

# Cannabidiol: Food or Drug? A Positioning

Karin Kraft<sup>1</sup>, Michael Thomsen<sup>2</sup> and Mathias Schmidt<sup>3,\*</sup>

<sup>1</sup>Centre for Internal Medicine, Medical Faculty of the University of Rostock, Ernst-Heydemann-Str. 6, 18057 Rostock, Germany

<sup>2</sup>Sydney University Medical School, Discipline of Pharmacology, The University of Sydney, Camperdown NSW 2050, Australia

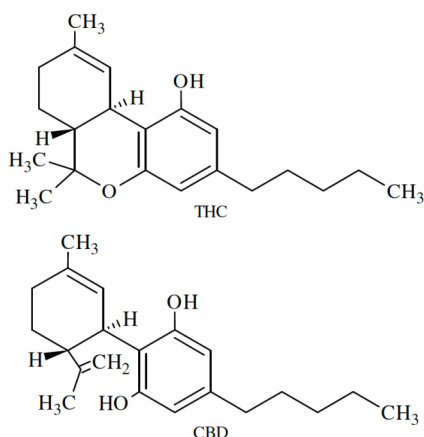
<sup>3</sup>Herbresearch Germany, Wartbergweg 15, 86874 Mattsies, Germany

**Abstract:** Products containing cannabidiol (CBD) such as CBD oil, are marketed in Europe as food and dietary supplements. They are also frequently advertised as potential treatments for serious illnesses. Applications for Novel Food Status are currently being processed in Europe. On closer scrutiny however, the basis for classifying CBD as a foodstuff is at best, questionable. The use of CBD in the management of severe disease is based on demonstrated pharmacological and clinical effects, which is clearly the domain of drug use. CBD lacks food-typical properties. Although CBD has a high level of toxicological safety even in high doses, this does not imply that it qualifies to be categorised as (novel) food simply because it has been proven to be safe. Herein, we examine the presentation of CBD-containing preparations with the background of European legislation.

**Keywords:** Cannabidiol, Novel Food, Drug by presentation, narcotics, food supplements.

## INTRODUCTION

Preparations containing cannabinoids are currently advertised and internationally sold in increasing quantities. The major psychotropic constituent of *Cannabis sativa*,  $\Delta$ -9-tetrahydrocannabinol (THC) is a narcotic, for which the current regulations allow a medicinal use under strictly supervised conditions. The focus of this text is on cannabidiol (CBD; Figure 1). Currently marketed products with CBD include food items, food supplements, aromatics and tobacco replacement products [1]. Typical examples are CBD-enriched sweets or so-called CBD oils. The marketing of such products is quite clear: It does not even disguise its approach as a *de facto* medicinal product for the treatment of severe disease.



**Figure 1:** Major cannabinoids in hemp leaves and flowers:  $\Delta$ -9-Tetrahydrocannabinol (THC) and cannabidiol (CBD).

\*Address correspondence to this author at the Herbresearch Germany, Wartbergweg 15, 86874 Mattsies, Germany; Tel: +49-8268-908174; E-mail: schmidt@herbresearch.de

A real-life example citing from marketing texts of a CBD product formulated as a mouth spray: The following text snippets are directly quoted from the FAQs on the product website (the reference and the product name are omitted, as this is just one of many examples).

*Why do people use CBD?*

[...] The majority of German CBD consumers use CBD for the following purposes: Pain relief (47,6%), relaxation (42,1%), general well-being (39,7%), sleep aid (31,1%), against inflammation (22,6%), muscle relaxation after sports (8,5%), promotion of concentration (6,1%) and 14,5% use CBD for other purposes.

*What is CBD oil used for?*

[...] Scientific research thus far has shown that CBD can be used to treat rare forms of childhood epilepsy such as Dravets or Lennox-Gastaut syndrome. There is moderate evidence that CBD can also be used for pain relief and some evidence that it can be used to promote sleep and relaxation, as well as reduce stress, anxiety and skin irritation.

*How do I take CBD?*

[...] The CBD oil is sprayed under the tongue and is left there until it's completely absorbed by your mouth. As your body digests the oil, you'll likely start to feel its effects in 15-30 minutes.

In the following, we examine the different categories of products more closely on the background of

currently applicable EU regulations. This publication should not be considered as a legal expertise, as it simply represents the interpretation of the authors.

### **CBD as a Constituent of Regular Food**

According to the definitions of the European Food Directive 178/2002/EC, food is “*any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans. Food includes drink, chewing gum and any substance, intentionally incorporated into the food during its manufacture, preparation or treatment*”. Food explicitly does not include (among others) medicinal products, tobacco and tobacco products, or narcotic or psychotropic substances within the meaning of the United Nations Single Convention on Narcotic Drugs of 1961 and the United Nations Convention on Psychotropic substances of 1971 (<https://www.unodc.org/unodc/en/commissions/CND/conventions.html>).

Food supplements or food additives legally count as food, even though there is more specific legislation defining the conditions of their use. Food as such, is expected to deliver basic nutritional requirements such as proteins, fats or carbohydrates, but also dietary fibres, vitamins, minerals, trace elements and water. There is no obvious basic nutritional requirement for CBD. CBD does not correspond to any of the mentioned macro- and micronutrients.

### **Conclusions on CBD-containing preparations as a regular food item:**

**CBD-oil and other foods artificially enriched with CBD do not fulfil any of the basic nutritional functions as defined in the European Food Directive 178/2002/EC.**

### **CBD in Food Supplements**

Food supplements are regulated by the European Directive 2002/46/EC. Article 2 of this directive defines food supplements as foodstuff with the purpose “*to supplement the normal diet and which are concentrated sources of nutrients and other substances with a nutritional or physiological effect*”. The Directive also defines “nutrients” more closely: These are either vitamins or minerals. To justify secondary plant metabolites such as CBD in food supplements, the applicant must demonstrate that the substances in question have either a nutritional or a physiological effect. According to the usual

interpretation in court rulings, it must at least theoretically be possible to reach the claimed physiological effect of a food supplement through regular nutrition. In the case of CBD, it is impossible to identify a normal diet rich in cannabinoids. Cannabis flowers and isolated CBD are not part of the regular human nutrition, and hemp seed-derived food does not contain cannabinoids, except as a contamination from harvesting. Food items declared as THC-free such as hemp tea must not exceed the defined daily limits for THC (see below). In any case, CBD is not a constituent to which humans are regularly exposed through nutritional means, and all discussed CBD effects are clearly pharmacological in nature. The explicit mentioning of diseases treatable by CBD in advertisements underlines that the intended effects are not physiological. There is no conceivable situation where significant quantities of CBD can be supplied by nutritional sources.

### **Conclusions on CBD in food supplements:**

**The Food Supplement Directive 2002/46/EC expects the demonstration of nutritional or physiological effects for nutrients used in food supplements. As CBD has neither been shown to have nutritive nor physiological effects, there is no apparent foundation for its use in food supplements.**

### **CBD as a Food Additive**

Food additives are regulated through EU Directive 1333/2008/EC. They are “*substances that are not normally consumed as food itself but are added to food intentionally for a technological purpose*”. The technological purposes are defined in currently 26 categories listed in Annex I of the Directive (Table 1). Typical uses are, for example, the improvement of taste or texture, the physical aspects of a food or its shelf life.

CBD cannot be classified within any of the categories listed in Table 1. Food additives have a purely technological function in food, even though this does not exclude possible (albeit undesired) effects in the human organism.

### **Conclusions on the classification of CBD as a food additive:**

**CBD does not fit into any of the 26 categories of food additives listed in Annex I of Directive 1333/2008/EC.**

**Table 1: Functional Classes of Food Additives According to Annex I of Directive 1333/2008/EC**

1. Sweeteners	10. Bulking agents	19. Modified starches
2. Colours	11. Emulsifiers	20. Packing gases
3. Preservatives	12. Emulsifying salts	21. Propellants
4. Antioxidants	13. Firming agents	22. Raising agents
5. Carriers	14. Flavour enhancers	23. Sequestrants
6. Acids	15. Foaming agents	24. Stabilisers
7. Acidity regulators	16. Gelling agents	25. Thickeners
8. Anti-caking agents	17. Glazing agents	26. Flour treating agents
9. Anti-foaming agents	18. Humectants	

### CBD as a Flavouring

In many consumer products, CBD is simply declared as a flavouring, which also conflicts with the legislation. Flavours are regulated through the European Flavour Directive 1334/2008/EC. Flavours according to this regulation are used to improve or modify the odour or taste of food. Flavours must be safe, and their addition to a food must not mislead the consumer. New flavouring substances must be authorized following an application procedure laid down in Directive 1331/2008/EC, with newly authorized substances entered into the Union List of Flavourings ([https://ec.europa.eu/food/safety/food\\_improvement\\_agents/flavourings/eu\\_lists\\_flavourings\\_en](https://ec.europa.eu/food/safety/food_improvement_agents/flavourings/eu_lists_flavourings_en)). CBD and any other constituent or preparation of Cannabis are not listed.

CBD is also marketed in flavoured tobacco replacement products, whereas at the same time the EU is striving for a ban of tobacco flavouring. The EU Tobacco Directive 2014/40/EC is currently asking the member states to prohibit tobacco products with a characterizing flavour. Already now, tobacco and tobacco replacement products such as e-cigarettes are not allowed to be marketed by referring to flavours (Tobacco Directive 2014/40/EC).

### Conclusions on the classification of CBD as a flavour:

**Flavouring agents require an authorization and an entry into the Union list for flavourings. CBD has no entry therein. It would also not be legal to market CBD in tobacco replacement products as a “flavour”.**

### Are Cannabis and CBD “Novel Food”?

“Novel Food” is a regulatory definition for any food item lacking the historical background of having been

consumed to a significant extent in the European Union prior to 15<sup>th</sup> of May 1997 – this date representing the day of the creation of the legislation. The enrichment of hemp oil or other food oils with CBD via concentrates or with isolated or synthetic CBD could not have existed prior to May 1997, as in 1997 the use of Cannabis preparations was still banned under the International Convention on Narcotics.

Food items considered “novel” can only be legally sold in the EU when officially approved through an entry in the Union list for Novel Food of the European Union. The Union list unequivocally states that CBD is not a traditional food item. In addition, the list entry for cannabinoids defines that “*extracts of Cannabis sativa L. and derived products containing cannabinoids are considered novel foods as a history of consumption has not been demonstrated. This applies to both the extracts themselves and any products to which they are added as an ingredient (such as hemp seed oil). This also applies to extracts of other plants containing cannabinoids. Synthetically obtained cannabinoids are considered as novel*”. An application for registration is indispensable if CBD is to be used in a given food, regardless of the origin (from natural sources or by synthesis): [https://ec.europa.eu/food/safety/novel\\_food/catalogue/search/public/?event=home&seqfce=940&ascii=C](https://ec.europa.eu/food/safety/novel_food/catalogue/search/public/?event=home&seqfce=940&ascii=C).

Novel Food applications are specific for a defined food item. An application submitted for a hemp oil enriched with CBD could, even if it were accepted, not automatically be transferred to a mouth spray or gummies with CBD. Such products would require a separate application. There are currently more than 50 applications for food items containing CBD pending on the level of the EU, many of them using synthetic CBD. The intake recommendations tend to be quite high in these applications, with 150 mg and more per day

(e.g., [https://ec.europa.eu/food/sites/food/files/safety/docs/novel-food\\_sum\\_ongoing-app\\_2019-0935.pdf](https://ec.europa.eu/food/sites/food/files/safety/docs/novel-food_sum_ongoing-app_2019-0935.pdf)), which is justified by the applicants with the lack of toxicity of CBD at doses exceeding 1200 mg/day. As of the 1<sup>st</sup> of June 2021, no registration was granted.

When the EU procedure for the registration of Novel Food is examined more closely, it seems striking that there is no obvious mechanism to first clarify whether a Novel Food is in fact food. The contents of Novel Food applications are regulated by Article 10 of the Novel Food Directive 2015/2283/EC. The EFSA has created a checklist for submissions of applications as Novel Food [2]. This check for completeness calls, among other technical details, for data on the manufacturing, toxicology and quality control, but does not include a plausibility check on the classification as food.

### **Conclusions on the requirement of registration of CBD as Novel Food:**

**CBD is defined by the Union list as a substance requiring an application for registration as Novel Food. The CBD products currently marketed, such as CBD oils, do not have an approved Novel Food status. Traders therefore risk legal prosecution. In addition, the current procedure for Novel Food applications focusses on technical and toxicological aspects but seems to neglect the question whether the item in question would in fact fulfil any of the legal definitions of food. It might make sense to add a justification of the food status to the documentation to be supplied with applications for Novel Food registration.**

### **Is CBD a Narcotic?**

Whereas THC is explicitly listed as a narcotic in the UN Single Convention on Narcotic Drugs, CBD is not listed: It does not cause addiction and cannot be abused. The WHO explicitly voted for not declaring CBD a narcotic, as CBD does not fulfil the preconditions and characteristics of a narcotic substance [1].

CBD is sold either as a concentrated extract from leaves or flowers of Cannabis, as an isolate or as synthetic CBD. Restrictions derived from definitions valid for the plant material in the narcotics legislation cannot apply to synthetic CBD. This situation led to a differing regulatory handling of natural and synthetic CBD, which was regarded unacceptable by the European Court of Justice (ruling No. C663-18 of 19<sup>th</sup>

of November 2020). The court confirmed that if CBD is not a narcotic, this property would be independent from the original source of the material. CBD from natural sources and synthetic CBD cannot be treated differently. In a press release of 3<sup>rd</sup> of December 2020 (albeit of importance for all EU member states, the comment is only available in German), the EU Commission referred to the court ruling by drawing the conclusion that CBD could be classified as food, if in fact is not a narcotic ([https://ec.europa.eu/germany/news/20201203-cannabidiol-produkte\\_de](https://ec.europa.eu/germany/news/20201203-cannabidiol-produkte_de)). This conclusion seems somewhat out of context, as there are still several steps to be taken from a confirmed non-classification as a narcotic to the use in food. In fact, the European Court of Justice had not commented on the classification of CBD as a food.

### **Conclusions on the regulation of CBD as a narcotic:**

**As a pure compound, CBD is clearly not a narcotic and is not subject to the restrictions of the Narcotics Act. It would, however, be premature to conclude that CBD can therefore be used in food.**

### **Definition of Threshold Doses**

Threshold doses can be helpful tools when deciding which exposure level can still be considered safe. Food in the European Union must by legal definition be safe, which is why the European Food Safety Authority (EFSA) published an acute reference dose (ARfD) of 1 µg/kg body weight (b.w.) per day as a safe dose of THC [3]. This dose was derived from a Lowest Observed Adverse Effect Level (LOAEL) of 2.5 mg THC per day in published studies. The ARfD and the NOAEL are used by regulatory authorities as a benchmark for the risk assessment of food items. In Germany, where Cannabis-derived preparations are under close supervision, the authorities regularly report cases where these limits are exceeded [4]. The rationale in the approach of the German authorities is rather simple: whenever the ARfD of 1 µg/kg b.w. is exceeded or the daily limit of 2.5 mg is met, the corresponding product is considered unsafe and therefore not marketable [4].

Extract preparations with CBD as the major cannabinoid almost always also contain certain amounts of THC. Switching to synthetic CBD is not a valid solution, as synthetic CBD also contains THC as an impurity from synthesis. This implies that even food items with synthetic CBD can exceed the safety

thresholds for THC, although the designated thresholds appear to be greatly exaggerated.

Example:

A commercial hemp oil is labelled as containing 20 % CBD and 0.1 % THC, corresponding to 200 mg CBD and 1 mg THC per millilitre of oil. The quantity of THC is below the threshold of 0.2 % for a narcotic. On the first glance there is no obvious problem, however the recommended intake must be taken into account:

- a. A daily dose of 2.5 ml of this oil would reach the NOAEL of 2.5 mg/day and would therefore be considered unsafe when exceeding this dose. As food by definition must be safe, a product with this dose recommendation could not be legally sold.
- b. The usual regulatory assumption is a body weight of 70 kg. Based on the ARfD of 1 µg/kg b.w. and a content of 0.1% THC in the oil, the maximum daily exposure of 70 µg of THC is already reached by 70 µg of oil!

There is currently no official threshold for CBD. Comparative analyses of hemp oil versus CBD oils found a typical content of less than 0.1 % CBD in hemp oils [5]. High quantities of CBD in commercial “CBD oils” with typical concentrations ranging from 10 to 40 % can therefore only be the result of an artificial addition of CBD to a native oil, as CBD is not a natural constituent of hemp seeds.

Pharmacological effects of CBD are to be expected above a dose of 1000 mg [6]. The oral bioavailability of CBD is poor [7], it is estimated with only around 6 % [1]. Modern galenical formulations (e.g., using lipids and micronisation) can considerably increase the bioavailability at distinctly lower doses [8]. Should CBD be accepted as a food constituent, the EFSA will probably have to deal with threshold doses in food, taking the pharmacokinetic aspects into consideration.

#### **Conclusion on threshold doses:**

**CBD-containing Cannabis preparations containing even just small amounts of THC frequently exceed the defined daily benchmark doses, and can therefore be regarded as narcotics.**

**There is currently no threshold dose for CBD. A reference dose for CBD would, however, only make sense if food enriched with CBD would fulfil any**

**precondition for the regulatory classification as food. As this does not seem to be the case, the definition of a reference dose is not necessarily required.**

#### **CBD as an API in Medicinal Products**

Article 1 of the European Drug Directive 2001/83/EC defines a medicinal product as “*any substance or combination of substances presented for treating or preventing disease in human beings*” or “*any substance or combination of substances which may be administered to human beings with a view to making a medical diagnosis or to restoring, correcting or modifying physiological functions in human beings*”.

The legislation deals with borderline cases, potentially defining any item not classified as a medication as an active pharmaceutical ingredient (API) when advertised with typical characteristics of a medicinal product. This means that items classified as food, in addition to cosmetics or tobacco replacement products, would be *de facto* medicinal products requiring a marketing authorization if marketed with therapeutic indications. The text cited in the introduction is merely one of many examples encountered in online advertising and newspaper ads, where CBD is sold as a food supplement, yet marketed as a medicinal product.

There are authorized medicinal products and magistral formulations containing cannabis preparations, THC or CBD with a specified dose. The use relates to the treatment of specified diseases. Typical medicinal uses are the treatment of spastic syndromes such as multiple sclerosis or epilepsy. Other potential medical indications are anxiety disorders, inflammation of nerves, neurodegenerative diseases or some specific forms of cancer. The pharmacological effects and the possible therapeutic benefits are presented in recent monographs [9, 10].

The marketing of CBD products frequently oversteps the grey zone between healthy food and medicinal products. Countless websites and advertisements in newspapers inform the consumers on the benefits of CBD in the treatment of diseases. Its physiological or nutritional benefit is rarely even tentatively discussed. It can be assumed that consumers purchase and apply CBD products primarily for medicinal purposes. The indications are generally not explicitly mentioned on the label of the CBD product. Due to the benefits of CBD being promoted by

popular and mass media, the sponsors of such products do not have to include indications on their products – notwithstanding the fact that a marketing of a food with medicinal indications is a clear infringement of the law.

The motivation for an enrichment of CBD in food preparations such as plant oils, must therefore be questioned: which function should CBD have in food and other consumer products if not the treatment of medical conditions? Carefully selected food may be useful for keeping the organism healthy, but the intention of treating diseases turns a food item into a medication, with all regulatory consequences.

#### **Conclusions on CBD as an API in medicinal products:**

**Medicinal CBD preparations are used for the treatment of diseases due to their pharmacological effects. Due to the well-known therapeutic benefits, CBD products presented as food, cosmetics or other non-drug commodities can be classified as medicinal products by default, even when the products carry no label indicating to therapeutic uses.**

#### **Advertisement of CBD Products with Medicinal Claims**

Any health-related statement on a food product is considered a so-called Health Claim and requires a positive response from the EFSA, as defined by the Health Claim Directive 1924/2006/EC. Health Claims are either general statements referring to maintain healthy bodily functions, or specifically state a risk reduction for a certain disease. In both cases, the addressee of the message is a healthy population. The EFSA is usually very strict when granting a claim. The relation of a given substance to a healthy bodily function must be demonstrated by scientific data, as does the impact of the daily intake. The latter needs to be at least theoretically achievable by normal nutrition. Referring to studies with medicinal use is generally not possible, as these studies deal with people with diseases.

To date, there is no single Health Claim for food enriched with CBD. To date, a physiological benefit of enriched CBD for keeping the body healthy has not been identified. The statements used in advertisements are unlikely to win an EFSA Health Claim. In a review of the year 2018, the WHO was critical of the widely advertised use of CBD as a remedy against epilepsy,

cancer, HIV, anxiety disorders, arthritis, pain and post-traumatic stress syndrome [1].

Frequently there is a disclaimer in the advertisements of CBD-containing preparations, which inform the reader that these uses and the given dose recommendations refer to medicinal use only. The disclaimer also states the seller does not endorse the medicinal use, in the event that someone might draw this conclusion from the previous presentation of therapeutic benefits. The authorities usually consider this kind of marketing as presenting a *de facto* medicinal product (medicinal product by presentation).

#### **Conclusions on Health Claims for CBD:**

**The marketing for CBD products clearly focusses on medical uses. Health-related effects of CBD have never been shown for sub-pharmacological doses, which means that health-related claims for food items containing CBD are not likely to be plausible or possible.**

#### **CONCLUSIONS**

Regardless of the origin of CBD – from synthesis or from extraction from plant material, it is hard to see any condition where CBD could be a food item based on EU regulations:

- CBD does not fulfil any of the functions of a food, nor has a nutritional or physiological effect been described.
- CBD does not fit into any of the defined categories of food additives.
- CBD extracts or concentrates in food preparations frequently far exceed the defined safe daily intake of THC present as an unavoidable contaminant. They can therefore be considered illicit drugs.
- CBD has an entry in the Union list declaring it as a substance for which a Novel Food application must be submitted. Currently there are no positive decisions available, therefore the marketing of any CBD-containing food item would be illegal until there is a positive decision. However, even such a decision would only confirm the safety of CBD, not any food properties.
- CBD preparations, especially CBD oils, are frequently marketed with medicinal claims for the

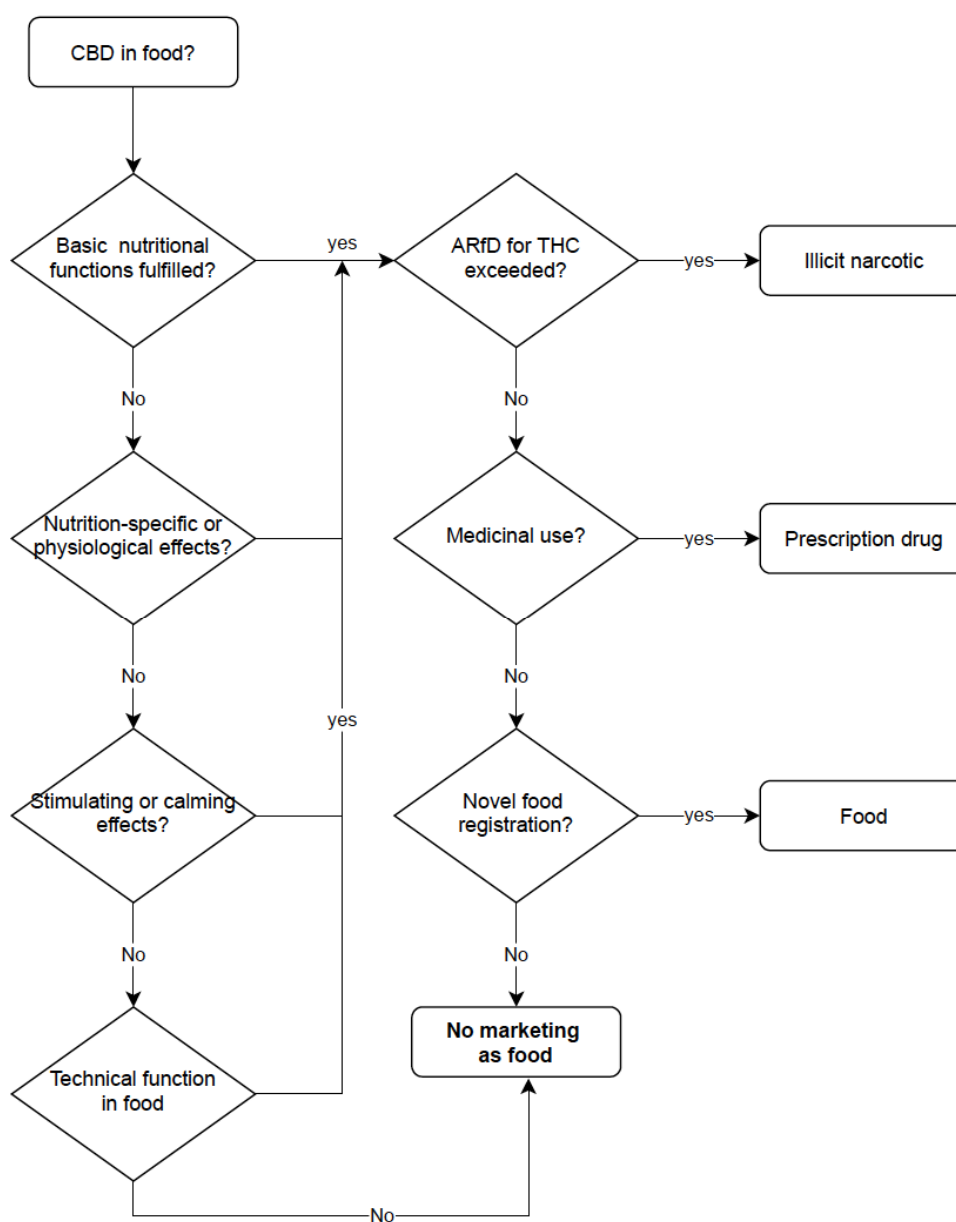
treatment of severe diseases, with the corresponding high dose recommendations for pharmacological effects.

Figure 2 shows a decision tree dealing with the question of whether Cannabis preparations may be considered as food. When the definitions of the EU directives are applied, there is no conceivable situation where CBD products might be marketable food items. The major impediment is the missing positive entry in the EU Novel Food catalogue. The decision on the Novel Food status is pending. As CBD is rather safe, it is possible that the Novel Food applications receive a positive vote due to the lack of toxicity. The

assessment of a lack of toxicity does, however, not mean that CBD has food properties.

The dilemma could easily be solved without a change to the existing and already rather complex European legislation. The EFSA's checklist for the completeness of Novel Food applications [2] could merely be amended by one basic initial requirement: Applicants should have to justify the food use of a new addition prior to discussing its safety.

With the context presented herein, the mentioned comment of the EU Commission to the ruling of the EU Court of Justice is all the more incomprehensible. The



**Figure 2:** Decision tree on the useability of CBD in food. The authors conclude that after answering the main questions there is no situation left where CBD could still be included into food.

court never stated that CBD must be a food, in fact the court did not even refer to the issue. The EU Commission did therefore rather add to the confusion, which makes the need for action in the clarification of the relation between food status and novel food applications all the more urgent.

### CONFLICT OF INTERESTS

K.K. and MT declare no conflict of interests. M.S. is working as a Qualified Person for CannaXan (Warngau, Germany), a pharmaceutical company manufacturing cannabinoid-based Cannabis extracts under the rules of the Narcotics Act.

### REFERENCES

- [1] Expert Committee on Drug Dependence. Cannabidiol (CBD). Critical review report <https://www.who.int/medicines/access/controlled-substances/CannabidiolCriticalReview.pdf>. Fortieth Meeting, 4-7 June 2018. Geneva: WHO; 2018.
- [2] EFSA. Administrative guidance on the submission of applications for authorisations of a novel food pursuant to Article 10 of Regulation (EU) 2015/2283. EFSA Supporting Publication 2018; EB-1381. <https://doi.org/10.2903/sp.efsa.2018.EN-1381>
- [3] EFSA. Scientific Opinion on the risks for human health related to the presence of tetrahydrocannabinol (THC) in milk and other food of animal origin. EFSA J 2015; 13(6): 4141. <https://doi.org/10.2903/j.efsa.2015.4141>
- [4] BfR. Tetrahydrocannabinol levels are too high in many hemp-containing foods - health impairments are possible. BfR Opinion 2018; (No 034/2018 of 8. November 2018). <https://www.bfr.bund.de/cm/349/tetrahydrocannabinol-levels-are-too-high-in-many-hemp-containing-foods-health-impairments-are-possible.pdf>
- [5] ElSohly MA, Murphy TP, Khan I, Walker LW, Gul W. Analysis of cannabidiol, delta-9-tetrahydrocannabinol, and their acids in CBD oil/hemp oil products. Med Cannabis Cannabinoids. 2020; 3: 1-13. <https://doi.org/10.1159/000509550>
- [6] Davies C, Bhattacharyya S. Cannabidiol as a potential treatment for psychosis. Ther Adv Psychopharmacol 2019; 9: 2045125319881916. <https://doi.org/10.1177/2045125319881916>
- [7] Millar SA, Maguire RF, Yates AS, O'Sullivan SE. Towards Better Delivery of Cannabidiol (CBD). Pharmaceuticals (Basel) 2020; 13(9): 219. <https://doi.org/10.3390/ph13090219>
- [8] Nakano Y, Tahjima M, Sugiyama E, Sato VH, Sato H. Development of a novel nanoemulsion formulation to improve intestinal absorption of cannabidiol. Med Cannabis Cannabinoids 2019; 2: 35-42. <https://doi.org/10.1159/000497361>
- [9] Müller-Vahl K, Grotenhermen F. Cannabis und Cannabinoide in der Medizin. Berlin: Medizinisch-Wissenschaftliche Verlagsgesellschaft 2020.
- [10] Grotenhermen F, Russo E. Cannabis and Cannabinoids. Pharmacology, toxicology, and therapeutic potential. New York: Routledge 2002.

Received on 10-04-2021

Accepted on 03-07-2021

Published on 19-07-2021

<https://doi.org/10.12970/2308-8044.2021.09.02>

© 2021 Kraft *et al.*; Licensee Synergy Publishers.

This is an open access article licensed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.