

INDUSTRIALIZATION OF CANNABIS AND ITS APPLICATION IN THE FOOD INDUSTRY

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Abstract

A documentary review was carried out on the production and publication of research papers related to the study of the variable industrialization of cannabis in the food industry. The purpose of the bibliometric analysis proposed in this document is to know the main characteristics of the volume of publications registered in Scopus database during the period 2016-2021 in Latin American countries, achieving the identification of 110 publications. The information provided by said platform was organized by means of tables and figures categorizing the information by Year of Publication, Country of Origin, Area of Knowledge and Type of Publication. Once these characteristics were described, the position of different authors regarding the proposed topic was referenced by means of a qualitative analysis. Among the main findings of this research, it is found that the United States, with 37 publications, is the country with the highest production. The area of knowledge that made the greatest contribution to the construction of bibliographic material referring to the study of the industrialization of cannabis in the food industry was biological and agricultural sciences with 49 published documents, and the type of publication that was most used during the period indicated above was the journal article, which represents 61% of the total scientific production.

Keywords: Cannabis, food industry, Scopus

1. Introduction

Cannabis or cannabis sativa is the plant from which marijuana is obtained and which has a great use in the pharmaceutical industry and in many countries is already regulated for recreational use and its potential to be included in other industries is sought to legislate on food safety issues to regulate the production, marketing and consumption of foodstuffs containing any cannabis derivative. One of the main problems of its application is the discrepancy that arises in some countries regarding its regulation, since federal and state laws do not coincide, which creates legal

loopholes that give rise to the creation of illicit products as they are not classified as medicine, drug or dietary supplement, and the products that are regulated as edibles tend to be monotonous. Even so, increasingly more people are talking about the need to regulate its use since hemp is a plant from which cannabinoids can be obtained, as it is catalogued as one of the key plants for the green economy in the coming years thanks to its low impact on harmful greenhouse gases and minimal damage to the environment, as it grows fast and does not need pesticides, besides not developing any type of insect or parasite of its own or of its nature.

Hemp can be used in construction, the food industry, medicine and the pharmaceutical industry and is also an alternative to reactivate the economy after the economic crisis facing the world as a result of COVID 19 and its implications on business operations and the little movement of trade in recent years, so being this a plant that does not need many resources and has a short time of use, it is also an alternative to the commercial stagnation suffered by the economy.

Thanks to the above, it is important to investigate the application of cannabis in the food industry and the challenges it faces, as well as determining future regulations in countries that have not implemented this product. Therefore, it is important to know the current state of research on the industrialization of cannabis in the food industry in terms of bibliographic resources, so a bibliometric analysis of the scientific production registered in the Scopus database during the period 2016-2021 is proposed to answer the question: how has been the production and publication of research papers related to the study of the variable industrialization of cannabis in the food industry during the period 2016-2021?

2. General Objective

To analyze from a bibliometric and bibliographic perspective, the production of high impact research papers on the variable the industrialization of cannabis in the food industry during the period 2016-2021.

3. Methodology

Quantitative analysis of the information provided by Scopus under a bibliometric approach on the scientific production concerning the industrialization of cannabis in the food industry is carried out. Also, from a qualitative perspective, examples of some research papers published in the area of study mentioned above are analyzed from a bibliographic approach to describe the position of different authors on the proposed topic.

The search is performed through the tool provided by Scopus and the parameters referenced in Table 1 are established.

3.1 Methodological design

	PHASE	DESCRIPTION	CLASSIFICATION
PHASE 1	DATA COLLECTION	Data was collected using the Scopus web page search tool, through which a total of 110 publications were identified.	Published papers whose study variables are related to the industrialization of cannabis in the food industry. Research papers published during the period 2016-2021. Without distinction of country of origin. Without distinction of area of knowledge. Without distinction of type of publication.
PHASE 2	CONSTRUCTION OF ANALYSIS MATERIAL	The information identified in the previous phase is organized. The classification will be	Word Co-occurrence. Year of publication

As shown in Figure 1, the most used keyword is *cannabis*, which is one of the variables under study and refers to the product obtained from *cannabis sativa*, which is used to produce drugs, medicinal products and recently edible products, being this product increasingly used, so its regulation is necessary.

There are also keywords such as cannabinoids, food safety and plants, which refer to one of the biggest problems that the implementation of cannabis in edible products faces and is the regulation of food safety in the countries as they tend to be chemically unstable products that can endanger human welfare. Even so, *cannabis sativa* is one of the plants that least damage the environment by not needing pesticides and grow quickly, so it is necessary to regulate it now for

future use in most possible industries. Finally, there is the drug industry, dietary supplements, drug legislation, which give light to the need to create or adapt the legislation of the countries in order to regulate cannabis edibles as they are not regulated as drugs, medicines or dietary supplements, so there is a legal vacuum that results in violation of regulations creating illicit products.

4.2 Distribution of scientific production by year of publication.

Figure 2 shows how the scientific production is distributed according to the year of publication, taking into account that the period from 2016 to 2021 is taken.

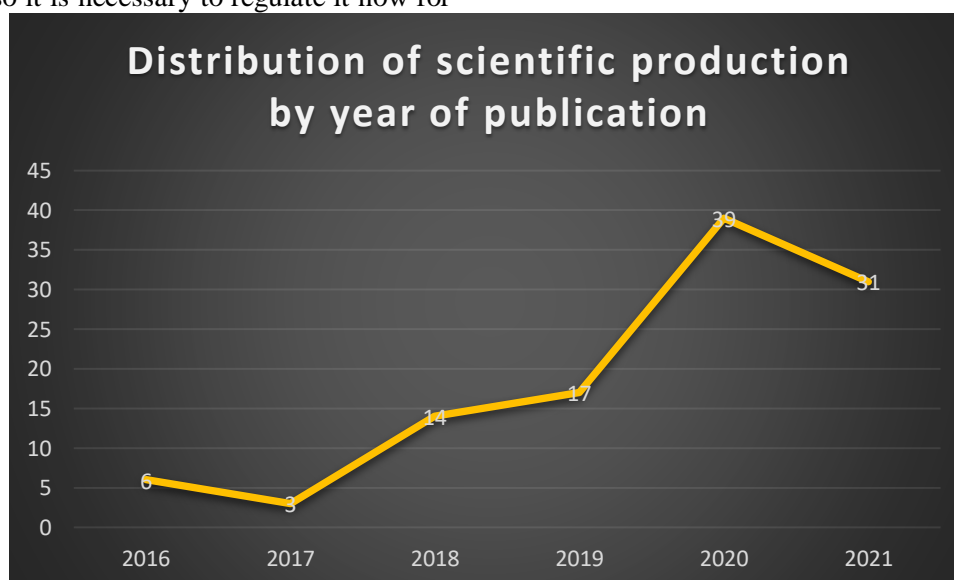


Figure 2. Distribution of scientific production by year of publication.

Source: Own elaboration (2022); based on data provided by Scopus.

2020 is the year with the highest number of publications registered in Scopus related to the variables under study, presenting 39 publications within which is the title “*Cultivating evidence-based pathways for cannabis product development: Implications for consumer protections*” (Walton et al., 2020). This paper examines the need to strengthen consumer protections in the cannabis market since the discrepancy in the regulation of cannabis at the federal and state levels creates products that do not comply with the Federal

Food, Drug and Cosmetic Act, putting the consumer at risk when offered products that are not apparently harmful, so the cannabis industry must submit to this law since it is based on science in order to avoid harm to consumers and regulate the production of products that go against personal well-being.

In second place is 2021 with 31 papers within which is the one entitled “*Cannabis: medicine, food or illicit drug?*” (Bajtel et al., 2021). This document has as main objective to present the evolution of the regulatory environment of Cannabis and its preparations in parallel with its history as a medicine, so it made a study to the legal legislations in force internationally, where

it was found that cannabis began to be commercialized in the 20th century and after these events it became stronger in the medicinal industry. Currently, there is a problem in its application in the food industry since products containing the anti-epileptic component of cannabis are available as food and are used for different medicinal purposes without medical supervision. For this reason, it is concluded that more studies are needed to help clarify the risk-benefit profiles of cannabinoids and will have a

great influence on the future of these compounds in evidence-based medicine.

4.3 Distribution of scientific production by country of origin.

Figure 3 shows the distribution of scientific production according to the nationality of the authors.

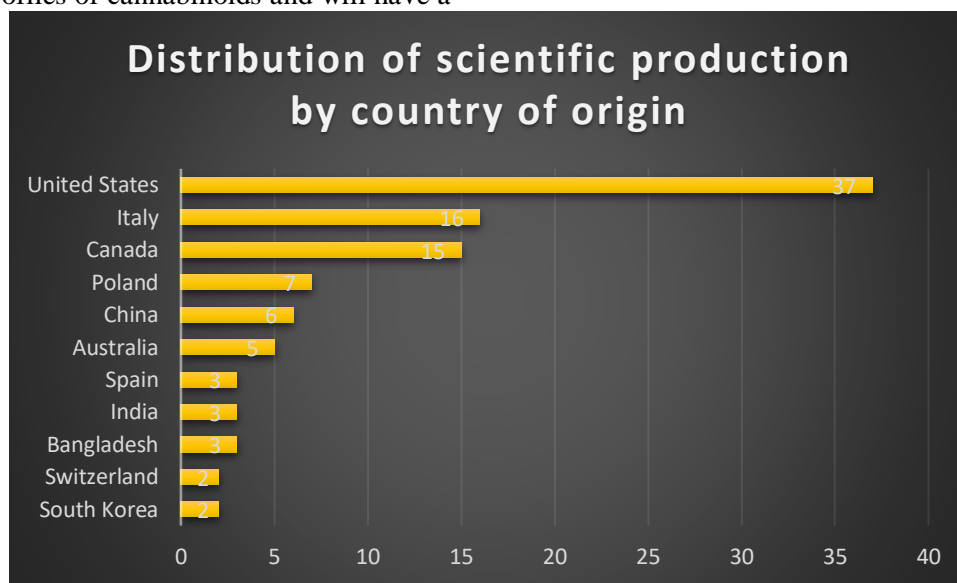


Figure 3. Distribution of scientific production by country of origin.

Source: Own elaboration (2022); based on data provided by Scopus.

The United States is the country with the largest contribution to research related to the variables under study during the period 2016-2021 presenting 37 publications, among which is “*Improvement of cannabidiol (CBD) compound in formulated hemp (Cannabis sativa L.) leaves Through the application of hot melt extrusion*” (Azad et al., 2021). In this paper, processing parameters were developed to improve the decarboxylation process of cannabidiolic acid in hemp leaves by hot melt extrusion (HME). With this study, at least 2.5-fold increase in extruded leaves and El cannabidiol content was four times higher when formulated with AP as the hemp leaves were formulated with two different acid-

based polymers, namely ascorbic acid (AA) and ascorbyl palmitate (AP), prior to HME, being Cannabidiol one of the innovative products in the medical and food industry in order to implement cannabis.

At this point, it should be noted that the production of scientific publications, when classified by country of origin, presents a special characteristic and that is the collaboration between authors with different affiliations to both public and private institutions, and these institutions can be from the same country or from different nationalities, so that the production of an article co-authored by different authors from different countries of origin allows each of the countries to add up as a unit in the overall publications. This is best explained in Figure 4, which shows the flow of collaborative work from different countries.

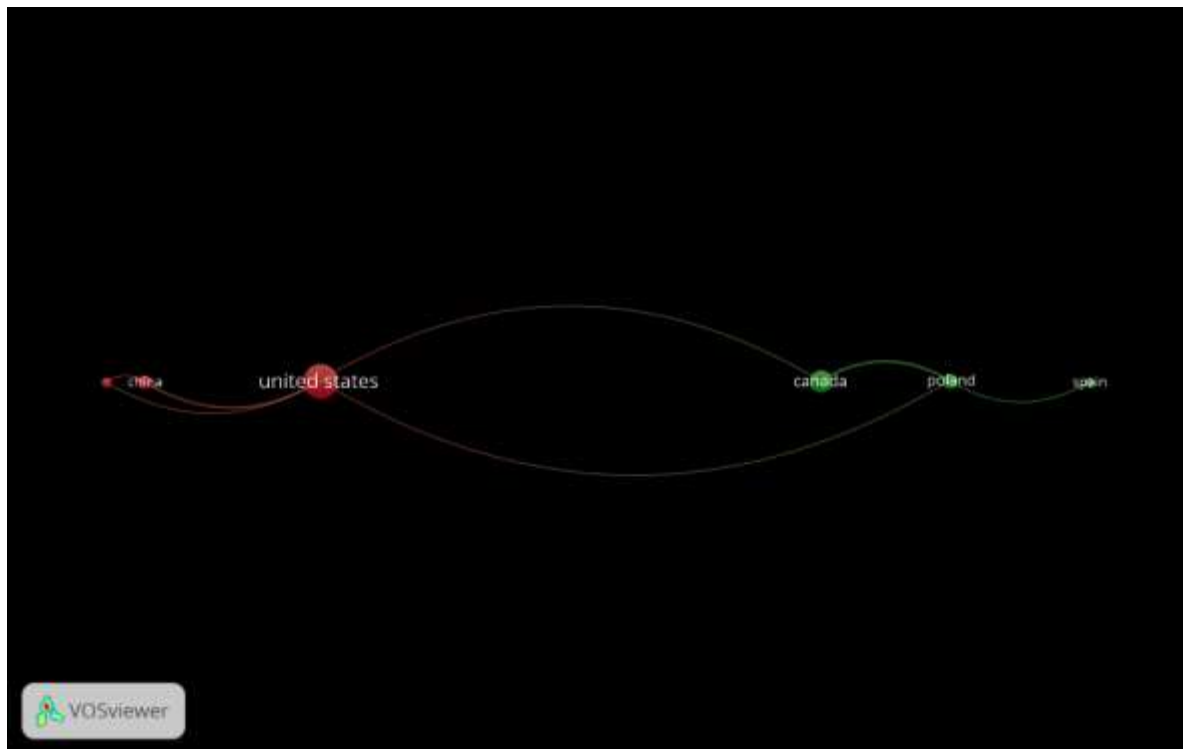


Figure 4. Co-citations between countries.

Source: Own elaboration (2022); based on data provided by Scopus.

As mentioned above, the United States is the country with the largest number of publications related to the variables under study, having documents in collaboration with authors affiliated to institutions in China and Canada in order to make comparative studies that allow them to distinguish the differences in legal regulations on the use of cannabis in different industries. In second place is Italy with 16 documents registered in Scopus, among which is “*Introduction to the emerging industrial applications of cannabis (Cannabis sativa L.)*” (Sorrentino, 2021). This document determines the use of hemp in Italy since on November 22, 2016 the cultivation of this product was legalized, being a plant that is not harmful, does not produce soil affectations, does not need pesticides and grows very fast, so it is

considered the product that will revolutionize the agriculture industry in Italy by being considered as one of the products that are a climate friendly crop that can mitigate climate change and desertification and one of the main protagonists of the green economy in the near future. Having its application in the food industry by using its seeds to generate flour, and the application of the stem in the green building sector and furthermore there is talk of the medicinal use of Δ^9 -tetrahydrocannabinol (THC) which is not yet regulated with Italian legislation.

4.4 Distribution of scientific production by area of knowledge

Figure 5 shows how the production of scientific publications is distributed according to the area of knowledge through which the different research methodologies are executed.

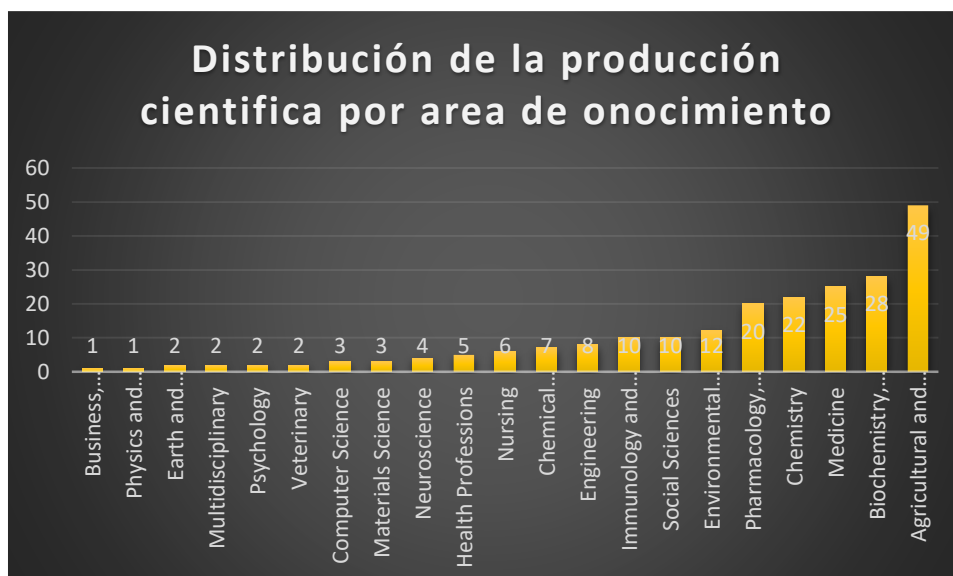


Figure 5. Distribution of scientific production by area of knowledge.

Source: Own elaboration (2022); based on data provided by Scopus.

Biological and Agricultural Sciences is the area of knowledge with the highest number of contribution through theories framed within it, in the search for new knowledge on the use of cannabis in the food industry presenting 49 papers in total, within which is “*Food Safety Lessons for Cannabis-Infused Edibles*” (Knutson, 2020). This book responds to the problem of cannabis-infused foodstuffs, which are not federally regulated as medicine, food or dietary supplements, so regulation is needed for the production, marketing and consumption of these foods as they may represent a risk to the welfare of people.

In second place is molecular biology and biochemistry where 28 documents were written following the guidelines of the topics related to this area, among these is the title “*Innovative*

and emerging applications of cannabis in food and beverages: From an illicit drug to a potential ingredient for the promotion of health” (Rasera et al., 2021). The main objective of this document is to synthesize the basic aspects related to the therapeutic use of cannabis, providing information that highlights its application as an emerging ingredient in the food and beverage industry. Its recreational use has been a controversial issue, but it is already regulated in some countries, but in the food sector it is a new product that can be implemented as an additive, so it is also necessary to study food health regulation in order to determine any risk that cannabinoids may pose to health.

4.5 Type of publication

Figure 6 shows how the bibliographic production is distributed according to the type of publication chosen by the authors.

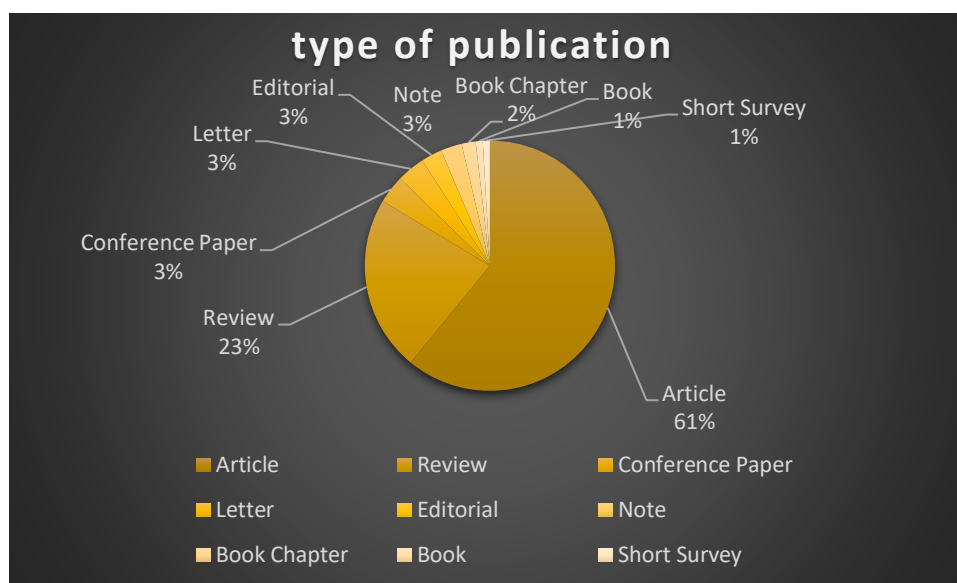


Figure 6. Type of publication

Source: Own elaboration (2022); based on data provided by Scopus.

As shown in Figure 6, among the different types of publications, 61% of the total number of documents identified in Phase 1 of the Methodological Design correspond to journal articles, including the one entitled “*Development and validation of the hplc/dad method for the quality control of products containing cannabidiol*” (Andonova et al., 2021). The main objective of this document is to develop, validate and apply the high-performance liquid chromatography (HPLC/DAD) method with diode array detection for the identification and assay of CBD in food supplements obtained through different types of extraction and purification. The study applied the method performed by European Pharmacopoeia and the International Council for Harmonization of Technical Requirements for Pharmaceuticals for Human Use in which it was determined that this project is useful for analytical identification tests and can be used in pharmaceutical industries.

In second place are the review proceedings which represent 23% of the total number of documents selected in this study. Within these publications is the title “*Cannabis and cannabis edibles: a review*” (Peng & Shahidi, 2021). This document reviews and updates a comprehensive understanding of the chemistry, metabolism,

toxicity, marketing and regulations related to edible cannabinoids taking into account their recent implementation in the food industry taking into account that some of its elements present chemical instability, so that legal edible products tend to be monotonous so some tend to be out of regulation putting food health at risk.

5. Conclusions

Thanks to the bibliometric analysis proposed in this research, it can be determined that the United States is the country with the highest number of bibliographic records in the Scopus database during the period between 2016 and 2021 with a total of 37 documents. The scientific production related to the study of the industrialization of cannabis in the food industry has presented an important growth during the above mentioned period, going from 6 publications in 2016 to 31 units in 2021 being 2020 the year with the highest number of publications presenting 39 documents, i.e., it was possible to greatly increase the creation of bibliographic records in a period of 5 years, which indicates the importance of researching on how cannabis is implemented in the food industry with respect to the regulations of each country taking into account the risks in health and welfare that this may generate, so it is necessary the creation of methods to determine its effectiveness.

Cannabis is increasingly used in the pharmaceutical industry due to its benefits, but recently there has been talk of its implementation in food industry since edible products are not regulated as medicines, drugs or dietary supplements, which translates into violations of food safety, so the creation of methods to determine the risks or benefits of its use is of great importance, in addition to legislation to determine its production, being a chemically unstable product, and its consumption. Hemp, which is one of the plants from which cannabis is obtained, represents the future of agriculture in many countries thanks to its great benefits and low environmental impact, so implementing it in the food industry is a way to expand its use.

All of the above allows this article to conclude the importance of knowing how cannabis is applied in the food industry and the challenges it faces when there is a discrepancy in the regulations of the countries, making its use in this sector difficult. It is for this reason that the need for studies such as the one presented in this document is highlighted, which make a tour of those texts that address the aforementioned topic, in order to give the reader a broad view of the current situation of the literature on the industrialization of cannabis in the food industry.

References

- [1] Andonova, L., Ivanov, E., Pencheva, I., & Konstantinov, S. (2021). Elaboration and validation of hplc/dad method for quality control of products containing cannabidiol. *Current Pharmaceutical Analysis*, 1218 - 1223.
- [2] Azad, M., Ryu, B., Rana, M., Rahman, M., Lim, J.-D., & Lim, Y.-S. (2021). Enhancing the cannabidiol (CBD) compound in formulated hemp (*Cannabis sativa* L.) leaves through the application of hot-melt extrusion. *Processes*.
- [3] Bajtel, Á., Kiss, T., Csupor-Löffler, B., Szendrei, K., & Csupor, D. (2021). Cannabis: medicine, food or illicit drug? *Orvosi hetilap*, 1808 - 1817.
- [4] Knutson, K. (2020). *Food Safety Lessons for Cannabis-Infused Edibles*.
- [5] Peng, H., & Shahidi, F. (2021). Cannabis and Cannabis Edibles: A Review. *Journal of Agricultural and Food Chemistry*, 1751 - 1774.
- [6] Rasera, G., Ohara, A., & de Castro, R. (2021). Innovative and emerging applications of cannabis in food and beverage products: From an illicit drug to a potential ingredient for health promotion. *Trends in Food Science and Technology*, 31 - 41.
- [7] Sorrentino, G. (2021). Introduction to emerging industrial applications of cannabis (*Cannabis sativa* L.). *Rendiconti Lincei*, 233 - 243.
- [8] Walton, A., Kellis, K., Tankersley, W., & Patel, R. (2020). Cultivating Evidence-Based Pathways for Cannabis Product Development: Implications for Consumer Protection†. *American Business Law Journal*, 773 - 825.
- [9] Haunreiter, K.J., Dichiara, A., Gustafson, R.
- [10] Structural and chemical characterization of hop bine fibers and their applications in the paper industry
- [11] (2021) *Industrial Crops and Products*, 174, art. no. 114217, .
- [12] Bajtel, Á., Kiss, T., Csupor-Löffler, B., Szendrei, K., Csupor, D.
- [13] Cannabis: medicine, food or illicit drug? [Article@Cannabis: gyógyszer, élelmiszer vagy kábítószer?]
- [14] (2021) *Orvosi hetilap*, 162 (45), pp. 1808-1817.
- [15] 2) <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85121653325&doi=10.1556%2f650.2021.32211&partnerID=40&md5=4ccDOI:10.1556/650.2021.32211>
- [16] Nissen, L., Casciano, F., Babini, E., Gianotti, A.
- [17] Prebiotic potential and bioactive volatiles of hemp byproduct fermented by lactobacilli
- [18] (2021) *LWT*, 151, art. no. 112201, . Cited 3 time
- [19]) Smulek, W., Siejak, P., Fathordoobady, F., Masewicz, Ł., Guo, Y., Jarzębska, M., Kitts, D.D.,
- [20] Kowalczewski, P.Ł., Baranowska, H.M., Stangierski, J., Sz wajca, A., Pratap-Singh, A., Jarzębski, M.
- [21] Whey proteins as a potential co-surfactant with *aesculus hippocastanum* l. As a stabilizer in

- [22] nanoemulsions derived from hempseed oil
- [23] Metcalf, D.A., Wiener, K.K.K., Saliba, A., Sugden, N.
- [24] Evaluating the acceptance of hemp food in Australian adults using the theory of planned behavior and
- [25] structural equation modelling
- [26] (2021) *Foods*, 10 (9), art. no. 2071, .
- [27] Rehman, M., Fahad, S., Du, G., Cheng, X., Yang, Y., Tang, K., Liu, L., Liu, F.-H., Deng, G.
- [28] Evaluation of hemp (*Cannabis sativa* L.) as an industrial crop: a review
- [29] (2021) *Environmental Science and Pollution Research*, 28 (38), pp. 52832-52843. Cited 2 times.
- [30] Rasera, G.B., Ohara, A., de Castro, R.J.S.
- [31] Innovative and emerging applications of cannabis in food and beverage products: From an illicit drug
- [32] to a potential ingredient for health promotion
- [33] (2021) *Trends in Food Science and Technology*, 115, pp. 31-41. Cited 2 times.
- [34] Wang, Y., Hao, Z., Pan, L.
- [35] HRMS Detector for the New HILIC CBD Method Development in Hemp Seed Oil
- [36] (2021) *Journal of the American Society for Mass Spectrometry*, 32 (8), pp. 1919-1927. Cited 3 times
- [37] Samaei, S.P., Martini, S., Tagliazucchi, D., Gianotti, A., Babini, E.
- [38] Antioxidant and Angiotensin I-Converting Enzyme (ACE) Inhibitory Peptides Obtained from Alcalase
- [39] Protein Hydrolysate Fractions of Hemp (*Cannabis sativa* L.) Bran
- [40] (2021) *Journal of Agricultural and Food Chemistry*, 69 (32), pp. 9220-9228. Cited 1 time