Study on Equipment and Processing Technology with Microwave

Study on Equipment and Processing Technology with Microwave pressure difference for ProcessPuffed apple flakes

Microwave expansion and differential pressure expansion are new directions in the development of modern puffed food production technology [1]. Its products do not contain oil and any additives, which avoids the problem of high oil content and short storage period of fried puffed food. The characteristics of microwave heating are simultaneous heating in the material table. When the material is heated by microwave radiation, it will rapidly heat up, and in a short time, the water in the material structure will be vaporized into steam, which will generate a strong vapor pressure difference, which will promote the expansion of the tissue and the moisture will escape. The material is shaped into micropores to obtain a puffed product [2-4]. Pressure differential expansion, also known as air expansion or low temperature vacuum expansion, is mainly suitable for the production of fruit and vegetable chips, mainly consisting of a pressure tank and a vacuum tank that is 5 to 10 times larger than the pressure tank. The pretreated fruit and vegetable raw materials enter the pressure tank. By heating, the water inside the fruit and vegetable is continuously evaporated, the pressure inside the tank is continuously increased, and then the pressure is suddenly decompressed, so that the internal moisture of the material is suddenly vaporized and flashed, and a strong vapor pressure difference is generated, so that the cells and tissues of the fruit and vegetable are expanded to achieve the purpose of expansion. 5-7].

Microwave expansion and differential pressure expansion technology have their own advantages and disadvantages. When applied alone, the product has a low degree of puffing, a hard taste, and a long puffing time, which is difficult to meet the needs of scale production. The organic combination of microwave technology and differential pressure technology can promote strength and avoid weakness, rational combination, complementary advantages, and cumulative expansion effect. In China's apple industry, the use of defective fruit has become a key issue that constrains the overall efficiency of the industry.

Research and development of microwave-pressure difference puffed apple chips can not only fully utilize the resources of apples in China, reduce the loss of rot, save costs, solve the problem of farmers' "selling fruit", improve the comprehensive benefits of apple industry, increase farmers Revenue; and the ability to develop an all-natural, high-grade nutritious food that meets the needs of the public and enrich people's lives.

1 Materials and methods

1.1 Materials and equipment

1.1.1 Materials Red Marshal Apple or Red Fuji Apple is commercially available.

1.1.2 Equipment Five sets of five-source multi-tube microwave equipment; one 50T fruit and vegetable expansion production line; one CT-CIV hot air circulation oven; one set of fruit peeling, enucleation, slicer, and supporting equipment and accessories. 1.2 Process raw materials ? cleaning ? peeling ? enucleation ? slicing ? inhibition of color protection ? pre-dehydration ? rehydration ? laminar equilibrium ? microwave pre-expansion ? conditioning ?

differential pressure puffing ? sorting ? packaging ? finished product 1.3 operation point cleaning : Raw apples are coarsely selected, and the rotted fruits of the pests and diseases are removed. For the residual, secondary and serious damages, they are first trimmed and then used, and then rinsed in tap water after classification. Peeling: Peel the apple peel with a peeler. Denuclear: Remove the apple core with a nuclear machine. Sectioning: The apple was cut into 5 mm thick rings, pieces or diced with a microtome.
Anti-enzyme color protection: use different VC, potassium sorbate, citric acid to soak the color. Pre-dewatering: Dehydration in a thermal cycle oven reduces the moisture content to 18% to 20%. Rehydration: Re-watering on the basis of accurate determination of the water content of the fruit pieces, so that the water content reaches 22%. Laminar Equilibrium: Pre-dehydrated, rehydrated fruit pieces are stacked together for 8 to 12 hours to achieve moisture balance. Microwave pre-expansion: The fruit pieces are spread on the conveyor belt of the microwave equipment, and through the tunnel, the pulp tissue is expanded while the microwave is dehydrated, and a honeycomb structure is formed inside. Process condition parameters: power 10kW, 5 groups of microwave groups are opened, conveyor speed is 9m/min; boiler heating pressure is 0.25~0.30MPa, and the number of fans is 1 set. Pressure difference puffing: put the pre-expanded fruit pieces in a pressure puffing tank, the boiler steam pressure is 0.25 ~ 0.3MPa, first heat for 5min, open the exhaust valve, remove the cold air inside the tank, close the exhaust valve, heat 50min When the temperature in the tank reaches 88-89 ° C and the water vapor pressure reaches 0.035-0.04 MPa, the vacuum valve is opened, and the pressure is reduced to -0.08 MPa instantaneously to expand the fruit pieces.
Then maintain the vacuum degree - 0.08MPa or so, the temperature is gradually reduced from 89 °C to 76 °C, in this negative pressure environment, the fruit pieces are fully dehydrated and dried, and the heating is stopped after 2.5 hours, the device interlayer is cooled by water, and the temperature is lowered to 25 ~30 ° C discharge. 1.4 Detection method
1.4.1 Determination of the puffing rate of puffed apple chips Puffing thickness thickness Puffing rate (%) =——————————×100 Fresh fruit slice thickness
1.4.2 Determination of moisture The measurement was carried out using a moisture dryer.
1.4.3 Sensory evaluation Visual inspection and tasting methods were used.
2 Results and analysis
2.1 Comparison of several expansion processes
2.1.1 Microwave Puffing Process Experiment At the beginning of 1999, microwave dehydration and puffing experiments were first carried out in a domestic microwave oven. Peel the apples, diced (10mm × 10mm), and bake them in a normal oven. After the moisture content is reduced by 40% to 45%, the fruit is placed in a microwave oven baking tray of 800W for 30s each time. Repeatedly heating until completely dry (water content is about 5%), fresh fruit diced 10mm × 10mm, dehydration and drying result, the volume of diced is about 6mm × 6mm, the shape is full, and the tissue has a sponge structure. This proves that the microwave does have a puffing function. In September 1999, the dehydration and puffing experiments of apple diced tablets were repeated on industrial microwave ovens and combined microwave equipment of Industrial Microwave Systems Co Ltd., and the same results were obtained. However, when the amount of raw materials is large, there is the following problem: in the process of transmission, the surface moisture of the fruit pieces is large to generate electric sparks, so that some products produce carbonized spots; when the slice shape, thickness and size of the fruit pieces are different, dehydration and puffing are not Uniform, difficult to control; when the microwave power is too large, the pulp tissue is prone to internal coking.

2.1.2 Pressure difference expansion process experiment At the beginning of 2000, the expansion process experiment was carried out on the differential pressure expansion equipment produced by Tianjin Qiaomeng Company. It is operated by the manufacturer's recommended multiple pressure decompression and dehydration process. Each tank is fed with 25kg, and the pressure and pressure are repeated 4-5 times. The whole dehydration process is 4.5h, and the fruit pulp expansion rate is 70%, which is higher than microwave expansion. 10%, low energy consumption, oil-free products, long shelf life. Disadvantages: uneven temperature distribution in the tank, the product is easy to coke; repeated pressure and decompression, not only the operation is cumbersome, but also affects the puffing effect; the fruit surface has a good puffing effect and the internal puffing effect is poor.
2.1.3 Microwave - Pressure Difference Puffing Process Experiment Through the comparison experiment of microwave expansion and differential pressure expansion, it is considered that the microwave expansion and differential pressure expansion process are suitable for the processing of puffed apple chips, which have complementary advantages. Therefore, microwave expansion, differential pressure expansion and general thermal drying technology are combined with each other to design a microwave-pressure differential expansion process. In September 2000, five sets of microwave experimental equipment and a set of differential pressure puffing experimental equipment were purchased from Nanjing and Tianjin, and a thermal cycle oven was purchased from Yangzhou. Since November 2000, the installation and commissioning of the experimental equipment, assembly and process adaptation have been carried out. Sexual modification. In December 2000, a systematic test of the microwave-pressure differential puffed apple chip processing process was officially launched. In the experiment, the processing of apple chips is divided into three stages: The first stage is the dehydration and drying stage: the apple is washed, peeled, enucleated, sliced, inhibited by enzymes, and dehydrated to reduce the moisture content of the fruit pieces. 20% to 24%. Anti-enzyme color protection: impregnated with 0.2% iso VC, citric acid, potassium sorbate solution. Thermal Dehydration: Dehydration using a steam heat cycle oven. The second stage is the microwave expansion stage: the dehydrated apple slices are rehydrated (water content 22%) and pre-expanded with a microwave unit.
The third stage is the pressure difference expansion stage: the microwave pre-expanded apple pieces are placed in an instant decompression expansion tank. Change the manufacturer's recommended multiple pressure reduction and dewatering expansion process as one pressurization, instantaneous decompression expansion, vacuum dewatering and solidification. The fruit extruded by the microwave-pressure difference expansion process has better puffing degree than the microwave expansion and instant decompression expansion, and has strong complementarity and additive effect. The puffing rate can reach 100%, the sheet shape is flat, and the taste is crisp. Apple has a rich flavor and a good color and flavor.
2.2 Equipment transformation and assembly
2.2.1 Five-combination multi-tube microwave expansion equipment unit transformation Five-box five-source multi-function microwave equipment was modified to increase the buffer section, assembly steam heat exchanger and moisture discharge system. The buffer section is added to avoid multi-chamber microwave continuous heating, coking due to excessive temperature, and time and space for water dispersion. The steam heat exchanger is installed to increase the temperature of the tunnel, remove the moisture from the surface of the fruit, and prevent condensation of the vaporized water. Increase the moisture removal system, eliminate humidity in time, and ensure the brittleness of the product.

2.2.2 Equipment assembly and matching The microwave expansion, instantaneous decompression expansion and ordinary thermal drying technology are combined with each other to form an experimental production line. Among them, there are five boxes of five-source multi-tube microwave equipment, one 50T fruit and vegetable expansion production line, one CT-CIV hot air circulation oven, one set of fruit peeling, enucleation, slicer, and supporting equipment and accessories. 2.3 Key Process Technical Parameters Experiment
2.3.1 Temperature and puffing effect
Temperature control is an important factor affecting the quality of puffed products, and is a sufficient condition for water evaporation and pressure formation. If the temperature is too high, it will cause burntness. If it is too low, it will not be puffed. Table 1 shows that the optimum puffing temperature of apple slices is between 75 and 90 °C. The main components of soluble solids in apple tissue are fructose and glucose. When the fruit slices are dehydrated and dried, the concentration of sugar reaches about 50%, the pulp becomes hard, the strength increases, and it is not easy to puff. As the temperature inside the puffing tank rises, the sugar is semi-melted, the flesh becomes soft and the structure is elastic, and the expansion resistance is reduced, which is beneficial to the maximum expansion of the fruit piece under vacuum conditions and the product expansion rate.
At the same time, proper temperature increase can accelerate the dehydration of the fruit pieces, shorten the puffing time and increase the crispness of the chips. However, if the temperature is too high, the heat-sensitive nutrients in the fruit will be destroyed and coking will be caused. In addition, the temperature rise is moderate due to the uniform heating inside the fruit piece, and the puffing effect is better than the rapid temperature rise. Based on the test results and repeated adjustment and verification, the temperature control curve of the puffed apple chip is proposed

The moisture content of the fruit pieces is one of the main factors affecting the puffing effect of the chips. The fruit is puffed with water as the power. If the moisture content is too low, the puffing power is insufficient, the puffing rate is low or even puffing, and it is easy to burn;
If the moisture content is too high, the product will be internally dried after being expanded, but the external moisture is not sufficiently removed, and the product is easily collapsed and retracted, and the expansion rate is low. The results in Table 2 show that when the moisture content of apple slices is 22%, the product has a puffing rate of 100% and the mouthfeel is crisp.
When the moisture content is less than 18%, the pulp is hard, it is not easy to expand or the degree of expansion is low during the pressure difference expansion, and the expansion rate can only reach 60% to 70%; when the moisture content is higher than 24%, the product is dry inside but The external moisture is not sufficiently removed, and the expansion rate is low. If the expansion effect is to be increased, the expansion time needs to be prolonged.
2.3.3 Pressure change and puffing effect Pressure control is the key to determine the quality of puffed products. Under the test conditions of 22% water content and temperature according to the above temperature control curve, three different pressure control curves are studied. The puffing effect of apple slices.
The pressure control curve of type A (Fig. 2) is the pressure curve of the expansion chemical technology recommended by the equipment factory. In the process of dewatering and puffing, the operation method of “multiple pressure and decompression cycle” is adopted. The original intention of this approach is to use multiple pressure differential changes in an attempt to

enhance the puffing effect, while ignoring the factors of softness and degeneration of the fruit pieces during gradual dehydration. After the first pressurization and depressurization cycle, the degree of pressurization shrinkage in each subsequent decompression cycle is greater than the degree of instantaneous decompression expansion, and the final puffing rate of the product is only 70%.

The B-type pressure control curve (Fig. 3) is an ordinary vacuum dehydration drying curve. The fruit piece after rehydration is placed in a puffing tank, heated and vacuumed, and the fruit piece is expanded by negative pressure, and heating is continued to gradually dehydrate the fruit piece. When the moisture content is gradually reduced to 3% to 5%, the shape of the fruit pieces is solidified and the final expansion rate of the product can reach 60%.

The C-type pressure control curve (Fig. 4) is a process in which “primary pressurization, instantaneous decompression puffing, vacuum dehydration and solidification are carried out during dehydration and puffing”. When the fruit pieces are the wettest, hottest, softest and elastic, they are instantly depressurized and the pressure difference exceeds 0.1 MPa, so that the fruit pieces are fully expanded. Subsequently, the dehydration is heated under a negative pressure of -0.08 MPa until completely dried, and the fruit piece is solidified and qualitatively cooled, and the puffing rate can reach 100% or more. Based on the above test results, under the C-type pressure control curve, the apple slices can obtain the desired puffing effect (Table 3).

3 Product quality indicators

"Microwave - differential pressure puffing" apple chip processing technology, the microwave equipment and instant decompression expansion equipment combination, first use the microwave equipment to dehydrate and pre-expand the sliced apple slices, and then use the instantaneous decompression equipment for pressure differential expansion . It can effectively overcome the disadvantages of low degree of puffing, poor mouthfeel and long puffing time when microwave expansion and instant decompression expansion are applied alone, so that the advantages are complementary, the puffing performance is increased, the puffing rate reaches 100%, and the microwave puffing and pressure difference puffing Technology alone, comparison, production

The product expansion rate is increased by 30% to 40%, and the moisture content is not more than 3%. The apple chip products can keep the apple's nutrients, fresh flavor, dehydrated thoroughly, crispy mouthfeel, full shape and even puffing. 4.2 Control the moisture content of the fruit pieces by 22%,

The temperature is controlled according to the temperature control curve, and the operation procedure of “one-time pressurization, instantaneous decompression expansion, vacuum dehydration and solidification” can be used to enhance the puffing effect; the control of the standard control curve of time and temperature and pressure can standardize the operation procedure and stabilize the product. Quality, suitable for large-scale production of apple chips. 4.3 Adding steam heat exchanger, microwave buffer section, hot air exchange box and moisture removal system to the microwave expansion equipment can solve the problem of coking, uneven heating and surface dehumidification of fruit pieces, and simultaneously heat the inside and outside of the fruit pieces to balance heat and eliminate the surface. Water vapor, improve the expansion efficiency, and solve the problem of “ignition” and internal coking in the process of microwave expansion.