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Study on the Fixation of Mulberry Leaf Tea in a Multiport Microwave System

Tao He, Fengxiu Li, Desheng Hou, Lin Wang, Dezhi Gou, Tao Hong and Zhengming Tang *

School of Electronic Information Engineering, China West Normal University, Nanchong 637002, China; h1484653925@163.com (T.H.)
* Correspondence: zhengmtang@163.com

Abstract: Microwaves have the advantages of faster heating speed, shorter fixation time, and less pollution in tea fixation. However, there are few studies on the microwave fixation of mulberry leaf tea, which is not conducive to the promotion of mulberry leaf tea production. In order to study the fixation of mulberry leaf tea, the coaxial probe method is used to measure the dielectric constant of mulberry leaves, and the relationship connecting the real and imaginary parts of the dielectric constant and the moisture content is obtained through fitting. Based on this, a multiphysics model for mulberry leaf fixation in a six-port microwave cavity is established, which combines the characteristics of mulberry leaves, multiport heating, and mobile heating techniques. The impact of some important parameters, such as the layout and position of input ports and the thickness of mulberry leaves on the fixation process, are studied. The results show that the mutual energy coupling between ports can be reduced by using the noncoherent polarization of electromagnetic waves when the position of the ports in their working planes and the thickness of the mulberry leaves are set to (−0. 14 m, −0.15 m), (0.25 m, −0.15 m), (0.25 m, 0.15 m), (0.14 m, 0.15 m), (0.11 m, 0.0 m), (0.25 m, 0.15 m), (−0.14 m, 0.15 m), (0.11 m, 0.0 m), (0.11 m, 0.0 m), and 0.015 m when good fixation of mulberry leaves can be obtained. The study established a continuous microwave fixation experimental system for mulberry leaf tea. The experimental results indicate that the thickness of the tea affects its temperature uniformity in the microwave fixation system, which in turn affects the final quality of the tea. This study provides a reference for the industrialization of the microwave fixation of mulberry leaf tea.

Keywords: microwave fixation; dielectric constant; coaxial probe; mulberry leaf tea; porous media

Citation: He, T.; Li, F.; Hou, D.; Wang, L.; Gou, D.; Hong, T.; Tang, Z. Study on the Fixation of Mulberry Leaf Tea in a Multiport Microwave System. *Processes* **2024**, *12*, 701. https://doi.org/10.3390/pr12040701

Academic Editor: Giancarlo Cravotto

Received: 17 February 2024
Revised: 24 March 2024
Accepted: 25 March 2024
Published: 29 March 2024

1. Introduction

Mulberry leaves are rich in nutrients and natural bioactive substances [1], which can significantly inhibit "three highs" and enhance the body's immunity and other functions [2,3]. Fresh mulberry leaves are shown in Figure 1. Mulberry leaf tea production involves a series of processes, including picking, fixing, kneading, drying, packaging, storage, and other steps [4]. Among these, fixation is the most crucial process in the production of mulberry leaf tea [5]. To achieve a higher organoleptic quality, mulberry leaves are subjected to fixation at temperatures ranging from 230 °C to 270 °C, a process that plays a decisive role in determining the overall quality of mulberry leaf tea. Fixation mainly involves the inactivation of polyphenol oxidase under high-temperature conditions to prevent the oxidation reaction of polyphenols and to avoid the development of a red color in the mulberry leaves due to oxidation [6–8]. Additionally, during this process, the water in the mulberry leaves evaporates, making them soft and preparing them for the subsequent production of mulberry tea.

Figure 1. Fresh mulberry leaves.

Microwave heating is widely used in food processing and agricultural product drying due to its rapid heating speed [9], strong penetrating ability, cleanliness, and hygiene [10,11]. The microwave method for fixing mulberry leaves can enhance fixation efficiency and prevent reddening of the leaves [12]. However, microwave reflection also occurs during microwave fixation, as the material absorbs microwaves [13], changing the energy transfer pathway and intensity. Moreover, the dielectric properties change during the drying process due to the loss of moisture [14], resulting in complex and variable electric field distributions [15]. Therefore, microwave tea fixing usually faces the problem of excessive energy loss and uneven heating. Considering that multiport and mobile heating can effectively improve the uniformity of microwave heating [16], the dielectric property of mulberry leaf is measured and discussed in this paper and a multiphysics model for mulberry leaf fixation in a six-port microwave cavity is established. In addition, some important parameters are analyzed that are highly dependent on the quality of fixation and can provide a reference for the fixation of mulberry leaf tea.

2. Materials and Methods

2.1. Model Assumptions

In this paper, the continuous microwave mulberry leaf tea fixation model is based on the following assumptions:

(1). The initial temperature of mulberry leaves is 20 °C and is uniformly distributed. Additionally, the temperature conduction during the continuous microwave mulberry leaf tea fixation process is considered isotropic, and the air temperature within the microwave fixation machine cavity is maintained at 20 °C.

(2). During the fixation process of mulberry leaves, there is no additional heat transfer material other than the mulberry leaf itself, and the shape of the mulberry leaf does not change.

(3). The metal waveguide and cavity wall of a continuous microwave fixer are assumed to be ideal electrical conductors.

2.2. Geometric Modeling

In this paper, the microwave reaction cavity is constructed as a rectangular structure with chamfered sides and geometric dimensions of 1 m × 0.6 m × 0.5 m. Four ports are positioned on the upper top surface of the microwave reaction cavity, and two ports are placed on the surfaces produced by the chamfering process. All ports are BJ22 standard waveguides. The layout of the ports, their relative positions, and the distance between the top surface of the cavity and the conveyor belt are considered as variables for computational optimization. The ports on both sides are situated on the chamfered surfaces, as illustrated in Figure 2.

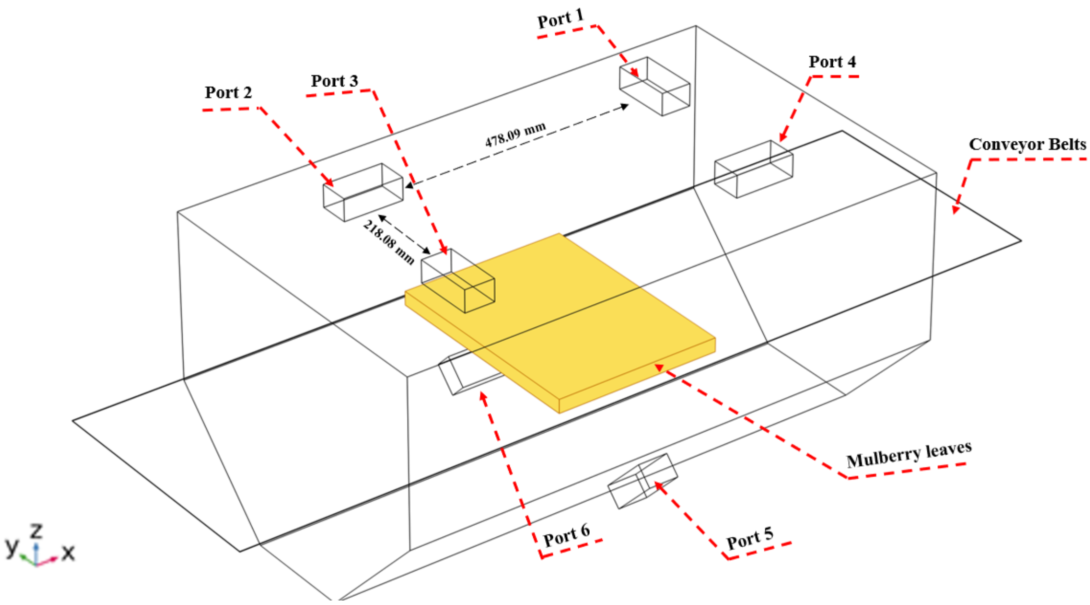


Figure 2. Simulation model of a continuous microwave fixation machine.

During the fixation phase, mulberry leaves can be considered a continuous porous medium [17]. Significant variations in the internal structure of mulberry leaves, combined with the complex physical and chemical changes during the fixation process, result in a high computational effort when solving for the fixation process of mulberry leaves [18]. In order to improve the speed of the calculation, the physical model of the mulberry leaves was simplified. Given that fresh mulberry leaves are typically cut and stacked into mulberry leaf blocks before fixation, the mulberry leaf model is defined as a rectangle with dimensions of 0.3 m in length, 0.4 m in width, and 0.025 m in thickness for the calculations. The excitation mode of the ports is set to TE10 mode; the frequency for all six ports is 2.45 GHz, and the power for each port is 1 KW.

2.3. Governing Equation

Maxwell's equations can be used to analyze the electromagnetic distribution in the cavity of a continuous microwave fixation system with the expression [16]:

$$\nabla \mu_r^{-1}\left(\nabla \vec{E}\right) - \left(\frac{2\pi f}{c}\right)\left(\varepsilon' - j\varepsilon''\right)\vec{E} = 0 \tag{1}$$

where is the relative permeability; is the electric field strength, V/m; is the frequency, Hz; is the speed of light, ε' andε'' is the dielectric constant and dielectric loss, respectively, is the imaginary part.

Using the electric field strength and dielectric properties from expression (2) to the heating medium volume heat [19],

$$Q_v = \sigma\left|\vec{E}\right| = 2\pi\varepsilon_0\varepsilon'' f\left|\vec{E}\right|^2 \tag{2}$$

where σ is the conductivity, S/m, ε_0 and is the vacuum dielectric constant, $\varepsilon_0 = 8.854 \times 10^{-12}(\mathrm{F/m})$.

In the microwave fixation process, the physical change process of mass transfer within the mulberry leaf is complex and varied, primarily involving the transfer of liquid water and water vapor. The expression is as follows:

$$\frac{\partial c_i}{\partial t} + u_i \cdot \nabla c_i = \pm\frac{I}{M_w} + \nabla(D_i \nabla c_i) \tag{3}$$

where $c_i(i = w, g)$ indicates the molar concentration of mulberry leaves (water and gas), $\mathrm{mol/m^3}$; D_i indicates the diffusion coefficient of the substance, $\mathrm{m^3/s}$; μ_i indicates the Darcy velocity, $\mathrm{m/s}$; I indicates the rate of water evaporation, $\mathrm{kg/(s \cdot m^3)}$; and M_w indicates the molar mass of water molecules, $\mathrm{kg/mol}$.

During the fixation process, the flow of water vapor from mulberry leaves is primarily driven by the air pressure gradient, and the fluid's momentum balance adheres to Darcy's law, considering mulberry leaves to be a porous medium. The expression is as follows:

$$u_i \times \mu_i + k_{i,p} \nabla P = 0 \tag{4}$$

where $k_{i,p}$ denotes the permeability, $\mathrm{m^2}$; μ_i denotes the dynamic viscosity, Pa·s; and P denotes the magnitude of the sum of the air pressure of water vapor and air, Pa.

The nonequilibrium evaporation method was used to describe the phase-change process of water molecules changing into water vapor in mulberry leaves with the following equation:

$$IRT = K \cdot M_\omega (p_{v,eq} - p_v) \tag{5}$$

where K is the water evaporation rate constant, $\mathrm{s^{-1}}$; $p_{v,eq}$ is the equilibrium water vapor pressure, Pa; p_v is the ideal water vapor pressure, Pa; and R is the ideal gas constant.

2.4. Mulberry Leaf Dielectric Properties

The coaxial probe method is a classical dielectric measurement technique that reconstructs dielectric properties by measuring the reflection coefficient of an open coaxial probe inserted into or in contact with the material under test (MUT) [20]. In this paper, the coaxial probe method was utilized to measure the dielectric properties of mulberry leaf samples. The measurement setup comprises cables, wireframe tables, and Plexiglas holders to prevent blade breakage during drying. Additionally, an Agilent E8363C vector network analyzer and Keysight N1501A dielectric probe kit, manufactured by Agilent in Shenzhen, Guangdong Province, China, are used. Plexiglas laminations with a glass sheet size of 86.4 mm × 43.2 mm and an aperture size of 2.5 mm were also utilized. The measurement system for dielectric properties is depicted in Figure 3.

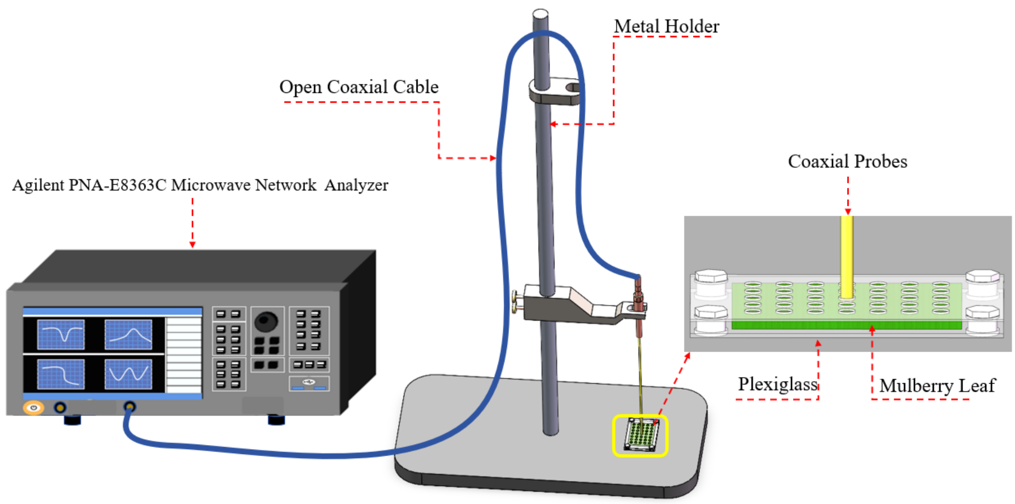


Figure 3. Schematic diagram of the dielectric property measurement device.

After calibrating the measurement system, we conducted measurements on air, deionized water, and PTFE. We compared the obtained data with known values and verified the results for accuracy before performing measurements on real samples. Figure 4 illustrates the real and imaginary parts of the complex permittivity of PTFE in the frequency range of 2 GHz to 3 GHz after calibration of the experimental equipment at room temperature, compared with the known real and imaginary parts of the complex permittivity of

PTFE at room temperature. The comparison results demonstrate the high accuracy of the measurement system.

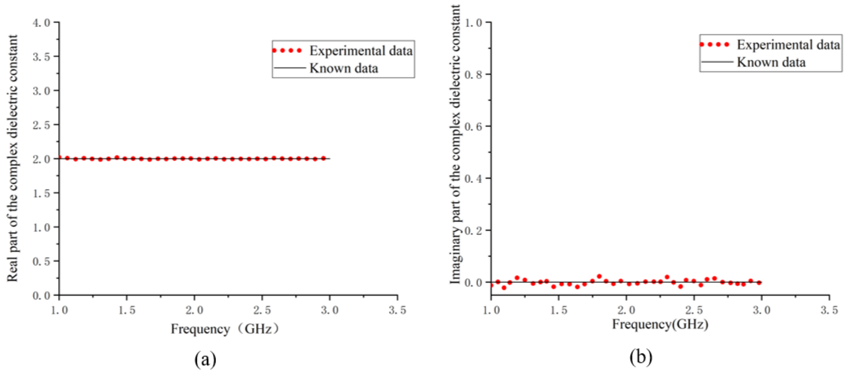


Figure 4. PTFE dielectric constant. (**a**) Relationship between real part and frequency; (**b**) Relationship between imaginary part and frequency.

Subsequently, the samples were fixed and compressed using Plexiglas, which had a negligible effect on the measurement of the dielectric constant of the mulberry leaves. To minimize errors, five measurements were conducted on individual samples, and the average value of the measured data was calculated. An expression for the relationship between the real and imaginary parts of the dielectric constant and the moisture content was fitted using Origin software with a third-degree polynomial. The fitting effects of the real and imaginary parts of the dielectric constant were R^2 = 0.97765 and R^2 = 0.98156, respectively, indicating a significant relationship between the dielectric properties and the water content. The relationship between the water content and the real and imaginary parts of the dielectric constant is illustrated in Figure 5, and the corresponding expressions for the relationship between the real and imaginary parts and water content are presented in Equation (6) below:

$$\begin{cases} e' = 20.75 + 10.77 \times c - 47.57 \times c^2 + 99.68 \times c^3 \\ e'' = 3.73 + 11.2 \times c - 30.06 \times c^2 - 41.64 \times c^3 \end{cases} \quad (6)$$

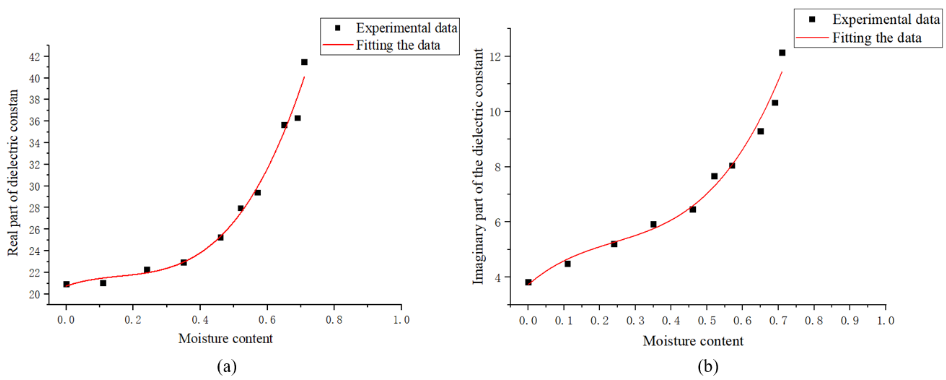


Figure 5. Dielectric properties of mulberry leaves. (**a**) Relationship between real part and moisture content; (**b**) Relationship between imaginary part and moisture content.

Figure 5 shows the curves illustrating the effect of moisture content on the dielectric properties of mulberry leaves at a frequency of 2.45 GHz and at the same temperature.

From the analyses in Figure 5, it can be observed that the dielectric properties of mulberry leaves are directly related to their water content. Under the same conditions, higher water content corresponds to larger real and imaginary parts of the dielectric constant. This is primarily attributed to water, as a typical polar molecule, being a significant parameter influencing dielectric properties. The above results also indicate that during the later stages of mulberry leaf tea fixation, the decreasing water content in mulberry leaves weakens their ability to absorb microwave energy, thereby affecting the uniformity and efficiency of the fixation process.

2.5. Material Parameters

For this paper, mulberry leaves were utilized as the fixed material, and the input parameters of the model are presented in Table 1.

Table 1. Model parameters.

Parametric	Value	Unit
Microwave frequency	2.45	Ghz
Output power	6	KW
Temperature	293.15	T_0 (K)
Density	538.36	kg/m^3
Water content of fresh leaves	0.75	1
Relative permeability	1	1
Porosity	0.46	1

2.6. Experimental Systems Design

In this study, a continuous microwave mulberry leaf tea fixation system was constructed, as shown in Figure 6. It mainly consists of a temperature control module, a magnetron power control module, and a conveyor speed control module. The corresponding physical system is shown in Figure 7a. Considering that water vapor will be generated during product processing, a cutoff waveguide is designed on top of the stationary machine. Up to the waveguide, an exhaust pipe combined with a fan motor is used so that water vapor can be discharged in a timely manner. In addition, a cooling fan is installed next to the power supply, as shown in Figure 7b.

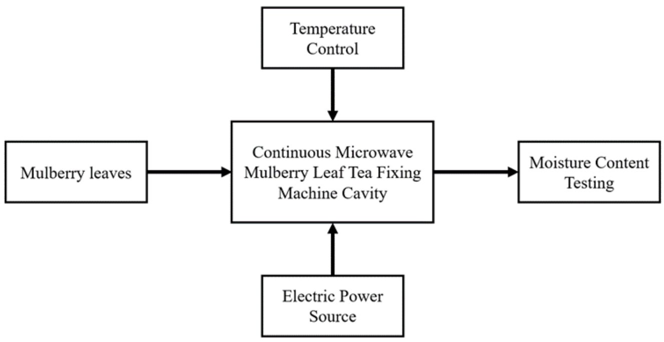
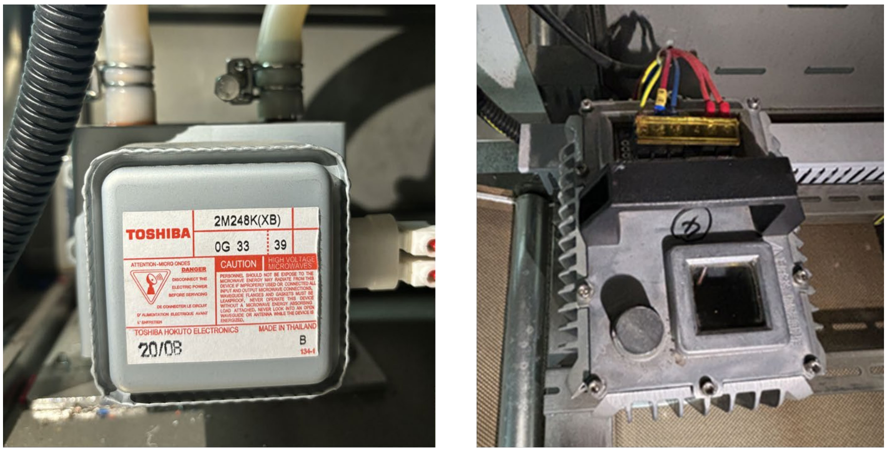


Figure 6. Overall framework of continuous microwave mulberry leaf tea fixation experiments.

Figure 7. Physical system of continuous microwave fixer for mulberry leaf tea. (**a**) Continuous microwave mulberry leaf tea fixing machine; (**b**) Part of the power supply and cooling fan.

Magnetrons, being the most economical microwave generators, have found extensive applications in various industrial microwave equipment. For this study, the Toshiba magnetron 2M248K (XB) was chosen as the microwave source primarily due to its affordability, stable performance, ease of control, and compatibility with conventional equipment. This kind of magnetron, which is widely used in industrial processes, such as microwave drying, sterilization, and medical production, can provide an output power of 1050 W at a frequency of 2450 MHz. On the other hand, the stability and performance of the magnetron are directly affected by the magnetron power supply, which is a power module that provides the magnetron with the appropriate voltage and current to enable its normal operation. There are two main types of magnetron power supply: oil-cooled power supply and air-cooled power supply. Compared with the air-cooled power supply, the oil-cooled power supply has obvious advantages, such as good heat dissipation, high output power, and good insulation. Therefore, considering the long fixed working time of mulberry leaf tea production, an oil-cooled magnetron power supply was used in this study to ensure the stability of the magnetron of the continuous microwave mulberry leaf tea fixing machine. The magnetron and its power supply are shown in Figure 8a,b, respectively.



(a) (b)

Figure 8. (**a**) Toshiba Magnetron 2M248K (XB); (**b**) Oil-cooled Magnetron Power Supply.

For this study, 220 V AC was directly used as the power supply for the whole system. As the maximum output voltage of the microwave power supply reaches 4.2 KV, we should pay attention to the operational safety of the experimental personnel in the process of designing the power supply, and we must correctly select the leakage protector, relay, and other related equipment. The final design of the continuous microwave power supply system is shown in Figure 9.

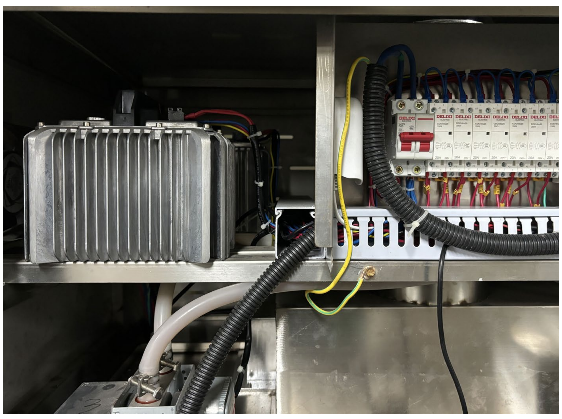


Figure 9. Physical power supply system.

2.7. Results and Discussion

2.7.1. Effects on Electromagnetic Fields of Different Port Layouts

In a continuous microwave fixation machine, the arrangement of the microwave energy input ports and the dielectric properties of the fixation medium impact the electromagnetic field distribution within the fixation chamber. In this study, the six ports were arranged in the following ways: horizontal arrangement of ports, port vertical arrangement, vertically, and nonconsistent polarization dispersion. The distribution of field strengths for the ports in these arrangements is illustrated in Figure 10.

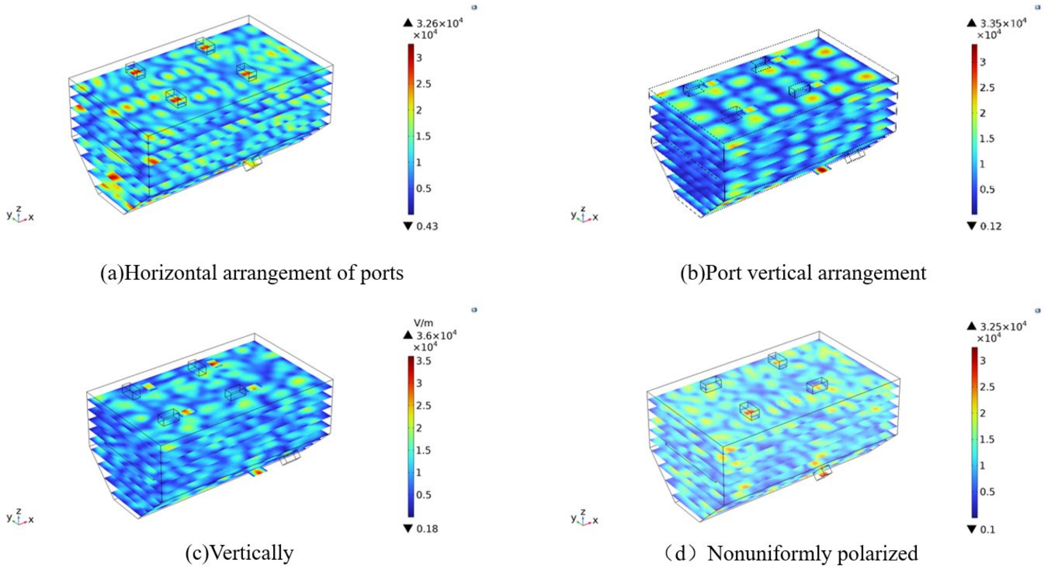


Figure 10. Electromagnetic field distribution in the cavity with different arrangements of ports.

According to the analysis of the simulation results, it can be seen that: Figure 10a in the case of horizontal arrangement of ports (Figure 10a), the maximum electric field strength inside the cavity is 3.26 $\times$ 10^4 V/m, and the minimum electric field strength is 0.43 V/m; in the case of vertical arrangement of ports (Figure 10b), the maximum electric field strength inside the cavity is 3.35 $\times$ 10^4 V/m, and the minimum electric field strength is 0.12 V/m; in the case of vertical arrangement of ports (Figure 10c), the maximum electric field strength in the cavity is 3.6 $\times$ 10^4 V/m, and the minimum electric field strength is 0.18 V/m; and in the case of a nonuniformly polarized arrangement of the ports (Figure 10d), the maximum electric field strength in the cavity is 3.25 $\times$ 10^4 V/m, and the minimum electric field strength is 0.1 V/m. The average electric field strengths and the coefficients of variation of the electric fields in the cavities with different port distributions were further compared. The electric field coefficient of variation is used to describe the uniformity of the electric field distribution and can be expressed as [21]:

$$COV_E = \frac{\sqrt{\sum_{i=1}^{n} (E_i - E_{av-t})^2}}{E_{av-t}} \tag{7}$$

where E_i and E_{av-t} are the electric field strengths (V/m) at each grid point, and smaller COV_E values indicate a more uniform electric field. The comparison results in this study are shown in Table 2.

From Table 2, it can be observed that the average electric field strength in the cavity of the fixation machine is 10,721.25 V/m in the nonuniformly polarized arrangement, and the average coefficient of variation is 0.36, which is higher than that of the other arrangements. The smaller the average coefficient of variation of the electric field in the cavity, the more uniform the distribution of the electric field, and the better the homogeneity of the fixation process. Hence, in this study, we opted for a nonuniformly polarized arrangement of the ports, aiming to enhance the homogeneity of the fixation process, minimize reflections, and improve energy utilization.

Table 2. Comparison of electric field strengths and coefficients of variation in the cavity of a continuous microwave fixation machine.

Figure Sequence	a	b	c	d
Average electric field strength (V/m)	10,602.31	9059.02	9797.04	10,721.25
COV	0.37	0.45	0.36	0.35

2.7.2. Effect of Port Position on the Uniformity of Mulberry Leaf Greening

The simulation model of the continuous microwave fixer is illustrated in Figure 2, with the thickness of the mulberry leaf set at 0.025 m and the speed of the conveyor belt at 0.01 m/s. The direction of movement of the ports is the same as the direction of movement of the mulberry leaves, with the steps from port 1 to port 4 set at 0.05 m and from port 5 to port 6 set at 0.1 m. According to the calculations, a total of eight groups of different positional data were obtained (Table 3).

Table 3. Port position parameters.

Ports \ Group	1	2	3	4	5	6
1	−0.38 m	0 m	0 m	−0.38 m	−0.38 m	−0.38 m
2	−0.33 m	0.03 m	0.03 m	−0.33 m	−0.28 m	−0.28 m
3	−0.28 m	0.08 m	0.08 m	−0.28 m	−0.18 m	−0.18 m
4	−0.23 m	0.13 m	0.13 m	−0.23 m	−0.08 m	−0.08 m
5	−0.18 m	0.18 m	0.18 m	−0.18 m	0.02 m	0.02 m
6	−0.13 m	0.23 m	0.23 m	−0.13 m	0.12 m	0.12 m
7	−0.08 m	0.28 m	0.28 m	−0.08 m	0.22 m	0.22 m
8	−0.03 m	0.33 m	0.33 m	−0.03 m	0.32 m	0.32 m

Different waveguide positions have different electric field standing wave distributions in the cavity of the stationary machine, which leads to different temperature distributions of the mulberry leaves in the fixed machine. The electric and temperature field distributions of the first and seventh groups in the calculation results are shown in Figure 11 and Figure 12, respectively.

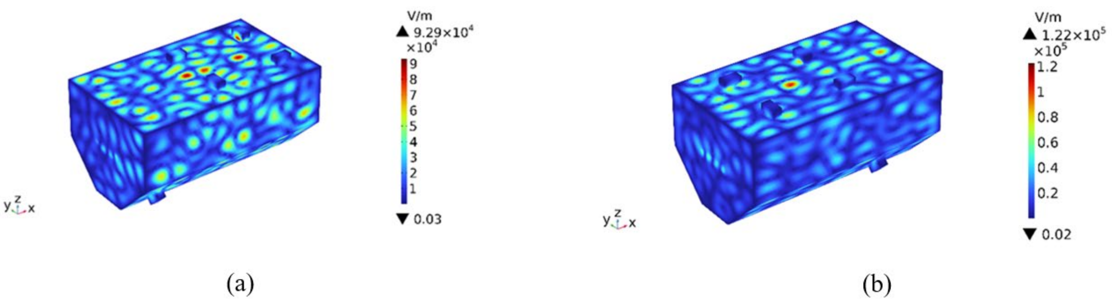


Figure 11. Electric fields at different port locations in the fixed machine cavity. (**a**) Electric field distribution of the first set of port parameters; (**b**) Electric field distribution of the seventh set of port parameters.

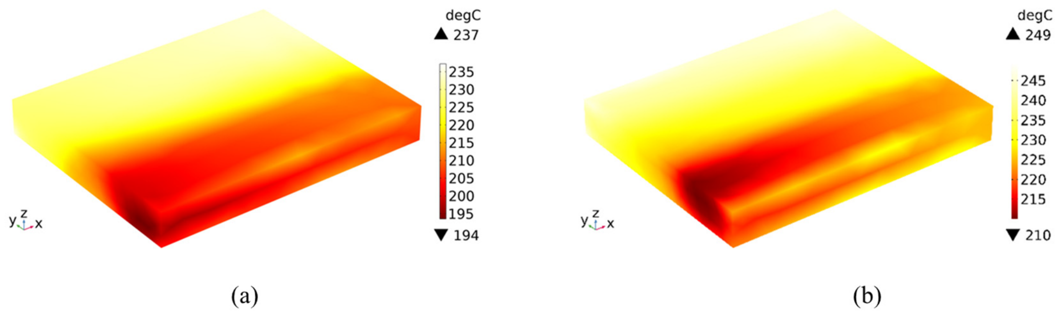


Figure 12. Temperature distribution of mulberry leaves under different inlet positions. (**a**) Temperature distribution of the first set of port parameters; (**b**) Temperature distribution of the seventh set of port parameters.

When the cavity size of the continuous microwave greening machine is certain, a change in port position will change the reflection coefficient in the cavity; the distribution of the electromagnetic field inside the cavity will also change, which will lead to a change in the temperature uniformity of the mulberry leaves in the cavity. The coefficient of variation (COV) of temperature is usually used to measure the uniformity of temperature distribution, and the smaller the value, the better the uniformity of heating [22]. The results of microwave reflection and heating uniformity at different port positions are shown in Figure 13.

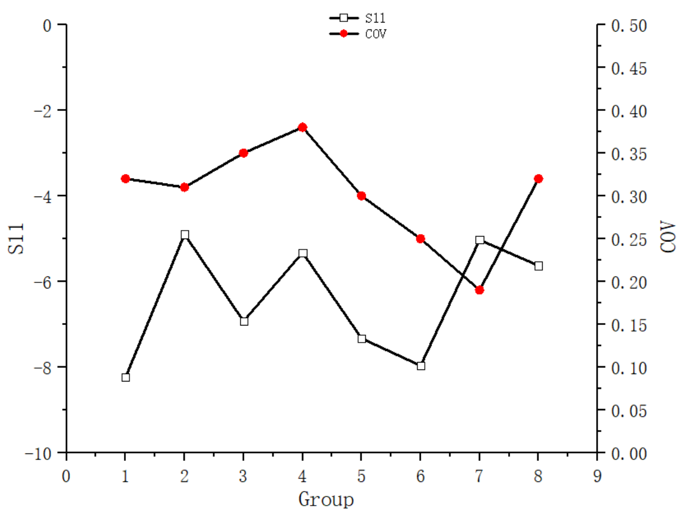
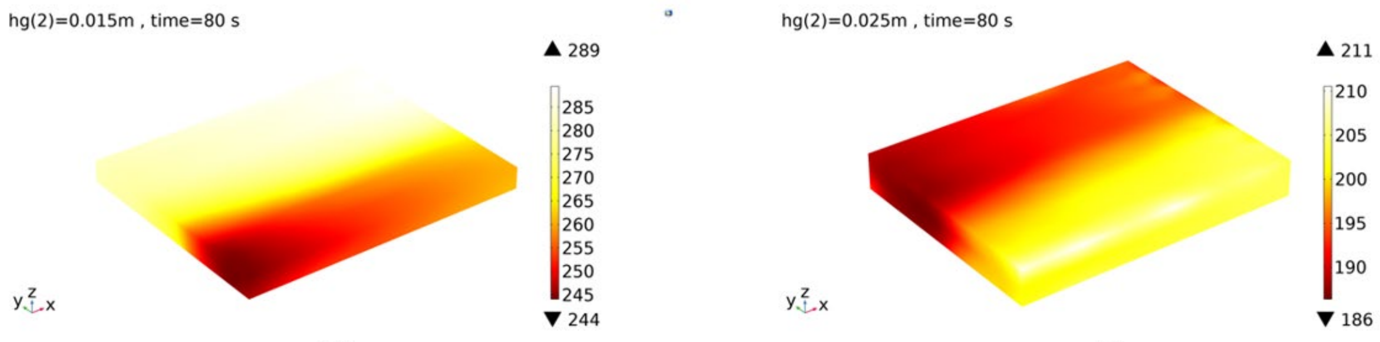


Figure 13. Impact of position variations on uniformity and S11 parameters.

It can be observed that among the eight different port coordinates, the reflection coefficient and uniformity indexes corresponding to the sixth port setting are generally superior. This configuration is more conducive to enhancing microwave energy utilization and improving the fixation quality of mulberry leaves.

2.7.3. Effect of Thickness on the Uniformity of Fixation of Mulberry Leaves

The sixth set of port positions was chosen as the energy input port for microwave fixation, and multiphysics field calculations for the fixation of mulberry leaf tea were subsequently performed. The temperature distribution in mulberry leaves after 80 s of heating in the cavity of the continuous microwave fixation machine is depicted in Figure 14.



(a) (b)

Figure 14. Temperature distribution after 80 s of blanching for various thicknesses. (**a**) The temperature distribution for a mulberry leaf thickness of hg = 0.015 m and (**b**) the temperature distribution for a mulberry leaf thickness of hg = 0.025 m.

Subsequently, the mean temperature and uniformity of mulberry leaf tea were further analyzed and calculated, and the results are presented in Table 4. According to the analysis of the results in Table 4, it is evident that changing the thickness of the mulberry leaves on the conveyor belt will result in variations in both the mean temperature and the coefficient of variation of temperature in the chamber. As the thickness of mulberry leaves increases, the heating speed in the chamber becomes slower, and failure to reach the desired fixation temperature quickly can result in the oxidation of mulberry leaves during the fixation process, which will cause the quality of mulberry leaf tea to decrease. In this study, when the thickness of mulberry leaves is 0.015 m, the appropriate temperature can be reached within the specified time, and the coefficient of variation of temperature is relatively small, creating the best mulberry leaf fix.

Table 4. Different thicknesses after 80 s of fixation in a continuous microwave fixation machine.

Thicknesses (m)	**0.01**	**0.015**	**0.02**	**0.025**	**0.03**
Average temperature of the body (°C)	236.49	252.02	210.77	186.98	183.99
COV	0.12	0.074	0.08	0.040	0.048

2.7.4. Fixed Experimental Results

Using the same total amount of mulberry leaves and under the same conditions, the speed of the conveyor belt and the thickness of the mulberry leaves laid flat on the conveyor belt will have obvious effects on the fixation. The water content after fixing is one of the most important quality evaluation indexes; according to the weight loss rate of each fresh leaf, it should be between 30% and 40% in order to reach the required fixing standards, including "fixing ripe", "fixing through", and "fixing uniform".

In this paper, the design of a continuous microwave mulberry leaf tea-fixing machine and the characteristics of mulberry leaves undergoing the fixing process are discussed. Table 5 shows the results of sensory evaluation indexes for different conveyor belt speeds and different thicknesses of mulberry leaves, with the moisture content ranging between 70% and 75% for the fresh mulberry leaves.

Table 5 shows that the fixation process is more effective when the conveying speed is 0.01 m/s and the thickness is 0.015 m, within the ideal range of fixation water loss rate. It is important to note that a water loss rate exceeding 40% in the fixation process can negatively impact the kneading of mulberry leaf tea at a later stage. The experimental results of different fixation degrees for mulberry leaf tea fixed using the continuous microwave mulberry leaf tea-fixing machine are presented in Figure 15.

Table 5. Comparison of water loss after fixation of mulberry leaf tea.

Group	Speed (m/s)	Thicknesses (m)	Fixed Water Loss Rate (%)
1	0.01	0.005	52.62
2	0.01	0.01	31.86
3	0.01	0.015	37.76
4	0.01	0.02	32.64
5	0.01	0.025	34.97
6	0.01	0.03	34.10
7	0.02	0.005	28.54
8	0.02	0.01	27.53
9	0.02	0.015	36.70
10	0.02	0.02	17.57
11	0.02	0.025	24.38
12	0.02	0.03	29.37
13	0.04	0.005	14.74
14	0.04	0.01	15.96
15	0.04	0.015	23.19
16	0.04	0.02	26.00
17	0.04	0.025	17.54
18	0.04	0.03	25.17

Figure 15. Comparison of the appearance of mulberry leaves with different degrees of fixation. (**1**) Incomplete fixation; (**2**) Moderate fixation; (**3**) Small number of burnt edges; (**4**) Large number of burnt edges.

3. Conclusions

For this paper, a multiphysics field model incorporating electromagnetic heating, porous media, and dilute matter transfer was constructed using the finite element method. The study investigates the effects of different port layouts on electromagnetic field distribution, the impact of port position on fixation temperature uniformity, and the influence of material thickness on fixation temperature uniformity. Utilizing the coaxial probe method to measure the dielectric constant of mulberry leaves under varying water contents and to establish the functional relationship between dielectric properties and water content, we determined the optima for the layout of the ports and the thickness of the mulberry leaves through multiphysics field calculations. In the computational model in this paper, the fixation uniformity and efficiency are higher when the coordinates of the six ports in their working planes are (−0.14 m, −0.15 m), (0.25 m, −0.15 m), (0.25 m, 0.15 m), (−0.14 m, 0.15 m), (0.11 m, 0 m), and (0.11 m, 0 m), and the thickness of the mulberry leaves is 0.015 m. The results of this study are summarized as follows: The final experimental results show that for mulberry leaf tea fixed at a conveyor belt speed of 0.01 m/s and a thickness of 0.015 m, the mulberry leaf tea fixation obtained is better. The experimental results are consistent with the data obtained from the simulation results, thus further verifying the correctness of the multiphysical field continuous microwave mulberry leaf tea fixation model. This study can provide a reference for analyzing the fixation uniformity and fixation efficiency of mulberry leaves.

Author Contributions: Conceptualization, T.H. (Tao He); Methodology, F.L.; Software, D.H.; Validation, L.W.; Formal analysis, D.G.; Investigation, T.H. (Tao Hong); Resources, Z.T. All authors have read and agreed to the published version of the manuscript.

Funding: This study was supported by the National Natural Science Foundation of China (62301449) and the project of Nanchong Key Laboratory of Electromagnetic Technology and Engineering (454011).

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflicts of interest.

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