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# Effectiveness of microwave killing live cocoon

## Abstract

This article presents the analysis of the methods of preliminary treatment of live cocoons and the methods of de-animation of sponges currently used in our republic. Time-varying microwave inactivation of living cocoons grown in season 1 of silkworms was investigated. Under the influence of microwaves, the heating of the cocoon shell, the degree of death of the sponge, the amount of cocoons with internal spots depending on the temperature, silkiness, the output of cocoon slime, the level of continuous worminess, and the percentage of residual moisture during the drying process of the cocoons were determined. Based on the analysis of the results, the rational drying values of the preliminary experiments were determined. The obtained results are presented in the form of tables and diagrams.

**Keywords:** sponge, deactivation, temperature, humidity, spotted cocoon, drying, silkiness, microwave, energy

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## Introduction

In the decision of the President of the Republic of Uzbekistan on "Additional measures to support the rapid development of the cocoon industry in the Republic", the development of the cocoon industry, the introduction of modern and innovative technologies in the process of growing and processing cocoons, increasing the volume of production and export of silk products and the network consistent measures are being taken to attract foreign direct investments. At the same time, despite the large-scale work carried out, there are still a number of problems that prevent the in-depth processing of cocoon raw materials and the acceleration of the production of competitive finished silk products with high added value.[1]

In our republic, SK-150K used for cocoon drying is 82.1%, KSK-4.5 is 10.6%, Yamato-Sanko is 1.4%, steam dryer is 2.6%, simplex is 3.3%. These are dryers that are outdated and consume a lot of energy. If we look at the example of a single dryer SK-150K, in this unit, cocoons are pre-treated under the influence of high 110-120ºC hot air. The amount of heat used for this process is 83 kDJ/s, and the amount of air is 15,000 $m^3$/s, and the power of the electric motor for moving the gears is 43 kW. In this unit, 120 liters of fuel and 70 kW of electricity are used to process 1 ton of live cocoons. Moreover, since it is completely made of metal, it takes a long time (2-3 hours) to heat up the preparation-drying chamber until it reaches the specified temperature.[2]

Liu Wenfeng; Tao Yuchun; Ma Yanming studied the moisture-controlled microwave pupa drying method and device.[3]

Wang Shaozhi; Zhu Huacheng is concerned with the drying method of silkworm cocoons, especially the double drying method to ensure the quality of silkworm cocoons. The method is carried out by immersing fresh silkworm cocoons in a 0.5 to 1% hydrochloric acid ethanol solution by mass for 10-15 minutes.[4]

Shen Binghong invented a microwave automatic drying machine, the invention can be used to dry and sterilize various materials, especially for drying and sterilizing materials such as wood and bamboo, which are heavier in material quality and require high sterilization.[5]

A.Ya. Aboltin, S.G. Vlasova. He invented a method and device for processing agricultural products. His invention is intended for use in the field of processing in the field of drying, disinfection, sterilization and processing of agricultural products before planting. Agricultural products are placed in the chamber in a positionally regulated state, a vacuum condition is created, and the material is complexly heated due to thermal air flow, ultrasonic elastic vibrations, infrared and microwave radiation.[6]

Effective use of local raw materials, their full processing and bringing them to the level of finished products is an important issue in improving the economy of our country. This means preparing the quality of raw cocoons grown in our country and the quality of raw silk produced from it in accordance with world standards, and increasing the variety and types of products made of natural silk that meet the demands of the times. To date, there are several methods of preliminary processing of cocoons, which use the processes of devitalization and drying of living cocoons, the technological properties of these dried cocoons are studied, and improved technologies for obtaining high-quality raw silk are produced.[7–17]

The obtained results and their analysis. Currently, instead of 80-85% hot air, which is the most common chemical method, Magnofos 66% toxic pereparat is used in most cocoon pretreatment bases. The cocoons are placed in a special area in the form of a greenhouse, and this is achieved by placing Magnofos 66% tablets inside. The time spent on the process of killing the cocoon by the chemical method is reduced. But this method also has negative sides, skin diseases and allergies are observed among the workers, which is manifested by the appearance of various wounds on the hands of the workers. In addition, it leads to the fact that the cocoon cannot be used in the food and pharmaceutical industry, as feed for poultry. Therefore, in order to prevent negative situations, we aimed to use an ecologically clean method of resuscitation with the help of microwaves. In the experiment, the dependence of the moisture release from the cocoons on the microwave power and processing time was studied.

As we know, there are six types of electromagnetic radiation, which are invisible waves: radio; micro; infrared; ultraviolet; X-rays and gamma rays are calculated and characterized by a frequency of 10 Hz. Visible color spectrum frequencies are as follows, Hz: red-4,83; orange (orange) 5,08; yellow – 5,36; green - 6,0; sky blue - 6,25; blue is 6,66 and purple is 7,89.

The moisture content of freshly harvested cocoons with silkworms is 380-440%. If the living pupa are not killed and the moisture removed to a certain extent, they will pierce the cocoons and make them unfit for reeling. Keeping the dried cocoons in warehouses allows you to reeling high-quality raw silk throughout the year.

We have conducted a series of repeated practical experiments using microwaves to inactivate the cocoon-drying sponge. 2 in a household oven with a microwave generator with a frequency of 2,45 GHz; 3; 4; 5; 6; After 7 minutes, the cocoons were dried and the sponge was killed (Figure 1).

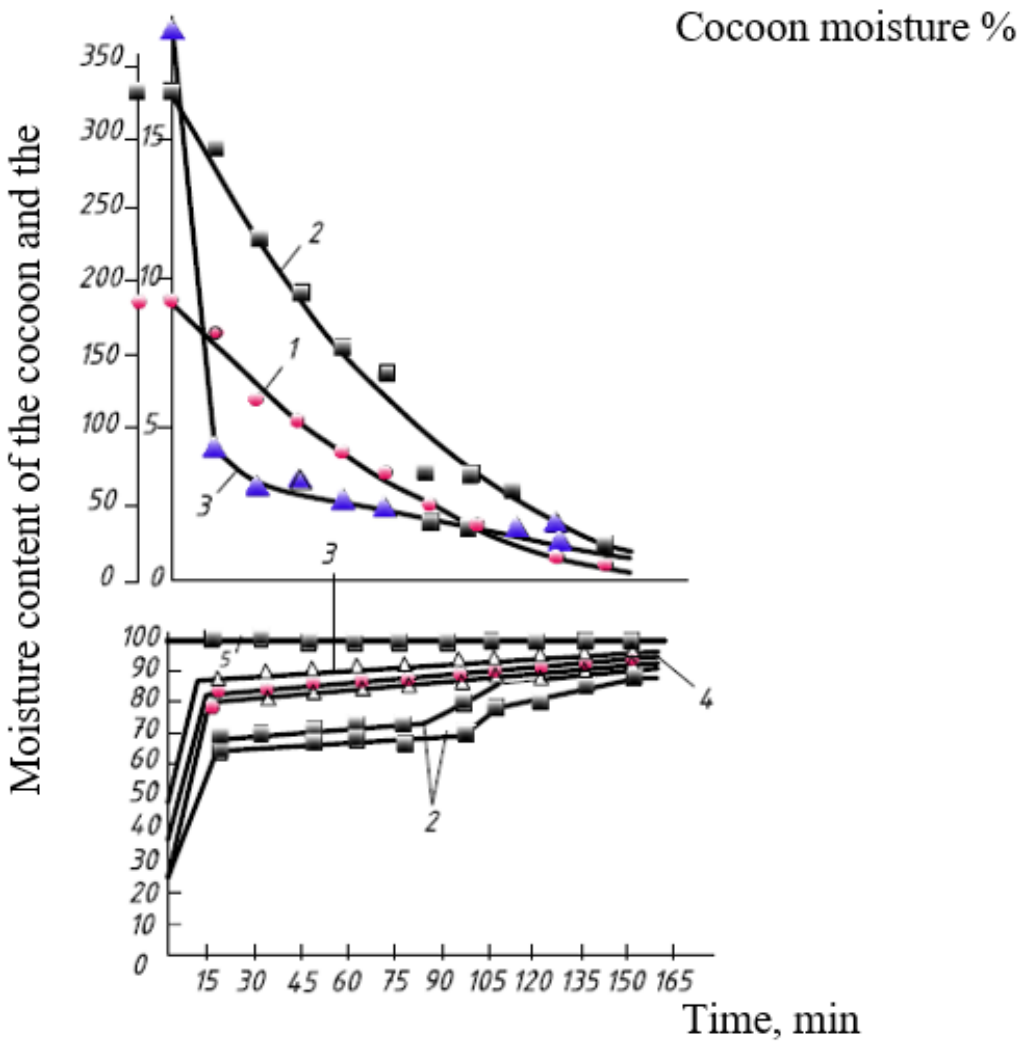


**Figure 1** Drying of the cocoon, shell, pupa and intermediate layers at a constant temperature of 100 °C (1-cocoons, 2-shell, 3-pupa, 4-inter-cocoon internal air, 5-drying air).

Threads were obtained from microwave-dried cocoons in a single reeling machine in a set order. The average yield of silk products and other technological indicators were determined by testing 50 times of each sample according to the requirements of the technological map and are presented in Table 1.

**Table 1** Effect of microwave duration on cocoon thread parameters

| Processing time, min | Cocoon weight, mg | Cocoon thread | | Cocoon slime | | Wasts | | Pupa | | Silk products (mg) | | The length of the cocoon thread | | Moisture content (Ch), % | Silkiness (I),% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mg | % | mg | % | mg | % | mg | % | mg | % | General (L) | Contin-uously (Ly.y.) | | |
| 2 | 670 | 288 | 42,9 | 9 | 1,34 | 12 | 1,7 | 340 | 50,7 | 309 | 46,1 | 882 | 882 | 93,2 | 46,1 |
| 3 | 530 | 264 | 49,8 | 10 | 1,88 | 8 | 1,5 | 236 | 44,5 | 282 | 53,2 | 980 | 980 | 93,6 | 53,2 |
| 4 | 450 | 204 | 45,3 | 15 | 3,33 | 14 | 3,1 | 205 | 45,5 | 233 | 51,7 | 863 | 287,6 | 87,5 | 51,7 |
| 5 | 490 | 216 | 44,0 | 6 | 1,22 | 11 | 2,2 | 273 | 55,7 | 233 | 47,5 | 837 | 279 | 92,7 | 47,5 |
| 6 | 450 | 196 | 41,7 | 14 | 2,97 | 8 | 1,7 | 226 | 50,2 | 218 | 46,3 | 869 | 869 | 89,9 | 48,4 |
| 7 | 460 | 182 | 39,5 | 15 | 3,26 | 15 | 3,1 | 231 | 50,2 | 212 | 45,3 | 775 | 387,5 | 85,8 | 45,9 |
| 8 | 470 | 197 | 41,9 | 16 | 3,40 | 9 | 1,9 | 230 | 48,9 | 222 | 47,2 | 777 | 388,5 | 88,7 | 47,2 |

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It is known from these diagrams that as the time of exposure to microwaves increased, the yield of cocoon slime and pupa increased, and the amount of cocoon thread and silk products decreased. Based on these, we can see that the most rational option is 3 minutes (Figure 2).

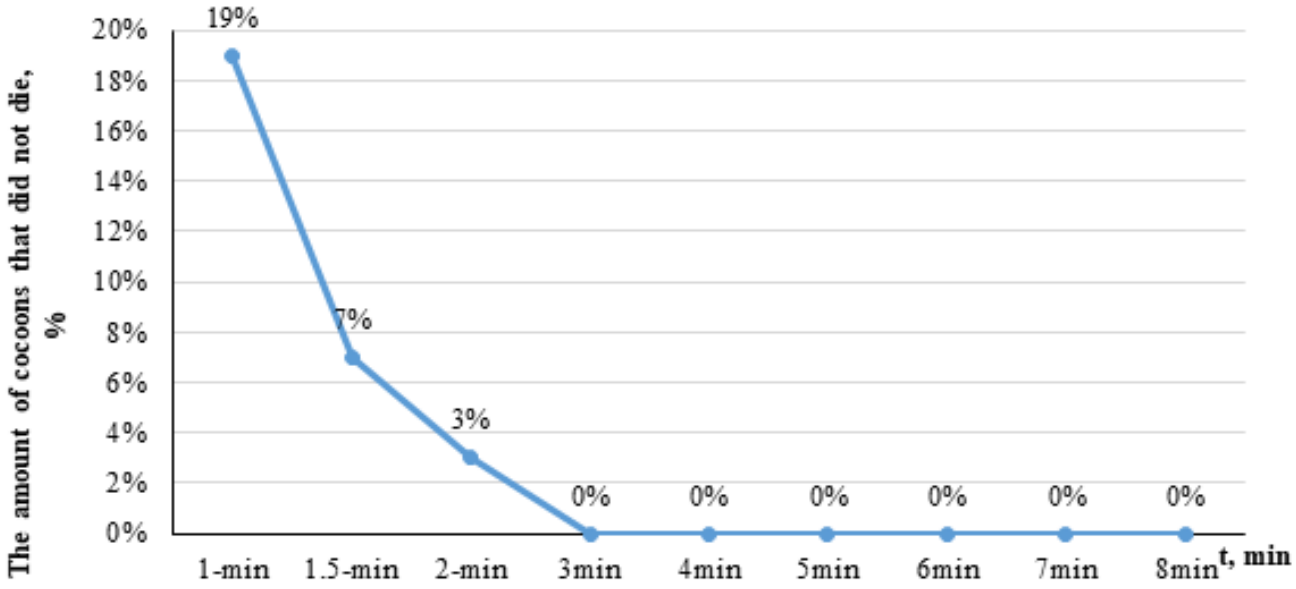


**Figure 2** Effect of microwaves on sponge inactivation.

For the experiment, 250g of Chinese hybrid cocoons were extracted in 9 different variants. Exposure time to 2.45 GHz microwaves using a household oven is 2 min, respectively; 3 minutes; 4 minutes; 5 minutes; 6 minutes; 7 minutes; It was made into 8 min and left to dry in the shade for 10 days. In this period of time, the number of cocoons that were not revived in the cocoons treated for 2 minutes was 19%. Taking into account that the resuscitation was not enough, when we extended the resuscitation time, it was practically proven that our cocoons were completely resuscitated in 3 minutes (Figure 3).

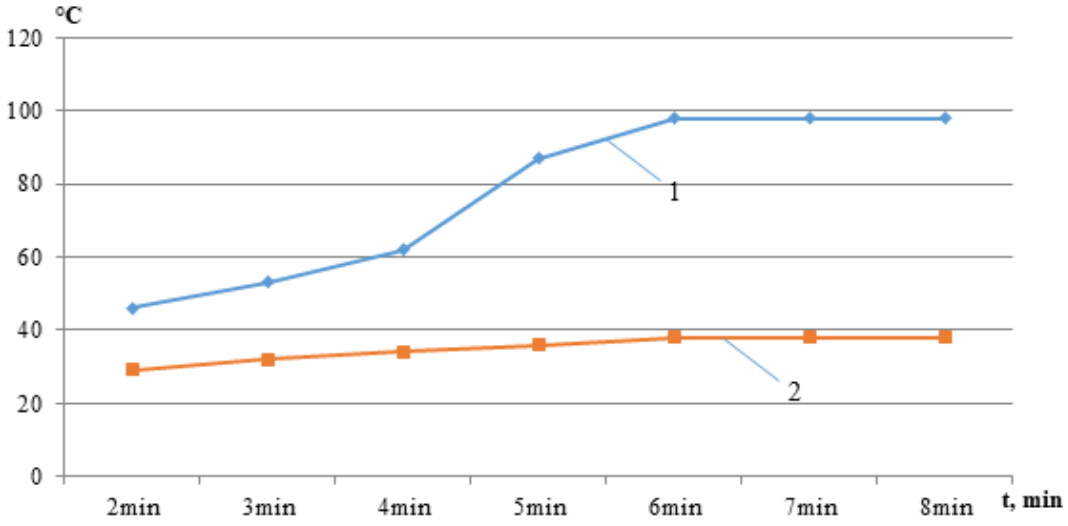


**Figure 3** Changes in the temperature of the sponge and the shell under the influence of microwaves, 1-sponge, 2-shell.

In the course of the experiment, the temperature of the shell increased by 46°C and the temperature of the shell by 29°C when exposure to 2,45 GHz microwaves was 2 min. It was observed that the temperature of the mushroom was 53°C and the temperature of the shell was 32°C. When we extended the processing time by 4 min, the bulb temperature was 62°C and the shell temperature was 34°C. At 5 min of microwave exposure, the bulb temperature was 87°C and the shell temperature was 36°C. When the processing time was 6, 7, 8

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min, the bulb temperature increased to 98°C and the shell temperature increased to 38°C. Figure 4. Dependence of the duration of drying time of internally spotted cocoons.

Due to the effect of microwaves on the inside of the cone, it was observed that when the temperature rises, the moisture of the cone turns into steam, the pressure increases inside the skin, and it cracks and the cocoons with internal spots are formed. Microwave exposure time 1; 1,5; 2; No internal spotted cocoons formation was observed at 3 min. The amount of cocoons with inner spots was 23% at 4 minutes, 50% at 5 minutes, 75% at 6 minutes, 90% at 7 minutes, and 95% at 8 minutes (Figure 4).

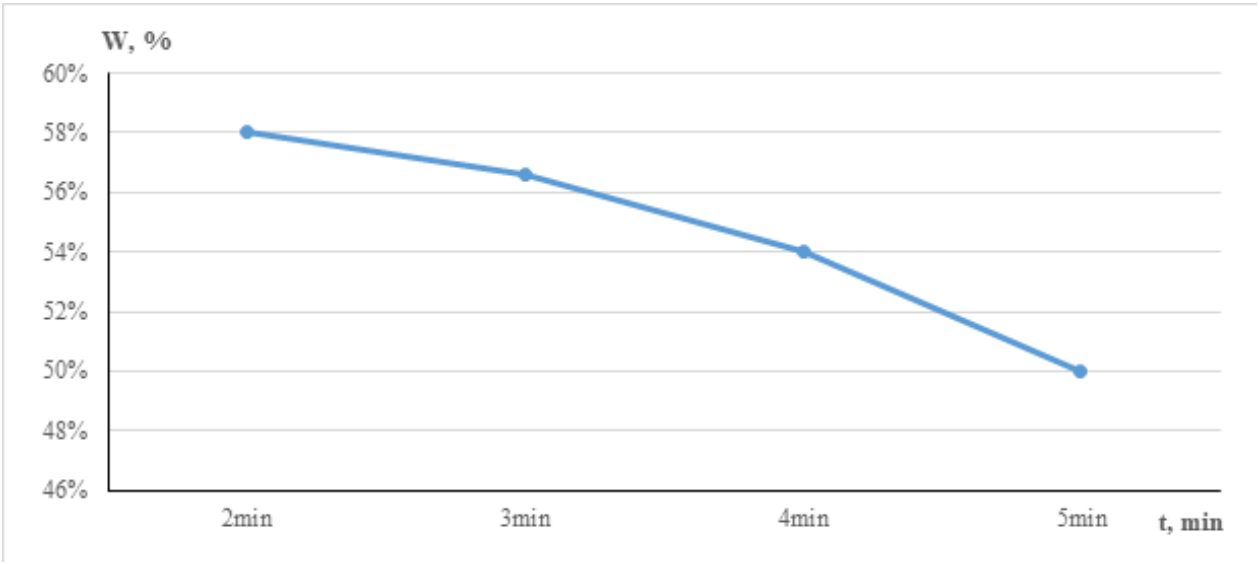


**Figure 4** Effect of cocoon drying duration on residual moisture.

Cocoon moisture was determined in a 41g sample using a MD-6P moisture analyzer. The residual moisture content of cocoons with microwave exposure time of 2 min was found to be 58%. Processing time is 3 min. in the cocoon, the residual moisture in the cocoon was 57%. 5 min. and the residual moisture in the cocoon was 50%.

## Conclusion

It can be said that during microwave treatment, moisture in the cocoons decreases to 57% residual moisture within 3 minutes and complete death of the sponge has been proven from a practical point of view. Drying for more than 3 minutes has been found to increase the temperature of the sponge to 98-100ºC and cause it to crack and cause cocoons with internal spots. According to the results of preliminary studies, drying the sponge for 3 minutes was accepted as a rational parameter. In practice, in the SK-150K unit, the moisture content of the cocoons, which have been killed, is 300-320%, and then in the shaded dryer, the conditioned moisture level (11%) of the shell is reached for 35-40 days. In the case of cocoons whose domes were devitalized by microwaves, the moisture level was around 57%, and the duration of shade drying was 8-10 days, and the cocoon shell reached the conditioned moisture level. This in turn significantly reduces shade drying areas and labor costs, resulting in lower cocoon costs. Practices are ongoing to use microwave units to inactivate locally grown cocoon.

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## Conflicts of interest

The authors declare no conflict of interest.

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