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Drying of Idared Apples Cut Into Cubes

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SUMMARY

The results of convective drying of Idared apples are presented in this paper. After washing and cleaning, the fruits were cut into 8 mm cubes and then immersed into a 0.1 percent solution of L – ascorbic acid to prevent enzymatic browning.

At the beginning of convective drying, the air temperature varied from 80 to 98^0C, while in the end it was 50 to 68^0C. The air speed of 2.0 m/s and the drying time of 160 minutes for 250.0 g sample produced satisfactory results in organoleptic characteristics and rehydration ratios of the investigated dried samples.

The drying curves (water content during drying) for all the samples were modelled by the following polinomial regression:

$$y = 89.408 - 0.945\ x + 0.003\ x^2,$$

where:

y – water content (%wb);

x - drying time (min)

with $r = -0{,}998$; $R^2 = 0.995$.

Testing of veriations in the drying curves of the investigated samples showed no statistically significant differences, with the probability of 99.99%.

KEY WORDS

cubes, convection, drying, Idared

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Sušenje jabuka sorte Idared rezane u kocke

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SAŽETAK

U radu su dati rezultati konvekcijskog sušenja jabuka sorte Idared. Nakon pranja i čišćenja plodovi su rezani u kockice veličine 8,0 mm i potapani u 0,1%-tnu otopinu L-askorbinske kiseline, da se spriječi encimatsko posmeđivanje.

Sušenje kockica rađeno je konvekcijom zagrijanog zraka u koji je u početku imao temperaturu od 80-98°C, a pred kraj sušenja 50-68°C. Brzina zraka od 2,0 m/s i vrijeme sušenja od 160 minuta za 250,0 grama uzorka dalo je zadovoljavajuće rezultate senzoričkih karakteristika i indeksa rehidracije u analiziranim uzorcima nakon sušenja.

Sadržaj vlage tijekom sušenja dat je krivuljom sušenja koja je za sve analizirane uzorke modelirana polinomom regresije koji glasi:

$$y = 89{,}408 - 0{,}945x + 0{,}003\ x^2$$

gdje je:

y - postotak vlage;

x - vrijeme sušenja (min),

uz $r = -0{,}998$; $R^2 = 0{,}995$

Testiranjem razlika u krivuljama sušenja istraživanih uzoraka nisu ustanovljene statistički signifikantne razlike, uz vjerojatnost od 99,99%.

KLJUČNE RIJEČI

Idared, kockice, konvekcija, sušenje

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INTRODUCTION

Fruit preservation by drying is one of the oldest ways of processing. A fresh apple contains from 83.0 to 85.0% (Smock and Neubert, 1950) of water which can be reduced by drying to 16 - 20% (Burić and Berki, 1978). In this way the growth and development of microorganisms is prevented.

In mainland Croatia, fruit is dried artificially, that is, by exposing it to heated air flows in a dryer. Heated air laps against apple cubes and, after absorbing the water which evaporates from a sample, it is taken away from the dryer. Due to this process, apple cubes change their physical, chemical and organoleptic properties.

The average yield of 47 to 70 thousands of tons in the period from 1990 to 1995 (SLJE 1996), and the average per capita consumption of 16 kg make apples a fruit leader in Croatia.

The World Health Organization recommends an annual per capita consumption of 35 kg of apples since they are rich in various chemical components.

Apart from being consumed fresh, apples can also be processed into different apple products, such as soft drinks, vinegar, dried products and many others.

A reduction in water content in dried apple cubes results in an increase in dry matter and in a higher energy level as well

REFERENCES

According to references, apples with lighter flesh and a more balanced correlation between acids and sugars in a finished product are more suitable for drying.

Autumn and winter varieties are most often industrially processed thanks to their ample yield and chemical composition (R. Gliha, 1978; Nadica Dobričević, 1996).

At the beginning of drying, air temperature varied from 70 to 90^{0}C (Burić and Berki, 1978; Wilhelm et al., 1981; Goffings, 1987; Chiang and Petersen, 1987; Nevenka Vrač, 1990; Nadica Dobričević, 1996). At the end of drying, air temperature was reduced to 50 – 65.5^{0}C (Burić and Berki, 1978; Wilhelm et al., 1981; Goffings, 1987 and Nadica Dobričević, 1996).

Air-flow speed varied from 1.3 to 4.0 m/s (Chiang and Petersen, 1987; Karathanos et al., 1995; Nadica Dobričević, 1996).

A dried product with its organoleptic characteristics and rehydratation ratio must comply with the nutrient requirements for such products. In other words, the basic parameters of quality must not be disrupted in the course of drying.

MATERIALS AND METHODOLOGY

Idared apple fruits were picked at an optimal harvest time and then put in cold store at temperature from 0 to 2^{0}C and relative air humidity from 90 to 92%. The measurements of hardness, starch content, outside colour and refractometric soluble dry matter confirmed that the fruits were ripe enough to be preserved by drying.

After washing and removing the epidermis, the fruits were cut into 8.0 mm cubes which were then immersed into a 0.1 percent L - ascorbic acid to prevent enzymatic browning. The solution temperature was 15^{0}C and the solution time 3 minutes.

Thus prepared sample was tested for water content (w_1 in percentage terms) in accordance with "Methods of chemical and physical analyses for fruit and vegetable quality control", *Službeni list* (the Gazette) 29/1983.

Drying was carried out on a RETSCH TG1 laboratory dryer.

The sample whose size varied from 248.8 to 250.5 grammes was exposed to drying for 120 minutes and then it was being cooled by the surrounding air for 40 minutes. Drying was conducted at two levels of temperatures: they varied from 80 to 98^{0}C in the first stage, and from 50 to 68^{0}C during the second.

In the beginning, the air speed was 2.0 m/s, and later on it was reduced to 1.0 m/s.

After drying, the samples were stored in glass containers and when the process of homogeneization was over, their water content was determined (w_2).

The quality of drying was assessed by rehydratation ratios and the evaluation of organoleptic characteristics.

RESEARCH RESULTS AND DISCUSSION

Drying of Idared apples, cut into cubes, was repeated ten times. Table 1 shows the average water content in fresh and dried cubes, and the sample weight as well.

The results obtained show significant increase in dry matter content, on average from 12.77% in fresh cubes to 81.67% in dried ones, which is 6.4 times higher. This increase in dry matter content ensures the quality of a stored product.

Table 1. Average water content (wb) in fresh and dried cubes

Parameters	x	s	CV (%)	s_x	Interval estimates
Water content in fresh cubes w_1 (%)	87,23	0,28	0,30	0,09	87,03 ÷ 87,44
Sample weight (g)	249,97	0,55	0,21	0,17	249,59 ÷ 250,35
Water content in dried cubes w_2 (%)	18,33	1,32	6,84	0,42	17,38 ÷ 19,28

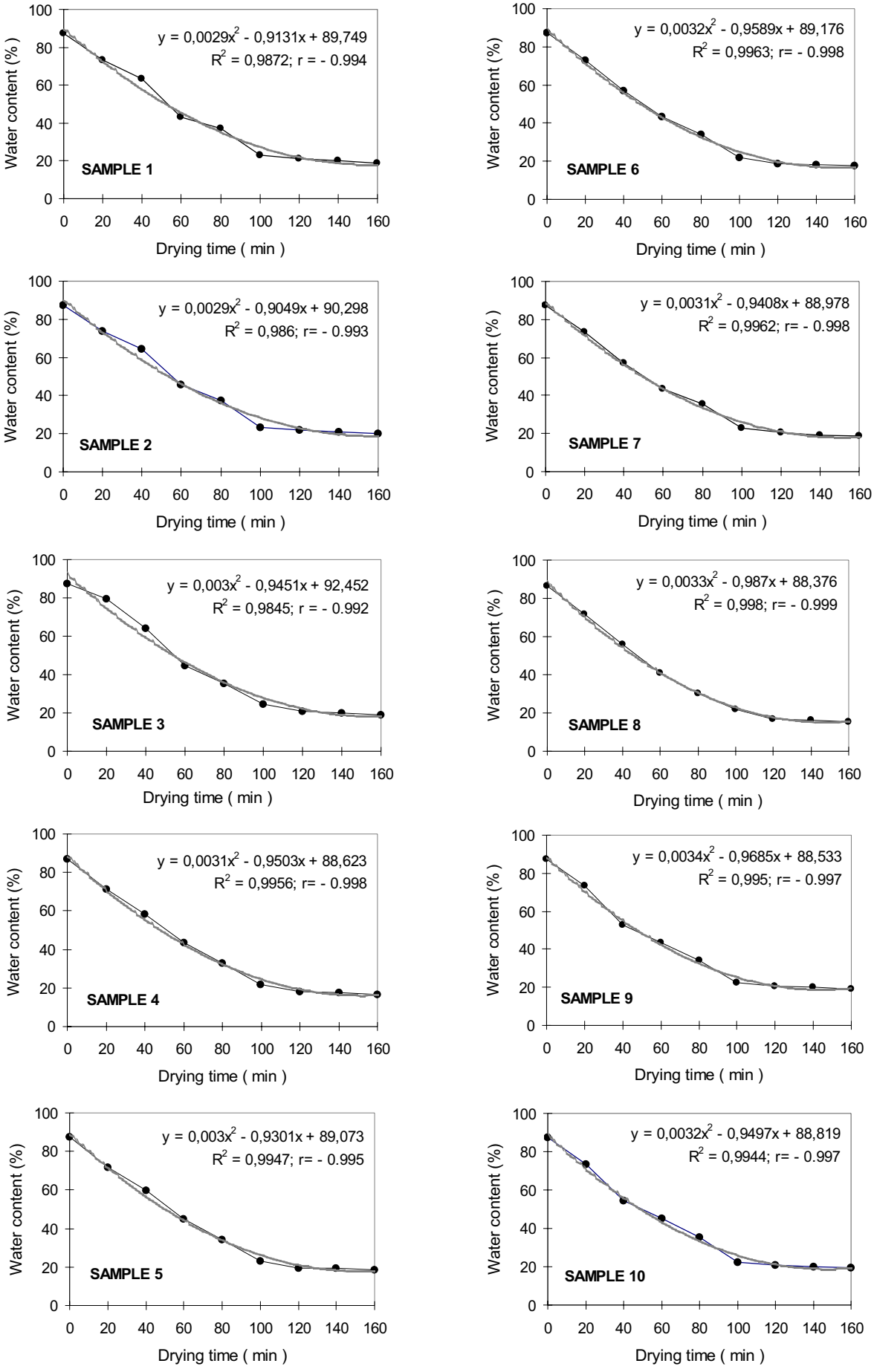

Figure 1. Drying curves of sample 1-10

With the probability of 95%, water content in fresh cubes can be found at intervals from 87.03 to 87.44%, whereas in dried cubes they are at intervals from 17.38 to 19.28 %.

The figure 1 shows the drying curves of sample 1- 10 which testifies to the reduction in water content in the course of drying.

The results of drying Idared apples cut into cubes, presented by the drying curves, show a high correlation of water evaporation throughout the process of drying, which can be supported by the high values of correlation coefficient r = -0.998 and of determination coefficient R^2 = 0.995. Testing of variations in the drying curves of all the samples, with the probability of 99.99%, showed no statistically significant differences.

Table 2. Average rehydratation ratios

	x	s	CV (%)	s_x	Interval estimates
Rehydration ratios	4,02	0,43	10,08	0,14	3,70 ÷4,34

Table 2 shows rehydratation ratios whose values were determined in the samples after drying.

With the probability of 95%, rehydration ratios lie at intervals from 3.70 to 4.34, thus producing satisfactory results in the dried cubes.

The organoleptic characteristics of colour, taste, smell and firmness received high marks.

CONCLUSION

Idared apples cut into 8 mm cubes were evenly exposed to convective drying. At the beginning of convective drying, the air temperature varied from 80 to 98^{0}C,

while in the end it was 50 to 68^{0}C. The air speed of 2.0 m/s and the drying time of 160 minutes for 250.0 g sample produced satisfactory results in organoleptic characteristics and rehydration ratios of the investigated dried samples.

The drying curves (water content during drying) for all the samples were modelled by the following polinomial regression:

$$y = 89.408 - 0.945\ x + 0.003\ x^2,$$

with $r = -0.998$; $R^2 = 0.995$.

Testing of variations in the obtained drying curves, with the probability of 99.99%, showed no statistically significant differences.

Dry matter content increased by 6.4 times on average (% DM after drying / % DM before drying).

Rehydration ratios and organoleptic characteristics resulted in satisfactory marks for dried Idared apples, cut into cubes.

REFERENCES

Burić, O., Berki, F., 1978: Suška plodov i ovošej, Pišćevaja promišljenost, Moskva.

Chiang, W.C., Petersen, J.N., 1978: Experimental measurement of temperature and moisture profiles during apple drying. Drying tech. 5, 25-49.

Dobričević, Nadica, 1996.: Utjecaj konvekcijskog postupka sušenja na kakvoću kriški jabuka Idared i Božićnica, Doktorska disertacija, AF Zagreb

Gliha, R., 1978: Sorte jabuka u suvremenoj proizvodnji. Radničko Sveučilište "Moša Pijade", Zagreb.

Goffings, G., 1987: Quelques methodes speciales de transformation des pommes. Fruit belge 418, 133-135.

Karathanos, V.T., Kostaropoulos, A.E., 1995.: Air-drying kinetics of osmotically dehydrated fruits. Drying tehnology 13(5-7), 1503-1521.

Smock, R.M., Neubert, A.M., 1950: Apples and apple products. Interscience Publishers, INC, New Yobrk.

Vrač, Nevenka, 1990: Utjecaj procesa sušenja u fluidiziranom sloju na pojedina kemijska, fizikalna i organoleptička svojstva jabuke, magistarski rad, PBF, Zagreb.

Wilhelm, L.R., Collins, J.L., Mullins, C.A., 1981: Factors Associated with Drying Apples. Tenness, Farm and Home Sci. 119, 28-30.

Službeni list, 1983: Metode obavljanja kemijskih i fizikalnih analiza radi kontrole kakvoće proizvoda od voća i povrća 29, Zagreb.

Statistički ljetopis, 1996: Republika Hrvatska. Državni zavod za statistiku, Zagreb.