COST-EFFECTIVENESS ASSESSMENT OF DRIED RASPBERRY PRODUCTION

OCENA ISPLATIVOSTI PROIZVODNJE SUŠENE MALINE

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ABSTRACT

This paper analyses different cost-effectiveness aspects of dried raspberry production. The drying performed was convective using straw as the main source of heat. A relatively small dryer, favorable for family farm production, was used with a capacity of 400 kg of raw material per day. The duration of raspberry drying is 15 days, whereas the duration of fruit drying season amounts to 135 days a year. Fresh raspberries, as the main raw material, have the greatest impact on the production costs of dried raspberry, with a share of 63.7 %, followed by significant packaging costs (28.3 %), labor costs (4.73 %) and energy consumption costs (1.21 %). Such cost structure primarily results from using straw as the main energy source, inasmuch as straw is considerably less expensive than other available fuels. The analysis shows that in the 15-days production of dried raspberries is realized a profit of around 6,210 €, which can be considered as a very good financial result. Furthermore, the economics of production coefficient is 1.41 and the rate of production accumulation is 28.8 %.

Key words: dried raspberries, costs, cost-effectiveness, comparative analysis.

REZIME

U radu se analiziraju različiti aspekti isplativosti proizvodnje sušene maline. Razmatraju se samo tehnološke faze sušenja, pakovanja i distribucije, ali ne i proizvodnje sveže maline. Istraživanje se odnosi na konvektivno sušenje u kome se kao osnovni izvor toplotne energije koristi slama. Radi se o relativno "manjoj sušari" kapaciteta oko 400 kg sirovog materijala na dan, koja je pogodna za proizvodnju na porodičnim poljoprivrednim gazdinstvima. Malina se suši 15 dana, a sezona sušenja voća traje ukupno 135 dana godišnje. U strukturi troškova proizvodnje sušene maline najvažnija je sveža malina kao osnovna sirovina (63,7%). Troškovi ambalaže takođe su vrlo značajni (28,3%) s obzirom da su predviđena manja pakovanja od 20 grama. Rad učestvuje sa 4,73%, dok je udeo troškova energije vrlo skroman (1,21%). Ovo je prevashodno rezultat korišćenja slame kao osnovnog energenta, sa ekonomske tačke gledišta pogodnija za korišćenje od drugih raspoloživih goriva. Analiza pokazuje da se za 15 dana efektivnog sušenja maline ostvaruje dobit od oko 6.200 €, što predstavlja vrlo dobar finansijski rezultat. Pri tom je kefcijent ekonomičnosti 1,41 i stopa akumulativnosti proizvodnje 28,8%. Ako se suši malina dobijena iz sopstvene proizvodnje stepen isplativosti može biti značajno veći. S obzirom da se u toku godine suše i druge vrste voća različitog stepena profitabilnosti (kajsija, breskva, kruška, dunja, višnja, šljiva, jabuka), nije moguće izvoditi precizne projekcije uspeha sušare na godišnjem nivou samo na osnovu podataka u proizvodnji sušene maline.

Ključne reči: sušene maline, troškovi, isplativost, komparativna analiza.

INTRODUCTION

Raspberry is one of the most important fruit species that is grown in the Republic of Serbia. Our country is one of the world's largest producers and exporters of this fruit. Other most important producers of fresh raspberries are USA, Poland and Chile. Raspberry production in Serbia varies with the tendency of growth in recent years. It is grown on around 11,041 ha, with an average yield of 6 t/ha. According to available data raspberry production increased in 2015 compared to 2014 from 61,715 t to 66,176 t (<http://webzr.stat.gov.rs>). Approximately 90 % of the produced raspberries freezes in large coolers and only 10 % are used for processing or sale in retail stores (<http://www.poljoberza.net>). Unfavorable circumstance is that a large share of this fruit production is register on small family farms and do not exceed 0.5 ha per farm.

In addition of the consumption in fresh condition, raspberry is very suitable raw material for the manufacture of various products: juice, jam, sweet, concentrate, compote, special wine, liqueur, raspberry powder and pulp, dried fruit. Raspberry is extremely rich in nutrients and contains all the essential vitamins and minerals (C, E, K, B3, folic acid, pantothenic acid, Fe, Mg, P, K, Zn, Cu, Mn). Kula *et al.*, (2016) indicate an increase in demand for products rich in polyphenols. In this respect, it is necessary to investigate the differences in the chemical structure of different varieties of raspberries to identify those with the highest levels of beneficial compounds. Drying is one of the

most effective ways of keeping fruit with high moisture content. Dried fruit has a relatively low humidity (5 -8 %), it is not prone to spoilage and undesired enzymatic reactions (Borquez *et al.*, 2010). Production of dried fruit in Serbia has a poor tradition, with the exception of dried plums. The reason is, among other things, significantly greater percentage of fruit processing into juices, compote, jam, sweet, etc. (Vukoje and Milić, 2011; Babić Lj. *et al.*, 2002). Domestic demand for dried fruits is settled mainly by imports, while a significant part of the local primary products collapsed due to lack of processing capacity. The development of new and reconstruction of existing dryers with old technology, adapted for fruit drying, would ensure better placement of products on the domestic and foreign market, higher energy efficiency, less environment pollution and improvement of the final product quality (Blagojević *et al.*, 2014; Babić Lj. *et al.*, 2006).

It is known that processing generates significant added value and provides a higher income to farmers. It is therefore necessary to devote greater attention to all aspects of fruit processing, especially those who are not sufficiently represented, as is the case with dried fruit. Production of dried raspberries in Serbia is underdeveloped, and its drying with conventional methods almost does not exist. Research at the Faculty of Agriculture in Novi Sad has shown that raspberries can be successfully dried with conventional convective drying method. The fact that this technological problem is solved it remains to determine the level of profitability of this production in local

conditions, which is also a basic objective of research in this paper.

MATERIAL AND METHOD

Raspberry can be dried using different technological methods and solutions. Freeze drying is a way of drying based on direct evaporation of water from the ice. The products made with this method have relatively high production costs compared to the convective drying method where straw is used as the main source of energy. *Sette et al., (2016)* indicate that the freeze-dried raspberry provides product with a higher quality in terms of strength and the reduction of the deformation of the dried fruit as compared to a drying process based on the thermal energy. In addition to freeze drying, raspberries can be treated by a conventional method (convection drying) shown in this paper and whose potentials have not been sufficiently explored in domestic literature and practice. Certain parameters used in the analysis, such as the ratio of the mass of fresh and dried product, have been obtained from the experiment of raspberry drying varieties polka. The experiment was carried out in convective experimental dryer IVA 2 at Faculty of Agriculture in Novi Sad. The dryer is equipped with devices to measure and control the most important parameters during the drying process, such as air temperature and weight of product. Sensors for measuring temperature and weight are connected with the acquisition and the computer that facilitate the gathering of measured data during the drying period.

Calculation and analysis are based on the following major assumptions:

- real dryer capacity per day is approximately 400 kg of fresh raspberries, or 70.6 kg of dried raspberries; Raspberry is dried for 15 days, a season of fruit drying lasts 135 days, which means that the remaining 120 days other kinds of fruit are dried;
- investments in the purchase of equipment and facilities, including a mini cold storages, amount to 30,900 € if there is an appropriate object in the economic yard, which can be adapted, investments can be significantly reduced (*Vukoje and Milić, 2011*);
- work is organized in three shifts with full capacity of dryer; it need a total of four workers, and one of them has to know the production technology;
- calculations are based on the laboratory established standards of material, labor and energy; according to the mass balance 82.34 % of fresh raspberries waste on evaporated water, and 17.66 % remains as dry raspberries;
- realistic market prices of inputs and final products are used, and the average euro exchange rate during the research period (1 € = 123 RSD); All prices are without VAT.

Economic analysis is based primarily on the calculation of production of dried raspberries. Direct costs are primarily calculated on daily basis. Then, based on the average euro exchange rate, are derived calculations for 15-days

production of dried raspberries (Table 1). The general production costs are determined on an annual basis, and then divided by 135 days of effective dryer work to get their daily amount. For reliable estimation of the cost-effectiveness of drying raspberry, additional absolute and relative indicators of success are determined (margin of coverage, income, time of return on investment, coefficient of economics of production and coefficient of production accumulation). With method of sensory analysis is observed the movement of the achieved results in relation to the change in market price of fresh and dried raspberries.

RESULTS AND DISCUSSION

Daily costs in the production of dried raspberry amounted to 125,682 RSD, or 15,327 € for 15 days of drying (Table 1). Fresh raspberries, as the main raw material, have the greatest impact on the production costs of dried raspberry, with a share of 63.7 %. The costs of packaging are also very significant (28.1 %) since they are provided in smaller packages of 20 grams. Labor costs participate with share of 4.73 %, while the share of energy consumption costs is very low (1.21 %). Such cost structure primarily results from using straw as the main energy source, inasmuch as straw is considerably less expensive than other available fuels. Once again it was confirmed that, contrary to popular opinion, the energy consumption costs are not crucial for (none) profitability of the production of dried fruit. The question is should straw be replaced with natural gas, which is in technical and organizational terms more favorable fuel. The equivalent amount of natural gas is 113.5 m³/day which at a price of 42.5 RSD/m³ is 4,822 RSD/day. This increases the cost of energy consumption in the production of dried raspberries for 415 € for 15 days, but their participation still remains at a relatively low level of 3.82%, which does not threaten the profitability of production significantly. Fixed costs are 2.3 % of total production costs (depreciation and maintenance are 1.5 %, general costs and interest are 0.8 %). General costs include mainly a proportional part of overhead

Table 1. Calculation of production of dried raspberry (1 € = 123 RSD)

Dryer capacity: 400 kg of fresh raspberry per day, or 6000 kg for 15 days							
No	TECHNOLOGICAL OPERATIONS	Unit	Quantity	Price	RSD / for 1 day	€/ for 15 days	%
1	Fresh raspberry	kg	400	200.0	80,000	9,756.1	63.7
2	Packaging and others				35,320	4,307.3	28.1
I	Material (1 to 2)				115,320	14,063	91.8
3	Electrical energy	kwh	15.0	6.97	105	12.8	0.08
4	Heat energy (straw)	kg	295.0	4.8	1,420	173.2	1.13
5	Labor costs	h	34.0	175.0	5,950	725.6	4.73
A)	VARIABLE COSTS (1 to 5)				122,795	14,975	97.7
6	Depreciation of equipment and facilities				1,852	225.8	1.5
7	General costs and interest				1,035	126.2	0.8
B)	TOTAL COSTS (1 to 7)				125,682	15,327	100.0
ACHIEVED RESULTS		Unit	Quantity	Price	RSD / for 1 day	COST PRICE	
						RSD/kg	€/kg
8	Dried raspberry	kg	70.6	2,500	176,600	1779.2	14.46
C)	VALUE OF PRODUCTION (17 to 18)				176,600	21,537	
D)	PROFIT (C - B)				50,918	6,210	
E)	Margin of coverage (C - A)				53,805	6,561.6	
2	Income of household (D+ 1/2 Profit)				53,893	6,572.4	
F)	The economics of production (C / B)				1.41		
G)	Accumulation of production (D / C)				28.8%		

Source: Authors' calculation based on own research

costs of households (telephone, fuel and travel costs, insurance, fees, taxes and contributions to property, administrative services, costs of sales, etc.). The cost price of dried raspberries is 1,779.2 RSD/kg (14.46 €/kg) and a wholesale price is 1,779.2 RSD/kg. It is necessary to add the VAT (20 %) and the average trading margin of 20 % to obtain a retail price of dried raspberry of 3,600 RSD/kg (29.3 €/kg). With this price, dried raspberry is very competitive in the domestic market, especially when it takes into account the relationship between price and quality. The analysis shows that in the 15-days production of dried raspberries is realized a profit of around 6,210 €, which can be considered as a very good financial result. The economics of production coefficient is 1.41 and the rate of production accumulation is 28.8 %. Expressed profit can be significantly increased by using fruit from their own production. Also, if 2 members of the household are involved instead of external workers, it can be achieved a significant additional benefit. In this case the result is expressed as income of household and amounts to 6,572 €15 days. Results of previous studies which covered other types of fruit (apricot, peach, pear, quince, cherry, plum and apple) show that the production of dried raspberry is far more cost-effective. Considering that during the year of drought other types of fruits are with different degrees of profitability, it is not possible to perform an accurate projection of dryer success on annual level only on the basis of data of the dried raspberries production. Reliable estimations can be made only on the basis of the overall cost-benefit analysis of building and operating of the drying plant for fruit on annual level. In our case it is possible to do, considering that there are research results for other types of fruits that were previously carried out and published within this project TR31058. Investment feasibility is calculated with presupposed days of drying during the year for individual fruit species: apricot 25 days, apple 25 days, peach 20 days, pear 20 days, quince 15 days, cherry 15 days and raspberry 15 days, with a total of 135 days (Table 2).

Table 2. Additional indicators of success

No	TYPE OF INDICATOR	€135 day
1	Total profit reduced by 15% tax	19,569
2	Annual depreciation	1,733
3	Financial flow (1+2)	21,301
4	Total investment (€)	30,900
5	Time of return on investment (4/3)	1.45

Source: Authors' calculation based on own research

Time of return on investment is one of the most important indicators of the justification of the entire project investment. In our case, the investment is repaid by 1.45 years, which is a relatively short period of repayment, especially for this type of investment. Method of sensitive analysis considers the movement of profit depending on the market price changes of fresh raspberries, or dried raspberry. The negative financial result occurs only with the increase in market prices of basic raw material (fresh raspberries) by 64 % (328 RSD/kg) with unchanged price of dried raspberries. Profitability is significantly more sensitive to variation in the market price of the final product, since with its reduction by 29 % (1,775 RSD/kg) financial result becomes negative.

Table 3. Sensitivity analysis

Change in the market price of fresh raspberries, or dried raspberry for +/- 20 %	Fresh raspberry (+/- 20 %)	Dried fruit hemisphere (+/- 20 %)		
		1,775	2,500	3,000
	160.0	15,704	66,918	102,238
	200.0	-296	50,918	86,238
	240.0	-16,296	34,918	70,238

Source: Authors' calculation based on own research

CONCLUSION

The Republic of Serbia is one of the world's largest producers and exporters of raspberries. Raspberry is exported from Serbia in the highest percentage (over 90 %) in a frozen state. Significantly better results could be achieved by export of various products made from raspberries, including dried raspberry. Analysis of economic parameters shows that the production of dried raspberries can be considered as a very profitable business. In the 15-days production of dried raspberries is realized a profit of around 6,210 €, with the economics of production coefficient of 1.41 and the rate of production accumulation of 28.8 %. Construction of mini-plant for fruit drying on the family farm is also a profitable business venture, considering that investment of around 30,900 € can be repaid by about 1.45 years. It is necessary to make an organized effort to take advantage of respectable natural and technical-technological resources in order to raise this production to a higher level in quantitative and qualitative terms. Already available programs of subsidizing the construction of mini-plants, as well as the new expected, with the introduction of new, more productive varieties in production, better training and the organization of producers, accessible sources of financing, etc., would contribute significantly to increasing exports of dried raspberries in the EU and other developed markets.

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REFERENCES

- Babić Ljiljana, Babić, M., Pavkov, I. (2006). Apricot drying. Journal on Processing and Energy in Agriculture, 6 (1-2), 1-4.
- Babić Ljiljana, Babić, M., Pavkov, I. (2006). Novel concepts for fruits drying. Journal on Processing and Energy in Agriculture, 10 (1-2), 9-15.
- Blagojević, R., Ranković, G., Stefanović, Z., Radojković, I. (2014). Tehnologija sušenja voća. Kancelarija za program podrške u privatnom sektoru za podršku sektoru voćarstva i bobičastog voća u Južnoj Srbiji, Niš.
- Borquez, R. M., Canales, E. R., Redon, J. P. (2010). Osmotic dehydration of raspberries with vacuum pretreatment followed by microwave-vacuum drying. Journal of Food Engineering, Vol. 99, Issue 2, 121-127.
- Kula, Marta, Majdan, Magdalena, Glod, D., Krauze-Baranowska, Mirosława. (2016). Phenolic composition of fruits from different cultivars of red and black raspberries grown in Poland. Journal of Food Composition and Analysis, Vol. 52, 74-82.
- Sette, Paula, Daniela, Salvatori, Carolina, Schebor. (2016). Physical and mechanical properties of raspberries subjected to osmotic dehydration and further dehydration by air- and freeze-drying. Food and bioproducts processing 100, 156-171.
- Vukoje, V., Pavkov, I., Babić, M. (2010). Economic Effects Of Dried Pear Production Using Combined Technology, Economics of agriculture, 57(Special issue 2), 219-227.
- Vukoje, V., Pavkov, I. (2015). Profitability of dried apple production in Serbia, Contemporary Agriculture, 64 (3-4).
- Vukoje, V., Milić, D. (2011). Analiza ekonomske opravdanosti proizvodnje sušenog voća u Srbiji, Agroznanje, Poljoprivredni fakultet Banja Luka, 12(1), 5-14.
- <http://webzrzs.stat.gov.rs>
- http://www.poljoberza.net/AutorskiTekstoviJedan.aspx?ime=PG023_7.htm&autor=7

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