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Yield and content of cannabidiol (CBD) and tetrahydrocannabinol (THC) in medicinal cannabis (*Cannabis sativa*) grown in the Ecuadorian highlands

Rendimiento y contenido de cannabidiol (CBD) y tetrahidrocannabinol (THC) en cannabis medicinal (*Cannabis sativa*) cultivado en la Sierra ecuatoriana

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ABSTRACT

Cannabis is an herbaceous species of the Cannabaceae family and is native to the Himalayas. It contains hundreds of metabolites with potential bioactivity, including cannabinoids, terpenes, and flavonoids. The objective of this experiment was to evaluate the yield and the cannabidiol (CBD) and tetrahydrocannabinol (THC) content of medicinal cannabis (variety Cherry Oregon) in two localities of the Ecuadorian highlands. A Randomized Complete Block Design with four treatments and four replications was carried out. Treatment 1 was maintained with natural light, treatment 2 received 16/8 photoperiod (16 hours light, 8 hours dark) for one week, treatment 3 received 16/8 photoperiod for two weeks, and treatment 4 received 16/8 photoperiod for 3 weeks. In the locality 1, treatment 4 showed better values of plant height, dry biomass, biomass yield per plant and greater biomass yield per m^2, in both cycles. In the locality 2, the treatments were statistically similar in all variables in both cycles, but a trend where treatment 4 presented higher values compared to the rest of the treatments was observed. The THC and CBD contents for the treatments and cycles ranged between 0.06% and 0.51%, and between 13.76% and 15.29% respectively in both localities. Finally, the results obtained agree with what is reported in the variety's technical sheet, and the THC content does not exceed the maximum value allowed by Ecuadorian regulations.

Keywords: photosynthesis; biomass; agricultural production.

RESUMEN

El Cannabis es una especie herbácea de la familia Cannabaceae y es originaria del Himalaya. Contiene cientos de metabolitos con bioactividad potencial, incluidos cannabinoides, terpenos y flavonoides. El objetivo de este experimento fue evaluar rendimiento y contenido de cannabidiol (CBD) y tetrahidrocannabinol (THC) de cannabis medicinal (variedad Cherry Oregon) en dos localidades de la Sierra ecuatoriana. Se utilizó un Diseño de Bloques Completos al azar con cuatro tratamientos y cuatro repeticiones. El tratamiento 1 se mantuvo con luz natural, el tratamiento 2 recibió fotoperiodo 16/8 (16 horas luz, 8 horas oscuridad) durante una semana, el tratamiento 3 recibió dos semanas fotoperiodo 16/8, y el tratamiento 4 recibió fotoperiodo 16/8 durante tres semanas. En la localidad 1, el tratamiento 4 presentó mejores valores de altura de planta, biomasa seca, rendimiento de biomasa por planta y mayor rendimiento de biomasa por m^2, en ambos ciclos. En la localidad 2, los tratamientos fueron estadísticamente similares en todas las variables en ambos ciclos, pero se observó una tendencia donde el tratamiento 4 presentó valores mayores respecto al resto de los tratamientos. Los contenidos de THC y CBD, en todos los tratamientos y ciclos oscilaron entre 0,06 % y 0,51 %, y, entre 13,76 % y 15,29 % respectivamente, en todas las localidades. Finalmente, los resultados obtenidos concuerdan con lo reportado en la ficha técnica de la variedad, además el contenido de THC no sobrepasa el valor máximo permitido por la regulación ecuatoriana.

Palabras clave: fotosíntesis; biomasa; producción agrícola

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INTRODUCTION

Currently, Ecuador has regulations that authorize and regulate the planting, cultivation and harvesting of plants that contain active ingredients of narcotic and psychotropic substances, exclusively to produce medicines, which will be sold under medical prescription, and for medical-scientific research. Thus, cannabis is an herbaceous species of the Cannabaceae family, it is an annual, dioecious plant, native to the Himalayas, Asia (Daya Foundation, 2020). It contains hundreds of specialized metabolites with potential bioactivity, including cannabinoids, terpenes, and flavonoids (Andre et al., 2016; Chandra et al., 2017). Female flowers of cannabis plants exhibit higher concentration levels of cannabidiol (CBD), and tetrahydrocannabinol (THC) compared to other organs of the plant (Koo et al., 2023).

Since this complex profile of specialized metabolites defines the medical and commercial potential of cannabis, the female inflorescence has attracted much attention (Small, 2016; Chandra et al., 2017; Grof, 2018). The plant needs a photoperiod of 16/8 (16 hours of light and 8 hours of darkness) in the vegetative phase and 12/12 in the flowering phase (12 hours of light and 12 hours of darkness) (Ángeles López et al., 2014). However, there is variability in the concentration of CBD and THC between each cannabis plant, these concentrations increase as the plant develops, the importance of adequate sampling to determine the concentration of CBD and THC as a way to prevent the elimination of the cultivation by regulatory agencies. (Arsenault et al., 2024).

It develops adequately in soils with a pH between 6 and 7. Environmental conditions such as mineral nutrients (Bernstein et al., 2011). The availability of water is essential in its cultivation, the lack of this resource in the flowering phase generates a risk because it can increase the percentage of THC (Morgan et al., 2024; Wang et al., 2018); in addition, substrate quality affects the plant development and function, including the synthesis of secondary metabolites in medicinal plants (Nascimento and Fett-Neto, 2010; Gorelick and Bernstein, 2014). Integrated crop pest management is also fundamental to guarante the quality and optimal development of the plant (Gezovitch et al., 2024).

The identified cannabinoids have been classified into 10 subclasses according to their chemical structure: 1. Cannabigerol. 2. Cannabichromene. 3. CBD. 4. Δ9-THC. 5. Δ8-THC. 6. Cannabicyclol (CBL). 7. Cannabielsoin (CBE). 8. Cannabinol and cannabinodiol (CBND). 9. Cannabitriol (CBT). 10. Miscellaneous (Brenneisen, 2007). From all these cannabinoids, Δ9-THC is the most pharmacologically active phytocannabinoid in cannabis, with addictive psychoactive effects in herbal or resinous form. THC was characterized in the 1960s, which opened the door to scientific research on the biological and medical properties of cannabis as a basis for the development of derivatives with therapeutic capabilities, in which an attempt was made to isolate the pharmacological properties of psychoactive drugs (Tamosiunas et al, 2013 and De la Fuente, 2015). It is also relevant to highlight that the absence of information about the concentration of active compounds in cannabis can have negative consequences on the health of those who consume it (Montón, et al., 2023). The objective of this experiment was to evaluate the yield and content of CBD and THC in medicinal cannabis Var. Cherry Oregon, in two localities in the Ecuadorian highlands.

MATERIALS AND METHODS

Locality of the experiment

The experiment was carried out during two growing cycles and in two localities. Locality 1 (0º 24’ 45’’ N, 78º 09’ 08’’ O) corresponded to the Tapiapamba parish, Urcuquí county, Imbabura province, altitude of 1964 masl. It has a warm dry climate, average temperature of 19°C, average annual precipitation of 200 mm and relative humidity of 60%. Locality 2 (00 o 02’ 37’’ N, 78 o 20’ 57’’ O) corresponded to the Tabacundo parish, Pedro Moncayo county, Pichincha province, altitude of 2940 masl. It has a cold humid climate, average temperature of 14°C, average annual precipitation of 1000 mm and relative humidity of 85%. The cannabis crop was grown in open field conditions in locality 1 while it was in greenhouse in locality 2. This difference in the characteristics of the experimental sites served to have comparative results between controlled versus uncontrolled conditions.

Regarding the nutritional content of the soil of the two localities, the results of the analysis indicated that in locality 1, the pH was 8.00, organic matter content of 2.5%, sandy loam texture. Its macro and microelement content were: Nitrogen 45.50 ppm; Phosphorus 20.28 ppm; Potassium 1.46 meq 100 g^{-1}; Calcium 16.43 meq 100 g^{-1}; Magnesium 4.49 meq 100 g^{-1}; Sulfur 11.82 ppm and Iron 13.00 ppm. In locality 2, pH was 8.39, organic matter content of 5.9%, sandy loam texture. Its macro and microelement content were: Nitrogen 97.00 ppm; Phosphorus 301.00 ppm; Potassium 5.83 meq 100 g^{-1}; calcium 31.81 meq 100 g^{-1}; Magnesium 6.81 meq 100 g^{-1}; Sulfur 39.00 ppm and Iron 5.70 ppm.

Agronomic management

The installation date in locality 1 was September 16, 2020 while in locality 2 was September 30, 2020. In locality 1, the second cycle was installed on March 4, 2021 while in locality 2 was on March 10, 2021. Soil from each area was used as a substrate placed in 10-liter pots to transplant one plant. Weed control was manual whereas pest controls were carried out by applying NEEM biological insecticide. Nutrients were delivered to the plant through fertigation, with an inection ratio of 90:1, organized in three cycles. The first cycle consisted of major elements + calcium nitrate. The second cycle delivered minor elements, and the third cycle only water. According to each treatment, the complementary light was provided through 40 W LED spotlights (100-240 V; 350 60 Hz) located at 1-meter distance, which turned on automatically at 6:00 hrs and turned off at 22:00 hrs.

Plant material

The variety used was Cherry Oregon, from USA, which is used for its good CBD production. According to the cultivar's technical sheet, its yield is between 0.5 to 1 kg plant^{-1}. It has good resistance to pests, and grow well without training. It achieves up to 20% CBD, while THC levels are low (less 1%), but should be monitored closely to ensure it meets local requirements.

Experimental design

The trials were evaluated with a Randomized Complete Block Design (RBCD), with 4 treatments and 4 repetitions. The surface of each treatment was 1 m^2, where 7 plants were placed in individual 10-liter pots. In each treatment, 3 plants were evaluated randomly. The treatments consisted of placing the cannabis plants in 16/8 photoperiods (16 hours of light and 8 hours of darkness), for 1, 2 and 3 weeks. Treatment 1 was the control and was maintained with natural light (12 hours of light and 12 hours of darkness), treatment 2 received the 16/8 photoperiod for 1 week, treatment 3 received for 2 weeks, and treatment 4 for 3 weeks.

Statistic analysis

Data were subjected to ANOVA at $p < 0.05$ after verifying the assumptions of normal distribution and homogeneity of variances. When these assumptions were not met, transformations were performed with the function ln (x+1). The means were compared using the LSD-Fisher test at the 95% confidence level. The statistical analysis was performed with the INFOSTAT statistical program (Di Rienzo et al., 2017).

Measurements

The germination percentage was established by evaluating 100 seeds for each repetition according to the methodology proposed by Velásquez et al (2008). The number of leaflets was determined in each experimental plot between the beginning of flowering and the beginning of seed maturity, in the last opposite and completely open leaves. Plant height was recorded one day before harvest (IHEMPFARMS, 2020).

Insect and disease evaluations were carried out with a portable microscope with 60x-100x LED of dimensions 8.4 x 3.5 x 2cm. The percentage of pest incidence was calculated using the formula of Arguedas-Gamboa et al. (2019) with modifications:

$$\%\,I = \frac{\text{Total diseased plants}}{\text{Total plants evaluated}} * 100 \qquad [1]$$

Where, %I correspond to the percentage incidence of the pest insect.

The percentage of severity was evaluated through the visual method according to the recommendation of Troya and Vaca Granda (2016), in their manual for the National Phytosanitary Surveillance Network; and, the scale proposed by Arguedas-Gamboa et al. (2019) with modifications was used (Table 1).

Table 1

Categories for evaluation of pest severity in hemp cultivation

Severity category	% of foliage affected
1	0.1-20
2	21-40
3	41-60
4	61-80
5	81-100

Flower yield corrected at 13% humidity was evaluated (IHEMPFARMS, 2020). The dry biomass yield of leaves, stems and flowers is considered by weighing three plants (IHEMPFARMS, 2020). Finally, the cannabinoid content (percentage of THC and CBD in flowers) was evaluated by taking a sample (mixture of three plants per material per repetition) from the upper 30 cm of the main stem measured from the apex and with female inflorescences. Sampling was done on harvest day; they were dried immediately (within 48 hours) at a temperature below 60 °C until acquired a constant weight and a humidity between 8 and 13%. After drying, the samples were subjected to a grinding process until obtaining a particle size < 1 mm, then they were placed in plastic bottles in a dark place at a temperature < 25°C. The analysis was carried out using the AOAC 2018.11 method, which consisted of the extraction of THC and/or CBD in ethanol and its quantification by High Resolution Liquid Chromatography (HPLC) coupled to a Diode Array Detector (DAD) at a length wavelength of 240 nm (UNODC, 2010).

RESULTS AND DISCUSSION

Presence of Pests

***Tetranychus urticae* (red mites)**

In both cycles, in locality 1 during the final flowering phase, the presence of *Tetranychus urticae* belonging to the Tetranychidae family was observed underside of the leaves. The main symptom was the presence of silk threads on the affected plants. Eggs, larvae, protonymphs, deutonymphs and adults were observed. The presence of this mite was possibly due to the climatic conditions of the sector, since this mite proliferates and causes damage of economic importance in dry environments, conditions that occurred in locality 1. The calculated incidence for this pest was 14%. This pest did not occur in locality 2, possibly because the climatic conditions were different and therefore were not predisposing to the mite attack. Severity is a parameter that accurately reflects the relationship of the pest with the damage caused to the crop (Lavilla and Ivancovich, 2016). The severity of *T. urticae* in inflorescences (locality 1) showed values that fluctuated between 0.1-20%, falling into category 2 (low); while locality 2 did not show mite damage.

Botrytis cinerea (gray mold)

The colonization of *B. cinerea* in Cannabis plants generally occurs during the last stages of crop development and usually manifests as rotting of the shoots before or after harvest. In addition, the mycelia will begin to develop with an increase in temperature and relative humidity (Punja, 2018). In the first cycle in both localities, the presence of this fungus was observed from the middle flowering phase. Its distribution was widespread in the trial, with the main symptom being a change in color in the infected flowers, turning brown or gray with dry and necrotic appearance. In both localities, the incidence was 42%, possibly because in locality 1, despite having a dry climate, during the flowering phase there was precipitation along with high temperatures, stimulating infection by the fungus. In locality 2, the trial was established in greenhouse, favoring high relative humidity and temperature; in addition, the thermal deltas stimulated the proliferation of the fungus. The infection of this fungus can be reduced or avoided by monitoring edaphoclimatic conditions of the place, predisposing to the pathogen, and in this way establishing appropriate sowing and harvest dates.

Agronomic measures

To compare the results of the variables between the first and second seasons (tables 2 and 3), a combined analysis of the experiments was carried out in which the interaction between year and treatment for all variables was significant ($p < 0.05$); therefore, data were analyzed separately.

In locality 1, the germination analysis showed a value of 98% and the number of leaflets varied between 7 and 9. The lowest plant height before harvest was recorded in treatment 1 (37.17 cm) and 2 (36.17 cm) being statistically equal between them ($p > 0.05$), while; treatment 4 presented plants with greater height before harvest (59.83 cm). Regarding dry biomass, treatment 4 recorded the highest value (38.81 g); furthermore, this treatment stood out for the highest yield of biomass per plant (33.61 g) and biomass per m^2 (235.26 g). Turning to plant height, in the second cycle, it was observed (table 3) that treatment 4 generated taller plants (53.42 cm), generated drier biomass (64.43 g), and greater biomass yield per plant (52.04 g) and biomass per m^2 (364.29 g).

In the locality 2, the germination analysis recorded a greater percentage than 98% and the number of leaflets varied between 9 and 11. In addition in this localityin the first cycle (Table 4), plant height did no showed statistical differences between treatments ($p > 0.05$). Similar results were obtained in the variables of dry biomass, flower yield per plant and yield per m^2; however, a trend was observed where treatment 4 showed the highest values. In the second cycle, the trend was repeated (Table 5), all treatments were statistically similar ($p > 0.05$) in all variables, and againg treatment 4 showed higher results.

In locality 1, treatment 4, which had the longest period of complementary light (3 weeks), showed the highest values of plant height, dry biomass, biomass yield per plant and higher biomass yield per m^2 in both cycles. In locality 2 in both cycles, although all treatments were statistically similar for all variables, a trend was observed where treatment 4 showed higher values compared to the rest of the treatments. These results could be explained considering that light is an essential factor for the photosynthesis process; if plants lack this vital resource, their growth and performance will be far from optimal. The development of vegetables depends on the interaction between biotic and abiotic factors, the genetic characteristics of each plant and agronomic management during the production cycle. All these factors affect fundamental physiological processes such as the absorption and distribution of water and minerals, photosynthesis and respiration (Villagrán, 2016). Cannabis production requires climatic factors that interfere with the development of physiological phenomena such as light, temperature and humidity (Cermeño, 2005), thus radiation is important for certain photosynthetic processes because it is the main source of energy as well as a regulator of plant growth and development (Azcón-Bieto & Talón, 2000). The greater the number of photons intercepted mainly by the leaves, photosynthetic processes and therefore the yields of biomass and other photosynthates will be maximized when plant are exposed to longer light conditions (Cermeño, 2005; Bart, 2017). When light is scarce, plants grow thin, with few leaves, small and thin inflorescences oriented in the direction of light entry (Schoepke, 2014).

Table 2
Agronomic evaluation recorded in the first cycle, locality 1

Treatment	Plant height (cm)				Dry biomass (g)				Yield 1 (biomass, g plant^{-1})			Yield 2 (biomass, g m^{-2})		
1	37.17	a			17.75	a			15.54	a		108.79	a	
2	36.17	a			18.59	a	b		16.57	a		115.97	a	
3	45.25		b		26.48		b		22.23	a		155.63	a	
4	59.83			c	39.81			c	33.61		b	235.26		b

Table 3
Agronomic evaluation recorded in the second cycle, locality 1

Treatment	Plant height (cm)				Dry biomass (g)					Yield 1 (biomass, g plant^{-1})					Yield 2 (biomass, g m^{-2})				
1	31.34	a			11.69	a				10.18	a				71.22	a			
2	41.16	a	b		23.16		b			20.61		b			144.31		b		
3	48.09		b		37.25			c		31.59			c		221.14			c	
4	53.42			c	64.43				d	52.04				d	364.29				d

The viability of cannabis seeds decreases rapidly and depends on factors such as storage, thus the quality of imported seed is not reliable (Islam et al., 2022). The seed germination process begins with the absorption of water by the inactive dry seed and concludes with the development of the embryonic axis and is influenced by intrinsic and extrinsic factors. In addition, the most important factors for germination include water, temperature, oxygen and light (Riftna et al., 2019). In a study conducted by Islam et al. (2022), when analyzing the germination percentage of seedlings of 14 industrial hemp varieties, it varied from 13 to 92%.

Plant height and dry biomass could vary or not depending on factors such as the light available for photosynthesis and, therefore, biomass production, resulting in a decrease or not in the components of performance (Merino et al., 2019).
Janatová et al. (2018) evaluated the inflorescence yield of seven medicinal cannabis genotypes at a density of 9 plants m^2, where the average yield plant^{-1} was 21.02 g, however in our study the yield plant^{-1} varied between 10.00 and 50.00 g. In cannabis, the flowering stage is the most important process in cultivation because the production of stems, inflorescences and seeds is directly affected in this period (Amaducci et al., 2015).

Table 4
Agronomic evaluation recorded in the first cycle, locality 2

Treatment	Plant height (cm)		Dry biomass (g)		Yield 1 (inflorescence, g plant^{-1})		Yield 2 (inflorescence, g m^{-2})	
1	70.5	a	86.29	a	49.09	a	343.58	a
2	71.75	a	75.38	a	41.3	a	289.05	a
3	74.75	a	87.42	a	45.63	a	319.38	a
4	80.33	a	87.29	a	50.42	a	352.92	a

Table 5
Agronomic evaluation recorded in the second cycle, locality 2

Treatment	Plant height (cm)		Dry biomass (g)		Yield 1 (inflorescence, g plant^{-1})		Yield 2 (inflorescence, g m^{-2})	
1	110.33	A	133.06	a	32.45	a	227.11	a
2	106.22	A	149	a	43.61	a	305.28	a
3	118.89	A	174.06	a	46.17	a	323.17	a
4	114.56	A	176.83	a	48.17	a	337.17	a

Cannabinoid contents

In locality 1, the total CBD contents varied from 13.94% to 15.29% in the first cycle, and from 14.27% to 15.14% in the second cycle (tables 6 and 7). The THC values ranged from 0.06% to 0.11% in the first cycle, and from 0.08% to 0.10% in the second cycle (tables 6 and 7). These results indicated that although there were not statistical differences, treatment 1 showed slightly higher contents of CBD and THC in the first cycle; while in the seconf cycle, treatment 3 had moderately higher CBD content and again treatment 1 showed slightly higher THC content (tables 6 and 7).

Table 6
Total CBD and THC content in the first cycle, locality 1

Treatment	CBD total* (%)	THC (%)
1	15.29	0.11
2	14.59	0.09
3	14.15	0.08
4	13.94	0.06
Averange	**14.74**	**0.09**

* CBD total= CBD + CBDA*0.877

Table 7
Total CBD and THC content in the second cycle, locality 1

Treatment	CBD total* (%)	THC (%)
1	14.27	0.10
2	14.84	0.09
3	15.14	0.09
4	14.78	0.08
Averange	**14.76**	**0.09**

* CBD total= CBD + CBDA*0.877

In locality 2, the total CBD contents ranged between 14.78% and 15.14% in the first cycle, and between 13.76% and 15.08% in the second cycle (Table 8 and 9). The THC contents, varied from 0.20% to 0.51% in the first cycle, and from 0.06% to 0.13% in the second cycle (tables 8 and 9). The average value of total CBD content was higher in the second cyle, in contrast to the THC content that was higher in the first cycle, possibly due to the contrast in environmental conditions between both cycles.

Table 8
THC and total CBD contents in the first cycle, locality 2

Treatment	CBD total* (%)	THC (%)
1	14.94	0.20
2	14.84	0.34
3	15.14	0.51
4	14.78	0.46
Averange	**14.76**	**0.38**

* CBD total= CBD + CBDA*0.877

Table 9
THC and total CBD contents in the second cycle, locality 2

Treatment	CBD total* (%)	THC (%)
1	13.76	0.07
2	15.05	0.10
3	15.08	0.13
4	14.56	0.06
Averange	**15.45**	**0.09**

* CBD total= CBD + CBDA*0.877

In the first and second cycle in locality 1, the average THC content was 0.09%; while in locality 2 the average THC content was 0.38% in the first cycle and the percentage of 0.09% was repeated in the second cycle. In all cases, the THC contents complied with national regulations (THC<1%, dry weight) (COIP, 2019), which demonstrated that these seeds can be used for medicinal purposes, due to this cannabinoid is associated with psychoactive properties (Lachenmeier et al., 2004). On the other hand, THC contents did not show statistical differences, however; it was observed that in both localities, treatment 3 showed a slightly higher content. In the case of total CBD content, the averages in the first and second cycle were 14.74% and 14.76% in the first locality; while in they were 14.76% and 15.45% in the second locality; confirming that this plant can be for medicinal use, since CBD is a biomolecule that has medicinal properties for the treatment of disorders related to anxiety, schizophrenia and different types of epilepsy. Plants for medicinal use have high CBD content and low THC content (Unicef, 2020). On the other hand, although CBD contents did not show statistical differences, it was observed that in both localities, treatment 3 showed a slightly higher content of this compound.

Montón et al. (2023), when analyzing the cannabinoid content in 14 samples of *C. sativa* inflorescences, found a CBD content of 0.49% and a Δ 9-THC content of 6.82%. In addition, Janatová et al. (2018) evaluated the inflorescence yield and content of THC and CBD of seven medicinal cannabis genotypes and found that the average levels of Δ 9-THC ranged between 15.69% and 19.31%, while the average CBD levels ranged between 0.45% and 0.57%. Arsenault et al. (2024) also evaluated Δ 9-THC and total CBD in 14 cultivars of hemp, demonstrating that both CBD and THC increase rapidly over a 1–2-week time frame with maximum concentrations (about 16% and 0.6%, respectively).

However, the increase in THC and CBD in *C. sativa* is not yet defined, it is known to be related to soil-climatic conditions and even the availability of nutrients (Danziger and Bernstein, 2022, Saloner and Bernstein, 2022).

CONCLUSIONS

In locality 1, treatment 4 (photoperiod: 3 weeks, complementary light) showed the best values for plant height, dry biomass, biomass yield per plant and highest biomass yield per m^2, in both cycles. In locality 2, all treatments were statistically similar in all variables in both cycles, however, a trend where treatment 4 showed good results was observed. Based on these outcomes, it is recommended to expose the plants to a period of complementary light of 3 weeks in both localities because this influence yield. The CBD contents ranged from 13.76% to 15.29%. The values of THC content ranged between 0.06% and 0.51%; therefore, the content of this cannabinoid was less than 1%, a value that comply with the provisions of the Ecuadorian Comprehensive Penal Code. The results of this study showed that the variety Cherry Oregon grown in the Ecuadorian highland conditions can be excluded from the classification as “scheduled substances subject to control” and becoming the so-called “medicinal hemp”. Furthermore, this research constitutes a starting point to study other varieties legally entered the country.

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