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Research Article

Hemp and its Sustainable Uses

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ABSTRACT

Hemp is in the genus, Cannabis, and is often confused with its psychoactive relative marijuana. But marijuana is a different species, sativa, and differs in the morphology, genetics, and amount of chemicals it produces. The chemicals produced by hemp are not hallucinogenic like the chemicals in marijuana but still cause scrutiny on hemp. Hemp can be cultivated for many uses, such as: using hemp oils to produce lotions, perfumes, and other cosmetics or using hemp fibers to make paper and other textiles or extracting the useful chemicals for medicine. The fact that hemp is so similar to illegal marijuana stops the U.S. from using hemp for commercial use and calls for the need to better understand this plant. The ignorance surrounding hemp and marijuana only antagonizes the situation and is the basis for the harmful effects associated with Cannabis. Several studies have been performed internationally and some in the U.S. in hopes of fulfilling this requirement for broader knowledge on the varied uses of hemp and its components. This paper is intended to enlighten the reader on the subject of hemp and its several sustainable uses [1].

INTRODUCTION

The genus Cannabis is best known for its psychoactive effects, but the genus includes both the non-intoxicant species C. sativa, called hemp, and its intoxicant relative C. indica, called marijuana (Hillig, 2005; Rashford, 2015). Some distinguishing phenotypic characteristics of C. indica from C. sativa include: more branching, a thinner cortex, and narrower leaflets (Hillig 2005). The limited branching of the hemp plant is usually compensated by large leaves with broad leaflets (Small and Marcus, 2003).While a genotypic assessment will show that several alleles that account for much of the differentiation between the two major species (ACN1-F, LAP1-B, 6PGD2-A, PGM-B, SKDH-D, UNK-C) are relatively common in the C. sativa gene pool, and uncommon in the C. indica gene pool. Overall, the sativa accessions exhibited greater genetic diversity than the indica accessions, therefore allowing us to accurately classify the two different species and several subspecies and varieties (Hillig, 2005) [2-5].

Cannabis contains a unique class of chemicals, called cannabinoids, which usually exist in the plant in the form of carboxylic acids (i.e., a carboxyl group is attached) and not effective psychologically (Small and Marcus, 2002; 2003; Johnson, 2018; Uchendu, Lata, et al., 2019). Until, heat (as provided when the substance is smoked or cooked) will decarboxylate the cannabinoids, including THC and CBD (Uchendu, Lata, et al., 2019; Small and Marcus, 2002). Concentrations of the potent intoxicating cannabinoid THC (delta9-tetrahydrocannabinol) is a basis for separating the two subspecies (Small and Marcus, 2003; Wilkinson, Whalley, et al.). C. sativa has less than 0.3% (dry weight) of THC in the generative part of the plant, while C. indica has more than 0.3% THC (Small and Marcus, 2002; 2003). Generally, there is an inverse relationship in the Cannabis plant resin between the concentration of THC and the concentration of the non-intoxicating cannabinoid CBD (Small and Marcus, 2002). Most of the marijuana species contains high levels of THC and low levels of CBD, whereas most of the hemp species contains primarily CBD and little to no THC (Small and Marcus, 2002; 2003; Johnson, 2018). The development of new hemp cultivars with improved traits could be further facilitated using biotechnological strategies (Feeney and Punja, 2003). A study has shown, that an Agrobacterium mediated transformation protocol would permit exploitation of a greater amount of genetic diversity for plant improvement and would facilitate

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clonal multiplication of plants with desirable traits (Feeney and Punja, 2003) [6-14].

CBD AND THC USES

Both constituents can be used to make medicines or used for types of medical therapies (Wilkinson, Whalley, et al., 2003). THC is not narcotic in the sense of producing sleep, however CBD has been shown to have sleep-inducing properties, consequently the term narcotic is rather contradictorily applied exclusively to the intoxicant types which contain high levels of THC (Small and Marcus, 2003).

THC mediates many of its activities through signaling via cannabinoid receptors, especially CB 1, which are expressed throughout the central nervous system (CNS) and other tissues (Wilkinson et al., 2003). Cannabis is under clinical investigation to gauge its potential for medicinal use, but the question arises as to whether there is any advantage in using cannabis extracts compared with isolated Δ9-transtetrahydrocannabinol (Δ9THC), the major psychoactive component in Cannabis (Wilkinson et al., 2003). When we compare the effect of a standardized cannabis extract (SCE) with pure THC, at matched concentrations of THC, and also with a THC-free extract(Δ9THC-free SCE), using two cannabinoid-sensitive models, a mouse model of multiple sclerosis (MS), and a rat brain slice model of epilepsy (Wilkinson et al., 2003). The SCE inhibited spasticity in the mouse model of MS to a significant level, it caused a more rapid onset of muscle relaxation, and a reduction in the time to maximum effect compared with THC alone (Wilkinson et al., 2003). The THC free extract or cannabidiol (CBD) causes no inhibition of spasticity (Wilkinson et al., 2003). However, in the in-vitro rat brain epilepsy model, in which sustained epileptiform seizures were induced by the muscarinic receptor agonist oxotremorine-M in immature rat piriform cortical brain slices, SCE was a more potent and again more rapidly-acting anti-convulsant than isolated Δ9THC,but in this model, the THC-free extract also exhibits an anti-convulsant activity (Wilkinson et al., 2003). Cannabidiol did not inhibit seizures, nor did it modulate the activity of THC in this model (Wilkinson et al., 2003). Therefore, as far as some actions of cannabis were concerned (e.g. anti-spasticity), THC was the active constituent, which might be modified by the presence of other components (Wilkinson et al., 2003). However, for other effects (e.g. anti-convulsant properties) THC, although active, might not be necessary for the observed effect (Wilkinson et al., 2003). Principally, these results demonstrate that not all of the therapeutic actions of cannabis herb might be due to the Δ9THC content (Wilkinson et al., 2003).

There is unsanctioned medical use of CBD based products with oils, supplements, gums, and high concentration extracts available online for the treatment of many ailments (Expert Committee of Drug Dependence, 2017). CBD is generally well tolerated with a good safety profile (Expert Committee of Drug Dependence, 2017). Reported harmful effects may be as a result of drug-drug interactions between CBD and patients' existing medications (Expert Committee of Drug Dependence, 2017). Several countries have modified their national controls to accommodate CBD as a medicinal product (Expert Committee of Drug Dependence, 2017). CBD does not appear to act directly at CB1 receptors, with several studies reporting that there is no measurable response in binding assays (Expert Committee of Drug Dependence, 2017). Studies examining potential agonist effects at CB1 receptors, most find no effect, with one report of a weak agonist and one of a weak antagonist effect, each at high concentrations (>10uM) (Expert Committee of Drug Dependence, 2017). CBD also shows low affinity at CB2 receptors (Expert Committee of Drug Dependence, 2017). Across a range of measures in humans and animals, CBD had been shown to have very different effects from those of THC (Expert Committee of Drug Dependence, 2017). In mice, CBD failed to produce the behavioral characteristics, such as: suppression of locomotor activity, hypothermia, anti-nociception, associated with CB1 activation, whereas THC generated all of the effects which occur when CB1 is activated (Expert Committee of Drug Dependence, 2017). Neuroimaging studies in humans and animals have shown that CBD has effects which are generally opposite to those of THC (Expert Committee of Drug Dependence, 2017). In contrast to THC, CBD has no effect on heart rate or blood pressure under normal conditions, but in animal models of stress it reduces heart rate and blood pressure (Expert Committee of Drug Dependence, 2017). Some studies have shown that CBD may reduce or antagonize some of the effects of THC (Expert Committee of Drug Dependence, 2017). The mechanism for this is unclear, with some suggesting that it may be a weak CB1 antagonist (Expert Committee of Drug Dependence, 2017). Recent evidence suggests that it may be a negative allosteric modulator of the CB1 receptor, thereby acting as a non-competitive antagonist of the actions of THC and other CB1 protagonists (Expert Committee of Drug Dependence, 2017). CBD may also interact with the endo-cannabinoid system through indirect mechanisms such as enhanced action of the endogenous cannabinoid ligand anandamide (Expert Committee of Drug Dependence, 2017). This results from blockade of anandamide reuptake and the inhibition of its enzymatic degradation (Expert Committee of Drug Dependence, 2017).

CBD has been shown to modulate several non-endocannabinoids signaling systems. It is not clear which, if any, of these mechanisms are responsible for any of CBD's potential clinical or other effects (Expert Committee of Drug Dependence, 2017). Some of these mechanisms include inhibition of adenosine uptake, possibly resulting in indirect agonist activity at adenosine receptors, enhanced activity at the 5-HT1a receptor, enhanced activity at glycine receptor subtypes, and blockade of the orphan G-protein-coupled receptor GPR55 (Expert Committee of Drug Dependence, 2017). Generally, CBD has been found to have relatively low toxicity, although not all potential effects have been explored (Expert Committee of Drug Dependence, 2017).

USES OF HEMP FIBERS

In recent years, there has been a shift to making environmentally friendly bio-plastics from plant resources for applications like packaging, automobile parts, agriculture, medicine and construction materials (Muneer, 2012). Availability of natural fiber, low cost and ease of manufacturing have urged the attention of researchers towards the possibility of reinforcement of natural fiber to improve their mechanical properties and study the extent to which they satisfy the requirements of good reinforced polymer composite for industrial and structural applications (Dixit, Goel, et al., 2017). Biodegradable polymers which are based on feedstock sources from annually grown crops like wheat (wheat gluten), soy (soy proteins), corn and potatoes (starch), make the basis of a platform for sustainable and eco-efficient products which can compete with plastics and composites made solely from petroleum based feedstock (Muneer, 2012). Natural fibers which are obtained from hemp, jute, flax, wheat straw etc. are an important source for reinforcing material for making composites, which are biodegradable and have market attraction (Muneer, 2012). Hemp fibers are currently used for making composites together with synthetic polymers like polypropylene, epoxy resin and acrylonitrile butadiene-styrene copolymer (ABS) for automobile applications (Muneer, 2012). Therefore, combining plant-based fibers with plant-based polymers for making environmentally friendly and biodegradable bio-composites can improve sustainability (Muneer, 2012).

Table 1: Three main pillars of the sustainability concept (Muneer, 2012).

Social aspects	Economic aspects	Environmental aspects
1. Public acceptance	1. Cost effectiveness	1. Low emissions
2. Development of the industry	2. Beneficial for farming community	2. Biodegradability
	3. Job opportunities	3. Waste management

The porous structure of hemp shiv allows for low thermal conductivity and for the material to adapt to varying humidity conditions providing comfortable indoor environment (Hussain, Calabria-Holley, et al., 2018). However, the porous surface and the hydrophilic nature of hemp shiv affects the compatibility and durability of a material when in moist conditions (Hussain, et al., 2018). In one study, a novel hemp shiv composite, which is characterized by increased absorption and mechanical properties, while having a low thermal conductivity was prepared in a starch-based or silica-based matrix and presented a lower water absorption capacity while retaining it moisture buffering ability (Hussain, et al., 2018). Also, the hemp shiv-based composites were resistant to water yet permeable to vapor and showed excellent moisture buffering capacity when compared to conventional hemp-lime composites (Hussain, et al., 2018). Hemp shiv composites with higher hygrothermal characteristics have immense potential as thermal insulation building material (Hussain, et al., 2018).

Using bio-based materials can also have a positive effect on the environment since they have the ability to capture CO2 from the atmosphere (Hussain, et al., 2018). Such as, bio-based plastics and composites, which are getting attention as an alternative to unsustainable petrochemical-based plastics (Muneer, 2012). Hemp fiber reinforced wheat gluten (WG) composites can be an alternative to petrochemical-based plastics in many applications, because of their interesting tensile properties and environmental friendliness (Muneer, 2012). Wheat gluten (WG) plastics are an alternative to synthetic or petrochemical-based plastics because these plastics have interesting properties including film forming properties, good oxygen barrier, relatively high mechanical strength, and they are also renewable (Muneer, 2012).

SEEDS AND OILS FROM HEMP

Interest in hemp (Cannabis sativa) for skin care and cosmetic use is due to the high content of oils in the plant, especially unsaturated fatty acids in seed with technological and therapeutic effects (Vogl, Molleken, et al., 2004). Oil from the crushed hemp seed is used in soap, shampoo, lotions, bath gels, and cosmetics (Johnson, 2018). The oils of hemp contain about 50-60% linoleic acid (C18:2ω6), 20-25% α-linolenic acid (C18:3ω3), and a substantial portion of γ-linolenic acid (C18:3ω6) that is of potential, for example in the medical treatment of neurodermatitis and psoriasis (Vogl, et al., 2004). These three fatty acids are interesting for skin care, because they are structural compounds of the phospholipids in the cell membranes and influence several cell membrane functions such as fluidity, the transport of electrolytes, and the activity of hormones (Vogl, et al., 2004). Therefore, they also stimulate the immunology of the cells (Vogl, et al., 2004).

Hemp seed and oilcake are used in a range of foods and beverages (e.g., salad and cooking oil and hemp dairy alternatives) and can be an alternative food and feed protein source (Johnson, 2018). Hemp seeds contain no THC, but THC contamination can result from contact of the seed with the resin secreted by the epidermal glands on the leaves and floral parts of the plant or by the failure to sift away all of the bracts, which have the highest concentration of THC of any part of the plant, that cover the seeds (Johnson, 2018). This results in trace amounts of THC appearing in hempseed oil and foods made with the seeds (Johnson, 2018). Even though, most of the western hemp-growing world uses 0.3% THC as a maximum concentration for legal cultivation of hemp plants, regulations in various countries only allow much lower levels of THC in human food products manufactured from the seeds (Johnson, 2018). Currently, up to 10 ppm THC is acceptable in seed and oil products used for food purposes in Canada (Johnson, 2018).

CONCLUSIONS

The global market for hemp consists of more than 25,000 products in nine submarkets: agriculture, textiles, recycling, automotive, furniture, food and beverages, paper, construction materials, and personal care. Hemp can be grown as a fiber, seed, or dual-purpose crop. Hemp fibers are used in fabrics and textiles, yarns and spun fibers, paper, carpeting, home furnishings, construction and insulation materials, auto parts, composites, animal bedding, material inputs, papermaking, and oil absorbents. Hemp is also being used in nutritional supplements and in medicinal and therapeutic products, including pharmaceuticals. With all the cited sustainable uses, hemp should be a viable option for manufacturing industries, even if they have to genetically modify it to have a desirable trait.

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