MUHANDISLIK & IQTISODIYOT

ijtimoiy-iqtisodiy, innovatsion texnik, fan va ta'limga oid ilmiy-amaliy jurnal

№5

2025
MAY

Milliy nashrlar

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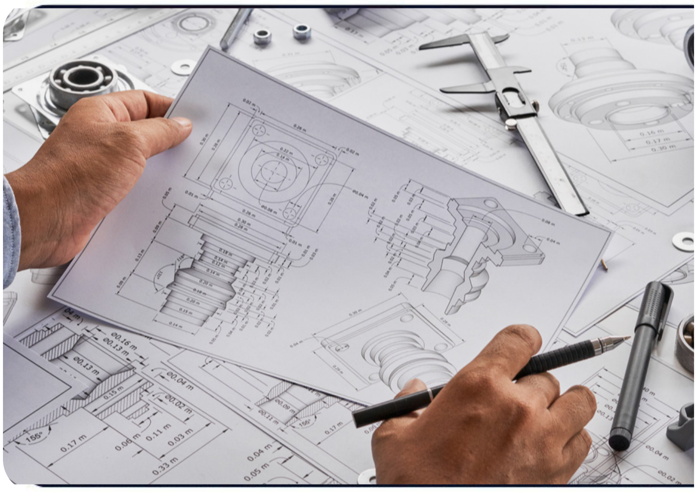
05.00.00 - Texnika fanlari
08.00.00 - Iqtisodiyot fanlar



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Elektron nashr, 228 sahifa, may, 2025-yil.

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05.01.00 – Axborot texnologiyalari, boshqaruv va kompyuter grafikasi
05.01.01 – Muhandislik geometriyasi va kompyuter grafikasi. Audio va video texnologiyalari
05.01.02 – Tizimli tahlil, boshqaruv va axborotni qayta ishlash
05.01.03 – Informatikaning nazariy asoslari
05.01.04 – Hisoblash mashinalari, majmualari va kompyuter tarmoqlarining matematik va dasturiy ta'minoti
05.01.05 – Axborotlarni himoyalash usullari va tizimlari. Axborot xavfsizligi
05.01.06 – Hisoblash texnikasi va boshqaruv tizimlarining elementlari va qurilmalari
05.01.07 – Matematik modellashtirish
05.01.11 – Raqamli texnologiyalar va sun'iy intellekt
05.02.00 – Mashinasozlik va mashinashunoslik
05.02.08 – Yer usti majmualari va uchish apparatlari
05.03.02 – Metrologiya va metrologiya ta'minoti
05.04.01 – Telekommunikasiya va kompyuter tizimlari, telekommunikasiya tarmoqlari va qurilmalari. Axborotlarni taqsimlash
05.05.03 – Yorug'lik texnikasi. Maxsus yoritish texnologiyasi
05.05.05 – Issiqlik texnikasining nazariy asoslari
05.05.06 – Qayta tiklanadigan energiya turlari asosidagi energiya qurilmalari
05.06.01 – To'qimachilik va yengil sanoat ishlab chiqarishlari materialshunosligi
05.08.03 – Temir yo'l transportini ishlatish
05.09.01 – Qurilish konstruksiyalari, bino va inshootlar
05.09.04 – Suv ta'minoti. Kanalizatsiya. Suv havzalarini muhofazalovchi qurilish tizimlari
10.00.06 – Qiyosiy adabiyotshunoslik, chog'ishtirma tilshunoslik va tarjimashunoslik
10.00.04 – Yevropa, Amerika va Avstraliya xalqlari tili va adabiyoti

08.00.01 - Iqtisodiyot nazariyasi
08.00.02 - Makroiqtisodiyot
08.00.03 - Sanoat iqtisodiyoti
08.00.04 - Qishloq xo'jaligi iqtisodiyoti
08.00.05 - Xizmat ko'rsatish tarmoqlari iqtisodiyoti
08.00.06 - Ekonometrika va statistika
08.00.07 - Moliya, pul muomalasi va kredit
08.00.08 - Buxgalteriya hisobi, iqtisodiy tahlil va audit
08.00.09 - Jahon iqtisodiyoti
08.00.10 - Demografiya. Mehnat iqtisodiyoti
08.00.11 - Marketing
08.00.12 - Mintaqaviy iqtisodiyot
08.00.13 - Menejment
08.00.14 - Iqtisodiyotda axborot tizimlari va texnologiyalari
08.00.15 - Tadbirkorlik va kichik biznes iqtisodiyoti
08.00.16 - Raqamli iqtisodiyot va xalqaro raqamli integratsiya
08.00.17 - Turizm va mehmonxona faoliyati

Ma'lumot uchun, OAK
Rayosatining 2024-yil 28-avgustdagi 360/5-son qarori bilan "Dissertatsiyalar asosiy ilmiy natijalarini chop etishga tavsiya etilgan milliy ilmiy nashrlar ro'yxati"ga texnika va iqtisodiyot fanlari bo'yicha "Muhandislik va iqtisodiyot" jurnali ro'yxatga kiritilgan.

M u a s s i s: "Tadbirkor va ishbilarmon" MChJ

H a m k o r l a r i m i z:

1. Toshkent shahridagi G.V.Plexanov nomidagi Rossiya iqtisodiyot universiteti
2. Toshkent davlat iqtisodiyot universiteti
3. Toshkent irrigatsiya va qishloq xo'jaligini mexanizatsiyalash muhandislari instituti" milliy tadqiqot universiteti
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9. Jizzax politexnika instituti

MUNDARIJA

METHOD OF DRYING MELON USING SOLAR RADIATION AND A HOUSEHOLD SOLAR-INFRARED DRYER

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Abstract: Preliminary processing is carried out in a solar greenhouse unit over two days, with the whole melon being turned 180 degrees daily. A household solar-infrared drying unit has been developed, in which the vapor-air mixture is removed during the drying process through natural vacuum. A two-day preliminary treatment of melon fruits using inexpensive solar radiation in the greenhouse unit is recommended. During this process, solar rays penetrate through the melon peel into the edible part, creating micro-pores at a depth of 1.2 cm, which helps accelerate the drying process and reduce drying time. Preliminary processing contributes to a 10.4% increase in moisture loss relative to the total weight of the melon.

With only one opening (the top one) for the vapor-air mixture to exit the drying chamber of the solar-infrared drying unit, a natural vacuum is created due to the pulsating release of the vapor-air mixture. This vacuum draws out the evaporated water vapor from the depth of the melon slices through the micro-pores, thereby accelerating the drying process by 30% compared to untreated melon fruit.

Keywords: Solar greenhouse, Preliminary processing, Melon drying, Solar-infrared drying, Natural vacuum, Micro-pores, Moisture loss, Drying efficiency, Pulsating vapor release, Drying time reduction

Annotatsiya: Dastlabki ishlov berish quyosh issiqxonasida ikki kun davomida amalga oshiriladi, butun qovun har kuni 180 daraja aylantiriladi. Maishiy quyosh-infraqizil quritish moslamasi ishlab chiqilgan bo'lib, unda bug'-havo aralashmasi quritish jarayonida tabiiy vakuum orqali chiqariladi. Issiqxonada arzon quyosh nurlanishidan foydalangan holda qovun mevalarini ikki kunlik dastlabki davolash tavsiya etiladi. Bu jarayon davomida quyosh nurlari qovun po‘stlog‘i orqali qutulish mumkin bo‘lgan qismga kirib, 1,2 sm chuqurlikda mikro-g‘ovaklarni hosil qiladi, bu esa quritish jarayonini tezlashtirishga va quritish vaqtini qisqartirishga yordam beradi. Dastlabki ishlov berish qovunning umumiy og'irligiga nisbatan namlikni yo'qotishning 10,4% ga oshishiga yordam beradi. Quyosh-infraqizil quritish moslamasining quritish kamerasidan bug '-havo aralashmasi chiqishi uchun faqat bitta teshik (yuqori) bilan bug'-havo aralashmasining pulsatsiyalanuvchi chiqishi tufayli tabiiy vakuum hosil bo'ladi. Bu vakuum bug'langan suv bug'ini qovun bo'laklari chuqurligidan mikro-g'ovakchalar orqali chiqaradi va shu bilan quritish jarayonini tozalanmagan qovun mevasiga nisbatan 30% ga tezlashtiradi.

Kalit so‘zlar: Quyosh issiqxonasi, Dastlabki ishlov berish, Qovunni quritish, Quyoshli infraqizil quritish, Tabiiy vakuum, Mikro gözenekler, Namlikni yo'qotish, Quritish samaradorligi, Pulsatsiyalanuvchi bug 'chiqishi, Quritish vaqtini qisqartirish.

Аннотация: Предварительная обработка проводится в солнечной теплице в течение двух суток, при этом вся дыня ежедневно переворачивается на 180 градусов. Разработана бытовая солнечно-инфракрасная сушильная установка, в которой паровоздушная смесь удаляется в процессе сушки посредством естественного вакуума. Рекомендуется двухдневная предварительная обработка плодов дыни с использованием недорогого солнечного излучения в теплице. В ходе этого процесса солнечные лучи проникают через кожуру дыни в съедобную часть, создавая микропоры на глубине 1,2 см, что способствует ускорению процесса сушки и сокращению времени сушки. Предварительная обработка способствует увеличению потери влаги на 10,4% относительно общего веса дыни. При наличии только одного отверстия (верхнего) для выхода паровоздушной смеси из сушильной камеры солнечно-инфракрасной сушильной установки создается естественный вакуум за счет пульсирующего выброса паровоздушной смеси. Этот вакуум вытягивает испарившийся водяной пар из глубины ломтиков дыни через микропоры, тем самым ускоряя процесс сушки на 30% по сравнению с необработанными плодами дыни.

Ключевые слова: Солнечная теплица, Предварительная обработка, Сушка дыни, Солнечно-инфракрасная сушка, Естественный вакуум, Микропоры, Потеря влаги, Эффективность сушки, Пульсирующий выпуск пара, Сокращение времени сушки.

INTRODUCTION

Melon drying is mainly carried out by small farming households and private homesteads, using predominantly manual labor. The technology is based on the method of air solar drying, in which cleaned slices of the edible part of the melon are placed in the open environment (under direct sunlight) in a horizontal position. This method does not meet sanitary and hygienic standards and is highly dependent on weather conditions. During the drying process, insects, dust, and rain settle on the surface of the drying melon, resulting in a final product that does not meet the established technical requirements [1].

Based on patent searches and literature sources, it is necessary to develop a highly efficient, low-cost, household, and combined drying unit that is also simple and convenient to operate.Выявлены задачи исследования, которые представлены в статье.

Development of a design model for a household solar-infrared drying unit, taking into account solar pre-treatment and the physical, biological, and technological properties of melon.

Conducting scientific and experimental research on the drying of solar pre-treated and untreated melon: changes in fruit mass during three days of drying in sunlight (under solar radiation) and two days of drying (during two nights) using an infrared heater.

Conducting scientific and experimental research to determine important operational and technological parameters of the drying process (steam-air mixture at the outlet of the solar unit): temperature and humidity of the steam-air mixture. Based on these parameters and using the i-d diagram, the partial pressure and mass fraction of water vapor in the steam-air mixture were determined.

Based on the obtained results, dependency curves, and data in the table, describe the technological process (operation) of solar and infrared drying and present an analysis.

Review of literature on the subject

The drying of agricultural products using solar energy has garnered substantial attention due to its environmental benefits and cost-effectiveness. Mujumdar emphasized that solar drying systems not only reduce dependence on fossil fuels but also help preserve the nutritional quality of fruits and vegetables. Melons, characterized by their high moisture content, are particularly susceptible to post-harvest losses, making them ideal candidates for solar-assisted drying technologies.

According to Esper and Muhlbauer, the application of solar drying in tropical and subtropical regions can significantly enhance the shelf life of perishable products while maintaining product safety. Their work demonstrated that solar dryers could reduce microbial activity and enzymatic degradation, both of which are critical in melon preservation.

Hybrid solar dryers, which integrate solar radiation with additional heat sources such as infrared, have shown improved efficiency. Belessiotis and Delyannis explored the potential of hybrid systems in agricultural processing and noted their ability to maintain drying even under fluctuating weather conditions. Similarly, Panwar, Kaushik, and Kothari developed a solar-infrared hybrid dryer that exhibited faster drying rates and better energy efficiency than conventional solar-only systems.

Fudholi et al. provided a detailed analysis of the thermodynamic and economic performance of mixed-mode solar dryers. They emphasized the importance of controlling temperature and humidity during drying, which directly influences product quality and energy usage. Their research serves as a foundation for the development of household solar-infrared dryers.

In a study specifically focused on melon drying, Orikasa et al. investigated the effects of various drying methods on the quality of melon slices. Their findings indicated that combining pre-treatment techniques with optimized drying temperatures helped retain the fruit's color, texture, and vitamin content. This aligns with the objective of the current study, which seeks to develop a solar-infrared dryer tailored for domestic use.

Collectively, these studies underscore the potential of solar and hybrid drying technologies to improve post-harvest processing. However, there remains a need for localized designs that consider climatic conditions, user convenience, and cost-effectiveness for household and small-scale applications.

RESEARCH METHODOLOGY

The study was based on a preliminary two-day treatment of whole melons with solar radiation in a greenhouse-type solar unit. This was followed by calibration, inspection, washing, and cutting the melon in half along its axis, removal of seeds and peel, slicing the edible part into pieces with dimensions of 25 × 6.0 × 1.5 cm, and drying in a stream of warm air [2].

Research Objective - The goal of the study is to develop a design model of a household solar-infrared (combined) drying unit that ensures reduced drying time and cost-effective operation, as well as convenience in drying melons using solar radiation combined with automatic infrared radiation during continuous movement. This unit provides heating by solar radiation during the daytime, and in its absence (at night or during cloudy weather), heating is provided by infrared radiation.

In the experimental research, the following instruments were used: devices for measuring the temperature and humidity of the steam-air mixture, tools for monitoring the change in melon mass, and an automated system for controlling the heating temperature of the melons.

ANALYSIS AND RESULTS

The temperature and humidity of the steam-air mixture at the outlet of the unit and in the surrounding environment are measured using the DHT11 sensor. The combined DHT11 sensor includes two useful measuring instruments – a thermometer and a hygrometer. The thermometer measures temperature, and the hygrometer measures the relative humidity of the air. Inside the DHT11 casing, there is a resistive element sensitive to changes in relative humidity, an NTC-type thermistor, and a microchip that transmits the readings from both sensors via a 1-wire digital protocol.

Sensor Specifications: Power supply voltage: from 3.3 to 5.5 V; Humidity sensor type: resistive; Humidity measurement range: from 20% to 90%; Humidity measurement error: ±5%; Temperature sensor type: NTC thermistor; Temperature measurement range: from 0°C to 50°C; Temperature measurement error: ±2°C; Sampling frequency: no more than 1 Hz (1 time per second); Response time for humidity measurement: 10 seconds; Software for Working with DHT11 (Here you may add or describe the specific software or code used to read data from the sensor) (Figure 1).

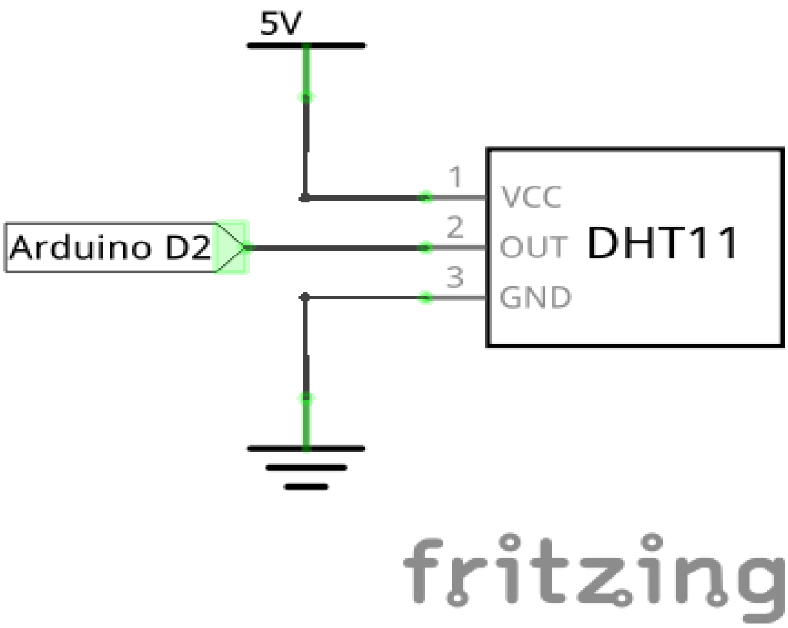

Figure 1. Circuit Diagram of the DHT11 Sensor

It is necessary to install an additional library in the Arduino IDE. There are many libraries available for working with DHT sensors, but we chose the version from the Adafruit portal [3].

Mass Change Measurement during Drying Process. The change in the mass of the fruits during the drying process was measured using SF-400 type electronic scales. Specifications of SF-400 Scales: Measurement accuracy: 1 gram; Measurement units: grams; Platform/bowl material: plastic; Maximum weighing limit: 7 kg; Power supply: battery-powered; Construction: platform-based.

These scales are universal instruments for weighing all kinds of ingredients – from spices and flour to vegetables and fruits. One of the main advantages of the SF-400 electronic kitchen scale is its high measurement accuracy – it can measure weights up to 5 kg with an accuracy of 1 gram. The SF-400 scale is very simple, easy to store, and highly convenient to use.

Infrared Heating For infrared heating, two halogen infrared quartz lamps (KHS type) with 750 W power each were used, connected in parallel. The total length of the lamps is 224 mm, and the diameter is 10 mm.

The solar radiation data used during the experimental research of the solar-infrared heating drying unit we developed was obtained from the “UNIFIED METEOROLOGICAL OBSERVATION PORTAL” [4] for the city of Bukhara, Republic of Uzbekistan, for the dates August 5, 2024, August 6, 2024, and August 7, 2024.

A preliminary treatment of whole melons was carried out before the experiments. Figure 1 illustrates a real-life image of the greenhouse-type solar unit designed for the two-day preliminary treatment of melons. The preliminary treatment involved keeping the whole melon in the greenhouse solar unit and turning it 180 degrees daily.

Melons of the "Torpedo" variety were selected for the preliminary treatment, with an initial weight of 4.968 kg. After the treatment, the weight was reduced to 4.451 kg (a weight loss of 10.4% after preliminary treatment).For the untreated sample, a "Torpedo" variety melon was also used, weighing 5.387 kg (Figure 2).

Figure 2. Greenhouse Solar Unit for Preliminary Melon Treatment.

The operating principle of the proposed household solar-infrared drying unit is as follows: Solar radiation primarily enters through the inclined glass surface, directly and at an angle, onto the heat accumulation surface. The rest of the radiation penetrates through the glazed sides of the drying chamber and falls indirectly onto the surface of the melons, heating them. The heat accumulator warms the surrounding air, which then flows through the melons, causing them to heat up and evaporate water vapor from their flesh. The resulting heated steam-air mixture flows vertically upward along the surface of the melons and disperses into the surrounding environment.

The recommended setup is illustrated in Figures 2 and 3, which show both schematic and real-life images of the developed unit.

The household solar-infrared drying unit (1) for drying melons consists of a drying chamber shaped like a parallelepiped with four corner bases. The height of the parallelepiped is 80 cm, and its width is 40 cm. Three sides of the parallelepiped are fitted with frames made of wooden bars with glass panels attached. The fourth side has a hermetically sealed door. Glazed inclined frames are attached to the three sides, with their walls slanted at a 45-degree angle to the horizontal. The bottom of the drying chamber is covered with a metal sheet, beneath which a heat insulator is installed. A hole is drilled in the lower part of the device for ventilation, and it is covered with mesh to protect the drying chamber from insects (Figure 3, 4, 5).

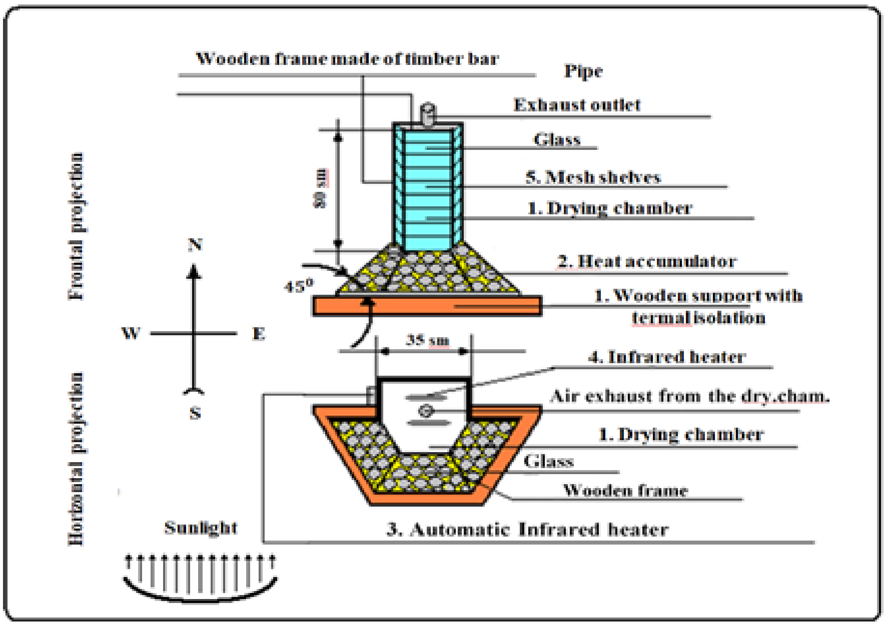

Figure 3. Diagram of the Solar-Infrared Drying Unit

Figure 4. Real-life Image of the Solar-Infrared Drying Unit Operating on Solar Radiation

Figure 5. Real-life Image of the Solar-Infrared Drying Unit Operating on Infrared Radiation

An infrared (IR) heater (4) is installed above the ventilation hole, and stones (2) are placed inside to serve as a heat accumulator. The IR heater is connected to an automated control system (3). A hole is drilled in the metal sheet and the heat insulator for air intake from the surrounding environment. A hole is also drilled in the ceiling of the drying chamber, where a pipe is installed for the outlet of the steam-air mixture from inside the chamber to the outside. Inside the chamber, 10 mesh shelves are installed for placing the fruit.

Operating Principle of the Unit. After the preliminary treatment of whole melons is completed, they are cut in half lengthwise along the axis, then seeds and peel are removed. The edible part is sliced into pieces measuring 25 × 6 × 1.5 cm. For the experiment, 3.141 kg of pre-treated melon slices and 3.968 kg of untreated melon slices (from the edible part) were selected. The slices, each with a surface area of approximately 20+6 cm², are placed on the mesh shelves, and the automated IR heater system is turned on.

When the temperature of the steam-air mixture at the outlet approaches the drying chamber temperature (50°C), the automated IR heater system switches off. The drying chamber door is hermetically closed. The three glazed sides and the glazed inclined surfaces of the drying chamber face south, southwest, and southeast.

Solar radiation enters the glazed walls of the drying chamber. Some of the radiation falls on the three glazed rectangular walls, but the main portion of the solar radiation hits the inclined surfaces. It should be noted that the solar radiation reaching the melon slices is indirect, while radiation reaching the heat accumulator is direct and at an angle. The solar radiation on the inclined glazed surfaces directly heats the heat accumulator. The heated air surrounding the heat accumulator convectively passes through the melon slices, warming them. Water contained in the melon evaporates, filling the drying chamber with water vapor, which is then expelled through pipes into the surrounding environment.

For the scientific study of the drying process, it is necessary to determine the moisture ratio. The moisture ratio (MR) of melon samples is determined using the following equation (1).

$$MR = \frac{M_t - M_e}{M_0 - M_e} \qquad (1)$$

where MR is the moisture ratio (dimensionless), M_t is the moisture content in the sample at any time t ($kg_{water}/kg_{dry\ matter}$), M_e is the equilibrium moisture content ($kg_{water}/kg_{dry\ matter}$), M_0 is the initial moisture content (kg of water/kg of dry matter). M_e is relatively small during long drying times compared to M_t or M_0. Therefore, in this study, M_e is taken as zero. Thus, the moisture ratio can be simplified as: $MR=M_t/M_0$ [5]. In most cases, the change in fruit mass during the drying process is measured.

The drying rate is an important parameter when studying drying kinetics. To establish the relationship between drying time and drying rate of melon slices, the following equation was determined:

$$DR = \frac{M_{t+\Delta t} - M_t}{\Delta t} \qquad (2)$$

where DR is the drying rate ($kg_{\ water}/kg_{\ dry\ matter} \cdot min$), M_t and $M_t{+}d_t$ are the moisture contents at times t and t + dt respectively, and t is the drying time (minutes) [5].

Figure 4 illustrates the results of the experiments conducted on August 5, 6, and 7, 2024, shown as curves of the change in the mass of the drying melon (in %) and the change in solar radiation (in W/m²) during hourly intervals of the day under the same conditions. It can be seen that the pre-treated melon dries 6 hours faster than the untreated melon. The drying rate of the pre-treated melon on sunny days reaches on average: First sunny day: 2.1 (%/hour), second sunny day: up to 2.4 (%/hour). For the untreated melon, the drying rate decreases and has an average value of: First sunny day: 1.5 (%/hour), second sunny day: 2.4 (%/hour), third sunny day: 1.6 (%/hour) (Figure 6).

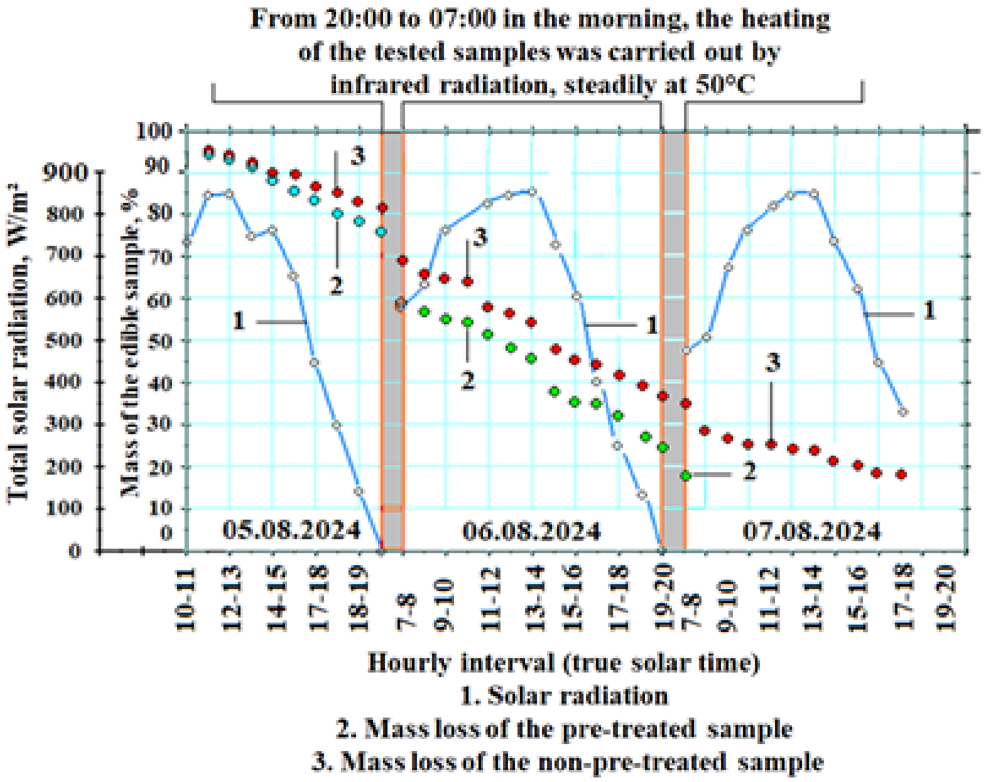

Figure 6. Dependence of solar radiation and change in melon fruit mass on drying time.

Thus, on the second day, the drying rate of untreated melon becomes equal to that of the pre-treated melon. On the first and third days of solar drying, the drying rate of the pre-treated melon fruits is faster than that of untreated fruits. This is explained by the fact that the edible part of the pre-treated fruits contains additional micropores, which facilitate extra evaporation of water from the drying melon, created during the preliminary treatment.

From 8:00 PM on 05.08.2024 to 8:00 AM on 06.08.2024, drying with the IR heater proceeded at a rate of 1.45 (%/hour) for the pre-treated fruits and 1.18 (%/hour) for the untreated fruits. From 8:00 PM on 06.08.2024 to 8:00 AM on 07.08.2024, drying with the IR heater proceeded at a rate of 0.55 (%/hour) for the pre-treated fruits and 0.18 (%/hour) for the untreated fruits. The increase in drying rate of melon fruits is explained by the fact that after preliminary treatment, additional micropores form in the melon slices, which allows water vapor to evaporate freely during drying.

Figure 5 illustrates the change in partial pressure of the vapor-air mixture during the drying process in the recommended setup (MPa). As solar radiation increases, the temperature of heating of the fruits and the humidity of the vapor-air mixture also increase. The concentration of vapor rises, which increases the partial pressure of the vapor-air mixture. The value of the partial pressure was determined based on humidity and temperature data of the vapor-air mixture using an id-diagram. Using the id-diagram, the fraction of water vapor in the vapor-air mixture (g/kg) was also determined. Measured temperature, humidity, fraction of water vapor in the vapor-air mixture, and surrounding environment are presented in Table 1.

From the curve shape of the drying process – the dependence of partial pressure on the time interval of the day – it is clear that with the increase of solar radiation during the day, the partial pressure of the vapor-air mixture pulsates hourly from 0.1 to 0.6–0.65 MPa relative to the partial pressure of the surrounding environment. In this case, the vapor-air mixture is pulsatingly released from the outlet (hole) of the drying cabinet into the environment, creating a pulsating vacuum inside the drying cabinet. Due to the vacuum, water vapor evaporated from deep inside the drying melon fruit is drawn out, leaving the fruit and the drying cabinet (Table 1).

Table 1. Results of measurements of humidity and temperature of the vapor-air mixture and the surrounding environment at the outlet of the drying cabinet.

Time Interval of the Day, hr	Temperature of Air-Vapor Mixture at Chamber Outlet, °C.	Humidity of Air-Vapor Mixture at Chamber Outlet, %	Mass Fraction of Water Vapor in Air-Vapor Mixture, g/kg	Temperature / Humidity of Ambient Air-Vapor Mixture, °C / %
		05.08.2024		
10:00-11:00	44.69	42	25.76	36.1/19.5
11:00-12:00	45.31	41	25.12	36.9/19.4
12:00-13:00	46.75	41	27.94	37.0/18.6
13:00-14:00	44.75	43	26.39	38.9/17.5
14:00-15:00	45.56	46	29.88	39.4/17.1
15:00-16:00	46.63	44.	30.08	38.5/15.8
16:00-17:00	42.00	43	22.44	37.9/14.6
17:00-18:00	41.31	45	22.28	37.0/13.2
18:00-19:00	43.38	45	23.53	36.1/12.9
19:00-20:00	39.09	44	19.49	33.7/12.2
		06.08.2024		
07:00-08:00	34.13	44	14.72	34.0/26.4
08:00-09:00	46.38	46	29.88	34.9/23.7
09:00-10:00	47.75	48	37.77	35.4/20.2
10:00-11:00	49.75	48	38.65	36.3/18.0
11:00-12:00	50.06	45	36.09	36.9/16.1
12:00-13:00	45.69	46	29.88	38.0/15.2
13:00-14:00	46.38	49	31.93	39.8/15.6
14:00-15:00	48.94	49	37.47	38.9/13.0
15:00-16:00	46.44	49	31.93	38.5/12.1
16:00-17:00	48.06	45	35.53	37.5/13.2
17:00-18:00	46.00	40	25.82	37.2/12.2
18:00-19:00	39.31	39	17.22	36.6/12.7
19:00-20:00	40.56	41	20.23	34.1/12.9
		07.08.2024		
07:00-08:00	34.50	42	14.85	34.2/239
08:00-09:00	36.75	42	16.62	34.7/22.1
09:00-10:00	36.75	37	14.60	35.6/19.6
10:00-11:00	40.55	38	17.71	36.4/16.6
11:00-12:00	40.05	41	19.15	37.1/15.8
12:00-13:00	43.06	44	24.27	38.3/14.3
13:00-14:00	49.75	48	38.65	39.8/14.0
14:00-15:00	51.25	49	41.64	38.7/13.6
15:00-16:00	51.19	50	42.55	38.2/12.8
16:00-17:00	50.44	42	35.36	37.3/12.1

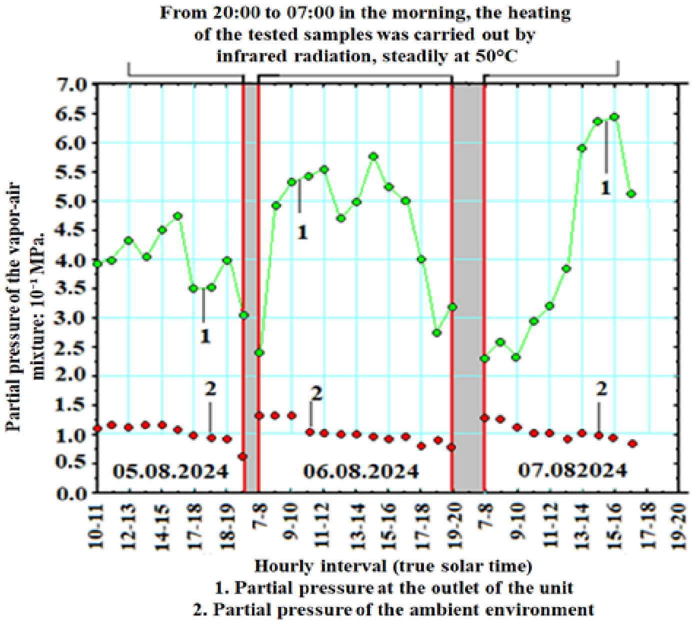

Figure 7. Dependence of the water vapor content in the air-vapor mixture on the time interval of the day

Note that the sizes of the outlet opening installed on the ceiling of the drying cabinet (for releasing the vapor-air mixture into the surrounding environment) and the inlet opening installed at the bottom of the drying cabinet (for atmospheric air intake from the environment) were selected based on the concept of the blackbody model. The linear size of the slit for incoming radiation relative to the linear size of the cavity is determined by the condition ($F_{cavity} \gg F_{opening}$), where the linear size of the cavity D_{cavity} is 10 to 16 times the size of the opening dopening.

Gases such as H_2O, SO_2, NH_3, CO_2, and others emit and absorb energy only in specific wavelength intervals $\Delta\lambda$, located in various parts of the spectrum; for other wavelengths, the gases are transparent. In terms of energy, the main absorption bands for water vapor are at wavelengths 2.2–3.0 μm, 4.8–8.5 μm, and 12–30 μm. Solar radiation covers a spectral interval with frequencies from 10^{14}-10^{12} Hz, and wavelengths from 10^{-6}-10^{-4} nm. As photons pass through the gas volume, some of them are absorbed by gas molecules (water vapor). The photon energy is transferred to the molecules, causing the gas to heat up; this process is the absorption of radiant energy within the gas volume. Only photons with energy hvh\nuhv matching the frequency v\nuv corresponding to the gas absorption bands are absorbed [6]. This phenomenon occurs inside the drying cabinet, especially when the concentration of water vapor becomes sufficiently high.

For validation of the results, Figure 6 shows the finished product, which was spread out after the experimental studies in the proposed household solar-IR heating drying installation (Figure 8).

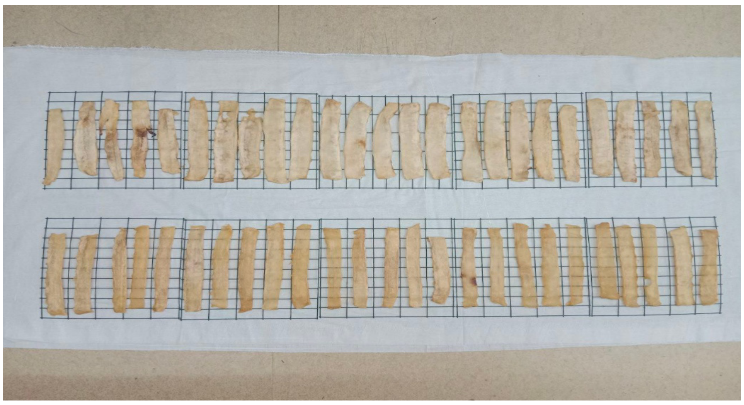

Figure 8. Illustration of the final dried melon product obtained after experimental processing in the proposed household solar-IR drying installation

CONCLUSION AND SUGGESTIONS

It is recommended to carry out a preliminary treatment of melon fruits using inexpensive solar radiation in a greenhouse-type installation for two days. During this process, solar radiation penetrates the edible part of the melon through the skin and creates micropores with a depth of 1.2 cm. This facilitates and accelerates the drying process (reducing the drying time). Preliminary treatment increases the moisture loss of melon by 10.4% of the total weight.

The use of a single exhaust opening in the household solar-IR drying unit creates a natural vacuum due to the pulsating release of the vapor-air mixture. As a result, water vapor is effectively drawn out from the interior (through micropores) of the melon slices. This leads to a 30% reduction in drying time compared to untreated melon slices.

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