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Recent Trends in Applied Zoology

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Chapter -08

Review-based Study on Dandelion (*Taraxacum Officinale*) biologically Effective Molecules for Animal Health with Special Reference to Diabetes

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Abstract:

The metabolic sickness type 2 diabetes (T2D) has surpassed societies in both industrialized and developing nations. Due to an unprecedented increase in diabetes incidence, the globe is currently dealing with a significant clinical and financial burden. T2D is thought to affect 380 million people globally, and if no preventive measures are put in place, this figure is predicted to increase by more than 200 million by 2035 [1]. According to a WHO poll, 70–80% of the world's population relies on alternative therapies, partly because traditional medicine is not widely accessible and is expensive. As a result of widespread prior rejection of plant-derived medicines as a potentially affordable way to treat diabetes, it is frequently difficult to find evidence-based verification of their usefulness. Despite this drawback, it is widely known that plant-derived therapies offer intriguing sources for complementary treatment approaches, some of which may even result in better treatment outcomes and fewer side effects than currently available medication [2]. As a result, affluent nations have shown a rising interest in food, nutraceuticals, and pharmaceuticals derived from plants and other natural sources that nonetheless possess positive health qualities [3].

Eighty percent of T2D patients, according to data from the International Diabetes Federation (IDF), reside in low- and middle-income nations. The fact that an estimated 175 million people with diabetes remain undiagnosed is even more concerning [4]. Diabetes treatment is exceedingly expensive in deprived areas, making medical care prohibitively expensive, leading to subpar healthcare and the adoption of alternative medicine [5].

Introduction

Bioactive plant-based traditional medicine has shown promise for easing diabetes symptoms, promoting healing, and enhancing health [6]. Different plants and poly-herbal combinations have been used to treat diabetes, and their bioactive components are what give them their anti-diabetic properties [7].

While around 75% of contemporary medications are derived from plants, about 80% of people in the world still use traditional medicine [8]. Numerous anti-diabetic ingredients can be found in medicinal plants; typically, they were discovered thanks to ethnomedical understanding [9, 10].

One of the main characteristics of Type 2 diabetes is the metabolic syndrome, which is characterised by obesity, hypertension, cardiovascular abnormalities, coronary artery disease, and dyslipidemias. This non-communicable illness is a metabolic disorder that affects pancreatic function, lipid, protein, and carbohydrate metabolism [7, 11].

Type 2 diabetes is a chronic, multifactorial disease that affects the liver, endocrine pancreas, skeletal muscle, adipose tissue, central nervous system, and gut. It is characterized by defects in insulin and glucagon secretion and action, which may result in a progressive rise in plasma glucose levels and a disruption of biological mechanisms in these areas. This dysregulation of glucose homeostasis is a crucial factor in the development of Type 2 diabetes [12].

Common endocrine disorders like Type 2 diabetes cause increased food and water intake, fat accumulation, hyperglycemia, and higher insulin production, which worsens already-existing insulin resistance and aids in pancreatic failure [13–15]. Due to insufficient transit of glucose and inappropriate lipid storage, insulin sensitivity causes dysregulation in the muscles, fat, and liver cells [16, 17].
A major risk factor for cardiovascular disorders and stroke, severe diabetes can eventually result in blindness and renal failure. Lower limb amputations may be necessary in extreme circumstances [13].
With a particular focus on the most recent research regarding the effects of its bioactive components on insulin function and glucose homeostasis, the objective of this review is to assess the properties of a promising herbal candidate, dandelion, and to explore its diverse biological activities relevant to Type 2 diabetes

1. The Dandelion

The genus Taraxacum and family Asteraceae include plants like the dandelion. It has a long history of use as a herb for health purposes. [18] Dandelion is produced for food and medicine, either from wild sources or through cultivation. Bulgaria, Romania, Hungary, and Poland are the main countries where it is grown and produced [19]. The dandelions thrives in tropical regions, cool highland (1,200–1,500 m), warm sub–temperate zones, and temperate regions across the northern hemisphere. It can withstand frost and drought [20, 21].

The taxonomy of tarsacum is complicated. There are over 2800 species that have been identified in subarctic and northern temperate regions [22]. Taraxacum platycarpum is a Chinese traditional medicine used to treat Type 2 diabetes T2D and hepatic problems, whereas Taraxacum officinale Weber Wigg is a species native to Europe and used for medicinal purposes [23].

Dandelion is a perennial weed that grows a strong taproot that is typically between 15 and 30 cm long [24]. Dandelion may produce new plants even when its roots are severed below the soil's surface. Each plant typically produces 5 to 10 flowers that bear brown, conical fruits with a hairy pappus that permits wind to disperse seeds. Young dandelion plants are grown under glass and planted in manure-enriched soil.

They're frequently sowed April to June in north region of Europe [25]. Because of its hepatic and hyperglycemic properties, dandelion has been utilised in ethnopharmacology as as a traditional folk medicine in Russia, India, and China [8]. Because it is a high source of micronutrients including minerals and vitamins, it is frequently eaten as a food (salads) [26]. Dandelion is utilised as a common traditional medicine in Turkey and Mexico for the control of T2D because it has several therapeutic advantages, including the treatment of T2D, blisters, spleen, and liver issues [27].

2. Nutritional, Chemical, and Biological Features of Dandelion

Dandelion contains significant amounts of -carotene, which shields cells from oxidation and cellular damage, according to a tandem liquid chromatography and mass spectrometry analysis [29]. Taraxacum officinale leaves and stems have 34.08 1.52 g/kg of polyphenols, making chicoric acid (CRA) the most prevalent component of dandelion according to recent biochemical study [30–32]. In comparison to stems, flowers and leaves have a higher quantity of polyphenols [33]. Additionally, there is a significant seasonal variation: although sitosterol and cycloartenol esters are more common during periods of prolonged sun exposure, methylsterols are more common in the winter [34].

Dandelion roots include minerals, sugars (such as glucose, fructose, and sucrose), choline vitamins, mucilage, and pectin in addition to carbohydrates (such as inulin), carotenoids (such as lutein), fatty acids (such as myristic acid), and other nutrients. Inulin, a complex carbohydrate (fructo-oligosaccharides) found in up to 45% of the roots, has several health benefits, including the removal of pathogens in the gastrointestinal tract and the prevention of obesity, cancer, and osteoporosis [35]. The leaf extracts are known to be useful against obesity and cardiovascular disease in addition to serving as a coffee substitute and flavour enhancer for beverages [36].

Sesquiterpene lactones, taraxasterol (TS), taraxerol, chlorogenic acid (CGA), and CRA are examples of possible bioactive components found in dandelion. For a list of the names and structures of dandelion components with antidiabetic activities, These components are non-toxic and can be used to potentially treat diabetes by taking use of their anti-inflammatory, anti-oxidative, anti-rheumatic, and chloretic capabilities. Little research has been done to far on the fascinating dandelion constituents, particularly TS and taraxerol. However, dandelion has been found to possess more of these elements than other plants, and it also includes a variety of intriguing bioactive elements that are pertinent to T2D and are likely to work in concert see [37, 38].

3. Bioactive compound

Plants belonging to the Asteraceae family frequently contain sesquiterpene lactones (SEL). The biological profile comprises qualities that are antibacterial, fungicidal, control growth, anti-mutagenic, anti-feedant, and repulsive [39]. Sesquiterpenes are colourless lipophilic components that are biosynthesized from isoprene units using the endoplasmic reticulum's farnesyl pyrophosphate [40]. Sesquiterpenes are typically isolated from the root and comprise a variety of substances, including 13-dihydrolactucin, Ixerin D, Eudesmanolides tetrahydoridentin B, Taraxacolide-0-glucopyranoside, Germacranolide acid, and 13-dihydrotaraxinic-acid -glucopyranoside [41].

Sesquiterpene lactones produce bitterness as a result of their anti-inflammatory characteristics, including taraxacolide, dihydro-lactucin, ixerin D, taraxinic acids, phenyl propanoids, and ainslioside [42]. These elements are frequently found as glycosides. Toxic compounds are prevented from being ingested by the bitter taste receptor (TAS2R16) on the tongue's cells, which causes an unpleasant sensory reaction [43].

This evolutionary mechanism, meanwhile, has drawbacks because many foods and medicines that are good for you taste bitter. These bitter compounds and the phenolic components, which have anti-oxidative and anti-inflammatory properties, are responsible for the dandelion's health-promoting effects [44].

Chemically speaking, the oxygen-containing ring structure (-methyl-lactone) with a carbonyl function mediates the anti-inflammatory characteristics. With nucleophiles such cysteine sulfhydryl groups, this structure interacts [45]. Sesquiterpene lactones are known to primarily target thiol groups, such as cysteine protein residues. Sesquiterpene lactones lack direct antioxidant action due to their structural makeup, although the inclusion of allylic alcohol may increase their effectiveness as a direct antioxidant [47, 48].

A pentacyclic-triterpene known as taraxasterol (TS) is abundant year-round in dandelion roots [49]. It can be found frequently in esculent plants such legumes, grains, nuts, seeds, and plant oils [50]. High concentrations of TS (2.96 g/ml) and taraxerol (1.69 g/ml) were found in a study using high-pressure liquid chromatography (HPLC) ultraviolet-visible (UV/VIS) detection; in callus culture, the root extract contained 3.0 g/ml TS and 1.75 g/ml taraxerol [48].

The richest phenolic substance in dandelion is called CGA, which is an ester of caffeic and quinic acid. It is present in the roots, flowers, leaves, and stems of the plant. The synthetic commercial standard Trolox® is a less potent antioxidant than natural CGA, according to research using ultra-performance liquid chromatography - tandem mass spectrometry (UPLC-MS/MS). CGA was found to be the most prevalent component (31.06 mg/g) when the phenol content of a fractionated ethyl acetate extract from dandelion roots was examined. The content in leaf extracts is 0.85 mg/g with 0.22% dry weight (Dw), according to other research utilising liquid chromatography with (photo) diode array detection (LC-DAD) [49–50].

Additionally, dandelion is a good source of minerals such iron, magnesium, sodium, calcium, silicon, copper, phosphorus, zinc, and manganese as well as vitamins A, C, D, E, and B, inositol, and lecithin [51]. The exocytosis of insulin may be aided by the passage of some of these ions, such as calcium ions in beta-cells [52]. Dandelion is one of the greatest sources of beta-carotene among vegetables (11,000 g/100 g leaves, the same as in carrots), which is the precursor of vitamin A [53]. A number of dandelion's health advantages, including anti-rheumatic, anti-carcinogenic, diuretic, laxative, hypoglycemic, and chloretic properties, have been established in recent years [54].

4. Dandelion and its constituents' anti-diabetic capabilities

Due to the pharmacological actions of substances such sesquiterpene lactones, triterpenes/phytosterols (taraxasterol), phenols, flavonoids, and phenolic acids, the bioactive components in dandelion have shown a variety of anti-diabetic benefits [44, 54]. The anti-diabetic medicine metformin, which is currently the first and most popular option, was first made from the galegine found in Galega officinalis [55]. The anti-diabetic medication acarbose, which inhibits alpha glucosidase, was also isolated from a bacteria [69].

Th The primary cause of T2D is the dysregulation of insulin production and sensitivity, which results in hyperglycemia and T2D and can subsequently contribute to the onset of vascular illnesses [56]. Many nations are turning more and more to anti-diabetic medications since T2D is both an epidemic phenomena and a significant economic and social burden [57, 58]. Dandelion roots contain fructo-oligosaccharides (FOS), which are found in inulin. FOS is a complex carbohydrate that aids bifido-bacteria in destroying infections in the digestive system [59].

Many nations are turning more and more to anti-diabetic medications since T2D is both an epidemic phenomena and a significant economic and social burden [27, 28]. Dandelion roots contain fructo-oligosaccharides (FOS), which are found in inulin. FOS is a complex carbohydrate that aids bifido-bacteria in destroying infections in the digestive system [53]. Mineral absorption causes FOS to stimulate the immune system, which in turn inhibits the formation of aberrant cells. This complex carbohydrate may aid in bringing blood sugar levels back to normal. When taken at high amounts of water extract, it lowers hyperglycemia,]. CGA has been considered as a possible anti-inflammatory and anti-obesity drug. Future anti-diabetic medications will be affected by its effects on insulin secretion and sensitivity [60].

5. Action against hyperglycemia

Hyperglycemia is primarily brought on by insulin resistance, which develops in multiple important tissues including the liver, muscles, and adipose tissue [72]. Insulin resistance is a characteristic in the pathogenesis of T2D. Oxidative stress, which is fueled by protein glycation and auto-oxidation, is another well-known process that impacts glucose homeostasis [61]. The development of -cell dysfunction may be aided by this process because it may result in an increase in the formation of lipid peroxide, which in turn causes a decline in the anti-oxidative defence [54]. Because of glucotoxicity and lipotoxicity, -cell dysfunction reduces insulin secretion, which has a deleterious impact on how proinsulin is converted into insulin [62].

According to research on dandelion extracts, it may increase the release of insulin in pancreatic -cells, which subsequently mitigates the consequences of hyperglycemia [76].

Rat insulinoma cells (INS-1E cells), as shown by Hussain et al. (2004), are insulin-active. In the presence of high glucose (6.0 mM), Taraxacum officinale (TO) dried ethanolic extract (40 g/ml) was administered to the cells while glibenclamide (an anti-diabetic medication) served as the control. In comparison to standard glucose (3.0 mM), the researchers discovered that INS-1E cells significantly secreted more insulin [63].

Due to the stimulation of insulin release in the pancreas, studies have shown that CRA also stimulates glucose absorption in muscle cells [61, 63]. In non-obese diabetic mice, dandelion, delivered as a 9.7% herbal preparation of ethanolic extract, exerts anti-hyperglycemic properties Additionally, -glucosidase and -amylase are inhibited by CRA and TS, which further increases the anti-hyperglycemic impact by delaying the digestion of complex carbohydrates like starch [44]. Dandelion reduces the level of glucose in the blood, which enhances -cells' ability to secrete insulin, according to studies done on diabetic rats .

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