

Nastić, Lana; Jeločnik, Marko; Subić, Jonel

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# PROCESSING OF MEDICINAL HERBS: ECONOMIC ANALYSIS

Lana NASTIĆ<sup>1</sup>, Marko JELOČNIK<sup>2</sup>, Jonel SUBIĆ<sup>3</sup>

Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia

Corresponding author email: lana\_n@iep.bg.ac.rs; marko\_j@iep.bg.ac.rs; jonel\_s@iep.bg.ac.rs

**Abstract:** Medicinal and aromatic plants have been usually used in traditional way of curing people for centuries, while their essential oils are mainly applied in medicine, pharmacy, dentistry, cosmetic industry, light chemistry, and other sectors. Besides, possibilities to use essential oils as plant protection agents or veterinary medicaments have been also increasingly studied. Considering the number of alternatives for using essential oils and growing tendency to increase the appliance of natural compared to synthetic products in many areas, the main goal of paper is to analyze the economic profitability of essential oils production based on exploitation of ten medicinal plants' species previously produced in plantation system of production. Analysis was performed according to data gained from coal mine Pljevlja, while dynamic methods of investment analysis (net present value, internal rate of return, payback period and annuity method) were used in assessment of economic effects of investing in essential oils production (processing of medicinal plants). Performed analysis has showed that investment in observed processing capacities is economically justified, as well as that economic effects of medicinal herbs processing mainly depend on production structure available at plantations, i.e. on volume and structure of available raw material used in processing capacities.

**Key words:** medicinal herbs, essential oils, costs, investments.

**JEL classification:** Q0

## INTRODUCTION

Medicinal herbs collected in natural habitats have been used in folk medicine for prevention and treatment since ancient times (Pan et al., 2014). With the increase in the need (demand) for medicinal herbs and emergence of modern systems for their growing (in addition to their collection from nature), there comes to constant increase in areas under plantation production (Sheldon et al., 1997; Van Wyk, Prinsloo, 2018). Riaz and associates (2021) have noticed following issues for medicinal and aromatic plants (MAPs) adaptation as arable crops, such are “lower prices, non-availability at transit markets, underdeveloped cultivation technology, poor availability of cultivation resources and genetic materials, etc.”.

Discussing international trade of medicinal herbs (Vasisht et al., 2016) there are determined that in period 2001-2014. “annual average growth rate (AAGR) of 2.4% in volume and 9.2% in value of export item was observed”. Analyzing market of medicinal and aromatic plants Parvin et al. (2023) have been listed China, India and Canada as the main exporters, while USA, Japan and Germany as the main importers. Mentioned authors have been also determined that “the USA, Hong Kong, Germany, the Republic of Korea, and China are the five main trade hubs for MAPs worldwide”. Similar conclusion concerning the most important trade centers for medicinal and aromatic plants were reached by Tripathi et al. (2017) and Vasisht et al., (2016).

Increasing attention has been paid globally to the possibilities for medicinal herbs processing, as well as the opportunities of applying the products gained in this way. Medicinal plants

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<sup>1</sup> Lana Nastić, Ph.D., Research Associate, Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia, Phone: +381 11 69 72 852, E-mail: lana\_n@iep.bg.ac.rs, ORCID: <https://orcid.org/0000-0003-1939-0718>

<sup>2</sup> Marko Jeločnik, Ph.D., Senior Research Associate, Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia, Phone: +381 64 66 88 357, E-mail: marko\_j@iep.bg.ac.rs, ORCID: 0000-0003-4875-1789

<sup>3</sup> Jonel Subić, Ph.D., Principal Research Fellow, Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia, Phone: +381 63 296 111, E-mail: jonel\_s@iep.bg.ac.rs, ORCID: 0000-0003-1342-1325

are processed in different ways, either by drying individual plants' parts, or by distillation, or by various types of processing in pharmaceutical industry (Ahad et al., 2021).

Due to the modern lifestyle (which includes less and less movement, high levels of stress and diet with insufficient level of nutrients), it is obvious that consumer's affinity to use products based on medicinal plants instead synthetic drugs has been becoming more pronounced. That is the reason why the use of pure medicinal plants is increasing, as well as the invention and production of new products that include them (Radojković et al., 2017). Medicinal plants, as was stated by Turudija Živanović (2016), have an advantage over synthetic drugs, as they rarely cause side effects.

In line to active substance inside the medicinal plants grown and cultivated within the Balkans, they can be divided into: alkaloid species, heteroside species, glycosidic species, species rich in tannins, or species rich in essential oils, mucus and vitamins. A group of medicinal plants particularly important for processing are plants rich in essential oils that can be found as wild or as cultivated plants (Stevanović, 2022).

Composition of etheric essential oil highly depends on specified medicinal herb species. Composition of essential oils was studied by Mašković and associates (2017), while they presented in detail the chemical composition of lavender (*Lavandula angustifolia*) and thyme (*Thymus serpyllum*) essential oils. According to them, performed research (observed content of essential oils) could be significant both for pharmaceutical and food industry. Trifunović and Tojić (2022) state that "essential oils are complex mixtures of a large number of organic compounds, such are aliphatic, alicyclic and aromatic hydrocarbons, different alcohols, aldehydes, ketones, carboxylic acids, lactones, esters, phenols, etc."

Essential oils can be used in a wide range of products gained from different industries such are food, pharmaceutical and cosmetic industry. Their use has beneficial effects on human body, such as soothing, anti-inflammatory, diuretic, expectorant, antiseptic and antibacterial, antispasmodic, etc. Before the use of certain essential oils, there has to be checked the optimal concentration for its appliance towards avoiding potential unwanted health issues. In medicine, essential oils can be also used as active substances or as auxiliary substances in process of drugs production (Džilani, Dicko, 2012; Govindaraj, 2019; Fatemeh, 2021; CEMFIK, 2024).

Essential oils have been stored in special conditions, as they behave as antioxidants, while they could be decomposed quickly. They need to be stored in dark and aired space in dark glass or porcelain containers with appropriate lids (glass or silicone). In accordance to plant species, essential oils can be extracted from different plant parts. From some of them, oils are extracted from the whole plant, or just from above-ground or underground plants' parts (Sovilj, Spasojević, 2001; Turek, Stintzing, 2013; Mathe, 2015).

The use of essential oils is diverse, while they are also used in dentistry. As stated Mirković (2002) "In dentistry and medicine, they are used towards their aromas, as aromatics, but also as antiseptics, analgesics, spasmolytic, expectorants, and carminatives". The usually used aromatic medicinal plants in dentistry or medicine are mint, chamomile, juniper, or lavender (Valnet, 2015).

Importance and possibility of using essential oils is multiple, while there come to increase in number of researches focused to efficient application of essential oils in agriculture and veterinary medicine. More precisely, researches are being performed towards reduction of pesticides use or decrease in veterinary drugs appliance, with possibility of changing them with essential oils (Benchaar et al., 2008; Pavela, Benelli, 2016). Duduk and associates (2010) experimented with alternative use of essential oils in plant protection, while they managed

thyme, cinnamon and cloves essential oils in controlling strawberry anthracnosis, as was verified that these products of extraction have anti-fungal effects. Grahovac and associates (2015) has been investigated the use of oregano essential oils in suppressing the appearance of *Monilia fructigena* on apple fruits. Performed research involved the use of four types of oregano essential oils that differ by geographical origins, while there was recorded that tested oils have the potential of bio-fungicide. Certain testing in veterinary medicine were done by Štrbac and associates (2022a; 2022b), as well as in the field of food safety, trying to assess the impact of essential oils on selected pathogenic bacteria isolated in meat production (Vidaković Knežević, 2022).

In line to huge importance and different ways of use of essential oils derived from medicinal plants, research serves to present economic analysis of investment in equipment for medicinal plants processing, i.e. essential oils production on the example of the Pljevlja coal mine.

## METHODOLOGICAL FRAMEWORK

In paper were used data collected form number of scientific and professional literature sources, as well as data of Coal mine enterprise from Pljevlja (Montenegro) that plans launching the facility for medicinal plants processing and essential oils production. This public company is planning the investment in distillery that will serve for processing the medicinal plants produced at 100 ha of company's plantation. Investment relates to required fixed assets (equipment) and permanent working capital (PWC), while the assessment period is 10 years.

In order to assess the economic effects of planed investment there are used common dynamic methods, as are Net Present Value, Internal Rate of Return and Payback Period (Ivanović, 2013; Gogić, 2014; Ivanovic, Marković, 2018; Gogić, 2021; Nastić et al., 2023; Nastić et al., 2024). In addition, there were applied method of annuities (Gogić, 2014), as intention was to determine and compare average annual incomes (B) and costs (T):

$$B = \left( \frac{b_1}{r} + \frac{b_2}{r^2} + \dots + \frac{b_n}{r^n} + \frac{B_n}{r^n} \right) \cdot \frac{r^n(r-1)}{r^n-1},$$

$$T = \left( A_0 + \frac{u_1}{r} + \frac{u_2}{r^2} + \dots + \frac{u_n}{r^n} \right) \cdot \frac{r^n(r-1)}{r^n-1}.$$

Where,

$b_1, \dots, b_n$  – incomes that derived from investment exploitation in certain years,

$u_1, \dots, u_n$  – costs made for investment exploitation in certain years,

$A_0$  – overall investment,

$B_n$  – salvage value,

$r$  – discount factor  $1 + \frac{p_k}{100}$ , while  $p_k$  is discount rate,

$n$  – period of investment exploitation.

If there are  $B - T \geq 0$  or  $\frac{B}{T} \geq 1$  investment is economically justified.

## RESULTS AND DISCUSSIONS

Essential oils production is planned based on processing 10 medicinal plant's species, such as: Lavandula Grosso, Lavandula Angustifolia, Sage, Thyme, Hyssop, Wild Oregano, Heather, Parsley, Sweet Wormwood and Lovage. From mentioned 10 medicinal plants, there are gained 11 products (essential oils), because two different essential oil are extracted from Lovage (one from herb, while second from root).

Overall investment amounts 344,300 EUR. Within the structure of overall investment (Table 1.) permanent working capital (PWC) accounts to 9.09%.

**Table 1.** Overall investment in medicinal plants processing (in EUR)

No.	Element	Overall investment	Share in overall investment (in %)
<b>I</b>	<b>Fixed assets</b>	<b>313,000</b>	<b>90.91</b>
1.	Equipment	313,000	90.91
<b>II</b>	<b>PWC</b>	<b>31,300</b>	<b>9.09</b>
<b>Total (I+II)</b>		<b>344,300</b>	<b>100.00</b>

Source: CMEP, 2023.

Investment in fixed assets entirely overlaps with investment in equipment, where investment in production equipment dominates (95.8%). In investment structure, other elements have much smaller share (laboratory equipment, apparatus for determining content of essential oil, etc.), (Table 2).

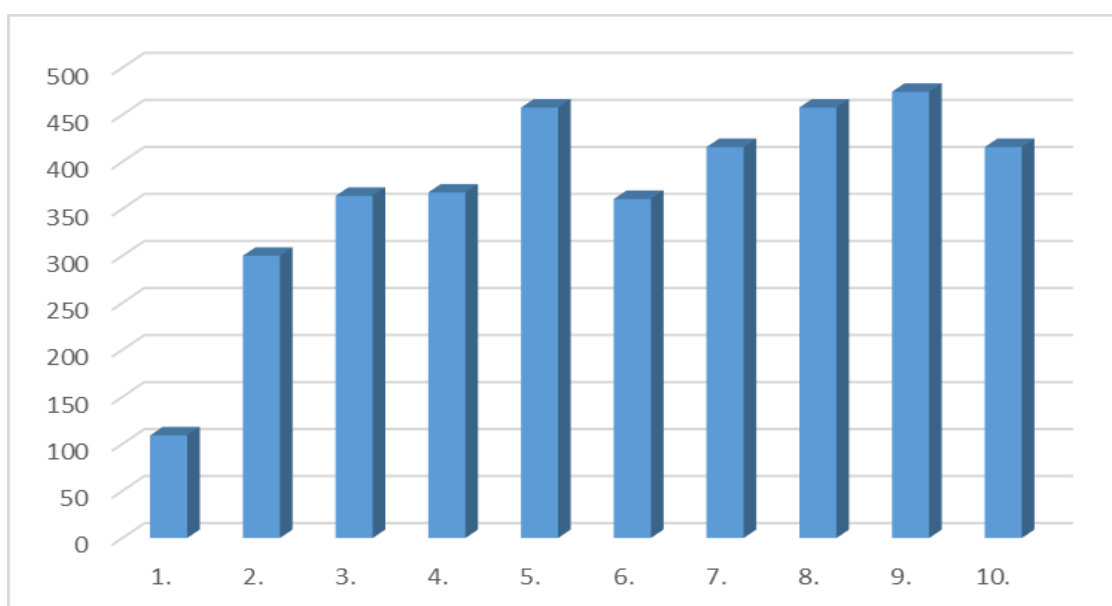
**Table 2.** New investment in fixed assets (in EUR)

No.	Element	Value without VAT	Value in %
<b>I</b>	<b>Equipment</b>		
1.	Production equipment	300,000.00	95.8
2.	Laboratory equipment (settled in master laboratory)	6,500.00	2.1
3.	Apparatus for determination of content of essential oils by Clevenger (heating pad or calotte)	1,500.00	0.5
4.	Apparatus – Digital densimeter	3,000.00	1.0
5.	Apparatus – Digital (refractometer and polarimeter)	2,000.00	0.6
<b>Total (1+2+3+4+5)</b>		<b>313,000.00</b>	<b>100.0</b>

Source: CMEP, 2023.

Investment in fixed assets is financed from own funds, while permanent working capital will be financed from short-term loan. Formation of total incomes from the planned investment over the observed period is shown in Graph 1., while it is based on the market value of produced essential oils from 10 medicinal plants' species. Income variability in certain years derived from characteristics of previously organized medicinal plants production (volume of different medicinal plants' species used in processing vary over the years). Planned prices are constant throughout the entire ten-year period.

**Graph 1.** Overall income forming per years of exploitation (in 000 EUR)



Source: CMEP, 2023.

Lavandula Angustifolia has the greatest importance (the largest share in formation of total income) during the most of observed production period. So, for example, the essential oil of mentioned plant during the 6<sup>th</sup> year of the investment exploitation participates in formation of total income with 42.9%, while the least impact of this medicinal plant is in the second year with share of 9%. On the other hand, the essential oils of Lovage (either gained from herb or root) have the weakest significance for incomes gaining, as they are even not produced in certain years (Table 3.).

**Table 3.** Share of certain products in overall incomes forming (in %)

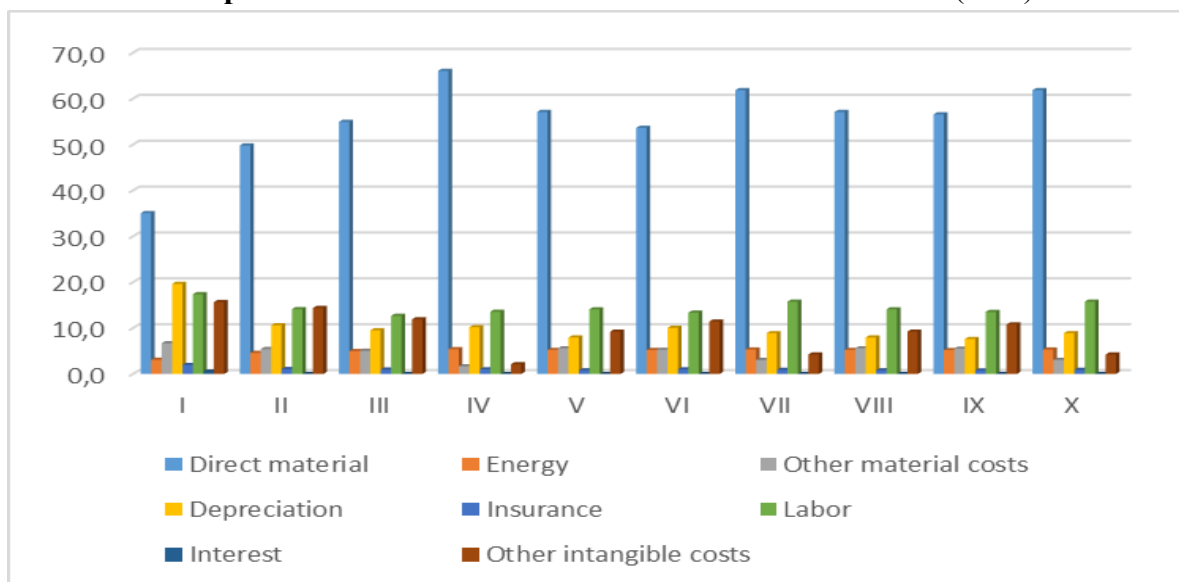
Product (essential oil)	Minimal share		Maximal share	
	Share in %	Year	Share in %	Year
Lavandula Grosso	2.7	II	10.5	VI
Lavandula Angustifolia	9.0	II	42.9	VI
Sage	3.8	VI	22.7	II
Thyme	0.6	VI	3.9	II
Hyssop	2.3	VI	7.5	II
Wild Oregano	5.6	VI	12.4	II
Heather	8.7	VI	16.9	II
Parsley	3.4	IX	5.4	II
Sweet Wormwood	3.5	IX	5.6	II
Lovage (herb)	0.0	IV, VII and X	14.0	II
Lovage (root)	0.0	There are no essential oils from root in several years II, IV, V, VII, VIII and X	4.7	VI

Source: CMEP, 2023.

The presentation of total costs that follow planned investment within entire period of exploitation is given in Graph 2. Direct material is the crucial element considering the structure of total costs, while they include only the costs of used raw material (medicinal herbs). Within the overall

costs, direct material has a share between 35.1% and 66.1% (considering the 1<sup>st</sup> or the 4<sup>th</sup> year of the investment exploitation). Besides, labor costs are also significant, as they participate with share from 12.7% to 17.4% within the sum of overall costs (considering the 3<sup>rd</sup> or the 1<sup>st</sup> year of investment exploitation), while the least important are the costs of interest, as they occurred just in the first year, or costs of insurance, as they range between 0.8% and 2%).

**Graph 2.** Share of certain costs in the structure of total costs (in %)



Source: CMEP, 2023.

According to previously mentioned data there was performed investment analysis that involves determining the value of dynamic indicators presented in Table 4. Considering that the Net Present Value of investment in production of essential oils is positive, while that the Internal Rate of Return is over the preset discount rate (7%), and that Payback Period of investment is shorter than the assumed lifetime of investment (10 years), it could be concluded that observed investment is economically justified for realization.

**Table 4.** Indicators of economic effectiveness of investment in medicinal plants processing

Dynamic indicators	Value
Net Present Value	131,433.43 EUR
Internal Rate of Return	12.62%
Payback Period	7 years and 9.84 months

Source: CMEP, 2023.

As additional method for assessing the economic effectiveness of planned investment, there was applied annuity method. According to its use, following results were obtained:  $B = 360,375.31$  EUR and  $T = 341,662.15$  EUR. Further applying of adequate formulas,  $B - T = 18,713.16$  EUR, what is over than zero, or  $B/T = 1.05$ , what is over than 1, have been showed than observed investment could be also considered economically justified.

## CONCLUSION

There is sharp increasing in number of consumers that are interested, or begin to use medicinal plants, in form of fresh or semi-processed (mainly dried), or in form of fully processed products (essential oils, tinctures, etc.), either as tool for disease and shortage in body functions prevention or their medical treatment. In line to mentioned market trends, there comes to increase in number of agricultural producers that have been interested for organizing the plantation production of medicinal plants, and later their processing into the wide range of final products. One of the most attractive way of processing is production of different essential oils. Therefore, performed research aimed to assess the economic efficiency of investing in medicinal plants processing, i.e. production of essential oils from previously in plantation system grown different plants.

Made investment analysis showed that the profit achieved in process of medicinal plants processing differs in certain years mainly due to specificities of preplanned sowing structure of medicinal plants in plantation production, i.e. it depends from volume and type of available raw material from which the essential oils are produced. Meanwhile, it was shown that in costs structure linked to medicinal plants processing, material costs are dominating. So, they deserve processors special attention. All values of indicators (dynamic methods and annuity method) used to assess the economic effectiveness of planed investment in medicinal plants processing (production of essential oils) show that observed investment could be considered economically justified.

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