Chemical Analysis and Effect of Fenugreek and Cinnamon Mixture Treatment on Blood Glucose Level for some Type 2 Diabetic Patients, Gezira State, Sudan

By

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Date of Examination: 7/8/2012
Dedication

To …

The Kindness of a lovely person …. Who assists and supports me on my way to knowledge. My Mother Monnera Mohammed Al-Ameen.
That gentleman who tries to give kind, help and happiness to my life.
My Father ….
To my Brother and Sisters …
With much love …
My friends who share with me nice times and show me what friendship means
With much love …
Acknowledgements

Thanks to Allah for his mercy and help without which I could not complete this work.

I express my deepest thanks and gratitude to my supervisor Prof. Dr. Sirelkhatim B. Elhardallou, who stands beside me by his advices, time, efforts and support to bring out this research.

Thanks are also due to my dear father who contributed to this work.

Special thanks are extended to Ustaz Manal Abasher for her unlimited help and moral support.

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Great thanks to all patients who contributed in this work.
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ABSTRACT

The disease of diabetes mellitus as an ancient one, is well known all over the world. Now a day it became widely spread over many countries of the world, including Sudan. It is obvious that, the treatment of diabetes mellitus disease is how to control the blood glucose level. This is through the medical drugs in the modern medicine, also there are many natural materials which have effective role in lowering blood glucose level. This study aimed to know the lowering effect of fenugreek – cinnamon mixture on blood glucose level. It was carried at Wad Medani, Abu Agla center for diabetes, by selecting randomly 23 diabetic patients' type 2. Blood glucose was measured for all the 23 patients. The period of study was 3 weeks during this period patient were treated at the beginning of the 2nd week with fenugreek – cinnamon mixture powder for 2 weeks by giving them 14 small plastic bags each one containing 8 g (4 g of fenugreek, 4 g of cinnamon), to consume 8 g per day. Blood glucose was measured 3 times (at the end of every week). By analyzing results of blood glucose it was noted that the mixture has a considerable role in lowering blood glucose level by 22.88 %. Also this study investigated the proximate analysis of fenugreek - cinnamon mixture powder. Showed that the amount of moisture, protein, ash, fat, and fiber was found 5.74, 13.56, 3.69, 12.28 and 9.22%, respectively. According to this result it is important to recommend for diabetic patients by the useful effect of this mixture. Also this study should be distributed through food research centers and health centers studies for more benefits.
التحليل الكيميائي ل الخليط الحلبية و القرفة وأثره على مستوي الجلكوز في الدم لبعض مرضى السكري النوع الثاني بولاية الجزيرة، السودان.

رفيدة فتح الرحمن علي مصطفي

ماجستير علوم و تكنولوجيا الأغذية (أغسطس 2012)

قسم علوم و تكنولوجيا الأغذية
كلية الهندسة و التكنولوجيا
جامعة الجزيرة

خلاصة البحث

مرض السكري يعتبر من الأمراض المعروفة منذ القدم إلا أنه أصبح الآن منتشرًا في دول العالم و من بينها السودان. من المعروف أن مفهوم معالجة السكري هو كيفية التحكم في مستوي الجلكوز في الدم عن طريق الأدوية الطبية في الطب الحديث. كما أن هناك العديد من المواد الطبيعية التي لها دور مؤثر في تخفيض مستويات الجلكوز في الدم (من بينها الحلبة و القرفة). هدفت هذه الدراسة إلى التعرف على تأثير مخلوط الحلبة و القرفة في خفض مستوي الجلكوز الدم. أجريت هذه الدراسة في مدينة ود مدني بمركز أبو عاقلة للسكري، وشملت ثلاثة و عشرين مريضاً (ذكور و إناث) من النوع الثاني تم اختيارهم عشوائيًا. فتره الدراسة كانت ثلاثية أسابيع حيث تم فيها معاملة المرضى في بداية الأسبوع الثاني بمخلوط مسحوقي الحلبة و القرفة لفتره إسبوعين بإعطائهم أربعة عشر عبوة بلاستيكيه صغيرة يحتوي كل منها علي 8 جرام من مخلوط الحلبة و القرفة لإستهلاك 8 جرام في اليوم. تم قياس جلوكوز الدم ثلاث مرات (عند نهاية كل اسبوع). عند تحليل عينات الدم أثبتت النتائج أن مخلوط (القرفة و الحلبة) له دور معنوي في تخفيض نسبة الجلكوز في الدم 22.88% بعد معاملة المرضى بالمكو. أيضاً، هذه الدراسة اختبرت التحليل التكويني لمخلوط مسحوقي الحلبة و القرفة لتحديد كمية الدهون، البروتين، الرماد، الدهون، والالياف. وقد وجد أن النتائج 5.74, 13.65, 3.69, 12.28 و 9.22% على التوالي. أوصت الدراسة مرضى السكري بالتأثير المفيد لمخلوط الحلبة و القرفة كما يجب نشر هذه الدراسة علي مراكز أبحاث الأغذية و المراكز الصحية للإستفادة منها.
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CHAPTER ONE

1 INTRODUCTION

Fenugreek is a herb that is native to southern Europe. It was originally used by Greek farmers as forage for livestock, according to Michael Castleman, author of "The New Healing Herbs." The seeds and leaves of this herb may also offer medicinal benefits. The chemicals contained in the leaves and seeds may help to lower blood glucose, which may relieve fatigue, confusion, dizziness and headaches associated with diabetes (Pearson, 2011).

Fenugreek seed is commonly used for seasoning purpose and used as ingredient of curry powder and sauces. Fenugreks increase the appetite for food. Cures body weakness and many chest diseases. (Abuzied1986, and Rosengraten1969) found that the seed when soaked in water produced shooting mucilage, which aid digestion. It's still employed today in Indian and Ethiopian medicine as a tonic for gastric troubles. Study done in Europe, demonstrated that 4-hydroxyisoleucine which is an amino acid extracted from fenugreek seeds has shown in vitro increase in insulin secretion (Broca, et al., 1999).

Cinnamon has a long history both as spice and medicine. It is the brown bark of cinnamon tree which is available in its dried tubular form known as quill or as ground powder.

Cinnamon essential oil enhanced insulin sensitivity in Zucker fatty rats (Talpur, et al., 2005) and, recently, in db/db mice, anti-diabetic effects of cinnamon extracts on blood glucose were observed in relation with
improved insulin sensitivity (Kim, et al., 2006). In patients with diabetes, cinnamon extracts have been reported to have beneficial effects in reducing fasting plasma glucose (Mang, et al., 2006, Khan, et al., 2003).

The oil contain active components called cinnamaldehyde, cinnamyl acetate and cinnamyl alcohol, plus a wide range of other volatile substances, also its content some tannins. (Fawze, 1987).

A systematic review of research indicates that cinnamon may reduce fasting blood sugar, but does not have an effect on hemoglobin A1C, a biological marker of long-term diabetes. (Dugoua, et al., 2007).

1.1 Objective:
1. To investigate the effect of fenugreek- cinnamon mixture treatment on glucose level for some diabetic type 2 patients.

2. Compositions of (fenugreek – cinnamon) mixture in comparison with separate fenugreek and cinnamon analysis.
CHAPTER TWO

2 LITERATURE REVIEW

2.1 Fenugreek:

Fenugreek, (*Trigonella foenum graceum* L.), is an erect annual herb native to Southern Europe and Asia. Undoubtedly one of the oldest cultivated medical plants. Fenugreek is widely grown today in the Mediterranean countries, Argentina, France, India, North Africa and the United States as a food, condiment, dye and forage plant. The plant reaches height of 0.3 to 0.8 meters and has trifoliate leaves; white flowers appear in early summer and develop into long, slender yellow-brown pods containing the brown seeds.

The reported life zone of fenugreek is 8 to 27 degrees centigrade with annual precipitation of 40 to 150 mm and a soil pH of 5.3 to 8.

The plant thrives in full sun on rich, well-drained soils. Growth is slow and weak in cold temperature and wet soils. As a leguminous plant fenugreek needs little of any nitrogen. There is considerable commercial interest in breeding and growing fenugreek.

In Sudan fenugreek seeds are grown mainly in the northern part of the country whereby the prevalent environmental conditions are favorable. The Sudanese fenugreek seeds were reported to have different sizes, shapes and seed color. Serpukhova (1943) classified fenugreek seeds into three classes according to shape, size and color.

There are many local names for fenugreek (Fazli, and Hardman, 1986). It is known as "hilba" in Arabic speaking countries, in India and Pakistan as "methi" in Ethiopia as "abish" in Persia "shamlit", in Armenia as
"shambala" in Azerbaijan as "kilbe" and in Russia as "Pazkitic". The German name is Bockhorns klover.

Diosgenin, a steroid sapogenin found in fenugreek but currently isolated from Dioscorea species, is the starting compound over 60% of the total steroid production by the pharmaceutical industry. Other sapogenins found in fenugreek seed include yamogenin, gitogenin, tigogenin, and netigogens. Other constituents of fenugreek include mucilage, bitter fixed oil, volatile oil, the alkaloids choline and trigonelline. Extract of fenugreek is obtained by alcoholic extraction.

The aroma and flavor of fenugreek has led to its uses in many baked goods, chutneys, confection, and imitation maple syrup for culinary purpose, seeds are ground and used in curries.

Young seedlings and other portions of fresh plant materials are eaten as vegetables. The plant is quite nutritious; being high in proteins, ascorbic acid, niacin and potassium. Fenugreek is also used as livestock feed.

As medicinal plant, fenugreek has traditionally been considered as carminative, demulcent, expectorant and laxative. The plant has also been employed against bronchitis, fevers, sore throats, wound swollen glands, skin irritation, diabetes, ulcers and in the treatment of cancer. Fenugreek has been used to promote lactation and as an aphrodisiac. Fenugreek seeds and seed extracts have been reported to lower blood glucose levels in laboratory animals. (Sharoma, 1986).

Botanical: *Foenum - graecum* (LINN).

Family: N.O. Leguminosae - Fabaceae (bean family).

Synonyms: Birds foot - Greek - hayseed.

Habitat and origin:

Endogenous to the countries on the eastern shores of the

**Sensorial quality:** Bitter and aromatic.

### 2.1.1 Used plant parts:

Seeds - the brownish-yellow seeds of rhombic shape (about 3 mm). Indians also like the fresh leaves which are eaten as a very tasty vegetable.

### 2.1.2 Etymology:

Trigonella is latinized diminutive Greek (trigonon-triangle) refers to the small, Three - corner flowers. The Latin species name *foenum graceum* means (Greek hay) the dried plant (leaves or the seeds) indeed exterminates strong hay- like scent.

### 2.1.3 Plant description:

There are about 70-75 species of fenugreek, herbs, annual erect plant with taproots system with nodules. The stem is erect could reach up to 50 cm in height. Leaves consist of 3 foliate toothed leaflets with pinnate venation. Stipules are present in the petiole. Flowers are yellow, blue or white in color, short raceme originate from the axel of the leaf. Bracts are minute. Calyx tube is short, loops ovate about as long as calyx tube. Petals are free from the staminal tube. The standard is ovate or oblong, narrowed in to a broad claw. Wings are oblong, eared, clawed and keel is oblong claw. Stamens are free or connected with uniform anther, ovary sessile or short stalked with few or many ovules. Pods are variable oblong or linear compressed or thick. Seeds 2.5 - 6 mm long, 4 mm wide and about 2 mm thick oblong or square dark brown in color. Members of this genus are native to the Mediterranean areas. They are widely distributed from Canary
Island to near east and from south western Asia and India. Isolated representatives appear in Australia and South Africa.

2.1.4 The Constituent:
Fenugreek seed contains 24-32% protein, 12% fibers, 9% lipids, 49% carbohydrates, as well as minerals like phosphorus, calcium, iron, and alkaloid like trigonelline, mucilage, saponin, nicotinic acid, bitter extract, a yellow coloring matter, also the seeds contain vitamin A and C, flavones glycoside (Copreet et al., 1982)

2.1.5 The environmental circumstances:
Fenugreek is one of the plants that have the ability to adapt to different environmental circumstances, because it can tolerate drought, water stress and high and low temperatures. The fenugreek is a winter plant which has a short light period and low temperatures. The fenugreek can be cultivated in many types of soils and it tolerates the salinity. Some species thrive in loam soils. All species grow best in well-drained soils in areas receiving 50-150 mm of rain fall.

2.1.6 Chemical composition of Fenugreek seed:
(Suleiman, A, E, 1995) determined the chemical composition of 2 types of fenugreek seeds namely Sudanese and Ethiopian. The results are shown in Table (2.1), and Sharoma (1986) determined the chemical composition of fenugreek seeds (whole and ether-extract seeds). The results are shown in Table (2.2).
Table (2.1): chemical compositions* of Sudanese and Ethiopian Fenugreek seeds:

<table>
<thead>
<tr>
<th>Component</th>
<th>Moisture %</th>
<th>Protein %</th>
<th>Oil %</th>
<th>Crude fiber %</th>
<th>Mucilage %</th>
<th>Ash %</th>
<th>Total sugars %</th>
<th>Reducing sugars %</th>
<th>Starch %</th>
<th>Total carbohydrates %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudanese</td>
<td>7.7 ± 0.1</td>
<td>25.5 ± 0.07</td>
<td>8.04 ± 0.1</td>
<td>9.8 ± 0.14</td>
<td>23.5 ± 0.04</td>
<td>4.4 ± 0.1</td>
<td>1.8 ± 0.1</td>
<td>0.2 ± 0.10</td>
<td>40.43 ± 0.1</td>
<td>42.43 ± 0.2</td>
</tr>
<tr>
<td>Ethiopian</td>
<td>8.4 ± 0.08</td>
<td>26.4 ± 0.04</td>
<td>9.1 ± 0.1</td>
<td>10.0 ± 0.13</td>
<td>22.6 ± 0.1</td>
<td>4.6 ± 0.7</td>
<td>2.1 ± 0.04</td>
<td>0.2 ± 0.04</td>
<td>38.5 ± 0.1</td>
<td>40.8 ± 0.1</td>
</tr>
</tbody>
</table>

* Results are reported as means of triplicate determination.

(Suleiman, A, E, 1995) found that there were some variations in chemical composition and he attributed this variation to one or more of the following:
- Environmental conditions
- Time of harvesting
- Storage conditions

Table (2.2) Composition of fenugreek seeds:

<table>
<thead>
<tr>
<th>Component</th>
<th>Whole</th>
<th>Ether extract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture %</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Ash %</td>
<td>3.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Lipids%</td>
<td>8.0</td>
<td>Negligible</td>
</tr>
<tr>
<td>Protein%</td>
<td>26.0</td>
<td>28.3</td>
</tr>
<tr>
<td>Total fiber%</td>
<td>48.0</td>
<td>51.7</td>
</tr>
<tr>
<td>Gum %</td>
<td>20.0</td>
<td>19.2</td>
</tr>
<tr>
<td>NDF*</td>
<td>28.0</td>
<td>32.5</td>
</tr>
</tbody>
</table>

* Neutral detergent fiber (Sharoma, 1986)
2.1.7 Fenugreek Protein:

Proteins are the most important constituents of the body and for growth and maintenance, proteins play a large part in the organoleptic properties in food (Rhodes, *et al.*, 1963). Protein exerts a controlling influence on texture of food. Proteins often occur in food in physical or chemical combination with carbohydrate or lipids. During heating (boiling, baking or roasting), the amino acid side chain is degraded or interact with other food components. Most proteins are readily denatured by wide variety of reagents and conditions. Recently fenugreek plant has attracted some interest specially the seed as a good source of good quality protein.

Protein deficiency and protein energy malnutrition (PEM) are considerably increasing worldwide. The value of 27% protein fraction (globulin, albumin, and nucleoprotein) of which amino acid composition was particularly established. Wunschendorff (1919), found that fenugreek seeds contain about 26.67% crude protein of which 25.2% are utilizable protein. The protein content of the seeds range from 22-27% as reported by several workers. The protein content of fenugreek similar to other leguminous proteins such as soya bean (Kolousek and Coulson, 1955 Jamalinan and Pellof, 1968, Elmadfa and Khul1976, Sauvaire*et al.*, 1976).

Fenugreek was found to be a good supplement foe cereal because of its high lysine and tryptophan contents (Tolwalker and Patel, 1970 Elmadfa, 1976).

Jamalian and Pellof (1968) showed that the protein of fenugreek is very similar in its composition to other leguminous proteins. Nour and Magboul, 1986) determined amino acid composition in Sudanese fenugreek seed protein as shown in table (3) bellow:
Table (2.3): amino acid composition of fenugreek seeds protein.

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>Content mg/g</th>
<th>Amino Acid</th>
<th>Content mg/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysine</td>
<td>57.4</td>
<td>Histidine</td>
<td>19.6</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>38.5</td>
<td>Tyrosine</td>
<td>24.5</td>
</tr>
<tr>
<td>Leucine</td>
<td>53.5</td>
<td>Alanine</td>
<td>29.7</td>
</tr>
<tr>
<td>Methionine</td>
<td>50.6</td>
<td>Aspartic acid</td>
<td>32.2</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>58.0</td>
<td>Proline</td>
<td>32.1</td>
</tr>
<tr>
<td>Threonine</td>
<td>26.6</td>
<td>Serine</td>
<td>35.5</td>
</tr>
<tr>
<td>Valine</td>
<td>50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source {Nour and Magboul 1986}.

The solubility of protein depends on the number of polar (hydrophilic) and non polar (hydrophobic) groups. Wunschendorff(1919) separated the different proteins as globulin (16.8%) albumin (5.4%) and nucleoprotein (14.8). The prolamine is stable in hot (70%) alcohol. Basha and Hassan (1932) and other workers noted the low content of basic nitrogen and high content of cystine and tryptophan in isolated fenugreek seed prolamine. (Elkady et al., 1984) reported that the fenugreek seed had high protein content (26.4%) but of low digestibility (32%) due to high content of anti-nutritive factors which do not seem to be concentrated in distinct parts of seed. EL-Mahadi (1985), found that 64% of fenugreek seed protein was digestible by pepsin-pancreatic enzyme while only 55% of seed protein were found digestible by pepsin enzyme (Abd-Ala and Rahama, 1986). Reported that in-vitro digestibility of Sudanese fenugreek seed protein by pepsin-pancreatic system ranged from 79.9% to 85.9%.
2.1.8 Fenugreek Mucilage:

Mucilage is a substance, which give a viscous mucilaginous solution. Fenugreek gums was reported to be similar to Guar gum in composition and properties (Sharoma1986) the mucilage on hydrolysis with dilute acid gave galactose and mannose residue.

2.1.9 Importance of mucilage:

There are many important uses of mucilage including:

i. Effect of mucilage in controlling hyperglycemia: High carbohydrate diet have been found to be effective in controlling hyperglycemia (Kichm, et al., 1976). Studies were carried out with purified form of vegetables like quar gum, pectin's etc… and this approach controls elevated glucose levels. Moreover, the incidence of non-insulin diabetes mellitus, which is usually associated with obesity, can be controlled. (Shorma, 1986), reported that the presence of gum in the intestine appears to retard the digestion and absorption of carbohydrate and utterly pattern the peak of glucose flow into blood stream that normally follows a carbohydrate rich meals.

ii. Hyocholesterolemic effect of mucilage:

During the last few years, considerable interest has been developed regardin the role of dietary fiber from different sources in reducing the serum cholesterol in hyper choleserolemic condition (Sharoma, 1984).

iii. Other benefits of mucilage:

Mucilage may be used in composition of medical tablets and capsules because is prevents moisture absorbance and hence increases shelf-live of these pharmaceutical products. Also the mucilage might well be used in the textile, printing, and painting industries. It has been reported to possess
swelling properties and it may well find applications in industries such as starch, agar, pectin and gelation. Mucilage is often used at quite low concentrations to smoothen the texture of products such as ice-cream.

2.1.10 Fenugreek seed sapogenin:

Suleiman and Mustafa (1945) reported the presence of steroidal sapogenin in fenugreek. Nour (1991), reported sapogenin in fenugreek seed. Diosgenin is starting material of choice for pharmaceutical industry. Sudanese fenugreek seed is promising as a commercial source of sapogenin mostly diosgein and yamogenin (Nour, 1991).

2.1.11 Fenugreek alkaloids:

It was reported that fenugreek seed is trigoneline in general they do not seem to be important in plant nutrition or development and their main role is ecological.

2.1.12 Benefits and uses:

Fenugreek seed is commonly used for seasoning purpose and use as an ingredient of curry powder and sauces. The peak edges of fenugreek can be eaten; also the fresh leaves and germinated seeds can be eaten. Fenugreek increases the appetite for food. Cures body weakness and many chest diseases. (Abuzied, 1986, and Rosengraten1969) found that the seed when soaked in water produced shooting mucilage, which aid digestion. It’s still employed today in Indian and Ethiopian medicine as a tonic for gastric troubles.

In Sudan the seeds have many uses especially in folk medicine. Whole seed are swallowed as anti- acids and against dysentery, stomach disturbances and diarrhea. A special porridge (Hilba – porridge) is made
from wheat flour and ground fenugreek seeds are added with or without milk, regarded as a good food for fattening woman and used by lactation women in a form of thin porridge (Gorafi, 1983).

2.1.13 Clinical studies in diabetes:

Improvement of blood sugar control and lipid in type 1 patients:

Fenugreek seed powder 20 gm per day for 10 days reduced fasting blood sugar improved the glucose excretion and reduced total cholesterol in a placebo. (Sharoma, 1990).

The addition of fenugreek seeds powder (15 gm) and soybean dietary fiber significantly reduced the subsequent post prandial glucose level in type 2 diabetic patients (Modar, 1987; Modar 1988).

Study done in Europe demonstrated that 4-hydroxyisoleucine which is an amino acid extracted from fenugreek seeds has been shown in vitro increase insulin secretion (Broca et al 1999). The study has shown the amino acid effect in vivo on rats and dogs. It reduced the hyperglycemia and improved the glucose tolerance in non insulin dependent diabetic (NIDD), putting in mind that rat model having major features of human type 2 diabetes.

2.1.14 Benefit in diabetes: Blood sugar control:

Whole seeds or seeds powder is clinically shown to have benefit in diabetes management.

Daily dose of at least 15 gm whole or powder seed is recommended by most clinical studies.

Some studies have also shown a 2.5 gm dose twice a day for 30 days to be effective (Bordia, et al, 1997).
2.2 Cinnamon:

Cinnamon is a spice obtained from the inner bark of several trees from the genus Cinnamomum which belong to Lauraceae family, cinnamon has dark brown colour and astringent taste. It is used in both sweet and savoury, (Fawze, 1987).

2.2.1 Origin:

The origin of the genus cinnamon is South East Asia. Wild species are found in Equatoria in Africa and some other countries. The main producers of cinnamon bark and oil are China, Tanzania, Kenya Argentina, (Alshahat, 1992).

2.2.2 Species:
A number of species are often sold as cinnamon

- Cinnamomum verum (true cinnamon, srilanka cinnamon or Ceylon cinnamon).
- C. buramanii (korintje of Indonesian cinnamon).
- C. loureiroi (Saigon cinnamon or Vietnamese cinnamon).
- C. aromaticum (Cassia or Chinese cinnamon).

2.2.3 Botany:

The genus cinnamon is large and ever-green tree more than 40 m in height, with strong and condenses branching. Stem diameter ranges between 0.5 m – 2.0 m in thickness and the bark is reddish. Leaves are leathery in appearance, opposite, simple, oval or oval rectangular in shape. The newly formed leaves are reddish green while the mature one is dark green in the upper surface and brighter the lower surface.
Flowers are white or white greenish, small in size. Fruits are rounded, smaller and with many rounded seeds, (Alshahat, 1992).

2.2.4 Chemical characteristics:

The volatile oil of leaves and bark are different in their natural character in different cinnamon species. Ceylon cinnamon contains about 1.4% volatile oil in bark. This volatile oil formed mainly from cinnamic aldehyde, but Chinese cinnamon content about 2% from it, (Fawze, 1987).

In a study carried by Department of Food Sciences and Nutrition – College of Food and Agricultural Sciences – King Saud University in 2007 determined chemical composition of 2 types of cinnamon: Srilankan cinnamon (*Cinnamon zeyalnicum*) and Chinese cinnamon (*Cinnamomum cassia*) the result are shown in Table (2.4) and Table (2.5).

**Table (2.4): Proximate composition or Srilankan and Chinese cinnamon bark (g 100g⁻¹).**

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Srilankan Cinnamon</th>
<th>Chinese cinnamon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>9.45 ± 0.14 %</td>
<td>7.70 ± 0.15 %</td>
</tr>
<tr>
<td>Protein</td>
<td>4.99 ± 0.10 %</td>
<td>4.10 ± 0.09 %</td>
</tr>
<tr>
<td>Fat</td>
<td>4.69 ± 0.12 %</td>
<td>4.65 ± 0.10 %</td>
</tr>
<tr>
<td>Ash</td>
<td>3.77 ± 0.10 %</td>
<td>2.89 ± 0.09 %</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>21.27 ± 0.09 %</td>
<td>33.41 ± 1.15 %</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>55.83 ± 0.09 %</td>
<td>1.24 ± 47.25 %</td>
</tr>
<tr>
<td>Metabolic energy (Kcal 100g⁻¹)</td>
<td>285.49 ± 0.9%</td>
<td>3.80 ± 247.25</td>
</tr>
</tbody>
</table>

Values are the mean of three replicates (Ahmed, et al, 2007)
Table (2.5): Mineral content of Srilankan cinnamon and Chinese and cinnamon bark (mg 100g⁻¹)

<table>
<thead>
<tr>
<th>Macromolecule:</th>
<th>Srilankan cinnamon</th>
<th>Chinese cinnamon</th>
</tr>
</thead>
<tbody>
<tr>
<td>(mg/100g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>690.01 ± 14.37</td>
<td>1157.36 ± 14.37</td>
</tr>
<tr>
<td>Magnesium</td>
<td>60.71 ± 1.83</td>
<td>74.89 ± 8.88</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>62.10 ± 4.23</td>
<td>66.31 ± 7.90</td>
</tr>
<tr>
<td>Sodium</td>
<td>72.64 ± 1.49</td>
<td>18.76 ± 0.20</td>
</tr>
<tr>
<td>Potassium</td>
<td>381.67 ± 4.73</td>
<td>197.00 ± 9.32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Micromolecule:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>10.37±1.33</td>
<td>2.74±0.35</td>
</tr>
<tr>
<td>Copper</td>
<td>0.65±0.06</td>
<td>0.41±0.05</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.33±0.05</td>
<td>0.35±0.04</td>
</tr>
</tbody>
</table>

Values are the mean of three replicates (Ahmed, et al, 2007)

2.2.5 Environmental requirements:

Cinnamon trees are considered as important tropical and subtropical plants. Temperature ranges between 25 – 40c and with relative humidity of 65 – 85% throughout the year. It does not grow well in temperate and cooled areas, because it requires high temperature during the long summer. Also it does not tolerate a dry climate.

It grows on mountains (200 – 500 m) above sea level, if the relative humidity and rain fall (100 – 150 cm) is available,(Ashahat,1993).
2.2.6 Harvesting:

Leaves and stem bark are collected when the tree is 4.5 – 5 years old, with branches diameter 1.5 - 3 cm and the tree height ranging 3 – 3.5 or 3.0 m when the tree is 2.0 – 3.5 years old. The long stems are cutted in spring season to facilitate pulling-off the bark and to obtain leaves and new growth with high oil quality and terpinene compounds.

Cutted branches are carried directly to a prepared for collecting leaves and new growing parts, with pulling-off the bark from the thick branches.

The bark is prepared by making longitudinal cracks on fresh stem cortex after pulling the leaves and new branches, and then the bark is pulled manually.

The bark is collected in form of package, and covered by layer of plastic. It is left in dark places for one day or more to get rid of green stains from the stem epidermis. Then cut into long parts (15 – 20 cm). The bark strips are put on each other and twisted strongly to become in a cylinder or tube form, 40 – 50 in length, then left in a shaded place for drying.

During drying the cylinder tubes should be twisted and rounded with low pressure to increase solidity and become bright brown in color. When a characteristic distinct aromatic perfume of cinnamon bark appeared/ it is packed ranging between 20 – 25 kg dried substances per each tree. The thickness of each segment range between 0.3 – 0.5 cm the quantity increase when the tree age increase, reaching 60 – 90 kg after 6 – 9 years, and the production dedine after 10 – 20 years and they should be planted in a new areas,(Alshahat,1992).
2.2.7 Uses and Benefits of Cinnamon:

Cinnamon bark is widely used as a spice, it is principally employed in cookery as a condiment and flavoring material. It is used in the preparation of chocolate, sweet dishes and drinks cinnamon bark is one of the few spice that can be consumed directly (Fawze, 1987).

Cinnamon bark powder used in pastries manufacturing to give it the distinct flavor and taste. Useful drinks for heart, rhematism curing, renal disorder and it are useful in stopping diarrhea, cold and in general nutrition.

Leaves and bark oil used to give flavor and taste in food industry mainly in sweet, pastries, milk and meat production. Medically, the oil is used in stomach disorder and to get rid of gases also the oil is used in liquid and dried cosmetics, disinfecting and curing teeth.

Good oil is used in manufacturing perfumes, soaps, creams and high quality alcoholic and non-alcoholic drinks.

Recently, cinnamon oil products are used in manufacturing sensitive photographic films, mobile films, drugs and disinfectants, (Alshahat, 1992).

2.2.8 Cinnamon and blood sugar control:

Cinnamon may also significantly help people with type 2 diabetes improve their ability to respond to insulin, thus normalizing their blood sugar levels. Both test tube and animal studies have shown that compounds in cinnamon not only stimulate insulin receptors, but also inhibit an enzyme that inactivates them, thus significantly increasing cells' ability to use glucose. Studies to confirm cinnamon's beneficial actions in humans are currently underway with the most recent report coming from researchers from the US Agricultural Research Service, who have shown that less than
half a teaspoon per day of cinnamon reduces blood sugar levels in persons with type 2 diabetes

In the dietary antioxidant group, polyphenols from cinnamon could be of special interest in people that are overweight with impaired fasting glucose since they might act both as insulin sensitizers and antioxidants. Aqueous extracts from cinnamon have been shown to increase \textit{in vitro} glucose uptake and glycogen synthesis, increase phosphorylation of the insulin receptor and likely help trigger the insulin cascade system (Imparl-Radosevich, \textit{et al.}, 1998)(Jarvill-Taylor, \textit{et al.}, 2001). Also it reported that aqueous extracts from cinnamon enhance the \textit{in vitro} activity of insulin (Anderson, \textit{et al.}, 2004). In animal studies, dried aqueous cinnamon extracts potentiate insulin-regulated glucose utilization via enhancing insulin signaling (Qin, \textit{et al.}, 2003) and prevent the insulin resistance induced by a high fructose diet in part by enhancing the insulin signaling pathway (Qin, \textit{et al.}, 2004). Cinnamon essential oil enhanced insulin sensitivity in Zucker fatty rats (Talpur, \textit{et al.}, 2005) and, recently, in db/db mice, anti-diabetic effects of cinnamon extracts on blood glucose were observed in relation with improved insulin sensitivity(Kim, \textit{et al.}, 2006). In patients with diabetes, cinnamon extracts have been reported to have beneficial effects in reducing fasting plasma glucose (Mang, \textit{et al.}, 2006, Khan,\textit{et al.}, 2003).

Given these findings, one can hypothesized that polyphenolic polymers found in cinnamon, with insulin-like biological and antioxidant activities, (Qin, \textit{et al.}, 2003). Could improve plasma fasting glucose and oxidative stress markers in people at high risk of oxidative stress. Therefore, this work was designed to investigate in people that are overweight or obese, with impaired fasting glycemia.
Botanical products can improve glucose metabolism and the overall condition of individuals with diabetes not only by hypoglycemic effects but also by improving lipid metabolism, antioxidant status, and capillary function (Bailey and Day, 1989).

A systematic review of research indicates that cinnamon may reduce fasting blood sugar, but does not have an effect on hemoglobin A1C, a biological marker of long-term diabetes. (Dugoua, et al., 2007).

2.3 Definition of diabetes mellitus:

According to the World Health Organization (WHO; 1980 and revised 1985, 1999) diabetes mellitus is defined as a metabolic disorder of multiple-aetiologies characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both.

2.3.1 Classification of diabetes mellitus:

The classification of diabetes mellitus is based on aetiological types (WHO, 1999)

a) Type 1:

Diabetes mellitus indicates the processes of beta-cell destruction that may ultimately lead to diabetes in which insulin is require for survival. Type 2 diabetes is characterized by disorder of insulin action and/or insulin secretion. The third category, "other specific types of diabetes, "includes diabetes caused by a specific and identified underlying defect, such as genetic defects or diseases of the exocrine pancreas (Wild et al., 2003).
Symptoms of marked hyperglycemia include polyuria, polydipsia, weight loss, sometimes with polyphagia, and blurred vision. Impairment of growth and susceptibility to certain infections may also accompany chronic hyperglycemia. Acute, life-threatening consequences of uncontrolled diabetes are hyperglycemia with ketoacidosis or the nonketotic hyperosmolar syndrome (Wild et al, 2003).

b) Type 2 Diabetes:

Type 2 diabetes is a heterogeneous group of conditions that constitute ~90% of diabetes in the United States. Previously, this group of conditions was known as non-insulin dependent diabetes or adult onset diabetes. Type 2 diabetes involves insulin resistance and relative insulin deficiency rather than an absolute insulin deficiency as seen in type 1 diabetes. Insulin resistance is thought to precede insulin deficiency in most patients, and autoimmune destruction of B-cells does not occur, although B-cell mass may be reduced. Because the insulin deficiency is relative rather than absolute, diabetic ketoacidosis occurs less frequently than in type 1 diabetes (Kim et al., 2002).

The majority of patients with this form of diabetes are clinically obese, and exercise and weight loss lead to improvement in the disease state and even clinical remission in some individuals. Pharmacotherapies directed toward increasing insulin sensitivity and increasing B-cell insulin production are useful in type 2, but not in type 1, diabetes.

Unlike type 1 diabetes, there is a strong genetic predisposition to developing type 2 diabetes, and the presence of several family members with type 2 diabetes suggests the diagnosis.
c) Gestational diabetes mellitus (GDM):

Is defined as "any degree of glucose intolerance with onset or first recognition during pregnancy." Unlike other forms of diabetes, GDM uses a different set of diagnostic criteria and screening because normal physiological levels of glucose are different during pregnancy (Kim et al, 2002).

d) Tropical diabetes:

Malnutrition related diabetes mellitus (MRDM), this term is used to describe a form of diabetes that occurs in young people in the tropics.

2.3.2 Diagnosis:

In most patients the diagnosis is suggested by classical symptoms of diabetes of:

Polyuria, polydipsia, weight loss. Sometimes, polyphagia, Fatigue and Mouth dryness. The diagnosis is confirmed by the presence of unequivocal hyperglycemia, random blood glucose measured from venous blood is 200 mg\dl or more (Salih, 2007).

Polyuria is due to osmatic diuresis that results when blood glucose levels exceed the renal threshod. Thirst is due to loss of fluid and electrolytes.

Weight loss is due to accelerated break down of fat and protein secondary to insulin deficiency.

Ketoacidosis may be presenting feature of these early symptoms. Also the clinical onset may be over several months or years (Hassan, 2004).
2.3.3 Types of treatment:

There are three types of treatment:

1. Diet alone.
2. Diet and oral hypoglycemia drugs.
3. Diet and insulin.

Approximately 40% of new cases of diabetes can be controlled adequately by diet alone, about 30% require insulin and another 30% will need an oral hypoglycemic drug.

2.3.4 Diet treatment:

In all diabetics, the amount and time of food intake particularly the carbohydrate, should be controlled, so as to prevent, as far as possible, fluctuations of blood sugar beyond the normal range. Intake of refined sugar should be low because their consumption is followed by rapid absorption and high peak of the blood glucose.

For type 2 diabetes the total intake of calories should be calculated for each individual patient. The calculation will depend on the physical activity of the patient, 35 Kcal/Kg for active diabetics and 40 Kcal/Kg to 50 Kcal/Kg for those who are engaged in heavy physical work (Salih, 2007).

Medical nutrition therapy for people with diabetes should be individualized with consideration to eating habits and other lifestyle factors.

Nutrition recommendations are developed to meet treatment goals and desired outcomes, metabolic parameters including blood glucose, hemoglobin, lipid, blood pressure and body weight.
2.3.5 **Types of diet:**

A normal well balanced diet is now considered the best. The composition of diet can include 45% - 60% of carbohydrates, 30% fats and 15% of protein per day (Salih, 2007).

2.3.6 **Dietary Changes in Sudan:**

The type of food eaten in Sudan varies according to climate, availability and cost. Sorghum is one of the stable foods eaten especially in rural areas, it is a drought resistant cereal crop and is eaten as thick porridge or with curry and sauce.

Wheat (refined) is now gradually replacing sorghum particularly in urban areas. Although the Sudanese diet has plenty of carbohydrate rich items, sugar consumption is increasing in both urban and some rural areas. Some patients believe that sugar is the major source of energy, on hot days people consume large amount of cold drinks with high sugar content. Some patients mistakenly, believe that such drinks contain only few or no calories.

2.3.7 **History of diabetes:**

The earliest description of diabetes mellitus was found on 3rd Dynasty Egyptian papyrus (1552BC) by physician Hesy-Ra, who mentioned polyuria (frequent uriation) as a symptom. In the third century BC, Indian physicians in the Indian Sanakrit Susruta recorded the sweetness of the urine. The recent name of disease (diabetes) appeared during the second century BC by Demetrios of Apamaia, a word that rooted from the Greek (diabeinein) which means siphon or to go excess, where mellitus a Latin word stands for honeysweet had been added to the term later as result of the sweet-tasting urine.
Aretaeus of Cappadocia drew the first clinical features of diabetes in first century AD, increased urine volume, increased thirst and burning in the intestine. The 19th century was a century of the great discoveries in diabetes, Lancereaux and Lapierre distinguished between types of diabetes, diabetes with pancreatic origin (diabetes gras) and of non-pancreatic origin (diabetes maiger) and Langerhans discovered the link between pancreatic islet cells and diabetes. Many other scientists made serious impact in the field of diabetes such as Minkowski Joseph von Mering and Banting.

Treatment of diabetes started with plant extracts in the ancient era and later limitation of dietary intake appeared to be useful especially for non-pancreatic diabetes. The discovery of insulin by Banting in early 1920s, the implication of sulphonylureas and other hypoglycaemic agents in the mid-forties and fifties played very significant roles in the management of diabetes.

2.3.8 Diabetes mellitus in Sudan:

The geographical diversity of Sudan has had a direct impact upon economic, social, political, and cultural life in modern Sudan with its multifarious ethnic and cultural composition. The distinct culture of Sudan is regarded as the oldest in Sub-Saharan Africa. Sudan has had contacts with Middle East and Mediterranean civilizations since ancient times. The western parts have many contacts with West Africa, and the eastern parts have maintained close links with the countries at the Indian Ocean. The population in the north-eastern parts of the country has undergone an ethnic absorption of immigrant Arabs during times of Islamisation, and culturally becoming Arabised. This process has been extended deep into central and
Western parts, but with much less influence on the population in the Western parts.

Internal migration has taken place in different parts of Sudan from rural areas and small towns to big cities, particularly to the capital Khartoum. This has been complicated by displacement of large proportion of populations from draught and famine prone area and war torn areas in the western and southern parts of the country. (Abusabib, 2004.)

The prevalence of DM in the Sudan, as in many other low-income countries, is increasing to epidemic proportions, leading to the emergence of a public health problem of major socio-economic impact. Before 1989 all knowledge about DM in the Sudanese population was based on a few hospital-based studies, but later a series of investigations explored epidemiology and characteristics of the disease in collaboration with Uppsala University, Sweden.
CHAPTER THREE

3 MATERIALS AND METHODS

3.1 Materials:

In the present study, Fenugreek and cinnamon were brought from Wad Medani local market. They were used for proximate analysis and further investigation with human subjects. The (fenugreek seeds and cinnamon bark) were ground each one separately to powder by using certain electric device. The weight of 4 g from each one was taken 4 g so as to form a mixture of 8 g. All these activities were done in a laboratory using a sensitive balance.

3.2 Methods:

Methodology were divided on two parts A and B

A-Proximate analysis:

Analysis was carried out on sample consisting of fenugreek and cinnamon powder, all analysis reported on dry matter- basis. The analysis included the following:

1. Moisture content:

Moisture content of the various samples, investigated in the present study was determined according to AACC methods (1983).

Principle:

Loss in weight after dehydrates by subtraction.

Weighed clean aluminum dishes were used. The samples were then placed in an air oven and dried at 105c for 3 hours. The samples were then
removed from the oven, cooled in desiccators at room temperature and weighed.

Moisture and dry matter (DM) contents were then calculated for various samples as follows:

\[
\text{Moisture content\%} = \frac{\text{sample weight (g)} - \text{dry weight (g)}}{\text{weight of sample}} \times 100
\]

2. **Protein contents:**

Protein contents of the samples analyzed were determined according AOAC method (1983) in which 1gm sample was digested using concentrated sulphuric acid for 2\text{1/2} hours. Then in a clean distillation unit 5 ml of the dilute digested sample was pipette, and 10ml of 40\%NA OH was poured into the funnel. The caustic soda was released gradually. The ammonia trapped in boric acid was titrated against 0.1N HCL solution. A faint pink color was taken as the end point (methyl red thymol blue was used as indicator). The protein percentage was calculated as follows:

\[
\text{Crude protein\%} = \frac{\text{ml of 0.1N HCl} \times 0.0014 \times 6.25}{\text{weight of sample}} \times 100
\]

3. **Oil content:**

Oil content of various samples was determined according to AOCS method (1983). In this method 5gm ground sample was weighed into a filter paper and enclosed in a second filter paper, folded in such a fashion as to prevent escape of the meal. A piece of absorbent cotton was placed on the top of the thimble to distribute the solvent as it drops on the sample. The wrapped sample was then placed in an extraction tube, and 150 ml of
hexane were put into the extraction flasks before attaching the tube. After 6 hours extraction, the extraction flasks were disconnected.

Hexane was recovered by distillation, last traces of solvent were removed by putting the flask in the oven. The flasks were cooled at room temperature and weighed. Oil content was calculated as follows:

\[
\text{Oil\% on fresh weight} = \frac{\text{weight of oil}}{\text{weight of sample}} \times 100
\]

\[
\text{Oil\% (on DM basis)} = \frac{\text{weight of oil}}{\text{weight of sample} \times \text{DM\%}} \times 100
\]

4. Crude fiber content:

Crude fiber content was determined for the various samples according to A.O. A. C. method (1980). Five gm of defatted sample were weighed into 600 ml of boiling 1.25% sulphuric acid and one drop of diluted antifoam agent were added. The content were boiled for 30 minutes and filtered through a Buchner funnel. The residue was then transferred back to beaker using 200ml of 1.25% boiling sodium hydroxide and boiled for 30 minutes. The content were transferred to pre-dried weighed dish and dried at 110°C to constant weight. The contents were then reweighed and ignited in muffle furnace at 550°C for 5 hours. The crude fiber content was calculated follows:

\[
\text{CF\%} = \frac{\text{Loss in weight of dish and contents}}{\text{weight of sample}} \times 100
\]

5. Ash content:

Ash content of the sample was determined by following the standard procedure as described by AOAC (1983).
I) principle

Obtaining the weight of Ash of sample after combustion in the electric muffle furnace.

II) Apparatus:

a) Electric muffle furnace
b) Desiccator
c) Ashing dish
d) Sensitive balance.

III) Procedure:

Porcelain crucibles were dried in an air dryer oven for 15 min, placed in a desiccator and weighed empty.

Three gm of sample weighed in sensitive balance and placed in muffle furnace at 550 – 600°C over night then cooled in desiccators and re-weighed, ash was calculated as follows:

$$Ash\% = \frac{\text{Weight of Ash} \times 100}{\text{Weight of sample}}$$

Area of the study:

The study was conducted in Wad Medni City of the Gezira State, the city is about 186 Km south of Khartoum, the study was carried out during the period from 4 April to 27 April 2012, at Abu Aagla Diabetic Center.

Selection of patients:

The study was carried out on 23 diabetic patients all of them were type2 randomly selected. Their ages ranged from 40 to 70 years. 10 were male, and 13 were female (the mean age was 55 years, 2 patients were on
dietary control alone 11 patients were on tablet, intake and 10 of them on insulin treatment.

All the patients were given brief account about the treatment procedure for the patients to be followed. All of them completed up a questionnaire including information about the age, sex, occupation etc. All the patients gave their consent for the involvement in the study. (See the questionnaire).

**Dose and form:**

Fenugreek and cinnamon mixture powder packed in small plastic bags containing 8 g each were given to the patients, they were instructed to take one bag at the morning per day on fast without leaving any residual of mixture powder in bag and this was taken for a period of two weeks. They were also instructed to be normal in their nutritional behavior without any change.

**Measurement of blood sugar:**

The investigation in this study is to measure the blood glucose level, by using glucometer (gluco – plus). As the baseline the same study group (23) patients were used as a control.

Fasting blood glucose of patients was measured once before starting fenugreek and cinnamon mixture regime.

Patients started to take fenugreek and cinnamon mixture regime for two weeks, at the beginning of the 2nd and 3rd week. All patients expressed their happiness to be involved in this study and they took fenugreek and cinnamon mixture powder regularly.
CHAPTER FOUR

4 RESULTS AND DISCUSSION

4.1 Proximate composition of fenugreek and cinnamon mixture:

Fenugreek – cinnamon mixture was analyzed for moisture, protein, fat, ash, and fiber.

Table (4.1): The proximate composition percentage of fenugreek – cinnamon mixture.

<table>
<thead>
<tr>
<th>Component</th>
<th>Moisture</th>
<th>Ash</th>
<th>Fat and oil</th>
<th>Protein</th>
<th>Crude fiber</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>5.74</td>
<td>3.69</td>
<td>12.28</td>
<td>13.56</td>
<td>9.22</td>
</tr>
</tbody>
</table>

By investigating the proximate composition fenugreek – cinnamon mixture, the mixture sample contain (13.56) protein, (12.28) fat, (9.22) crude fiber, the moisture and ash contents were found, (5.74) and (3.69), respectively.

By comparing results of protein, fat, and ash of the mixture were found (13.5, 12.28, and 3.69), respectively with results of study carried at Department of Food Science and Nutrition – College of Food and Agricultural Science - King Saud University in 2007, for the Chinese sample of cinnamon protein, fat, and ash were found, respectively (4.99, 4.69, and 3.77), respectively. Also compare the mixture results of fat, crude fiber, and ash were found (12.28, 9.22, and 3.69), respectively with results of fenugreek seeds namely Sudanese and Ethiopian, study carried by
(Suleiman, A, E, 1995) are shown fat, crude fiber, and ash (8.04, 9.8, and 4.4), respectively.

4.2 The therapeutic effect of fenugreek – cinnamon mixture on glucose level:

The number of patients was 23 patients. They are randomly selected to run glucose level test, 10 were male, and 13 were female the mean of their ages was 55 years. The characteristic of patients was shown in Table (4.2).

4.2.1 Blood glucose level:

Generally the blood glucose level was lowered after treating patients with fenugreek – cinnamon mixture. Table (4.3) shows the blood glucose levels before and after treatment. There was significant difference (P = 0.05) between blood glucose level after one control week and first week after treatment.
Table (4.2): Characteristics of treated diabetic patients.

<table>
<thead>
<tr>
<th>No</th>
<th>Age(years)</th>
<th>Social status</th>
<th>Education</th>
<th>Sex</th>
<th>Occupation</th>
<th>Duration (years)</th>
<th>Medical treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>48</td>
<td>Married</td>
<td>Secondary</td>
<td>Female</td>
<td>House wife</td>
<td>2</td>
<td>Tabs</td>
</tr>
<tr>
<td>2</td>
<td>48</td>
<td>Married</td>
<td>Graduate</td>
<td>Female</td>
<td>Teacher</td>
<td>3</td>
<td>Diet</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>Married</td>
<td>Graduate</td>
<td>Male</td>
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By comparing the mean of fasting patients blood glucose levels of the two week after treatment with control, there was significant lower (P= 0.05) . Also there was significant difference between levels mean of first week after treatment with (P=0.05). Odd case of patients (N0, 17) due to asthmatic stress, blood glucose level increased, due to use steroid drugs for treatment of asthma which can stimulate glucagon hormone (stimulates enzymatic pathways from amino acids to glucose). There was significant different between levels mean of second week after treatment with control (P=0.05).

Blood glucose level of tested diabetic2 patients has dropped at an average 22.88% after treatment with two weeks. This reduction appeared after first week treatment and increased after second week treatment.

Similar results were reported by many researchers, study done in Europe by Broca et al., published in (1999), demonstrated that 4-hydroxyisoleucine which is an amino acid extracted from fenugreek seeds has shown in vitro increase insulin secretion. The study has shown the amino acid effect in vivo on rats and dogs. It reduced the hyperglycemia and improved the glucose tolerance in non insulin dependent diabetic (NIDD), rat model having major features of human type 2 diabetes.

The additions of fenugreek powder (15 gm) in water significantly reduce the subsequent postprandial glucose level (Modar, 1987).

A systematic review of research indicates that cinnamon may reduce fasting blood sugar, but does not have an effect on hemoglobin A1C, a biological marker of long-term diabetes. (Dugoua, et al., 2007)
In patients with diabetes, cinnamon extracts have been reported to have beneficial effects in reducing fasting plasma glucose (Mang, et al 2006, Khan, et al 2003). The same results were obtained under the same condition of cinnamon by (Yousif 2012).

Because the diet plays important role in the treatment of diabetic patients. Therefore diabetic patients have abnormalities in the metabolism of glucose levels that contribute to the diabetic complications.
Table (4.3): Blood glucose level before and after treatment of diabetic type 2 patients with fenugreek – cinnamon mixture for cases.

<table>
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<th>No.</th>
<th>Before treatment</th>
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<td>Control</td>
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</tr>
<tr>
<td></td>
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<td>23</td>
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<td>126</td>
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</table>
4.3 Conclusion:

The mixture of fenugreek- cinnamon showed efficiency in reducing blood glucose level for treated diabetic type 2 patients. No residual effects were noted.

Further studies are suggested for diabetic patients' treatment with more or less a mount of the fenugreek – cinnamon mixture, and for periods more than two weeks.
4.4 **Recommendation:**

1. Natural products (including fenugreek and cinnamon) need special care in treating patients, other than drugs.

2. Further research work is needed on the chemical components of fenugreek and cinnamon, with extractions to determine the effective portion.

3. Diabetic centers can be informed the study results to enhance benefits to diabetic type 2 patients.
REFERENCES


Bordia, A. Vcma S, K., Sirvastrava K. C.,(1997) "Effect of Ginger (Zingiber officinal Rose), and fenugreek (Trigonella foenumgraecum L.) 384 -


Dugoua J.J, Seely D, Perri D.(2007)."From type 2 diabetes to antioxidant activity: a systematic review of the safety and efficacy of common


http://www.uni-graz.at/~katzer/eng1/Cinn_bur.html


## APPENDICES

### Appendix 1: Questionnaire

<table>
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<th>Patient No:</th>
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<tr>
<td>Name:</td>
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<table>
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<th>46-50 □</th>
<th>51-55 □</th>
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<tr>
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<td>56-60 □</td>
<td>61-65 □</td>
<td>66-70 □</td>
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<table>
<thead>
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<th>6-10 □</th>
<th>&gt;10 □</th>
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<table>
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<td></td>
<td>Insulin □</td>
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Appendix 2: ANOVA Table

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<th>Mean square</th>
<th>F. value</th>
<th>Probability (0.05)</th>
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Coefficient of variation = 22.88%

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Appendix 3: Photos