Economic Analysis of Thyme (Origanum Syriacum) Production for Smallholder Farmers

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Abstract

Cultivation of medicinal and aromatic plants significantly contribute to affordable healthcare and livelihood security. This study aims to investigate the economic analysis of Syrian oregano (Origanum syriacum) production with total area of 1000 m², depending on some standard economic indicators. The results showed that the annual net profit constitutes 56% of the total annual revenues. Furthermore, the net present value after six years was a positive value, and the index of profitability was 2.71, which confirms the economic viability of this project. The internal rate of return (IRR) reached 90.67%, which is a good number compared to the bank interest rate. Although this project does not occupy large areas, (a small possession 500-2000 m² is sufficient for its establishment), but it is able to achieve guaranteed profits within a short period. Therefore, Thyme cultivation should be expanded by providing small farmers the necessary technical support and drawing their attention to economic efficiency of such project.

Keywords: Economic efficiency, Thyme, Economic indicators, Internal rate of return.

1. Introduction

Medicinal plants have been widely used since ancient times to prevent or treat various diseases. The past three decades have witnessed a massive surge in public interest and acceptance of natural remedies in both developing and developed countries. It is estimated that up to four billion people (representing 80% of the world’s population) rely on herbal medicinal products as an alternative treatment to traditional medicines. Moreover, about 25% of all modern medicines are derived directly or indirectly from medicinal plants [1]. Thyme (Origanum syriacum) is a perennial herb belonging to Lamiaceae family with height ranging from 60 to 90 cm, woody creeping roots, and branched woody hairy stems [2]. Its common name is Syrian Oregano [3], it found as a wild plant, and the Mediterranean region can be described as the center of it [4]. It is considered to the ancient Greeks, as a symbol of love, honor and happiness. Thyme grows well in a temperate to warm, dry, sunny climate, and where the plants are not shaded, it needs full sun to grow to its best potential. Thyme species do best in coarse, rough soils that would be unsuitable for many other plant. It is considered as very resistant plants, which allows it to live under extreme climatic conditions concerning temperature and water supply [5]. It is considered as one of most popular plants that has in addition to its culinary uses in salads, or with sesame and sumac what we know locally as “Zaatar”, many other uses as a way of traditional treatments that used for thousands of years, it well known for its antimicrobial [6], Antifungal [7], anti-inflammatory [8], and antioxidant activity [9].

Cultivation of medicinal and aromatic plants today is not only a promising alternative and counterpoint to wild collection, but also represents a powerful economy branch providing raw material for pharmaceutical, cosmetic and the food industry [10]. Medicinal properties gave Thyme an economic importance, and recently it has been receiving a great deal of interest throughout the world [11]. Green consumerism and resurgence of interest for plant based products, liberalized and free market economy, increasing awareness about biodiversity, conservation and sustainable use of natural resources coupled with poor socio-economic conditions of native populations are ground realities for planning and harnessing the low-cost and purpose oriented process [12]. This study shows the assumptions and results that assess the role of medicinal plants for improving livelihoods and an expansion of medicinal plant cultivation. Because, profitability of cultivation of medicinal plants compete with profit achievable for standard field crop. This cultivation should be expanded by providing the small farmers the necessary technical support and paying attention to post-harvest operations such as packing and packaging, especially those intended for export, which could achieve added value and contribute to increasing national income and attracting foreign exchange.
2. Aims and Objectives
Cultivated medicinal and aromatic crops is increasingly preferred by the herbal industry, because it is easier to predict plant yield, quality and drug composition, especially when compared with wild harvested raw materials. With growth in economic demand, the pressure on natural resources of medicinal plant has rapidly increased during the last few years. In order to stop further biodiversity loss, cultivation may reduce harvesting pressure on wild thyme, considering this practice as a successful project among small farmers supporting them economically, and attracting who are, due to war and its economic crisis, jobless looking for some extra sources of the income. Hence, this study aimed to:

- Addressing the requirements of thyme cultivation.
- Economic analysis of Syrian Origanum production with total area of 1000 m².

3. Materials and Methods

3.1 Experimental site
This study was conducted on the Syrian coast.

3.2 Time period of research
The data were collected in 2021

3.3 Research Material
Economic analysis and economic feasibility study as a kind of cost-benefit analysis using some economic indicators:

3.4 Annual net profit
Annual Net Profit = Annual Gross Revenue - Annual Total Costs

3.5 Return on Investment (ROI) Payback Period
Payback period is the time in which the initial outlay of an investment is expected to be recovered through the cash inflows generated by the investment. It is one of the simplest investment appraisal techniques. Projects having larger cash inflows in the earlier periods are generally ranked as successful projects [13].

\[
ROI = \frac{\text{Total Capital Investment}}{\text{Annual Net Profit}}
\]

3.6 Cost of cultivation
Benefit-cost analysis (BCA) is a technique for evaluating a project or investment by comparing the economic benefits of an activity with the economic costs of the activity [14]

\[
\text{Cost of Cultivation} = \frac{\text{Annual Total Costs}}{\text{Annual Production Volume}}
\]

3.7 Economic efficiency
Economic efficiency is the main qualitative factor of economic growth, it is a term used to estimate the results of an economic activity comparing to the efforts involved in the respective activity [15]

\[
\text{Economic Efficiency} = \frac{\text{Annual Output Income}}{\text{Annual Output Cost}}
\]
3.8 Net present value (NPV) [16]

Net present value (NPV) = Net present value of revenue - Net present value of costs

3.9 Benefit cost ratio

Is a technique for evaluating a project or investment by comparing the economic benefits of an activity with the economic costs of the activity [17]. The benefit cost ratio was worked out by following the equation

\[
\text{Benefit : Cost ratio} = \frac{\text{Gross Income}}{\text{Total Costs of Cultivation}}
\]

3.10 The internal rate of return

This standard is represented when the present value of revenues equals the present value of costs, it is the discount rate that makes the net present value of an investment exactly equal to zero [6]

\[
\text{IRR} = a + \frac{\text{NPVa}}{\text{NPVa} - \text{NPVb}} \times (b - a)
\]

a: the discount rate to calculate NPVa

b: the discount rate to calculate NPVb

4. Results and Discussion

Thyme (Origanum syriacum) is native to the Mediterranean region where it grows wild or cultivated commercially in different countries [18] for its leaves that are used fresh and dried or extracted for the flavoring oil [19]. Its cultivation witness great development as the global market, because it makes good profit, it regains its capital quickly, and keeps on producing for seven years, with an average of one harvest each forty days (3 times on average). It is also characterized with its resistance to pests and diseases. Agricultural projects are considered as one of the vital sources to boost the economy, moreover they are family nature, where all family members can collaborate in the operation and management of this project. Thus, this study is to investigate economic viability of thyme grown in one dunam using exposed agriculture and drip irrigation in Syrian costal area, the data obtained from thyme producers and companies in the study area through questionnaire and interpreted by tables. Financial analysis was done according to investment costs, operational costs (commodity and service supplies) and revenues, in order to address the net value of the project’s cash flow, which is an indicator of the financial feasibility of this project.

4.1 Investment costs (Establishment)

The investment costs include the following:

4.1.1. Land rent

This project of thyme cultivation needs about one dunam (1000 m²), as the average rent of agricultural land per dunam is 120 USD annually (Figure 1).

4.1.2. Water pump

Water pump is used to draw water out of the source to the water tank, and out this tank down into the pipes of drip irrigation. (Fig. 2), total cost of water pump is 100 USD.

Life span / 10 / year → annual depreciation = 100/10 = 10 USD.
4.1.3. Dripper lines with water hoses, filter and compost

Drip irrigation is followed as (Figure 3). Irrigation scheduling is determined according to the type of soil and climatic conditions, also various growth stages, the optimum water use should be considered. While, seasonal rain precipitation might provide part of the water requirements during the irrigation season, that thyme field is irrigated once a month in winter, every 7-10 days in summer, and every 15-20 days in spring and autumn. On average, it needs 20 irrigations per year, and hoses are needed to draw the water to dripper lines, also there is an installed filter to purify the water (Figure 4), also this irrigation system has a fertilizer tank in which fertilizer would be mix with water for quantitative nutrition. The desired amount of fertilizer placed in the tank, dissolved and injected into the irrigation system. Table (1) shows the price of drip irrigation system needed for one dunam.

| No. | Structure                  | Quantity | Unit Price ($) | Total Price ($) |
|-----|----------------------------|----------|----------------|-----------------|
| 1   | Dripper lines              | 2000 m   | 0.13           | 260             |
| 2   | Water hoses (1.5 inch diameter) | 25 m     | 0.8            | 20              |
| 3   | Water filter               | 1        | 14             | 14              |
| 4   | fertilizer tank            | 1        | 30             | 30              |
| 5   | Accessories                | ----     | ----           | 20              |
|     | Total                      | --       | --             | 344             |

The life span of drip irrigation system with its accessories is /10 / year’s

$\rightarrow$ annual depreciation = $344/10 = 34.4$ USD.
4.1.4. Seedlings

One dunam needs about 4,500 seedlings (Fig. 5), the price of one seedling is 0.012 USD.
So the cost of seedlings per dunam = 4500 x 0.012 = 54 USD.

As seedlings remain for about 7 years, and gradually replaced over the last two years, since their survival period is practically 6 years.

→ Annual depreciation = 54/6 = 9 USD.
In the following, Table (2) that shows the total and annual investment costs for one dunam thyme field (1000 m$^2$).

**Table 2.** The total and annual investment costs for one dunam thyme field (Unit USD).

| Component              | Total investment costs | Life span (year) | Annual depreciation |
|------------------------|------------------------|------------------|---------------------|
| Land rent              | -                      | -                | 120                 |
| Water pump             | 100                    | 10               | 10                  |
| Drip irrigation systems| 344                    | 10               | 34.4                |
| Seedlings              | 54                     | 6                | 9                   |
| Total                  | 498                    |                  | 173.4               |
| Capital interest 11%   | 54.78                  |                  | 19.074              |
| Petty cash 5%          | 24.9                   |                  | 8.67                |
| Total summation        | 577.68                 |                  | 201.144             |

### 4.2. Operating and production costs

#### 4.2.1. Agricultural operations and commodity requirements: It includes the following

##### 4.2.1.1. Tillage

Plowing the soil with deep plowing to a depth between 40–45 cm, followed by two shallow plows perpendicularly, thus, the total would be three tillers, since the fee of one plowing is 6 USD, then:

The cost of the plowing operation = the number of times of plowing x the fee of one plowing: $3 \times 6 = 18$ USD / dunam.

##### 4.2.1.2. Organic manure

To grow any crop, the point of paramount importance is to get maximum yield with minimum inputs. This includes standardization of nutritional requirements through organic and inorganic fertilizers. Integration of nutrient proved to be a best approach could increase the yield and quantity [20].

One dunam of thyme needs 1 m$^3$ of organic manure every year, at first year its application would be as a mixture with other fertilizers (phosphorous and potassium) before transplanting the seedlings, the price per cubic meter is 60 USD.

So the annual cost of organic manure = quantity x price = 1 x 60 = 60 USD.

##### 4.2.1.3. Mineral fertilizer

Phosphate and potash fertilizers mixing with organic manure as following dose: 10 kg superphosphate + 10 kg of sulfate will be applied as basal dose before planting, then after an after 45 days of transplanting nitrogen and potassium fertilizers will be added as follows: 10 kg of urea + 5 kg of potash.

As for urea, 10 kg should apply about a month before harvest also addition repeated after harvest, and similar method of application is followed after every harvest, so we need 60 kg of urea.

After weeding, chemical fertilizers are added in the following quantities:

- 5 kg phosphate + 5 kg potash, on August to November months

Therefore, the final required quantities of fertilizers are:

Used Urea fertilizer = 7 x 10 = 70 kg, and its cost of would be = 48 USD.

Used superphosphate fertilizer = 15 kg, and its cost would be = 6 USD.
Used potash fertilizer = 20 kg, and its cost would be = 12 USD.
Thus, Total cost of fertilizers = 48 + 6 + 12 = 66 USD / donum / year

4.2.1.4. Water

The needs water for thyme field cost 16 USD annually.
In the following, Table (3) that shows the costs of agricultural operations and commodity inputs for thyme cultivated in one dunam field.

Table 3. Costs of agricultural operations and commodity inputs for one dunam thyme field (Unit USD).

| Agricultural operations and commodity inputs | Annual costs |
|---------------------------------------------|--------------|
| Tillage                                     | 18           |
| Organic manure                              | 60           |
| Chemical fertilizer                         | 66           |
| Water                                       | 16           |
| Total                                       | 160          |
| Capital interest 11%                        | 17.6         |
| Total summation                             | 177.6        |

4.2.2. Labor costs it includes

a) The cost of land preparation:
   It includes removing stones and weeds before the planting in addition to applying the fertilizers mixture and leveling the soil, as two agricultural labors are needed to perform this work on one day, the wage of one agricultural labor is 3 USD, therefore,
   Labor Cost for soil preparation = number of workers \times worker's wages per day
   \[= 2 \times 3 = 6 \text{ USD / dunam.}\]

b) The cost transplanting: Two agricultural labors are needed to perform seedlings transplanting on one day, and the wage for one worker per day is (3) USD, so:
   Labor cost of seedlings transplanting for one dunam = number of workers \times wages per worker per day
   \[= 2 \times 3 = 6 \text{ USD / dunam}\]

c) The cost of irrigation and mineral fertilization: the field needs an average of 20 irrigations per year, and one agricultural labor could perform the irrigation process for an hour each time, that is, about 2.4 days so:
   Labor cost of irrigation and fertilization = number of working times \times number of workers \times worker's wages per day
   \[= 2.4 \times 1 \times 3 = 7.2 \text{ USD / dunams per year.}\]

d) The cost of weeding process:
The plants were kept weed free throughout the growing period by weeding at regular intervals. First weeding was done after 20 days of transplanting and later as and when required. Totally four weeding were done during the entire period of crop growth and harvest. This work is carried out by one labor, so:
   Labor cost of weeding = number of weeding times \times number of workers \times worker's wages per day
   \[= 4 \times 1 \times 3 = 12 \text{ USD / dunam per year.}\]
e) The cost of harvesting:

Thyme harvesting should be done just before the plant flowering, by cutting 10-15 cm above the ground level to ensure good regeneration capacity using secateurs to avoid any physical damage to the plants, two labor is needed to perform this work for one day with taking in consideration that thyme is harvested three times a year, so:

Labor cost of harvesting = number of harvesting × number of workers × worker's wages per day

\[ = 3 \times 2 \times 3 = 12 \text{ USD / dunam per year} \]

The details are in Table (4) that shows the labor costs for a field of one dunam that is cultivated with thyme.

**Table 4.** Labor costs of agricultural operations for one dunam thyme field (Unit USD).

| Labor Costs For                        | Annual Costs (Unit USD) |
|----------------------------------------|-------------------------|
| Land preparation                       | 6                       |
| Transplanting                          | 6                       |
| Irrigation and mineral fertilization   | 7.2                     |
| Weeding                                | 12                      |
| Harvesting                             | 12                      |
| Total costs                            | 43.2                    |

Table (5) shows the total annual operating and production costs, which include Agricultural operations and commodity requirements and labor costs for one dunam cultivated with thyme

**Table 5.** Total annual operating costs for one dunam thyme field (Unit USD).

| Operating costs                                     | Annual Costs (Unit USD) |
|-----------------------------------------------------|-------------------------|
| Agricultural operations and commodity requirements  | 177.6                   |
| Labor costs                                         | 43.2                    |
| Total costs                                         | 220.8                   |

Figure (6) shows the percentages of operating and labors costs for cultivation thyme field with an area of one dunam. As is apparent, investment costs recorded the highest percent with 54.22% of total costs, followed by agricultural operations and commodity requirements by 17.42%, while land rent was 13.07%, and finally, the labor costs with 4.7% of the total costs. Labor is an essential input for most agricultural activities, this project does not require high labor costs (man-days), producing more with less efforts, as the agricultural operations are simple and few comparing with other agricultural projects.

4.3. **Revenue and Sales**

The average annual production per dunam is about 1 ton of fresh thyme. The crop is harvested three times a year, with average of 350 kg thyme / dunam per one harvest. The price of one kilogram of fresh leaves of thyme is estimated at 0.96 USD.

\[ \text{Annual field revenues} = \text{cultivated area} \times \text{production per dunam (kg)} \times \text{price of 1 kg} \]

\[ = 1 \times 1,000 \times 0.96 = 960 \text{ USD}. \]

And according to this, Table (6) shows the annual costs, revenues, and annual net profit of a 1 dunam field planted with thyme.
Figure 6. Percentages of operating and labors costs for cultivation thyme field with an area of one dunam.

Table 6. The annual costs, revenues, and annual net profit for one dunam thyme field (Unit USD).

| Component                        | Value (USD) |
|----------------------------------|-------------|
| Annual investment costs          | 201.144     |
| Annual operating costs           | 220.8       |
| Annual total costs               | 421.944     |
| Annual total revenue             | 960         |
| Annual net profit                | 538.056     |

4.4. Economic analysis of one dunam thyme field

For the economic analysis of Syrian Oregano production with total area of 1000 m² some economic indicators were chosen such as:

4.4.1. Annual net profit

Annual Net Profit = Annual Gross Revenue - Annual Total Costs.

Annual net profit = 960 – 421.944 = 538.056 USD Therefore:

The profit ratio which is a profitability ratio that shows the relationship between net profit and total net sales revenue is equal to = (538.056/960) x 100 = 56.05%, and this ratio is excellent and much higher than the interest rate prevailing in Syrian Banks.

4.4.2. Return on Investment (ROI) Payback Period

Investment costs of this project estimated at 577.68 USD as showed in (Table 1).

→ Payback Period = Total Capital Investment / Annual net profit.

= 577.68/538.056 = 1.07 ≈ 1 year.

And this is considered as a very suitable period to recover the invested capital for this project.
4.4.3. Cost of cultivation 1 kg of thyme

Taking in consideration that the annual produced volume produced is 1 ton.

\[
\text{Cost of cultivation 1 kg of thyme} = \frac{\text{Annual total costs}}{\text{Annual production volume}}
\]

\[
= \frac{421.944}{1000} = 0.421 \text{ USD.}
\]

4.4.4. Economic Efficiency

Economic efficiency is the main qualitative factor of economic growth = Annual output income / Annual output cost

\[
= \frac{960}{421.944} = 2.275
\]

It is more than one, which indicates the feasibility of the project.

4.4.5. Accounting Rate of Return (ARR)

Accounting rate of return = (Annual total revenue / Annual total costs) x 100

\[
= \frac{960}{421.944} \times 100 = 227.5%. 
\]

And this number is considered as an excellent percentage that reflects the economic feasibility of this project because that exceeds 100%.

4.4.6. Net present value (NPV)

Net present value (NPV) = Net present value of revenue - Net present value of costs

Considering that the discount factor: is a fixed number, as a discontinuous number of cash flows, and that is to give the correct values of numbers related to cash flows over the project’s years, using the following equation:

\[
\text{Discount factor} = \frac{1}{(1 + m)^n}
\]

As: \( m = \text{discount rate} \), \( n = \text{number of years from 1, 2, 3 ....} \) etc.

**Table 7.** The present value of annual costs and revenues at a discount factor of 10% (Unit USD).

| Year No. | Total costs | Total revenues | Discount factor of 10% | Present value of costs at a discount factor of 10% | Present value of revenues at a discount factor of 10% | Net present value |
|----------|-------------|----------------|------------------------|-----------------------------------------------|-------------------------------------------------|------------------|
| 0        | 577.68      | 0              | 1                      | 577.68                                        | 0                                               | -577.68          |
| 1        | 220.8       | 960            | 0.909                  | 200.7072                                      | 872.64                                         | 671.9328         |
| 2        | 220.8       | 960            | 0.826                  | 182.3808                                      | 792.96                                         | 610.5792         |
| 3        | 220.8       | 960            | 0.751                  | 165.8208                                      | 720.96                                         | 555.1392         |
| 4        | 220.8       | 960            | 0.683                  | 150.8064                                      | 655.68                                         | 504.8736         |
| 5        | 220.8       | 960            | 0.621                  | 137.1168                                      | 596.16                                         | 459.0432         |
| 6        | 220.8       | 960            | 0.564                  | 124.5312                                      | 541.44                                         | 416.9088         |
| Total    | 1902.48     | 5760           |                        | 1539.043                                      | 4179.84                                        | 2640.797         |

The net present value (after 6 years at a discount rate of 10%) = 4179.84 – 1539.043 = 2640.797 USD. Since the net present value is of positive value, this indicates that the project is economically feasible.

4.4.7. Revenue / Cost Ratio (Profitability Index)

Benefit/cost ratio (at appropriate discount factor) = Gross income (present value of revenues / Total cost of cultivation (present value of costs)

And based on Table (7):

\[
\text{Benefit / Cost Ratio (at a 10% discount factor)} = \frac{4179.84}{1539.043} = 2.71
\]
This value is greater than 1, and this is another indication that the project is economically viable.

4.4.8. Economic analysis and the present value of cash flows at discount rates of 90% - 95%

Table (8). Shows the revenues and net profit of one dunam thyme field during the six years of this project, and Table (9). Shows the present value of net profit over six years at the discount rates of 90% -95%.

| Year No. | Investment costs | Operating costs | Total costs | Total revenue | Net profit |
|---------|------------------|----------------|-------------|---------------|------------|
| 0       | 577.68           | 220.8          | 798.48      | 0             | -798.48    |
| 1       | 0                | 220.8          | 220.8       | 960           | 739.2      |
| 2       | 0                | 220.8          | 220.8       | 960           | 739.2      |
| 3       | 0                | 220.8          | 220.8       | 960           | 739.2      |
| 4       | 0                | 220.8          | 220.8       | 960           | 739.2      |
| 5       | 0                | 220.8          | 220.8       | 960           | 739.2      |
| 6       | 0                | 220.8          | 220.8       | 960           | 739.2      |
| Total   | 577.68           | 1545.6         | 2123.28     | 5760          | 3636.72    |

| Year NO. | net profit | Discount factor at 90% | Present value at 90% | Present value at 95% |
|----------|------------|------------------------|----------------------|----------------------|
| 0        | -798.48    | 1                      | -798.48              | 1                    | -798.48    |
| 1        | 739.2      | 0.5263                 | 389.041              | 0.5128               | 379.0618   |
| 2        | 739.2      | 0.2770                 | 204.7584             | 0.2630               | 194.4096   |
| 3        | 739.2      | 0.1458                 | 107.7754             | 0.1349               | 99.71808   |
| 4        | 739.2      | 0.0767                 | 56.69664             | 0.0692               | 51.15264   |
| 5        | 739.2      | 0.0404                 | 29.86368             | 0.0355               | 26.2416    |
| 6        | 739.2      | 0.0213                 | 15.74496             | 0.0182               | 13.45344   |
| Total    | 3636.72    | -                      | 5.4                   | -                    | -34.4429   |

4.4.9. The internal rate of return

This standard is represented when the present value of revenues equals the present value of costs, it is the discount rate that makes the net present value of an investment exactly equal to zero [6].

$$IRR = a + \frac{NPVa}{NPVa - NPVb} \times (b - a)$$

$$IRR = 90 + \left[ \frac{5.4}{(5.4 + 34.4429)} \right] \times (95-90) = 90.67\%$$

Thus, this project can recover the capital and cover the production and operating costs in addition to achieving an additional return or profit of 90.67% on the used funds, which is higher than the standard interest rate for long-term loans given by
Syrian Banks, and that indicates the priority and importance of this project as a vital source to boost the economy and increase the Syrian farmers income, taking in consideration that the internal rate of return is higher than the global average of 12%.

Conclusion

Medicinal and aromatic plants offer an alternative source of income for farmers, Syrian Origanum, has an important place in Syrian cultural identity and its demand have been increasing gradually. According to this study, the project of thyme cultivation is economically feasible depending on many studied economic indicators. Therefore, Agricultural extensions and decisions makers should take some measurements to encourage farmers to transfer thyme production from wild agriculture to a research-based and organized one. Furthermore, there are needs to expand the scope of the control and high-quality production practices at all stages of the process, from field to packaging. With these standards, it will be possible to produce products with higher quality and therefore economic value, and the producers will be able to earn more profit.

References

[1] Abdullah G.P., Zohreh E. B., Fatemeh M. (2015). An overview on genus Thymus., Journal of Herbal Drugs., 6(2): 93-100.
[2] Amr E. Edris, Ahmed S. Shalaby, Hoda M. Fadel, (2009). Effect of Organic Agriculture Practices on the Volatile Flavor Components of some Essential oil Plants Growing in Egypt: III. Thymus vulgaris L. essential oil., Journal of essential oil-bearing plants., 12 (3): 319 – 326.
[3] Baraa Almansour, Kalaivanan, D and Suryanarayana, M.A. (2019). Effects of organic and inorganic fertilizers on soil fertility, nutrient uptake and yield of French basil. International Journal of Phyto medicines and Related Industries., 11(1):40-45.
[4] Bipin Chandra Joshi & Rakesh K. Joshi, (2014 ). The Role of Medicinal Plants in Livelihood Improvement., International Journal of Herbal Medicine; 1 (6): 55-58
[5] Boardman, A.E., D.H. Greenberg, A.R. Vining and D.L. Weimer (1996). Cost Benefit Analysis: Concepts and Practice. Englewood Cliffs, NJ: Prentice Hall.
[6] Carlo A. M., (2010). Average Internal Rate of Return and Investment Decisions: A New Perspective., The Engineering Economist., 55:1-39.
[7] Anmar Razak Khamis and Alaa Sabeeth Jabbar, 2021, Evaluation of The Predatory Efficiency of Orius Albidipennis Reuter for Two Prey Species Myzus Persicae (Sulzer) and Thrips Tabaci Lind. on The Carrot Plant in Laboratory, Al-Qadisiyah Journal For Agriculture Sciences, 11, 1, 14-22. doi: 10.33794/qjas.2021.168286
[8] Ethan Basch, (2004). Thyme (Thymus vulgaris L.), Thymol. Journal of Herbal Pharmacotherapy, 4(1):49-66.
[9] Fardos A. M. Hassan & Ashraf Awad, (2017). Impact of thyme powder (Thymus vulgaris L.) supplementation on gene expression profiles of cytokines and economic efficiency of broiler diets, Environ Sci Pollut Res., 24:15816–15826.
[10] Shakir, A.A., Salman, E.F., Shakir, A.J., Mohammed, M.A., Abdulridha, W.M., Almayahi, B.A., (2019), Optical properties of polyvinyl alcohol membrane with n-HAp for bio-medical applications, Prensa Medica Argentina, 105 (11), pp. 836-841.
[11] Fernanda, C., Fachiini-Q., Raquel K., Camila F. E.-Silva, Maria D., Joice M., Renata G., Ciomar A., Bersani-A., Roberto Kenji N. C., (2012), Effects of Thymol and Carvacrol, Constituents of Thymus vulgaris L. Essential Oil, on the Inflammatory Response, Evidence-Based Complementary and Alternative Medicine, 10:1-10.
[12] Foteini K., Efstathios, G., Julien D, Agapi, D., (2016). Hydrosol of Thymbra capitata is a highly efficient biocide against biofilms of Salmonella Typhimurium: real-time visualization of bacterial inactivation by CLSM. Applied and Environmental Microbiology 82 (17).
[13] Gerald S., (2012). An Overview of Benefit-Cost Analysis., discussions, stats, at: https://www.researchgate.net/publication/255661807.
[14] Ismet Ozturk , (2014). Antifungal Activity of Propolis, Thyme Essential Oil and Hydrosol on Natural Mycobiotata of Sucuk, a Turkish Fermented Sausage: Monitoring of Their Effects on Microbiological, Color and Aroma Properties. Journal of food processing, 39(6): 1148-1158.
[15] Jamzad, Z.(. 2010). Thymus and Satureja spp of Iran, Research institute of Forests and rangelands Press, 172 P.
[16] Marianela G., (2011). Economic efficiency and profitability., Studia Universitatis „Vasile Goldis” Arad – Economics Series.,116-119.
[17] Peter A. and Alexei B., (2011). The Use of Return on Investment (ROI) in the Performance Measurement and Evaluation of Information Systems., Project. Toronto, Ontario, Canada.5–3-11.
[18] Salman, S.R., Hassan, H.B., Mohammed, M.A., (2018), The Hydrogen and Sulfur Surfaces Effect on the Structural and Electronic Properties of Graphene Nano Ribbon. Journal of Global Pharma Technology, 10 (6), pp. 386-392.
[19] Seidemann J. World Spice Plants: Economic Usage, Botany, Taxonomy. 1st ed. Berlin, Heidelberg: Springer-Verlag; 2005.
[20] World Health Organization; (2019). WHO global report on traditional and complementary medicine, Geneva: Licence: CC BY-NC-SA 3.0 IGO.