DRYING FRUITS AND VEGETABLES IN THE INFRARED FIELD

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Annotation. This article describes the drying of fruits and vegetables in the infrared field. It also provides equipment for drying vegetables and fruits, grains, cereals and other food and non-food materials based on the use of infrared radiation, which is the most promising at present.

Key words: drying, radiation, infrared fields, energy, solid, dry products, technological process, processing.

Introduction. Our independent republic of Uzbekistan is flourishing! The reason for this prosperity is the unique natural and climatic conditions of our region, the industriousness of our people and the gradual transition to a market economy. Traditional drying technologies, such as hot-air convective drying, vacuum drying, microwave drying, freeze-drying, among others, aim to ensure that the food quality and stability are preserved during the storage period, being, at the same time, as efficient as possible. However, so as to fulfill efficiently the drying process, shortening operation times and enhancing product quality, as well as using combined drying technologies in which different sources of energy are involved, are becoming more and more current. In this sense, there is the possibility of assisting the different drying processes with several forms of energy that accelerate transfer of matter from the diverse feed sources. In order to successfully transfer knowledge acquired experimentally from studies on food dehydration into industrial applications, drying kinetics modeling is necessary. Besides, a mathematical model is an important tool used to optimize the management of operating parameters and to simulate the drying processes behavior. These simple models, also known as thin-layer models, allow prediction of mass transfer during dehydration and are applied to simulate drying curves under similar conditions. Convection is the most common mode of heat transfer in drying. Convective drying employs transfer of heat from hot air to the targeted product by convection, and evaporation of water back to the air also by convection. There are many drawbacks associated with convective drying of agricultural products such as longer drying time, uneven product quality, low efficiency, and high-energy consumption. Higher energy consumption in convective drying is associated with the heating of air and then indirect heating of the product with One of the main requirements of a market economy is the modernization of the production of exportable

products and the reduction of the cost of the finished product. To do all this, specialists require top-level knowledge. Drying in food and non-food agro-industrial products is a unitary operation of great importance both at a business level and at an academic and research level, since the sectors of application are quite broad, such as fruit, flowers, grains, meat, dairy, spices, and dyes. It is also an operation before many size reduction operations, increasing the useful life of the products by eliminating the highest available water content and therefore reducing costs in product transportation freight.

In terms of production of fruits and vegetables, fruits and grapes, the Republic of Uzbekistan occupies a leading position among the CIS countries. The natural and climatic conditions of our Republic make it possible to obtain several harvests of many types of vegetables and other crops during the year. Infrared drying of food products, as a technological process, is because the water contained in the product actively absorbs infrared radiation of a certain wavelength. However, the fabric of the dried product does not absorb it, so moisture can be removed at a low temperature (40-60 degrees Celsius), which makes it possible to almost completely preserve vitamins, biologically active substances, natural color, taste and aroma of the products undergoing drying.

Materials and methods. Equipment for drying vegetables and fruits, meat and fish, grains, cereals and other food and non-food materials based on the use of infrared radiation is the most promising at present. Infrared drying is the most relevant and promising now is the drying of food using infrared radiation. Infrared radiation from solids is due to the excitation of the molecules and atoms of the body due to their thermal motion. When an irradiated body, the thermal motion of atoms and molecules increases in it, which causes it to heat up, absorbs infrared radiation.

Taking into account that the drying process is a very important operation for the conservation of food and the quality of the final product. Which leads to innovate in new drying processes or evaluate the different technologies that exist to determine which is the most appropriate, taking into account the type of product and the process to which it will be submitted after the drying to ensure the higher performance of the product and longer duration

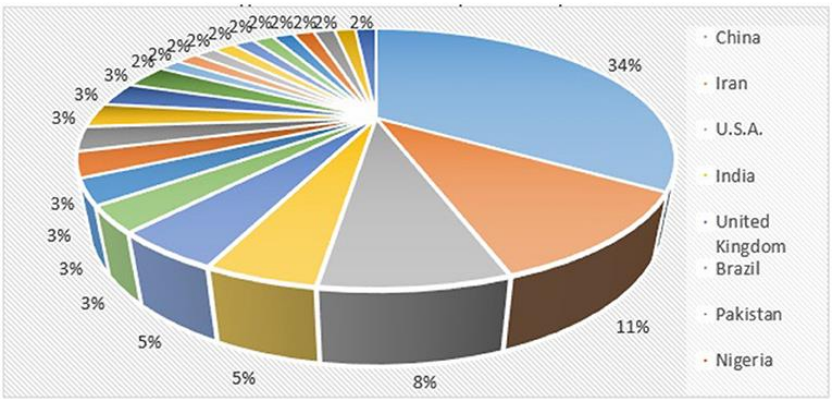

Figure 1. Countries that produced publications. Source: the authors.

The transfer of energy occurs from a body with a large potential for heat transfer to a body with a lower potential. For foodstuffs, the penetration depth of infrared rays reaches 6 - 12 mm. A small part of the radiation energy penetrates to this depth, but the temperature of the layer lying at a distance of 6-7 mm from the surface of the material grows much more intensively than when heated by the convective method. Short-wave infrared rays have a stronger effect on food products, both due to the greater penetration depth and more effective effect on the molecular structure of products. Drying products using this technology allows you to keep the content of vitamins and other biologically active substances in a dry product at the level of 80-90% of the original raw material. With a short soak (10-20 minutes), the dried product restores all its natural organoleptic, physical and chemical properties and can be used fresh or subjected to any kind of culinary processing. Drying products (drying vegetables and fruits, drying fish, meat, cereals, etc.) in this way makes it possible to produce a variety of instant food concentrates: first, second, third courses, snacks, cereals, cereals, vegetable and fruit powders, which are used in the baking, confectionery industry, as a component of dry mixes of baby food.

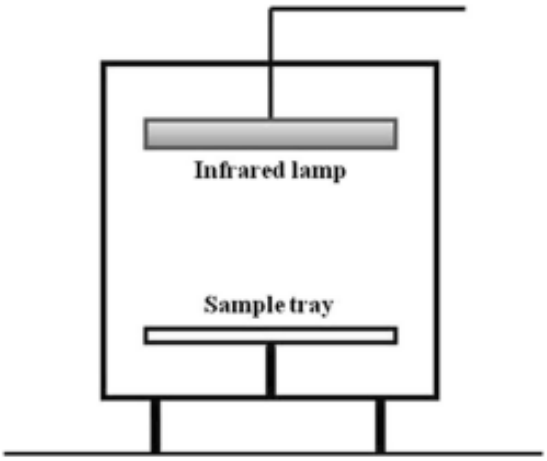

Fig. 2 Schematic diagram of infrared drying

Compared to traditional drying, vegetables processed by infrared drying after recovery have a taste that is as close as possible to fresh. In addition, infrared dried powders have anti-inflammatory, detoxifying and antioxidant properties. Application of electromagnetic radiation together with hot air is considered more effective as compared with hot air or radiation heating alone, as it gives a synergistic effect. The materials exposed to IR radiation absorb the radiation and results in increased molecular vibration, which develops heat in the material at the surface as well as in the internal layers at the same time. IR heating enhances the rate of moisture movement toward the surface and the airflow removes the moisture from the surface, lowers the surface temperature, and increases mass transfer. The use of products that have undergone infrared drying in the dairy, confectionery, and baking industries makes it

possible to expand the range of food products with specific taste properties. Infrared drying produces products free of preservatives and other foreign substances, these products are not exposed to harmful electromagnetic fields and radiation. Infrared radiation itself is harmless to the environment and humans, as well as equipment for drying fruits, equipment for drying vegetables, meat, fish, grains, cereals, etc. using it. The dried product is not critical to storage conditions and is resistant to the development of micro flora. Up to a year, dry products can be stored without special containers (at low ambient humidity), while the loss of vitamins is 5-15%. Dry food can be stored in an airtight container for up to two years. Drying products reduces their volume by 3-4 times, and in mass by 4-8 times compared to the feedstock (depending on its type). The dried product restored by soaking in water can be subjected to any traditional culinary treatment: boiling, frying, stewing, and can also be eaten raw or dry. However, not only the properties of the resulting dry products deserve attention, but also the features of equipment for drying products using infrared radiation and technological processes based on this principle. The technology of infrared drying of wet products allows almost 100% use of the energy supplied to the dry product. Since the water molecules in the product absorb infrared rays and, being excited, heat up, that is, unlike all other types of drying, the energy is supplied directly to the product water. Which achieves high efficiency, with this heat supply, there is no need to significantly increase the temperature the product undergoing drying, and the drying process can be carried out at a temperature of 40 - 60 degrees. Such drying of the product gives two advantages: firstly, at such temperatures the product is maximally preserved: cells are not torn, vitamins are not killed, sugar is not caramelized; secondly, low temperatures do not heat the drying equipment, that is, there is no heat loss through the walls, ventilation. At the same time, infrared radiation at a temperature of 40-60 degrees allows you to destroy the entire micro flora on the surface of the product, making the dried product practically sterile.

Conclusion. In addition to all of the above, drying equipment is universal and allows you to process any plant and animal products to obtain quickly regenerated dry products. Vegetable drying equipment, fruit drying equipment, like all drying equipment used in this type of drying vegetables and fruits and other products, has the following advantages: the lowest specific energy consumption per 1 kg of evaporated moisture; less than 1 kWh/kg (two times less than any dryers); drying of products is carried out at a low temperature - 50-60 degrees. Celsius; drying of products is carried out at a high speed - 30-200 minutes; simplicity and reliability, low price and high payback.

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