Extraction of Essential Oils of Cannabis Sativa

Varieties Punto Rojo and Mango Biche

Denicce Licht Ardila, Jhon Alexander Mora Diaz,
Mathius Mora Vanegas and Ana Lucia Paque Salazar

Industrial Engineering Program, Corporation University of Huila, Colombia

Abstract

This research is intended to idenfify the process and optimum solvent for the extraction of sativa cannabis oil from the punto rojo and mango biche varieties. There are multiple techniques used for their extraction. Their key principle is the use of an extractor agent, which may be petroleum ether, ethyl alcohol / ethanol, water, among others. When in contact with the solid material, the extractor agent allows the solutes, that is, the phyto-cannabinoids, to be transferred to the solvent to be then separated. In this way the essential oils are obtained. The aims of the stuy are (1) to identify the existing processes for extraction of essential oils and the description of the different solvents; (2) determine the advantages and disadvantages of each of these; (3) make the selection of the most appropriate method; and (4) put it into practice and perform laboratory tests to determine the percentage of Tetrahydrocannabinol (THC) and Cannabidiol (CBD).

Keywords: Cannabidiol, Tetrahydrocannabinol, essential oils, extraction, phyto-cannabinoids, Tetrahydrocannabinol

Introduction

This research project seeks the extraction of the essential oils of the cannabis sativa varieties of the species Punto Rojo and Mango Biche by using previously established methods. The essential oil extracted from the different varieties of cannabis demonstrates the therapeutic versatility from studies conducted with this plant in a natural way. This plant has revealed the effects in: psychotic diseases, anxiety, depression, anorexia and cachexia, asthma (bronchodilator action), pain,

musculoskeletal disorders, arthritis, neuralgia and neuropathy, dysmenorrhea, ulcerative colitis, Crohn's disease [1]. The methods of obtaining essential oils determine the use of them. The type of solvent can contaminate them or limit their use, depending on the toxicity of the solvent and the techniques used for its elimination. Thus, the importance of investigating new and / or alternative methods for obtaining extracts and essential oils [2].

I. Problem Statement

In recent years, several scientific studies have been conducted in order to identify the therapeutic benefits of certain cannabis-derived compounds. However, there are still debates among those who believe that this plant is the cure for multiple diseases and those who believe it is a harmful drug, which should be censored regardless of whether it is used for recreational purposes or medicinal purposes. This is due to the stereotype imposed on society, where the use of cannabis is associated with an increased risk of developing physical, mental and inadaptability health problems.

Currently, cannabis is a psychoactive substance that controlled and / or regulated by international drug control agencies. Additionally, it is included as a controlled drug in the United Nations Single Convention on Narcotic Drugs. However, levels and patterns of cannabis use vary significantly across the world, with higher prevalence rates in Africa, North America and the Western Pacific region [3].

All this has created obstacles for the approval of cannabis in the social field, due to prejudices about the use of this, and in the legal field, by laws and policies that prohibit its use.

However, it is evident a growing availability of cannabis for medical use. Although natural and synthetic cannabinoids for medicinal use are more frequently used in different parts of the world, data on their impact on health are not widely available [4]. Despite the increase in studies about cannabis, the research work has become more complicated since much of that information does not come to light.

Colombia is a country which allows the free use of cannabis for medicinal and scientific purposes. However, this does not mean that there is no difficulty in implementing studies, since there are laws which regulate the planting and trade of cannabis. According to the Ministerio de Salud y Protección Social, under Law 30 of 1986, Decree 613 of 2017, the cultivation of a number not exceeding twenty (20) units of cannabis plants, from which narcotic or psychotropic drugs can be extracted and intended exclusively for personal use, is allowed. For this, no cultivation license will be required.

In case that a license is required, there are 4 types: for the manufacture of cannabis derivatives; for the use of seed for sowing; for the cultivation of non-psychoactive cannabis plants; and for the cultivation of psychoactive cannabis. This becomes another obstacle due to the large number of procedures required to request and issue such licenses.

The Ministerio de Justicia reported that 33 cannabis licenses for medicinal and scientific purposes have been issued by the Subdirección de Control y Fiscalización de Sustancias Químicas y Estupefacientes since 2017.

"14 out of these 33 licenses are for cultivation of psychoactive cannabis plants. One of them was granted to a small and medium grower, producer and national marketer of medicinal cannabis and another to an association composed of 63 small and medium growers, national producers and marketers. 16 licenses were given for the cultivation of non-psychoactive cannabis plants and three for the use of seed for sowing" [5].

The available cannabinoid drugs begin to be used in the treatment of various diseases in order to alleviate their symptoms. However, its effectiveness still remains under discussion [6]

There are several methods to obtain essential oils from plant material such as eucalyptus, lavender, olive, among others. For the extraction of essential oils from cannabis, however, there is no defined technique by which a higher percentage of this and better quality can be obtained. This is a serious problem if the extraction is carried out on an industrial scale since the production costs would be higher than the profits. Therefore, it is necessary to identify the best method for the extraction of these oils. Hence the research question is as follows:

What is the extraction method that allows to obtain more THC and CBD in the essential oils of cannabis sativa varieties punto rojo and mango biche?

II. Research Objective

To determine the cannabis essential oil extraction method with the highest THC and CBD concentration levels for the Sativa Punto Rojo and Mango Biche strains.

III. Cannabis In Colombia

Colombia is currently one of the few countries that approves cannabis for medicinal purposes: in 2015 a decree was signed to rule cannabis production and exportation for scientific and medicinal purposes. Therefore, it is established that market products available meet all the safety conditions [8].

IV. Methodology

Type of Research
This is a descriptive research that specifies on the properties, characteristics and key features that contextualize the object of the study. The objective is adopted from qualitative research, through data collection and the analysis of the references. The process starts with an idea which has a limited scope and provides certain objectives with their respective research question in order to develop a theoretical framework [9].

Research Approach
The research approach for this study is qualitative, through data collection and the analysis of documental references, and it starts with a limited-scope idea where certain research objectives emerge given the statement of the problem, in order to develop a theoretical framework. Hypothesis are established and a plan is developed to analyze them and demonstrate their reliability and trust in the results, thus allowing the development of strengths through academic education [10].

Scope of the research
This research is done in Neiva in the Department of Huila by the Procing S research seedbed at the Corporación Universitaria del Huila (CORHUILA); the high reputation of the university contributes to a municipal, departmental and national impact. This research started in March 2017 up to this date, using all the literature that addresses cannabis used for medicinal purposes, beneficial uses, and references to different types of essential oil extraction methods.

Procedure

Compilation and literatura review
Data collection was done from documental sources such as handbooks, workshops, technical handbooks, dissertations and different articles and publications related to cannabis, its therapeutic uses and essential oil extraction methods from vegetable-related materials. This methodology was built upon the collection of information which allowed the comparison of the methods' performances for further analysis.
The literature review for this study was done through reading, comprehension, and analysis of the information which was relevant to the research problem for the organization of ideas, clarification through hypothesis and conclusions of the obtained documents.

Analysis methodology
This stage of the research will be developed using charts that will show all the textual information and the information presented in lists, matrices, figures, and tables that will allow for better reading and understanding [11]

Sample laboratory analysis.
Interpretation of the results of a cannabis oil sample obtained in a laboratory using the steam distillation extraction method.

Results and discussion
The obtained results will be interpreted in light of the research question or the hypothesis, explaining and comparing the results with data that other researchers have obtained by means of a critical assessment of the results from the author's perspective, taking into account the work of other studies and our own [12].

Theoretical proposal
Research attempts will be formulated based on the literature revision in order to give a tentative response.

V. Results

Cannabis strains and THC and CBD levels.

There are currently 3 types of cannabis that are characterized by having a different composition due to their THC and CBD concentration levels.

Table 1. *THC and CBD levels in different types of cannabis*

Types of cannabis	Levels of cannabinoid compounds	
	THC	CBD
Sativa	High	Low
Indica	Low	High
Ruderalis	Low	Low

Cannabis strains

THC and CBD percentage in cannabis strains.

Table 2. *THC and CBD percentage in cannabis strains.*

Type of cannabis	Strain	Percentage of cannabinoid compounds	
		THC	CBD
Sativa	Punto Rojo	12-15%	>1%
Indica	Pakistan Chitral Kush Standard	8-12%	2%
Sativa	Malawi Standard	24-27 %	>0.05 %
Sativa	Mango Biche	12-15%	>1%

Table 2. *(Continued): THC and CBD percentage in cannabis strains.*

Indica	Bubba Kush x PCK Feminized	14%	0.15-1%
Indica	Erdbeer x Purpurea Ticinensis.	0.5-8 %	6-12 %
Sativa	Destroyer standard	20 %	1%
Sativa	Golden Tiger Standard	20-28 %	0.5 %
Indica	HashFruit Standard	15%	1%
Sativa	Panama Standard	15-21 %	Null

National and worldwide geographical location.

Table 3. *Cannabis strains worldwide location.*

Type of cannabis	Strain	Location (Country)
Sativa	Punto Rojo	Panama, Peru, Colombia
Indica	Pakistan Chitral Kush Standard	Pakistan
Sativa	Malawi Standard	Malawi
Sativa	Mango Biche	Colombia
Indica	Bubba Kush x PCK Feminized	Pakistan
Indica	Erdbeer x Purpurea Ticinensis.	Afganistan
Sativa	Destroyer standard	Thailand, Mexico, Colombia
Sativa	Golden Tiger Standard	Malawi
Indica	HashFruit Standard	Morocco
Sativa	Panama Standard	Panama

Table 4. *Colombian strain location.*

Type of cannabis	Strain	Location (Department)
Sativa	Punto Rojo	Cauca, Huila, Caqueta
Sativa	Mango Biche	Valle del cauca, Huila
Sativa	Destroyer standard	Putumayo

Supply, location and price.

Table 5. *Supply, location and price.*

Type of cannabis	Strain	Location (Country)	Price in Colombian	Units (Seeds)
Sativa	Punto Rojo	Panama, Peru,	123.673	10
Indica	Pakistan Chitral	Pakistan	116.606	5
Sativa	Malawi Standard	Malawi	93.638	5
Sativa	Mango Biche	Colombia	123.673	10
Indica	Bubba Kush x	Pakistan	176.675	5
Indica	Erdbeer x Purpurea	Afganistan	176.675	5
Sativa	Destroyer standard	Thailand, Mexico,	229.678	10
Sativa	Golden Tiger	Malawi	141.340	10
Indica	HashFruit Standard	Morocco	141.340	10
Sativa	Panama Standard	Panama	176.675	10

Extraction methods used in the extraction of essential oils

Table 6. *Methods of extraction and effectiveness.*

METHOD	VEGETAL MATERIAL	EFFICACY			¿WHY?
		HIG	AVE	LOW	
orange	Pressed in cold		X		Requires much time for a performance in the same way is estándar
orange	Water Vapour	X			With a good pressure extraction yield is increased, and mass transfer is favorable from the plant material into the vapor phase
basil	Water vapour	X			It is a simple and high process rendimiento

Table 6. (Continued) *Methods of extraction and effectiveness.*

basil	Pressed in cold			X	The performance is low in comparison to other methods
basil	Hypercritic fluids		X		longer in your static extraction does not consider the performance of extraction
basil	Water vapour	X			The use of compounds is the best
anisette	Decoction			X	By its simple preparation yields are low
anisette	Infusions			X	By its simple preparation yields are low
anisette	Pressed in cold	X			Its performance is superior to standard values
anisette	Water vapour	X			Its transformation and time are considerable yield formidables
cinnamon	Pressed in cold			X	Requires much time for a performance in the same way is standard
cinnamon	Infusion		X		Obtaining in the process is good, but there are some impurities
cinnamon	WaterVapour	X			The separation of aqueous solution is a high performance
Bay	WaterVapour	X			It is a simple and high-performance process
bay	Pressed in cold		X		By its simple preparation yields are low
Mint	Solvent	X			The breakdown and attraction of necessary compounds is high
Mint	Infusion		X		Obtaining in the process is good, but there are some impurities
Mint	Water Vapour	X			It is a simple and high-performance process

Table 6. (Continued) *Methods of extraction and effectiveness.*

Oregano	Water Vapour	**X**			Its transformation and time are considerable by ~~formidable yields~~
Oregano	Infusion			**X**	By its simple preparation yields are low
Oregano	Solvent		**X**		Requires much time for a performance in the same way is standard
Thyme	Water Vapour	**X**			The separation of aqueous solution is a high
Thyme	Infusion			**X**	By its simple preparation yields are low
Cannabis	Water Vapour	**X**			It is a simple and high-performance process
Cannabis	Pressed in cold		**X**		The dynamic is optimal ~~performance and considerable~~
Cannabis	Hypercritic fluids		**X**		The provision of machinery is difficult

Solvents used for each type of extraction and quality oil obtained

Table 7. *Oil quality respect to the type of solvent.*

Material vegetal	Extraction Method	Solvent used	quality
Orange	Cold pressed	None	Low
Orange	Water Vapour	Water	High
Basil	Water Vapour	Water	High
Basil	Cold pressed	None	High
Basil	Supercritical fluid	Water	Half
Basil	Water Vapour	Water	Half
Anisette	Decoction	Water, Tolueno	Half
Anisette	Infusion.	Water	Low

Table 7. (Continued): *Oil quality respect to the type of solvent.*

Anisette	Water Vapour	Tolueno Water	Average
Anisette	Pressed in cold	Any	High
Cinnamon	Pressed in cold	Any	Low
Cinnamon	Infusion	Water	Low
Cinnamon	Wáter Vapour	Water	High
Bay	Wáter Vapour	Ethyl alcohol, water	High
bay	Pressed in cold	Any	Low
Mint	Solvent	Ethyl alcohol, water	Low
Mint	Infusion	Water	Low
Mint	Wáter Vapour	Ethyl alcohol, water	High
Oregano	Wáter Vapour	Ethyl alcohol, water	Average
Oregano	Infusion	Water	Low
Oregano	Solvent	Ethyl alcohol, water	Low
Thyme	Wáter Vapour	Ethyl alcohol, water	High
Thyme	Infusion	Water	Low
Cannabis	Wáter Vapour	Gas, Ethyl alcohol,	High
Cannabis	Pressed in cold	Any	Low
Cannabis	Hypercritic Fluids	Ethyl alcohol, water	Average

Results sample sent to CROM MASS laboratory

Table 8. *Minimum levels of quantification (NMC), retention (tR) by GC/FID times and quantification of the phytocannabinoid (s) sample (s), sent (s) by the CORPORACIÓN UNIVERSITARIA del HUILA - CORHUILA.*

Compuesto	t, min	NMC, g kg^{-1}	Concentración en la muestra, g kg^{-1}
			988150-DQ
			Aceite de cannabis 1
Cannabidiol	11,36	0,25	3,4
Tetrahidrocannabinol	13,20	0,25	46,5
Cannabinol	14,78	0,25	3,2

Note. Detected below the minimum level of quantification
Source. Report of laboratory of chromatography and mass spectrometry. Crom Mass. Industrial University of Santander. 2018

VI. Results Analysis

Cannabis medical analysis

Currently variety of authors covers the issue of the appropriateness of the use of cannabis in the medicinal field, because to seem to be promising to use cannabis in modern medicine.

According to the above, some authors conclude that one of its major applications should focus on therapeutic medicine, in addition to be used for the treatment of neurodegenerative diseases. Highlights the good results to the use of cannabis as an analgesic.

Rick Simpson elaborated a protocol to treat cancer and other diseases which do not possess a definite treatment in her medicine today. Which promotion tests in living beings (albino rats) which found that the cannabis works better than how anti-inflammatory indomethacin.

Similarly, there are currently few authors who considered cannabis must not be applied to the medical area, due to the fact that the use of cannabis is still associated with the stigma of the recreational consumption.

Analysis type of cannabis

Sativa cannabis contains levels more THC high, in comparison to cannabis indica containing higher levels of CBD. While the ruderalis contain lower levels in cannabinoid compounds.

Species analysis of cannabis sativa and indica

Analysis percentage of THC and CBD in species of cannabis
Species Golden standard tiger and Malawi are the variety of cannabis sativa that have higher percentage of THC, contrary to the Erdberr x porpuera ticinencis that has highest percentage of CBD, along with the Golden tiger standard, Malawi and Bubba Kush feminized PCK by with values less than 1%. However, the Green mango and red dot presents similar levels of THC and CBD.

Geographical location analysis

a) Worldwide
• Species red dot and destroyer standard are those that are more distributed globally.
• Only panama species occurs in panama
• The standard Hashfruit species only occurs in Morocco.
• The kush and bubba kush chitral pakistan species are found in Pakistan.
• The species Malawi standard and Golden standard tiger found in Malawi.
• Species red dot, green mango and destroyer standard found in Colombia.
• Erdbeer species x purpuera only occurs in Afghanistan.

b) National (Colombia)
The red dot is which is more distributed in Colombia, with a total of 3 apartments, on the other hand, the standard destroyer is only located in the Department of putumayo. Species point red and mango biches are present in the Department of Huila.

Supply analysis, location vs cost
The species Erdberr x porpuera ticinencis and bubba kush, they have a similar cost, also have the highest market price, instead the standard Malawi has the lowest price of the market and in terms of Colombia the species red dot and green mango are priced more b garlic.

Extraction Method Analysis
The most used for essential oils extraction methods are Enfleuraje, pressing, exudation, solvent, supercritical fluid, distillation, by steam drag, expression, distillation, Infusion, ultrasound, decoction, maceration.

Plant and method of extraction Material analysis
Most of plant material used for essential oils extraction method by water vapor, on the other hand, as second option is infusion and cold-pressing method.

The method effectiveness
The most effective method considered to perform the extraction is water vapor, which obtained greater quantity of essential oil by mass transfer from the plant material into the vapor phase obtaining favourable performance; in comparison to methods such as infusion and the supercritical fluid which provide a medium certainty regarding its effectiveness in the use of extraction by waiting for a considerable time.

Methods such as decoction have a low consideration with respect to water vapor by the performance in the separation of aqueous solutions.

Cost of the method
Water vapor is the most cost-effective method to apply in the extraction of essential oils, in comparison with pressing cold and supercritical fluid required a high investment for the cost of acquisition of machine and tools. Therefore, methods of infusion and solvents are considered medium costs since resources such as tools and materials are affordable.

Solvents for extraction methods
The most commonly used solvents for the extraction of essential oils are ethyl alcohol, water, toluene, methanol, hexane, liquid carbon dioxide, petroleum ether or naphtha.

Solvents used for each extraction type
By cold pressing, no type of solvent is necessary, however, the extraction by infusion uses water as the best solvent, applied in some vegetable materials such as orange, basil and cinnamon.

Oil quality in relation to the type of solvent
In relation to water, it does not alter or degrade the components of the extracted oils and therefore they are of good quality, but there are some that degrade the quality of the oil, but they allow to reduce the extraction time, such as ethanol and naphtha. As for toluene, the quality of the oil decreases because it has a low level of toxicity.

Oil costs in relation to the type of solvent
The solvent with the high access facility is water, in the same way its cost is economical like ethanol and toluene. As for Naphtha and 100% pure alcohol are the most expensive solvents.

Analysis of sample results sent to the CROM MASS laboratory
The samples sent were analyzed in duplicate. For the quantification of CBD, THC and CBN in the samples, the internal standardization technique was used. To do this, it was used the response factor (Rf) established for the analysis of the standard

solutions of CBD, THC and CBN in different concentrations, in relation to the ISTD.

In the results shown in Table 8, it is observed that a high percentage of THC was obtained, which indicates that the sample is suitable for use in the medicinal field.

VII. Discussion

The different implementations that were carried out in small experimental cycles by most of the listed authors above in table x, have generated positive results with cannabis as a central compound, making known its value in the therapeutic and neuropathic treatment of various diseases. In addition, to possess a potential as an analgesic.

These positive results give a strong argument to the world health entities to counteract the stigma that currently exists, of cannabis as a psychoactive drug.
Because the cannabinoid compound THC is mainly required for the manufacture of medicines and treatments, it is established that cannabis sativa fulfills the required conditions, due to its high levels of THC, unlike ruderalis and indica. Although the indica generates a medical debate, because its high levels of CBD makes it suitable for the treatment of localized pain and skin problems.

It is highlighted that currently several authors do not consider ruderalis as a type of cannabis in the medicinal field, but they integrate it as an essential component to create new hybrids of cannabis species, due to its high resistance to adverse conditions.

Focusing on the study objective of the present project and the spatial delimitation where it is developed, it is considered that the cannabis species to be taken into account are the red spot and biche mango, due to the fact that they are found in the Huila region in the Colombian territory. Another of the key point to reach this consideration is the comparison of costs to obtain the plant.

Although it is debated that the standard destroyer species possesses 3% more of the THC compound, its high monetary cost and the difficulty of obtaining it in the area where it is located, do not make it viable for the development of this project.

In general there is a great variety of methods of extraction of essential oils, for the purposes of the present study only the most used in Colombia will be focused, this is delimited in this way to make an accurate comparison between the effectiveness and costs of the methods; In the same way, information was collected based on the vegetal materials that are more common in the extraction of essential oils (Orange, Albaca, Cannabis, Anise, Cinnamon, Laurel, Mint, Oregano, and Thyme), Cannabis

was included due to the increase of its demand for the legalization of it for medicinal use in Colombia.

When extracting essential oils at the industrial level, high quality at low cost is thought, very rarely high quality is considered at high costs, an example of this is when you want to systematize a whole process with cutting-edge technology. According to the above, it was observed in the results analyzed that the water vapor trapping method is the most viable for obtaining oils on an industrial scale, because it is possible to have control of the different variables during its process, generating that a greater quantity be obtained in the product achieved; If we go deeper into its approach to extracting essential oils from cannabis, it is more suitable due to its performance in aqueous separations.

On the other hand, there are project references that suggest that by using the supercritical fluid method in a systematized industry, essential oils will be obtained in high quality, but with high initial investments; but that in a short period the costs will decrease.

It is important to note that in addition to the extraction method, another factor must be taken into account when extracting essential oils, and even more so when talking about cannabis, which is the central base of the present project, and is the type of solvent to be used in the development of the method process. The most used are: ethanol, water, toluene, hexane, methanol, liquid carbon dioxide and naphtha.

According to the authors in the consulted references and in the analysis of results, there are solvents such as water that are economical, but do not generate an optimum quality, this is more used in extraction of oils from vegetable materials of foods such as oranges; but for the purpose of our study, the most representative solvent is 100% naphtha, because it meets all the properties and requirements for the extraction of essential oils on an industrial scale, because it reduces the extraction time and at the same time maintains the quality of the oil.

Other sources conclude that ethanol is at naphtha level because its behavior during the process is similar, but for the purposes of the present project, it is not thought in this way, because if ethanol is used, the quality of the extracted oil decreases and the cost of use at an industrial level is high.

Theoretical approach

Based on the referential foundations, results obtained from the bibliographic review and the thereof analysis, the following theory is presented:

The extraction of cannabis essential oils can be done in two stages: at the laboratory level and at the industrial level, the first used for an experimental scale and the second at a production scale. Likewise, the cannabis species in the Colombian territory suitable for the previous approach, are red spot and biche mango, due to the ease of obtaining the plant and seeds.

In this regard, to produce cannabis essential oils at an industrial level, two extraction methods are proposed. The first is the water vapor drag, based on high quality and low investment costs. The second is the supercritical fluid focused on the systematization of the process, high quality and high initial investment costs that will be profitable over the years.

The solvent used in these methods is naphtha at 100% concentration, because it generates a high quality oil product and helps reduce costs in the process, taking into account that ethanol has similar characteristics during the process, but this solvent must be used at the laboratory level.

Conclusions

In consideration of the tables presented and their respective analysis, steam extraction is the most optimal method for obtaining essential cannabis oils, due to its high yield.

Regarding the arguments made by different authors, it is considered that cold pressing is a method where the vast majority of properties of oils are conserved, however, it is a lot of material.

Ethyl alcohol is not as efficient as naphtha for extracting essential oils from cannabis, however, its monetary cost is economic, which facilitates its purchase and use.

The most effective solvent for the extraction of essential oils is Naphtha or petroleum ether, since it allows a higher extraction, but due to its high cost in the market and volatility, its use is recommended on an industrial scale.

In conclusion, the essential oils of cannabis sativa are the most commonly used for medicinal uses, for their healing potential and for the benefits provided by THC and CBD cannabinoids.

The use of supercritical fluid and cold pressing methods is not recommended, since the acquisition of machinery and tools has a high cost in the market, in addition the cold pressing has a better performance with seeds.

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