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Usage of plants for influencing diabetes control by diabetic patients in Czech Republic

Master Thesis

Prague, 2015

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Declaration:

I, Jana Nečasová, declare that this Diploma thesis, submitted in partial fulfillment of the requirements for the degree of Master of Science, in the Faculty of Tropical AgriSciences of the Czech University of Life Sciences Prague, is wholly my own work unless otherwise referenced or acknowledged. I agree this work to be placed of CULS Prague and was accessible to study purposes.

In Prague, 12.01.2015

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Acknowledgment

Primarily, I would like to express my gratitude to my supervisor Doc. Ing. Eloy Fernández Cusmani, Ph.D. for goodwill and supporting me in every problem, which occurred during writing this thesis and for providing me a specialized publications. Also I am very grateful for his help in improving my knowledge in these topics. My thanks also belong to my next supervisor Robert Bém, MD, PhD. For his support, beneficial advices and knowledge, help with processing the data and to his team of nurses from Institute of Institute of clinical and experimental medicine in Prague 4 for collecting the questionnaires and many thanks to prof. MUDr. Michal Anděl, CSc., dean of Third Faculty of Medicine in Prague, for his support and advices. Of course, many thanks to all patients with diabetes who willingly filled out questionnaires, which are a main part of my work.

Abstract

The long term remarks point out the fact of increasing interest of diabetic patients in Czech Republic in alternative or supportive treatment and also usage of natural plant medicine as adjunct therapy. The aim of the research was to document the plant species used by diabetic patients for supporting treatment of Diabetes Mellitus.

From 207 questionnaires, where the valuation was made in 162 questionnaires (100%) because 7 had to be taken out because of not being rightly and fully filled. The distribution was made in diabetic departments and through media focused on Diabetes Mellitus, were filled by diabetic patients from all over the republic, where 40% of respondents were Prague residents. The gained data were processed by standard statistical methods. Via analyzing the results were patients divided into group of patients that are plant abused, represented by 43% of the total respondents and in group of patients that do not use the plants, not plants abused represented by 57%. Although, the worse glycaemia compensation, (over the 6,0) and Type 2 Diabetes had have the plant abused diabetic patients.

From those 48 plant species were most of them belonging to the family *Compositae* represented by 9 species, less to the family *Lamiaceae* (5 species) and family *Apiaceae* was represented by 4 species. To *Rosaceae, Vaccinacea*e and *Cucurbitaceae* family belong after 2 species.

The most commonly used specie was bilberry mentioned by 40% of plant abused respondents, garlic by 30%, 26% belonged to onion, peppermint in 22%, ginger was represented by 21% and sweetener stevia by 20%. The effectiveness of the plants, which requires regularity of use which would lead to awareness of the disease as itself, with a positive impact on health status, is always dependent on the overall regime that can't be changed without any interest and effort expended by diabetic patients.

Key words: Alternative treatment, Diabetes, Phytopharmacy, Medicinal plants, Anti-diabetic plants

Abstrakt

Dlouhodobá pozorování poukazují na zvyšující se zájem diabetických pacientů České republiky, o alternativní či podpůrnou léčbu a také používání přírodní rostlinné medicíny jako doplněk léčby. Cílem výzkumu bylo zdokumentovat rostlinné druhy používané pacienty jako podpůrný prostředek při léčbě cukrovky.

Z 207 vybraných dotazníků, z čehož 100% představuje 162 a to díky vyražení 7 nesprávně anebo nedostatečně zodpovězeným dotazníkům. Distribuce probíhala v diabetologických odděleních a skrze taktéž zaměřená média české republiky, bylo celkem 40% respondentů z Hlavního města Prahy. Získaná data byla vyhodnocena pomocí standartních statistických metod. Díky analýze výsledků byli pacienti rozděleni na skupinu pacientů, kteří rostliny používají, představující 43% z celkového počtu respondentů a na skupinu pacientů, kteří neužívají žádné druhy, čeledi rostlin v celkové hodnotě 57%. Ačkoli horší kompenzaci (nad 6,0), a 2. typ cukrovky měli pacienti, kteří rostliny užívají.

Z počtu 48 druhů rostlinných čeledí, byla nejvíce zastoupena čeleď Compositae, reprezentující 9 druhů, méně čeleď Lamiaceae (5 druhů) a čeleď Apiaceae byla zastoupena 4 druhy. Ostatní čeledě; Rosaceae, Solanaceae a Cucurbitaceae byly zastoupeny po 2 druzích.

Nejvíce používaným druhem byla brusnice borůvka, zmíněná 40% respondentů, česnek 30%, cibule s 26%, máta peprná byla zmíněna 22%, zázvor 21% a stévie 20%. Účinnost vlastností rostlin je přímo závislá na pravidelném užívání, by mohlo vést k porozumění vlastní choroby a vést k pozitivnímu dopadu na jejich zdravotní stav, které je vždy závislé na celkové životosprávě ovlivněné zájmem a úsilím pacienta.

Klíčová slova: alternativní léčba, diabetes, fytofarmaka, léčivé rostliny, rostliny pro diabetiky

Content

LIST OF ABBREVIATIONS

Abbreviation list

ADA – American Diabetes Association

CULS - Czech University of Life Sciences Prague

DM – Diabetes Mellitus

FDA – Food and Drug Administration

IDF – International Diabetes Federation

IKEM – Institute of clinical and experimental medicine

T1D – Type 1 Diabetes

T2D - Type 2 Diabetes

UZIS – Institute of Health Information and Statistics of the Czech Republic

WHO - World Health Organization

1 Introduction

Despite the fact that we live in a modern society with the rapidly emerging scientific disciplines where still occurs the new finding in genetics, molecular biology or chemistry, we are still unable to prevent the occurrence of many diseases. Modern and effective medicine that is necessary for treating is not always being accessible to everyone.

One of the most widespread diseases and according to realistic prediction; the 7th leading cause of death in 2030 (WHO, 2013) became *diabetes mellitus* or diabetes, often called as "silent killer" is formerly and especially domain in low and middle-income countries, where the health care, accessibility and availability of medicines is deficient, covering about 80% of the total number of diabetics patient that is over than 381 million adult population (20 – 79 years old) worldwide (IDF, 2013) and doubling of the amount is expecting till 2030. This for now cureless disease affects the global economy that spends annually at least US$376 billion that is 11, 6% of the total world expenditures (IDF, 2010). Comparing to United States that has the 3rd largest number of confirmed diabetics cases in the world: 17, 9 million (ADA, 2013) the Czech Republic has 950 thousand confirmed patients (2013) and annual expenses are about over than US$1 billion (2013).

Diabetes mellitus has become a serious health, social and economic problem not only in Czech Republic, where every 10 seconds 1 person dies on vascular complication associated with diabetes (Pelikánová, 2013). Although, the several oral hypoglycemic agents are the primary forms of treatment for diabetes, the prominent side-effects of drugs are the main reason for an increasing number of people seeking alternative therapies in case that they may have better glycaemia value compensation.

In the world is known over than 400 plant species that have a direct or proven indirect effect on diabetes (Gupta *et al.*, 2009). These plants form an important part of the traditional; a primary source of drugs and many of the actually available drugs, and part of alternative medicine. Their effectiveness depends on many factors, in addition to the chemical composition also the frequency and regularity of use, quantity, their life style etc. The use of these plants is far more prevalent in countries of Africa, Asia and South America compared to the people of Europe and North America relying mainly on the latest drug treatments and modern ways.

Nowadays, there is a number of plant-based medicinal products available on the market, designated specifically for diabetics, mainly including tea fewer tablets, syrups and extracts. Which is the one of the alternatives how you can use the anti-diabetic plants in developed countries, where the customer prefers the final pre-prepared product which is ready to use.

In addition, exist effective herbs crops which are suitable for patients with diabetes than other species or plants with natural sweetening effect but free of redundant carbohydrates.

2 Aims of the Thesis

2.1 Hypothesis

Based on facts about rapidly raising of number of patients with diabetes all around Czech Republic we identified several hypotheses that should be corresponding to the dissertation aims. The first hypothesis could prove the fact that Czech diabetic patients use or ever tried to use the plant species in purpose and the next hypothesis is that plants are taken as a nature supplement to diabetes mellitus treatment and can't be used as treatment by itself.

According to worldwide available research, natural or supplementary funds are more desirable and more popular as a commodity and not only because of financial accessibility but also, because of the evidence, supporting it's' the positive effects. So this trend in modern time of society cannot be excluded even in Czech Republic.

However, due to the great diversity of the domestic flora, there was no study done that determine the families of the used plants for improving the glycemic control.

2.2 Aims and objectives

The main aim of diploma thesis, following the stated hypothesis, was to the plant species used by diabetic patients for supporting treatment of Diabetes Mellitus. As the additional is to determine the main objective which is to assess the overall situation and visions of plant supportive potential for diabetic patients in Czech Republic, by the classification of mentioned species, measuring the frequency of usage and its relation to diabetes control.

3 Literature review

3.1 Diabetes Mellitus

3.1.1 Definition

Diabetes mellitus (DM) is a group of metabolic diseases causes a several health complication (kidney failure, heart disease, blindness, etc.) caused by malfunction of pancreatic beta cells that are responsible for production of insulin. The consequences of the lack or absence of insulin are not only in the rising of glucose in the blood that cannot be transferred and absorbed into the cells of the human body characterized by thirst, lethargy, hunger, etc. but insulin is also involved in the metabolism of carbohydrates, proteins and fats, diabetes is not limited to a disturbance of glucose homeostasis alone.

Glucose is the irreplaceable energy source for all cells of the human body resulting from the digestion of food containing carbohydrates (sugar, starch). Maintained in a relatively narrow range, which ensures uniform cells extracting. Management of glucose together with direct influence is controlled by the interplay of several hormones. The most important is insulin, which is responsible for its storing and allowing the glucose to be absorbed by liver cells.

On the contrary, the glucagon and adrenaline are insulin antagonist.

The value of glycaemia (level of glucose concentrated in blood) is expressed in mmol/l.

When the glucose concentration, stated from the venous blood (fasting take), is higher than 8.0mmol per liter or higher than 11mmol per liter (taken after meal), it is more the probable that the person has diabetes. The goal of the treatment is to maintain the value as close as possible to the physiological healthy condition of individual. Because of many different organism influences, the method of treatment also depends on the type of diabetes.

3.1.1.1 Type 1 Diabetes

Type 1 Diabetes is insulin dependent otherwise known as "juvenile diabetes" that usually has a sudden onset associated with genetic preconditions of every human being. Autoimmune character of the disease can be demonstrated by finding relevant antibodies in the blood.

The cellular immune response if the manifestation of the disease is present and the triggering mechanism of the process may include some of the viral infection. This type is usually

manifested by children, adolescents, and not over than 40 years old. In Finland, where is the highest occurrence of diabetes in the world and where the disability has increased about 57% for the last 20 years, the diabetes mostly occurs in two, nine, or fourteen years boys and three, five or eleven years girls (FDA, 2012). Recently, the occurrence was appeared in elders, although the onset is mostly rare in the older age, so theoretically, anyone in any age can be affected. Also statistically more frequently diagnosed in summer than in other seasons (Douglas *et al.*, 1999).

The causes of the origin are still entirely unknown, however the part of the play role are genetic predispositions and environmental influences. The origin of the disease is not always associated with a simple subject which finally causes the diabetes, but it is a combination of events. The substantiality remains that it is an autoimmune disease which destroys the body's beta cells and based on it, the organism is not able to produce insulin anymore. This type of diabetes is irreversible and strictly requires lifelong treatment that can be done by using of insulin in regular intervals (approx. 4 times per day and about twenty minutes before a meal) with combination of diet and physical activity.

From the total amount of diabetics registered in the Czech Republic, there are only 8.4% of Type I diabetics (UZIS, 2013).

3.1.1.2 Type 2 Diabetes

Its formation occurs in later life, typically over the age of 40 years people with tendency to obesity. Although the studies show that in patients families' tents to this disease, the real cause were not discovered yet. The assumption is that type 2 must be stated on genetic basis.

The actual outbreak could be taken by long phase (many years of latency) before it goes to its manifestation. It is estimated that in America lives of at least 6 million people who have diabetes but they still do not know (Aubert, 1995) because the symptoms are not taking the effectiveness until the disease is fully developed. Developmental stage can take several years, during which time patients have impaired glucose tolerance (blood sugar levels are higher than normal), and which can be detected only by blood tests.

Type 2 Diabetes Mellitus is conditioned misbalance between secretion and effect of insulin in glucose metabolism. Beta cells produce enough or sometimes more or abundance of insulin.

There are several kinds of its treatment. The base for successful treatment is becoming diet, physical activity and change of life style.

From the beginning, the patients are putting on the drugs, oral anti-diabetics (PAD), which increase the sensitivity of tissues of insulin, or increasing its production. But if the treatment is not successful, patients have to begin with insulin therapy. According to the Institute of Health Information and Statistics of the Czech Republic there were 772.585 diabetic patients registered in 2012.

Table 1: Table of number of Diabetic patients in Czech Republic

		Type 1 DM				
	Type 2 DM	**0-14 years**	**15-19 years**	**20 and more**	**other types**	**DM in total**
2012	772 585	1 071	895	54 548	12 128	841 227
2011	758 719	981	862	53 699	11 121	825 382
2010	739 859	890	860	54 061	10 560	806 230
2009	717 365	830	940	53 644	10 542	783 321
2008	708 847	858	913	52 703	10 240	773 651
2007	692 074	816	869	51 128	10 074	754 961
2006	686 159	808	864	49 398	11 299	748 528
2005	678 760	804	815	48 887	10 039	739 305
2004	654 153	758	817	46 642	9 709	712 079
2003	630 330	566	602	45 386	9 981	686 865
2002	610 868	530	564	45 995	9 178	667 135
2001	599 6400	528	660	43 905	8 685	653 418
2000	599 640	497	716	44 870	8 299	654 164
1999	572 104	417	520	43 797	7 248	624 086
1998	557 395	408	576	43 633	7 018	609 030
1997	556 218	409	539	37 694	5 446	600 306
1996	536 480	360	492	37 759	7 335	582 426

Source: UZIS, 2013

Globally, the total prevalence of diabetes seems to be very negative and not only in the developed countries of Europe and North America but also in the area of the Middle East, Southeast Asia, Australia and South America.

3.1.1.3 Other types of diabetes

These types of diabetes are rare and include "the secondary diabetes" which is diabetes resulting in certain diseases of the pancreas (e.g. inflammation, tumors after surgery or pancreas) or excessive hormone acting against the insulin. Another type is gestational diabetes (GDM), which occurs in 2-8% of pregnant women (Buchanan & Diana, 2008) and mostly in the second part of the pregnancy period but after the birth of the child, in most of the cases it disappears.
Other minor type of diabetes reported by the World Health Organization (1999), various genetic diseases such as LADA (Latent Autoimmune Diabetes of Adults) or MODY (Maturity onset diabetes of the young), and more were identified.

3.1.2 History of diabetes mellitus

The first reference about diabetes, which has been noticed on papyrus, was recognized by ancient Egyptians around 1500 B.C. attempted to treat by liquid extract of bones, grain, grit, wheat, green lead and earth (Polonsky, 2012). On 230 B.C. the Egyptian Apollonius of Memphis used the Ionian Greek word for siphon "constant water flow" to describe patients' symptoms when the patients were urinated excessively and visible loss of weight.

The first name *diabetes* was given by Greek physician Aretaeus of Cappadocia (80 – 138 A.D.) also provided a clinical description of diabetes as a remarkable disorder consisted of a moist and cold flesh and limbs wasting into urine and never stop making water, the discharge is as ceaseless as a sluice let off. Although his recommendation for treatment; oil of roses, dates, raw quinces, and gruel (Sattley, 2008) was this modern physician powerless.
In 17th century the English neuroanatomist doctor Thomas Willis (1621-1675 A.D.) by observation, coined the term *mellitus* (sweet honey, honeyed), stressed that urine of patients is "really sweet as if imbued with honey or sugar". In addition, he was quiet correctly assuming

that frequency of diabetes was rising after the ancient time because of food and wine consumption.

Several years later (1889) German doctors Joseph von Mering and Oskar Minkowski presented by removing the pancreas from the dogs let to the similar conditions of diabetes with the rising of blood glucose.

At the turn of century, the islets of Langerhans were functioned as an endocrine gland. After so many years of searching for successful treatment (up until 1910 were opium used as widely spread medicament), on 31st Oct. 1920, doctor Frederick Banting and Charles Best have discovered that substance extracted from pancreas reduce the blood glucose. This substance is the protein insulin and thereafter used for human treating. Nowadays, Insulin (from Latin name *insula* means islands) remains a vital part of therapy for people with type 1 diabetes; a variety of drugs are now available to control blood sugar levels in people with type 2 diabetes.

3.2 Plant species with anti-diabetic properties

The present-day modern treatment options are mostly very expensive and its effect is limited which results in stimulation of research for new medicines or possible supplements (Suchý *et al.*, 2008). The final effects always depends on good diabetic patients cooperation, changes of their lifestyle including rightly dosage of medicaments, being under the appropriate diet, physical activities and so on.

In traditional medicine the herbal medicine was also used for glycemic control. In the period before the discovery of insulin, up to several hundred plant species has been used. These species differ depending on area of origin. Attempts of finding the specific categorization and its contexts, for example by phylogenetic relationship or by using the current knowledge containing the active substances, are still unsuccessful. In Europe, around the year 1900 A.C. was known more than one hundred species, for which the anti-diabetic activity was prerequisite.

Some of the species' presumption was verified by clinical study or chemical analyses otherwise some of them was the anti-diabetic activity negated. Mostly performed attempts of substances with potential anti-diabetic effect are done with rodents with alloxan-induced diabetes. (Kar *et al.*, 2003, Kameswararao *et al.*, 2003).

In the case of the use of herbal medicine as complementary or supportive treatment can be distinguished many different approaches. (Valíček *et al.,* 1996). The main and the first option is make effort to slash down the glycaemia, i.e. hypoglycemic effect. Other option is effort putting into the replacement of redundant carbohydrates by sugar-free and low calorie sweeteners. The last option is to add some appropriate and non-traditional crops into the dietary regimen. It must be specific supplement that do not contain inulin instead of starch.

Nowadays, there are more than 800 plant species with certification or at least suggestion about having the anti-diabetic impact (Alarcon-Aguilar *et al.,* 1998). As it is reported by Jahodář, 1993, a several predictable or proved principles of impacts of the plant metabolites can be categorized. The fist of them is the direct influence on the β-cells of the pancreas, which results in increased secretion of insulin or proinsulin. Another possibility is to increase the insulin effect by acting on insulin receptors, which is the change of the basal glucose transport and inhibition of insulin-degrading enzyme (IDE). For example it's the effect of *Momordica Charantia* L. polypeptide (Khanna *et. al,* 1987). Next possibility is to influence the enzymes of glycogenesis, glycogenolysis, gluconeogenesis and glycolysis. Another proven effect is to increase peripheral glucose utilization or modifying the mechanism of absorption of glucose from the digestive tract, i.e. a reduction in the activity of digestive enzymes and slowing down the absorption.

Certain substances can act like ligands of nitrated nuclear receptors PPAR (peroxisome proliferator-activated receptors), which play a key role in glucose and lipid homeostasis, or inhibit α-glucagon producing cells. The inhibition of glycation of proteins such as curcumin of Curcuma longa (Seo *et al,* 2008) or other biological activities are also possible. For many of the identified substances with biological activity is the chemical principle clarified and study of these substances is still ongoing. Some contained substances have also become a direct or indirect model for the production of synthetic drugs (Suchý *et al.,* 2008).

The unforgettable role of some plants are being used as sweeteners. The most famous and most widely used plant as a sweetener is Stevia (*Stevia rebaudiana* (Bertoni) Bertoni), where the most effective chemical that causes the sweetness, is diterpenoidic glycoside stevisoid. It also contains a number of other substances, such as rebaudiosides, steviol, sterebines and flavopropanoides. The stevioside based sweeteners are only allowed in Japan and Brazil (Valíček *et al,* 1996). Since 1997, the European legislation still rejects the classification of Stevia in the amendment

of Food regulations (Lähteenmäki-Uutela, 2007). A couple of the other plant species (*Opuntia ficus indica* L.) are studied for their sweetness and potential use for production of artificial sweeteners (Saenz *et al*, 1998).

Although, plants suitable for diabetic patients are characterized by their composition, which sets them apart from others. They are especially rich in inulin, fructo-oligosaccharides and dietary fiber. Firstly discovered store polysaccharide present in some plant species, called inulin, was discovered in 1804 A.C. in Elecampane (*Inula helenium* L.) that was named by its Latin name. Fructose-oligosaccharides or abbreviated oligo-fructanes may be formed by degradation of inulin from which differs by different degrees of polymerization and after splitting up into fructose is used for the production of alternative sweeteners.

For many reasons is inulin very important for the human body. Notably creates a nutrient source for bifid bacteria, strengthens the immune system, supports the synthesis of vitamin from precursors, and reduces the glycemic index of foods and so on. Because the animal organism do not know how to use inulin as energy source, it behaves as soluble dietary fiber in intestines but it also serves as energy source for symbiotic intestinal bacteria. And because of its very low caloric value that can reach zero which is beneficial for diabetic patients since they must comply with physician determined diet regime.

Today, the adequate fiber intake is emphasized not only in diabetic or reducing diets but also as the foundation of a healthy diet. Soluble fiber, rather contained in young plants, acts like a cleaner of intestinal lining, it also absorbs fluids, facilities the emptying and helps to reduce blood sugar and cholesterol level in the human body. Insoluble fiber increases the density of the diet, reducing the time of its passage through the digestive tract and improves intestinal peristalsis. The above mentioned ingredients are contained in various kinds of fruits and vegetables, but plants from the family *Astereceae*, contain much larger quantity of inulin 7 than the other species. For example: yacon has on average 22% of inulin, artichoke about 16-20%, 13-20% chicory and artichoke has about 5.5% (Lachman, 2010).

3.3 History of plant medicine in Europe and World

Since the ancient times, people were interested into the plants not only in sense of food but also because of their effects on the human health. More than frequently they were the only chance for

alleviating the pain or used for healing. Thanks to coincidences and tragic mistakes made by a human being even at the lowest grade of evolution, has allocated a group of medicinal plants. Initially, the plants were using untreated. Later and up at a time of slavery and feudal society began to be used and processed the certain parts such as leaves, flowers etc. in the form of leachate and extract. However, the overall essence of the healing effects has remained as a secret for centuries.

In the first half of the third millennium BC, teaching about the properties of plants has begun at the same time in Sumerian ad Egypt. Very important role in the development and discovery of herbal medicine in Europe played the Greeks and Romans, where in the fifth century BC Democritus, Greek philosopher and scientist, wrote the first ancient overview of medicinal plants. Not long afterwards, Hippocrates, who is considered as father of medicine, recommended the asparagus (*Asparagus officinalis* L.) and garlic (*Allium sativum* L.) because of its diuretic ability, poppy (*Papaver somniferum* L.) as hypnotic and the willow (*Salix alba* L.) leaves to treat pain and fever, to people of Greece. In the second half of the 5th century BC Hippocratic School was developing its activity and about a century later, Theofrastos put the foundations of systematic botany. The first teacher of medicinal plants was Dioskorides (1st cent. BC), who in his work; "*De Materia Medica*" describes more than 500 medicinal plants and drugs. *De Materia Medica* was an essential teaching aid for next incredible 15 centuries. A great expert of medicinal plants Galenos, living in the 2nd century, has reworked many of Hippocratic's ideas and formulated them into his body fluids theory. With the fall of the Roman Empire in the 5th century, herbal medicine has developed especially in the Muslim part of the world. The Arabs used the complicated extract procedures and they have been given the foundations of galenic pharmacy. Perhaps the most popular masterpiece of the time was "*Canon Medicinae*" written by Avicenna. A huge impact on expansion the number of medicinal plants had a great geographical discoveries and travels made to India and America. Dissemination of gained knowledge about plant medicines greatly facilitated the invention of the printing press. That was the beginning of publishing a herbarium, which positively affected the use of medicinal plants, however the essence of the therapeutic effect has up to now remained hidden.

At that time, Europe was also enriched with exotic plants from Asia and Africa, as ginger (*Zingiber officinale* Roscoe), cinnamon (*Cinnamomum cassia* (L.) J.Presl/*zeylandicum*), nutmeg

(*Myristica fragrans* Houtt.) or ginseng (*Panax gingsen* C.A.Mey.) are. During the middle Ages, the use of herbal medicines accompanied by superstition and magic spells. Women who were interested and oriented in the plant treatment, were often considered as witches and condemned to be burned. Until Renaissance period entails effort to create several of elixirs. Early 19th century is associated with research in chemistry, wherein was putting the focus on the active plant substances and connected to it they began with effort of its isolation. They were succeed with identification of morphine from opium poppy, then atropine from belladonna (*Atropa belladonna* L.) or quinine from the bark of the cinchona tree (*Cinchona calisaya* Wedd.).

At present, the scientists are mainly focusing on therapeutic effects of the plants.

Also an important turning point, not only for plant medicine, has become the construction of microscope by Leeuwenhoek (around 1670 AC), that allowed to study the structure of plant tissues and its organs, which contributed to development of anatomy and morphology. The most important period for the history of pharmacognosy and pharmacy was the turn of the 18th and 19th century, characterized by many discoveries of active substances in plants. Some of them are an inseparable part of modern todays medicine. In nominal; discovery and isolation of morphine, atropine, quinine, theobromine, etc. The differentiation of pharmacognosy as a separate scientific field occurs only in the 19th century. Technical and scientific progress in the early of 20^{th} century largely influenced the role and methods of pharmacognosy. The gradual introduction of new methods took a close look at study of the active ingredients of drugs and the biologically originated medications.

Nowadays, there is a huge amount of plants in nature, whose effects have been not discovered yet. And around the world continues the research for plants and its contained substances that could become a new basis for commercial produced medicaments.

4 Patients and Methods

For obtaining significant and required data was assembled the questionnaire which has about 22 questions, that has been prepared in cooperation with Robert Bém, MD, PhD, physician at the Institute of clinical and experimental medicine (IKEM) in Prague 4 - Krč, and Doc. Ing. Eloy Fernández Cusmani, Ph.D. from Czech University of Life Sciences, and then finally generated by system Survio (see Appendix 1.) which is available on www.survio.com. The completed questionnaire was intended to patients being treated at any type of diabetes. However, almost 70% of the respondents were diagnosed as I. type. Due to the content and types of the questions, the questionnaire was divided into two main parts, the general part that contained about 14 questions asking about exact personal data and the second part, that has been filled only if the respondents were users or ever been using the plants as an alternative kind of treatment.

Data was collected in four ways. The first way of the distribution was placed on the diabetes department of IKEM. In cooperation with Robert Bém, MD, PhD, and its pre-personal department were questionnaires given to patient in the waiting room. The total number of distributed and printed questionnaires was 145 sheets, out of which 100 sheet were filled and subsequently included in this research.

The second irreplaceable part for obtaining the data from patients was through the website www.vyplnto.cz in the period from July 5th to 6th October 2013. The questionnaires were used and transformed into this official server without any changes concerning the content. Because of very specific topic and requirements of the users, it was obtained 32 filled questionnaires.

Another part for obtaining the data was random street walking distribution at the World Diabetes Day in Prague where was collected 47 filled sheets from these event participants having the diabetes.

The last way for gaining the important data was distribution placed on the diabetes department of the health center of Prosek, Prague where 28 filled questionnaires were collected.

Evaluated on-line questionnaires were transcribed to paper for better handling and put together with the questionnaires from the other ways of collection. A total of 45 questionnaires had to be excluded due to insufficient, incomplete or improper completion.

After final collecting of filled questionnaires were divided into two major categories of diabetic patients; diabetic patients which use a plants and plant supportive preparations and diabetics that have never used any. These two categories were further divided in accordance of the group of users into four more specific categories; patients that have used and use the plant supplements, patients that have used and nowadays they don't use any, and finally into patients that have never used any and nowadays they use some kind of supportive plant treatment.

Each of the selected categories was statistically and separately processed by statistical methods (T-test and Chi – quadrate). The table of used plants or their parts has been compiled on the basis of selected plants in the questionnaire, afterwards filed into the family and settled on the frequency of use. Because the answer "tea" belonging to the second part of questionnaire is not credible and significant, couldn't be included into the table thanks to the inability to identify the exact composition.

If the box of the column was filled, that information has been mentioned and answered 50% and more percentage of the respondents. If was not, the box has remained to be empty and respondents hasn't been reported this information.

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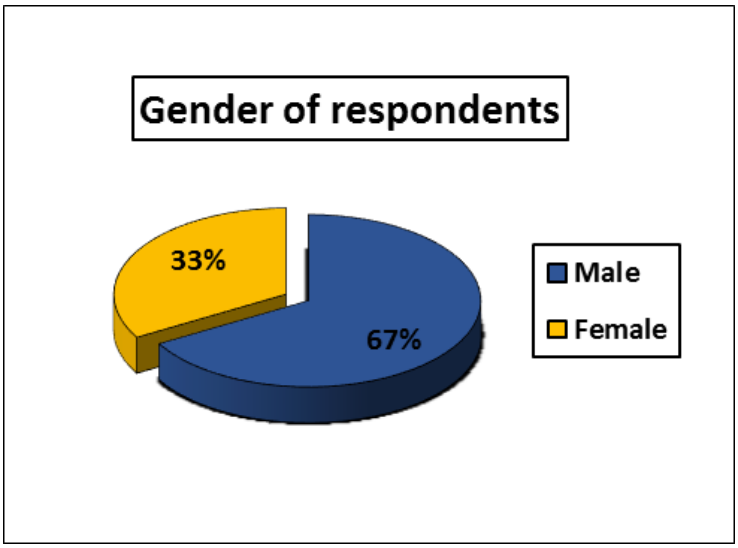
5 Results and Discussion

5.1 Results

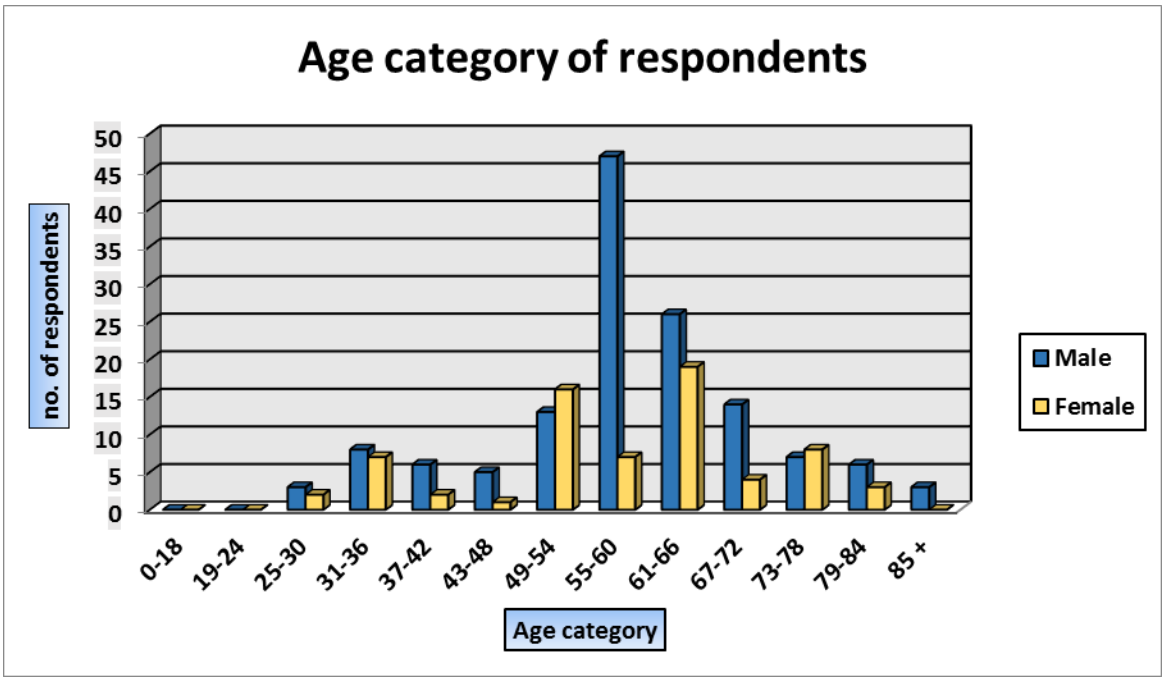
Through the study and over the research we gained 207 filled questionnaires from the diabetic patients living all over the Czech Republic. From which them, we had to take out 7 questionnaires, because of inability to process thanks to absence an important information, showed by unfilled parts.

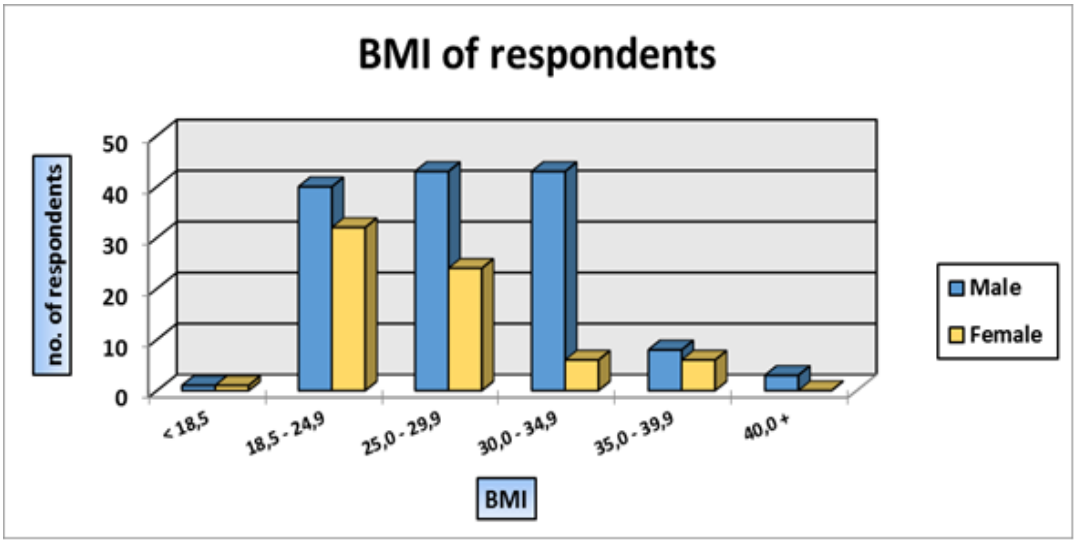
At first the respondents were divided by their gender (Graph1) where 67% of respondents were males and 33% females. Then the genders were divided into the several group of age showing the proportional representation of male and female. The highest number of respondents was between 55 to 60 years old males and 61 to 66 years old females (Graph 2).



Graph 1: Gender of respondents

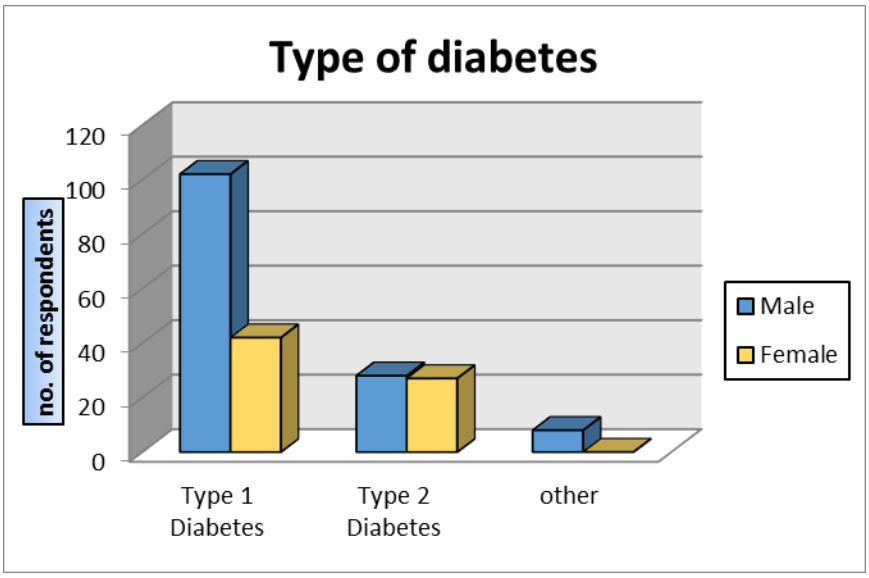
Althought the widely ranged age distribution, the number of Body Mass Index average was almost similary represented by males comparing to female (Graph 3).





Graph 3: Body Mass Index of Czech diabetic respondents

Based on the gender was also valueted the represention of Type 1 Diabetes, Type 2 Diabetes and the other (Graph 4). The biggest differention was showed by Type 1 Diabetes where the male were taking the dominat part.



Graph 4: Disparity of figures, based on gender and diabetes type

The gender was also major in case to value the respondents based on the usage. The Table 2 shows that 91 males are not using any plants as a supplement. Where 77% males belonged to group of patients that were not plant abused, comparing to female which 53% of total were plant abused.

Table 2: Division of respondents based on the usage of plants

	Male	**Female**	**Both**
YES	36	36	72
NO	91	27	118
Not filled	12	5	17
Total	139	68	207

Another division was made in case of valuation the respondents with actual usage or any use of plants (Table 3). It showed the fact that actually 26% use the plants, although 54% of both gender respondents have not answered the question.

Table 3: Division of respondents with actual usage or any use of plants

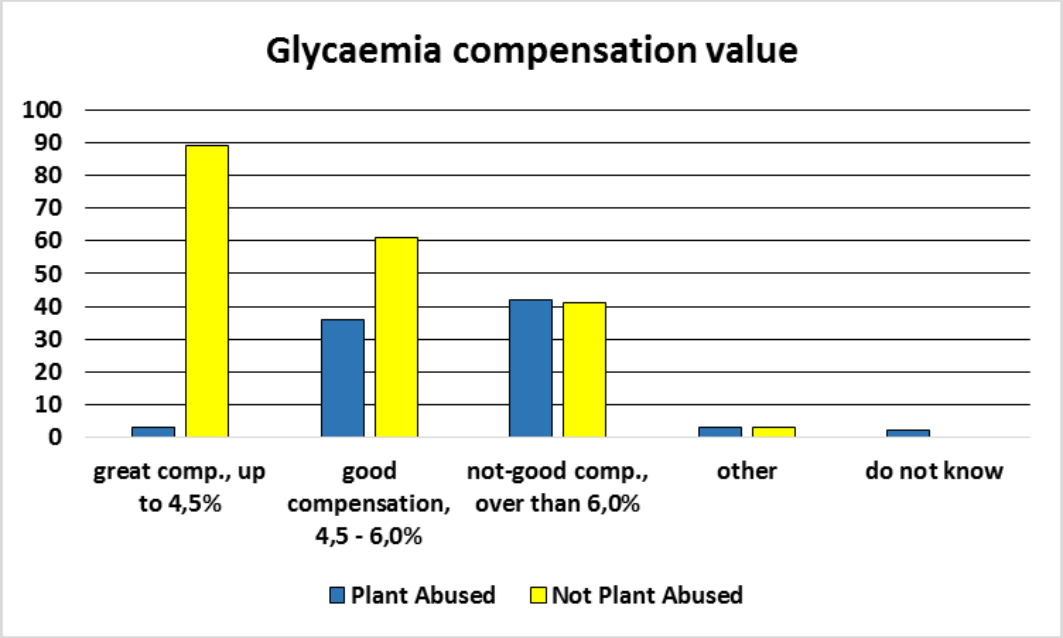
	Male	Female	Both
YES	18	35	53
NO	14	28	42
Not filled	106	6	112
Total	138	69	207

The completed overview of respondents that have filled the questionnaires during these 1st part questions, shows the differences between no. of respondents, its BMI average and the Type of Diabetes belonging to status of usage. This table (Table 4) pointed the fact that patients that do not use and never used were more frequent (57%) but had higher number of BMI in average and belonged to Type 2 Diabetes. On the other hand the group of plant abused plant were lower in value, but had better BMI in average and treated with Type 1 Diabetes.

Table 4: Overview of respondents

Status	no. of respondents	BMI Ø	Type 1 Diabetes	Type 2 Diabetes	Other Types	Not answered
Do not use and never used	118	28,25	30	76	0	2
Never used and use	9	26,17	5	3	0	0
Use and do not use	29	27,18	11	17	0	1
Used and use	51	26,14	24	24	1	1

Following the datas mentioned in Table 4, we made a graph that shows the differenes between plant abused and not plant abused patients compared to the glycaemia value (Graph 5). Significant fact was great compensation up to 4,5% of not plant abused diabetic patients.



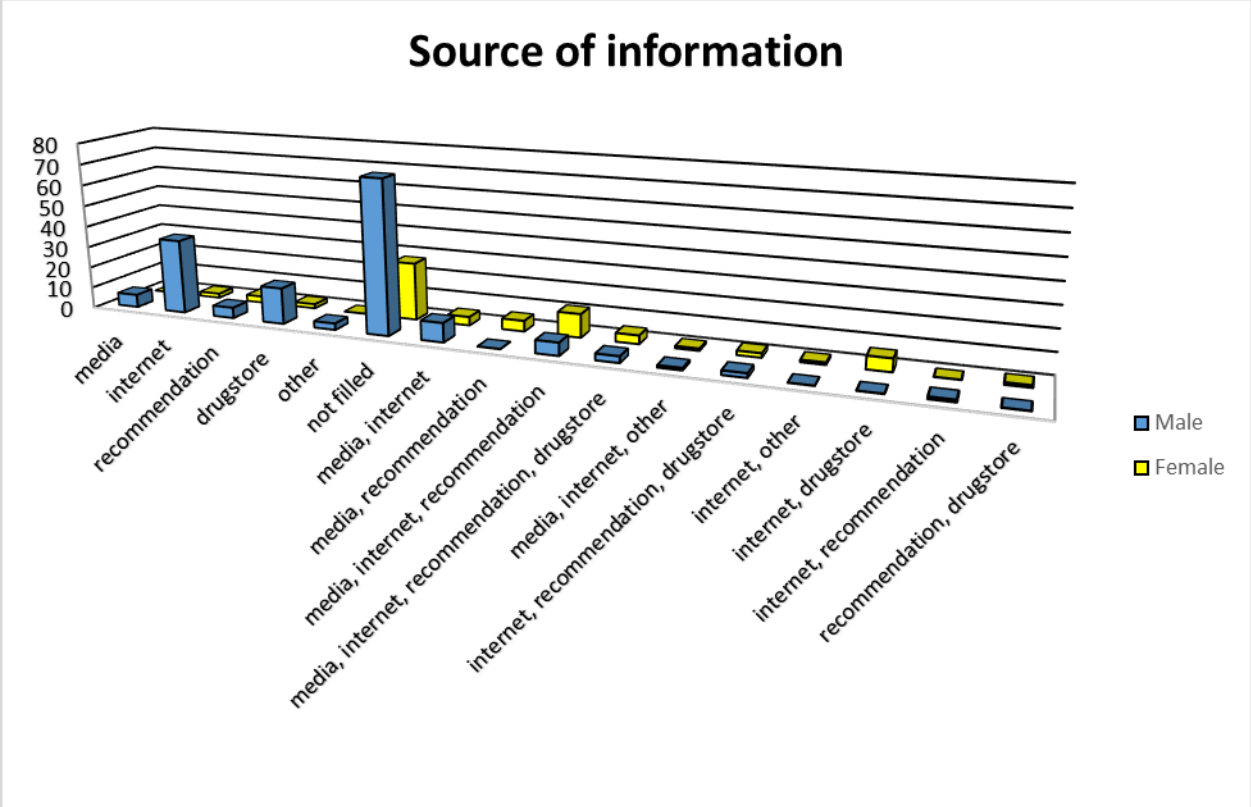
Graph 5: Distribution of diabetic patients abused or not abused on plant based on their glycaemia compensation value

Table 5: Reasons of respondents of plant usage

Reason	Male	Female	Both
to control the glycaemia	67	28	95
to try something new	8	5	13
other	6	7	13
not answered	52	24	76
to control the glycaemia, to try something new	6	4	10
to control the glycaemia, other	1	2	3
Total	138	69	207

Based on the Glycaemia compensation value the patients were asked about the reason of the plant usage (Table 5). The highest number got the reason of control the glycaemia, mentioned by 46% of both genders in total. These diabetic patients had been asked for the source

of information, showed in Graph 6, where the internet as the most popular source of males was mentioned (25% of male respondents). The females were mostly responding the combination of internet, media and recommendation (16% of female respondents).



Graph 6: List of information sources

In this case of knowledge of reason and getting the information about the plant supplement were made a table based on the used species (Table 6).

Table 6: Data table of species that have been mentioned by respondents

LATIN NAME	CZECH NAME	FAMILY	USED PART	MALE	FEMALE	TOTAL
Agrimonia eupatoria L.	Řepík lékařský	*Rosaceae*	ND	4	3	10
Allium cepa L.	Cibule kuchyňská	*Amaryllidaceae*	all plant	12	10	23
Allium sativum L.	Česnek	*Amaryllidaceae*	all plant	15	11	28

LATIN NAME	CZECH NAME	FAMILY	USED PART	MALE	FEMALE	TOTAL
Allium schoenoprasum L.	Pažitka pobřežní	*Amaryllidaceae*	stems	5	4	11
Aloe vera (L.) Burm.f.	Aloe	*Asparagaceae*	leafs	7	6	17
Cannabis sativa L.	Konopí seté	*Cannabaceae*	leafs	1	0	1
Carum carvi L.	Kmín kořenný	*Apiaceae*	fruits	5	5	16
Cichorium intybus L.	Čekanka obecná	*Compositae*	leafs	2	1	7
Cinnamomum cassia (L.) J.Presl /zeylandicum	Skořice	*Lauraceae*	cortex	9	8	25
Coriandrum sativum L.	Koriandr setý	*Apiaceae*	seeds, leafs	0	1	1
Crocus sativus L.	Šafrán setý	*Iridaceae*	pestils	1	0	1
Cuminum cyminum L.	Kmín římský	*Apiaceae*	seeds	5	4	10
Elaeagnus rhamnoides (L.) A.Nelson	Rakytník řeštlákovitý	*Elaeagnaceae*	fruits	6	4	11
Foeniculum vulgare Mill.	Fenykl obecný	*Apiaceae*	ND	1	3	6
Gingko biloba L.	Jinan dvoulaločný	*Ginkgoaceae*	leafs	5	3	9
Gynostemma pentaphyllum (Thunb.) Makino	Ženšen pětilistý	*Cucurbitaceae*	tubers	1	0	1
Helianthus tuberosus L.	Topinambura hlíznatá	*Compositae*	tubers	0	2	10
Hypericum perforatum subsp. chinense N.Robson	Třezalka tečkovaná	*Hypericaceae*	flowers	1	0	1

Table 6 continuation

LATIN NAME	CZECH NAME	FAMILY	USED PART	MALE	FEMALE	TOTAL
Lamium spp.	Hluchavka	*Lamiaceae*	leafs	1	0	2
Laurus nobilis L.	Vavřín, bobkový list	*Lauraceae*	leafs	2	5	15
Levisticum officinale W.D.J.Koch	Libeček lékařský	*Apiaceae*	leafs	4	6	11
Linum usitatissimum L.	Len setý	*Linaceae*	fruits	3	2	7
Matricaria chamomilla L.	Heřmánek pravý	*Compositae*	flowers	6	5	13
Melissa officinalis L.	Meduňka lékařská	*Compositae*	leafs	8	7	17
Mentha x piperita L.	Máta peprná	*Lamiaceae*	leafs	11	8	29
Momordica charantia L.	Hořká dýně	*Cucurbitaceae*	seeds	0	0	1
Ocimum spp.	Bazalka	*Lamiaceae*	leafs	4	5	15
Origanum majorana L.	Majoránka zahradní	*Lamiaceae*	leafs	0	1	1
Panax ginseng C.A. Mey.	Ženšen pravý	*Araliaceae*	ND	2	2	5
Phaseolus vulgaris L.	Fazol obecný	*Leguminacea*	fruits	2	3	8
Pimenta dioica (L.) Merr.	Pimentovník pravý/nové koření	*Myrtaceae*	fruits	8	7	16
Plantago lanceolata L.	Jitrocel kopinatý	*Plataginaceae*	leafs	3	2	6
Pleurotus ostreatus	Hlíva ústřičná	*Agaricomycetes*	all	11	9	21
Rosa canina L.	Růže šípková	*Rosaceae*	flowers	4	3	8
Salvia officinalis L.	Šalvěj lékařská	*Lamiaceae*	leafs	6	7	18

Table 6 continuation

LATIN NAME	CZECH NAME	FAMILY	USED PART	MALE	FEMALE	TOTAL
Sambucus nigra L.	Bez černý	*Adoxaceae*	flowers	5	4	13
Sesamum indicum L.	Sezam indický	*Pedaliaceae*	seeds	0	2	3
Stevia rebaudiana (Bertoni) Bertoni	Stévie cukrová	*Compositae*	leafs	10	7	25
Taraxacum officinale	Smetanka lékařská	*Compositae*	leafs	2	3	7
Urtica dioica L.	Kopřiva dvoudomá	*Urticaceae*	leafs	7	6	24
Vaccinium myrtillus L.	Brusnice borůvka	*Vacciniaceae*	leafs, stem	19	15	49
Vaccinium vitis-idaea L.	Brusnice brusinka	*Vacciniaceae*	fruits	11	6	19
Verbascum densiflorum Bertol.	Divizna velkokvětá	*Scrophulariaceae*	flowers	1	2	4
Viscum album L.	Jmelí bílé	*Santalaceae*	ND	0	0	2
Zingiber officinale Roscoe	Zázvor	*Zingiberaceae*	rhizomes	10	8	28

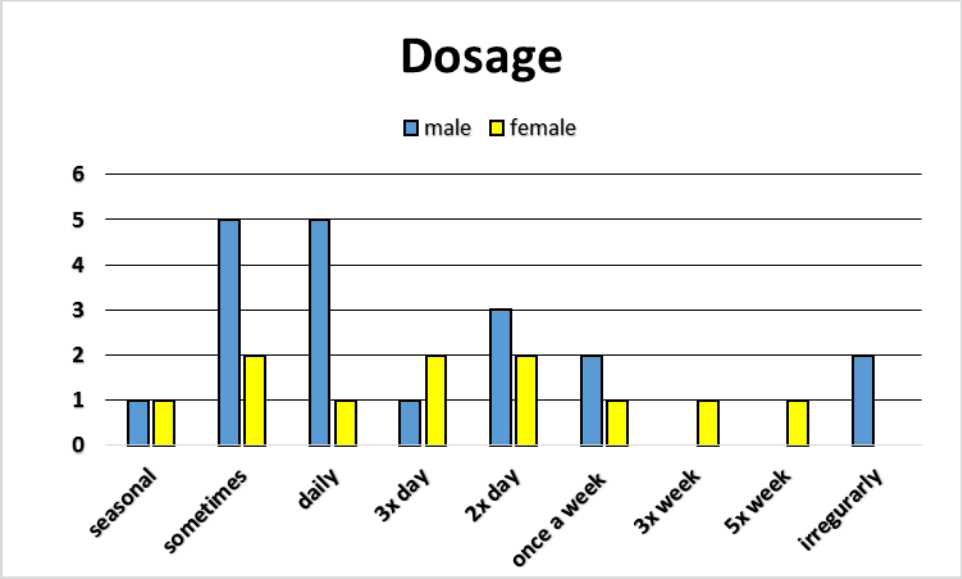
(ND – not data has been found)

The table showed and gained the data about what plant species, which parts are used by diabetic patients of each gender. The most commonly used specie was bilberry mentioned by 40% of plant abused respondents, garlic by 30%, 26% belonged to onion, peppermint in 22%, ginger was represented by 21% and sweetener stevia by 20%. The each plant specie was given into the belonging family from which has been counted the number of frequency distribution shown in Table 4. Where most distributed family was *Compositae* with 9 plant species, then *Lamiaceae* with 5 species, following by 5 species of *Apiaceae*.

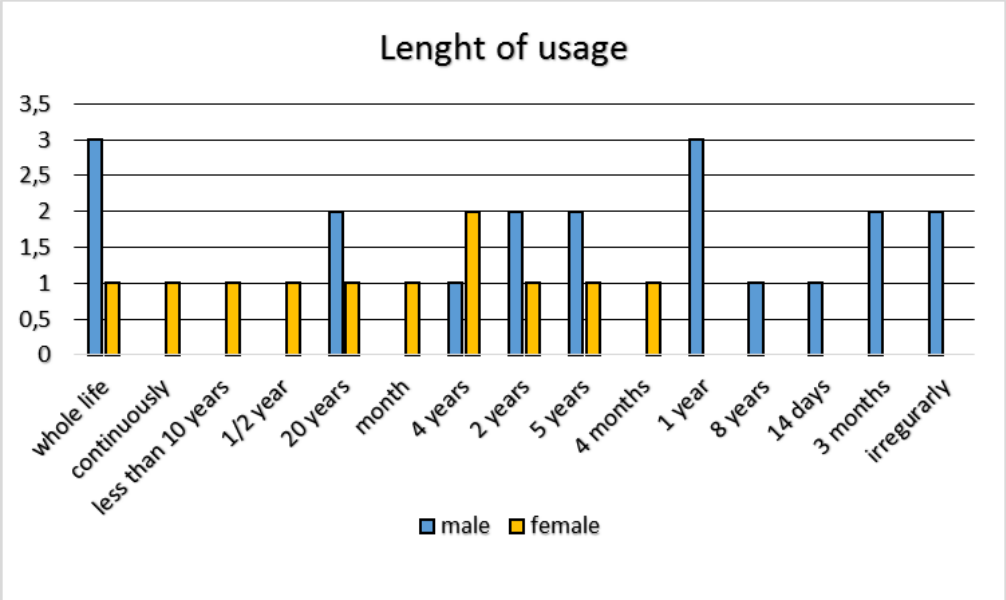
Table 4: List of mentioned families and the number of mentioned species that belong to each family

FAMILY	no.of species
Adoxaceae	1
Agaricomycetes	1
Amaryllidaceae	3
Apiaceae	4
Araliaceae	1
Asparagaceae	1
Cannabaceae	1
Compositae	9
Cucurbitaceae	2
Elaeagnaceae	1
Ginkgoaceae	1
Hypericaceae	1
Iridaceae	1
Lamiaceae	5
Lauraceae	1
Leguminacea	1
Linaceae	1
Myrtaceae	1
Pedaliaceae	1
Plataginaceae	1
Rosaceae	2
Santalaceae	1
Scrophulariaceae	1
Urticaceae	1
Vacciniaceae	2
Zingiberaceae	1

The next valuated data belonged to question about the frequency of plant use, also mentioned as dosage (Graph 7). When the males were two percentage similarity for sometimes and daily dosage (26% of total males' gender). The females responded with 18% for twice and three times a day the frequency of use.



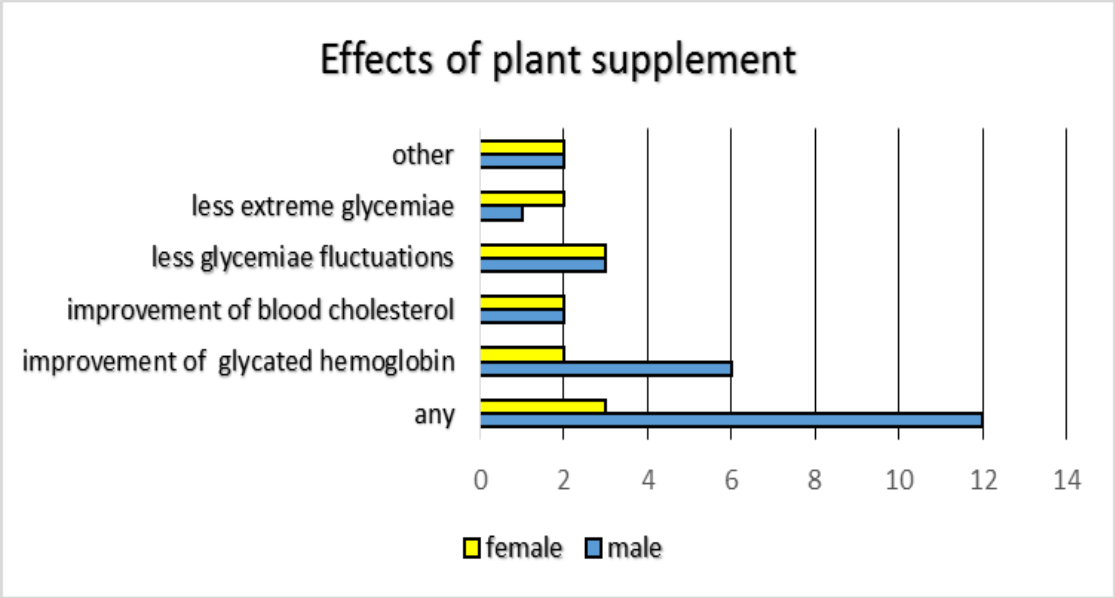
Graph 7: Frequency of use and dosage



Graph 8: Length of plant usage

By the Graph 8 has been valuated the length of the usage that was rapidly more long-term used by males, especially shown in answer “whole life” and “1 year” that was responded by

16% of total number of male respondents, following by “3 months” and “irregularly” usage taken by 10% .



Graph 9: Subjective assess the effects of plants

The last question was about their own observation and evaluation the effects of plant usage. Mostly frequented answer “any” were taking the top place for both genders, males 46% of their total amount and female in amount of 21% (Graph 9).

5.2 Discussion

According to the available resources in the Czech Republic, there has not been any conducted ethno botanical survey focusing on alternative utilization of plants in patients with diabetes. Although in some countries all around the world, it was carried out. Namely; under the leadership Leduc C. in Canada, Yaniv Z. in Israel, Jouada H. in Morocco, Abo K. A. in Nigeria, Rowaise A. in Saudi Arabia and for example Mahabir D. in Trinidad and Tobago. Comparison of these works was unfortunately impossible, because of basis of the differences of climatic and living conditions, national culture closely associated with geographic location, which is one of the basic indicators.

The importance of the culture and lifestyle of the nation has been described by collective under the leadership of C. Leduce from Quebec, Canada, took a place in last decade on 20 and years older, and has proved the 150% increase in the prelevance of Type 2 Diabetes. And that the conventional therapeutic methods has yield only a limited success within Cree Nation of Enjou Istchee. Based on survey has been identified potential anti diabetic plant species (18 plants classified in 9 families) that has been locally grown and used as unknown traditional pharmacopoeia. Another ethno botanical studies of medicinal plants used in the management of diabetes mellitus done in southwest Nigeria by collective under the leadership K. A. Abo were inventorying plants used by 100 local healers that has been interviewed. It has been identified 31 plants mainly classified in family *Rutaceae*, *Leguminaceae* and *Cucurbitaceae*.

Supporting and significant study was done by D. Mahabir. Where the patients were dividing by their ethnicity and educational attainment. The lowest age category that has been less than 44 years old and type of diabetes was not taken into account. The significance was determined only by the differences of patients treated and untreated with insulin. Similar issues were on the way of acquisition and frequency of use. Table was prepared frequency mentioned plants, but due to other genetic heart was a different species. This study also did not take into account the use of crops or plants with an appropriate nutritional composition as diversification of diet conducive to diabetes control. Similar issues were on the way of acquisition and frequency of use.

Based on the frequency of mentioned plants were prepared a table but thanks to another genetic center has been used a different species. This study also did not take into consideration use

of crops or plants with an appropriate nutritional composition as diversification of diet conducive to diabetes control. Distribution by gender was represented by 138 (67%) men and 69 (33%) were women. From the remaining part were 144 (69.6%) respondents diagnosed as Type 1 diabetes mellitus and 65 respondents (31.4%) were treated with Type 2.

The following questions about exact weight and height were cardinal for calculation the Body Mass Index (BMI) that measure body fat by formula depending on height (meters) and weight filled in kilograms (Formula 1). The resulting number separated patients into several categories.

According to available studies, people with increased of body fat are associated with risk of metabolic diseases such as type 2 diabetes mellitus, hypertension and dyslipidemia (Bays *et al,* 2007). Resulting average of men and women reached the number of 27.72 that is classified as overweight with increased risk of developing health problems. Based on the results, the differences between genders were more visible.

Comparing to research about the average of BMI of population in Czech Republic that was in amount of 23.78 (WHO, 2012) are patients with diabetes mellitus of all age categories more tended to risk of other metabolic diseases according to their physical proportions.

The next step made among the respondents who indicated that never used any plants were predominance of males (77%), while respondents who even try to use plants was about exactly 50/50 males and females. Comparing to nowadays, differences between males and females respondents were more significant with females' predominance (66%) of actual using of some plant species.

Another important fact was shown after division of diabetic patients into 4 groups. The first group of patients that do not use and never used and plants to control glycaemia was 57% of the total number of respondents and 64% were treated with Type 2 diabetes. This group of patients has also the highest Body Mass Index gained 28,25 belonging to overweight category with increasing risk of health problems and complications, compering to the other groups that even tried or are active users of plant species as supportive treatment. The best average of BMI had the patients that used and use a plants covering about 24% of respondents that takes the second most answered place that can be significant to the fact of increasing interest in alternative and supportive medicine of modern society in time of developing media. Follow endpoint was about the age of the respondents. The assumption was that patients using plants

or manufactures thereof will be merely older. This is due belonged to the fact that among young people, mostly in the age groups under 30 years, predominantly type I diabetes who do not trust too alternative possibilities in the complementary treatment of diabetes and fully rely on the procedures of modern medicine.

This fact is also supported by differences in age category of female and male respondents. The male respondents were represented by 34% in the age category ranges from 55 to 60 years and female highest number was represented by 28% of female respondents in 61 to 66 years category.

Other important fact and necessary to know was about the value of the HbA1c, glycaemia compensation. Although the females are being worse in diabetic compensation, the do less search for information. To the question "Please indicate the method of preparation the plant that you use", not all of the respondents answered, but some indicated more options. As regards the method of preparation and use in general, a large majority of the most frequent use was about tea preparation. By answering "tea" were included preparation methods brewing, steeping a decoction, as a result of the following of procedures should ideally always be an herbal concoction that is herbal tea.

Therefore, respondents who said they use plants, asked about their reasons. Diabetic patients who completed the questionnaires in written and on-line version had named some most frequented examples of reasons that could be supplemented.

The main reason for taking or even looking for supplements were mentioned by 45% because advantage of controlling the glycaemia in case for both genders. The fact that 76 respondents haven’t answered is attributed to the fact of low knowledge of the effects of supplements or possible alternative of treatment.

Another of the issues, common to all respondents examined whether patients with diabetes searched for information on herbs, plants and crops or products made from them, appropriate within the prescribed treatment. The tree mostly mentioned sources of information was internet, drugstore and other kinds of media including newspapers, TV spots, commercials and so on. We can say that patients find drugstores as the most trusted and most reliable source. Male respondents were with 25% searching for information on the internet and only 4% of them were influenced by media against the women part with 69 respondents, that believe and get the

useful advices and information most likely from media and recommendation were represented by 16%. Under the category “others” should be included, for example, not too often herbalism, in the case of crops such as yacon and Jerusalem artichokes then market or farmers' markets, where they can get some recommendation and also buy the products. More frequent are then organic food, health food stores and organic shops that today are experiencing a boom in popularity and are becoming more popular and old customers. In these shops you can buy especially stevia and quantity of teas and tea blends designed for diabetics are also skilled persons ready to help.

For the next results were necessary to ask for the experiences and actual use of medicinal plants as a supporting treatment. A number of 89 (43%) of respondents said they use or have used diabetic plants. The second part i.e. 118 (57%) persons, on the contrary said that plants suitable for diabetic policy have never used.

Respondents which have reported and confirmed the use of plants and crops in purpose of diabetes, were asked for concrete species. The lists of the plant species how they have been reported by respondents together with frequency along with the most frequently used parts of a forms. However, a few respondents rather answered in general, often such as "tea" or "tea blend" (a total of 11 patients). That is 12.4% of patients who did not specify the types of plants that use and they could not be included in this table, even though most teas designed for patients with diabetics distribute on the Czech market, have very similar composition.

From those 48 plant species were most of them belonging to the family *Compositae* represented by 9 species, less to the family *Lamiaceae* (5 species) and family *Apiaceae* was represented by 4 species. To *Rosaceae*, *Vaccinacea*e and *Cucurbitaceae* family belong after 2 species.

To all other families, namely: *Adoxaceae, Agaricomycetes, Araliaceae*, *Asparagaceae*, *Cannabaceae*, *Elaeagnaceae*, *Ginkgoaceae*, *Hypericaceae*, *Iridaceae, Lauraceae*, *Leguminacea*, *Linaceae*, *Myrtaceae, Pedaliaceae*, *Plataginaceae*, *Santalaceae*, *Scrophulariaceae, Urticaceae* and *Zingiberaceae* were having after 1 specie.

The most frequently mentioned plant was bilberry (*Vaccinium myrtillus* L.). A decoction of the leaves is traditionally used to reduce blood sugar (Upton, 2001) and its use as a tea or decoction is among Czech diabetic patients by far most widely used of these plants. It is also part of many tea blends for use with patients with diabetics.

The second most frequently used plant was peppermint (*Mentha x piperita* L.). Widespread used among the patients in Morocco (Jouad *et al.,* 2001) and Israel (Yaniv *et al.,* 1987). Peppermint is again not a part of the tea blends for diabetic patients. The decisive characteristics of its use may be distinctive taste and aroma.

Another multiply mentioned was also ginger (*Zingiber officinale* Roscoe). Gingers extract has demonstrable hypoglycemic effect proved by experiments with laboratory rats. (Mascolo *et al.,* 1989). According to available information, the research was not conducted on diabetic patients. In the section about how do they use it, respondents reported that is mostly used to the cooking and for tea. Some also answered only "as instructed" or "common usage" Such a response was classified according to said plant or product. As already stated, tea is the most common form of the use of herbs and of all respondents who answered the question said it 61%. In other responses included all responses that could not be classified. In specific cases, an elderberry syrup, sweetening Jam by stevia, salad (use yacon) and cooked like potatoes (sweet potato).

Some of these categories would be included in the category of "into meals" (total 12%) but thanks to clarify responses were included in the "other". Using the "into meals" is the importance of herbs and spice and seasoning (such as fennel, laurel, garlic, etc.). The smallest share is represented by identical (2%) response, dried and raw. Dried as in the case of "bitter pumpkin" (*Momordica charantia* L.) and cranberry (*Vaccinium vitisidaea* L.) and raw Jerusalem artichokes and chicory (*Cichorium intybus* L.).

Interesting finding was in often reported usage of cinnamon and stevia. Originally cinnamon has two botanical species, Ceylon cinnamon (*Cinnamomum zeylanicum* Blume) and Chinese cinnamon (*Cinnamomum cassia Nees* ex Blume) but the way use is similar and also the active substances are identical (Verspohl *et al.,* 2005). Its bark is a frequent source for manufacturing of secondary supplements for diabetic patients. Most often is in the form of an extract. It is also possible to the use a mixture of tea (herbal medicine tea with cinnamon). The effect of cinnamon extract on diabetic patients was verified by clinical studies (Khan *et al.,* 2003). Stevia (*Stevia rebaudiana* (Bertoni) Bertoni); (Shivanna *et al.,* 2012) or low calorie sweetener, popular for exception of aspartame that cannot be digested in the human body so it provides no extra calories (ADA, 2014), got a wider recognition because of the controversial EU legislation, and also because of the current distribution through health food stores.

Another plant that has been mentioned was the stinging nettle (*Urtica dioica* L.) quoted in connection with the anti-hyperglycemic effects on diabetic patients (Bnouham et al., 2003). But it is not a part of any commercial tea blends. Commonly used form, which is specific for more than 50% of respondents was the decoction of the leaves. Among the plants the respondents more than one reported species primarily used as herbs in the kitchen.

The good example garlic and onion which is effectively used for control of the hyperglycemia and hypoglycemia proved by male Wistar rats experiments done Campos K.E. et al. in 2003.

Especial mention was made to the hemp (*Cannabis sativa* L.); (Fisher *et al.*, 2010), saffron (*Crocus sativus* L.) where its pestils are used as spice to significantly reduce blood glucose levels by ethanolic extract (Mohajeri D, 2008; Samphatu *et al.*, 2009), St. John's Wort (*Hypericum perforatum* subsp. *chinense* N.Robson), coriander (*Coriandrum sativum* L.), marjoram (*Origanum majorana* L.) commonly used in traditional Czech cuisine, basil (*Occimum* spp), sage (*Salvia officinalis* L.), fennel (*Foeniculum vulgare* L.) and lemon balm (*Melissa officinalis* L.) and so on.

In all of these species, though they are used more in the kitchen have been described compounds with anti-diabetic activity (Singh *et al.*, 2009). All of the mentioned plant species were described and recommended by authors in Journals all around the world before.

Written question about dosage, frequency of use and duration of use of plants, herbs, plants or of products thereof has considerable variance. For these issues, as well as in some previous points, it's a fact that not all respondents answered (a total of 34 responses).

Most patients 24%, respectively answered that they sometimes use plants, than about 20% referred the usage at least once a day, 17% of diabetic patients out of 30 who responded said use twice a day and 10% use 2x a week. A large number of respondents cited answers such as "variously" or "irregularly" ones were unified as "irregularly" and thus responded to a total of 7% of patients. These diabetic patients therefore tend to use complementary herbal treatment in the event of decompensating treatment or complications associated with it. 5% of patients reported using 1x a week and every other day and 3% written response "according to the manual." These diabetics thus tend to use supplementary herbal therapy in case of decompensating of treatment or complications associated with it.

Duration of usage was highly variable, because the answers were categorized into broader intervals.

Some patients also reported length, but specified that the usage is intermittently. Total number of respondents that answered to question was 30. Only short-term use, including up to 14 days, reported one male patients (3%).

Taking a short-term character is either due to the necessity of their compensation and at the completion or achievement as the use of a new product (often based on recommendations from either other patients of the forums or in the media). The other 3 male patients (10%) reported the usage of the plants supplement for their whole life.

Altogether, ten patients (30%) said then use that may be included in the category of 1-4 years. Also 30% of these patients (i.e., 9) reported the use of length contained in the interval 5-9 years. The second largest proportion of respondents, a quarter (8; 27%) reported use of long 10 years or more, some with a note that it was not a continuous use but as intermittently or irregularly in any given period. Although 4 respondents both genders said in response, "ongoing", which can be understood that the plants or crops with effect on diabetes-used since the beginning of the disease. The last group consists of patients who answered a "do not know" or "do not remember." Thus, responded to 12 people that weren't mentioned graphically.

The last question concerned about subjective feeling of the effects of plants supplements suitable for diabetic patients. It should be emphasized that this is not a clinical study to investigate the effect of different plant species, but only about mapping and obtain information on how patients themselves perceive the effects used plants, herbs, plants and natural products. There is also a necessary to distinguish a group of these products to those which are thanks to its nutritional composition suitable for food and those that have a biochemical effect, because the plants or crops for food assumption, are no significant changes in physiological values closely associated with diabetes, but their use due the composition related to compliance with the appropriate dietary regimen and as is shown in results; 38% of all respondents (15 responses) to this question was "any". This can be explained by the use of plants and crops as food or only as a spice flavored or where no assumption changes in physiological values, or the patients themselves do not follow the physiological parameters and do not recognized the changes. It should be emphasized that the use of these plants, if the patients themselves do

not comply with laid down dietary and therapeutic procedures cannot have an effect on the patients' health. But as it's evidenced by other patients, treatment can greatly help to partly improve the treatment. The total of 15% of diabetics (6) of the group has stated in response to the of use the plants or products has improved the glycaemia fluctuation, the other 10% of diabetics (4 responses) reported improvements in cholesterol, which is a very important factor observed in connection with glycemic control, as patients with diabetes are more likely to develop cardiovascular disease and complications associated with them than in the general population (Kannel and McGee, 1979).

Altogether, 20% of respondents (8 responses) answered an "improvement of glycated hemoglobin," which is one of the most important indicators of treatment and compensation the impairment when leads to reduction in the risk of late complications of diabetes (NASP, 2010).

10% reported (4 respondents) "other", the response was as "not know", "I cannot judge" but also "improve glucose", "low glycemic" and "just better to herself." The remaining 8% of the responses (i.e. 3 answers) were "less extreme glucose."

6 Conclusion

This diploma thesis has found out that from 207 respondents who completed the questionnaire and from which them 7 respondents were discharged because of not answering the basic questions, 162 was valuated. About 43% of them said that they use, have used or ever tried to use the plants or crops suitable for diabetics or products made from them.

On the other hand, unexperienced diabetic patients in plant species supplement represents 57% of the total amount. The first positive group with 86 respondents was further divided into three subgroups to diabetic patients that used and do not use (34%), did not use and use (9%), used and use (57%) the plants species. The precondition, why most of diabetic patients never used or do not use this option is the total lack of information of the respondents. In the case of a better grasp use of selected suitable plant species, could occur the extension of their usage.

For example, some crops suitable for diabetic patients must be privately cultivated because they are not available in regular shops or markets and even if they are, then for higher price.

The unavailability again reducing the overall awareness of these crops (yacon, Jerusalem artichokes). As can be seen from Table 3, diabetic patients have learned how to include less well-known Jerusalem artichokes in their diet instead of for example widened dandelion (*Taraxacum officinale*) or *Verbascum densiflorum*.

The use of yacon was mentioned only two respondents, however the crop is very suitable for diabetic patients. In Czech Republic it is grown as an annual plant, sensitive to frost which is problematic. The tubers are sensitive to damage. This makes it impossible in its commercial cultivation in temperate climatic zone and its release to the business networks. Another reason for non-utilization of plant natural potential is poor presentation or unloading effects.

So if someone expects "a miraculous healing", it is obvious that the position must be reconsidered. It is really pity that the number of patients would impoverish themselves in the opportunity to diversify the diet about non-traditional crops, spices and so on.

Based on the answers of respondents, we can assumed that variance of used herbs and plant species, within the prescribed therapy, is very wide. However the results, it would seem to be appropriate to carry out of research in a larger group of diabetic patients, especially focused on Type 2 diabetes for which the phytotherapy has greater importance.

Changes perceived by the patients themselves are very subjective and the question in the questionnaire in this thesis, which concerned an effect on diabetes, was about an indicative character. The usage of plants with active metabolites, depends on overall lifestyle and to its failure of anti- diabetic effects, are plant metabolites suppressed.

The pre-prepared products, May appeared to be more interesting for some patients because the often complicated and hardly understanding way of preparation of herbal decoction or the extracts which have a greater concentration of active ingredients, are eliminated.

Although, the final effectiveness of the plant supplement always depends on cooperation as the right drug dosage, regular physical activity, right diet and also caring about themselves is.

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8 Annexes

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Annex A: The questionnaire

Dotazník - Podpůrné prostředky u pacientů s diabetem

Dobrý den,

věnujte prosím několik minut svého času vyplnění následujícího dotazníku.

1. **Pohlaví**
   - ○ žena
   - ○ muž

2. **Místo bydliště - okres**

3. **Věk**

4. **Váha (kg)**

5. **Výška (cm)**

6. **Typ diabetu**
   - ○ Diabetes mellitus 1.typu
   - ○ Diabetes mellitus 2.typu
   - ○ Jiné (MODY, gestační...)

7. **Stupeň glykovaného hemoglobinu**
   - ○ Výborná kompenzace, do 4,5%
   - ○ Uspokojivá kompenzace, 4,5 - 6,0%
   - ○ Neuspokojivá kompenzace, nad 6,0%

8. Délka onemocnění

9. Druh léčby

- ○ Inzulín (inzulínová pumpa, pera, injekce)
- ○ Perorální antidiabetika
- ○ Kombinace

10. Vyhledával/a jste informace o přírodních podpůrných prostředcích ?

- ○ Ano
- ○ Ne

11. Používal/a jste někdy přírodní podpůrné prostředky ?

- ○ Ano
- ○ Ne

12. Používáte nějaké přírodní podpůrné prostředky ?

- ○ Ano
- ○ Ne

13. Kde jste se o nich dozvěděl/a ? (možné zaškrtnout více možností)

- ☐ Média (TV, noviny, ..)
- ☐ Internet
- ☐ Doporučení lekaře, známých,..
- ☐ Lékárna, nemocnice
- ☐ Ostatní (jaké?)

14. Proč jste začal/a používat přírodní preparáty ?

- ☐ Zlepšení diabetu
- ☐ Vyzkoušení něčeho nového
- ☐ Jiné zdravotní problémy
- ☐ Jiné (jaké?)

15. Jaké přírodní doplňky či preparáty používáte? (více možností)

- ☐ Čaje, výluhy, vývary
- ☐ Koření
- ☐ Listy rostlin
- ☐ Semena rostlin
- ☐ Plody rostlin
- ☐ Stonky, oddenky rostlin
- ☐ Kořeny rostlin
- ☐ Ostatní (jaké?)

16. Jakou rostlinu, bylinu, dřevinu apod. používáte nebo jste používal/a ?

- ☐ Borůvka, Brusnice borůvka, Vaccinium myrtillus
- ☐ Kopřiva dvoudomá, Urtica dioica
- ☐ Máta peprná, Mentha x piperitae
- ☐ Zázvor, Zingiber officinale
- ☐ Skořice, Cinnamomum cassia/zeylandicum
- ☐ Topinambura hlíznatá, Helianthus tuberosus
- ☐ Vavřín (bobkový list), Laurus nobilis
- ☐ Stévie cukrová, Stevia rebaudiana
- ☐ Kmín kořenný, Carum carvi
- ☐ Bazalka, Ocimum spp.
- ☐ Šalvěj lékařská, Salvia officinalis
- ☐ Aloe vera
- ☐ Čekanka obecná, Cichorium intybus
- ☐ Bez černý, Sambucus nigra
- ☐ Řepík lékařský, Agrimonia eupatoria
- ☐ Fazol obecný, Phaseolus vulgaris
- ☐ Ostropestřec mariánský, Silybum marianum
- ☐ Česnek, Allium sativum
- ☐ Pažitka pobřežní, Allium schoenoprasum
- ☐ Fenykl obecný, Foeniculum vulgare
- ☐ Len setý, Linum usitatissimum
- ☐ Heřmánek pravý, Matricaria recutita
- ☐ Meduňka lékařská, Melissa officinalis
- ☐ Pampeliška, Smetanka lékařská, Taraxacum officinale
- ☐ Brusinka, Brusnice brusinka, vaccinium vitis-idaea
- ☐ Jmelí bílé, Viscum album
- ☐ Cibule kuchyňská, Allium cepa
- ☐ Kmín římský, Cuminum cyminum
- ☐ Jinan dvoulaločný, Ginko biloba
- ☐ Rakytník řešetlákovitý, Hippophae rhamnoides
- ☐ Hluchavka, Lamium spp.
- ☐ Libeček lékařský, Levisticum officinale
- ☐ Hořká dýně, Momordica charantia
- ☐ Ženšen pravý, Panax gingsen
- ☐ Nové koření, Pimentovník pravý, Pimenta dioica
- ☐ Jitrocel kopinatý, Plantago lanceolata
- ☐ Hlíva ústřičná, Pleurotus ostreatus
- ☐ Růže šípková, Rosa canina
- ☐ Sezam indický, Sesamum indium
- ☐ Jakon, Smallamthus sonchifolius
- ☐ Zlatobýl obecný, Solidago virgaurea
- ☐ Divizna velkokvětá, Verbascum densiflorum
- ☐ Jiné - prosím vypište

17. Používáte, používal/a jste nějaké preparáty ? Prosím napište název produktu

18. Uveďte prosím způsob přípravy u rostliny, kterou používáte

19. Dávkování, četnost užívání:

20. Délka užívání:

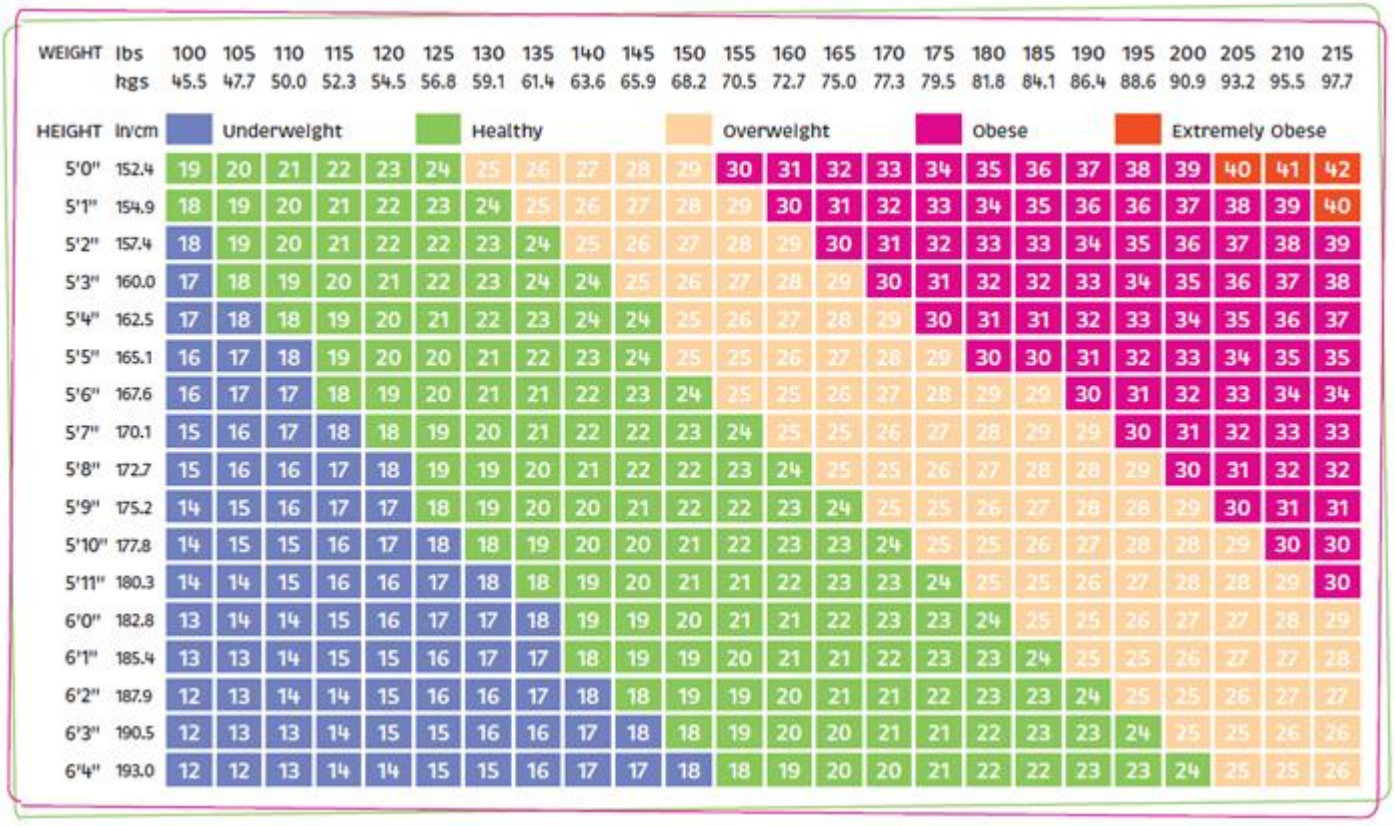
21. Cítil/a, či cítíte nějaké účinky nebo změny?

- ☐ Žádné
- ☐ Zlepšení glykovaného hemoglobinu
- ☐ Zlepšení hladiny cholesterolu
- ☐ Menší výkyvy glykemií
- ☐ Méně extrémních glykemií
- ☐ Jiné (prosím uveďte)

22. Máte nějaké speciální recepty na přírodní doplňky při léčbě diabetu? Pokud ano, prosím napište

Děkujeme za Vaše odpovědi a čas věnovaný vyplnění tohoto dotazníku.

Annex B: The table of BMI categories (Dietary guidelines, 2013)



WEIGHT	lbs	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215
	kgs	45.5	47.7	50.0	52.3	54.5	56.8	59.1	61.4	63.6	65.9	68.2	70.5	72.7	75.0	77.3	79.5	81.8	84.1	86.4	88.6	90.9	93.2	95.5	97.7
HEIGHT	in/cm	Underweight					Healthy						Overweight					Obese							Extremely Obese
5'0"	152.4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
5'1"	154.9	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	36	37	38	39	40
5'2"	157.4	18	19	20	21	22	22	23	24	25	26	27	28	29	30	31	32	33	33	34	35	36	37	38	39
5'3"	160.0	17	18	19	20	21	22	23	24	24	25	26	27	28	29	30	31	32	32	33	34	35	36	37	38
5'4"	162.5	17	18	18	19	20	21	22	23	24	24	25	26	27	28	29	30	31	31	32	33	34	35	36	37
5'5"	165.1	16	17	18	19	20	20	21	22	23	24	25	25	26	27	28	29	30	30	31	32	33	34	35	35
5'6"	167.6	16	17	17	18	19	20	21	21	22	23	24	25	25	26	27	28	29	29	30	31	32	33	34	34
5'7"	170.1	15	16	17	18	18	19	20	21	22	22	23	24	25	25	26	27	28	29	29	30	31	32	33	33
5'8"	172.7	15	16	16	17	18	19	19	20	21	22	22	23	24	25	25	26	27	28	28	29	30	31	32	32
5'9"	175.2	14	15	16	17	17	18	19	20	20	21	22	22	23	24	25	25	26	27	28	28	29	30	31	31
5'10"	177.8	14	15	15	16	17	18	18	19	20	20	21	22	23	23	24	25	25	26	27	28	28	29	30	30
5'11"	180.3	14	14	15	16	16	17	18	18	19	20	21	21	22	23	23	24	25	25	26	27	28	28	29	30
6'0"	182.8	13	14	14	15	16	17	17	18	19	19	20	21	21	22	23	23	24	25	25	26	27	27	28	29
6'1"	185.4	13	13	14	15	15	16	17	17	18	19	19	20	21	21	22	23	23	24	25	25	26	27	27	28
6'2"	187.9	12	13	14	14	15	16	16	17	18	18	19	19	20	21	21	22	23	23	24	25	25	26	27	27
6'3"	190.5	12	13	13	14	15	15	16	16	17	18	18	19	20	20	21	21	22	23	23	24	25	25	26	26
6'4"	193.0	12	12	13	14	14	15	15	16	17	17	18	18	19	20	20	21	22	22	23	23	24	25	25	26

Annex C: The list of anti-diabetic plants in Ayurveda medicine (Joseph B, 2011)

Plant name	Ayurvedic/common name/herbal formulation	Antidiabetic and other beneficial effects in traditional medicine	References
Annona squamosa	Sugar apple	Hypoglycemic and antihyperglycemic activities of ethanolic leaf-extract, Increased plasma insulin level	Kaleem *et al.* (2006) and Gupta *et al.* (2005a, b)
Artemisia pallens	Davana	Hypoglycemic, increases peripheral glucose utilization or inhibits glucose reabsorption	Subramoniam *et al.* (1996)
Areca catechu	Supari	Hypoglycemic	Chempakam (1993)
Beta vulgaris	Chukkander	Increases glucose tolerance in OGTT	Yoshikawa *et al.* (1996)
Boerhavia diffusa	Punarnava	Increase in hexokinase activity, decrease in glucose-6-Phosphatase and fructose bis-phosphatase activity, increase plasma insulin level, antioxidant	Pari and Satheesh (2004a,b) and Satheesh and Pari (2004)
Bombax ceiba	Semul	Hypoglycemic	Saleem *et al.* (1999)
Butea monosperma	Palasa	Antihyperglycemic	Somani *et al.* (2006)
Camellia sinensis	Tea	Anti-hyperglycemic activity, antioxidant	Gomes *et al.* (1995) Devasagayam *et al.* (1996)
Capparis decidua	Karir or Pinju	Hypoglycemic, antioxidant, hypolipidaemic	Agarwal and Chauhan (1988)
Caesalpinia bonducella	Sagarghota, Fevernut	Hypoglycemic, insulin secretagogue, hypolipidemic	Chakrabarti *et al.* (2003) and Sharma *et al.* (1997)
Coccinia indica	Bimb or Kanturi	Hypoglycemic	Kamble *et al.*, 1998
Emblica officinalis	Amla, Dhatriphala, aconstituent of herbal formulation, Triphala	Decreases lipid peroxidation, antioxidant, hypoglycemic	Bhattacharya *et al.* (1999), Kumar and Muller (1999 and Devasagayam *et al.* (1995)
Eugenia uniflora	Pitanga	Hypoglycemic, inhibits lipase activity	Arai *et al.* (1999)
Enicostema littorale	Krimihrita	Increase hexokinase activity, Decrease glucose 6-phosphatase and fructose 1,6 bisphosphatase activity. Dose dependent hypoglycemic activity	Maroo *et al.* (2003), Ravi *et al.* (2000) and Augusti *et al.* (1994)
Ficus bengalenesis	Bur	Hypoglycemic, antioxidant	
Gymnema sylvestre	Gudmar or Merasingi	Anti-hyperglycemic effect, hypolipidemic	Chattopadhyay (1999) and Preuss *et al.* (1998)
Hemidesmus indicus	Anantamul	Anti snake venom activity, anti-inflammatory	Alam and Gomes (1998)
Hibiscus rosa-sinesis	Gudhal or Jasson	Initiates insulin release from pancreatic beta cells	Sachadeva and Khemani (1999)
Ipomoea batatas	Ipomoea batatas	Reduces insulin resistance	Kusano and Abe (2000)
Momordica cymbalaria	Kadavanchi	Hypoglycemic, hypolipidemic	Nagaraju (1992) and Rao *et al.* (1999)
Momordica charantia	Bitter gourd	Hypoglycemic	Singh *et al.* (2008)
Murraya koenigii	Curry patta	Hypoglycemic, increases glycogenesis and decreases gluconeogenesis and glycogenolysis	Khan *et al.* (1995)
Musa sapientum	Banana	Antihyperglycemic, antioxidant	Dhanabal *et al.* (2005), Pari and Umamaheswari, (2000) and Pari and Maheswari (1999)

Annex D: The list of anti-diabetic plants in Indian medicine (Jeyachandran R, 2007)

Botanical name	Family	English	Vernacular	Parts of uses
Acacia catechu (Linn. f.) Willd.	Mimosaceae	Cutch tree	Karunkali	Heart wood
Acacia nilotica Linn.	Mimosaceae	Babul	Karuvelam	Gum
Acacia polyacantha Willd.	Mimosaceae	White catechu	Kovil	Heart wood
Aegle marmelos (Linn.) Corr.	Rutaceae	Bael tree	Vilvam	Leaves
Albizia odoratissima (Linn, f.) Benth	Mimosaceae	Black siris	Karuvakai	Bark
Alpinia calcarata Rose.	Zingiberaceae		Chittarattai	Rhizomes
Alpinia galangal (Linn.) Willd.	Zingiberaceae	Greater galangal	Perarattai	Rhizomes
Anogeissus latifolia (DC.) Wallich ex Beddome	Combretaceae	Axle wood	Vellanagai	Roots
Aphanamixis polystachya (Wall.) Parker	Meliaceae	Rohituka tree	Malampuluvan	Bark
Argyreia speciosa Sweet	Convolvulaceae	Elephant creeper	Samuttirappachai	Roots
Butea monosperma (Lam.) Taub.	Fabaceae	Bastard teak	Parasa	Bark
Caesalpinia bonduc (Linn.) Roxb.	Caesalpiniaceae	Fever nut	Kazhichikay	Seed
Caesalpinia sappan Linn.	Caesalpiniaceae	Sappan wood	Patungam	Heartwood
Callicarpa macrophylla Vahl	Verbenaceae	Priyamgu	Nalal	Flowers and Fruits
Cassia auriculata L.	Caesalpiniaceae	Tanner's cassia	Avaram	Flowers and Fruits
Cassia fistula L.	Caesalpiniaceae	Purging fistula	Konnai	Bark
Cassia occidentalis L.	Caesalpiniaceae	Negro coffee	Nattam takarai	Roots
Catharanthus roseus (L.) Don	Apocynaceae	Madagascar periwinkle	Sudukattu mallikai	Whole plant
Cedrus deodara (Roxb.) Don.	Pinaceae	Deodar	Tevataram	Heart wood
Ceiba pentandra (L.) Gaertner	Bombacaceae	White silk cotton tree	Ilavum	Root
Chonemorpha fragrans (Moon) Alston	Apocynaceae	-	-	Root
Coccinia indica Wight and Arn	Cucurbitaceae	Lvy gourd	Kovaikai	Root, leave, fruits
Commiphora candata (Wight and Arn) Engl.	Burseraceae	Hill-mango	Kiluvai	Root.
Coscinium fenestratum (Gaertn.) Colebr.	Menispermaceae	Tree turmeric	Maramanjal	Stem
Cressa cretica. L.	Convolvulaceae	-	Uppumarikkolunru	Whole plant
Cucumis trigonus Roxb.	Cucurbitaceae	Bitter gourd	Kattutummatti	Fruits
Dioscorea alata L.	Dioscoreaceae	Greater yam.	Perumvalli kizhangu	Tubers
Diospyros peregrina ((Gaertner) Guerkc	Ebenaceae	Gaub persimon	Kattatti	Bark
Ficus arnottiana Miq.	Moraceae	-	Kotiyarasu	Bark
Ficus benghalensis Linn.	Moraceae	Banyan	Alamaram	Bark
Ficus microcarpa Linn. f.	Moraceae	-	Kallicci	Bark, leaves
Ficus racemosa Linn.	Moraceae	Fig	Atti	Bark, root
Flacourtia jangomas Raeusch.	Flacourtiaceae	Puncala plum	Vaiyyankarai	Fruits
Gymnema zylvestre (Retz.) R. Br.	Asclepiadaceae	Periploca of the woods	Shirukurinja	Leaves
Helicteres isora Linn.	Sterculiaceae	East Indian s crew tree	Valampiri	Root
Holoptelea integrifolia (Roxb.) Planch.	Ulmaceae	Indian elm, Kanju	Avail	Bark and leaves
Hydnocarpus laurifolia (Dennst.) Sleumer	Flacourtiaceae	Marothi tree	Maravattai	Seeds and oil
Ichnocarpus frutescens (L.) R. Br.	Apocynaceae	-	Udarkkoti	Roots
Kyllinga monocephala Rottb.	Cyperaceae	-	Vellutta nirbasi	Tuber
Limonia acidissima W and A.	Rutaceae	Elephant apple	Vilankay maram	Gum
Ougeinia dalbergioides Benth.	Fabaceae	Sandan	Narivengai	Bark
Pandanus odoratissimus (L. f.)	Pandanaceae	Screw Pine	Talai	Root
Portulaca oleraceae L.	Portulacaceae	Common Purslane	Pulikkirai	Stem and Leaves
Premna corymbosa Rottler and Wild.	Verbenaceae	-	Munnai	Root
Pterocarpus marsupium Roxb.	Fabaceae	Indian Kino tree	Pirasaram	Heart wood
Rubia cordifolia Linn.	Rubiaceae	Indian madder	Manjitti	Root
Rotula aquatica Lour.	Boraginaceae	-	Seppunerinji	Root
Semecarpus anacardium L.f.	Anacardiaceae	Marking Nut tree	Serangottai	Fruits
Sphaeranthus indicus Linn.	Asteraceae	East Indian globe-thistle	Kottakkarand ai	Whole plant
Strychnos potatorum Linn. f.	Loganiaceae	Clearing nut tree	Tetankottai	Seeds
Syzygium cumini (Linn.) Skeels	Myrtaceae	Jambolan	Naval	Bark, Seeds
Terminalia arjuna W and A	Combretaceae	Arjun	Marudu	Bark
Terminalia paniculata Roth.	Combretaceae	Flowering Murdah	Pumarudu	Bark
Tinospora cordifolia (Willd.) Hook. F. and Thorns.	Menispermaceae	Gulancha tinospora	Cintilikkoti	Stem
Tragia involucrate Linn.	Euphorbiaceae	Indian stinging-nettle	Kannichi	Root
Woodfordia fruticosa (Linn.) Kurz	Lythraceae	Fire-flame bush	Velakkai	Flowers
Zanthoxylum armatum DC.	Rutaceae	Toothache tree	Tumpunalu	Bark and Fruits

Formula 1: Formula of Body Mass Index

(Source: My own research)

$$\text{BMI} = \frac{\text{mass(kg)}}{(\text{height(m)})^2}$$

Table 5: Categories of Body Mass Index and its risk of health problems, BMI number gives the classification and belonging risk of developing health problems

(Source: WHO,1997.)

Body Mass Index (BMI) Categories		
Classification	**BMI Category (kg/m2)**	**Risk of developing health problems**
Underweight	< 18.5	Increased
Normal Weight	18.5 - 24.9	Least
Overweight	25.0 - 29.9	Increased
Obese class I	30.0 - 34.9	High
Obese class II	35.0 - 39.9	Very High
Obese class II	> = 40.0	Extremely high

Table 6: The list of Authors that has been given the plant species recommendation

(Source: authors own research)

LATIN NAME	**AUTHOR**
***Cannabis sativa* L.**	Comelli *et al.,* 2009; Fisher *et al.,* 2010.
***Carum carvi* L.**	Sadiq *et al.,* 2010; Tahraoui *et al.,* 2007.
Cinnamomum cassia* (L.) J.Presl / *zeylandicum	Verspohl *et al.,* 2005.
***Coriandrum sativum* L.**	Gray A, 1999; Waheed A, 2006.
***Crocus sativus* L.**	Mohajeri D, 2008; Samphatu *et al.,* 2009.
***Foeniculum vulgare* Mill.**	Eddouks *et al.,* 2002.
***Helianthus tuberosus* L.**	Bae *et al.,* 2010; Kays *et al.,* 2007.
***Hypericum perforatum* subsp. *chinense* N.Robson**	Zou *et al.,* 2004; Arokiyaraj *et al.,* 2011.
***Laurus nobilis* L.**	Aljamal A, 2011.
***Melissa officinalis* L.**	Chung *et al.,* 2010.
***Mentha x piperita* L.**	Büyükbalci A, 2008; Aguilara *et al.,* 1998.
Ocimum spp.	Tahraoui *et al.,* 2007.
***Origanum majorana* L.**	Tahraoui *et al.,* 2007; Lemhadri *et al.,* 2004.
***Salvia officinalis* L.**	Eidi *et al.,* 2009; Behradmanesh *et al.,* 2013.
***Stevia rebaudiana* (Bertoni) Bertoni**	Shivanna *et al.,* 2012.
***Urtica dioica* L.**	Bnouham *et al.,* 2003.
***Vaccinium myrtillus* L.**	Cignarella *et al.,* 1996; Upton *et al.,* 2001; Stull *et al.,* 2010.
***Zingiber officinale* Roscoe**	Akhani *et al.,* 2010.