the appearance of functional foods. The concept of "Healthier food" has been developing in Japan since 1989. Gradually, the idea of functional nutrition took root in Europe, and from there spread to the whole world. The objects of our research were chosen based on the functionality of their composition, i.e. rich in mono and dinaturated fatty acids, the so-called omega3 and omega6 fatty acids. The content of linolenic acid (omega3) in the oil indicates its biological value, since this acid is essential. In addition, the vegetable oils studied by us from oil sources are rich in fat-soluble vitamins and biologically active substances: Melon oil. The composition of melon oil is dominated by unsaturated fatty acids and natural melon oils are represented by linolenic, linoleic and oleic, while saturated ones include palmitic and stearic. Directly due to this composition, the beneficial properties of melon oil are obvious, which determine the use of this vegetable substance in the official and non-traditional fields of medicine. Watermelon oil. The chemical composition of watermelon oil is based on polyunsaturated fatty acids. About 60of the composition is linoleic acid, 25oleic acid. Also, high content of tocopherols, zinc, carotene and selenium, optimal ratio of vitamins PP, C and B. The chemical composition of the oil is generally similar to the composition of almond oil, and the fatty acid almost exactly repeats the composition of pumpkin oil, but at the same time the base of watermelon seeds is absolutely not similar to either in its properties and texture. In the Tables 1 and 2 are the general information of the above seeds.

The optimal moisture content of the material before pressing is related to the design and technological characteristics of the presses. Determining the optimal humidity of the pressed material is very important, because if insufficient humidity can lead to deterioration of the indicators of the products obtained due to high pressure and friction in the screw space, with an increased moisture content, due to insufficient plasticity of the material, insufficient pressure is created in the screw space, the yield decreases, the content of fuze and moisture in the oil increases. In connection with the above, we decided to experimentally determine the optimal humidity of the studied objects before pressing. We have selected a Chinese-made ZX-130 press for processing samples of research objects. The choice of this press is not accidental. It should be noted that more than 300 of the 500 existing vegetable oil production enterprises in the republic today have a press of this brand based on the practicality and durability of the design. The press is designed so that it can work in 2 modes, i.e. both in the "pre-pressing" mode and in the "expeller" mode. To switch from the 1st mode to the 2nd, it is necessary to change the spin parameters at idle, by compressing the gap of the output cone or opening to the desired value. In the experiments, crushed material from the studied samples was used. The crushed seeds were moistened until the humidity reached 11with water, the temperature of which was 80C. Then the moistened material was subjected to heat treatment at a temperature of 100C to obtain a pulp with a humidity of3to 9and subjected to pressing. The results are shown in Figure 1.

As can be seen from Figure 1, the highest oil yield is observed at a humidity of 7 ± 0.5To determine the optimal humidity of hydrothermal treatment, the crushed seeds were moistened until the humidity reached 11with water, the temperature of which was 80C. Then the moistened material was subjected to heat treatment at a temperature of 80C for 60 minutes and a decrease in humidity was observed in the time interval every 10 minutes. The optimal duration of heat treatment is considered, at which the moisture content of the material is 7 ± 0.5The effect of the duration of heat treatment on reducing the moisture content of the pulp is shown in Figure 2.

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Table 1.

Physical parameters of the studied oil seeds

Type of oil seed raw materials	Humidity, %	Absolute weight, gr	Weight of 1 м^3 of seeds, kg	Borehole, %
Melon	5,7-7,2	3,9-7,8	590-630	27-35
Watermelon	6,5-6,9	5,4-6,9	770-810	21-24

Table 2.

Chemical composition of the studied oil seeds

Type of oil seed raw materials	Lipids	Squirrels	Fiber	Ash content
Melon	35,2-43,1	23,7-25,6	12,1-15,4	4,2-4,7
Watermelon	23,7-25,9	19,8-22,3	16,7-19,2	5,7-11,4

Figure 1.

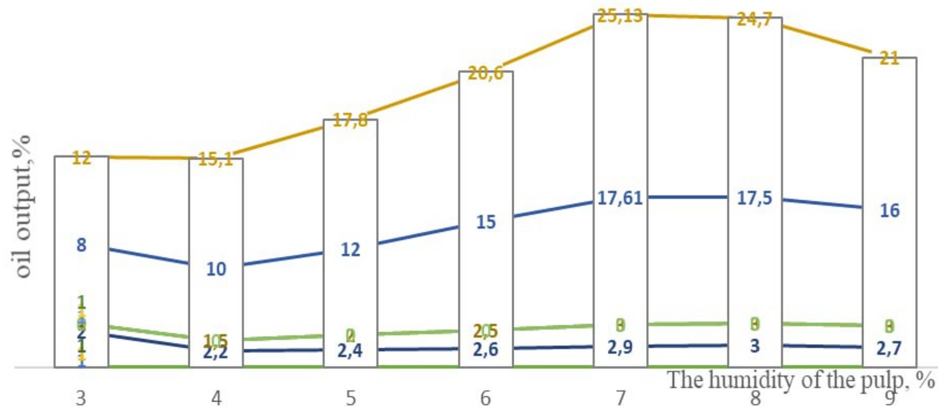

Figure 1 . The effect of the moisture content of the material on the oil output during pressing

Figure 2.

As can be seen from Figure 2, crushed materials from melon and watermelon seeds release moisture more slowly. For example, when the duration of heat treatment is up to 25 minutes, the above materials almost do not lose moisture. In the interval of 30-50 minutes, the moisture content decreases rapidly and in the interval of 40-50 minutes, the humidity decreases to 7This is due to the structure of the material. The higher the oil content, the lower the content of the protein and structural part, which prevents the evaporation of moisture and vice versa. Based on the data obtained, it can be concluded that the optimal interval of heat treatment of the studied samples of raw materials at a temperature of 80C is 40-50 min. To verify the reliability of the data obtained, at the next stage of the experiments, the oil yield from the selected research objects was determined. In order to obtain comparative results, seeds from one batch were used in all further experiments, i.e. one sample from all the objects of study. Seed quality indicators are given in Table 3.

In experiments, first the seeds were crushed in a hammer crusher to 60of the passage through a 1 mm sieve and moistened with water at a temperature of 80C, and bringing the moisture content of the

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material to 11The moistened seeds were treated at a temperature of 80C for 40-50 minutes. To extract the oil, a ZX-130 press was used in the pre-pressing mode. The results obtained are shown in Table 4.

As can be seen from the data given in Table 4, pressing mint from melon produced 24.3and watermelon 3.1of crude oil. The low yield of oil from watermelon mint is due to the rigidity of the husk, as a result of which moisture penetrates the material more slowly and reduces the processing effect. When the mint was moistened and treated at a temperature of 80C for 50 min. the increase in oil yield is significant, so 26.2of melon pulp and 17.6of watermelon oil were obtained. When pressing pulp obtained from watermelon seeds, the oil yield from hydrothermically treated material is 14.5higher compared to untreated. The above data indicate that hydrothermal treatment of the studied samples of unconventional oilseeds under gentle regimes (no more than 80C) increases the yield of prepress oil. Despite the fact that with the help of preliminary hydrothermal treatment, the yield of first-pressed oil increases, especially when processing watermelon seeds from 12.9 to 73.4the residual amount of oil in the cake is still high, the enzymes are not completely inactivated and the development of optimal final pressing modes is required. During the final pressing, it is very important to carry out hydrothermal treatment after grinding the primary cake. Hydrothermal treatment is necessary to reduce the activity of enzymes that catalyze the oxidation of unsaturated fatty acids to the formation of hydroperoxides, leading to rancidity and spoilage of vegetable oils before the expiration of the shelf life. However, waterlogging of the mint of the studied seeds leads to swelling of the gel part, especially mucous substances, which reduces the effect of subsequent heat treatment and increases fuz in oil. As is known, steaming prevents the swelling of mucus, leads to a mild denaturation of protein, which increases the digestibility of proteins, reduces the activity of enzymes and increases the shelf life of products. The optimal temperature for the activity of lipase enzymes strongly depends on the humidity of the medium. At a medium humidity of 12-14the optimal activation temperature is 37C and with an increase in humidity, the activity temperature decreases, i.e., an increase in the humidity of the medium is directly proportional to a decrease in the activity of the enzyme phase. In experiments, the optimal temperature of hydrothermal treatment of the moistened material was determined before the final oil extraction. To determine the optimal processing temperature, the crushed cake was first moistened to 12with steam at a temperature of 120C and a pressure of 0.5 MPa. Then, the moistened material was thermally treated at different temperatures (from 100 to 130C) for 60 minutes. The results of the experiments are shown in Table 5 and Figure 3.

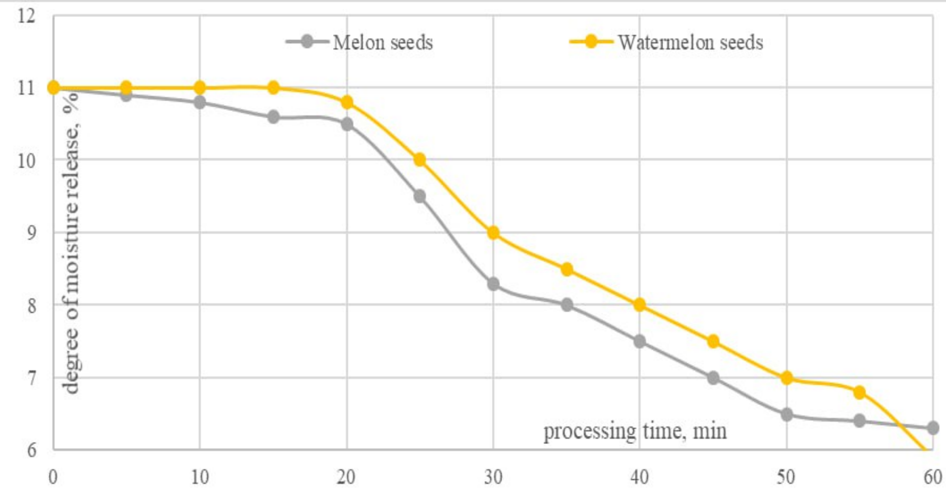

Figure 2 . The effect of the treatment duration on the change in humidity at a temperature of 80 ° C

Figure 3.

As can be seen from the data given in Table 5, frying of the crushed and moistened material of the studied samples at a temperature above 100C provides intensive evaporation of moisture in all

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time intervals. Based on the fact that the moisture content of the material within 7 ± 0.5of moisture is required for pressing the pulp, the optimal time interval and temperature are considered to provide the required value. After studying the data in Table 5, we came to the conclusion that the optimal roasting temperature, before the final pressing of the studied samples, is 120C with a process duration of 30 minutes, because in this time interval, the residual moisture of the seeds decreases to 7.0 ± 0.5in almost all the studied samples. Changes in the intensity of moisture evaporation, depending on the duration of the process at a temperature of 120C, are shown in Figure 3.

As can be seen from Figure 3, the evaporation rate increases from 20 min to 40 min and continues almost uniformly up to 50 min. In the interval from 50 to 60 minutes, the evaporation intensity decreases. It can be seen from the constructed diagram that the processing time of 30 minutes is optimal. The effect of the duration of heat treatment at 120C on the degree of oil extraction during final pressing is shown in Figure 4.

Table 3.

The main qualitative indicators of the seeds used

Type of seeds	Oil content, %	Humidity, %	Soreness, %	Acid number of oil, mg KOH/g
Melon	35,3	7,2	2,1	0,18
Watermelon	23,9	6,8	1,9	0,98

Figure 4.

Table 4.

Results of pre-pressing of heat-treated and untreated pulp

Indicators	Type of processing			
	Melon		Watermelon	
	Without hate treatment	80 °C	Without hate treatment	80 °C
Oil output, %	24,3	26,2	3,1	17,6
Pomace output,%	74,8	69,3	95,8	78,3
Moisture loss, %	0,9	4,5	1,1	4,1
Balance:	100	100	100	100

Figure 5.

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Table 1. The effect of the temperature of the frying process on the evaporation of moisture from the moistened material (crushed pomace).

Heat treatment temperature, °C	Processing time, min					
	10		30		50	60
	Evaporation of moisture and volatile substances, %					
from melon seeds						
100	1,47	1,78	2,21	2,78	3,22	3,65
110	1,66	2,11	3,17	3,44	3,99	4,24
120	1,90	2,34	5,11	5,54	5,97	6,29
130	2,60	3,03	5,24	6,02	6,34	6,99
from watermelon seeds						
100	1,12	1,54	2,05	2,57	3,29	4,18
110	1,31	1,78	3,11	3,38	4,03	4,78
120	1,45	2,02	4,67	5,07	5,87	6,25
130	1,57	2,23	4,97	5,41	6,12	6,78

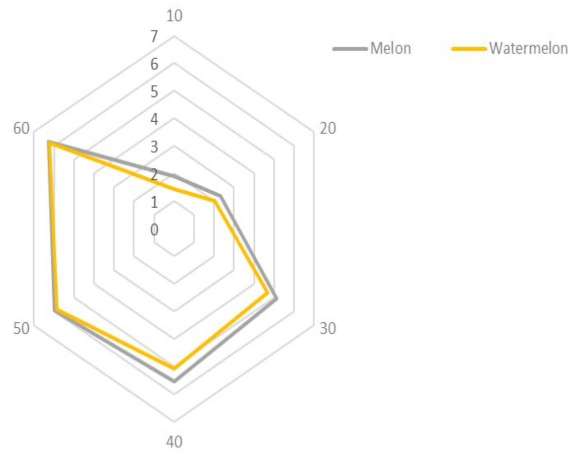

Fig. 3 . Change in the intensity of moisture evaporation depending on the duration of the process at 120°C

Figure 6.

It can be seen from Figure 3 that during heat treatment, with a decrease in humidity, the yield of expeller oil increases in the time interval from 10 to 30 minutes, and almost all samples begin to decrease after this interval, which is associated with overcooking the pulp. To confirm the obtained results of the study of the effect of hydrothermal processing of mint, before pre-pressing, and crushed cake, before final pressing, a series of experiments were conducted, the results of which were investigated in a complex. In control experiments, the studied seeds were first processed according to a well-known technology, i.e. the crushed seeds were first moistened to 8-9thermally treated at a temperature of 70C for 30 minutes and pre-pressed. At the second stage, the oil was extracted by expelling the primary cake, without humidification and heat treatment. In experimental experiments, first seeds (melon, watermelon) were crushed in a hammer crusher up to 60of the passage through a 1 mm sieve, moistened with water at a temperature of 80C, bringing the moisture content of the material to 11regardless of the type of oilseed raw materials. Then it was processed at a temperature of 80C for 50 minutes, based on the results of preliminary experiments. The heat-treated pulp with a humidity of 7.0 ± 0.5was pressed in the pre-pressing mode. Part of the resulting oil and cake was sent to the laboratory to determine the physico-chemical parameters. At the second stage, the cake obtained at the first stage of the experiments was first crushed to 55-60of the passage through a 2 mm sieve, moistened to 12with steam at a temperature of 120C and a pressure of 0.5 MPa. Then, the resulting material was thermally treated at a temperature of 120C for 30 minutes with a decrease in the moisture content of the pulp to 7 ± 0.5and subjected to final oil extraction in the expelling mode. The results of the experiments are shown in Table 6.

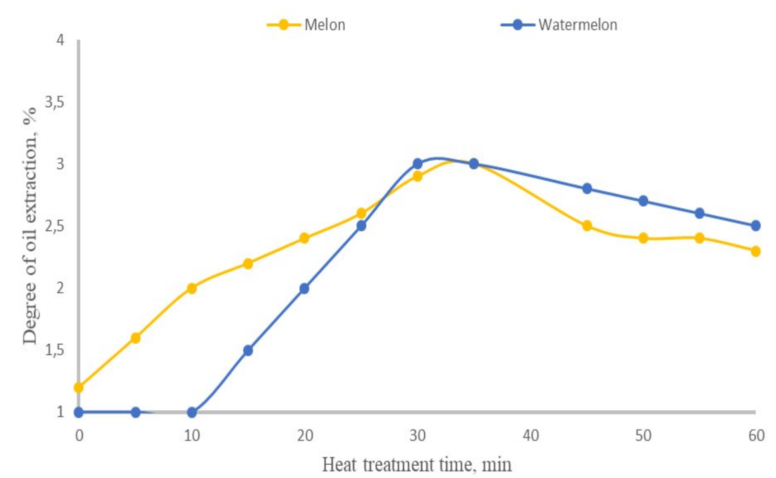

Fig. 4. The effect of the duration of heat treatment on the degree of oil extraction during final pressing

Figure 7.

Indicators	Type of oilseed raw materials:	
	melon	watermelon
The main indicators of seeds		
Oil content of seeds, %	35,3	23,9
Moisture, %	7,2	6,8
Control. Indicators of double pressing of mint seeds without hydrothermal treatment in the "Forpress-expeller" mode		
First-pressed oil output, % (% of total content in raw materials)	20,10 (56,94)	8,23 (34,43)
Final pressing oil output, % (% of total content in raw materials)	2,13 (6,03)	0,38 (1,59)
The total volume of the oil obtained during double pressing, % (% of the total sod.)	22,23 (62,97)	8,61 (36,02)
Acid number of oil, mg KOH/g	0,21	1,74
Chromaticity on the iodine scale, mg/iodine	12	28
Oil humidity, %	0,17	0,11
Sludge content, %	1,22	0,54
Crude protein content, in terms of absolutely dry substances, %	20,27	18,91
Experience. Primary pressing in the "Forpress" mode: Mint humidity-11%, processing temperature-80C, duration-50 min., pulp humidity-7 ± 0.5%		
Yield of prepress oil, % by weight of mint (% of total content in raw materials)	26,22 (74,28)	17,61 (73,68)
Acid number of oil, mg KOH/g	0,19	1,68

Figure 8. Table 6. The results of obtaining unconventional oils according to the existing technology and using the developed modes of double pressing.

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Chromaticity on the iodine scale, mg/iodine	8	32
Oil humidity, %	0,18	0,10
Sludge content, %	0,94	0,42
Oil content of prepress pomace, %	10,9	7,5
Humidity of the prepress pomace, %	9,1	8,7
Crude protein content, in terms of absolutely dry substances, %	25,4	24,3
Experience. Final pressing in the "Expeller" mode: Humidity -12%, processing temperature-120 °C, processing duration-30 min., mezg humidity-7 ± 0.5%		
Expeller oil output, % (% of total content in raw materials)	2,9 (8,22)	2,7 (11,3)
Acid number of oil, mg KOH/g	1,25	2,74
Chromaticity on the iodine scale, mg/iodine	17	55
Oil humidity, %	0,12	0,10
Sludge content, %	0,76	0,8
Oil content of expeller pomace, % (% of total content in raw materials)	8,69 (17,51)	3,59 (15,02)
Humidity of expeller pomace, %	10,0	9,1
Crude protein content, in terms of absolutely dry substances, %	26,1	24,1
Oil yield in total (forpress+expeller), % (% of total content in raw materials)	29,12 (82,72)	20,31 (84,98)

Figure 9. Table 6. The results of obtaining unconventional oils according to the existing technology and using the developed modes of double pressing.

As can be seen from the data in Table 6, in control experiments, the yield of first-pressed oil ranged from 34.43 to 56.94 of the total oil content in the raw material. It is worth noting that the yield of watermelon oil was only 36.22which is due to insufficient preparation of the pulp for oil extraction using a well-known technology. Also, with the final pressing according to the known technology, the yield of expeller oil was from 1.59 to 6.03The total oil intake does not exceed 62.97of the total oil content in the raw material, which indicates a high content of residual oil in the expeller cake, as a result of which the percentage of protein decreases to 20.27In experimental experiments, the yield of pre-pressed watermelon oil increased to 73.68,i.e. by 39.25compared with the control. The indicators of the second spin in the experiments also differ from the indicators of the control experiments. The increase in the color number of the oil compared to the prepress oil was up to 23 mg of iodine, the acid number up to 1.68 mg KOH / g, which is explained, as a consequence, by more stringent processing regimes (moisture, temperature and high pressure). The total volume of watermelon oil was 20.31, and melon oil was 29.12

5. Discussion

Experimental studies have shown that the optimal interval of heat treatment of the studied samples of raw materials (melon and watermelon seeds) at a temperature of 80C is 40-50 min. When the mint was moistened and treated at a temperature of 80C for 50 min. the increase in oil yield is significant, i.e. 26.2was obtained from melon pulp and 17.6of pressed oil was obtained from watermelon pulp. When pressing pulp obtained from watermelon seeds, the oil yield from hydrothermically treated material is 14.5higher compared to untreated. The above data indicate that hydrothermal treatment of the studied samples of unconventional oilseeds under gentle regimes (no more than 80C) improves the yield of prepress oil. Currently, the expelling (final pressing) of

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the pre-pressed cake is carried out without pretreatment, i.e. the primary pressed cake is crushed and subjected to final pressing. As experiments have shown, despite the fact that with the help of preliminary hydrothermal treatment, the yield of first-pressed oil increases, the residual amount of oil in the cake is high, along with the loss of oil in quantity, it leads to a decrease in the quality of the by-product - cake. In order to increase the efficiency of oilseed pressing, we have conducted comprehensive studies on the development of optimal modes of both primary and final pressing. Hydrothermal treatment is necessary to reduce the activity of enzymes, reduce the viscosity of the oil separated by pressure and improve the drainage properties of the material. Based on the experimental results, we propose a new technology for preparing the cake for final pressing, characterized in that at the second stage, the cake obtained at the first stage of pressing is first crushed to 55-60of the passage through a 2 mm sieve, moistened to 12with steam at a temperature of 120C and a pressure of 0.5 MPa. Then, the resulting material is thermally treated at a temperature of 120C for 30 minutes with a decrease in the moisture content of the pulp to 7 ± 0.5and subjected to final oil extraction in the expelling mode. Processing of the oilseed material before the primary and final pressing according to the developed technology, due to the improvement of the technological parameters of the pressed material, provides an increase in the amount of prepress and expelling oils of improved quality.

6. Conclusions

Based on the properties and role of water and aqueous solutions in oil extraction, an improved double-pressing technology has been developed, which provides for grinding seeds without separating husks up to 60of the passage through a 1 mm sieve, humidification with steam condensate up to 11and heat treatment at a temperature of 80°C for 50 minutes before pre-pressing and grinding up to 60of the passage pre-pressed cake, humidification of the material to a humidity of 12by steam with a temperature of 120°C and a pressure of 0.5 MPa for 15 minutes before expelling. We know that this technology is used for various purposes, for example, when processing grain crops to improve the quality of the crop, since this technology does not affect the structure of raw materials while maintaining all the organoleptic characteristics of the raw materials under study.[32] [992–1004pp.] A distinctive part of the technology is the re-moistening of the primary pressed and crushed material to 12and heat treatment for 30 minutes with a decrease in the moisture content of the pulp to 7 ± 0.5which ensures the maximum amount of oil is consumed. The above-mentioned processing technology has a number of advantages in comparison with the existing technology: - gentle hydrothermal treatment of the studied samples of oilseed materials will lead to some positive results. Along with an increase in oil removal, when heated to 80C, starch is converted to dextrins, which are easily absorbed by the body, the main part of protein substances undergo denaturation, which gives rigidity to the material and retains drainage properties during compression. The fatty acid part is practically unchanged, vitamins and the digestibility of nutrients are improved by 20-25[33][214p.]. - the increased humidity of mint and pulp ensures the penetration of water into the cellular structure where the oil is located, and when the proteins swell, they displace the oil from the cell; - during frying, during protein denaturation, moisture turns into steam and internal pressure increases, as a result of which steam tends to the outside and creates microcapillaries, so-called drains, which subsequently serve to extract oil; - unlike existing technologies, the moisture content of the material is up to 12followed by a decrease to 7for 30 minutes. leads to intensive evaporation of moisture, therefore, improvement of the drainage structure and additional removal of expeller oil.

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