Design and Research on Shell Breaking Mechanism

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Abstract. For the large demand but low acquisition efficiency of the black olive kernel, the automatic assembly line instead of the traditional artificial olive kernel, automatically complete the shell breaking and kernel, kernel screening. Based on the design requirements of kernel extraction, we determine the overall structure of the olive kernel machine. Focus on analyzing material conveying device and cutting and shell breaking device, in the pipeline design, mainly use vibration disc, linear feeder, sprocket conveyor, pneumatic pressure device and linear screening machine and other institutions. Furthermore, three machining-sized molds were designed for the irregularities of the olive core. Finite element analysis showed that the design organization are reasonable.

Keywords. Black olive core, open olive core machine, cutting mechanism.

1. Introduction
Large amounts of black olives are produced annually in southern China, most of which are used to make olive kernel products for market sales. Traditional black olive pulp and kernel are mainly used as raw material for food processing, and olive kernel is used as raw material for activated carbon processing [1]. Among them, the olive kernel is very rich in various nutrients, especially in which the protein and fat content is as high as 82.3%. Olive nucleolar protein has a complete variety of amino acids and 8.9%, accounting for 34.2% of the total amino acids. It is a plant protein with high nutritional value [2]. As a valuable part of black olive, black core has huge revenue potential in the sales market.

At present, the production method to extract olive meat, and there is no automatic production machinery on the market. And China's mechanization of shell breaking, shell separation of shell kernel, peach kernel color separation, peach kernel grading and other aspects of the technology is relatively backward [3]. Low efficiency requires large manpower, and it is difficult to achieve mass production. The application of mechanical design automation can ensure the high production efficiency while reducing the waste of various materials in the production process, which greatly saves the production energy consumption [4], effectively break the olive core shell, reduce the labor force, greatly improve the production efficiency.

2. Design of the General Scheme of the Black Olive Core Shell Breaker

2.1. Design Requirements
(1) Simple operation and high efficiency.
(2) Automatic feed, automatic shell break, automatic screening material.
(3) Multi-type core mold sleeve to meet the requirements of black olive size and shape difference.

2.2. Organization and Working Principle

Through the work needs of the open olive core, the overall design scheme of the assembly line is set. In the course of work, directional arrangement, size screening, delivery, cutting, shell breaking and material screening are shown in figure 1. Following these requirements, the black olive shell breaker as shown in figure 2 was designed.

![Work flow chart](image)

**Figure 1. Work flow chart**

1. Vibration disc 2. Straight feeder 3. Sprocket conveyor 4. disc saw sheet 5. Press device 6. Straight sieve.

**Figure 2. Black olive shell breaker device.**

The first process is a directional arrangement, realized by the vibration disc. The vibration disc arranges the olive core in a consistent direction and delivers it to the next process orderly. The second process is size screening, realized by the linear feeder, which is equipped with checkpoints to divide the olive core screen output by the vibration disc into three sizes, and continue to pass the olive core to the next process. The third process is delivery, which is realized by the sprocket transport machine. There are three sizes of imitation olive shaped mold bearing the olive core output from the linear feeder. The sprocket conveyor delivers the mold cycle, so as to realize the mold bearing olive core processed successively cut and shell breaking area. The fourth process is cutting, which is realized by the disc saw blade. Saw blades of three different sizes are installed on one shaft to drive the tool to move up and down through air pressure, and the shaft drives the saw blade to cut the crack into the olive core. The fifth process is the shell breaking, which is realized by the pressure device, which is
controlled by the pneumatic device. When the olive core is transported by the conveyor, the press device breaks the cracked olive core. The sixth process is the material screening score, which is realized by the straight line screening. The broken olive core is transported to the straight line screen. The straight line screen is divided into three layers to screen out the olive core.

3. Design of Various Mechanical Devices

3.1. Material Conveying Device

The material conveying device transmits the olive core from the starting position to the processing station, which includes the directional conveyor mechanism, the olive core size screening mechanism, and the sprocket conveyor mechanism. The directional delivery mechanism transmits the olive core to the arrangement mechanism in a consistent direction. Directed transport of the olive core is achieved by vibration discs. There is a pulse electromagnet under the vibration disc hopper, which vibrates the hopper in the vertical direction, and the inclined spring sheet drives the hopper around its vertical shaft. The olive core of the hopper, due to this vibration, rises along the spiral orbit. In the process of rising, through the exit level of the track, the olive core can automatically enter the position corresponding to the next process in the same state according to the processing direction requirements.

The olive core size screening mechanism is shown in figure 3. The olive core size screening organization divides the olive core screen into three sizes, namely large, medium and small olive nuclei. The size screening of the olive core is achieved by a linear feeder. The linear feeder is driven by a double vibration motor. When the two vibration motors are synchronous and reverse rotation, the shock force generated by its eccentric block is offset in the direction parallel to the motor axis and stacked as a joint force in the direction perpendicular to the motor axis, so the movement trajectory of the screening machine is a straight line. The two motor axes have an inclination angle relative to the screening surface. Under the joint action of shock force and material self-gravity, the material is thrown on the screen surface by jumping forward for the straight line, so as to achieve the purpose of screening and grading the materials. The olive core enters from the 8 loss entrance to level 9 I, when the large olive core is screened to the 11 output port I output. When the core reaches level 10, the median core is screened to the 13 output port. The olive core of the remaining trumpet is output from the 12 output port.

![Figure 3. Line feeder.](image)

Sprocket conveying mechanism. The conveyor mechanism is used to transport the olive core to the processing area. See figure 4 for the sprocket transport machine. Its sprockets are driven by a motor, and the chain is equipped with molds to carry the olive core. As the die passes through the baffle, the olive core falls to the die. The baffle can separate the excess olive core. The mold is shown in figure 5. Driven by the sprocket chain to the tool processing place and the pressing tool processing place to cut and break the shell of the olive core, and finally remove the cutting and pressing working area to transport the processed olive core to the straight line sieve for screening.
3.2. Cutting and Shell Breaking Device

The cutting mechanism is shown in figure 6. The cutting mechanism cuts the olive core out of the crack. Cutting of the olive core is achieved by a circular saw blade. The tool is equipped with three different sizes through one shaft, large saw blade: diameter 80 mm, hole diameter 15,30 blade port, blade spacing 9.5mm blade: diameter 60 mm, hole diameter 10,30 blade spacing 7.33 mm blade blade: diameter 52, hole diameter 10,30 blade port, blade spacing 6.51 mm. One end of the shaft is fixed through the bearing, the other end connects the motor to the shaft with a coupling, the motor drives the shaft to turn, then the shaft drives the saw blade to turn, and drives the tool up and down through air pressure. To ensure the stability and safety of the olive core processing process, the olive core is covered with a cover plate under the saw blade.

The shell breaking mechanism is shown in figure 7. The broken shell mechanism breaks the olive core. The olive core can be broken through the press and the olive core. After the tool, the olive core is transported to the conveyor directly under the press device. The bottom of the press device has different ladder layers according to the size of the olive core. The pressure through the cylinder drives the pressure rod to break the olive core with cracks.

3.3. Material Screening Device

Leave the shell of the black olive core from the olive kernel meat as shown in figure 8. The separation of the olive core shell and the kernel is realized by the linear vibration sieve, using the vibration motor as the vibration source so make the material is thrown on the sieve network and make the linear motion forward, and screen the olive core, olive kernel meat and a small amount of broken slag through the multi-layer sieve. The final material are discharged from the respective exits.
4. Automatic Olive Core Workflow
The work of the olive machine is divided into six steps, which separate the directional arrangement of olive nuclei, size screening, delivery, cutting, shell breaking and broken olive nuclei.

Step 1: The vibration disc sends the olive core into a linear feeder in a consistent direction.

Step 2: The linear feeder for the size of the olive core, the linear feeder has two levels, the olive core into three sizes. The three large, medium and small sizes are orderly and directionally sent to the processing mold.

Step 3: Sprocket transport the olive core, the chain has a mold bearing the olive core, following the previous process, three sizes of olive core fell into the mold, the sprocket transport machine sends the mold to the tool processing area.

Step 4: The disc saw blade cuts the olive core. When the sprocket transport machine transports the olive core directly below the cutting processing area, the disc saw blade is driven by the motor, the cylinder cuts the olive core shell down, the core cutting depth is limited to 2mm, the core cuts a 2mm deep crack.

Step 5: The pressure tool breaks the olive core with cracks. The pressure device is fixed by the pressure rack, and the cylinder drives the pressure device and breaks the olive core.

Step 6: The olive core is transported from the processing area by the sprocket transport machine, and finally falls into the straight sieve. The olive core, olive meat and crushed slag separated by the straight sieve are discharged from their respective exits respectively.

5. Mechanical Property Analysis
In the process of transmission and processing mold, the transmission shaft on the sprocket drives the chain and the processing mold to move, which needs to carry a large torque. To test the design rationality, relevant mechanical calculation and calibration.

The traction force generated by the transmission shaft here is mainly used to drive the rotation of the sprocket and move the processing mold and chain from bottom up. The traction required of other similar conveyors on the market and the mold weight of the product design, and the maximum traction required during rotation can be calculated according to the gravity of the processing mold and the chain structure. The design diameter of the sprocket dimension is the total mass of all the mold and chain structure. Therefore, the sprocket drive shaft bore a maximum torque of

\[
T_{\text{max}} = F_{\text{max}} \times R = m_{\text{total}} g \times D/2 = 70 \times 9.8 \times 0.125N \cdot m = 85.75N \cdot m
\]  

(1)

To ensure the design rationality of the design, finite element analysis was performed on the —— sprocket drive shaft in the transmission device using SolidWorks Simulation [5]. First, the sprocket drive shaft material is set to the conventional alloy steel, after the constraint, the applied torque, divided into the corresponding discrete grid, for torsion deformation analysis. Results of the analysis are shown in figure 9.
By analyzing the torsion deformation, the maximum stress value is 42.6 Mpa. Considering safety here, adopt high reliability, safety factor $S=1.60$ \[6\] $\tau_{\text{max}} \leq [\tau] = \frac{\tau_{\text{limit}}}{S}$, Get. Therefore, after verification, the sprocket drive shaft meets the strength conditions \[7\].

6. Conclusion
After conception and experiment, an automatic open olive kernel assembly line was developed. This pipeline enables the nucleolar separation of the olive nucleus. The automatic operation of the assembly line greatly reduces the waste of manpower. It solves the problem of the artificial olive kernel and improves the efficiency of the olive kernel, and then realizes the mass production. This design has achieved some results in solving the problem of artificial olive core. Compared with labor open olive kernel, it greatly reduces labor cost and improves the efficiency of open olive kernel. The design has the advantages of small size, simple structure and easy to produce. Admittedly, there are still shortcomings, which need to be further improved and improved \[8\].

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