Impact of Drying Method on the Bioactive Compounds in Extracts from the Leaves of Moroccan Myrtus Communis L

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Abstract
This study examines the impact of different drying methods on the secondary metabolites and antioxidant activity of the leaves of Moroccan *Myrtus communis* L., an important aromatic and medicinal plant. The fresh plant material collected was treated with five drying methods before the methanolic extraction of the dry leaves. The results show that the choice of drying method significantly influences the preservation of bioactive compounds. Indirect HD drying proved to be the most effective method for maintaining extract quality, particularly in terms of preserving polyphenols and antioxidant activity. However, air drying also showed promising results, offering an economical and sustainable alternative. The variability observed between the different compounds (polyphenols, flavonoids, sugars) underlines the need for a nuanced approach in the choice of drying method, depending on the specific compounds of interest. These results highlight the importance of the choice of drying method in optimizing the quality of *Myrtus communis* L. leaf extracts. This research provides a solid basis for optimizing drying practices in the aromatic and medicinal plant industry in Morocco, while highlighting the importance of a holistic approach that takes into account economic, environmental and practical aspects.

Keywords: Myrtus communis L., Drying, Bioactive compounds.

1. Introduction

Thanks to its unique geographical position and climatic diversity, Morocco is home to an exceptionally rich and varied flora. This remarkable biodiversity translates into considerable potential for aromatic and medicinal plants (MAP), with more than 800 endemic species. This natural wealth positions Morocco as a major player in the production and export of aromatic plants and their extracts worldwide [1, 2].
Medicinal plants, defined in pharmacopoeias as plants with at least one part with medicinal properties, are characterized by their complex secondary metabolism. This complexity is reflected in a wide variety of chemical structures, depending on the species [3]. Among these plants, *Myrtus communis* L., commonly known as Myrtle, occupies a prominent position. This aromatic shrub of the Myrtaceae

family, which is widespread throughout the Mediterranean Basin as far as the Middle East and Asia, is of significant ecological and socio-economic importance [4, 5, 6, 7].
Recent research has highlighted the versatility of myrtle. In addition to its ornamental use (Agrimonti et al., 2007), it plays a crucial role in traditional medicine, the cosmetics industry and the agri-food sector [3]. In Morocco, myrtle leaves are traditionally used to treat a variety of ailments, testifying to their therapeutic virtues [8]. In addition, leaf extracts have demonstrated strong antioxidant activity and antimicrobial properties, paving the way for potential applications in the food, pharmaceutical and cosmetics industries. The richness of essential oils, tannins, phenolic acids and flavonoids in myrtle leaves and fruit reinforces its scientific and commercial interest [9].
Despite the significant evolution in the characteristics of Myrtle bioactives in Morocco and the intensification of research into the extraction of essential oils, the effect of drying methods on the secondary metabolites of this plant remains an insufficiently explored area. Inadequate drying can lead to significant deterioration of the plant, resulting in total loss of its oils [10]. Bioactive compounds, particularly antioxidants, phenolics, flavonoids and anthocyanins, are particularly vulnerable to heat, oxygen and light during the drying process [11]. Drying is therefore a crucial step in the processing of agricultural crops and medicinal plants, aimed at preserving their properties [11]. This procedure is essential for maintaining the quality of the leaves by reducing their moisture content, thus inhibiting microbial proliferation and preventing chemical alterations during storage [12]. In addition, drying optimizes storage by reducing mass and volume, while concentrating the active components and preserving the nutritional values of the plants [13]. Drying techniques vary from direct exposure to the sun to more sophisticated methods such as direct [14] or indirect [2] kiln drying.
In this context, our study aims to assess the impact of drying methods on the bioactive compounds in methanolic extracts of Moroccan Myrtle leaves. This research is part of an effort to optimize conservation practices and enhance the value of this valuable natural resource for Morocco.

2. Materials and methods

2.1 Plant material

Fresh leaves were systematically sampled between December 2021 and February 2022. The plant material was carefully stored in paper bags. This plant material was kept in the refrigerator at 4°C until it was used for the different drying modes.

2.2 Drying modes tested

The drying operations were carried out in the drying laboratory of the physics department of the Agdal Faculty of Science, Mohammed V University. The types, definitions and principles of drying methods are as follows:

Indirect dryer

In indirect solar dryers, the products to be dried are not exposed to direct sunlight. In fact, they are protected from light, which means that the nutritional qualities of the food are better preserved. Indirect dryers essentially consist of two parts: a solar collector and a drying chamber. The solar collector is generally a separate module that is attached to the drying chamber during exposure to the sun, and is tilted to maximise the capture of solar energy. It consists of a glass surface above and an absorbent surface, usually painted black. The air is first heated in the solar collector, and then led into the drying chamber where heat is transferred from the air to the product. There are two types of indirect dryer [14]. There are two types of indirect dryer, namely:

- Indirect dryer type 1 (Sech Ind HJ) (Figure 1a): This is a dryer composed of two compartments: a collector and a drying chamber.
- Indirect dryer type 2 (Sech Ind HD) (Figure 1b): This is a single-compartment dryer that both absorbs radiation and dries [24].

Greenhouse drying

The greenhouse is a framed structure surrounded by transparent roofs and walls made of glass, polycarbonate, polyethylene film, etc. The operating principle of greenhouse technology is based on placing the product in trays receiving solar radiation through a plastic cover, and moisture is removed by natural or forced convection [25]. For this processing mode there are two sub-types of drying: i) indirect greenhouse (Serre Ind) for this type using the products in another block inside the greenhouse, ii) direct greenhouse (Serre Directe): The products are spread out on racks or mats in the greenhouse directly [26].

- Ambient free air (Outside air)

In this type of dryer, amber drying in ambient air is used directly. The plant material is spread out on racks or mats, or on the ground.

2.3 Grinding

After each drying operation, the dried samples were ground using an electric grinder of the type (IKA model A11 basic), to obtain a powder which was stored in tins for the methanolic extraction of the treated myrtle leaves.

2.4 Preparation of methanolic extract

The extraction was carried out according to the protocol of Bouyahya et al. [27]. 3 g of myrtle fruit were extracted with 20 ml of pure methanol by maceration at room temperature for 3 days. The crude extract obtained was filtered through filter paper, then concentrated in a rotary evaporator and finally dried at room temperature. The dry residue recovered is weighed to determine its yield.

Calculation of yield

The extraction yield was obtained using the following formula: $R (\%) = (Me/Mv) \times 100$. With

R (%): Extraction yield in %,

Me: Mass of extract after evaporation of solvent,

Mv: Mass of plant material used for extraction.

2.5 Determination of total polyphenols

The total polyphenol content of the extracts was determined by the Folin Ciocalteu method [28] with the modifications described by Laouicha et al. (2020). A volume of 0.3 ml of each extract was added to 1.5 ml of Folin-Ciocalteu reagent over 4 min. Next, 1.2 ml of sodium carbonate Na_2CO_3 (7.5%) was added. After one hour's incubation at room temperature, absorbance was measured at 750 nm using a spectrophotometer. The calibration curve was run with gallic acid at different concentrations. The results are expressed in milligrams of gallic acid equivalent per gram of dry extract (µg GAE/mg extract).

2.6 Determination of total flavonoids

The total flavonoid content of the methanolic extract of myrtle leaves was determined using the method described by Tenuta et al. (2002). 250 µl of the extract was added, followed by 1250 µl of distilled water and 75 µl of 5% sodium nitrite. After 5 min, 150 µl of ammonium trichloride ($AlCl_3$ 10%) was added. After 5 min, 500 µl of 1M sodium hydroxide was added, the reaction mixture was made up to 2.5 ml and the solution obtained was shaken vigorously. The absorbance was measured at 510 nm after 30 min.

Catechin was used as the standard to plot the calibration curve. Results were expressed as milligram catechin equivalent per milligram extract (µg CE/mg extract).

2.7 Total sugars

Extraction of total soluble sugars

Soluble sugars were extracted in accordance with the method of Babu et al [31]. For this extraction, 0.4g of sample was ground with 2 ml (Vethanol) of 80% ethanol and then introduced into tubes suitable for centrifugation. This was done at 2000 rpm for 40 min. The supernatant was then introduced into centrifuge tubes and stored at 4°C until use.

Determination of total soluble sugars

Total soluble sugars were determined by the method of Dubois et al. [32]; 50 µl of extract (Vextrait) was added to 0.5 ml of 5% phenol and 1.5 ml of sulphuric acid solution (H_2SO_4). The mixture was heated in a water bath at 100°C for 5 minutes. After cooling in melting ice, the optical density (OD) was read at 485 nm.

A standard was constructed using a glucose range from a 1 mg/mol stock solution. The contents are expressed in mg/g of fresh matter. The formula is as follows:

Sugar content= (DO*Vethanol) / (a*Vextract*PF)

a: Directing coefficient of the calibration line;

V ethanol: Volume of ethanol in ml;

V extract: Volume of extract in µl;

FP: Fresh weight of plant material used in g ;

OD: Variation in optical density.

2.8 Antioxidant activity: 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging test

Antioxidant activity was assessed by measuring the scavenging power of the DPPH (1,1 -Diphenyl-2-picryhydrazyl) radical according to the method described by Bouyahya et al. [27]. Where 0.3 ml of different concentrations of methanolic extract are mixed with 2.7 ml of DPPH solution (0.1 mM). After 30 min of incubation at room temperature and protected from light, absorbance is measured at 517 nm. The results obtained by measuring the anti-free radical activity of DPPH were expressed in relation to those obtained by measuring the activity of Ascorbic acid (Vitamin C), the reference antioxidant, at different concentrations under the same conditions.

The anti-free radical activity of the extracts was expressed as a percentage according to the formula : **% I = (ADPPH - A sample) / A DPPH**

ADPPH: Absorbance of the control (Methanol + DPPH);

A sample: Absorbance of sample (Extract + DPPH).

The 50% inhibitory concentration (IC50) was determined from the DPPH reduction percentages. The IC50 is expressed in µg/ml and is compared with that of the standards.

2.9 Statistical analysis

Descriptive analysis and one-way analysis of variance (ANOVA I, drying mode) were performed using IBM SPSS 26 software.

3. Results

This study examined the impact of different drying methods on the bioactive compounds and antioxidant activity of *Myrtus communis* L. leaves from Morocco. The results show that the drying method has a significant influence on the content of secondary metabolites and the antioxidant properties of the extracts.

3.1 Impact of drying methods on secondary metabolites

Extraction yield

Extraction yield varied considerably according to the drying method used (Figure 2). Indirect greenhouse drying appears to give the highest yield (11% ± 1.5), followed by drying in free ambient air (7.67% ± 0.78). Direct greenhouse drying (5% ± 0.69) and indirect dryer methods type 1 (7.67% ± 0.78) and type 2 (4.67% ± 0.77), produced lower yields. This suggests that drying conditions affect the preservation and extractability of bioactive compounds in myrtle leaves.

Phenolic compound content

The results in Table 1 show significant differences in total polyphenol content depending on the drying method. Indirect drying type 2 produced the highest polyphenol content (498.91 ± 42.96 µg EAG/mg extract), followed by open air drying (477.30 ± 2.34 µg EAG/mg extract). On the other hand, indirect greenhouse drying gave the lowest content (245.21 ± 14.88 µg EAG/mg extract). These results suggest that drying methods at low temperature and protected from direct light (such as indirect drying type 2) better preserve phenolic compounds. High temperatures and prolonged exposure to light in greenhouse drying methods could lead to degradation of the phenolic compounds.

Flavonoid content

In contrast to total polyphenols, the highest flavonoid content was observed with indirect greenhouse drying (73.41 ± 1.18 µg EC/mg extract), followed by indirect drying type 1 (64 ± 2.12 µg EC/mg extract). Indirect drying type 2, which gave the highest polyphenol content, produced the lowest flavonoid content (41.65 ± 2.12 µg EC/mg extract). This discrepancy could be explained by the different sensitivity of the various classes of phenolic compounds to drying conditions. Flavonoids could be more stable under certain conditions that degrade other types of phenolic compounds. The results of the descriptive statistics and the one-way analysis of variance (ANOVA) show that the differences observed are significant. Furthermore, this analysis suggests that the heat generated by the drying methods has an influence on the total flavonoid content.

Sugar content

The sugar content showed great variability between drying methods, with significant standard deviations for some methods. Direct greenhouse drying gave the highest average sugar content (0.57 ± 0.72 g/100g DM). Indirect greenhouse drying produced the lowest content (0.11 ± 0.01 g/100g DM). The results observed for indirect dryer type 1 and type 2 show contents of 0.17 g/100 g DM and 0.21 g/100 g DM with a coefficient of variation of CV = 4.24% and 8.98%, respectively. On the other hand, the sugar content of the extracts of air-dried leaves was average (0.24 g/100 g DM). The sugar content was higher in the high-temperature drying mode. This result could be due to differences in the degradation of complex sugars or variations in extraction efficiency depending on the drying conditions.

3.2 Antioxidant activity (IC 50)

Figure 3 shows the median inhibitory concentration (IC50) values for different drying methods applied to *Myrtus communis* L. leaves. The IC50 is a measure of antioxidant activity (a lower value indicates higher antioxidant activity). The antioxidant activity of compounds is due to their reducing power. This power is assessed by the DPPH test.

Analysis of the results shows that the direct greenhouse drying method had the lowest IC50 value (36.63 µg/mL), indicating that it produced the extract with the highest antioxidant activity. The method of drying the leaves with free air gave the highest IC50 value (68.54 µg/mL), suggesting the lowest antioxidant activity of the methods tested. The other drying methods fall between these two extremes, with IC50 values as follows: 47.92 µg/mL for indirect dryer type 1, 54.81 µg/mL for indirect greenhouse, and 56.61 µg/mL for indirect dryer type 2.

There was significant variation between the different drying methods ($P < 0.001$), suggesting that the drying method has a significant impact on the preservation of antioxidant activity. Controlled drying methods (such as direct greenhouse and indirect type 1 dryer) generally appear to preserve antioxidant activity better than open air drying. This analysis shows that the choice of drying method can have a significant impact on the quality of extracts in terms of antioxidant activity. Direct greenhouse drying appears to be the most effective method for preserving the antioxidant properties of *Myrtus communis* leaves in this study.

3.3 Inhibition kinetics as a function of concentration

Figure 4 shows the inhibition percentages as a function of concentration (mg/ml) for different drying modes applied to extracts of *Myrtus communis* L. For all drying modes, the analysis reveals an increase in inhibition percentage with increasing concentration, which is typical for antioxidant activity tests. Efficacy at low concentration: At 50 mg/ml, "Direct Greenhouse" drying appears to be the most effective, closely followed by indirect type 2 drying. Type 1 indirect drying shows the lowest efficiency at this concentration. At 200 mg/ml, all the drying methods reached an inhibition plateau of around 90-95%, independent of the drying method. The differences between the methods are less pronounced at this concentration. This suggests a maximum efficiency limit.

At low concentrations, comparison between drying methods is recommended. The direct greenhouse drying method appears to be generally more effective, especially at low concentrations. Open-air drying shows average performance. On the other hand, type 1 indirect dryer drying starts with the lowest efficiency but quickly catches up with the other methods at high concentrations. This suggests that the choice of drying method may be more crucial for applications requiring low extract concentrations, where the differences between the methods are more pronounced.

This analysis suggests that the drying method has a significant impact on the antioxidant efficacy of extracts, particularly at low concentrations. Direct greenhouse drying appears to offer advantages, but the optimal choice may depend on the intended use concentration and other practical or economic factors.

4. Discussion

4.1. Impact of drying methods on phenolic compounds and on Antioxidant activity

Polyphenols: The results of this study show that indirect drying type 2 best preserved total polyphenols (498.91 ± 42.96 µg EAG/mg of extract). This observation is consistent with the work of Rahimmalek and Goli [15], who reported that low-temperature drying methods better preserve phenolic compounds in aromatic plants. They found that drying in the shade and at low temperatures (25°C) maintained higher levels of phenolic compounds compared to drying in the sun or at higher temperatures. The lower polyphenol content observed with greenhouse drying (245.21 ± 14.88 µg EAG/mg of extract) could be explained by the thermal degradation of phenolic compounds. This hypothesis is supported by the study of Hossain et al. [16], who demonstrated that high drying temperatures (>60°C) led to a significant decrease in phenolic compounds in aromatic herbs.

Flavonoids: Unlike total polyphenols, the highest flavonoid content was observed with indirect greenhouse drying (73.41 ± 1.18 µg EC/mg extract). This divergence is interesting and could be explained by the synthesis of certain new flavonoids in response to moderate thermal stress. This hypothesis is supported by the work of Sánchez-Rodríguez et al. [17], who showed that moderate heat stress can induce the biosynthesis of certain flavonoids in plants as a protective mechanism.

Antioxidant activity: A relationship between the total polyphenol content and the antioxidant activity (measured by the IC50 of the DPPH test) is observed. This strengthens the hypothesis that polyphenols are the main contributors to the antioxidant activity of *Myrtus communis* extracts. The fact that indirect drying type 2 produced both the highest polyphenol content and the highest antioxidant activity highlights the importance of this method for preserving the bioactive properties of the leaves. The observed correlation between total polyphenol content and antioxidant activity (measured by the IC50 of the DPPH assay) is consistent with many previous studies. For example, Tawaha et al. [18], demonstrated a strong positive correlation between total polyphenol content and antioxidant activity in various medicinal plants.

However, it is important to note that antioxidant activity does not only depend on the total amount of polyphenols, but also on their specific nature and potential synergy with other compounds. The drying method could influence not only the quantity, but also the qualitative composition of antioxidant compounds. As pointed out by Cai et al. [19], some individual phenolic compounds may have higher antioxidant activity than others, even at lower concentrations.

4.2 Impact of drying methods on sugar content

The large variability observed in the sugar content, particularly for direct greenhouse drying (0.57 ± 0.72 g/100g), deserves particular attention. This variability could be linked to complex transformations of sugars during drying. As shown by Vega-Gálvez et al. [20] in their study on berry drying, drying conditions can significantly influence not only the total sugar content, but also the profile of different types of sugars. The variability observed in the results, particularly for sugar content, highlights the complexity of the processes involved in drying medicinal plants. Factors such as drying time, relative humidity, and temperature fluctuations could play an important role.

4.3 Implications for quality and business value

The results of this study have significant implications for the aromatic and medicinal plant industry. The significant variation in the content of bioactive compounds depending on the drying method is in agreement with the findings of Sellami et al. [21], which highlighted the crucial importance of the choice of drying method to preserve medicinal plant quality. The fact that drying in outside air gave good results is particularly interesting from a practical and economic point of view. This is consistent with the observations of Müller and Heindl [22], who noted that traditional drying methods can often produce results comparable to more advanced methods, while being more accessible to small producers.

These results and conclusions provide a solid basis for the optimization of drying practices in the aromatic and medicinal plant industry in Morocco, particularly for *Myrtus communis* L., and pave the way for future research in this crucial area for the valorization of the country's natural resources. The results of this study highlight the crucial importance of the drying method in preserving the bioactive compounds of Myrtle leaves. Greenhouse drying methods, although effective for certain compounds such as flavonoids, seem less suitable for preserving all bioactive compounds. This could be due to higher temperatures or prolonged exposure to light. Also, air drying, as traditional and economical method, showed good results. This result encourage for producers with limited access to advanced technologies. These results suggest that optimization of drying methods could significantly improve the quality and value of Myrtle-derived products.

4.4 Ecological and economic considerations

The comparison between natural (open air) and artificial (dryer, greenhouse) drying methods raises important questions about the balance between product quality, energy cost and environmental impact. Although indirect drying type 2 seems to offer the best results in terms of preserving bioactive compounds, its energy cost and its accessibility for small producers must be considered. This study highlights the importance of a holistic approach in the production of medicinal plants, taking into account not only the preservation of bioactive compounds, but also economic and environmental aspects, a perspective widely supported in recent literature on sustainable production of medicinal plants [23]. Particularly encouraging is the fact that air drying, a traditional and economical method, gave good results for the preservation of polyphenols and antioxidant activity. This suggests that it is possible to obtain high quality products without necessarily resorting to advanced and expensive drying technologies.

5. Conclusions

This study confirms the crucial importance of the choice of drying method for preserving the bioactive compounds of *Myrtus communis* L. The variability of the results between the different compounds highlights the need for a nuanced approach to the choice of drying method, depending on the specific compounds of interest.

This study shows that the drying method has a significant impact on the preservation of secondary metabolites and the antioxidant activity of *Myrtus communis* leaves. Indirect type 2 drying appears to be the most promising method for maintaining extract quality. However, further research is needed to optimize the drying parameters and fully understand the degradation mechanisms of bioactive compounds during the drying process. However, open air drying also offers good results, which is promising for sustainable and economical production.

In conclusion, these results provide a solid basis for optimizing drying practices in the Moroccan aromatic and medicinal plant industry, particularly for *Myrtus communis* L., and pave the way for future research in this crucial area for the valorization of the country's natural resources. This study highlights the importance of a holistic approach to medicinal plant production, taking into account not only the preservation of bioactive compounds, but also economic and environmental aspects and practical feasibility for local producers.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The data that support this study are available from the corresponding author upon reasonable request.

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Authorship contribution statement

Nora Salim: Writing, Methodology, Software, Formal analysis, Data curation. Nora Arbaoui: Methodology, Formal analysis. Ilias Oussif: Investigation, Data curation. Maria Mouden: Investigation.

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Figures and Tables

Figure 1: Indirect solar dryers. a) Type 1 indirect solar dryer. b) Type 2 indirect solar dryer.

Figure 2: Yield of methanolic extracts from *Myrtus communis* L. leaves according to drying methods. Sech Ind 1: type 1 indirect dryer; Sech Ind 2: type 2 indirect dryer; Serre ind: indirect greenhouse; Serre direct; Air libre: free air.

Figure 3: IC50 of *Myrtus communis* L. leaf extracts using different drying methods. Sech Ind 1: type 1 indirect dryer; Sech Ind 2: type 2 indirect dryer; Serre ind: indirect greenhouse; Serre direct; Air libre: free air.

Figure 4: Antioxidant inhibitory activity of Myrtle leaf extracts as a function of concentration and drying method. Sech Ind 1: type 1 indirect dryer; Sech Ind 2: type 2 indirect dryer; Serre ind: indirect greenhouse; Serre direct; Air libre: free air.

Table 1 : Descriptive statistics and ANOVA of the bioactives studied (polyphenols, flavonoids and sugars) in methanolic extracts of the leaves of *Myrtus communis* L. Moroccan.

Figure 1: Séchoirs solaires indirects. a) Séchoir solaire indirect de type 1. b) Séchoir solaire indirect de type 2

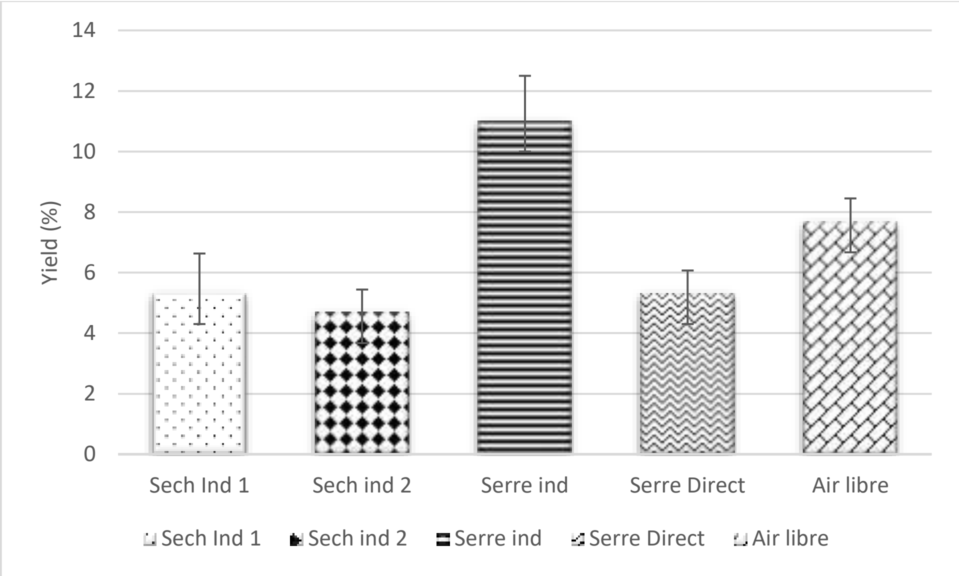

Figure 2 : Rendement des extraits méthanoliques des feuilles de *Myrtus comminus* L. en fonction des modes de séchages

Sech Ind 1: séchoir indirect type 1; Sech Ind 2: séchoir indirect type 2; Serre ind: serre indirecte; Serre directe; air libre

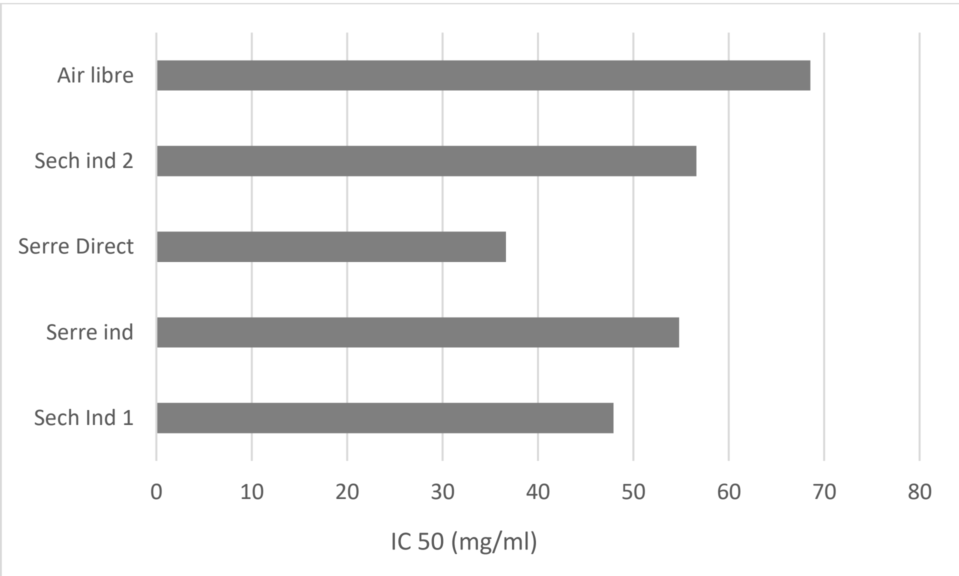

Figure 3 : IC50 des extraits des feuilles du *Myrtus comminus* L. à différents modes de Séchage

Sech Ind 1: séchoir indirect type 1; Sech Ind 2: séchoir indirect type 2; Serre ind: serre indirecte; Serre directe; air libre

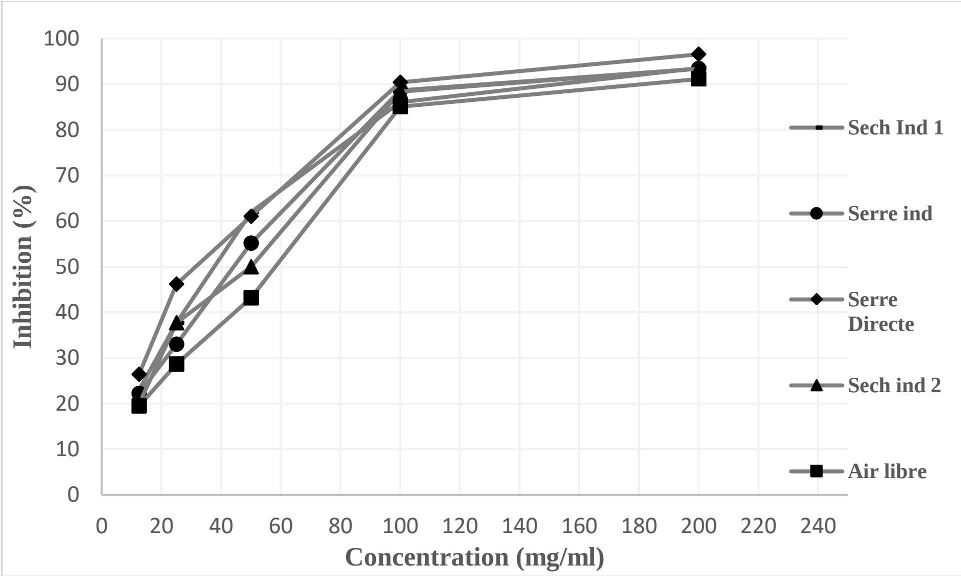

Figure 4: L'activité antioxydante inhibitrice des extraits de feuilles du Myrte en fonction des concentrations et de modes de séchage

Sech Ind 1: séchoir indirect type 1; Sech Ind 2: séchoir indirect type 2; Serre ind: serre indirecte; Serre directe; air libre

Table 1 : Descriptive statistics and ANOVA of the bioactives studied (polyphenols, flavonoids and sugars) in methanolic extracts of the leaves of *Myrtus communis* L. Moroccan.

	Polyphenols (µg EAG/ mg of extract)	Flavonoïdes (µg EC/ mg of extract)	Sugar (g/100g)
Sech Ind 1	362.9± 0.62 362.28-363.52 CV: 0.17	64±2.12 62.24-66.35 CV: 3.31	0.21±0.09 0.11-0.28 CV: 41.58
Serre ind	245.21±14.88 229.57-259.20 CV: 6.07	73.41±1.18 72.24-74.59 CV: 1.60	0.11±0.01 0.10-0.12 CV: 8.81
Serre Direct	341.5±8.67 333.27-350.56 CV: 2.54	50.47±3.67 47.53-54.59 CV: 7.28	0.57±0.72 0.08-1.39 CV: 125.76
Sech ind 2	498.91±42.96 457.35-543.15 CV: 8.61	41.65±2.12 39.29-43.41 CV: 5.09	0.17±0.02 0.15-0.18 CV: 8.98
Free air	477.30±2.34 474.63-478.95 CV: 0.49	51.06±4.24 46.35-54.59 CV: 8.31	0.24±0.06 0.17-0.27 CV: 24.04
F-statistic	75.785	56.256	0.918
Probability)	0.016**	0.001***	0.002***

Sech Ind 1: indirect drying type 1; Serre ind: indirect greenhouse; Sech ind 2: indirect drying type 2; EAG: gallic acid equivalent; EC: catechin equivalent; CV: coefficient of variation.