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COMPETITIVENESS OF APPLE PROCESSING[4]

Abstract

Fruit production has important role in development of the Serbian agriculture. Within the structure of grown fruits, apple takes remarkable share. As a fruit species suitable for processing and longer storage, apple is traditionally use in households as fresh or processed. One of the alternatives for apple processing that could be a good solution for small family agricultural holdings represents the production of apple chips. Implementation of mentioned processing is suitable as from the aspect of size of needed investments and relatively simple technological requirements, as well as towards the quit a short period of return on invested assets, or possibility to engage installed equipment and farm members out of apple processing campaign. On the other hand, apple processing would certainly ensure the creation of added value and continuity of the farm income, what would primarily have a positive effect on farm sustainability. The main goal of paper is to consider the power of contribution margin obtained in apple chips production at farm level. Research involves one production cycle (three-month campaign), where presented data and results are referring to 2018. According to gained results, derives a conclusion that processing of apples into the apple chips could be a good alternative for small farms concerning the creation of its additional income.

Key words: *agro-food processing, apple chips, contribution margin.*

JEL classification: *Q12, Q19*

КОНКУРЕНТНОСТ ПРЕРАДЕ ЈАБУКЕ

Апстракт

Производња воћа има значајну улогу у развоју српске пољопривреде. У структури производње воћа, јабуке имају сразмерно велики удео. Као воћна врста погодна за прераду и дуже складиштење, јабука је традиционално присутна у домаћинствима у свежем или прерађеном стању. Један од видова прераде

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јабуке који би могао бити добра солуција за мала породична пољопривредна газдинства је производња чипса од јабуке. Имплементација поменуте прераде је погодна како из угла величине потребних инвестиционих улагања и релативно скромних технолошких захтева, тако и у погледу кратког повраћа уложених средстава, или могућности да се упосле инсталирана опрема и чланови газдинства ван кампање прераде јабуке. Са друге стране, прерада јабуке би сигурно обезбедила стварање додатне вредности и континуитет прихода на газдинству, што ће примарно имати позитиван утицај на његову одрживост. Основни циљ рада је да размотри снагу генерисане марже покрића у производњи чипса од јабуке на нивоу малих газдинстава. Истраживање се базирало на једном производном циклусу (тромесечној кампањи прераде јабуке), при чему се приказани подаци и резултати односе на 2018. годину. Сходно добијеним резултатима проистиче закључака да прерада јабуке у чипс може представљати добру алтернативу малим газдинствима у циљу стицања додатних прихода.

Кључне речи: *прерада, чипс од јабуке, маржа покрића.*

Introduction

Apples are sweet-sour, tasty, healthy and edible fruits gained as a product of apple tree (*Malus Domestica*) that represents perennial, cultivated, woody plant. Apple belongs to the rose family, and originated from the area in-between the Caspian and Black Sea. Certain archaeological evidences show that human population is in contact with apples since 6,500 B.C. Today, apple production is widely spread worldwide. So, currently is grown around 7,500 varieties, while just couple hundreds of them are grown commercially. Fruit of known apple varieties mutually differs in size from a little larger than a cherry to a size of grapefruit. Besides, commercially grown varieties largely differ in taste, so it's possible to find the apples that leave aftertaste of pears, citrus, cinnamon, cloves, coconut, strawberries, grapes, or pineapple (IAC, 2019).

In human diet, apples have highly expressed nutritional and medicinal value. They are rich in fibre (up to 4 gr, what represents 1/6 of required daily value in human nutrition), but low in calories, as 100 gr of apples usually generate just around 50 kcal (up to 14 gr of carbs, where more than 10 gr come from fructose). Content of fat and proteins is up to 0.5 gr. Although involves many vitamins and minerals in small doses, they are primarily solid source of vitamin C and potassium. Besides, apples are full of different phytochemicals in function of strong antioxidants, as are quercetin, catechin, phloridzin, or chlorogenic acid. It was detected that their storing for a longer period do not have any effect on level and quality of phytochemicals, otherwise they could be greatly affected by processing activities. Several scientific research have been shown that apples carry out the large impact against diabetes, asthma, heart diseases, cancer and other diseases (Boyer, Liu, 2004; Arnarson, 2019).

In human nutrition, apple could be used as a fresh or processed (valuable input in food industry), like ingredient within the certain food products. It has to be noted that apples and grapes are two the most processed fruits (Bolarinwa et al., 2015). Apples represent the most widely grown fruit. They could be produced wherever around the globe, but primarily are

concentrated in the Northern hemisphere. Around 95% of all produced apples originated from the zones framed by the 35-50°N and 30-45°S latitudes (Barrett et al., 2004).

In line to change in weather conditions, volume of apple production can annually oscillate for up to 20%. Besides the fact that nowadays are grown number of apple cultivars, just 20 of them have certain commercial importance, or much narrower, only 5 of them covers the majority of worldwide production (Delicious, Golden Delicious, McIntosh, Rome Beauty and Granny Smith), (Bates et al., 2001).

Apples are the fruit that could be stored for a long time before being consumed. Storing could last up to 9, or even 12 months in the conditions of controlled atmosphere (automatized controlling and levelling of temperature, oxygen, carbon dioxide and humidity in line to fruit requirements). Nowadays, the high-tech storage facilities enable buying of crisp and juicy apples throughout the whole year (Hickey, 2007). At the same time, they enable the producers to achieve the higher fruit prices (or profits) out of harvesting season (Ivanović et al., 2009).

In modern economies apples are usually marketed throughout the wholesale to a fruit packers or processors. First one sorts the apples according to their quality packing them for the fresh apples' market (this contingent of apples yields the higher return than processed apples). Meanwhile, processors use apples to produce apple sauce, or juice, spirits and cider, as well as to can, dry or freeze them, etc. (Crassweller et al., 2017).

Globally observed there is no strict line between the volume of apples that goes to market as a fresh or processed. This is framed by cultural, technological, economic and other aspects within the certain country. For example, during the 2018, within the territory of USA, 67% of nationally produced apples are consumed as fresh, while 33% are processed. In last few decades consumption of fresh apples has moderately increasing tendency (USApple, 2019).

On the other hand, this structure highly differs across the states (related to producers and consumers affinity). For example, Pennsylvanian growers are producing around 70% of apples for processing, what is much higher than in state of NY, around 60/40, or Michigan state, around 50/50. All previously mentioned does not mean that processed apples do not have a future, as in average Americans annually consume more than 12 kg of applesauce, apple pie, or apple juice, while less than 10 kg of apples in fresh condition (Lenhert, 2015).

According to total production, harvested areas and export potential, globally observed in long term period apples are among top 3 fruits (by production volume after bananas and melons), (van Rijswick, 2018).

Main elements linked to global, European or EU apple production could be seen in next table (Table 1.).

Table 1. Apple production at global, regional and national level

Element/year/territory	Harvested area (in mil ha)*			Yields (in t/ha)			Production (in mil t)*		
	2015.	2016.	2017.	2015.	2016.	2017.	2015.	2016.	2017.
World	5.10	5.16	4.93	16.18	16.50	16.85	82.44	85.20	83.14
Europe	1.0	1.0	0.96	17.10	17.26	14.85	17.21	17.41	14.25
EU	0.54	0.53	0.53	23.81	23.75	19.20	12.78	12.64	10.11
Serbia	24.70	24.82	25.13	17.48	16.14	15.06	431.8	400.5	378.6

Source: FAOSTAT, 2019.

Note: *harvested area in thousands hectares and total production in thousand tones.

It could be seen that 20% of global production potentials are located in Europe, while half of them are possessed by EU countries. Similar relations exist between the world and European volume of apple production, while in this case EU has better position, as in line to higher average yields it takes more than 70% of European apple production. Although Serbia takes a role of the regional leader (within the Balkan), actually it's a small European producer that has just around 2.4% of total European production capacities, and achieves apple yields close to global average.

As world top-ten producers could be listed: China, USA, Poland, Turkey, India, Iran, Italy, Russian Federation, France and Chile. Among them, China is real super star, with total production (almost 44.5 million t) higher than half of total world production (Khushboo, 2018).

Some estimation assume decrease in current world production (2018/19), even the lowest production level in last eight years, caused by Chinas' losses under the damaging weather (decrease in yields for around 25% affected by spring frost and heavy rains and hail in May in leading production provinces). Squeezed global output will certainly press down export quotas, while reduced quality in export supplies will cut down final consumption of fresh apples and boost their processing (USDA, 2019).

Focusing to Serbia, by the production surface, apple is positioned as the second fruit species just behind the plums. Within the total surfaces under the orchards, it takes the share of above 15% (what is insufficiently given the favourable climate and soil conditions for fruit growing). The largest areas under the apples are located in Subotica, Smederevo, Grocka, Čačak and Arilje (Keserović et al., 2014).

During the last couple decades, apple production in Serbia is expanding. Until recently, producers were dominantly family farms who grown apples in orchards up to 5 ha, while today there are a lot of commercial farms that organize production on more than 10 ha and use the ULO coolers. Besides, there are several large-scale companies that cultivate plantations up to 250 ha. Average apple producer gradually advance and intensify his production, introducing the new technologies (cultivation systems and agro-technics) and competitive varieties under the constant irrigation (Maric, 2018).

Today, we are witnessing the struggle between the small and large commercial producers. Confrontation is based on economic differences that rise from available capacities. The most often small orchards cannot compete with the bigger ones in terms of applied agro-technics and technology, reached apple yields and prices, etc. In return, they can achieve certain level of farm income sustainability by organizing apple processing and like this created additional value.

Some research showed that it is justified end economically efficient to develop short value chain models for apples, after investing in fruit marketing and processing cooperative. The short value chain is defined as a business in which post-harvest activities are integrated and conducted within the single economic unit (family farm or cooperative). Post-harvest activities assume collecting and processing the fruits, as well as selling the processed food products (Ion, 2017).

The largest part of apples produced in Serbia is consumed fresh. Certain contingent of apples is processed, usually into the juice, brandy, compote or jam. In the last several years, drying of apples (in the form of cubes or chips) has been increasingly present, as by this process many of apple nutrients could be preserved and energy successfully concentrated. Generally, all apple products can be available to consumers throughout the whole year, while the period of presence of fresh ones is certainly narrower.

The benefits of apples drying are also coming from lower costs of products storing, transport and packaging (Vučićević, Vukoje, 2016).

There is certain number of factors affecting the farm income and sustainability. Among them as the crucial could be reconsidered initiating of added value throughout the processing of previously produced primary products, even implementation of the part or complete value chain from any sector of agriculture at the farm (Kahan, 2012; FAO, 2014).

So, boosting of small farm sustainability could be turned to production of specific food product as the result of processing of locally available inputs that could be later easily distributed to local consumers. Related to apples, one of profitable solutions could be their drying into the form of apple chips.

This product has several attributes potentially suitable for practicing of niche marketing. So throughout the apple chips farm could offer to limited but precisely determined segment of market, which prefer quality than quantity, new, absolutely valuable food product. Apple chips represents excellent food product for following consumers' groups: vegetarians, sportsmen, older population or kids, consumers turned to healthy, or organic products, etc.

Globally, specialization in production of particular food product can help farmer in spreading of list of potential consumers and getting of positive feedback from the targeted market. Farmer will gradually build his market reputation related to specialized knowledge expressed through the offered product. Some studies shows that approximately 70% of producers would like to operate in niche market, as turning themselves to specialists will enable them to expand previously used practice, or by new product (processing concept) they can enlarge possibilities to reach higher incomes (Kallenbach, 2011).

Methodology and data sources

Data used for economic estimations are gained throughout the in-depth interview with the members of one small family farm turned to fruit production and processing within the couple generations. Farm is located at the territory of Lazarevac municipality. Farm was previously involved both in fruits growing and processing, while in last several years it mainly practice the fruit processing. It produces various dry fruits and fruit brandies, while in certain volume it also dries medicinal herbs, mushrooms and vegetables for third persons. Gained data relates to production cycle of 2018. Additionally, certain secondary data provided by FAO, or scientific and professional sources turned to area of apple growing and processing are used.

Primary goal of the paper is to estimate the potential of economic effects generated in apple processing (production of apple chips) organized at the small family farms. Estimation considers one calendar year, or more precisely three months processing campaign of conventionally grown apples (from August to October).

Like in some previous research (Ivanović et al., 2010; Jeločnik et al., 2011) economic justification of fruit processing is done according to analytical calculations based on variable costs (contribution margin). Simplified, a calculation could prove the farmer that entering into the certain line of agricultural production (including fruits growing) or production of food product (agricultural products processing) is justified.

It implies deduction of incurred variable costs from the sum of generated incomes related to previously specified production (processing) line. Variable costs in fruit (apple) processing are mainly framed by used inputs and services, as are: fresh fruit, citric acid, packaging material, fresh water, engaged labour, certain fees and taxes, energy, outsourced services, etc.

Calculation is based on assumption that total volume of produced apple chips (volume of processed fresh apples) at the family farm is in line to the capacity of production facilities and installed equipment. All data are presented in tables (in RSD and EUR).

Results with discussion

Economic analysis of apple processing relies to data received throughout the in-depth interview with small, primarily fruit processor located in Lazarevac municipality. Farm is registered, but last several years it is not active in fruit growing. It is dominantly oriented to processing of purchased fruit (fruit drying and brandy production). The largest share within the dried fruits production takes the apple chips. Final products are usually sold at the farm gate, or to local health food shops.

Initiation of apples processing (production of apple chips) at the small farm in the volume of around 15 t of fresh apples per year requires significant level of investments for equipping the processing facility and purchasing the needed equipment. Mentioned facility and large part of equipment could be also used in drying of other fruits, vegetables, mushrooms, medicinal and aromatic herbs, etc. during the rest of calendar year. At the total investment amounts around 22,500 EUR.

Establishment of apple chips production at the small family farm requires a production facility larger than 80 m^2 that consists from several rooms: space for power plant (installed solid fuel thermo-generator), stockroom of final products and packaging material, looker room with toilet, space for inputs manipulation, space for drying and space for cooling, measuring and packaging of final products, etc. Facility should be electrified, with access to fresh water and sewage system, tiled and equipped with natural lightening and ventilation. As the cold storage could be used the truck cooler additionally insulated with thermal panels (with the total capacity of 5 t and operating temperature of 2-4^{o}C). Recommended equipment considers: standalone container dryer (dimensions 6.5 m x 2.5 m x 2.9 m) delivered with stainless steel trolleys and 24 trays, as well as with thermo-generator, power fans and system for hot air circulation; two weighing scales (up to 200 kg and 5 kg); stainless steel container with shower and drainage for apples washing; machine for the seed removing; fruit chopper; stainless steel container for soaking of apples in citric acid; stainless steel worktables and chairs; cart; set of knifes; plastic bag welder; etc. (Subić, Tomić, 2019).

In next table (Table 2.), it could be seen brief description of technological approach in apple chips production, as gained incomes and costs, or value of contribution margin derived throughout the apples drying. Further, there is a need for clarification of some elements presented in table above.

The season of apples processing at the farm is enclosed by the three month period (August - October). Volume of processed apples depends on the capacity of available cold storage (5 t) and capacity of dryer (80 kg per one load). Drying of one load lasts for

5 hours (at the temperature of 50-60 °C), so daily capacity of dryer is two loads (160 kg of fresh apples or 12 working hours). According to presented dynamics, the campaign of drying of one fully loaded cold storage lasts approximately for one month, while processor should fill in and empty the cold storage three times during the season of apple processing (in total 15 t of fresh apples).

For processing is used Idared cultivar, as its medium intense sweet-sour taste matches the requirement of final consumers. Farmer has been mostly purchased the II quality class of apples (with fruit diameter from 5 to 7 cm and without visible spots) from local fruit growers at average price of 14 RSD/kg.

Through one load of fresh apples (80 kg), after the previous cleaning, removing of seeds and unwanted parts of apple, around 75 kg of fresh and prepared apples are chopped into the 4 mm thick rings and later dried. As result, it's got around 10 kg of apple chips (with 96% of dry matter). After the calculation of 5% of breakage during the product handling and packaging, there are around 9.5 kg of final product ready for market per each load. In total, there are approximately 188 loads for drying per season, or around 1,781 kg of produced apple chips and around 94 kg of broken final product.

Apple chips is packing and selling in 50 gr plastic bags. Wholesale price is 48.5 RSD/bag (including VAT), or 970 RSD/kg (product delivered at the farm gate). Part of broken product is selling in bulk for 675 RSD/kg (packing in 5 kg plastic bags).

Table 2. Contribution margin in apple chips production

Element	U.M.	Quantity	Price/U.M. (in RSD)	Total (in RSD)	Total (in EUR)
I Incomes					
Apple chips (final)	kg	1,781	970	1,727,570	14,702.7
Apple chips (breakage)	kg	94	675	63,450	540
Subsidies	pack.			-	-
Value of production (total I)				1,791,020	15,242.7
II Variable costs					
Fresh apples	kg	15,000	14	210,000	1,787.2
Citric acid	kg	15	725	10,875	92.5
Plastic bags (50 gr)	pcs	35,620	2.25	80,145	682.1
Plastic bags (5 kg)	pcs	20	20	400	3.4
Transport box (5 kg)	pcs	360	45	16,200	137.9
Bags designing	-	-	-	5,875	50
Declarations' verification	times	3	11,750	35,250	300
Labour	h	2,880	275	792,000	6,740.4
Electricity	-	-	-	47,250	402.1
Energy (pellets)	kg	9,375	20	187,500	1,595.7
Water and sewage	-	-	-	1,915	16.3
Disinfection	-	-	-	17,625	150.0
Pest control	-	-	-	5,875	50.0
Bookkeeping	-	-	-	10,575	90.0
Certification	-	-	-	7,200	61.3
Garbage	-	-	-	9,150	77.9
Taxes	-	-	-	5,250	44.7
Other costs	-	-	-	7,500	63.8
Sum of variable costs (total II)				1,450,585	12,345.4
III Contribution margin (I-II)				340,435	2,897.3

Source: IAE, 2019.

Note: middle exchange rate for 1 EUR = 117.5 RSD (NBS, 2019).

Entire cycle of apple processing involves following operations: periodical purchase and storing of fresh apples; withdrawal of fresh apples from the cold storage on daily basis in line to dryer capacity; washing and extraction of seeds; chopping apples into the rings and soaking in citric acid; placing the fresh rings on trays and carts; inserting the cart into dryer and drying; cooling the apple chips after the process of drying; packaging (in bags and transport boxes) and storing the final product in dry storage (for maximally 5-6 months).

According to required inputs, except fresh apples, processor should also purchase the citric acid that is used as antioxidant in prevention of final products darkening. It is usually purchased the 1 kg of citric acid per 1 t of processed apples.

Packaging of final products' requires small plastic bags (50 gr) and large plastic bags (5 kg) with double print (farm logo and products' declaration), as well as cardboard transport boxes (capacity of 100 small bags/box). Designing of farm logo and declarations printed on the bags have been done before the processing campaign of apples. Each month during the processing campaign, final products are taken to the local Public Health Institute in order to verify the content of products' declaration (quality control).

Costs of engaged labour considers employment of 5 persons (farmer and external labour) in two to some extent overlapping shifts. External employees have 8 hours working day, covering just processing activities. Calculation covers just costs of external labour, so at total monthly paid labour engagement is 960 working hours, while gross wage is around 275 RSD/hour.

Costs of electricity that covers the function of cold storage and needs of processing facility are around 15,750 RSD/month. Source of energy used for drying process is pellets, while usually is combusted 50 kg of pellets/load.

Disinfection of facility and used equipment is doing on monthly basis. Pest control within the facility is conducting twice per processing season.

Costs of bookkeeping are paid monthly. Implementation of HACCP is paid once, while annual inspection is free of charge, so it's assumed that calculation should be burden with 20% of total costs of certification.

Process of apple chips production requires daily consumption of around 250 l of fresh water (22.5 m^3 for whole season), while monthly costs of garbage collection considers flat rate amount determined by local utility company. Besides, apple processing also involves monthly costs of certain local and national taxes and fees, and some other production costs.

In line to presented calculation there are following conclusions:

- Gained incomes derived from selling of the apple chips are for around 23% higher than expenditures for used inputs and services. Similar results are gained in some previous researches related to production of apple chips, as there were calculated income - expenditures ratio of over 1.5 and gross income of over the 3.5 thousands EUR for the processing season (Vučićević, Vukoje, 2016);
- Apple chips production results positive contribution margin (around 113,480 RSD per month) that could provide the processor enough space for covering all fixed costs. It has to be mentioned that after finishing the apple processing campaign installed equipment could be also used for drying of other seasonal fruits, vegetables, medicinal herbs, etc.;

- Within the structure of variable costs dominates the labour costs (over the 54%). Having in mind that initial assumption was directed to engagement of 4 external workers, changing of each external employees with one farm member could boost the value of contribution margin for additional 198,000 RSD (1,685.1 EUR) per processing campaign.

Conclusion

Apples are among the most grown and used fruit species in Serbia. In human nutrition, besides in fresh condition, apples are presented in wide range of processed products. Apple chips could be one of the apple food products whose production at the farm level might have good impact on diversification of farm activities and growth of gained incomes. Some facts are supporting previously mentioned, such as: availability of cheap major input (apples) of good quality, relatively low level of investment even for small farms, quite a seasonal character of apples processing, technologically simple process that could be easily organized and that does not require specific skills and knowledge, available equipment could be used later for drying of other fruits species, vegetables, mushrooms, spices or medicinal plants, final product (apple chips) could be easily realized at local market niche, etc.

In paper are evaluated the economic effects of establishing of apple chips production at the farm, considering the use of method of contribution margin (analytical calculation based on variable costs). Gained results show certain level of economic justification in organization of this processing line at the farm, as the achieved contribution margin is positive, as well as gained incomes surpass the incurred variable costs for over the 20%.

Certain risk is concentrated in fact that apple processing requires a considerable volume of engaged labour (over the half of total variable costs are the expenditures for the labour). Noticed risk could be considered from two sides: 1) Labour as a problem could occur if farm does not have on disposal larger part of required labour in form of its own labour force (farm members), and there is a local shortage of working population. In that case farm could or reduce the volume of processing, skip to processing of plants that are not labour intensive, or just quit the processing for some period (if processor has to offer higher wage than usual for this activity in order to attract potential workers, what will endanger gaining of positive economic results). 2) Other situation could be seen through the fact that with diversification of its economic activities farm is luring the local working population with new activity affecting the reduction of unemployment, as well as the economic growth of local rural community.

Certainly, there are some market expectations that apple chips production in limited quantities could successfully establish, penetrate and cover certain niche market at national level towards the consumers of wine (it perfectly match the drinking of white and rose wines), health food, sportsman, etc. Mentioned is crucial for two reasons: 1) At first place, it can affects diversification of activities at farms oriented to fruit growing, but limited by area under apple plantations. They will be in position to reach the higher farm incomes throughout the created value added within apple processing. 2) Secondly, the current processors that deal with dry food products could find in apple chips the product that will extend their season of drying up to the full capacity of installed equipment (even

with introduction of second or third shift). Of course it will happen only if characteristics of used inputs (agricultural products) are complement to equipment used for processing.

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