STUDY OF THE CBD AND THC CONTENT OF CANNABIS AND ITS DERIVATIVES BETWEEN 2018 AND 2023

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INTRODUCTION

This study presents the statistical results of the identification and quantification of various cannabinoids present in samples of cannabis and of derived or processed cannabis-based products for each of the different matrices during the years 2018 to 2023.

MATERIALS AND METHODS

The matrices under study are plant samples, oils, extracts and *e-liquids*. Cannabinoid analysis was performed via a high performance liquid chromatography (HPLC) machine equipped with a diode array detector (DAD) using Norgestrel as internal standard (IS). The methods used are based on those published by the New York State Department of Health [1,2]. The limit of quantification (LOQ) for all cannabinoids is 0.033 wt/wt%.

Total tetrahydrocannabinol (THC) and total cannabidiol (CBD) were calculated by adding to the neutral cannabinoid value the theoretical value of the decarboxylated acid cannabinoid (0.877,x% acid cannabinoid).

Plant samples were classified according to the EUROPEAN PHARMACOPOEIA 11.5: THC-dominant (Total THC >5% and total CBD <1%), THC/CBD intermediate type (Total CBD and total THC >1%) and CBD-dominant (total CBD >5% and total THC <1%). Those with total THC content under 0.2% were classified as being of fibre type (total CBD ≤5% and total THC ≤0.2%).

Oils and extracts were divided between *Full Spectrum* (THC>LOQ, CBD>LOQ and presence of two or more other cannabinoids) and *Broad Spectrum* (THC<LOQ, CBD>LOQ and presence of two or more other cannabinoids). We also distinguished oils containing only CBD, without other cannabinoids being present (isolates).

RESULTS

Plants

THC-dominant type. In all samples (N=675), total THC average is 16.05%,(sd 4.37) with a maximum of 28.38%. The ANOVA ($p<0.05$) shows that there are significant differences between yearly averages.

CBD- dominant type. In all samples (N=1262), total CBD average is 10.93% (sd 3.57) with a maximum of 23.94%. The ANOVA ($p<0.05$) shows significant differences between yearly averages. Average and maximum values, as well as details by classification and year, can be seen in **image 1.**
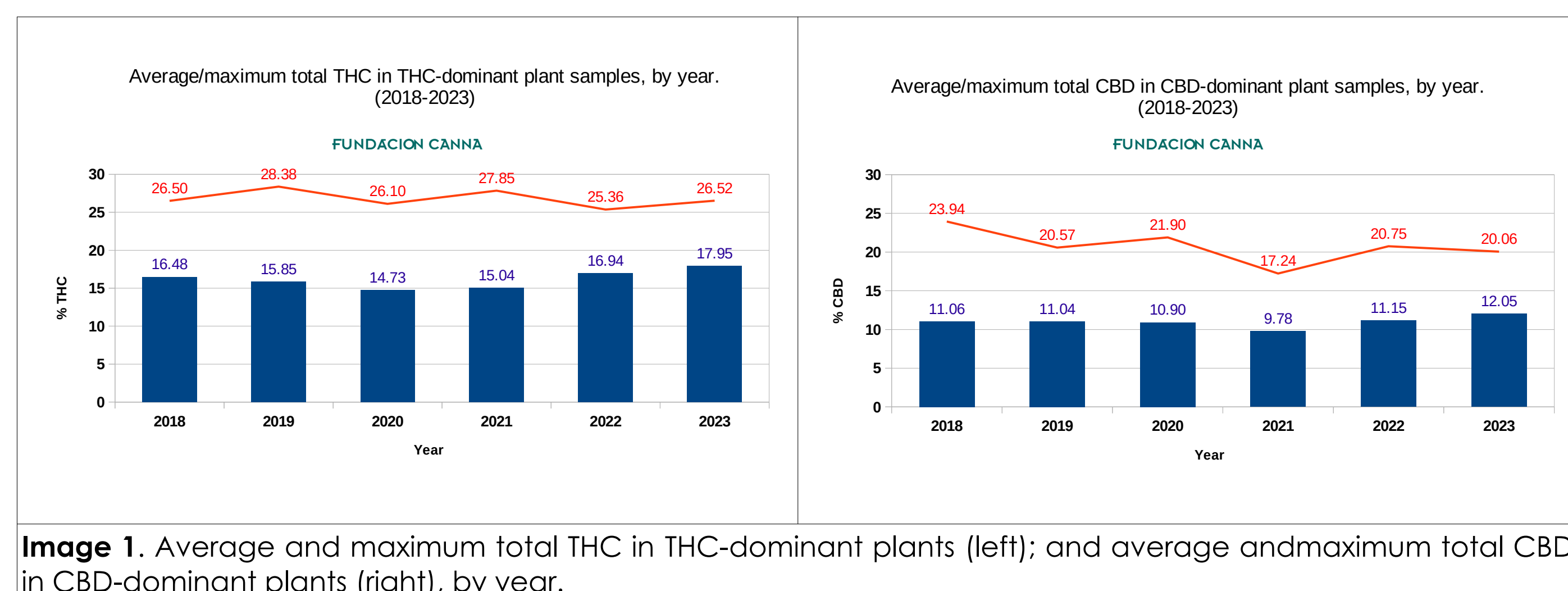

Image 1. Average and maximum total THC in THC-dominant plants (left); and average andmaximum total CBD in CBD-dominant plants (right), by year.

THC/CBD intermediate type. In all samples (N=230), average total CBD is 7.50% (sd 3.38) with a maximum of 17.17%; average total THC is 4.96% (sd 2.30) with a maximum of 11.37 %. Data by year can be seen in **image 2**. The average total THC / total CBD ratio of these samples is 0.77 (sd 0.51).
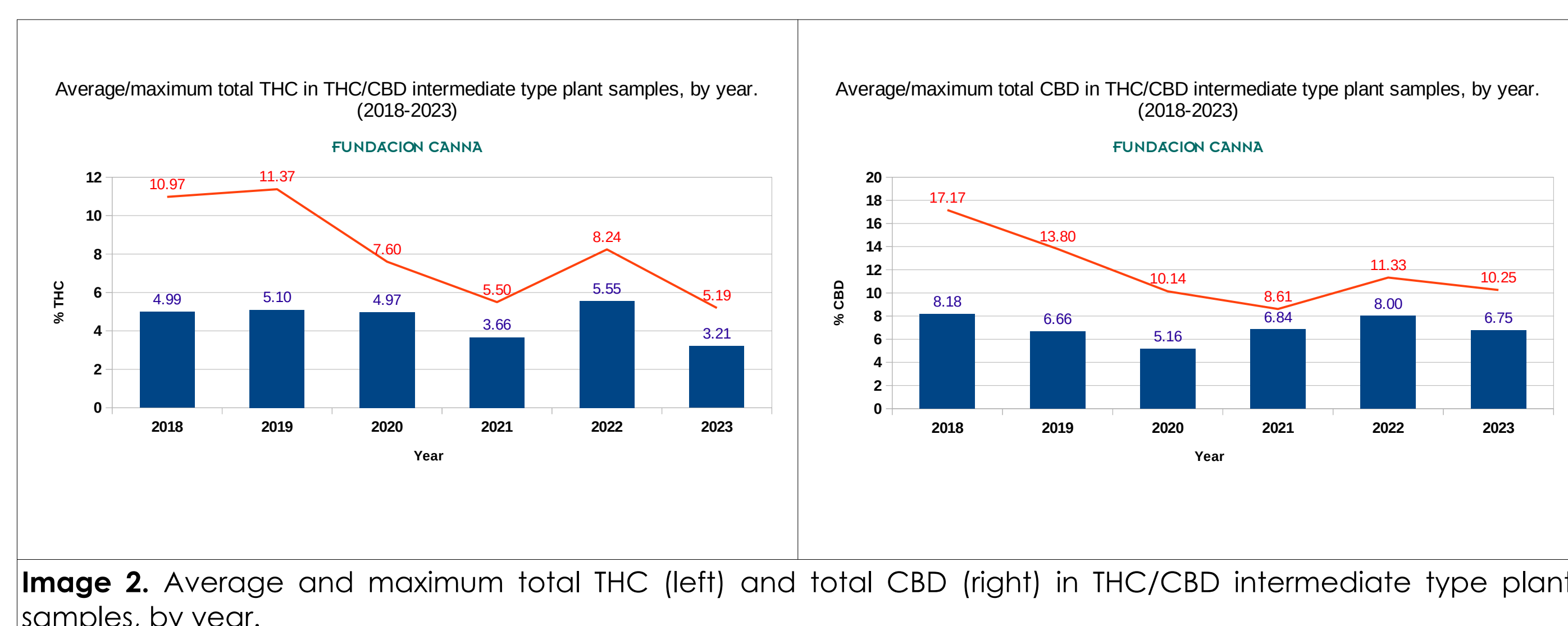

Image 2. Average and maximum total THC (left) and total CBD (right) in THC/CBD intermediate type plant samples, by year.

Fibre type. In all samples (N=624), total CBD average is 2.28% (sd 1.31) with a maximum of 4.97%. The various average and maximum values per year can be seen in **image 3**. Average total CBD ratio: THC total is 20.42 (sd 8.49). The ANOVA ($p<0.05$) does not show significant differences between yearly averages.
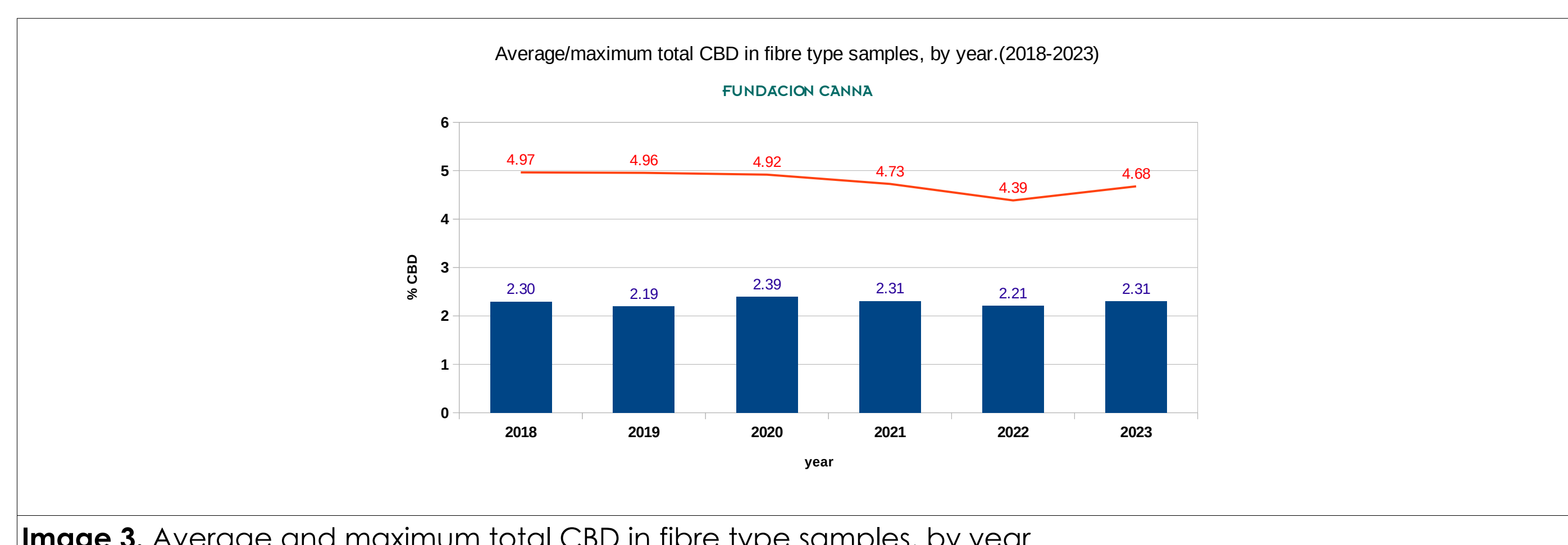

Image 3. Average and maximum total CBD in fibre type samples, by year .

Oils

Full Spectrum. In all samples analysed (N=1299), average CBD is 9.54% (sd 9.15) with a maximum of 48.65%, while average THC is 0.93% (sd 3.38) with a maximum of 40.38%, as shown in **image 4**. Average CBD:THC ratio is 75.26 (sd 115.21). The ANOVA ($p<0.05$) shows no significant change in average CBD over the years of the study.
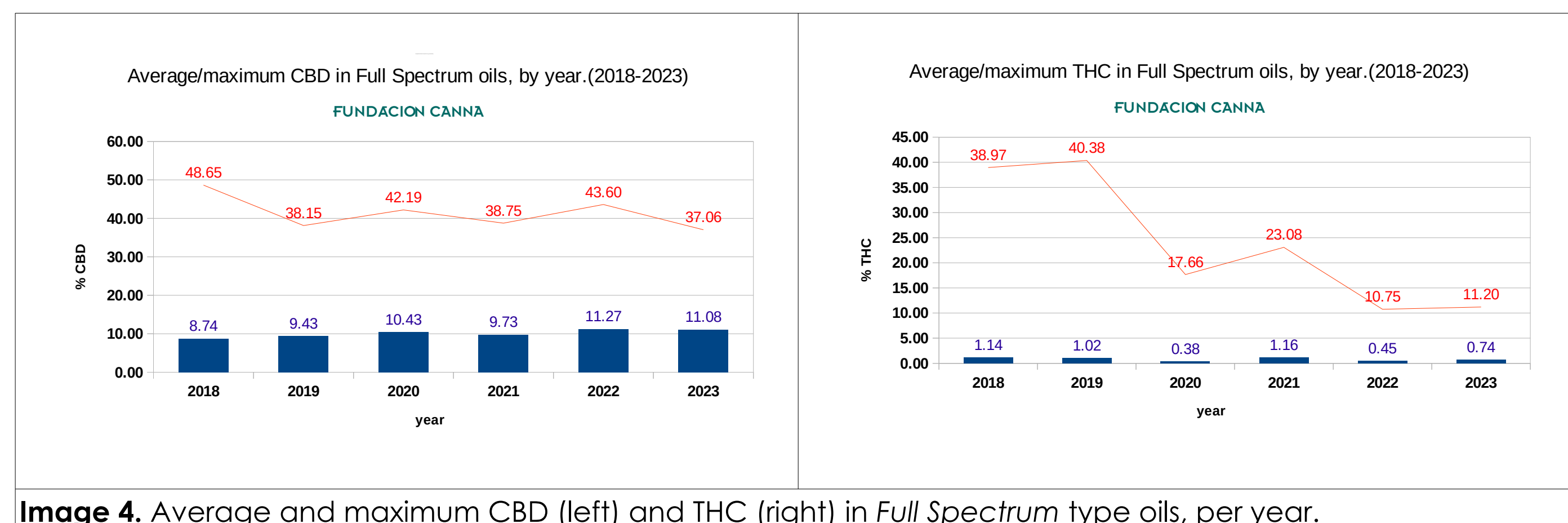

Image 4. Average and maximum CBD (left) and THC (right) in *Full Spectrum* type oils, per year.

Broad Spectrum. In all samples analysed (N=701), total CBD average is 10.85% (sd 8.32) with a maximum of 43.94%. The ANOVA shows significant differences in the average CBD value throughout the years.

Isolates. In all samples (N=659), total CBD average is 4.64%,(sd 7.06) with a maximum of 52.91%. The ANOVA ($p<0.05$) shows significant differences between yearly averages.

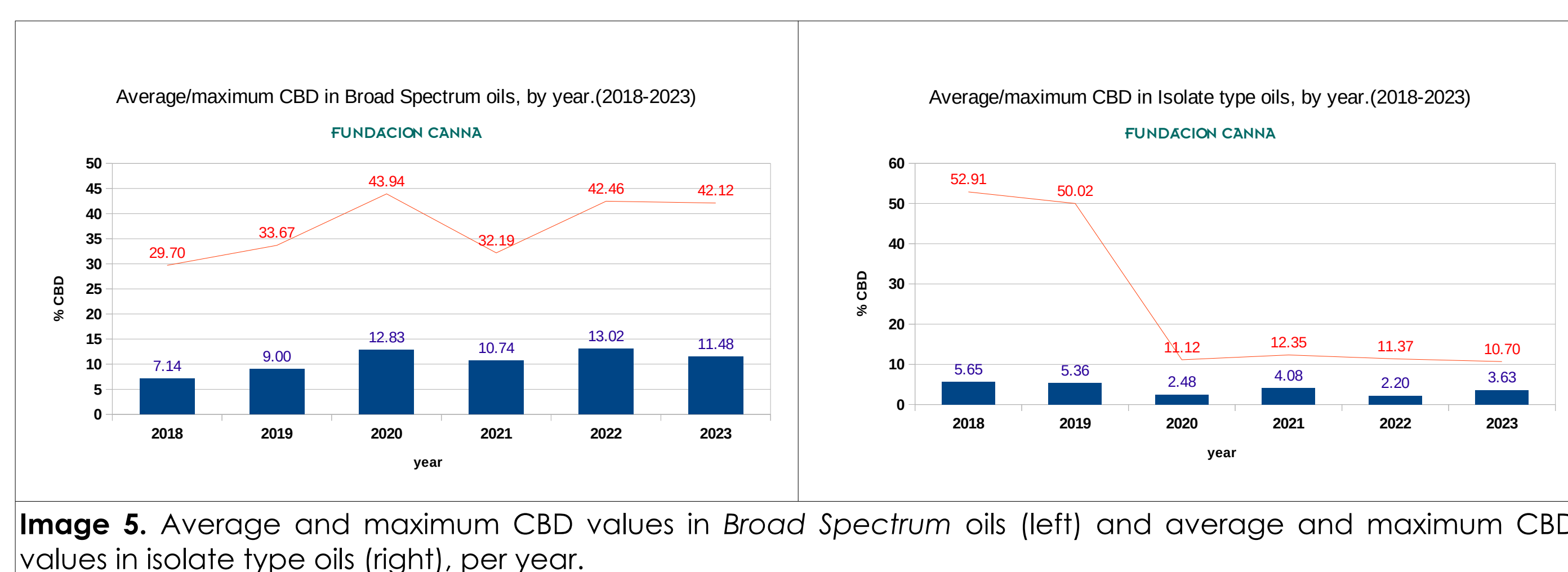Average and maximum values, as well as details by classification and year, can be seen in **image 5.**

Image 5. Average and maximum CBD values in *Broad Spectrum* oils (left) and average and maximum CBD values in isolate type oils (right), per year.

Extracts

Full Spectrum. In all samples analysed (N=1100), total CBD average is 21.50% (sd 23.33) with a maximum of 96.30%. Average THC value is 10% (sd 19,90) with a maximum of 85,45%. The relationship between average and maximum values per year can be seen in **image 6**. The ANOVA ($p<0.05$) shows significant differences between yearly averages.

Broad Spectrum. In all samples analysed (N=139), total CBD average is 29.50% (sd 31.59) with a maximum of 98.66%. The relationship between average and maximum values per year can be seen in **image 6**. The ANOVA ($p<0.05$) shows significant differences between yearly averages.
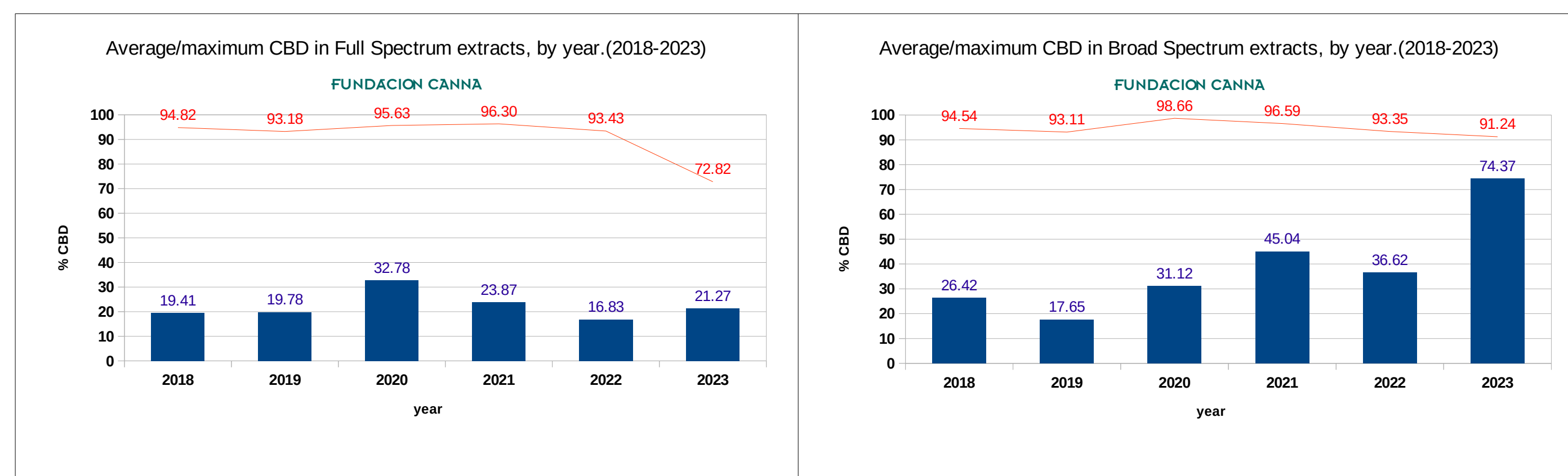

Image 6. Average and maximum CBD values in *Full Spectrum* (left) and *Broad Spectrum* (right) extracts, by year.

E-liquids

In all e-liquid samples analysed (N=436), total CBD average is 4.37%,(sd 7.23) with a maximum of 46.74%. Only 11.7% of samples had THC values above the LOQ. The average total THC in these samples is 0.82% (sd 2.99) with a maximum value of 18.92%.

CONCLUSIONS

According to the ANOVA, there are significant differences in average total THC in THC-dominant samples in the year 2023 compared to the four earlier years, with the THC in 2023 being the highest. In intermediate THC/CBD samples, the trend is towards plants with higher total CBD content than total THC. The average and maximum total CBD content in CBD-dominant plants is lower than the total THC content in THC-dominant samples . Although the ANOVA shows significant differences in average total CBD in CBD-dominant samples over the years, these differences are not significant between 2018 and 2023, so a trend towards a higher CBD value cannot be inferred. The maximum concentration of total CBD in fibre samples is conditioned by the legal limit of total THC, as it is difficult to exceed total CBD concentrations of 5% if there is a risk of exceeding the value of 0.2% in total THC.

Average CBD content of so-called *Full Spectrum* and *Broad Spectrum* oils is very similar. However, oils that only contain CBD (isolates) have a much lower average. One of the causes may be that when *Full Spectrum* extracts are used in the production of the oil the amounts added must be low to avoid a significant presence of THC in the final product. While average CBD in *Full Spectrum* oils do not show significant differences over the years, *Broad Spectrum* oils did show a slight increase compared to the first two years. This may be due to the improvement and/or implementation of new or more efficient extraction techniques that allow for a higher concentration of CBD in the extract used for the production of the oil, with a lower content of THC and other residues. This is in line with what was observed in *Broad Spectrum* extracts, in which average CBD value has increased significantly over the years.

In the case of *e-liquids*, there is a predominance of those containing CBD, with hardly any THC present. The average concentration of total CBD in these *e-liquids* (4,37%) is conditioned mainly by the low solubility of the cannabinoid in these matrices.

REFERENCES

1. New York State Department of Health. Wadsworth Center. Laboratory of Organic Analytical Chemistry. *Measurement of Phytocannabinoids using HPLC-PDA NYS DOH MML-300*. https://www.wadsworth.org/sites/default/files/WebDoc/NYS DOH MML-300-02.pdf (last accessed on 17 September 2024)

2. New York State Department of Health. Wadsworth Center. Laboratory of Organic Analytical Chemistry. *Medical marijuana sample preparation protocols for potency analysis NYS DOH MML-301*. https://www.wadsworth.org/sites/default/files/WebDoc/1495494332/MML-301-01.pdf (last accessed on 17 September 2024)

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