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SIMULATION OF FRUIT DRYING PROCESS IN VACUUM DRYING EQUIPMENT IN COMSOL SOFTWARE.

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Annotation: Simulation of fruit vacuum drying process is important for more effective control and optimization of this process. Simulation of the vacuum drying process with the help of COMSOL Multiphysics software is an effective tool in the analysis of heat and mass exchange processes. This program allows you to monitor the temperature and humidity during the drying process and determine the optimal drying conditions.

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Annotatsiya: Mevalarni vakuumli quritish jarayonini simulyatsiya qilish, bu jarayonni yanada samarali boshqarish va optimallashtirish uchun muhim ahamiyatga ega. COMSOL Multiphysics dasturi yordamida vakuumli quritish jarayonining simulyatsiyasi, issiqlik va massa almashinuvi jarayonlarini tahlil qilishda samarali vosita bo'ladi. Bu dastur orqali quritish jarayonida harorat va namlikni kuzatib borish, quritishning optimal sharoitlarini aniqlash imkonini beradi.

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Аннотация: Моделирование процесса вакуумной сушки фруктов важно для более эффективного контроля и оптимизации этого процесса. Моделирование процесса вакуумной сушки с помощью программного обеспечения COMSOL Multiphysicals является эффективным инструментом анализа процессов тепло- и массообмена. Данная программа позволяет контролировать температуру и влажность в процессе сушки и определять оптимальные условия сушки.

Dried berries are a popular product today, because they contain all the vitamins, so the process of drying food products gives a valuable result. The process of drying food products is important not only for the amount of vitamins, but also for the level of small elements.

Drying fruits is a method of extending their shelf life by reducing their moisture content. Dried fruits retain their natural sweetness, taste and nutritional value. This process is mainly carried out with the help of sunlight, heat or special drying devices. Vacuum drying technology is

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considered the most suitable method for drying fruits. Vacuum drying is a product drying technology in a low-pressure environment, which is the process of removing moisture by turning it into steam at low temperature. This method is used for products that are sensitive and require high quality, such as fruits, medicines and biological substances.

The goal of this project is to completely dry berries in a sufficient amount of time using a vacuum dryer. This drying process was carried out using a simulation program called COMSOL. In this program, several parameters similar to the target raw material (berry) were controlled. After completing the simulation process using COMSOL software, the complete result such as drying time was obtained. The results were presented in tables and graphs for ease of understanding.

Modeling method (COMSOL)

In the previous points, we talked about the vacuum dryer. At this point, the method of modeling a vacuum dryer using COMSOL is explained in the diagram below. Engineers try to minimize drying time, as this leads to a lower cost and shorter storage time. The figure below shows the structure of a vacuum dryer.

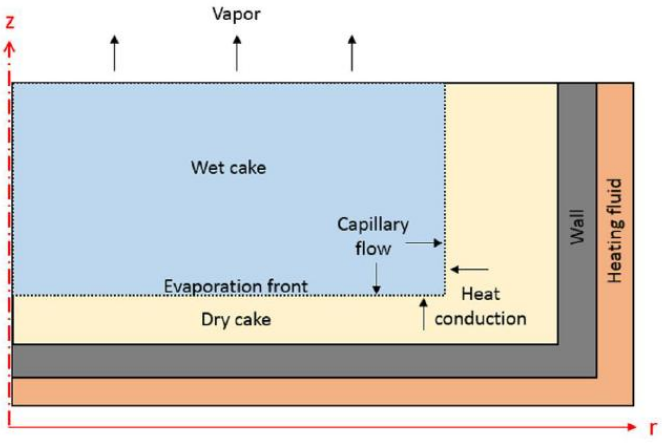

Figure 1. Design of vacuum dryer

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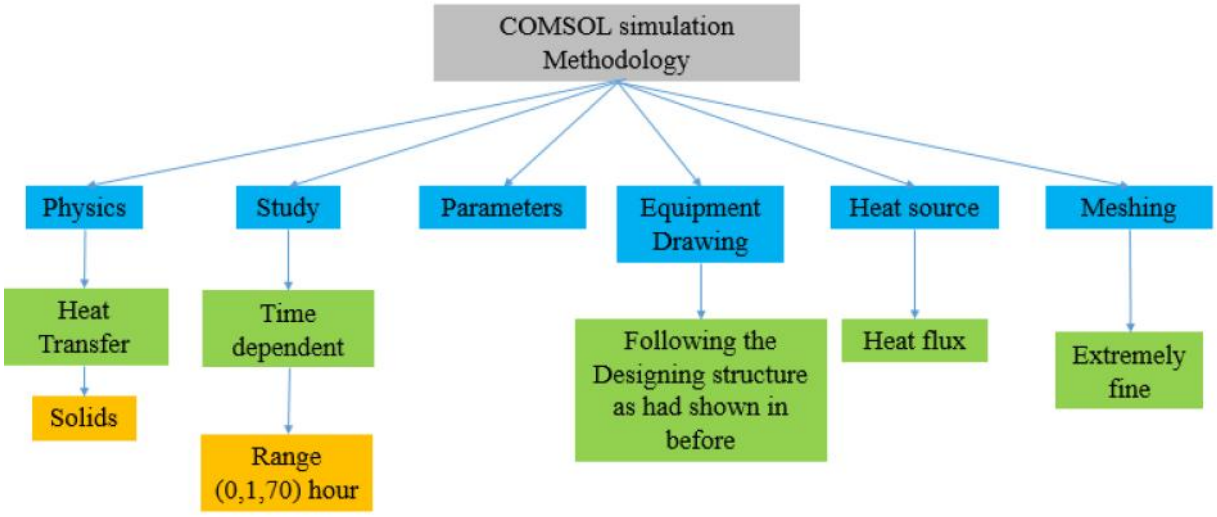

Figure 2. Scheme of the modeling process

Access to the program

This section presents all the results of the vacuum dryer simulation process. Results such as model temperature distribution. These results are obtained by generating a full report from COMSOL after completing the entire simulation process. In addition, the animation was produced using COMSOL software. Some photos are posted below to show the temperature distribution in the paste[31].

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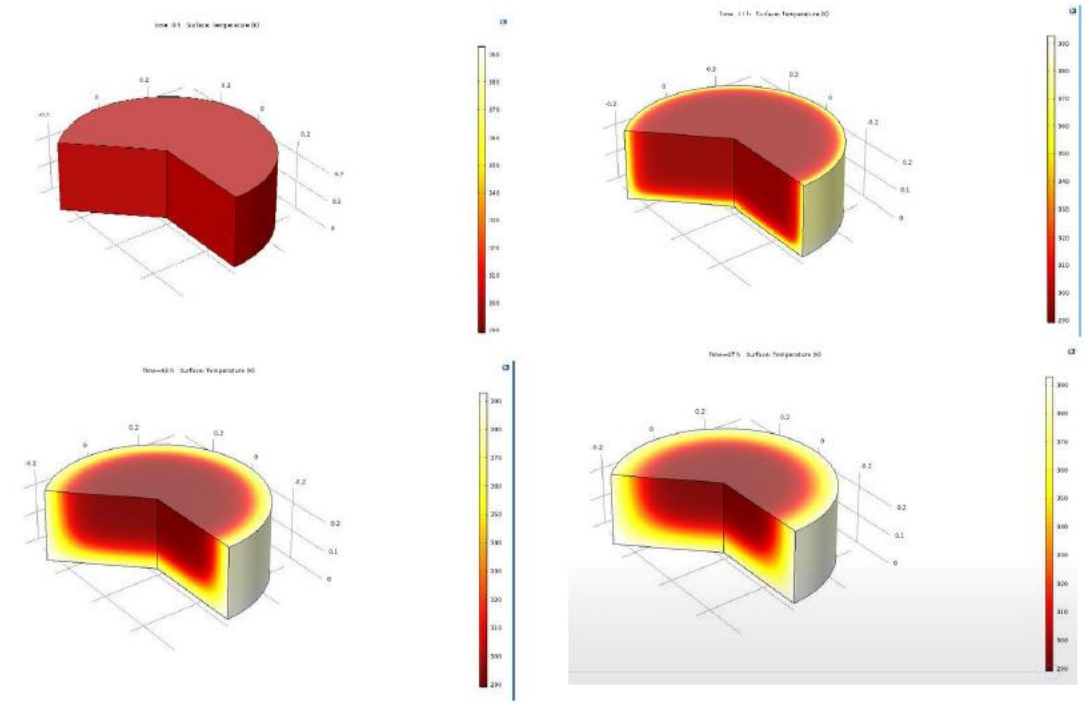

Figure 3. Vacuum drying in different time intervals

In the pictures above, it shows the temperature at different times of the drying process. The best temperature distribution can be obtained by varying the temperature of the cake shape and the thickness or height of the cake shape.

COMSOL produces several graphs that plot the results of the drying process. These results are shown below.

Temperature

The final table of the drying simulation process after 70 hours is shown below in 3D mode. Yellow indicates low temperature and red indicates high temperature. This is the last step after drying the berries for 70 hours. As shown in the figure below, the temperature distribution showed a spread through the product cake shape[30].

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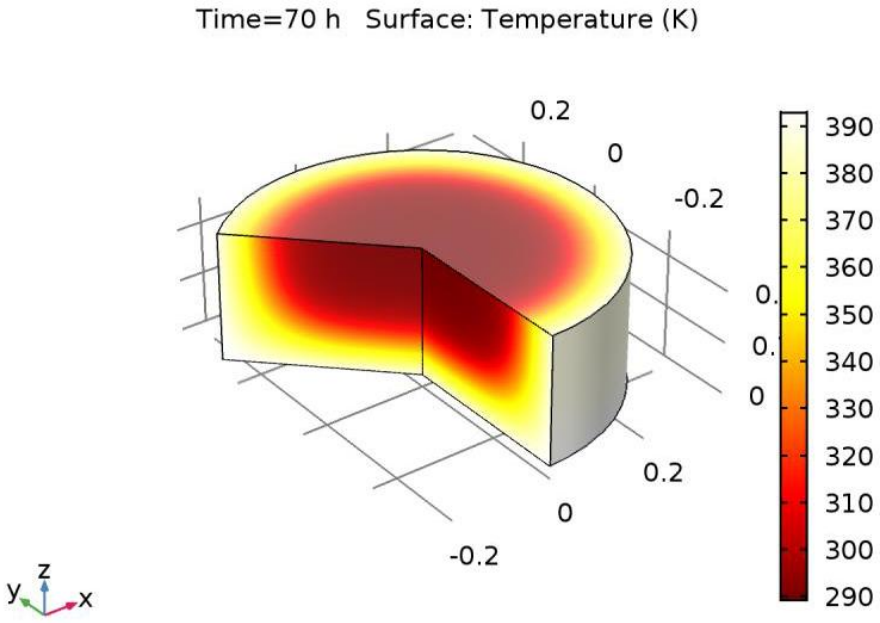

Figure 2.6. Temperature distribution graph after 70 hours

3D graphics

This graph shows the residual saturation after 30 hours of the simulation process for the dryer.

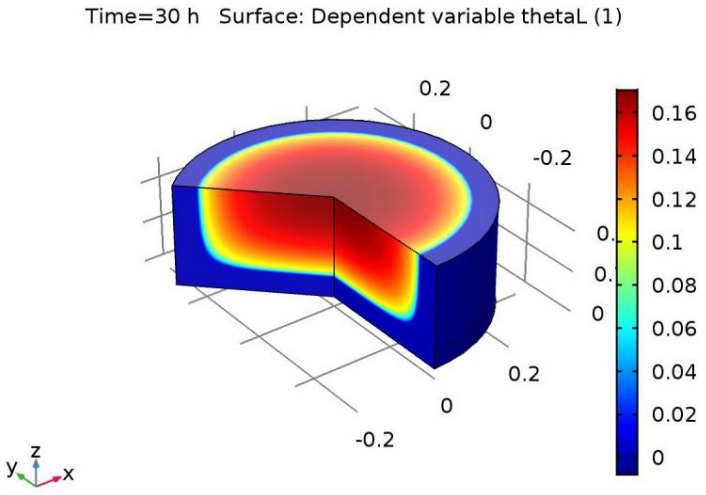

Figure 4. Plot of residual saturation after 30 hours of simulation

Evaporation rate

This section shows the results of the evaporation of the substance. It is clear that evaporation

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occurs during the drying process for the water inside the fruit. COMSOL software simulated the evaporation process after 10 hours of drying.

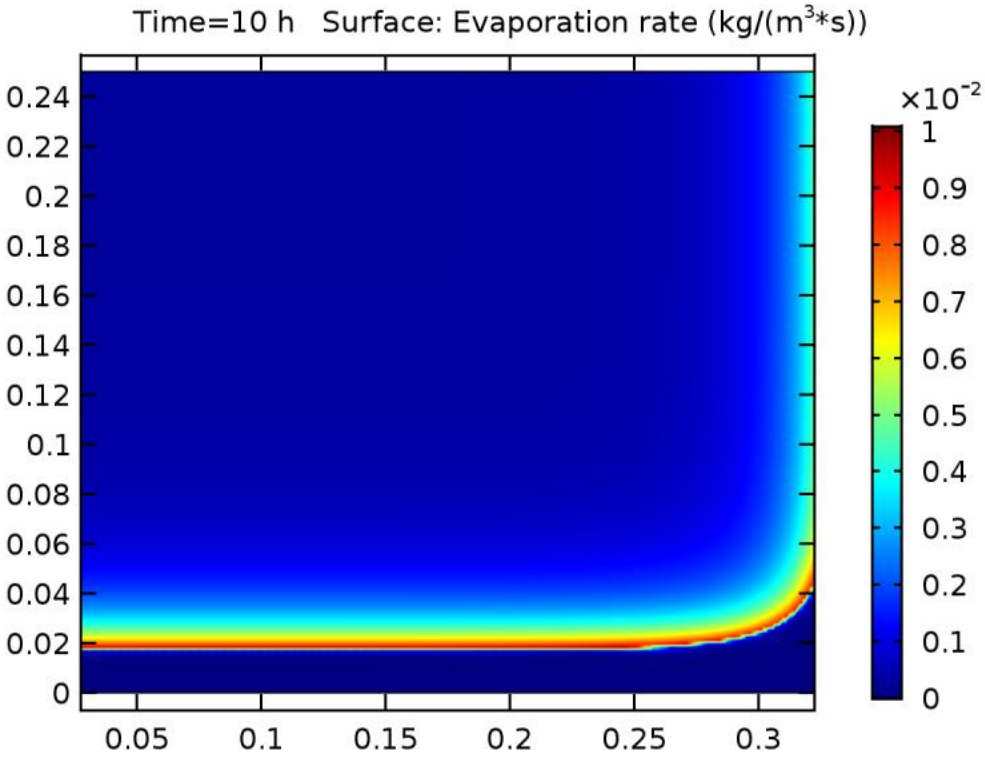

Figure 5. Evaporation rate

Obviously, the temperature used at 120°C reached almost all of its interior. These parameters can achieve better results than the modeling process, because the modeling process did not take into account several factors, such as the gaps in the cake shape or the uniformity of the cake shape.

Conclusions on modeling in the program

This simulation process showed the drying process for a cake shape of a certain size. The results met the demand in the field, but still took into account the type of material, the capabilities of the dryer, etc.

In summary, the drying process is not complicated, but requires several different simulations to obtain the optimal temperature to avoid wasting energy and time.

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