Technical science and innovation

Volume 2021 | Issue 2 Article 7

7-26-2021

EXPERIMENTAL STUDY OF DRYING YACON TUBERS

U K. Khujakulov
Tashkent State Technical University named after Islam Karimov, 100095, Tashkent, Uzbekistan,
azamatusenov1111@gmail.com

Sh A. Sultanova
Tashkent State Technical University named after Islam Karimov, 100095, Tashkent, Uzbekistan,
sh.sultanova@yahoo.com

J E. Safarov
Tashkent State Technical University named after Islam Karimov, 100095, Tashkent, Uzbekistan,
jasursafarov@yahoo.com

Recommended Citation

Khujakulov, U K.; Sultanova, Sh A.; and Safarov, J E. (2021) "EXPERIMENTAL STUDY OF DRYING YACON TUBERS," *Technical science and innovation*: Vol. 2021: Iss. 2, Article 7.
DOI: https://doi.org/10.51346/tstu-01.21.2-77-0125
Available at: https://btstu.researchcommons.org/journal/vol2021/iss2/7

UDC 5995

EXPERIMENTAL STUDY OF DRYING YACON TUBERS

U. K. Khujakulov, Sh.A. Sultanova, J.E. Safarov
Tashkent State Technical University, 100095, Tashkent, Uzbekistan

Abstract. *This study discusses the method and experimental drying unit for drying yacon tubers at different temperatures. And also the scheme of experimental drying unit is given, which controls temperature, speed of warm air and shows the mass of dried material. The cross-sectional area of the flow in the tunnel is 20×20 cm, the thermal air passed horizontally through a chute with holes and a surface area of 12×12 cm. The exhaust gas did not circulate in this experiment. The accuracy of the temperature control system was 0.1 °C, the weight control system 0.1 g. The variation of moisture ratio depending on the drying time of yacon took place at temperatures of warm air of 65, 70, 75, 80 and 85 °C, cut to a thickness of 4 mm and air speed of 1.05 m/s. The air temperature was controlled by a proportional controller. The variation of the drying speed as a function of moisture content is shown in Fig.2-7. The curves show that the drying rate decreases continuously with increasing time.*

Keywords: *yacon, enzyme, inulin calorie content, moisture content, diffusion coefficient, slice.*

INTRODUCTION. Yacon (*Latin: Smallanthus sonchifolius*) is a species of perennial herbaceous plant in the genus Smallanthus in the family Asteraceae. It comes from the Andes. The yacon is grown for its sweet, crunchy roots. Yacon grows in a variety of soil conditions (sod-podzolic and gray-forested soils, leached chernozem), but the best result is achieved on well-tilled and drained soil. Yacon can grow in a wide range of positive temperatures, from +12 °C to +40 °C. Optimal for growing yacon are temperatures from +18 °C to +30 °C. The above-ground part of the plant is damaged at low positive temperatures (+3...+1 °C), rhizomes can withstand small frosts [1].

Root tubers of yacon have the potential to be a dietary food. The human body lacks enzymes that hydrolyze inulin and its derivatives, so yacon passes through the digestive tract without being broken down, which means it is low in calories. This may appeal to dieters and diabetics. In this respect, yacon is much more valuable than topinambur. From Colombia to Argentina, children in particular consider yacon root tubers a special delicacy; in some areas it is grown in almost every family [2].

MATERIAL AND METHODS. An experimental drying unit for drying yacon slices, which controls the temperature and speed of the thermal air and indicates the mass of the drying material. The tunnel dryer basically consisted of a centrifugal fan for air flow, an electric heater, and an electronic proportional controller that controlled the temperature and speed of the thermal air and indicated the mass of the drying material. The air velocity was controlled by a valve. The air, having passed through the heating element, is heated to the preset temperature and directed into the drying tunnel [3, 4].

The air temperature was controlled by a proportional regulator. The cross-sectional area of the flow in the tunnel is 20×20 cm, the thermal air was passed horizontally through a tray with holes and a surface area of 12×12 cm [5-7]. The exhaust gas was not circulated in this experiment. The accuracy of the temperature control system was 0.1 °C, the accuracy of the mass control system was 0.1 g. The schematic diagram of the setup is shown in Fig.1.

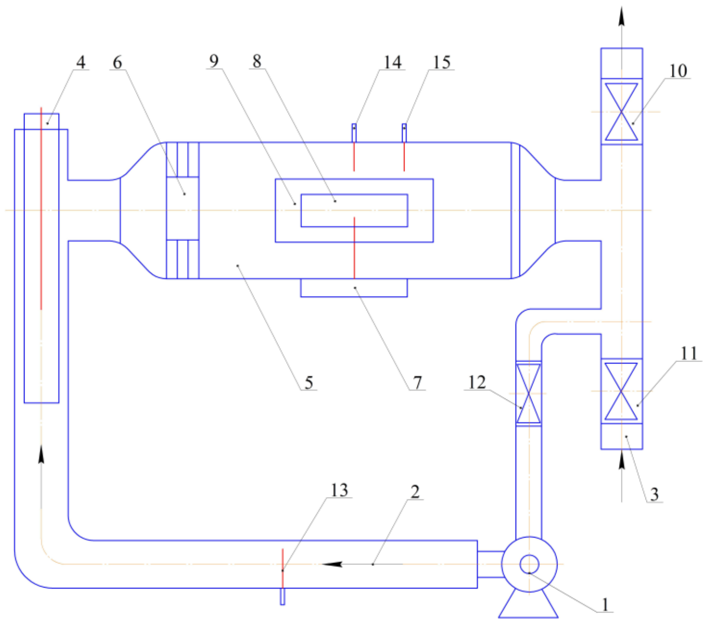

Fig. 1. Principle diagram of the installation:
1 – discharge fan; 2 – pipe; 3 – inlet air; 4 – heater; 5 – tunnel dryer; 6 – equal blower; 7 – weight sensor; 8 – tray for material; 9 – inspection window; 10, 11 and 12 – blower valve; 13 – pressure gauge; 14 – temperature sensor for dry thermometer; 15 – temperature sensor for wet thermometer.

The change in moisture ratio as a function of the drying time of yacon at heat air temperatures of 65, 70, 75, 80 and 85 °C, sliced to a thickness of 4 mm, and air speed of 1.05 m/s are shown in Fig.2. Increasing the drying air temperature resulted in shorter drying times. Changes in drying rate with humidity are shown in Fig.3. From the curves, an important effect of air drying temperature on the drying rate can be observed [8, 9]. This shows that the drying rate decreases continuously with increasing time. There is almost no constant drying rate on these curves, and the entire drying process occurred during a period of decline [10].

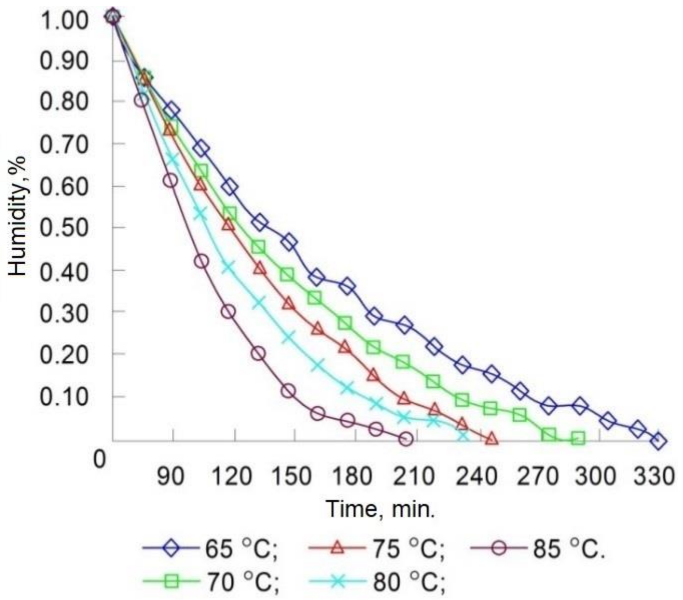

Fig. 2. Yacon drying curves for different temperatures at 1.05 m/s and a thickness of 4 mm

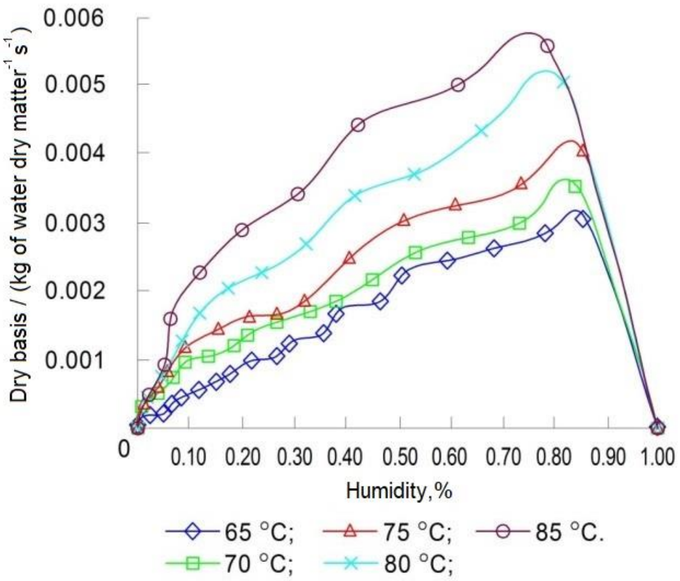

Fig. 3. Yacon drying speed curves for different temperatures at 1.05 m/s and a thickness of 5 mm

Moisture removal inside the yacon slices at 85 °C was higher and faster than at the other temperatures investigated during the study, because the migration of moisture to the surface and the rate of evaporation from the surface into the air decreased with decreasing product moisture and thus the drying rate was clearly reduced. Shorter drying times were observed at higher temperatures, which increased the drying rate. This increase is due to increased heat transfer potential between air and yacon slices, which contributes to evaporation of water from yacon slices [11, 12].

Fig.4 shows the drying characteristics at 75 °C for yacon sliced to a thickness of 4 mm and at air speeds of 0.53, 0.70, 0.84, 1.05 and 1.23 m/s. Fig.5 shows the change in drying speed as a function of humidity at the same air velocity. It is clear that humidity and drying rate continuously decrease with drying time. As shown in Fig.4, there was also no period of constant drying speed, and the entire drying process occurred during a period of falling speed.

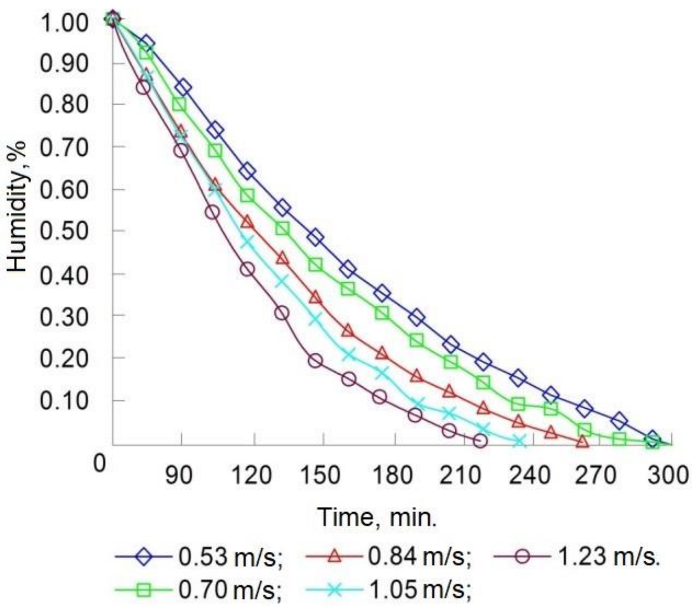

Fig. 4. Drying curves of yacon for different air speeds at 75 °C and a thickness of 4 mm

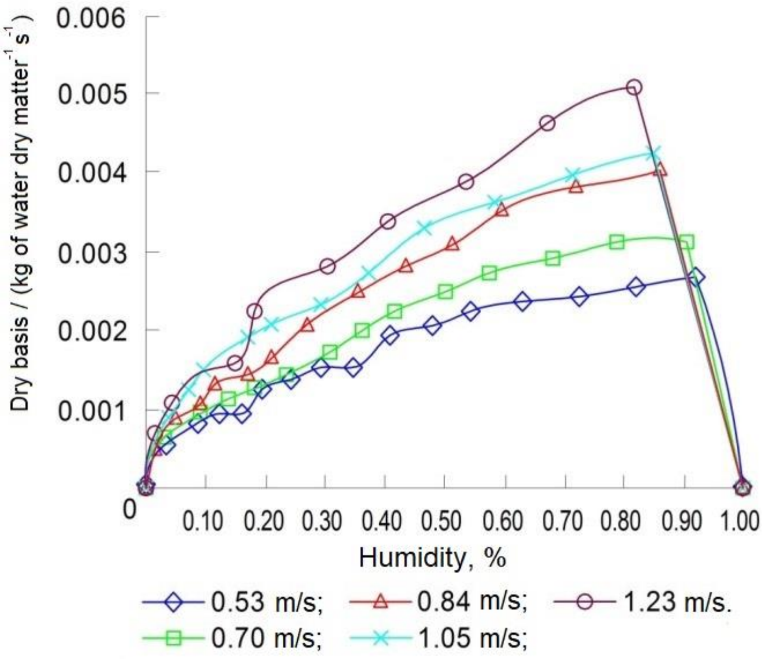

Fig. 5. Drying rate curves of yacon for different air speeds at 75 °C and a thickness of 4 mm

Moisture removal at 1.23 m/s was higher and faster than at the other air speed studied. Shorter drying times were observed at higher air speeds, which increased the drying rate. This increase is due to the increased convective heat transfer coefficient and quality transfer coefficient between the air and yacon slices, which promotes evaporation of water from the yacon slices [12-13]. The effect of drying air velocity is significant at the beginning of the process, implying that evaporation initially occurs at the surface, so it is more directly affected by air velocity. The initial surface evaporation is gradually replaced by an evaporation front that recedes inside the solid. Thus, the predominance of air velocity is replaced by the process of moisture diffusion, which becomes the most important factor.

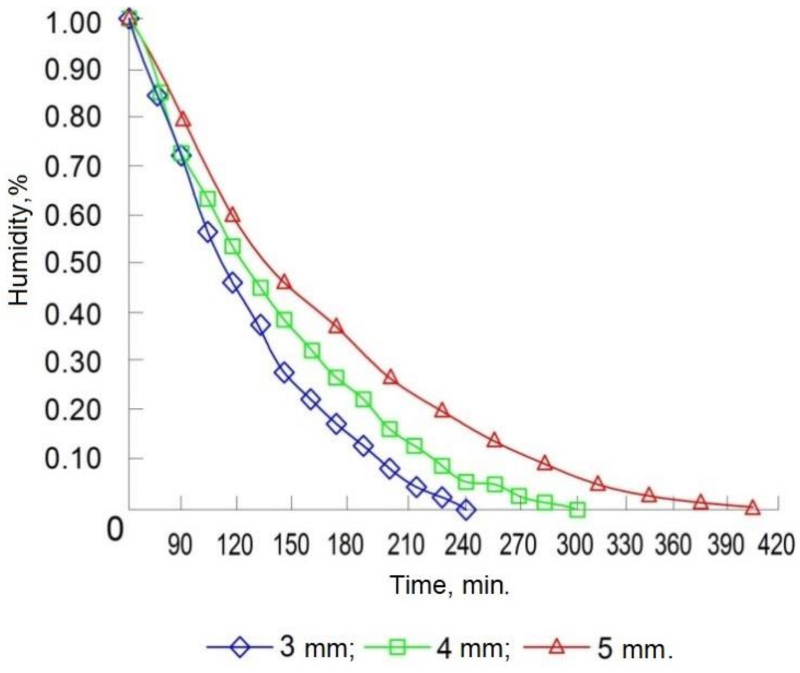

Fig. 6. Drying curves of yacon for different thicknesses at 75 °C and a speed of 1.05 m/s

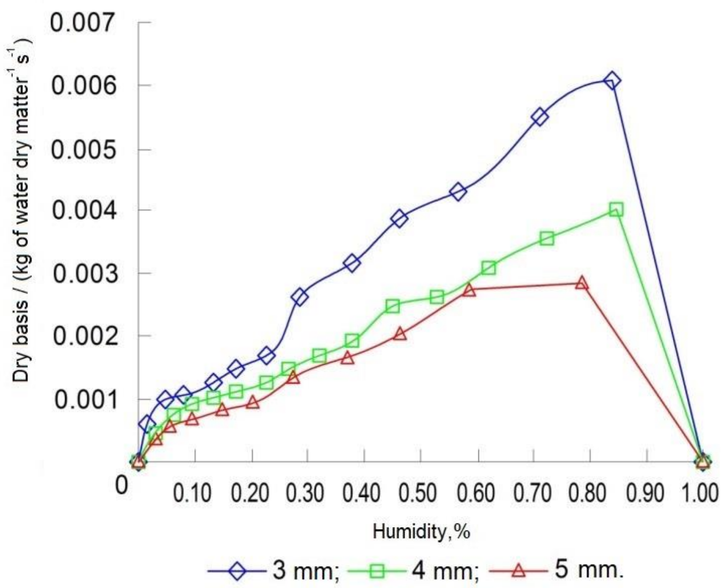

Fig. 7. Yacon drying speed curves for different thicknesses at 75 °C and a speed of 1.05 m/s

Fig.6 shows the drying characteristics at 75 °C and an air speed of 1.05 m/s for thicknesses of 3, 4 and 5 mm. Fig. 7 shows the variation of the drying speed as a function of humidity at the same thickness. Similar results for air velocity are observed. Moisture removal at the 3 mm thickness was higher and faster than at the other thickness studied. A shorter drying time was observed at the lower thickness, which increased the drying rate. This increase is due to the reduced quality transfer resistance of the yacon slices, which promotes the migration of water from inside to surface transfer from the yacon slices [14].

RESULTS. The values of $D_{eff.}$ ranged from 5.7091×10^{-10} to 1.3484×10^{-9} $m^2\cdot s$ at 65-85 °C for a shear thickness of 4 mm and 1.05 m/s rates ranged from 6.7735×10^{-10} to 1.2360×10^{-9} $m^2\cdot s$ at air speeds of 0,53-1.23 m·s for 4 mm shear thickness and 75 °C temperature, and a range of 4.2452×10^{-10} to 1.2112×10^{-9} $m^2\cdot s$ for 3-5 mm thickness at 75 °C and 1.05 m·s velocity, respectively. It was observed that the $D_{eff.}$ values increased significantly with increasing drying temperature, air velocity, and thickness. The effective moisture diffusion coefficient was related to moisture concentration, except for temperature, when the samples were dried at higher air speed, this would increase the quality diffusion coefficient, leading to a better diffusion rate, the moisture concentration at the material surface was accelerated to reduce, the internal moisture content of the material was promoted to spread the form from inside to outside, and thus the $D_{eff.}$ was increased [15].

CONCLUSION. The effect of drying temperature, thermal air velocity, and yacon slice thickness on the drying characteristics of yacon slices was studied in a tunnel dryer with forced convection. Drying occurred during a period of falling velocity, and no constant rate of the drying period was observed. The results showed a change in moisture content with drying time in the temperature range from 65 to 85 °C. The $D_{eff.}$ values for drying at 65-85 °C, an air velocity of 1.05 m/s, and a yacon slice thickness of 4 mm ranged from 5.7091×10^{-10} to 1.3484×10^{-9} $m^2\cdot s$. The activation energy of moisture diffusion was 43.36 kJ/mol.

References:

1. Kononkov P.F., Gins M.S., Gins V.K., Sidorova N.V., Chekmarev P.A., Mel'nik L.S. Introduktsiya yakona v Rossii: nauch. izdaniye. - M.: FGNU «Rosinformagrotekh», 2011. -140 s.
2. Safarov J.E., Sultanova Sh.A., Khujakulov U.K., Samandarov D.I. Studies drying process products. // International Journal of Advanced Science and Technology. Vol.29, №9s. 2020. pp.5823-5828.

3. Khuzhakulov U.K. Study of the drying process of yacon tubers. International conference "Innovative ways of solving urgent problems of the development of the food and petrochemical industry." Bukhara, 2020. Volume №1. –S.214-216.
4. Thorvaldsson K., Janestad H. A model for simulteneous heat, water and vapour diffusion. Journal of Food Engineering, 40:167–172, 1999.
5. Chagin O.V., Kokina N.R., Pastin V.V. Oborudovaniye dlya sushki pishchevykh produktov. Ivanovo, Ivan. khim. - tekhnol. un-t. 2007. -138 s.
6. Luikov A.V. System of differential equations of heat and mass transfer in capillary-porous bodies (review). International Journal of Heat and Mass Transfer, 18:1–14, 1975.
7. Veli`c D., Planini`c M., Tomas S., Bili`c S. Influance of air velocity on kinetics of convection of apple drying. Journal of Food Engineering, 64:97–102, 2004.
8. https://link.springer.com/article/10.1007/s00231-018-2334-2
9. Nikitina L.M. Termodinamicheskiye parametry i koeffitsiyenty massoperenosa vo vlazhnykh materialakh. −M.: Energiya, 1968. −499 s.
10. Khujakulov U.K. Kinetic dependences of the drying process. International scientific and technical journal «Innovation technical and technology». Vol.1, №.1. 2020. pp.15-21.
11. Sunil Verma, Khujakulov U.K., Dadayev G.T., Safarov J.E. Studying the kinetics of drying. International conference «Innovative ways of solving urgent problems of development of the food and petrochemical industry». Bukhara, 2020. Vol.1. –S.99-102.
12. Raxmanova T, Sultanova Sh.A., Safarov J.E., Capanoglu E Investigation of the moisture binding forms in plant raw materials and thermal characteristics determination Technical science and innovation: Vol. 2020 : Iss. 4, Article 1.
13. Samandarov D.I., Safarov J.E. Kinetiki sushki i effektivnost' diffuzii vlagi i yeye vliyaniya na udel'noye energopotrebleniye. Mezhdunarodnaya nauchno-prakticheskaya konferentsiya "Sovremennyye problemy innovatsionnogo razvitiya nauki, obrazovaniya i proizvodstva". Andizhan, 2020. -S.67-72.
14. Ceylan I., Aktas M., Dogan A. Mathematical modelling of drying characteristics of fruits. Applied Thermal Engineering, 27:1931–1936, 2007.
15. Khujakulov U.K., Safarov J.E. Research yakon tubers (Polymnia sonchifolia) as the object of study. // International journal of advanced research in science, engineering and technology. –India, 2019. Vol. 6, Issue 12, p.12114-12118.
16. Khujakulov U.K. Obtaining biologically active substances in order to use them as antioxidant preparations from yacon. International scientific and practical conference "Problems and prospects of innovative machinery and technologies in the agri-food sector". Tashkent, 2020. –p.486-487.

UDC 629.331

DETERMINING THE CONGESTION TIMES AND ENERGY SAVING CHARACTERISTICS OF A VEHICLE IN CITY DRIVING CYCLE THROUGH AN INTELLIGENT TRANSPORT SYSTEM

S.S. Yusupov[1], J.Sh. Inoyatkxodjaev[2]

[1]Tashkent State Technical University named after Islam Karimov,
100095, University St. 2, Tashkent, Uzbekistan
[2]Turin Polytechnic University in Tashkent, 17 Small Ring Road, Tashkent

Abstract: *Traffic congestion and other related issues occur in mega-cities where traffic is dense. It is therefore recommended to assure the energy-saving properties of the car engine during periods of congestion. Ensuring energy saving features by using the "Intelligent start-stop*