The content of cannabinoids in common hemp plants in the conditions of the Republic of Bashkortostan

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Abstract. Cannabis sativa L. – a herbaceous plant. Recently, interest in this fast-growing plant has increased again due to its multipurpose use: It is indeed a treasure trove of phytochemicals and a rich source of both cellulose and wood fibers. The pharmaceutical and construction sectors are equally interested in this plant, since its metabolites have powerful biological activity for human health, and stem outer and inner tissues can be used to manufacture bioplastics and concrete-like materials, respectively. Cannabinoids are the most studied group of compounds, mainly because of their wide range of pharmaceutical effects on the human body, including psychotropic activity. The content of the main cannabinoids in common hemp plants of the Vera, Nadezhda, Surskaya, Omegadar-1 varieties for 2020-2023 has been studied. The predominant cannabinoid in all varieties during the years of the study is CBD. The studied common hemp varieties in the years of research fully comply with the requirements of the law. The THC content did not exceed 0.1%.

1 Introduction

Common hemp (*Cannabis sativa L.*) is an annual cross-pollinated fibre and oil-bearing plant of the genus *Cannabis* of the family *Cannabinaceae*. Known since ancient times for its medical and textile applications [1, 2], hemp is currently undergoing a revival due to a rich set of phytochemicals, fibers and agricultural features, namely, fairly good resistance to drought and pests, a well-developed root system that prevents soil erosion, less need for water compared to other crops for example, cotton (fig. 1).

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Fig. 1. Spheres of technical cannabis application.

The hemp industry has long been one of the leading branches of the agricultural sector in many regions of Central Russia. In terms of the production of organic matter per unit of acreage, hemp is the leader, along with other tileld crops. Until recently, hemp occupied an area of up to 900 thousand hectares [3], the export of hemp and hemp oil was included in the list of the most important items of foreign exchange income of the state. According to the FSBEI "National Grain Center named after P.P. Lukyanenko", income from 1 ha of hemp is 250-380 thousand rubles, while income from 1 ha of wheat reaches 50-70 thousand rubles. The industrial production of technical culture was carried out by collective farms and state farms, including in the south of Russia. In general, 90 hemp plants operated in the country, and the cultivated area of hemp was 1 million hectares [4].

In the 70s of the twentieth century, the cultivation of hemp declined due to the growth of drug addiction problems. One of the naturally biologically determined characteristics of hemp is the accumulation of cannabinoids, the consumption of which (inhalation of smoke with molecules of these compounds) can cause a feeling of euphoria and other signs of drug intoxication. It is because of this property that hemp began to be used for drug production, which played a significant role in the spread of drug addiction [5].

There are two varieties: technical hemp, which is used as a source of high-quality fiber, seeds, cellulose, hemp oil, and narcotic, containing a substance with hallucinogenic activity - tetrahydrocannabinol, listed as narcotic drugs. Technical and narcotic hemp varieties differ in fiber and seed productivity, but the main difference lies in the content of tetrahydrocannabinol (THC). It is assumed that the THC content in technical varieties of hemp is less than 0.1% [6, 7], while in narcotic varieties it is more than 20%. It is

economically unprofitable and practically impossible to extract THC from technical hemp, the content of which is less than 0.1%. The World Health Organization recommends to classify varieties with a THC content in inflorescences of no more than 0.1 as drug-free [8].

In the Russian Federation, only the cultivation of non-narcotic hemp is allowed. This is regulated by Federal Law No. 3-FZ dated January 8, 1998 (as amended on April 28, 2023) [9] and Decree of the Government of the Russian Federation dated February 6, 2020 No. 101 [10]. It is allowed to cultivate for industrial purposes (with the exception of the production and manufacture of narcotic drugs and psychotropic substances) on the territory of the Russian Federation hemp varieties included in the State Register of Breeding Achievements of the Russian Federation, approved for use, considering the zoning of growth places (only varieties containing in the dry mass of leaves and inflorescences of the upper parts of the plant not exceeding 0.1% THC).

Over the past 25 years, breeders have bred varieties with a low content of cannabinoids. When creating these varieties, close attention was paid to ensuring the necessary characteristics and properties, which are crucial in agriculture [11, 12, 13]. Nowadays, industrial hemp varieties are successfully grown in various regions, which are included in the state register of breeding achievements and are intended for commercial purposes. In the Russian Federation, for 2024, 34 varieties and hybrids of hemp have been included in the State Register of Breeding Results, which are allowed to be used [14].

Five federal districts can be attributed to the regions of Russia engaged in the cultivation of hemp, the main part of the crops is located in the regions of the Volga Federal District. In the next five years, according to the Ministry of Agriculture of Russia, the hemp area will double.

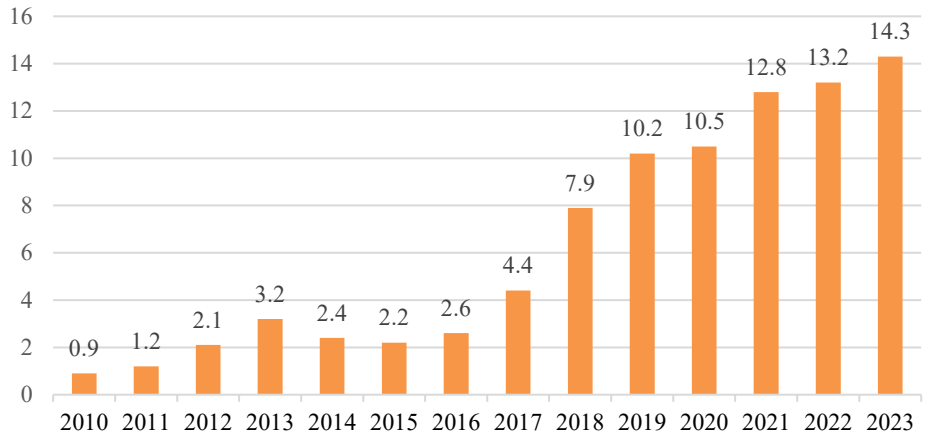

Fig. 2. Acreage of hemp in the Russian Federation (2010-2023).

As can be seen from the presented graph, there is a noticeable increase in the acreage occupied by hemp (Fig.2). It is worth noting that, despite the constant ups and downs of acreage in the period 2010-2019, this crop managed to rise from 0.9 thousand hectares to 10.2 thousand hectares. Even analyzing the data for the last two years, you can see a growth trend, so the acreage in 2021 reached 12.8 thousand hectares, which is 2.3 thousand hectares more than in 2020 [15, 16, 17, 18].

The purpose of the study: To determine the concentration of the main cannabinoids in the inflorescences of hemp cultivated in the Republic of Bashkortostan.

Fig. 3. Seedlings of seeded hemp (photo by the authors).

2 Materials and methods of research

The research was conducted at the educational and scientific center of the FSBEI HE Bashkir State Agrarian University in 2020-2023 (Fig. 3-4.). For research, the varieties of hemp seeds Nadezhda, Vera, Surskaya, Omegadar-1 were selected, which have become most widespread in the farms of the Republic of Bashkortostan cultivating it [19, 20, 21].

The soil of the experimental site is represented by leached chernozem, medium-sized, high in humus, heavy-loamy in granulometric composition: the content of humus is 9%, mobile phosphorus is 150 mg/kg, exchangeable potassium is 200 mg/kg.

The total area of the plot is 36 m^2, the accounting area is 18 m^2. The repetition is threefold. The number of options is 4. Forecrop - naked steam. Scheme of experiment: Vera, Nadezhda, Surskaya, Omegadar-1. At the beginning of flowering, the tops of the inflorescences were selected (Figure 1) to determine the content of the main cannabinoids (CBN – cannabinol, CBD – cannabidiol, CBH – cannabichromene, THC – tetrahydrocannabinol). For analysis, the upper part of the inflorescences was cut 10-12 cm long, placed in pre-prepared bags, which indicated the variety, location and number of the plant (Figure 3). The cut and prepared samples were dried in the shade to an air-dry state. The analysis was carried out by gas-liquid chromatographic analysis in the analytical laboratory of the Penza Research Institute (Fig. 5.) [22, 23]. HTC during the years of research: 2020 - 0,8; 2021 - 0,3; 2022 - 0,7; 2023 - 0,3.

Fig. 4. Hemp crops (photo by the authors).

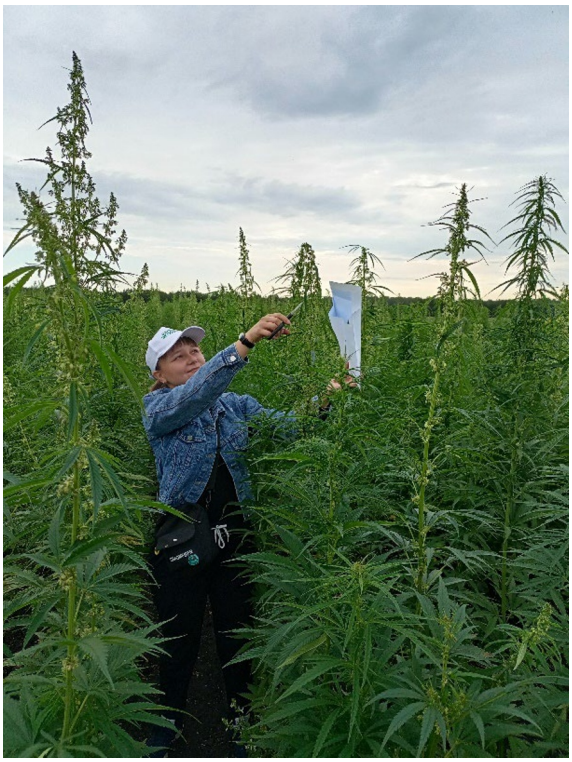

Fig. 5. Sampling for analysis to determine the content of the main cannabinoids (photos of the authors).

Table 1-5 shows the results of laboratory analysis to determine the content of CBD, CBH, THC, and CBN for 2020-2023.

From the data presented in 2020 (Table 1), it can be seen that the maximum and minimum values are marked differently for each variety. Thus, for example, if the maximum values for the content of CBD (0.864%) and THC (0.024%) were noted in

Nadezhda, then for the content of CBD – Surskaya (0.054%), for CBD – Omegadara-1 (0.023%).

Table 1. The content of the main cannabinoids, % (2020).

Variety	CBD	CBH	THC	CBN
Vera	0,862	0,052	0,022	0,022
Nadezhda	0,864	0,053	0,024	0,021
Surskaya	0,863	0,054	0,021	0,020
Omegadar-1	0,860	0,052	0,022	0,023

It is clearly shown that the Nadezhda variety combines the maximum values for two indicators, these are CBD and THC. According to the content of CBD, we see that Vera and Omegadar-1 varieties occupy the same positions (0.052%). This value is considered to be the minimum in terms of CBH content. According to the CBN, the minimum indicators were for Surskaya (0.050%) and Nadezhda (0.021%).

According to the results of the analysis (Table 2), it can be seen that 2021 shows completely different results of laboratory analysis compared to 2020. Prevailing in the following indicators were: CBD – Surskaya (0.883%); CBH – Nadezhda (0.059%) and Omegadar-1 (0.059%); THC – Vera (0.027%), Surskaya (0.027%), Omegadar-1 (0.027%); CBN – Nadezhda (0.027%).

Table 2. The content of the main cannabinoids, % (2021).

Variety	CBD	CBH	THC	CBN
Vera	0,882	0,058	0,027	0,026
Nadezhda	0,880	0,059	0,026	0,027
Surskaya	0,883	0,058	0,027	0,026
Omegadar-1	0,881	0,059	0,027	0,026

It can be seen that the minimum values for CBD are for the Nadezhda variety (0.880%); for CBH – Vera (0.058%) and Surskaya (0.058%); for THC – Nadezhda (0.026%); for CBN Surskaya (0.026%) and Omegadar-1 (0.026%). According to the results of 2020 (HTC 0.8) and 2021 (HTC 0.3), it can be said that agrometeorological conditions affected the accumulation of basic cannabinoids.

The results of 2022 differed from those of 2020-2021. (Table 3). The CBD value varied between 0.862...0.866%, the predominant one was in the Nadezhda variety (0.866%). The CBH varied in the range of 0.053...0.055%. The minimum (0.053%) was in all varieties except Surskaya (0.055%). The THC value ranged from 0.023...0.025%, with the highest content in the Nadezhda variety (0.025%). CBN ranged from 0.022...0.025%, with the predominant value in the Omegadar-1 variety (0.025%).

Table 3. The content of the main cannabinoids, % (2022).

Variety	CBD	CBH	THC	CBN
Vera	0,862	0,053	0,023	0,023
Nadezhda	0,866	0,053	0,025	0,022
Surskaya	0,864	0,055	0,024	0,023

Omegadar-1	0,862	0,053	0,023	0,025

The minimum CBD content (Figure 5) was observed in Vera and Omegadar-1 varieties (0.862%). CBH was the same in all studied varieties (0.053%), except for Surskaya (0.055%). If the maximum THC values were noted in Surskaya (0.024%) and Nadezhda (0.025%), then the minimum values in Vera and Omegadar were 1 (0.023%). The minimum CBN was for the Nadezhda variety (0.022%).

In 2023, the maximum CBD (Table 4) was achieved in the Nadezhda variety (0.879%); CBH – Surskaya (0.056%); THC – in all varieties was equal to 0.027%, except Vera (0.026%); CBN – Omegadar-1 (0.026%). As you can see, the difference between the maximum and minimum values was small and amounted to 0.006% for THC; 0.002% for CBH; 0.001% for THC and CBN.

Table 4. The content of the main cannabinoids, % (2023).

Variety	CBD	CBH	THC	CBN
Vera	0,877	0,054	0,026	0,025
Nadezhda	0,879	0,055	0,027	0,025
Surskaya	0,873	0,056	0,027	0,025
Omegadar-1	0,876	0,054	0,027	0,026

Studies in 2022-2023 showed a difference between the indicators depending on the variety. Since the HTC in 2022 was 0.7, we observe the lowest values for the content of the main cannabinoids compared to 2023, where the HTC was 0.3.

On average, the range in indicators was: CBD - from 0.870% (Omegadar-1) to 0.0872% (Nadezhda); CBH - from 0.054% (Vera) to 0.056% (Surskaya); THC - from 0.025% (Vera, Surskaya, Omegadar-1) to 0.026% (Nadezhda) CBN - from 0.024% (Vera, Nadezhda, Surskaya) to 0.025% (Omegadar-1).

Table 5. The content of the main cannabinoids, % (average 2020-2023).

Variety	CBD	CBH	THC	CBN
Vera	0,871	0,054	0,025	0,024
Nadezhda	0,872	0,055	0,026	0,024
Surskaya	0,871	0,056	0,025	0,024
Omegadar-1	0,870	0,055	0,025	0,025

Over the four years of the study, the maximum CBD content was observed in the Nadezhda variety (0.872%), CBH – Surskaya variety (0.056%), THC – Nadezhda variety (0.026%), CBN – Omegadar-1 variety (0.025%).

4 Conclusions

Studies have shown that in all the years of the study, the predominant cannabinoid in hemp varieties is cannabidiol. Its indicators were higher than the rest of the studied cannabinoids (CBH, THC, CBN). The content of the main cannabinoids in the studied varieties was different during the years of the study. The agrometeorological conditions prevailing in the Republic of Bashkortostan played a special role in the accumulation of these substances. The highest concentration was recorded in 2021 and 2023. The studied hemp varieties in the years of research fully complied with the requirements of the standard for the content of

cannabinoids. The THC content in them is not more than 0.05%, varies from 0.025 to 0.026%.

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