TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The main goals of this study were to study the nutritional value of Doum fruit and its effects as aqueous extract (5% T.S.S) on patients suffering from high blood pressure in Mezegela Village in El-Gezera State. The results obtained in this study indicated that Doum fruits contain high concentration of dry matter (93.91%), total carbohydrates (86.52%), crude fiber (19.59%), total sugars (16.03%) and ash (8.90%), on dry matter basis. Among the total sugars, the reducing and non-reducing sugars represent 3.37% and 12.69%, respectively. Moreover, the fruit was found very rich in potassium (3421.10 mg), moderately rich in magnesium (134.64 mg), calcium (95.01 mg) and iron (10.32 mg), and with low levels of sodium (5.32 mg), cupper (1.23 mg), manganese (1.08 mg) and zinc (1.10 mg) per 100g dry pulp.

Concerning the effects of Doum fruits extract (5%T.S.S) on Mezegela Village patients (37) suffering from high blood pressure, the results showed that the systolic and diastolic blood pressure in all patients were found to be more than 120 mmHg and 83.32 mmHg before serving Doum fruits extract, respectively. After serving the extract (250ml) daily for 30 days before any medical treatment, the systolic blood pressure in 45.95% of patients was found to be less than 120 mmHg, while that in 35.13% of patients remained between 120 and 129 mmHg. In addition to that, the percent (%) of patients with systolic blood pressure ranging from 130-139 mmHg and more than 150 mmHg were significantly decreased from 37.84% and 10.81% to 8.11% and 2.70%, respectively. The mean value of the systolic blood pressure in all patients was significantly decreased from 134.73 mmHg to 124.07 mmHg after serving Doum fruits extract.

On the other hand, the mean value of the diastolic blood pressure in all the patients before and after serving Doum fruits extract daily for a period of 30 days before any medication was found to decrease from 83.32 mmHg to 81.54 mmHg. However, the percent (%) of patients with diastolic blood pressure less than 80

mmHg and between 80-81 mmHg was significantly increased from 2.70% and 18.92% before serving Doum extract to 13.51% and 59.47%, respectively. While, the percent (%) of patients with diastolic blood pressure ranging between 82-83 mmHg, 84-85 mmHg and more than ≥ 85 mmHg before serving Doum extract was significantly decreased from 62.16%, 5.41% and 10.81% to 21.62%, 2.70% and 2.70%, respectively after Doum extract serving.

ملخص البحث

كانت الأهداف الأساسية لهذا البحث هي دراسة القيمة الغذائية لثمار فاكهة الدوم و مدي تأثيرها كمستخلص مائي (5٪ مواد صلبة ذائبة) على مرضى ارتفاع ضغط الدم في قرية مزيقيلا بولاية الجزيرة. أوضحت النتائج المتحصل عليها في هذه الدراسة أن ثمار الدوم تحتوي على تركيزات عالية من الوزن الجاف (93.91٪) و الكربوهيدرات (86.52٪) و الألياف الخام (19.59٪) و السكريات الكلية (16.03٪) ونسبة الرماد (8.90٪)، على أساس الوزن الجاف. و تمثل السكريات المختزلة وغير المختزلة 3.37٪ و 12.69٪, على التوالي بالنسبة للسكريات الكلية (16.03٪). وبالإضافة إلي ذلك، كانت الثمار غنية جدا في عنصر البوتاسيوم (3421.10 ملجم) ومتوسطه التركيز في كل من عنصر المغنيسيوم (134.64 ملجم) و الكالسيوم (95.01 ملجم) والحديد (10.32 ملجم)، إلا أنها كانت تحتوي علي مستويات منخفضة من الصوديوم (5.32 ملجم) والنحاس (1.23 ملجم) و المنجنيز (1.08 ملجم) والزنك (1.10 ملجم) لكل 100 جم من اللب الجاف.

أما بالنسبة لتأثير مستخلص الدوم المائي (5٪ مواد صلبة ذائبة) على المرضى الذين يعانون من ارتفاع ضغط الدم بقرية مزيقيلا، أظهرت النتائج أن ضغط الدم الانقباضي و الانبساطي لدى جميع المرضى (37) أكثر من 120 مم زئبق و 83.32 مم زئبق قبل تناول مستخلص الدوم. ولكن بعد تناول مستخلص الدوم (250مل) يوميا لمدة 30 يوما قبل تناول أي دواء، أصبح ضغط الدم الانقباضي في 45.95٪ من المرضى أقل من 120 مم زئبق، بينما ظل الضغط الانقباضي في ما بين 120 و 129 مم زئبق في 35.13% من المرضي. بالإضافة إلي ذلك، وجد أن هنالك انخفاضا معنويا في نسبة المرضي الذين كان ضغطهم الانقباضي ما بين 130-139 مم زئبق او اكثر من 150 مم زئبق حيث انخفضت نسبتهم من 37.84% و10.81 % إلي 8.11% و 2.70% ؛ علي التوالي. كما ان متوسط قيمة الضغط الانقباضي لدي جميع المرضي انخفض معنويا من 134.73 مم زئبق إلى 124.07 مم زئبق بعد تناول مستخلص الدوم.

و من جهة أخرى، وجد أن متوسط قيمة ضغط الدم الانبساطي لدى جميع المرضى قبل وبعد تناول مستخلص الدوم يوميا لمدة 30 يوما قبل تناول الدواء قد انخفض من 83.32 مم زئبق إلى 81.54 مم زئبق. وعموما؛ وجد أن نسبة المرضي الذين كان ضغطهم الانبساطي اقل من 80 مم زئبق وبين 80-81 ملم زئبق قد زادت معنويا من 2.70٪ و 18.92٪ قبل تناول مستخلص الدوم إلى 13.51٪ و 59.47٪؛ على التوالي بعد تناول مستخلص الدوم. بينما نسبة المرضي الذين كان ضغطهم الانبساطي ما بين 82-83 مم زئبق و 84-85 مم

زئبق وأكثر من 85 مم زئبق قبل تناول مستخلص الدوم انخفضت بشكل معنوي من 62.16٪، 5.41٪ و 10.81٪ إلى 21.62٪ ، 2.70٪ و 2.70٪، على التوالي بعد تناول مستخلص الدوم.

1. INTRODUCTION

The variation in topography, soil types and rainfall in Sudan resulted into different ecological zones extending from the desert in the north to the tropical forest in the south (**Harrison and Jackson 1958**). The savannas areas constitute about 37% of the entire land in Sudan with considerable variation in micro and macro-habitats and high diversity of plant species particularly forest trees and shrubs (**Abbiw 1990**). The forest trees and shrubs are playing a significant role in maintaining the natural ecosystem preventing and combating desertification, providing food security and meeting the nutritional needs for humans and animals in Sudan, (**Vogt 1995 and Mohammad *et al*. 1996)**.

In Sudan, forest fruits are used traditionally as foods as well as medicines and playing an important role in food security as it provides 93 different natural plants species that give different fruits such as Doum, Tabaldi and Dalib (**Mohammad 1996 and Abdel-Rhman 2011**). *Hyphaene thebaica* is native to upper Africa. It is found along the River Nile in Egypt and Sudan, in the Inner Niger Delta, in riverine areas of northwestern Kenya, and along the Niger River in West Africa. Doum is listed as one of the useful plants of the world.

Doum palm (*Hyphaene thebaica*), native to the semi-arid Sahelian zone of West and middle Africa, is an important tree species for local farmers who harvest the *fruit* for food, the foliage for local crafts, the stem for construction material, and the roots for medicinal use **(Moussa, H. *et, al*. 1998)**.In addition, Doum palm is considered as one of the most important multipurpose forest trees that belong to the family Arecaceae.

In Sudan, Doum palm trees are widely distributed in arid, semiarid and savannah regions. The fruit is considered very rich in carbohydrates, crude fiber, tannins, minerals and vitamins. Moreover, the aqueous extract of Doum fruits is used as a traditional medicine for many diseases. In addition, the fruit is usually used as diuretics, laxative, haematic, hypolipdemic, and hypocholesterolemic agents (**Dosumu *et. al*., 2006**).

The Federal Ministry of Health in Sudan stated that about 24.3% of the Sudanese population (more than 25 years old) suffering from high blood pressure which leads to increasing risk of heart attacks, strokes and kidney failure. Furthermore, it also causes blindness, heart arrhythmias and heart failure. Therefore, the early detection and treatment of high blood pressure will reduce the risk of heart attack and strokes and of course is much less expensive for individuals and governments from heart surgery and health care after stroke and kidney dialysis and other interventions that may become necessary if it is not brought under control **(Almakke, 2013)**.

Objectives

The main objectives of this research can be summarized under the following:

1. To study the chemical composition of Doum fruits.
2. To Study the nutritional value of Doum fruits.
3. Study the effects of Doum fruits as aqueous extract on human blood pressure.

2. LITERATURE REVIEW

2.1 Doum trees (*Hyphaenethebaica*)

2.1.1 Botanical classification and nomenclature

Doum tree (*hyphaene thebaica*) is one of about eleven (11) species that belong to the genus (*hyphaene*) which is belong to the family *Arecaceae,* under the subkingdom *(tra. cheobionta*) and kingdom (*Plantae*). The tree (*hyphaene thebaica*) has many different names in different languages and countries. For example: in Amharic "Zembaba", in Arabic "Doum", in English "Gingerbread palm", in Egypt "Doum palm", in French "Palmierdoum", in Swahili "Mkoma", and in Tigrigna "Kambash" or"Arkobkobai" **(FAO, 1988 and Orwa, *et.al.*,2009)**.

2.1.2 Description

Doum tree has oblong shape (Fig. 1), yellow-orange apple sized fruit with a red outer skin, a thick, spongy and rather sweet fibrous fruit pulp (mesocarp) that tastes like gingerbread and a large kernel **(Hsu, *et. al*., 2006)**.

2.1.3 Distribution

Doum tree is usually grown in the Sahel, in hot and dry savanna between 12-28 N **(Dosumu, *et. al*., 2006)**.

It is widely spread from Mauritania to Egypt, from Senegal to central Africa and east of Tanzania. It is also found in parts of the Sahara where water occurs, in oases and wadis and is widely distributed near rivers and streams, sometimes on rocky slopes. It does not do well in waterlogged areas; it is very resistant to bush fire **(Orwa, *et. al*., 2009)**.

Fig. 1. Doum tree (*Hyphaenethebaica*) and its fruits

In Sudan, the trees are found on silty soils by the river and stream banks on rocky hilly slopes on the Blue Nile State, South Kordofan State. Also, Doum trees are found along Atbara river where different of species associated with doum tree can be found, such as *Acacia seyal var. seyal, Balanitese gyptiaca, Acacia tortilis* and *Ziziphus spina-christi.* The average annual production of the single tree is range between 70-100 kg (2 sacks). Recently, Doum forests are degraded due to illegal practices by the local people and desertification **(El-Amin, 1990**; **FNC, 2012)**.

2.1.4 Requirements

The trees require a mean annual temperature above 28 ^{o}C and a mean annual rainfall between 100-600 mm. Also, the tree is grown in wide variety of soils and it is considered as an indicator for good soils with high water tables. It tolerates in medium salinity when the optimal pH is between 6.5-7.5, mostly on sand dunes **(Vogt, 1995)**.

2.1.5 Doum utilization

2.1.5.1 As food

Brewed Doum fruit drink made from the dried fruit pulp is widely consumed as a health tonic drink **(Sharaf, *et. al.*, 1972**).

According to the surveillance that made by the FAO, Doum powder is obtained after beating the dried fruits with a hard metal tool. Then, the powder is ground, sieved, mixed with water and pancake is prepared from the mixture. Alight porridge called Medida also is prepared by mixing Doum powder with water and heating for a short time, the flour may be added. The same auther also, reported that 14% of the villages in Kadugli council, 11% of the interviewees in south Kordofan and 11% in south Darfor ate Doum fruits during the famine. The kernels of the seeds are often sprouted in moist earth and eaten as a vegetable. The heart of the palm can also be eaten as a vegetable known as palm cabbage **(Salih, 1991)**.

Doren (1997) mentioned that, doum fruit pulp is used in cooking in various ways. The unripe Doum kernel is edible, the ripe kernel is hard and used only as a vegetable ivory.

The covering skin and pulp of doum fruit is edible and it can either be pounded to form a powder or cut off in slices; the powder is often dried then added to food as a flavouring agent **(Orwa, 2009)**.

Ready- to - serve concentrated drink from crushed Doum fruits pulp was developed by **Babiker (2013)**. The crushed fruits pulp was found to be easily extracted after soaking for only two hours at (100˚C) of a ratio of (1:8) with reasonable total soluble solids (8.5%), hydrogen ions concentration (5.04) and yield (47.89%) compared to a cold extraction method used in this study for 16 hours at the same fruit: water ratio.

2.1.5.2 As antioxidant

Cook, *et. al.*(1998) reported that, the antioxidant activity of Doum fruit was determined by measuring only hydrogen-donating activity as trolox equivalents.

Physiologically, antioxidants play a major role in preventing the formation of free radicals, which are responsible for many oxidative processes, Antioxidants may be synthetic, such as butylatedhydroxyanisole (BHA), Propylegallate (PC) and butylatedhydroxytoluene (BHT) or of natural origin such as -tocopherol, phenolic compounds as well as polyphenolics **(Abas, *et. al.*, 2006)**.

Doum fruits were found to affect the reactive oxygen species (ROS) that results from the metabolism in human cells. ROS can react with most bio-molecules including: carbohydrates, proteins, lipids, and DNA. In addition, oxidative damage is one of the major factors for deterioration of food products during processing and storage. The ability of the phenolic compounds to serve as antioxidants activity of doum fruits is mainly due to its substantial amount of their water-soluble phenolic contents **(Mohamed, *et. al.*, 2009)**.

The aqueous extract of Doum fruits showed an antioxidant and anticancer activities; this is due to the substantial amount of their water-soluble phenolic contents **(Hsu, *et. al.*, 2006 and Abou– Elalla, 2009)**.

2.1.5.3 As medicine

Sharaf, *et. al.* (1972) showed that, the aqueous extract of Doum stimulated the contractions of frog's heart and rat intestine but inhibited uterine contractions in rats. On the arterial blood pressure, the extract proved to be capable of lowering the blood pressure both in normotensive and hypertensive anaesthetised dogs.

Also, Doum extracts are being used in the treatment of bilharziasis, haematuria, bleeding especially after child birth **(Adaya, *et. al.*, 1977)**.

While the resin of the tree has diuretic, diaphoretic properties and recommended for tap worm as well as against animal bites **(Boulos, 1983)**.

As mentioned by **Carter (1993),** the phytochemical called lignans in Doum fruits having apparent anti-carcinogenic action, while Doum extract is used as hypolipidemic and hematinic suspension **(Kamis, *et. al*., 2003)**.

The tea of Doum is popular in Egypt and believed to be good for diabetes. It has been used by Egyptian people as a folk medicine for treatment of hypertension **(Hetta, *et. al*., 2005)**.

Hetta and Yassin (2006) reported that, constituents of Doum fruit exhibited a significant decrease in serum total cholesterol and Non-HDL cholesterol in rats; this can reduce the risk of atherosclerosis and subsequent cardiovascular diseases.

Roots of Doum palm are used for treatment of bilharzias while the fruit is often chewed to control hypertension. The hard seed inside the fruit, known as ‘vegetable ivory’, is used to treat sore eyes in livestock using charcoal from the seed kernel **(Orwa, *et. al*., 2009**).

The effect of Doum extract on acute myeloid leukemia cells has been studied by **Abou-Elalla (2009)**. The results revealed that Doum fruits extract has significant anticancer activity against acute myeloid leukemia (AML). The anticancer activity was suggested to be due to the antioxidant activity of Doum extract.

2.1.5.4 As antimicro-organisms

As reported by **Dosumu, *et. al.* (2006),** the aqueous extract of Doum fruits has an antifungal activity against a wide range of fungal isolates. Also, prominent antibacterial activities of Doum fruits were reported against gram positive and gram negative bacteria.

The same author indicated that, the methanolic extract of Doum fruits (*H. thebaica*) showed stronger antifungal activities than the aqueous extract and it has been found to inhibit the growth of *Pseudomonas aeruginosa* and *Klebsiella pnthogenic*. Moreover, the ethyl acetate extracts of Doum fruits showed growth inhibition of the pathogenic bacteria. The effect is pronounced on *B. subtitis* , *Aeruginosa* and *K. pneumonia*, particularly at high concentration and comparable to that of the reference drug (Gentamycin). While, the hexane and ethyl acetate extracts of Doum fruit did not affect the growth of fungi. The mesocarp in some fruit are not edible but that of doum fruit is very palatable, highly aromatic and sweet with the taste of ginger. When eaten, it serves as febrifuges and parasite expellant. Also, the aqueous extract of *H. thebaica* fruits has been reported to have significant antifungal properties **(Nwosu, *et al.*, 2008)**.

Mohamed, *et. al.* (2009) suggested that, the antimicrobial activity of Doum fruit *(H. thebaica)* may involve complex mechanisms such as the inhibition of the synthesis of cell walls, cell membranes, nucleic acid and proteins as well as the inhibition of the metabolism of nuclide acids.

2.1.5.5 Folkloric utilization

Doum fruits are used to make a black dye often applied on leather industry. Moreover, the hard seed inside the fruit, which is known as "vegetable ivory", is used for making buttons, small carvings and as artificial pearls. Also, the ash from the stripes of the trees is used as a salt substitute **(Vogt, 1987).**

Doum palm is usually used for local craft while, the foliage is used to make mats, ropes, baskets, and hats while the stem with the leaves are used for construction purpose **(Moussa *et. al.*, 1998).**

2.2 Nutritional value

According to the literature, the fruit pulp was found to contain trace minerals, proteins and fatty acids, in particular the nutritionally essential linoleic acid. The fruit was also found to contain significant amounts of saponins, coumarins, hydroxycinnamates, essential oils and flavonoids **(Sharaf, *et. al.*, 1972).**

Doum palm is among the more important plant families that supplies human with dietary fibers, carbohydrates and a good source of iron and niacin (vitaminB3) **(Salih, 1991)**.

Doum fruit was reported to contain 12.65% ash, 89.25% carbohydrates, 0.95% oil, 316 mg/g glucose contents and anti-nutritional factor value of 8.30 mg/g tannin content. But, it has very low protein content of 0.01% and high calorific values of 3655.9⁄kcal/kg. Moreover, the concentrations of Ca, Mg, Fe, Cu and Zn in Doum fruits pulp were found to be 245.10, 236.45, 47.96, 0.38 and 0.62 mg⁄100g, resspctively, which were found to be adequate enough for the different biochemical activities, **(Nwosu, 2008)**.

Doum fruit was found to contain high percentages of soluble carbohydrates and excellent quantities of ascorbic acid (63.64 mg/100g pulp). Also, the fruit was very rich in phosphorous (P) and potassium (K), leucine, isoleucine, valine and arginine and some non-essential amino acids such as alanine, aspartic acid, glutamic acid, glycine, serine and proline **(Abdel-Rahman, 2011)**.

The chemical composition and minerals content in whole Doum fruits pulp were studied by **Babiker (2013)**. The dry matter, total carbohydrates, crude fiber and ash contents were found to be 96.79%, 84.87%, 22.36%, and 5.68%, respectively on dry weight basis. Among the total sugars, the reducing sugars and non-reducing sugars constitute about 3.16% and 26.24%, respectively. The whole fruit pulp was also, found very rich in calcium (336.40 mg), potassium (171.60 mg), iron (168.87 mg), sodium (153.92 mg) and magnesium (131.35 mg) and moderately rich in phosphorous (65.63 mg) and manganese (32.66 mg), per 100 g pulp on dry basis.

2.3 Blood pressure

Blood pressure (BP) is the pressure exerted by circulating blood upon the walls of blood vessels. When used without further specification, "blood pressure" usually refers to the arterial pressure in the systemic circulation. Blood pressure is usually expressed in terms of the systolic (maximum) pressure over diastolic (minimum) pressure and is measured in millimeters of mercury (mmHg). It is one of the vital signs along with respiratory rate, heart rate, oxygen saturation, and body temperature. Normal resting systolic (diastolic) blood pressure in an adult is approximately 120 mmHg (80 mmHg), abbreviated as "120/80 mmHg" **(Chobanian, *el. al.,* 2003).**

Blood pressure varies depending on situation, activity, and disease states. It is regulated by the nervous and endocrine systems. Blood pressure that is low due to a disease state is called hypotension, and pressure that is consistently high is hypertension. Both of them have many causes which can range from mild to severe. Both may be of sudden onset or of long duration. Long term hypertension is a risk factor for many diseases, including heart disease, stroke and kidney failure. Long term hypertension is more common than long term hypotension in Western countries. Long term hypertension often goes undetected because of infrequent monitoring and the absence of symptoms **(Klabunde, 2005).**

2.3.1 Physiology

During each heartbeat, blood pressure varies between a maximum (systolic) and a minimum (diastolic) pressure. The blood pressure in the circulation is principally due to the pumping action of the heart. Differences in mean blood pressure are responsible for blood flow from one location to another in the circulation. The rate of mean blood flow depends on both blood pressure and the resistance to flow presented by the blood vessels. Mean blood pressure decreases as the circulating blood moves away from the heart through arteries and capillaries due to viscous losses of energy. Mean blood pressure drops over the whole circulation, although most of the fall occurs along the small arteries and arterioles. Gravity affects blood pressure via hydrostatic forces (e.g., during standing), and valves in veins, breathing, and pumping from contraction of skeletal muscles also influence blood pressure in veins **(Klabunde, 2005).**

2.3.2 Classification

Table (1) shows the classification of blood pressure adopted by the American Heart Association for Adults who are 18 years and older. Blood pressure fluctuates from minute to minute and normally shows a circadian rhythm over a 24-hour period, with highest readings in the early morning and evenings and lowest readings at night. Loss of the normal fall in blood pressure at night is associated with a greater future risk of cardiovascular disease and there is evidence that night-time blood pressure is a stronger predictor of cardiovascular events than day-time blood pressure. Various factors, such as age and sex, influence a person's blood pressure and variations in it. In children, the normal ranges are lower than for adults and depend on height. Reference blood pressure values have been developed for children in different countries (Table, 2), based on the distribution of blood pressure in children of these countries. As adults age, systolic pressure tends to rise and diastolic tends to fall. In the elderly, systolic blood pressure tends to be above the normal adult range, thought to be largely because of reduced flexibility of the arteries. Also, an individual's blood pressure varies with exercise, emotional reactions, sleep, digestion and time of day (circadian rhythm). Differences between left and right arm blood pressure measurements tend to be random and average to nearly zero if enough measurements are taken. However, in a small percentage of cases there is a consistent difference greater than 10 mmHg **(Eguchi, *et. al*., 2007)**.

Table (1): Classification of blood pressure for adults

Classification of blood pressure for adults (mmHg)		
Category	Systolic	Diastolic
Hypotension	< 90	< 60
Desired	90–119	60–79
Prehypertension	120–139	80–89
Stage 1 hypertension	140–159	90–99
Stage 2 hypertension	160–179	100–109
Hypertensive urgency	≥ 180	≥ 110
Isolated systolic hypertension	≥ 160	< 90

Table (2): Reference ranges for blood pressure in children

Reference ranges for blood pressure in children (mmHg)			
Stage	Approximate age	Systolic	Diastolic
Infants	1 to 12 months	75–100	50–70
Toddlers and preschoolers	1 to 5 years	80–110	50–80
School age	6 to 12 years	85–120	50–80
Adolescents	13 to 18 years	95–140	60–90

The risk of cardiovascular disease increases progressively above 115/75 mmHg. Clinical trials demonstrate that people who maintain arterial pressures at the low end of these pressure ranges have much better long term cardiovascular health **(Appel, *et. al*., 2006).**

2.3.3 Disorders

Disorders of blood pressure control include: high blood pressure, low blood pressure:

2.3.3.1 High blood pressure

Arterial hypertension can be an indicator of other problems and may have long-term adverse effects. Sometimes it can be an acute problem, for example hypertensive emergency. Levels of arterial pressure put mechanical stress on the arterial walls. Higher pressures increase heart work load and progression of unhealthy tissue growth (atheroma) that develops within the walls of arteries. The higher the pressure, the more stress that is present and the more atheroma tend to progress and the heart muscle tends to thicken, enlarge and become weaker over time **(Gottdiener, *et. al*., 2002).**

Persistent hypertension is one of the risk factors for strokes, heart attacks, heart failure and arterial aneurysms, and is the leading cause of chronic kidney failure. Even moderate elevation of arterial pressure leads to shortened life expectancy. At severely high pressures, mean arterial pressures 50% or more above average, a person can expect to live no more than a few years unless appropriately treated. In the past, most attention was paid to diastolic pressure; but nowadays it is recognized that both high systolic pressure and high pulse pressure (the numerical difference between systolic and diastolic pressures) are also risk factors. In some cases, it appears that a decrease in excessive diastolic pressure can actually increase risk, due probably to the increased difference between systolic and diastolic pressures. If systolic blood pressure is elevated (>140 mmHg) with a normal diastolic blood pressure (<90 mmHg), it is called "isolated systolic hypertension" and may present a health concern. For those with heart valve regurgitation, a change in its severity may be associated with a change in diastolic pressure. In a study of people with heart valve regurgitation that compared measurements 2 weeks apart for each person, there was an increased severity of aortic and mitral regurgitation when diastolic blood pressure increased, whereas when diastolic blood pressure decreased, there was a decreased severity **(Poulter, *et. al*., 2015).**

2.3.3.2 Low blood pressure

Blood pressure that is too low is known as hypotension. Hypotension is a medical concern if it causes signs or symptoms, such as dizziness, fainting, or in extreme cases, shock. When arterial pressure and blood flow decrease beyond a certain point, the perfusion of the brain becomes critically decreased (i.e., the blood supply is not sufficient), causing lightheadedness, dizziness, weakness or fainting. Sometimes the arterial pressure drops significantly when a patient stands up from sitting. This is known as orthostatic hypotension (postural hypotension); gravity reduces the rate of blood return from the body veins below the heart back to the heart, thus reducing stroke volume and cardiac output. When people are healthy, the veins below their heart quickly constrict and the heart rate increases to minimize and compensate for the gravity effect. This is carried out involuntarily by the autonomic nervous system. The system usually requires a few seconds to fully adjust and if the compensations are too slow or inadequate, the individual will suffer reduced blood flow to the brain, dizziness and potential blackout. Also, the Sepsis, hemorrhage (blood loss), toxins including toxic doses of blood pressure medicine, hormonal abnormalities (such as Addison's disease), eating disorders, particularly anorexia nervosa and bulimia were reported to be as other causes of low arterial pressure **(Franco, 2007).**

However, the previous author defined the blood pressure shock as a complex condition which leads to critically decreased perfusion. The usual mechanisms are loss of blood volume, pooling of blood within the veins reducing adequate return to the heart and/or low effective heart pumping. Low arterial pressure, especially low pulse pressure, is a sign of shock and contributes to and reflects decreased perfusion. If there is a significant difference in the pressure from one arm to the other, that may indicate a narrowing (for example, due to aortic coarctation, aortic dissection, thrombosis or embolism) of an artery.

2.3.4 Hypertension

Hypertension (HTN or HT), also known as high blood pressure (HBP), is a long term medical condition in which the blood pressure in the arteries is persistently elevated **(Chobanian, *el. al.*, 2003).**

High blood pressure usually does not cause symptoms. Long term high blood pressure, however, is a major risk factor for coronary artery disease, stroke, heart failure, peripheral vascular disease, vision loss, and chronic kidney disease. High blood pressure is classified as either primary (essential) high blood pressure or secondary high blood pressure. About 90–95% of cases are primary defined as high blood pressure due to nonspecific lifestyle and genetic factors. Lifestyle factors that increase the risk include excess salt, excess body weight, smoking and alcohol. The remaining 5–10% of cases are categorized as secondary high blood pressure, defined as high blood pressure due to an identifiable cause, such as chronic kidney disease, narrowing of the kidney arteries, an endocrine disorder, or the use of birth control pills **(Lackland and Weber, 2015).**

Lifestyle changes and medications can lower blood pressure and decrease the risk of health complications. Lifestyle changes include weight loss, decreased salt intake, physical exercise and a healthy diet. If lifestyle changes are not sufficient then blood pressure medications are used. Up to three medications can control blood pressure in 90% of people. The treatment of moderately high arterial blood pressure (defined as >160/100 mmHg) with medications is associated with an improved life expectancy. The effect of treatment of blood pressure between 140/90 mmHg and 160/100 mmHg is less clear, with some reviews finding benefit and others not finding benefit. High blood pressure affects between 16 and 37% of the population globally. In 2010 hypertension was believed to be the main factor of deaths in 18% (9.4 million) of the total population **(Poulter, *et. al*., 2015).**

2.3.4.1 Secondary hypertension

Hypertension with certain specific additional signs and symptoms may suggest secondary hypertension, i.e. hypertension due to an identifiable cause. For example, Cushing's syndrome frequently causes truncal obesity, glucose intolerance **(Fisher and Williams, 2005).**

2.3.4.2 Hypertensive crisis

Severely elevated blood pressure (equal to or greater than a systolic 180 or diastolic of 110) is referred to as a hypertensive crisis. Hypertensive crisis is categorized as either hypertensive urgency or hypertensive emergency, according to the absence or presence of end organ damage, respectively. In hypertensive urgency, there is no evidence of end organ damage resulting from the elevated blood pressure. In these cases, oral medications are used to lower the blood pressure (BP) gradually over 24 to 48 hours. In hypertensive emergency, there is evidence of direct damage to one or more organs. The most affected organs include the brain, kidney, heart and lungs, producing symptoms which may include confusion, drowsiness, chest pain and breathlessness. In hypertensive emergency, the blood pressure must be reduced more rapidly to stop ongoing organ damage; however, there is a lack of randomised controlled trial evidence for this approach (**David J. Karras, *et.al.*, 2006**).

2.3.4.3 Hypertension on pregnancy

Hypertension occurs in approximately 8–10% of pregnancies. Two blood pressure measurements six hours apart of greater than 140/90 mm Hg is considered diagnostic of hypertension in pregnancy. High blood pressure in pregnancy can be classified as pre-existing hypertension, gestational hypertension or pre-eclampsia. Pre-eclampsia is a serious condition of the second half of pregnancy and following delivery characterised by increased blood pressure and the presence of protein in the urine. It occurs in about 5% of pregnancies and is responsible for approximately 16% of all maternal deaths globally. Pre-eclampsia also doubles the risk of perinatal mortality. Usually there are no symptoms in pre-eclampsia and it is detected by routine screening **(Perez and Musini, 2008).**

When symptoms of pre-eclampsia occur the most common are headache, visual disturbance (often "flashing lights"), vomiting, pain over the stomach, and swelling. Pre-eclampsia can occasionally progress to a life-threatening condition called eclampsia, which is a hypertensive emergency and has several serious complications including vision loss, brain swelling, seizures, kidney failure, pulmonary edema, and disseminated intravascular coagulation (a blood clotting disorder). In contrast, gestational hypertension is defined as new-onset hypertension during pregnancy without protein in the urine **(Poulter, *et. al*., 2015).**

2.3.4.4 Hypertension in children

Failure to thrive, seizures, irritability, lack of energy, and difficulty in breathing can be associated with hypertension in neonates and young infants. In older infants and children, hypertension can cause headache, unexplained irritability, fatigue, failure to thrive, blurred vision, nosebleeds, and facial paralysis **(Perez and Musini, 2008).**

2.3.4.5 Signs and symptoms

Hypertension is rarely accompanied by symptoms, and its identification is usually through screening, or when seeking health care for an unrelated problem. Some with high blood pressure report headaches (particularly at the back of the head and in the morning), tinnitus (buzzing or hissing in the ears), altered vision or fainting episodes. These symptoms, however, might be related to associated anxiety rather than the high blood pressure itself **(Fisher and Williams, 2005).**

2.3.4.6 Causes of hypertension

2.3.4.6.1 Primary hypertension

Hypertension results from a complex interaction of genes and environmental factors. Numerous common genetic variants with small effects on blood pressure were identified as well as some rare genetic variants with large effects on blood pressure. Also, Genome-Wide Association (GWAS) identified 35 genetic loci related to blood pressure **(Palatini and Julius, 2009).**

Blood pressure rises with aging and the risk of becoming hypertensive in later life is considerable. Several environmental factors influence blood pressure. High salt intake raises the blood pressure in salt sensitive individuals; lack of exercise, obesity, and depression can play a role in individual cases. The possible role of other factors such as caffeine consumption, and vitamin D deficiency are less clear. Insulin resistance, which is common in obesity. Events in early life, such as low birth weight, maternal smoking, and lack of breast feeding may be risk factors for adult essential hypertension, although the mechanisms linking these exposures to adult hypertension remain unclear. An increased rate of high blood urea has been found in untreated people with hypertensive in comparison with people with normal blood pressure, although it is uncertain whether the former plays a causal role or is subsidiary to poor kidney function **(Meng, *et. al.*, 2012).**

2.3.4.6.2 Secondary hypertension

Secondary hypertension results from an identifiable cause. Kidney disease is the most common secondary cause of hypertension. Hypertension can also be caused by endocrine conditions, such as Cushing's syndrome, hyperthyroidism, hypothyroidism, acromegaly, hyperaldosteronism, hyperparathyroidismand pheoc hromocytoma. Other causes of secondary hypertension include, sleep apnea, pregnancy, and certain prescription medicines **(Meng, *et. al.*, 2012).**

2.3.4.7 Pathophysiology

In most people with established essential hypertension, increased resistance to blood flow (total peripheral resistance) accounts for the high pressure while cardiac output remains normal. There is evidence that some younger people with prehypertension or 'borderline hypertension' have high cardiac output, an elevated heart rate and normal peripheral resistance, termed hyperkinetic borderline hypertension. These individuals develop the typical features of established essential hypertension in later life as their cardiac output falls and peripheral resistance rises with age. Whether this pattern is typical of all people who ultimately develop hypertension is disputed. The increased peripheral resistance in established hypertension is mainly attributable to structural narrowing of small arteries and arterioles, although a reduction in the number or density of capillaries may also contribute. Whether increased active arteriolar vasoconstriction plays a role in established essential hypertension is unclear. Hypertension is also associated with decreased peripheral venous compliance which may increase venous return, increase cardiac preload and, ultimately, cause diastolic dysfunction **(Perez and Musini, 2008).**

Pulse pressure (the difference between systolic and diastolic blood pressure) is frequently increased in older people with hypertension. This can mean that systolic pressure is abnormally high, but diastolic pressure may be normal or low a condition termed isolated systolic hypertension. The high pulse pressure in elderly people with hypertension or isolated systolic hypertension is explained by increased arterial stiffness, which typically accompanies aging and may be exacerbated by high blood pressure **(Palatini and Julius, 2009).**

Many mechanisms have been proposed to account for the rise in peripheral resistance in hypertension. Most evidence implicates either disturbances in the kidneys' salt and water handling and/or abnormalities of the sympathetic nervous system. These mechanisms are not mutually exclusive and it is likely that both contribute to some extent in most cases of essential hypertension. It has also been suggested that endothelial dysfunction and vascular inflammation may also contribute to increased peripheral resistance and vascular damage in hypertension. Interleukin 17 has garnered interest for its role in increasing the production of several other immune system chemical signals thought to be involved in hypertension such as tumor necrosis factor alpha ***(*Bauman, *et. al.*, 2013)**.

2.3.4.8 Diagnosis

Hypertension is diagnosed on the basis of a persistently high blood pressure. Traditionally, the National Institute of Clinical Excellence recommends three separate sphygmomanometer measurements at monthly intervals. The American Heart Association recommends at least three measurements on at least two separate health care visits. Ambulatory blood pressure monitoring over 12 to 24 hours is the most accurate method to confirm the diagnosis. An exception to this is those with very high blood pressure readings especially when there is poor organ function. Initial assessment of the hypertensive people should include a complete history and physical examination. With the availability of 24-hour ambulatory blood pressure monitors and home blood pressure machines, the importance of not wrongly diagnosing those who have white coat hypertension has led to a change in protocols. In the United Kingdom, current best practice is to follow up a single raised clinic reading with ambulatory measurement, or less ideally with home blood pressure monitoring over the course of 7 days. The United States Preventative Services Task Force also recommends getting measurements outside of the healthcare environment. Pseudohypertension in the elderly or non-compressibility artery syndrome may also require consideration. This condition is believed to be due to calcification of the arteries resulting in abnormally high blood pressure readings with a blood pressure cuff while intra arterial measurements of blood pressure are normal. Orthostatic hypertension is when blood pressure increases upon standing **(Hemmelgarn, *et. al*., 2005)**.

Once the diagnosis of hypertension has been made, healthcare providers should attempt to identify the underlying cause based on risk factors and other symptoms, if present. Secondary hypertension is more common in preadolescent children, with most cases caused by kidney disease. Primary or essential hypertension is more common in adolescents and has multiple risk factors, including obesity and a family history of hypertension. Laboratory tests can also be performed to identify possible causes of secondary hypertension, and to determine whether hypertension has caused damage to the heart, eyes, and kidneys. Additional tests for diabetes and high cholesterol levels are usually performed because these conditions are additional risk factors for the development of heart disease and may require treatment. Serum creatinine is measured to assess for the presence of kidney disease, which can be either the cause or the result of hypertension. Additionally, testing of urine samples for protein is used as a secondary indicator of kidney disease. Electro cardio gram (EKG/ECG) testing is done to check for evidence that the heart is under strain from high blood pressure. It may also show whether there is thickening of the heart muscle or whether the heart has experienced a prior minor disturbance such as a silent heart attack. A chest X-ray or an echocardiogram may also be performed to look for signs of heart enlargement or damage to the heart **(O'Brien, *et. al*., 2007)**.

2.3.4.9 Prevention

As reported by **Whelton, *et. al.*(1997),** much of the disease burden of high blood pressure is experienced by people who are not labeled as hypertensive. Consequently, population strategies are required to reduce the consequences of high blood pressure and reduce the need for antihypertensive drug therapy. Lifestyle changes are recommended to lower blood pressure, before starting drug therapy. The 2004 British Hypertension Society guidelines proposed lifestyle changes consistent with those outlined by the US National High BP Education Program in 2002 for the primary prevention of hypertension:

- Increase potassium intake, potassium intake and blood pressure are inversely related (higher potassium intakes are associated with lower blood pressures). Results from clinical trials found that high dietary potassium may help to prevent and control hypertension
- Maintain normal body weight for adults (e.g. body mass index 20–25 kg/m2).
- Reduce dietary sodium intake to <100 mmol/ day (<6 g of sodium chloride or <2.4 g of sodium per day).
- Engage in regular aerobic physical activity such as brisk walking (≥30 min per day, most days of the week).

- Limit alcohol consumption to no more than 3 units/day in men and no more than 2 units/day in women.
- Consume a diet rich in fruit and vegetables (e.g. at least five portions per day).

Also, **Williams, *et. al.*(2004)** mentioned that effective lifestyle modification may lower blood pressure as much as an individual antihypertensive drug. Combinations of two or more lifestyle modifications can achieve even better results. There is considerable evidence that reducing dietary salt intake lowers blood pressure, but whether this translates into a reduction in mortality and cardiovascular disease remains uncertain. Estimated sodium intake ≥6g/day and <3g/day are both associated with high risk of death and/or major cardiovascular disease, but the association between high sodium intake and adverse outcomes is only observed in people with hypertension.

2.3.4.10 Medical treatments

Several classes of medications, collectively referred to as antihypertensive medications, are available for treating hypertension. First line medications for hypertension include thiazide-diuretics, calcium channel blockers, angiotensin converting enzyme inhibitors and angiotensin receptor blockers. These medications may be used alone or in combination; the latter option may serve to minimize counter-regulatory mechanisms that act to revert blood pressure values to pre-treatment levels. The majority of people require more than one medication to control their hypertension **(Bauman, *et. al.*, 2013)**.

3. MATERIALS AND METHODS

3.1 Materials

Crushed whole Doum fruits (*Hyphaene thebaica*) used in this study were obtained from Nayala town, Darfour state. The crushed fruit samples were carefully cleaned, finely, ground, kept in tightly closed bags and stored at -18 ºC until needed for different investigation.

3.2 Methods

3.2.1 Chemical methods

3.2.1.1 Moisture content

The moisture content in each sample was determined following the standard method described by the **AOAC (2003).**

Two grams (2g ± mg) of well mixed sample was weighted accurately in cleaned, dried Petri dishes using a sensitive balance (Item No: AR2140, Made for OHAC,S CORO. USA). Then, the samples were placed in an oven (Carblite, sheffield, England) at 105°C for five hours. After that the Petri dishes were transferred to a desiccator and re -weighting after cooling to room temperature. Again, the dishes were transferred to the oven and weighted after two hours and this was repeated till a constant weight was obtained. Then, the moisture content (M.C) as per-cent was calculated as the loss in weight after drying:

$$\text{Moisture (\%)} = \frac{(Ws - Wd) \times 100\%}{\text{Sample weight (g)}}$$

Where:

Ws = weight of sample before drying.

Wd = weight of sample after drying.

3.2.1.2 Crude protein

The crude protein content in the sample was determined by the micro-Kjeldahl method following the method of **AOAC (2003)**.

Principle:

Doum fruits sample was digested with a strong sulphuric acid so that the sample release its nitrogen content which can be determined by a suitable titration technique. A conversion factor of 6.25 (equivalent to .16 g nitrogen per 100 grams of protein) was used in this method to calculate the sample protein content. The kjeldahl method is divided into three steps which can be summarized under the following:

A) Digestion

The Doum palm fruit sample (0.2g±1mg) was transferred into a digestion flask and then digested by heating for 2-3 hours in (3.5N) sulphuric acid. The digestion process was catalyzed by a mixture 0.4 of 10 parts K_2SO_4 to one part of $CuSo_4$. The heating was continued till the black colour turned to pale blue and the fumes disappeared which indicate that the digestion process was completed.

B) Distillation

After the digestion has been completed the digestion flask was cooled and transferred to a distillation unit using a minimum volume of water. The solution in the distillation unit was then turned alkaline by addition of 20 ml of sodium hydroxide (40%) to release the ammonia. Then, the released ammonia was distilled into 20 ml of 2% boric acid in a conical flask with 2 to 3 drops of Bromochresol Methyl red as indicator.

C) Titration

The nitrogen content in the sample was then estimated by titration of the ammonium borate formed with a standard hydrochloric acid (0.1N). The titrations continued till the colour of the solution turned to red (pink). Then, the following formula was used to determine the protein concentration as per-cent:

$$\text{Crude protein \%} = \frac{(TV \times N \times 14.00 \times F)\ 100\%}{1000 \times \text{sample weight (g)}}$$

Where:

TV: actual volume of HCl used for sample titration (ml HCl–ml blank).

N: normality of HCl.

F: protein conversion factor = 6.25

3.2.1.3 Fat content

The sample oil content was determined by using a continuous extraction apparatus (Soxhlet type) as described by **Pearson (1970).**

About five grams (5g ± 1mg) samples were weighed and transferred to an extraction thimble covered with a piece of glass wool and then placed in the Soxhlet apparatus. After that, the solvent (petrolum ether) was added into a dried weighted Soxhlet flask and the extraction process was continued for about six hours. Then, the oil sample was dried in an oven (Carblite, sheffield, England) for a 30 minutes to eliminate any remaining amounts of the solvent and the flask was reweighted. The fat per-cent was calculated by using the following equation:

$$\text{Crude fat (\%)} = \frac{(W2 - W1)\ 100\ \%}{\text{Sample weight (g)}}$$

Where:

W1 = weight of the empty Soxhlet flask (g).

W2 = weight of Soxhlet flask with oil content (g).

3.2.1.4 Determination of total and available carbohydrates

The total carbohydrates and available carbohydrates as per-cent were calculated by difference as described by **West, et. al. (1988)**.

Total carbohydrates (%) **=** 100 % - (Moisture %+Protein %+Fat %+Ash %)

Available carbohydrates (%) = Total carbohydrates (%) - crude fiber (%)

3.2.1.5 Crude fiber

The crude fiber contents in the different samples were determined according to the **AOAC (2003)**.

About two grams (2g±1mg) sample were weighted and two hundred (200) ml of sulphuric acid (0.26N) were added, boiled for 30 minutes and then filtered. The residue was washed three times by using hot water and after that 200 ml of NaOH was added, boiled again for 30 minutes and filtered. Then, the residue was carefully washed three times with hot water until it was free from alkali. After that, the sample was transferred to an oven (Carblite, sheffield, England) at 105° C (overnight) and reweighted. The residue was ached in a muffle furnace (LEF-103S, watts: 2KW10A serial no: 07033002, Korea) at 550° C for three hours till a light gray ash was formed and a constant weight was obtained. Then, the total crude fiber per-cent was calculated using the following equation:

$$\text{Crude fiber \%} = \frac{(W_1 - W_2) \times 100\%}{\text{Sample weight(g)}}$$

Where:

W_1 = weight of the sample before ignition (g).

W_2 = weight of sample after ignition (g).

3.2.1.6 Total sugars, reducing and non-reducing sugars

The total sugars, reducing and non-reducing sugars were determined according to Lane and Eynon titrometric method as described by the Association of Official Analytical Chemists **(AOAC, 1984).**

Principle: Reducing sugars in pure solution in plant materials after suitable pre-treatment (to remove interference substances) may be estimated by using copper sulphate as oxidizing agent in a standard Fehling's solution.

Sample preparation:

(A) Reducing sugars

A sample of 10 g + 1 mg was weighted and transferred to 250 ml volumetric flask. 100 ml of distilled water was carefully added and then neutralized with 1.0 N NaOH to a pH 7.5 – 8.0. Then, about 2 ml of standard lead acetate (NO. 23500, BDH, England) was added and the flask was shaked and left to stand for 10 min. After that, 2 grams of sodium oxalate was added to remove the excess amount of lead acetate and the solution was made up to volume with distilled water (250 ml) and filtered.

(B)Total sugars

From the previous clear sample solution, 50 ml was pipetted into a 250 ml conical flask and 5g citric acid and 50 ml distilled water were added slowly. Then, the mixture was gently boiled for 10 min to complete the inversion of sucrose and left to cool at room temperature. After that, the solution was transferred to 250 ml volumetric flask, neutralized with 20% NaOH solution in the presence of few drops of phenolphthalein (NO. 6606 J. T Baker, Holland) until the colour of the mixture disappeared and the sample was made up to volume before titration.

Procedure:

A volume of 10 ml from the mixture of Fehling's (A) and (B) solutions was pipetted into 250 ml conical flask. Then, sufficient amount of the clarified sugars solution was added from burette to reduce Fehling's solution in the conical flask. After that, the solution was boiled until a faint blue colour is obtained. Then, few drops of methylene blue indicator (S-d-FINE-CHEM LIMITED) were added to Fehling's solution and titrated under boiling with sugars solution until brick-red colour of precipitate cuprous oxide was observed. Finally, the titer volume was recorded and the amount of inverted sugars was obtained from Lane and Eynon Table and the total sugars, reducing and non-reducing sugars were calculated by using the following formulas:

Calculation:

$$\text{Total sugars } \{\%\} = \frac{\text{invert sugar (mg) x dilution factor} \times 100\%}{\text{Titer x sample weight (g) x 1000}}$$

$$\text{Reducing sugars } \{\%\} = \frac{\text{invert sugar (mg) x dilution factor} \times 100\%}{\text{Titre x sample weight (g)x 1000}}$$

Non-reducing sugars {% } = {Total sugars (%) – reducing sugars (%)}

3.2.1.7 Determination of ash content

The ash content of the different samples were determined according to the official method of the **AOAC (2003).**

The empty crucibles were accurately weighed and then two grams of Doum fruit flesh were transferred to each crucible by using a sensitive balance. Then, the crucibles and their content were placed in a muffle furnace (LEF- 103S, watts: 2KW10A serial no: 07033002, Korea) at 550° to 700° C for more than 6 hours until white to grey ash was obtained. After that, the crucibles were transferred from the furnace to a desiccator to cool to room temperature and re-weighed. The ash content was calculated by using the following equation:

$$\text{Ash (\%)} = \frac{(Wt1 - Wt2) \times 100\%}{\text{Sample weight (g)}}$$

Where:

Wt1 = weight of crucible with the remaining ashed sample (g).

Wt2 = weight of the empty crucible (g).

3.2.1.8 Determination of minerals

Ten milliliters (10 ml) of HCL (2N) were added to the remaining ash sample and placed in a hot sand path for about 10-15 min. After that, the sample was filtered and diluted to 100 ml in a volumetric flask. Then, the trace elements ferrous (Fe^{++}) and manganese (Mn^{++}) were determined according to **Perkin Elmer, (1994)** by using Atomic Absorbance Spectroscopy (JENWAY 3110, UK). Sodium (Na) and potassium (K) were determined by using Flame Photometer (Model PEP7 JENWAY). While, calcium (Ca), magnesium (Mg) and phosphorus (P) were determined as described by **Chapman and paratta (1961).**

3.2.1.9 Titrable acidity

The titrable acidity of Doum extracts was determined according to **Ranganna (2001).**

Procedure:

50g ± 1g sample was diluted to 100 ml, and then 20ml of the diluted solution was titrated against (0.1N) sodium hydroxide using phenolphthalein solution (1%) as an indicator. The titrable acidity was calculated as percent citric acid according to the following equation:

Titrable acidity (%) =

$$\frac{\text{Titre(ml)} \times \text{N (NaOH)} \times \text{equivelent wt of citric acid} \times 100 \times 100\%}{\text{sample volume (ml)} \times \text{initial wt.of sample(g)} \times 1000}$$

3.2.1.10 Food energy value

The energy value of Doum fruits were calculated based on Atwater factors as indicated by **Leung (1968).**

Protein = 3.87 Kcal/g

Fat = 8.37 Kcal/g

Carbohydrate = 4.12 Kcal/g

kcal = 4.184 kj

3.2.2 Physico-chemical methods

3.2.2.1 Hydrogen ions concentration

The hydrogen ions concentration (pH) in the different extracts was measured following the method of the **AOAC (1990).**

Principle:

The sample is measured potentiometrically with a pH-meter. After standardization of the meter electrodes with buffer solutions, the reading is taken when the equilibrium potential across the electrodes is achieved.

Procedure:

After standardization of the pH-meter (JENWAY, 3510 pH meter) with two buffer solutions (pH of 4.00 and 7.00), the electrode of the pH-meter was rinsed with distilled water, immersed in the sample solution (20° C) and left to stand until a staple reading was achieved. All the readings were expressed as pH to the nearest 0.01 pH units.

3.2.2.2 Total soluble solids

The total soluble solids (T.S.S %) of Doum extracts were measured using a Hand Refractometer (0 – 50, Brix) and the results were expressed as (%) sucrose according to the **AOAC (1984).**

Principle:

The index of refraction of a sample is a ratio of light velocity under vacuum to its velocity in the substance which is largely dependent on the composition, concentration and temperature of the sample solution.

Procedure:

After the adjustment of the Hand-Refractometer (0 — 50 Brix, Eclipse BS 002603, UK.) with distilled water, the sample was placed on the surface of the Refractometer prism, the prism was closed and the reading was recorded to the nearest 0.01 as (T.S.S. %).

3.2.3 Experimental methods

3.2.3.1 Doum fruits extraction method

for determination of optimum extraction conditions and yield, two replicates from the crushed Doum sample (50g) were soaked overnight (16h) at room temperature (27° C) in tap water at different ratios (1:2 , 1:4 , 1:6 , 1:8 , 1:10). Then, the mixtures were blended by a magnetic stirrer (Gallenkamp P 2375, England) for 5 min., immediately filtered with coarse silk sieve and weighed. After that, the filtrates were checked for their hydrogen ions concentration (pH), volume (ml), weight (g), total soluble solids (T.S.S.%) and yield (%). The yield of each extract was calculated by using the following equation:

Yield % =

$$\frac{\left(\text{extract T.S.S \%} \times \text{extract weight (g)}\right) 100\ \%}{\text{initial weight of smple (g)}}$$

3.2.3.2 Blood pressure measurement

The blood pressure was measured daily for each patient during aperiod of 30 days, before and after half an hour from serving Doum fruits as an aqueous fresh drink (without adding sugars) by using manual Blood Pressure Measuring Device and the results were immediately recorded as mm hg.

3.2.4 Statistical analysis methods

The results obtained in this study were subjected to statistical analysis using the Statistical Package for Social Science (SPSS) programme version 16. While the mean value were tested by using the Analysis of Variation Programme (ANOVA). The relationships between the clinical findings (blood pressure before and after serving Doum fruit extract) and the selected variables of the study were assessed by using Chi-square test according to **Montgomery(2001).**

4. RESULTS AND DISCUSSION

4.1 Nutritional value of Doum fruits

4.1.1 Chemical composition and energy value

Table (3) shows the chemical composition and energy value of whole Doum fruits pulp, on wet and dry basis. From the results, the dry matter, crude protein, crude fat, total carbohydrates and ash were found to be 93.91%, 3.68%, 0.93%, 86.52% and 8.90%, respectively on dry matter basis. Among the total sugars (16.03%), the reducing and non-reducing sugars represent 3.37% and 12.69%, respectively on dry matter basis.

Moreover, the fruits pulp was found to provide 297.70 K.cal (1245.62 K.j) per 100g pulp, on dry weight basis. However, the results obtained in this study agree well with those reported by **Salih (1991); Nwosu (2008) and Babiker (2013). Abdel-Rahman (2011)** stated that, Doum fruits pulp contains high percentage of soluble carbohydrates.

4.1.2 Minerals content

The minerals content of whole Doum fruits pulp as mg/100g is shown in Table (4). The fruits pulp was found very rich in Potassium (3421.10 mg) and moderately rich in Magnesium (134.64 mg), Calcium (95.01 mg) and Iron (10.32 mg) per 100g fruit pulp, on dry basis. But with low levels of Sodium (5.32 mg), Cupper (1.23 mg), Manganese (1.08 mg) and Zinc (1.10 mg) per 100g dry pulp.

However, the concentrations of Cupper and Zinc in this study are very close to those reported by **Nwosu (2008)**. Also, **Abdel-Rahman (2011)** found Doum fruits pulp to be very rich in Potassium. On the other hand, except for Manganese concentration, the other minerals concentration reported in this study are not similar to those obtained by **Babiker (2013)**.

Table (3): Chemical composition and energy value of whole Doum fruit

Chemical composition (%)	Whole Doum fruit	
	On wet basis	On dry basis
	[n = 3 ± SD]	
Moisture or dry matter	6.09 ± 0.09	93.91 ± 0.00
Crude protein	3.46 ± 0.04	3.68 ± 0.00
Fat content	0.87 ± 0.01	0.93 ± 0.00
Total carbohydrates	81.25 ± 1.29	86.52 ± 0.00
Available carbohydrates	62.85 ± 0.00	66.93 ± 0.00
Crude fiber	18.40 ± 0.25	19.59 ± 0. 00
Total sugars	15.08 ± 0.17	16.03 ± 0.00
Reducing sugars	3.16 ± 0.02	03.37 ± 0.00
Non-reducing sugars	11.92 ± 0.14	12.69 ± 0.00
Ash content	8.36 ± 0.11	08.90 ± 0.00
Caloric value:		
K.cal/100 g DM	279.58 ± 0.00	297.71 ± 0.00
K. Joule / 100 g MD	1169.76 ± 0.00	1245.62 ± 0.00

Values are mean±SD.

SD = Standard deviation

n = number of independent determinations.

Table (4): Minerals content of whole Doum fruits

Minerals content	On wet basis	On dry basis
	[mg/100g]	
Potassium (K)	3212.75	3421.10
Sodium (Na)	05.58	05.32
Calcium (Ca)	89.22	95.01
Magnesium (Mg)	126.44	134.64
Iron (Fe)	09.69	10.32
Manganese (Mn)	01.01	01.02
Cupper (Cu)	01.15	01.23
Zinc (Zn)	00.99	01.10

4.2 Effects of Doum fruits extract on patients with high blood pressure

4.2.1 Evaluation of Doum fruits extract

The method used in this study for preparation of Doum extract has been previously described **(Babiker, 2013**). From the results in Table (5), the volume, weight and yield (%) of Doum fruits extract were found to increase significantly ($P \leq 0.05$) with the increasing of fruit : water ratio but, the opposite was observed with respect to their total soluble solids (T.S.S %).

However, among the different fruit : water ratios used in this study, the ratio of 1 : 8 was found more suitable for preparation of Doum fruits extract with suitable volume (332.00 ml), total soluble solids (5.00%) and yield (38.33%). Doum fruits extract prepared with this method has been used as oral treatment for patients under investigation with high blood pressure history, which were selected from Mezegela Village at El-Gazera State.

4.2.2 Patients distribution according to their gender, age, weight, marital status and tribe

Thirty seven (37) patients suffering from high blood pressure were selected randomly from Mezegela Village in El-Gazera State. The majority of the patients were females (72.97%) and the rest were males (27.03%) as shown in Table (6) and Fig (2). Also, the distribution of patients according to their ages as presented in Table (7) and Fig (3) shows that the age of the most of the patients under this study ranged between 50-59 years old (29.73%) or more than 70 years old (29.73%). While the percentages of patients between the age groups 60-69 years and less than 50 years old were found to be 27.03% and 13.51%, respectively.

Moreover, the weights of 37.84% of the patients either between 60-69 kg or more than 70 kg. The percent of patients whom their weight range between 60-69 kg or those less than 50 kg were found to be 18.92% and 5.40%, respectively as indicated in Table (8) and Fig (4). In addition to that, 94.60% of patients

Table (5): Cold extraction of whole Doum fruits pulp

Doum fruits : water ratio	1:2	1:4	1:6	1:8	1:10	$Lsd_{0.05}$	SE±
Weight of Doum fruits (g)	50.00±0.00^{a}	50.00±0.00^{a}	50.00±0.00^{a}	50.00±0.00^{a}	50.00±0.00^{a}	-	-
Hydrogen ions concentration (pH)	4.31±0.05^{b}	4.32±0.06^{b}	4.41±0.08^{a}	4.44±0.09^{a}	4.46±0.11^{a}	0.13*	0.094
Volume of fruit extract (ml)	33.00±1.64^{e}	137.00±2.58^{d}	243.00±3.61^{c}	332.00±4.88^{b}	432.00±5.29^{a}	12.05**	7.838
Weight of fruit extract (g)	33.42±1.69^{e}	137.57±2.59^{d}	243.44±3.61^{c}	383.34±5.11^{b}	431.22±5.27^{a}	9.632**	1.467
Total soluble solids (T.S.S %)	15.00±0.71^{a}	9.00±0.54^{b}	6.00±0.23^{c}	5.00±0.18^{d}	3.00±0.01^{e}	0.758*	0.311
Yield % (on wet basis)	10.02±0.59^{e}	24.76±0.80^{d}	29.21±0.84^{b}	38.33±0.89^{a}	25.87±0.81^{c}	1.004**	0.756

Values are mean±SD.

SD = Standard deviation

n = number of independant determinations.

Mean(s) having different superscript(s) in a row are significantly different (P≤0.00) according to Duncan’s multiple range test.

*= Significant (P≤0.05); ** = Highly significant (P≤0.01).

Table (6): Distribution of patients according to gender

Gender	Frequency	(%)
Males	10	27.03
Females	27	72.97
Total	**37**	**100%**

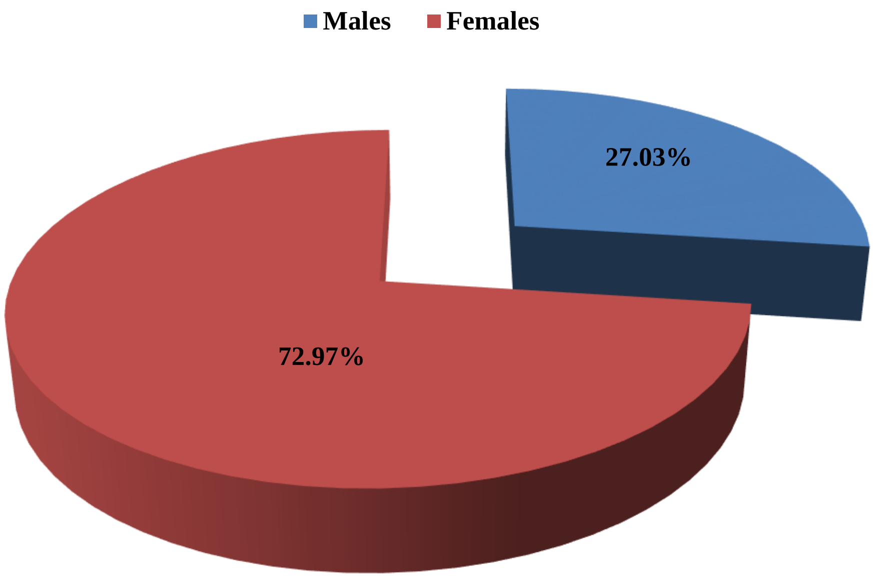

Fig. (2): Distribution of patients according to gender

Table (7): Distribution of patients according to their ages

Age group (years)	Frequency	(%)
<50	5	13.51
50-59	11	29.73
60-69	10	27.03
≥70	11	29.73
Total	**37**	**100%**
Mean±SD	61.57±10.79	
Range	45-83	

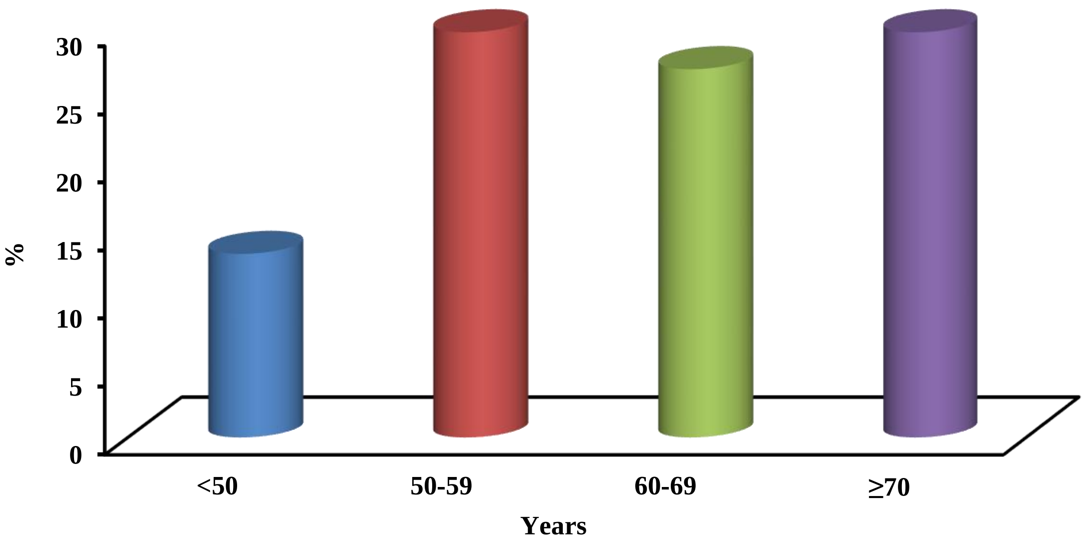

Fig. (3): Distribution of patients according to their ages

Table (8): Distribution of patients according to their weights

Weight (kgs)	Frequency	(%)
<50	2	5.40
50-59	7	18.92
60-69	14	37.84
≥70	14	37.84
Total	**37**	**100%**
Mean±SD	67.32±12.46	
Range	45-96	

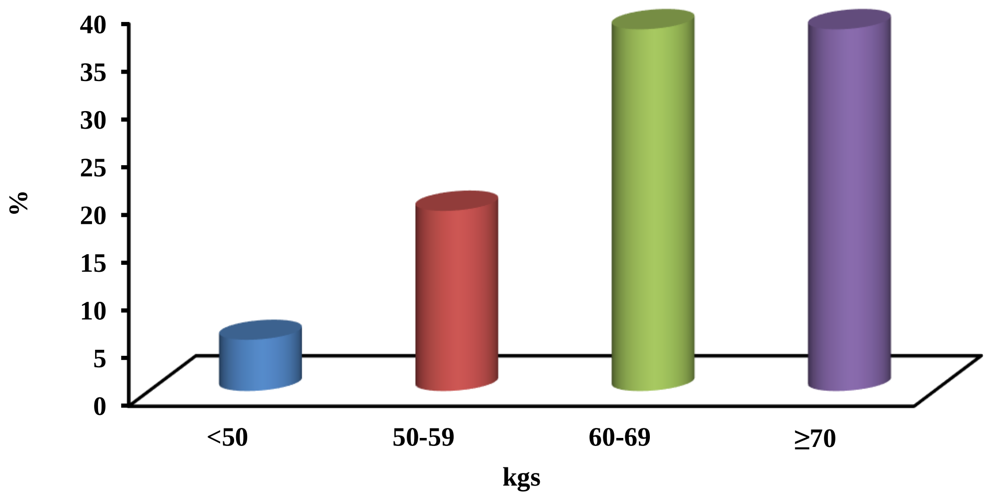

Fig. (4): Distribution of patients according to their weights

under this study were married, while 5.40% of them were single (Table, 9) and Fig (5). Also, the data in Table (10) and Fig (6) stated that, the majority of the patients were from Bidirya tribe (78.38%) while, (8.11%) of patients were Kawahla, and the rest of the sample (13.51%) were from other tribes (Shaigya, Hawaweer, Galeen and Mahas).

4.2.3 Patients family history with hypertension and other diseases

Table (11) and Fig (7) show the family history with hypertension within the patients sample. From the results, 78.38% of the patients understudy were found from families with hypertension history. The remaining cases (21.62%) had no previous family history with high blood pressure disease. However, high blood pressure disease may be due to genetic lifestyle (excess salt, excess body weight, smoking and alcohol) and environmental factors (**Palatini and Julius, 2009; Lackland and Weber, 2015**).

On the other hand, about 51% of the patients sample hand no any previous history with other diseases (Table, 12 and Fig.8). But, the remaining cases (49%) had previous history with the other diseases. **Lackland and Weber (2015)** stated that, high blood pressure may be due to chronic kidney disease, narrowing of the kidney arteries, an endocrine disorder, obesity, glucose intolerance or the use of birth control pills. Moreover, human blood pressure was found to rise with aging and the risk of becoming hypertensive in later life is considerable (**Meng, *et. al*., 2012**). In fact, about 57% of the hypertensive patients under this study were above 60 years old as indicated in Table (7).

4.2.4 Patients preference and utilization of Doum fruits

Table (13) and Fig (9) indicate patients hypersensitivity against Doum fruits juice. The results revealed that, most of the patients sample (86.49%) had no any hypersensitivity against Doum fruits juice. Also, most of them had previous

Table (9): Distribution of patients according to their marital status

Marital status	Frequency	(%)
Married	35	94.60
Single	2	5.40
Total	**37**	**100%**

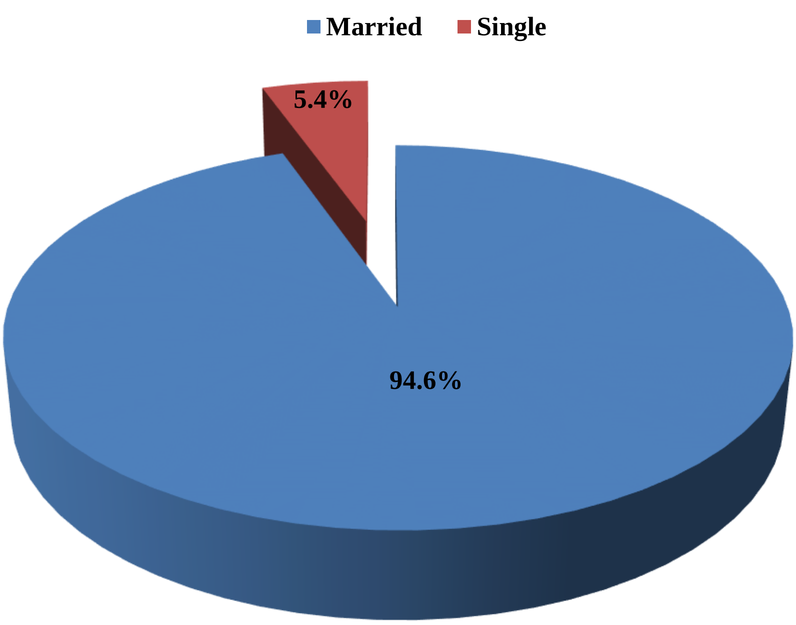

Fig. (5): Distribution of patients according to their marital status

Table (10): Distribution of patients according to their tribes

Tribe	Frequency	(%)
Bidirya	29	78.38
Kawahla	3	8.11
Other	5	13.51
Total	**37**	**100%**

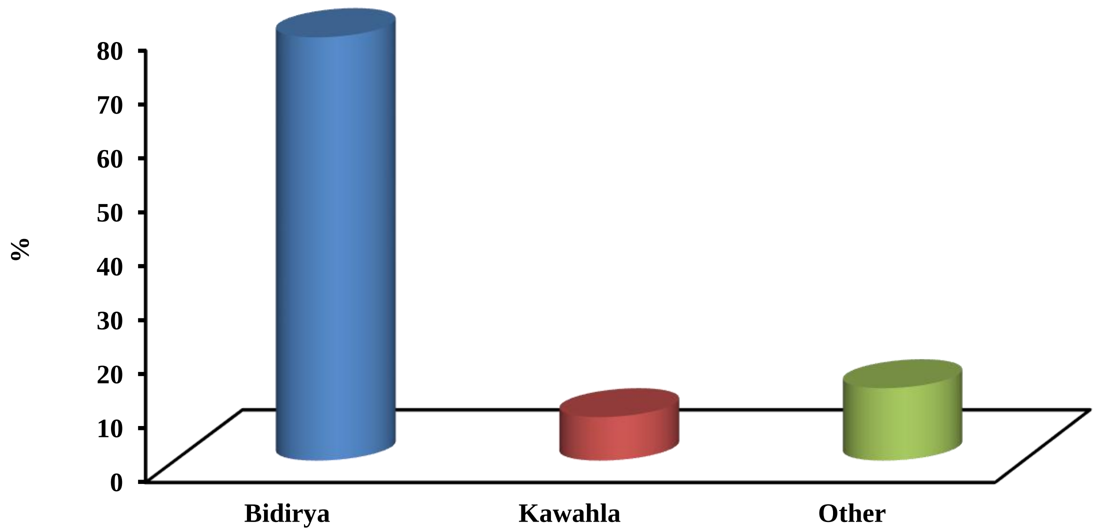

Fig. (6): Distribution of patients according to their tribes

Table (11): Patients family history with hypertension

History of hypertension	Frequency	(%)
Yes	29	78.38
No	8	21.62
Total	**37**	**100%**

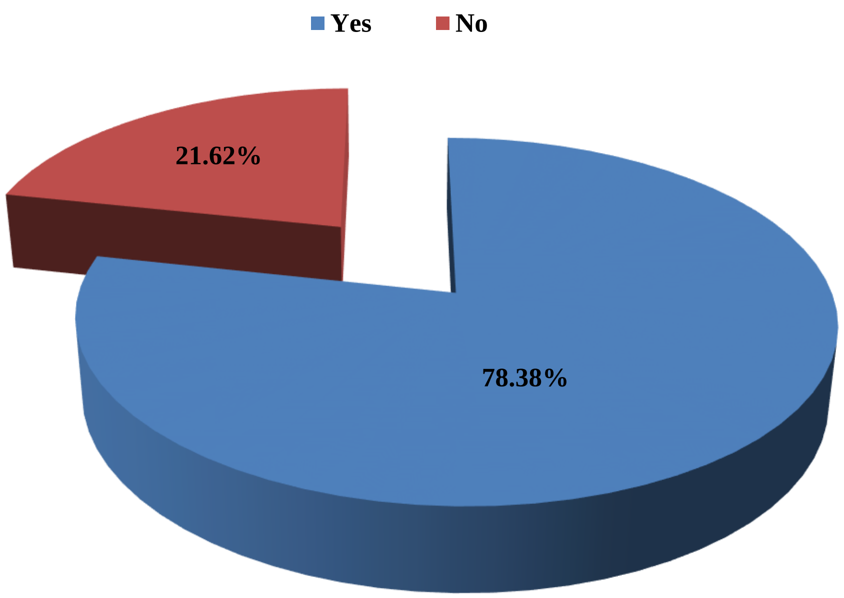

Fig. (7): Patients family history with hypertension

Table (12): Patients incidence with other diseases

Incidence with other diseases	Frequency	(%)
Yes	18	48.65
No	19	51.35
Total	**37**	**100%**

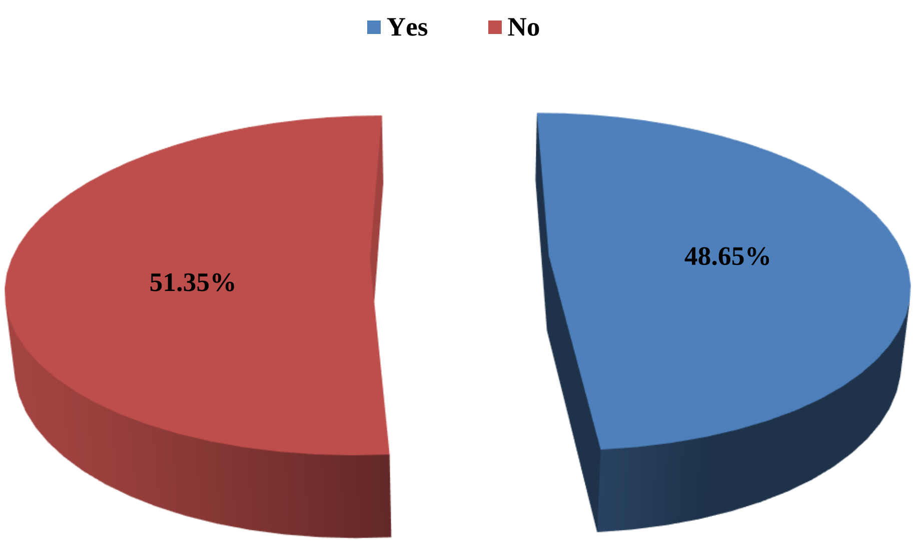

Fig. (8): Patients incidence with other diseases

Table (13): Patients hypersensitivity against Doum juice

Hypersensitivity	Frequency	(%)
Yes	5	13.51
No	32	86.49
Total	**37**	**100%**

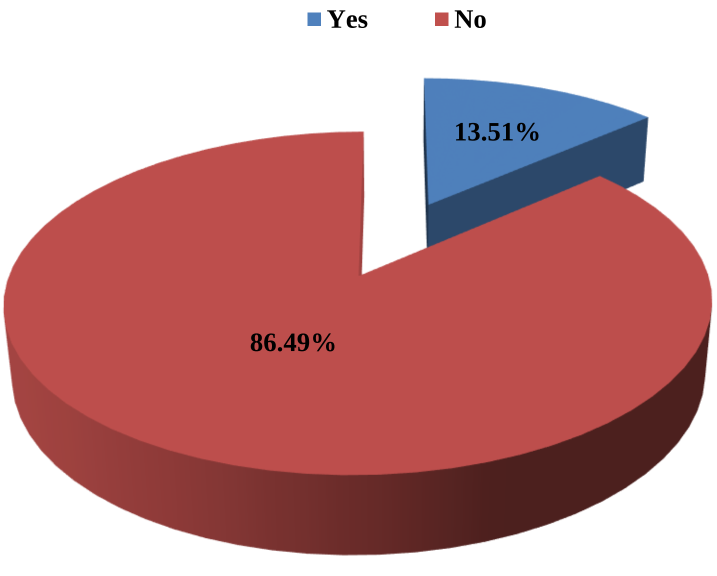

Fig. (9): Patients hypersensitivity against Doum juice

knowledge about the beneficial effects of Doum fruits in reducing human hypertension (Table, 14 and Fig, 10).

However, the majority (91.89%) of the patients under this previous study were never use Doum fruits as juice or extract (Table, 15 and Fig, 11). But, after introducing Doum extract to them during this study, most of them (67.57%) accepted the taste of Doum extract (Table, 16 and Fig, 12). Moreover, the majority of them (97.30%) were found to use Doum juice to cure other diseases (Table, 17 and Fig, 13).

4.2.5 Effects of Doum fruits extract on patients systolic and diastolic blood pressure

Thirty-seven (37) patients suffering from hypertension disease in Mezegela Village at El-Gazera State were daily treated for a period of thirty (30) days with 250 ml (5% T.S.S) freshly prepared Doum fruits extract (1 : 8 fruit : water) ratio before any medical treatment. Then, the blood pressure for each patient was measured manually before and after 30 min from serving Doum fruits extract. Table (18) and Fig. (14) show the effects of Doum fruits extract on patients systolic blood pressure before and after Doum fruits extract intake. While Table (19) and Fig. (15) indicate the effects of Doum fruits extract on patients diastolic blood pressure before and after Doum fruits extract intake.

From the results in Table (18) and Fig. (14), the systolic blood pressure in all patients was found to be more than 120 mmHg before serving Doum fruits extract. But, after serving the extract daily for 30 days, the systolic blood pressure in 45.95% of patients was found to be less than 120 mmHg, while that in 35.13% of patients remained between 120 and 129 mmHg. Moreover, the percent (%) of patients with systolic blood pressure ranging from 130-139 mmHg and more than 150 mmHg were markedly decreased from 37.84% and 10.81% to 8.11% and 2.70%, respectively. In general, the mean value of the systolic blood

Table (14): Knowledge of patients about the beneficial effect of Doum fruits in reducing hypertension

Knowledge	Frequency	(%)
Yes	6	16.22
No	31	83.78
Total	**37**	**100%**

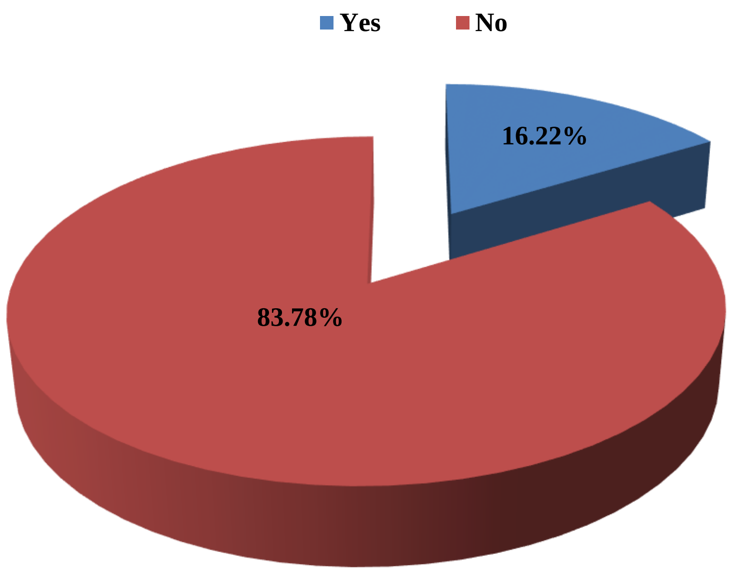

Fig. (10): Knowledge of patients about the beneficial effect of Doum fruits in reducing hypertension

Table (15): Usage of Doum juice by patients

Usage of Doum by patient	Frequency	(%)
Yes	3	8.11
No	34	91.89
Total	**37**	**100%**

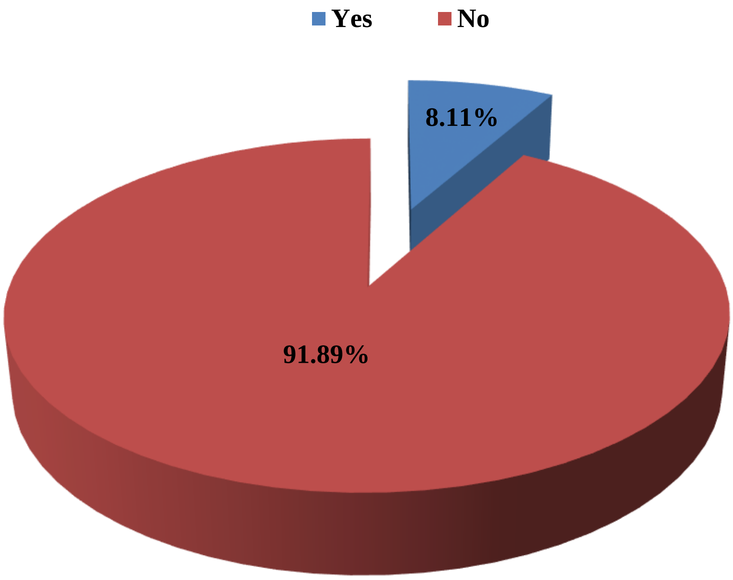

Fig. (11): Usage of Doum juice by patients

Table (16): Patients acceptance of Doum extract taste

Acceptance of Doum juice taste	Frequency	(%)
Yes	25	67.57
No	12	32.43
Total	**37**	**100%**

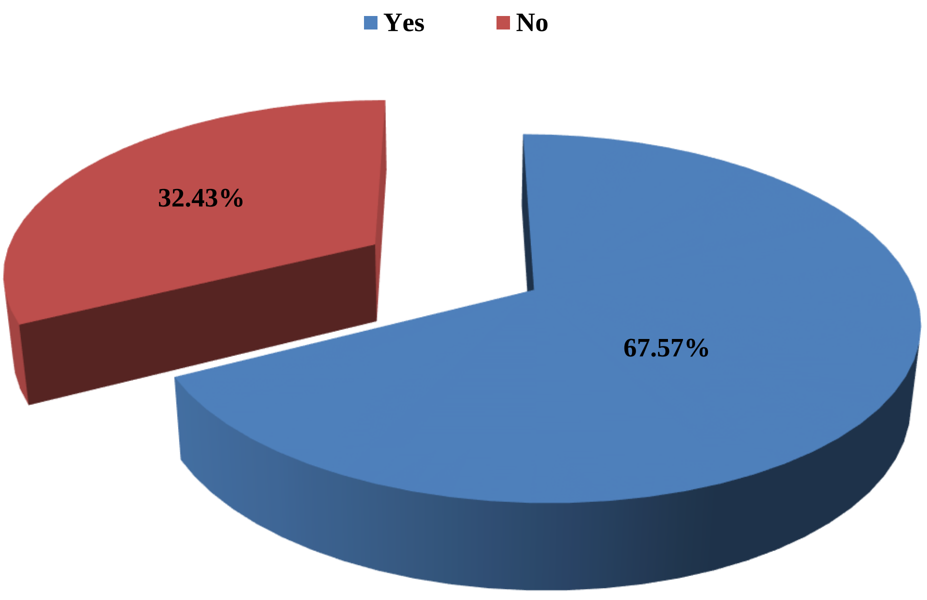

Fig. (12): Patients acceptance of Doum extract taste

Table (17): Using Doum juice by patients to cure other diseases

Cure of other diseases	Frequency	(%)
Yes	36	97.30
No	1	2.70
Total	**37**	**100%**

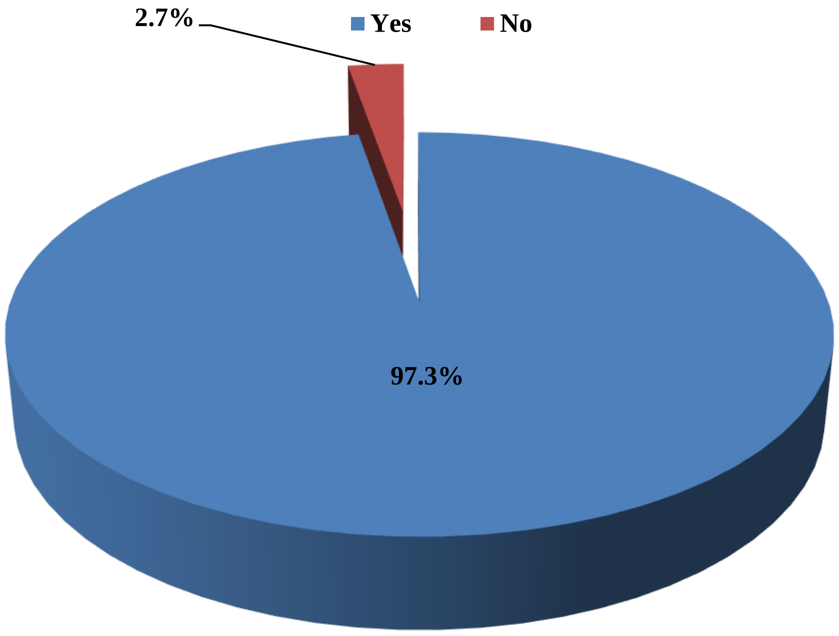

Fig. (13): Use Doum juice to cure other diseases

Table (18): Effects of Doum extract on patients systolic blood pressure before and after serving Doum fruits extract

Systolic blood pressure (mmHg)	MmHg			
	Before		After	
	Frequency	(%)	Frequency	(%)
<120	-	-	17	45.95
120-129	15	40.54	13	35.13
130-139	14	37.84	3	8.11
140-149	4	10.81	3	8.11
≥150	4	10.81	1	2.70
Total	**37**	**100%**	**37**	**100%**
Mean±SD	134.73±12.68		124.07±12.22	
Range	122.17-187.00		112.00-178.33	

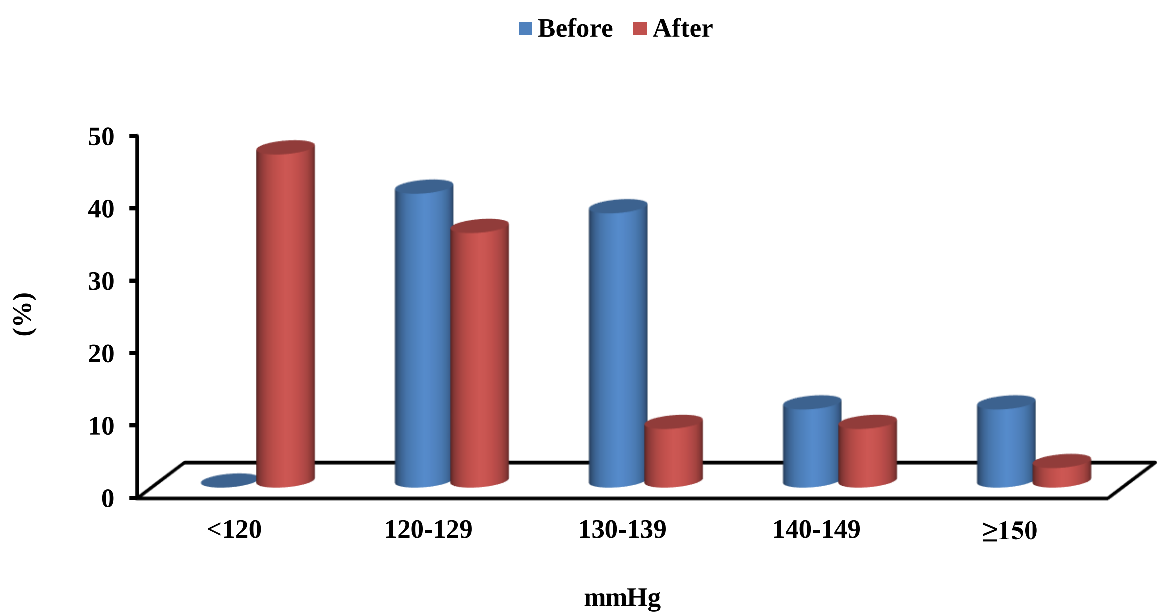

Fig. (14): Effects of Doum extract on patients systolic blood pressure before and after serving Doum fruits extract

Table (19): Effects of Doum extract on patients diastolic blood pressure before and after Doum extract intake

Diastolic blood pressure (mmHg)	MmHg			
	Before		After	
	Frequency	%	Frequency	(%)
<80	1	2.70	5	13.51
80-81	7	18.92	22	59.47
82-83	23	62.16	8	21.62
84-85	2	5.41	1	2.70
≥85	4	10.81	1	2.70
Total	**37**	**100%**	**37**	**100%**
Mean±SD	83.32±3.41		81.54±2.66	
Range	79.00-100.00		78.33-95.00	

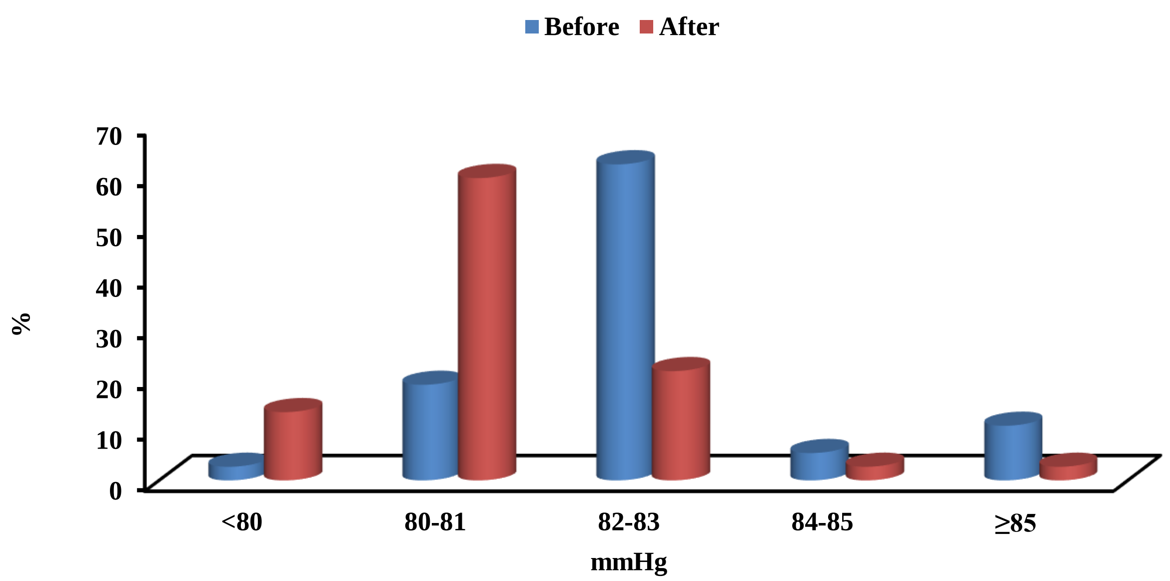

Fig. (15): Effects of Doum extract on patients diastolic blood pressure before and after Doum extract intake

pressure in all patients was greatly decreased from 134.73 mmHg to 124.07 mmHg after serving Doum fruits extract.

On the other hand, the mean value of diastolic blood pressure in all patients before and after serving Doum fruits extract for a period of 30 days was found to decrease from 83.32 mmHg to 81.54 mmHg (Table, 19 and Fig. 15). The percent (%) of the patients with diastolic blood pressure less than 80 mmHg and between 80-81 mmHg was markedly increased from 2.70% and 18.92% before serving of Doum extract to 13.51% and 59.47%, respectively. While, the percent (%) of patients with diastolic blood pressure ranging between 82-83 mmHg, 84-85 mmHg and more than ≥ 85 mmHg before serving of Doum extract was markedly decreased from 62.16%, 5.41% and 10.81% to 21.62%, 2.70% and 2.70%, respectively after Doum extract treatment.

In fact, the aqueous extract of Doum fruits pulp was proved to be capable of lowering the blood pressure both in normotensive and hypertensive dogs (**Sharaf, *e t. al.*, 1972**) and also, exhibited a significant decrease in serum total cholesterol and non-HDL cholesterol in rats (**Hetta and Yassin, 2006**). Moreover, the tea of Doum fruits was found to be popular in Egypt and is usually used by the Egyptian people as a folk medicine for treatment of hypertension (**Hetta, *et. al.*, 2005**).

4.2.6 Relationship between patients systolic blood pressure and their ages before and after serving of Doum fruits extract

Table (20) and Fig. (16) show the relationship between patients systolic blood pressure and their ages before serving of Doum fruits extract. The systolic blood pressure of all patients under this study was found to be more than ≥ 120 mmHg.

However, patients below 50 years old, their systolic blood pressure were found to range between 120-129 mmHg, 130-139 mmHg and more than 150 mmHg for about 2.7%, 8.11% and 2.7%, respectively of the total patients (13.51%)

Table (20): Relationship between systolic blood pressure and age before Doum juice intake

Systolic blood pressure (mmHg)	Age group (years)				Total (%)
	<50	50-59	60-69	≥70	
<120	-	-	-	-	-
120-129	1(2.70%)	6(16.22%)	6(16.22%)	1(2.70%)	37.84
130-139	3(8.11%)	3(8.11%)	2(5.40%)	7(18.92%)	40.54
140-149	-	1(2.70%)	2(5.40%)	1(2.70%)	10.81
≥150	1(2.70%)	1(2.70%)	-	2(5.40%)	10.81
Total %	13.51	29.72	27.03	29.72	100
P-value	0.041*				

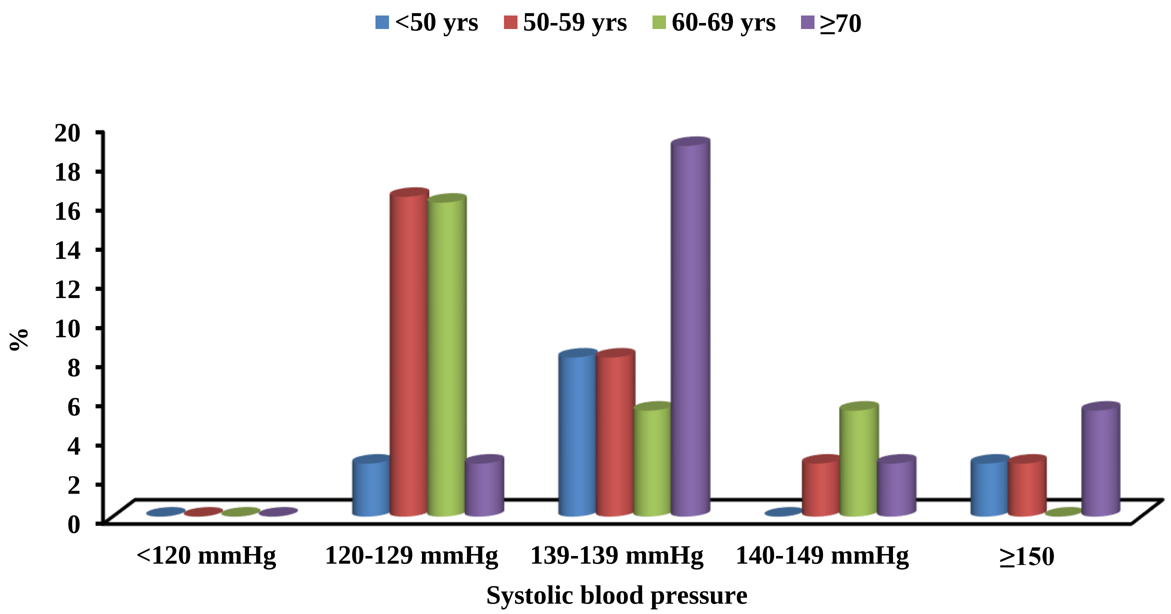

Fig. (16): Relationship between systolic blood pressure and age before Doum juice intake

within this age group. While the systolic blood pressure for patients aged 70 years old or more was found to range between 120-129 mmHg, 130-139 mmHg, 140-149 mmHg and equal or more than 150 mmHg for about 2.70%, 18.92%, 2.70% and 5.40%, respectively from the total percent of patients (29.72%) within this age group. In fact, the age of most of the patients (56.75%) under this study was found to range between 50-69 years old and their systolic blood pressure ranged between 120-129 mmHg, 130-139 mmHg, 140-149 mmHg and ≥150 mmHg for about 32.44%, 13.51%, 8.1% and 2.70%, respectively from the total patients number (21) within this age group.

In general, the systolic blood pressure for about 21.6% of the patients under this study was found to be more than 140 mmHg. But, after the patients drank the Doum fruits extract for a period of 30 days, only 8.1% of the patients sample their systolic blood pressure was more than 140 mmHg (Table, 21 and Fig. 17). Moreover, the systolic blood pressure for about 43.24% of the patients age group 50-59 years, 60-69 years and ≥70 years old become less than 120 mmHg. Also, 40.54% of the patients age groups <50, 50-59, 60-69 and ≥70 years old, their systolic blood pressure remain between 120-129 mmHg. The remaining cases (8.1%), their systolic blood pressure ranged between 130-139 mmHg.

In fact, **Meng, *et. al*. (2012)** stated that, blood pressure is usually rises with aging as the risk of becoming hypertensive in later life is considerable. Besides, lack of exercises, obesity, depression and environmental factors can play great roles in individual cases.

4.2.7 Relationship between patients diastolic blood pressure and their ages before and after serving Doum fruits extract

Table (22) and Fig. (18) illustrate the relationship between patients diastolic blood pressure and their ages before serving Doum fruits extract. While,

Table (21): Relationship between patients systolic blood pressure and age after Doum extract intake

Systolic blood pressure (mmHg)	Age group (years)				Total (%)
	<50	50-59	60-69	≥70	
<120	-	7(18.92%)	7(18.92%)	2(5.40%)	43.24
120-129	5(13.51%)	3(8.11%)	1(2.70%)	6(16.22%)	40.54
130-139	-	-	2(5.40%)	1(2.70%)	8.10
140-149	-	1(2.70%)	-	2(5.40%)	8.10
≥150	-	-	-	-	
Total %	13.52	29.37	27.02	29.72	100
P-value	0.008**				

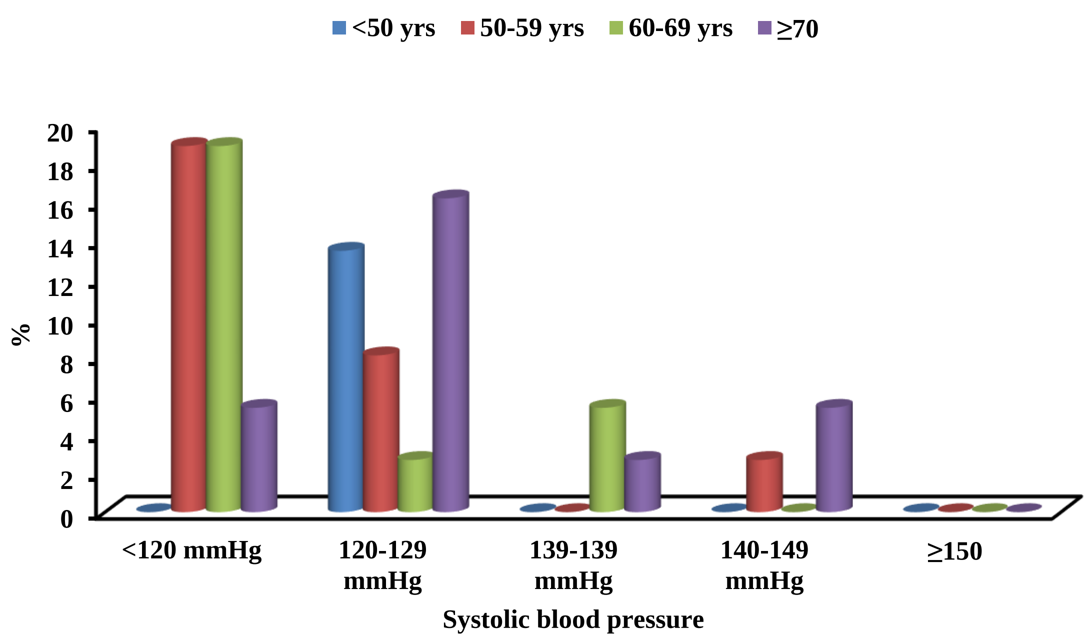

Fig. (17): Relationship between patients systolic blood pressure and age after Doum extract intake

Table (22): Relationship between patients diastolic blood pressure and their ages before Doum extract intake

Diastolic blood pressure (mmHg)	Age group (years)				Total (%)
	<50	50-59	60-69	≥70	
<80	-	-	-	1(2.70%)	2.70
80-81	-	2(5.40%)	1(2.70%)	4(10.81%)	18.91
82-83	4(10.81%)	7(18.92%)	7(18.92%)	4(10.81%)	59.46
84-85	-	1(2.70%)	2(5.40%)	-	8.10
≥86	1(2.70%)	1(2.70%)	-	2(5.40%)	10.80
Total %	13.51	29.72	27.02	29.72	100
P-value	0.044*				

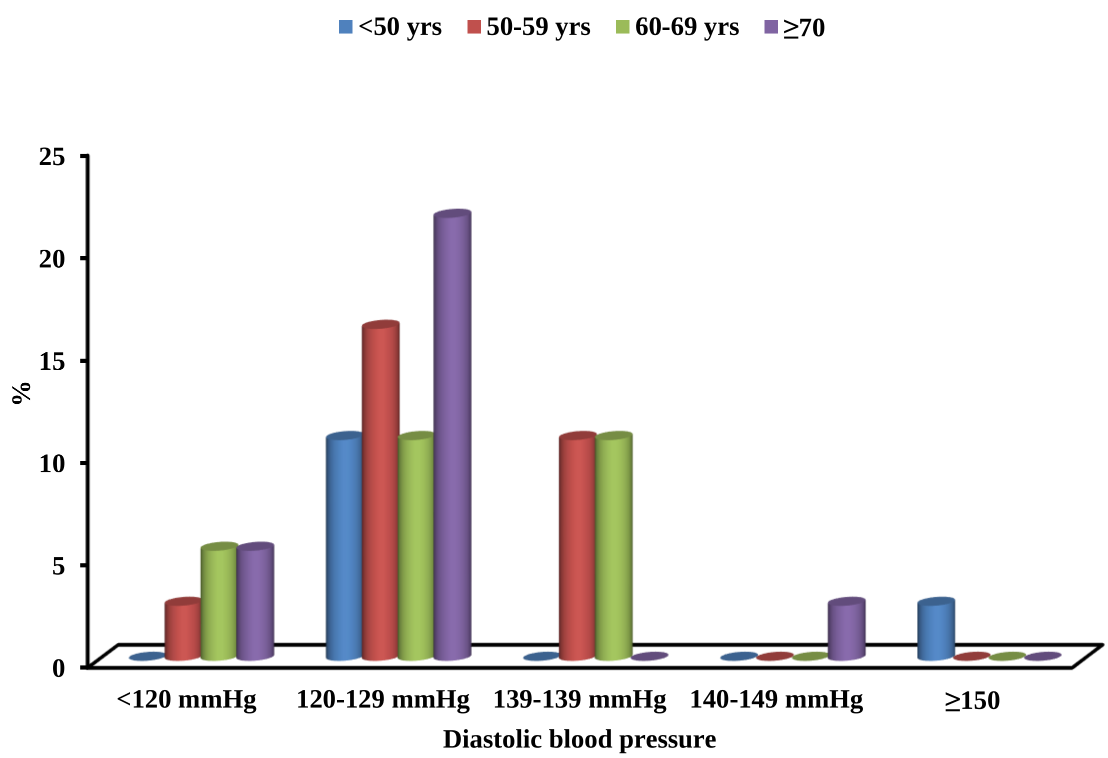

Fig. (18): Relationship between patients diastolic blood pressure and their ages before Doum extract intake

Table (23) and Fig. (19) indicate the same relationship but after the patients drank the Doum fruits extract.

In general, the diastolic blood pressures of 59.46% of the patients was found to range between 82-83 mmHg before serving Doum fruits extract. While, the diastolic blood pressures of the other patients were found to range between 80-81, 84-85 and ≥85 mmHg for about 18.91%, 8.10% and 10.80% of the patients, respectively. Only 2.7% from the patients were found to have a diastolic blood pressure less than 80 mmHg.

As mentioned before, the age of the majority of the patients (56.74%) was found to range between 50-69 years old and their diastolic blood pressure were ranged between 80-81, 82-83, 84-85 and ≥86 mmHg for about 8.10%, 37.84%, 8.10% and 2.70% of the patients, respectively. However, 10.80% of the patients under this study were found to have a diastolic blood pressure more than or equal to 86 mmHg, 5.4% of them their ages were ≥70 years old. But, after serving Doum fruits extract daily for 30 days, only 2.7% from the total patients were found to have diastolic blood pressure more than or equal to 86 mmHg (Table, 23 and Fig. 19).

In fact, the majority of the patients (81.08%) after serving Doum fruit extract their diastolic blood pressures remained between 80-83 mmHg and surprisingly 13.50% of the patients their diastolic blood pressures were found to be less than 80 mmHg, 10.80% of them their ages were more than 60 years old. However, according to the American Heart Association for Adults, the desired systolic and diastolic blood pressure for 18 years and older should be ranged between 90-119 and 60-79, respectively (**Eguchi, *et. al.*, 2007**). Also, **Chobanian, *et al*. (2003)** stated that, the normal resting systolic (diastolic) blood pressure in an adult is approximately 120 mmHg (80 mmHg), abbreviated as 120/80 mmHg.

Table (23): Relationship between patients diastolic blood pressure and their ages after Doum extract intake

Diastolic blood pressure (mmHg)	Age group (years)				Total (%)
	<50	50-59	60-69	≥70	
<80	-	1(2.70%)	2(5.40%)	2(5.40%)	13.50
80-81	4(10.81%)	6(16.22%)	4(10.81%)	8(21.62%)	59.46
82-83	-	4(10.81%)	4(10.81%)	-	21.62
84-85	-	-	-	1(2.70%)	2.70
≥86	1(2.70%)	-	-	-	2.70
Total %	13.51	29.73	27.02	29.72	100
P-value	0.006**				

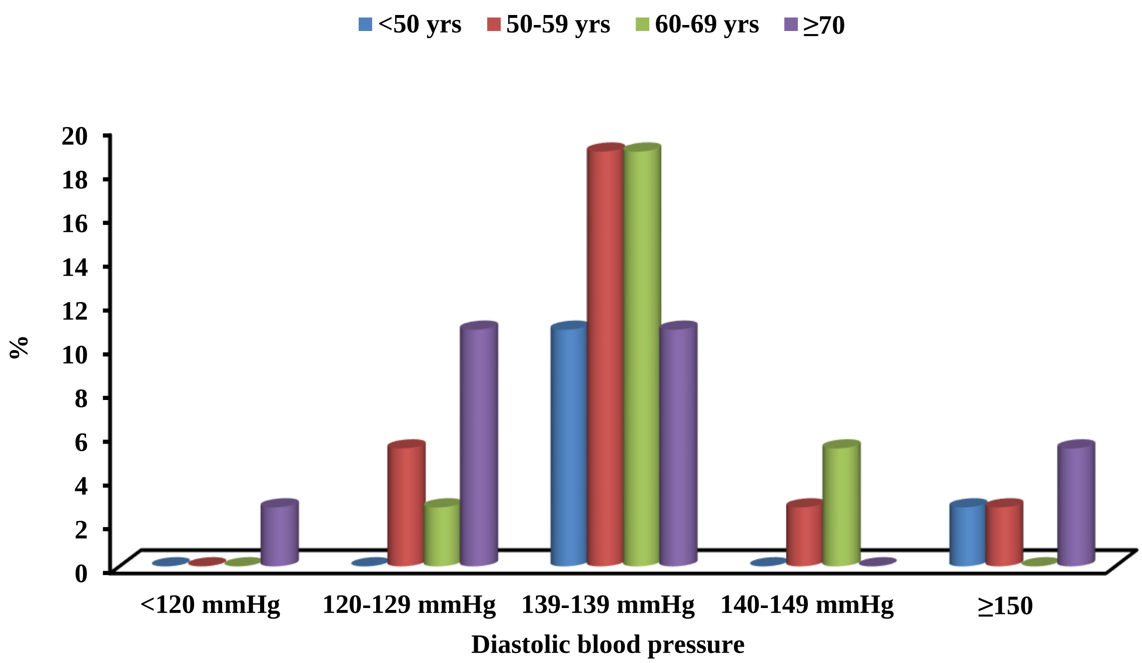

Fig. (19): Relationship between patients diastolic blood pressure and their ages after Doum extract intake

4.2.8 Relationship between patients systolic blood pressure and their tribes before and after serving Doum fruits extract

As mentioned before, the majority of the patients were from Bidirya tribe (78.38%) and 8.11% of patients were from Kawahla tribe. The rest of the patients (13.51%) were from other tribes such as Shaigya, Hawaweer, Galeen and Mahas (Table 10). Table (24) and Fig. (20) show the relationship between patients systolic blood pressure and their tribes before serving Doum fruits extract, while Table (25) and Fig. (21) indicate the same relationship but after serving Doum fruits extract to the patients.

In general, the systolic blood pressure of 75.66% of the patients before serving Doum fruits extract was found to range between 120-139 mmHg, 56.75% of them were from Bidirya tribe, 8.11% were from Kawahla tribe and the remaining cases (10.81%) were from other tribes. In addition to that, 18.92% of patients from Bidirya tribe their systolic blood pressure before serving Doum fruits extract was found to be more than 140 mmHg, 10.81% of them they had systolic blood pressure equal to or more than 150 mmHg. However, Chi-square test showed highly significant difference ($P \leq 0.014$) between systolic blood pressure and tribes of the different patients before serving Doum fruits extract.

On the other hand, after serving of Doum fruits extract daily for a period of 30 days for the different patients before any medications, 40.54% of Bidirya tribe patients, 2.70% from each Kawahla and other patients, their systolic blood pressure was found to be less than 120 mmHg. Moreover, 35.13% of patients from the different tribes their systolic blood pressure remained between 120-129 mmHg. While, only 10.81% patients from Bidirya tribe had a systolic blood pressure more than 140 mmHg, 2.70% out of them their systolic blood pressure was equal to or above 150 mmHg.

Table (24): Relationship between patients systolic blood pressure and their tribes before Doum extract intake

Systolic blood pressure (mmHg)	Tribe			Total (%)
	Bidirya	Kawahla	Other	
<120	1(2.70%)	-	-	2.70
120-129	12(32.43%)	1(2.70%)	1(2.70%)	37.83
130-139	9(24.32%)	2(5.40%)	3(8.11%)	37.83
140-149	3(8.11%)	-	1(2.70%)	10.81
≥150	4(10.81%)	-	-	10.81
Total %	78.37	8.1	13.51	100
P-value	0.014*			

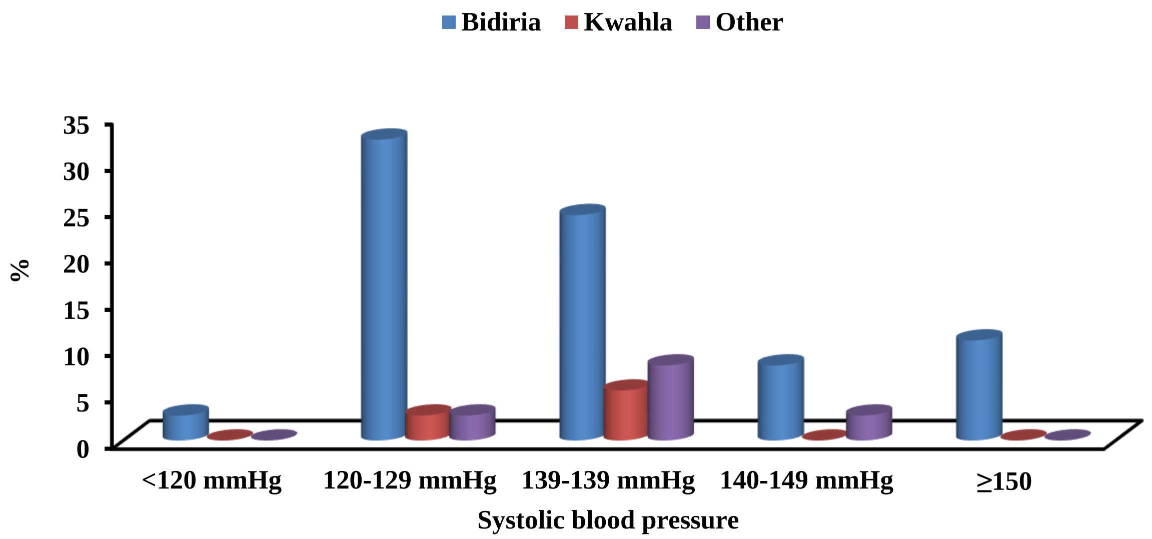

Fig. (20): Relationship between patients systolic blood pressure and their tribes before Doum extract intake

Table (25): Relationship between patients systolic blood pressure and their tribes after serving Doum extract

Systolic blood pressure (mmHg)	Tribe			Total (%)
	Bidirya	Kawahla	Other	
<120	15(40.54%)	1(2.70%)	1(2.70%)	45.94
120-129	7(18.92%)	2(5.40%)	4(10.81%)	35.13
130-139	3(8.11%)	-	-	8.11
140-149	3(8.11%)	-	-	8..11
≥150	1(2.70%)	-	-	2.70
Total %	78.38	8.10	13.51	100
P-value	0.005*			

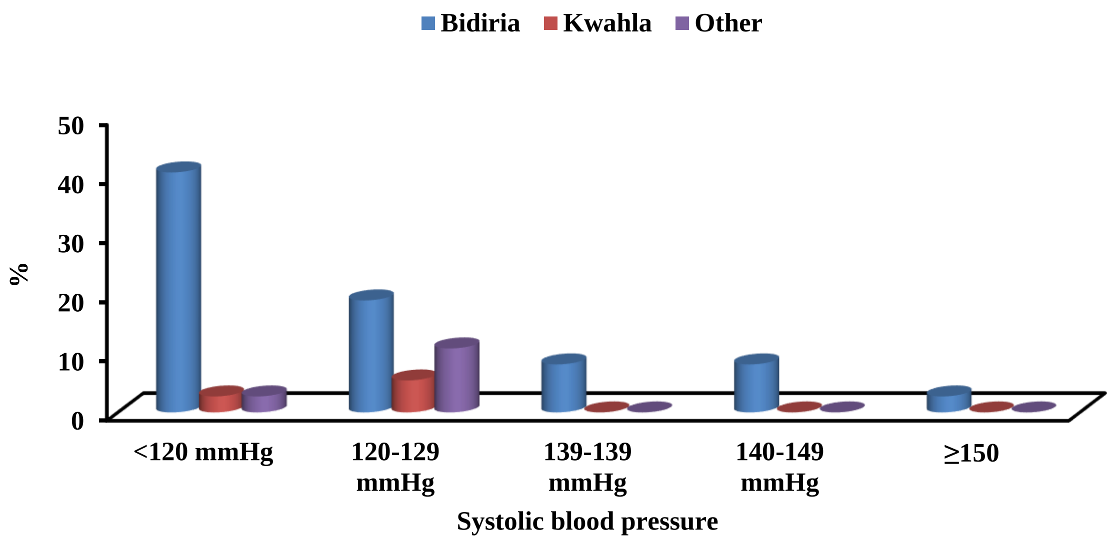

Fig. (21): Relationship between patients systolic blood pressure and their tribes after serving Doum extract

However, according to chi-square test, high significant differences ($P \leq 0.005$) were found between patients systolic blood pressures and their tribes after serving of Doum fruits extract to the different patients under this study. In fact, hypertension disease is resulted from complex interactions of genetic and environmental factors (**Palatini and Julius, 2009**).

4.2.9 Relationship between patients diastolic blood pressure and their tribes before and after serving Doum fruits extract

The relationship between patients diastolic blood pressure and their tribes before serving Doum fruits extract is presented in Table (26) and Fig. (22), whereas, the same relations but after serving Doum fruits extract is shown in Table (27) and Fig. (23). In general, the diastolic blood pressure of most of the patients (59.45%) under this study was found to range between 82-83 before serving Doum fruits extract, 48.65% out of them from Bidirya tribe, 5.40% from Kawahla and the remaining cases from other tribes. Within the Bidirya patients, 8.11% of them were found to have diastolic blood pressure less than 80 mmHg and 10.81% of them with a diastolic blood pressure more than or equal to 86 mmHg.

However, the percent of patients from the different tribes with a diastolic blood pressure between 80-81 mmHg was only 10.81% before serving Doum fruits extract. But after serving Doum fruits extract daily (Table, 27 and Fig. 23) to the different patients for a period of 30 days, the diastolic blood pressure of most of the patients (94.57%) was found to be less than 83 mmHg, 56.75% of them had diastolic blood pressure between 80-81 mmHg, 48.65% out of them from Bidirya tribe, 2.70% from Kawahla tribe and the remaining cases (5.40%) from other tribes. Moreover, the diastolic blood pressure of 16.21% of the patients was found to be less than 80 mmHg, 10.81% out of them from Bidirya tribe, 2.70% from Kawahla tribe and the remaining (2.70%) from other tribes. However, high significant differences ($P \leq 0.007$) were observed between patients diastolic blood pressure and their tribes before and after serving Doum fruits extract.

Table (26): Relationship between patients diastolic blood pressure and their tribes before serving Doum fruits extract

Diastolic blood pressure (mmHg)	Tribe			Total (%)
	Bidirya	Kawahla	Other	
<80	3(8.11%)	-	1(2.70%)	10.81
80-81	3(8.11%)	-	1(2.70%)	10.81
82-83	18(48.65%)	2(5.40%)	2(5.40%)	59.45
84-85	1(2.70%)	-	2(5.40%)	8.10
≥86	4(10.81%)	-	-	10.81
Total %	78.38	5.40	16.20	100
P-value	0.021*			

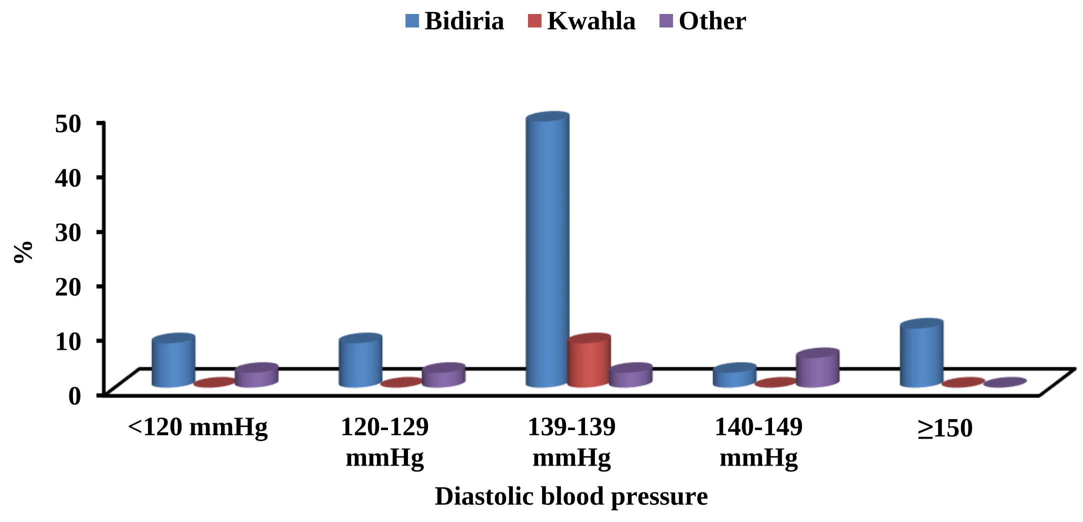

Fig. (22): Relationship between patients diastolic blood pressure and their tribes before serving Doum fruits extract

Table (27): Relationship between patients diastolic blood pressure and their tribes after serving Doum fruit extract

Diastolic blood pressure (mmHg)	Tribe			Total (%)
	Bidirya	Kawahla	Other	
<80	4(10.81%)	1(2.70%)	1(2.70%)	16.21
80-81	18(48.65%)	1(2.70%)	2(5.40%)	56.75
82-83	5(13.51%)	1(2.70%)	2(5.40%)	21.61
84-85	-	-	-	-
≥86	2(5.40%)	-	-	5.40
Total %	78.37	8.10	13.50	100
P-value	0.007^{**}			

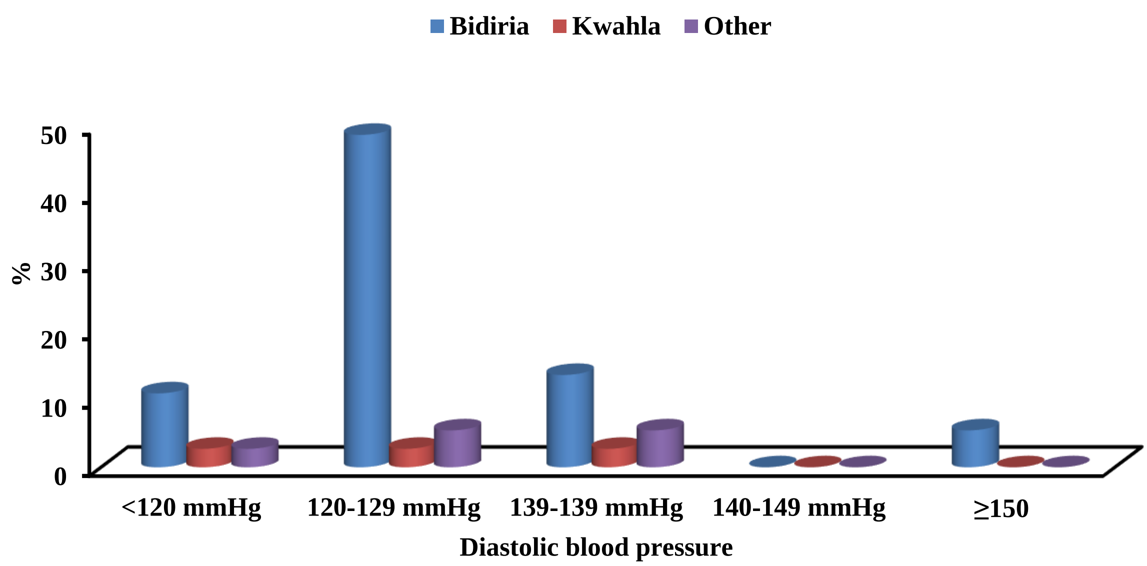

Fig. (23): Relationship between patients diastolic blood pressure and their tribes after serving Doum fruit extract

5. CONCLUSION AND RECOMMENDATIONS

5.1Conclusion

From the results obtained in this study it can be concluded that, Doum fruits conatin high concentration of dry matter, total carbohydrates, total sugar, crude fiber and ash. Also, the fruits is very rich in potassium, moderately rich in magnesium, calcium and iron, but with very low levels of Sodium manganese and zinc.

Moerover, the aquous extract of Doum fruits has great beneficial effects on patients suffuring from high blood pressure. The systolic and diastolic blood pressure in most of the patients under this study are greatly decreased and remained within the recommended levels after serving Doum extract daily for 30 days before receivingany medicinal treatment.

5.2 Recommendations

1. The industrial development and utilization of Doum fruits as traditional medicine or processed food should be encouraged in Sudan.
2. Further Studies at large scale level should be conducted to confirm the findings of this study about the effects of Doum aqueous extract on human high blood pressure.
3. Additional Studies are definitely needed to focus on Doum active ingredients for lowering the systolic and diastolic blood pressure.
4. Comprehensive national Surveys should be conducted to estimate the total production and productivity of Doum fruits and to determine the chemical and physical characteristics of the different Doum fruits cultivars grown in Sudan.

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Plate (1): Doum Fruits Aqueous Extract

Plate (2): Doum Fruits

Plate (3): Manual Blood Pressure Instrument

Plate (4): Body Weight Instrument