

TECHNICAL SUPPORT FOR COLD-PRESSED OIL PRODUCTION

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Problem statement. In modern agro-industrial production, the demand for environmentally friendly, biologically active products, in particular cold-pressed edible oils, is growing. Flax, pumpkin and sesame oils are characterized by a high content of omega-3, omega-6 fatty acids, antioxidants, vitamins and trace elements. Their production requires precise technical and technological support, which includes modern equipment, automated control systems, compliance with sanitary standards and an effective packaging system. The introduction of innovative solutions in the processing of crop products allows to improve quality, reduce losses and ensure competitiveness in the domestic and foreign markets [1].

Main materials of the study. For the production of cold-pressed edible oils, seeds of high-quality oil crops are used - flax, pumpkin and sesame. Each of these species has unique properties that affect the processing technology, the yield of the finished product and its nutritional value. Oilseed flax is grown mainly in the southern, northern and central regions of Ukraine. The seeds contain about 35–42% oil, rich in omega-3 fatty acids and vitamin A. An important condition is to harvest flax at the optimal time to avoid waterlogging and spoilage of the seeds.

Pumpkin seeds have a high oil content - up to 50%, especially in varieties of the "gymnosperm" type. It contains valuable phytosterols, zinc, selenium, as well as saturated and unsaturated fatty acids. Pumpkin is grown in the southern regions, and the seeds are obtained by mechanical extraction from the fruit, drying and cleaning.

Sesame is a thermophilic crop that is grown mainly in experimental or niche farms in Ukraine. Sesame seeds contain up to 50% - 60% oil, rich in sesamin, sesamol, calcium and antioxidants. Due to their small size and high hygroscopicity, sesame requires special attention during storage and preparation for processing.

Before being submitted for pressing, the raw material undergoes several stages of preparation: cleaning from mechanical impurities, dust, stones and metal particles (using separators and magnetic traps); drying to an optimal moisture content of 6–8% in shaft or drum dryers; calibration by size and density to ensure uniform pressing; grinding in roller crushers to a fraction of 0.5–1.5 mm, which contributes to the effective extraction of oil.

The quality of raw materials is determined by such indicators as humidity, oil content, purity, absence of foreign odors, microbiological

safety and compliance with varietal characteristics. Not only the yield of oil, but also its stability, taste properties and shelf life depend on the correct selection and preparation of raw materials.

Pressing is a key stage in the production of cold-pressed edible oils, since it is at this stage that the mechanical extraction of oil from prepared seeds takes place without the use of high temperatures. The main goal is to obtain oil with maximum biological value, preserving all natural components: fatty acids, vitamins, antioxidants and phytosterols.

Screw presses are used to perform cold pressing, which ensure gradual compression of the seed mass in the pressing chamber. The seeds are fed into a hopper, from where they enter the screw mechanism, where the oil is squeezed out under the action of the rotational movement of the screw and high pressure (30–50 MPa). It is important that the temperature in the pressing zone does not exceed 45°C, as overheating leads to the destruction of heat-sensitive substances, especially omega-3 acids in linseed oil [2, 3].

The pressing process is controlled by automated systems that regulate: the speed of rotation of the screw; the temperature of the press body; the pressure in the compression zone; the level of raw material supply. For linseed oil, it is especially important to minimize contact with oxygen. Pumpkin seeds, due to their soft structure, are easy to press, but require careful moisture control to avoid sticking. Sesame seeds have a fine fraction, so pressing requires precise calibration of the screw and uniform supply. After pressing, the resulting oil contains mechanical impurities, so it is sent for filtration. At the same time, the seed residues (cake) are removed from the press and can be used as a feed additive or raw material for biofuel. Thus, effective pressing ensures a high oil yield, stable product quality and preservation of its beneficial properties without the use of chemical or thermal methods [4].

Research results. The technological process of cold-pressed oils production is based on the use of specialized equipment that ensures the preservation of biologically active substances and stable product quality. At the drying stage, shaft or drum dryers are used, which allow reducing seed moisture to the optimal level - 6–8% - at a temperature of 40–60°C. Grinding is carried out using rollers.

The main unit is a cold-pressed screw press, which operates at a temperature not exceeding 45°C and a pressure of 30–50 MPa. This allows the oil to be extracted without thermal destruction of its beneficial components. Bag or membrane filters with a porosity of 1–5 micrometers are used to purify the oil, which ensure the transparency of the product without the use of chemical reagents.

The oil is stored in sealed containers made of food-grade stainless steel or dark glass, which protects the product from light and oxidation. The storage temperature is maintained within +5...+15°C. Automated control systems are implemented at all stages of production: frequency converters, PLC controllers regulate temperature, pressure and humidity.

Additionally, quality control sensors are used - optical, temperature, vibration - which are integrated into production lines to ensure the stability of parameters.

Packaging is the final stage of the technological process of producing cold-pressed edible oils and is crucial for preserving the quality, biological activity and presentation of the products. For linseed, pumpkin and sesame oils, packaging is used exclusively in glass containers that meet the requirements for the storage of light- and oxygen-sensitive products. Preference is given to dark glass bottles - amber, green or black - that provide protection against ultraviolet radiation and photochemical oxidation. The volume of the bottles varies depending on the target market: 100 ml, 250 ml, 500 ml and 1 liter. Capping is carried out using screw metal or polymer caps with a seal that guarantees tightness.

For premium segment products, packaging is carried out on automatic or semi-automatic lines that include dispensers, cappers, and labeling machines. Before bottling, the oil undergoes final filtration, and after packaging, visual inspection of transparency, tightness and labeling. Labeling is carried out in accordance with the requirements of DSTU and TU, indicating the date of production, expiration date, storage conditions, composition, manufacturer and contact information. Labels may contain QR codes for going to the manufacturer's website or viewing quality certificates. Sanitary and hygienic conditions of the packaging shop must meet food safety requirements: air cleanliness, temperature control, absence of foreign odors, regular disinfection of surfaces and equipment.

After packaging, the products are packed in corrugated containers or shrink film for transportation. Packaged bottles are stored in dry, dark rooms at a temperature of $+5...+15^{\circ}\text{C}$, with a relative humidity of no more than 60% [4].

The production of cold-pressed edible oils from non-traditional raw materials – flax, pumpkin and sesame – is an economically feasible and environmentally friendly direction of development of the agro-processing industry. This approach allows to combine high added value of products with minimal impact on the environment. From an economic point of view, cold-pressed oils belong to the category of niche products with high demand among consumers focused on healthy eating. The cost of a liter of flax, pumpkin or sesame oil in the retail segment significantly exceeds the cost of traditional sunflower oil, which ensures high profitability of production even with relatively small volumes of processing. In addition, the cake remaining after pressing is not waste, but is used as high-protein animal feed, fertilizer or raw material for biofuel, which allows for complete utilization of raw materials without loss.

From an environmental point of view, the production of cold-pressed oils is low-waste and safe for the environment. The absence of chemical reagents, minimal water consumption, low levels of air and wastewater emissions make this process suitable for implementation even in small

farms or environmentally sensitive regions. In addition, packaging in glass bottles that can be reused or recycled meets modern requirements for environmentally friendly packaging and reduces the burden on the environment.

Thus, the production of cold-pressed flaxseed, pumpkin and sesame oils is an example of a sustainable agro-processing business that combines economic benefit with responsibility to nature and society.

Conclusions. Technical and technological support for the production of cold-pressed flaxseed, pumpkin and sesame oils covers all stages - from the preparation of raw materials to the packaging of finished products. High-tech equipment, process automation, compliance with technical conditions and sanitary standards allow you to obtain high-quality, safe and competitive products. This approach contributes to the development of small and medium-sized agribusiness, environmental safety and strengthening of Ukraine's position in the world market of edible oils.

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