DESIGN AND EXPERIMENT OF A ROTARY CUTTER-TYPE DRIED CHILI SEGMENTING MACHINE
/
滚刀式干辣椒切段机的设计与试验

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ABSTRACT
In response to the lack of machines for cutting dried chili peppers into segments and the problems of low efficiency and high damage rate of existing segmenting machines, a rotary knife-style dried chili pepper segmenting machine was designed. The working mechanism of the rotary knife in coordination with the drum for cutting was explained, and structural parameters were determined based on the motion characteristics of the rotary knife and practical requirements. Three factors affecting chili pepper segmenting efficiency were identified, and the chili pepper segmenting qualification rate and damage rate were used as experimental indicators. Experiments and data processing were conducted using software, a regression model between the experimental indicators and influencing factors was established, and the optimal parameter combination was determined. The experimental results showed that when the rotary knife speed was 51 r/min, the conveyor belt speed was 0.6 m/s, and the drum speed was 51 r/min, the device damage rate was 1.42%, and the cleaning rate was 98.21%, meeting industry standards. This study can provide a reference for the research of rotary knife-style dried chili pepper segmenting machine technology and equipment.

摘要
针对干辣椒切段机械匮乏且现存切段机工作效率低、破损率高等问题，设计了一种滚刀式干辣椒切段机，阐述滚刀与滚筒配合切割的工作机理，根据滚刀的运动特点和实际需要得出结构参数。确定了影响辣椒切段效率的三个因素，以辣椒切段合格率和破损率作为试验指标，通过软件进行试验设计及数据处理，建立了试验指标与影响因素之间的回归模型，并确定最优参数组合。试验结果表明，当滚刀转速为 51r/min，传送带速度为 0.6m/s，滚筒的转速为 51r/min 时，装置损伤率为 1.42％，脱净率为 98.21％，符合行业标准。该研究可为滚刀式干辣椒切段机技术与装备研究提供参考。

INTRODUCTION
China is the world's largest producer, consumer and exporter of chili peppers. The annual planting area of chili peppers in China exceeds 2 million hectares, accounting for about 10% of the national vegetable planting area, with an annual output value of more than 250 billion yuan. Capsaicin, which is abundant in chili peppers, has vasodilatory effects, contributes to blood pressure reduction, lowers the risk of thrombosis, and helps regulate lipid metabolism, thereby conferring significant nutritional and medicinal value to chili peppers. At present, the mechanization of chili pepper harvesting has been gradually popularized in China, but there are very few machines for dried chili segmenting, and the segmenting work is still mainly done manually. Manual segmenting is of low efficiency, and long-term manual operation may cause hazards such as dermatitis and respiratory tract damage. With the development of the chili pepper industry, a stable and efficient dried chili segmenting machine is urgently needed to meet the market demand and promote the development of the chili pepper industry.

In recent years, there have been many studies on the technology and equipment for segmenting and crushing crops such as cotton stalks, sugar beets and straws, while the research on chili pepper segmenting equipment is relatively scarce.

Pang et al, (2025), designed a feeding device and a chopping device, with the qualification rate of segment length reaching 96.76%, which met the operational requirements of the maize harvester with both ear and stalk collection functions and the national feed chopping standards. *Jiang et al, (2019),* studied the effects of the speed of feeding pressure roller and the spindle speed of chopper on the qualification rate of stalk chopping length and power consumption, and optimized to obtain the optimal operational parameters. *Wang Qinghui et al, (2012),* developed a mixed grid-guided rotary cutter-type straw crushing device, which solved the prominent problems of high power consumption, heavy dust and poor working environment for operators of unsupported cutting machinery. *Zhang et al, (2018),* designed a rotary cutter-type combined machine for silage corn stubble cutting and residual film recovery, and the stubble cutting rate reached 88.25% under the optimal working parameters. *Yuan et al, (2023),* designed a chili slicer with the integrity rate of chili slicing reaching 97.85%. *Carlos Labra et al, (2015),* established a DEM-FEM coupled model to simulate the rock-breaking process of a roller cutter; they analyzed rock crack propagation, fragmentation patterns, and the forces on the roller cutter; they revealed the microscopic mechanism of roller cutter rock breaking, providing a numerical method for optimizing roller cutter structure.

To address the shortage of chili pepper segmenting machinery and the low working efficiency of the existing segmenting machines, a rotary cutter-type dried chili segmenting machine was designed in this paper. Through single-factor experiments and Box-Behnken response surface experiments, the influence laws of the key parameters of the chopping device on the qualification rate and damage rate of chili segmenting were explored, the optimal parameter combination was obtained and verified by experiments, so as to provide a reference for the research and development of chili pepper segmenting technology and equipment.

MATERIALS AND METHODS

Overall structure and working principle

Overall structure

The rotary cutter-type dried chili segmenting machine is powered by a 3.5 kW motor, and realizes chili cutting through the relative rotation of the rotary cutter and the drum. The machine is mainly composed of a drum (1),a rotary cutter (2), a conveyor belt (3), a feeding hopper (4), two vibration motors (5), a frame (6), a control system (7) and other components. The overall structure is shown in Fig. 1.

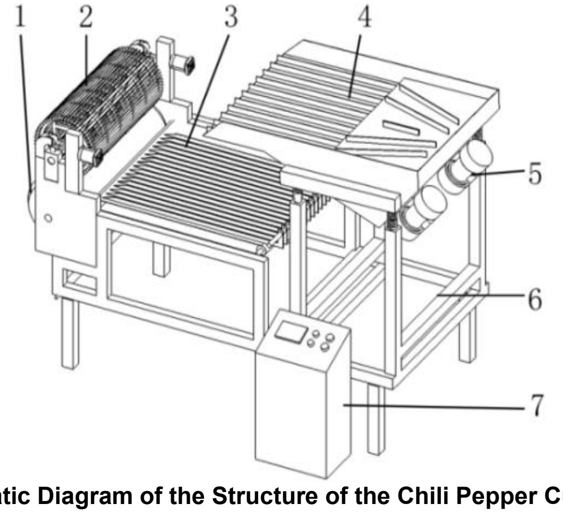


Fig. 1 – Schematic Diagram of the Structure of the Chili Pepper Cutting Machine

1 – Drum; 2 – Rotary cutter; 3 – Guide rail; 4. – Feeding hopper; 5 – Vibration motor; 6 – Frame; 7 – Control system

Working principle and main parameters

During the operation, the relative position of the rotary cutter and the drum is first precisely adjusted by the height adjustment device. After the adjustment is completed, the motor drives the rotary cutter and the drum to rotate. During the operation, the vibration motor vibrates to promote the uniform scattering of chili peppers in the feeding hopper onto the surface of the conveyor belt, ensuring the orderly progress of the feeding operation. The conveyor belt continuously conveys chili peppers to the rotary cutter, and the chili peppers are adjusted in posture by the guiding and limiting effect of the guide rail during the conveying process and then conveyed to the feeding position. Under the action of the relative rotation of the rotary cutter and the drum, the chili peppers are cut into small segments with uniform size. The specific structural and operational parameters of the rotary cutter-type dried chili segmenting machine are shown in Table 1.

Table 1

Technical Specifications

Parameter	Value
Dimension (Width×Length×Height), [mm]	950×1550×1420
Working efficiency, [kg/h]	1000
Power of vibration motor, [kW]	1.5
Power of rotary cutter motor, [kW]	3.5
Rated voltage, [V]	380
Working width of conveyor belt, [mm]	1000
Rotary cutter speed, [r/min]	30~70
Conveyor belt speed, [m/s]	0.4~0.8
Total mass of the machine, [kg]	1780

Design of key components

Control system

The control system is responsible for the start and stop control of the rotary cutter-type chili segmenting machine, and its operation process and control logic are as follows: on the operation interface of the control panel, the start commands of the main machine and the auxiliary machine are first activated. Among them, the main machine corresponds to the vibration motor, which drives the vibration of the feeding hopper after startup to make the chili raw materials in the hopper fall evenly onto the conveyor belt; the auxiliary machine controls the operation of the rotary cutter and the drum to provide power for the segmenting process *(Wang et al, 2019)*.

After entering the parameter setting interface, the precise control of the lifting of the rotary cutter is realized through the servo fine-tuning function. The specific operation logic is as follows: clicking the forward rotation control button makes the rotary cutter perform the descending action; clicking the reverse rotation control button makes the rotary cutter perform the ascending action *(Paradkar et al, 2021)*. When the rotary cutter is adjusted to a suitable position meeting the production requirements, the zero clearing button is clicked to set this position as the reference position, providing a positioning reference for the subsequent cutting operation. With the help of the servo fine-tuning system, the relative position and operating speed of the rotary cutter and the drum can be flexibly adjusted, so as to adapt to the segmenting processing requirements of chili peppers of different varieties and specifications. The electrical control principle is shown in Fig. 2.

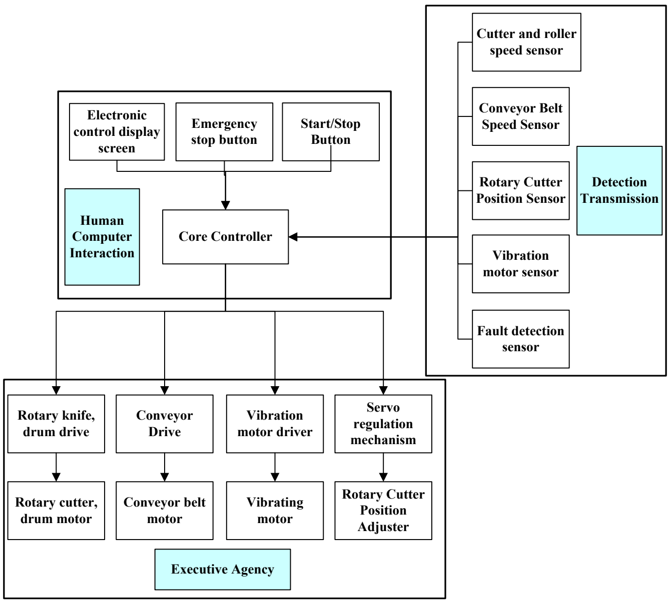


Fig. 2 – Schematic Diagram of the Electronic Control System

Feeding mechanism

As the core feeding component of the chili segmenting machine, the feeding mechanism is mainly composed of a feeding hopper, a conveyor belt, guide rails and a vibration motor, and its specific structure is shown in Fig. 3. Among them, the ZDS-2-2 type vibration motor is selected with a single exciting force set to 2000 N, which can provide stable and continuous vibration power for the feeding process and ensure the orderly progress of the feeding operation. In view of the problems that chili peppers are prone to posture deviation and messy arrangement during the conveying process, which further affect the segmenting accuracy, a number of guide rails are arranged on the conveyor belt. The guide rails have a limiting and guiding effect on chili peppers, which can ensure that chili peppers always move in a straight line during the conveying process, thus realizing the regular cutting of chili peppers and ensuring the segmenting quality.

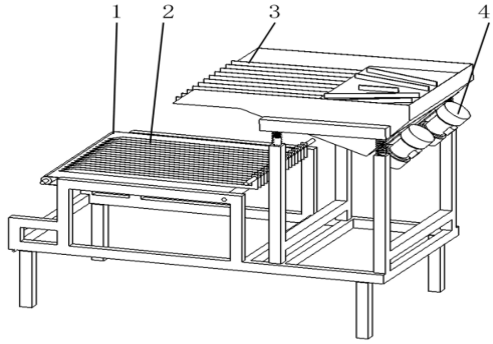


Fig. 3 – Schematic Diagram of the Feeding Mechanism
1 – Conveyor belt; 2 – Guide rail; 3 – Feeding hopper; 4 – Vibration motor

The angle of the feeding hopper affects the falling state of chili peppers, and then affects the distribution state of chili peppers on the conveyor belt, which is a prerequisite for the uniform cutting of chili peppers. It is required to ensure that chili peppers are in a static state when the vibration motor is not working, so as to avoid chili peppers falling into the conveyor belt irregularly. It requires that the force of the chili in the normal component friction be greater than the force in the tangential component, as shown in Figure 4 and satisfying Equation (1).

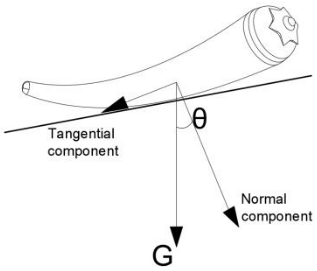


Fig. 4 – Force Analysis of Chili in the Feed Box

$$\mu mg\cos\theta > mg\sin\theta \tag{1}$$

where:

m is the mass of chili pepper, [g]; g is the gravitational acceleration, [m/s²]; θ is the included angle between the bottom surface of the feeding hopper and the horizontal plane, [°]; μ is the friction coefficient between chili pepper and the steel plate of the material hopper.

The friction coefficient between chili pepper and the steel plate of the material hopper is measured to be 0.45. Substituting it into the equation *(Hou et al, 2020)*, the condition for chili peppers to be in a static state is obtained:

$$\theta \le 24.23^\circ \tag{2}$$

The size of the guide rail should ensure the passage of a single chili pepper to avoid the superposition and crowding of chili peppers, which will affect the segmenting quality, as shown in Fig. 5.

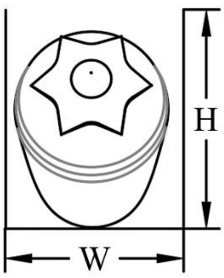


Fig. 5 – The state of the chili in the guide rail.

The width W and height H of the guide rail should satisfy the following conditions:

$$\begin{cases} d_{max} < W < d_{max} + d_{min} \\ d_{max} < H < d_{max} + d_{min} \end{cases} \tag{3}$$

where: W is the width of a single guide rail, [mm]; H is the height of a single guide rail, [mm]; d_{max} is the maximum diameter of chili pepper stem, [mm]; d_{min} is the minimum diameter of chili pepper stem, [mm].

200 Xinjiang Red Dragon plate peppers were randomly selected, and their sizes were measured with a vernier caliper: the maximum diameter d_{max} was 28.2 mm, and the minimum diameter d_{min} was 21.6 mm. Combined with the preliminary experiments, the width and height of the guide rail were determined to be 30 mm.

Segmenting mechanism

The segmenting mechanism is mainly composed of a rotary cutter and a drum. The rotary cutter takes cutting blades *1*, cutter frame *2*, cutter shaft *3* as the core, and its structure is shown in Fig. 6. The cutting blades are made of 304 stainless steel with an oblique edge structure, which takes into account both cutting performance and corrosion resistance. The inside of the drum adopts a hollow structural design, which effectively reduces the power loss during the operation of the equipment while ensuring the structural support strength. The outer side of the drum is covered with synthetic rubber BR9000, which has the mechanical characteristics of high toughness and high wear resistance, and is suitable for the working conditions of chili pepper segmenting. During operation, the chili pepper segmenting is realized by the relative rotation of the rotary cutter and the drum, and its working principle is shown in Fig. 7.

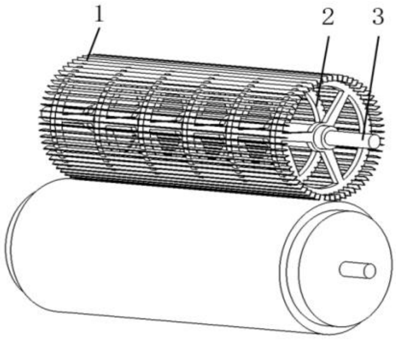


Fig. 6 – Schematic Diagram of the Segmenting Mechanism
1 – Cutting blade; 2 – Cutter frame; 3 – Cutter shaft

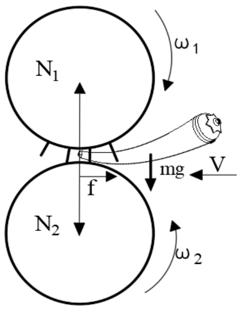


Fig. 7 – Force Analysis of the Chili Cutting Process

In the figure, N_1 and N_2 are the extrusion forces of the rotary cutter and drum on chili pepper, [N]; f is the friction force of the drum on chili pepper, [N]; ω_1 and ω_2 are the rotational speeds of the rotary cutter and drum, respectively, [rad/s]. Considering the operation conditions and the service life of the machine, the rotational speeds of the rotary cutter and the drum are set to be the same. The length of chili pepper segment is equal to the feeding length of chili pepper on the conveyor belt within the interval time between two cutting actions of adjacent rotary cutter blades. The interval time between two cutting actions of adjacent rotary cutter blades is:

$$\begin{cases} t = \dfrac{2\pi r}{N\omega r} \\ \omega = \dfrac{\pi n}{30} \end{cases} \tag{4}$$

where: N is the number of rotary cutter blades, [pcs]; t is the interval time of cutting actions, [s]; ω is the angular velocity of the rotary cutter, [rad/s]; r is the radius of the rotary cutter, [m]; n is the rotational speed of the rotary cutter and the drum, [r/min].

The time interval t is obtained from Formula (4):

$$t = \frac{60}{nN} \tag{5}$$

Assuming the conveyor belt speed is V_0, the moving distance of chili peppers on the conveyor belt is obtained:

$$L = V_0 t \tag{6}$$

Substituting Formula (5) into Formula (6), the length of chili pepper segment is obtained:

$$L = \frac{60V_0}{nN} \tag{7}$$

To reduce the manufacturing cost and unify the specifications of parts, the number of blades on the rotary cutter is designed uniformly. Combined with the above formula, it can be seen that the length of chili pepper segment is related to the rotational speed of the rotary cutter, the rotational speed of the drum and the speed of the conveyor belt. In actual production, the flexible regulation of the length of chili pepper segment under different requirements can be realized by adjusting the rotational speeds and the conveyor belt speed.

Experimental conditions

To verify the performance of the dried chili segmenting machine, a chili segmenting experiment was carried out at Qingdao Lulu Machinery Co., Ltd. on December 1, 2025. Xinjiang Red Dragon plate peppers were selected as the experimental objects. The test showed that their moisture content was 13.8%, which met the requirements of relevant industry standards; the average length of dried plate peppers was 112.6 mm, and the average mass of a single fruit was 3.6 g. The specifications of the experimental samples were unified to ensure the accuracy and reliability of the experimental data *(Zhuo et al, 2022; You et al, 2021).*

Experimental indicators and methods

During the segmenting process, chili peppers may stick to each other or be crushed by extrusion. The damage rate Y_1 and qualification rate Y_2 of chili segmenting were taken as the experimental indicators, and the rotary cutter speed X_1, conveyor belt speed X_2 and drum speed X_3 were taken as the experimental factors for the experiment. Referring to the JB/T13265-2017 vegetable processing industry standards and processing requirements, the qualification rate and damage rate indicators were measured *(Wang et al, 2025)*.

$$Y_1 = \frac{M_1}{M} \times 100\% \tag{8}$$

$$Y_2 = \frac{M - M_1 - M_2}{M} \times 100\% \tag{9}$$

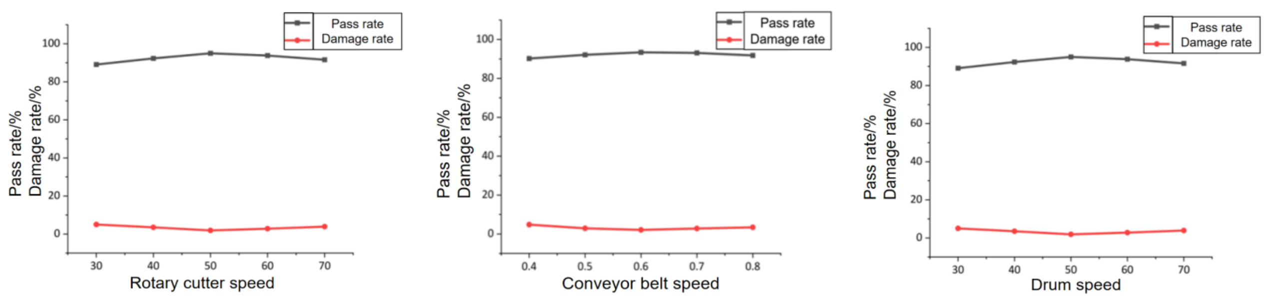
where:

Y_1 is the damage rate of chili peppers, [%]; Y_2 is the qualification rate of chili peppers, [%]; M is the total mass of experimental chili peppers, [g]; M_1 is the mass of damaged chili peppers, [g]; M_2 is the mass of unsegmented chili peppers, [g].

RESULTS

Single-factor experiments

Combined with the above analysis, the rotational speeds of the rotary cutter and the drum as well as the conveyor belt speed are positively correlated with the chili processing efficiency. However, an excessively high operating speed will put forward higher requirements for the machine, and also reduce the quality of chili segmenting, which is prone to problems such as uneven segment size and fruit damage. In this experiment, the qualification rate and fruit damage rate of chili segmenting were taken as the evaluation indicators, and single-factor experiments were carried out. Combined with the theoretical analysis above and the results of the preliminary pre-experiments, the parameter ranges of each experimental factor were determined as follows: the rotational speed of the rotary cutter was 30~70 r/min, the conveyor belt speed was 0.4~0.8 m/s, and the rotational speed of the drum was 30~70 r/min. The experimental results are shown in Fig. 8.



a) *b)* *c)*

Fig. 8 – Results of the Single-factor Experiment

a) Rotary cutter speed; b) Conveyor belt speed; c) Drum speed

It can be seen from Fig. 8(a) that when the conveyor belt speed and the drum speed remain constant, with the increase of the rotary cutter speed, the qualification rate first increases and then decreases, and the damage rate first decreases and then increases, reaching 95% and 1.9% respectively at 50 r/min. It can be seen from Fig. 8(b) that when the rotary cutter speed and the drum speed remain constant, with the increase of the conveyor belt speed, the qualification rate first increases and then decreases, and the damage rate first decreases and then increases, reaching 93.4% and 2.1% respectively at 0.6 m/s. It can be seen from Fig. b(c) that when the rotary cutter speed and the conveyor belt speed remain constant, with the increase of the drum speed, the qualification rate first increases and then decreases, and the damage rate first decreases and then increases, reaching 92.8% and 1.9% respectively at 50 r/min.

Three-factor and three-level orthogonal experiment

To explore the interaction between each experimental factor and the evaluation indicators and obtain the optimal working parameter combination of the device, a three-factor and three-level orthogonal experiment was designed according to the Box-Behnken experimental principle based on the value range of each factor obtained from the single-factor experiments. The factor coding is shown in Table 2 *(Zhang et al, 2025)*.

Table 2

Experimental Factors and Levels

Encoding	Factor		
	X_1 (r/min)	X_2 (m/s)	X_3 (r/min)
-1	40	0.5	40
0	50	0.6	50
1	60	0.7	60

Results and analysis

Design-Expert 13 software was used for experimental design and data processing to find the optimal parameter combination and influence laws of chili segmenting, and improve the performance and segmenting effect of the chili segmenting device. The specific experimental results are shown in Table 3.

Table 3

Experimental Plan and Results

Serial Number	Factor			Y_1	Y_2
	X_1	X_2	X_3		
1	-1	-1	0	90.3	5.1
2	1	-1	0	92.5	6
3	-1	1	0	91.1	5.3
4	1	1	0	93.7	5.3
5	-1	0	-1	90.2	7
6	1	0	-1	93.3	5
7	-1	0	1	93.6	3.1
8	1	0	1	93.8	5.1
9	0	-1	-1	92	4.7
10	0	1	-1	91.5	4.5
11	0	-1	1	91.9	4.5
12	0	1	1	95.3	4.2
13	0	0	0	97.7	1.3
14	0	0	0	98.1	0.9
15	0	0	0	98.3	2
16	0	0	0	98.7	1.3
17	0	0	0	98.6	1.1

From the analysis of variance in Table 4, the primary and secondary order of the influence of factors and their interactions on the qualification rate is X_1, X_1^2, X_2^2, X_3^2, X_3, X_2X_3, X_2, X_1X_3, X_1X_2. Among them, X_1, X_1^2, X_2^2, X_3^2, X_3, X_2X_3, X_2 and X_1X_3 have an extremely significant influence ($P \le 0.01$), and other factors have an insignificant influence ($P \ge 0.1$). The lack-of-fit term $P=0.5562$ is insignificant, which proves that there are no other main factors affecting the experimental indicators *(Jiao et al, 2024)*.

Table 4

Variance Analysis of Qualification Rate

Source	Sum of squares	Degree of freedom	Mean square	F	P
model	146.73	9	16.30	110.21	<0.0001**
X_1	8.20	1	8.20	55.44	0.0001**
X_2	3.00	1	3.00	20.29	0.0028*
X_3	7.22	1	7.22	48.81	0.0002**
X_1X_2	0.04	1	0.04	0.2704	0.6191
X_1X_3	2.10	1	2.10	14.21	0.0070**
X_2X_3	3.80	1	3.80	25.70	0.0014**
X_1^2	42.18	1	42.18	285.12	<0.0001**
X_1^2	43.52	1	43.52	294.20	<0.0001**
X_3^2	24.05	1	24.05	162.58	<0.0001**
Residual	1.04	7	0.1479		
Missing planned item	0.3875	3	0.1292	0.7973	0.5562
Error	0.6480	4	0.1620		
Sum	147.76	16			

*Note: ** indicates extremely significant influence (P<0.01), * indicates significant influence (P<0.05), the same below.*

Multi-variate regression fitting analysis was carried out on the experimental data by using Design-Expert software, and the insignificant factors were eliminated. The regression equation of the influence of each factor level on the qualification rate was obtained as follows:

$$\begin{aligned} Y_1 &= 98.28 + 1.01X_1 - 0.61X_2 + 0.95X_3 + 0.1X_1X_2 - 0.73X_1X_3 \\ &+0.98X_2X_3 - 3.17X_1^2 - 3.22X_2^2 - 2.39X_3^2 \end{aligned} \tag{10}$$

From the analysis of variance in Table 5, the primary and secondary order of the influence of factors and their interactions on the damage rate is X_1^2, X_2^2, X_3^2, X_1X_3, X_3, X_1X_2, X_2, X_1, X_2X_3. Among them, X_1^2, X_2^2, X_3^2 and X_1X_3 have an extremely significant influence (P≤0.01), X_3 has a significant influence (0.01≤P≤0.05), and other factors have an insignificant influence (P≥0.1). The lack-of-fit term P=0.1700 is insignificant, which proves that there are no other main factors affecting the experimental indicators *(Awuah et al, 2022; Jiang et al, 2025)*.

Table 5

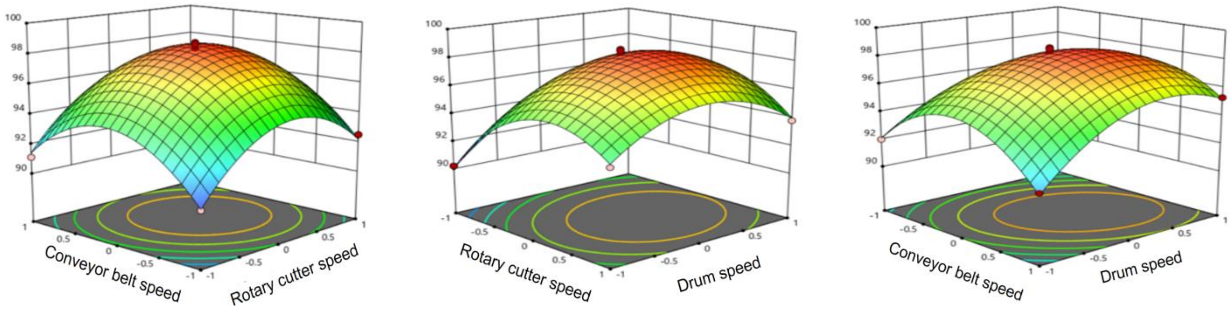
Variance Analysis of Damage Rate

Source	Sum of squares	Degree of freedom	Mean square	F	P
model	55.94	9	6.22	20.23	0.0003**
X_1	0.1012	1	0.1012	0.3296	0.5839
X_2	0.1250	1	0.1250	0.4069	0.5438
X_3	2.31	1	2.31	7.52	0.0288*
X_1X_2	0.2025	1	0.2025	0.6591	0.4436
X_1X_3	4.00	1	4.00	13.02	0.0086**
X_2X_3	0.0025	1	0.0025	0.0081	0.9306
X_1^2	23.06	1	23.06	75.05	<0.0001**
X_1^2	13.12	1	13.12	42.70	0.0003**
X_3^2	8.14	1	8.14	26.48	0.0013**
Residual	2.15	7	0.3072		
Missing planned item	1.46	3	0.4875	2.83	0.1700
Error	0.6880	4	0.1720		
Sum	58.09	16			

Multi-variate regression fitting analysis was carried out on the experimental data by using Design-Expert software, and the insignificant factors were eliminated. The regression equation of the influence of each factor level on the damage rate was obtained as follows:

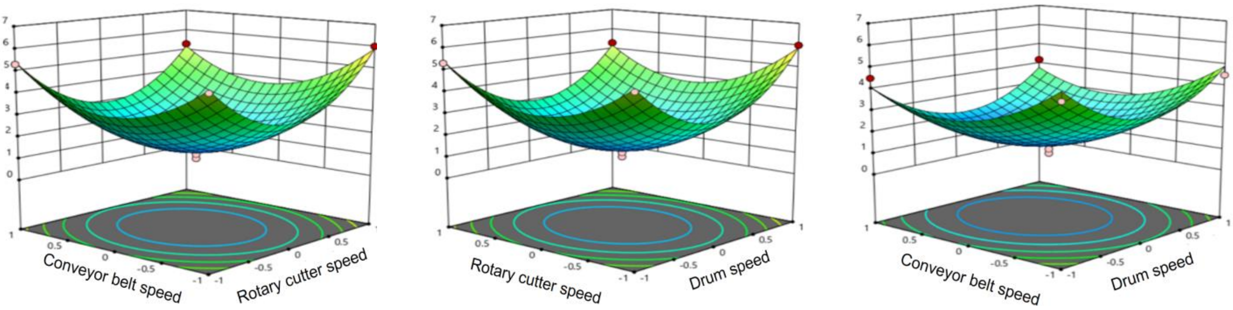
$$Y_2 = 1.32 + 0.11X_1 - 0.13X_2 - 0.54X_3 - 0.23X_1X_2 + X_1X_3 - 0.03X_2X_3 - 2.34X_1^2 + 1.77X_2^2 + 1.39X_3^2 \quad (11)$$

The response surfaces of the significant interactions on the qualification rate and damage rate were obtained by using Design-Expert software, from which the influence laws of the interactions on the experimental indicators can be clearly seen *(Wang et al, 2023; Zhang et al, 2023)*, as shown in Fig. 9 and Fig. 10.



(a) *(b)* *(c)*

Fig. 9 – Impact of Interaction Factors on the Qualification Rate



(a) *(b)* *(c)*

Fig. 10 – Impact of Interaction Factors on the Damage Rate

Parameter optimization and verification

Parameter optimization

Considering the response degree of the indicators to each factor, multi-objective optimization was carried out. According to the working conditions, performance requirements and analysis results of the dried chili segmenting machine *(Jo et al, 2018)*, the multi-objective optimization model was determined as follows:

$$\begin{cases} max\, Z_1 \\ min\, Z_2 \\ 40r/min \leq x_1 \leq 60r/min \\ 0.5m/s \leq x_2 \leq 0.7m/s \\ 40r/min \leq x_3 \leq 60r/min \end{cases} \quad (12)$$

Through the constraint and optimization solution function of Design-Expert, the optimal parameter combination was obtained: the rotary cutter speed was 51 r/min, the conveyor belt speed was 0.6 m/s, and the drum speed was 51 r/min. Under this parameter combination, the comprehensive response value of the model surface was the maximum, with the qualification rate of 98.49% and the damage rate of 1.37%.

Experimental Verification

Considering the feasibility of the experiment, 10 prototype experiments were carried out under the optimal parameter combination, and the results are shown in Table 6.

Table 6

Comparison of Evaluation Metrics Between Test and Software Optimization Results

Project	Pass Rate/%	Damage Rate/%
Experimental mean	98.21	1.42
Software optimization value	98.49	1.37
Relative Error	0.28	3.65

It can be seen from the experimental results in Table 6 that the relative errors between the experimentally measured values and the software optimized predicted values of the qualification rate and damage rate of chili segmenting are both less than 5%, which meets the expected experimental requirements. At this time, the qualification rate of chili segmenting is 98.21% and the damage rate is 1.42%, which meets the requirements *(Jin et al, 2024)*. The rotary cutter-type dried chili segmenting machine has the prominent advantages of high processing efficiency and stable operation, which effectively solves the prominent problems existing in the current chili segmenting operation and provides practical convenience and technical support for the post-processing link of chili peppers. The working state of the machine and the experimental effect are shown in Fig. 11.

Fig. 11 – Working Status and Segmenting Effect

CONCLUSIONS

Aiming at the actual demand of mechanization of chili pepper segmenting, a rotary cutter-type dried chili segmenting machine was designed in this paper, which can realize the automatic operation of dried chili segmenting. The segmenting machine adopts a combined segmenting structure of rotary cutter and drum, which effectively improves the processing efficiency and operation stability, and solves the problems of low efficiency and poor stability of the traditional chili pepper segmenting operation.

Single-factor experiments and response surface experiments were carried out on the core working parameters of the chili segmenting machine, and the influence laws of three key factors (rotary cutter speed, drum speed and conveyor belt speed) on the qualification rate and damage rate of chili segmenting were analyzed. Based on the experimental data, a three-factor and three-level quadratic polynomial model was established, and the influence laws and response surfaces of each experimental factor on the experimental indicators were obtained.

The experimental data were optimized and analyzed by using Design-Expert software, and the optimal working parameter combination was obtained: the rotary cutter speed was 51 r/min, the conveyor belt speed was 0.6 m/s, and the drum speed was 51 r/min. The experimental verification showed that under the optimal parameter combination, the qualification rate of chili segmenting was 98.21% and the damage rate was 1.42%, and the relative errors between the actual measured values and the software predicted values were both less than 5%, indicating that the established optimization model has high reliability and can meet the actual operational requirements of dried chili segmenting.

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