Comparative Hypolipidaemic Effects of *Allium cepa, Allium sativum* and *Zingiber officinale* Aqueous Extracts on Alloxan-Induced Diabetic *Rattus novergicus*

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Abstract

This study compares the hypolipidaemic effects of the increasing dosages of A. cepa, A. sativum and Z. officinale aqueous extract on alloxan-diabetic Rattus novergicus for possible use in the management of hyperlipidaemia characteristic of diabetes mellitus. Diabetes mellitus was induced in 108 out of a total of 117 adult Rattus novergicus using 150mg/kg b wt of alloxan monohydrate. Increasing dosages (200, 250 and 300mg/kg bw ip) of A. cepa, A. sativum and Z. officinale aqueous extracts were given to the diabetic rats for six weeks while the control rats got either normal saline (1ml) or increasing dosage of glibenclamide (2.5, 3.8 and 5.0mg/kg b wt ip) during the same period. Total serum lipids and total serum cholesterol were assessed using routine methods. Increasing dosages of plants aqueous extracts produced a dose-dependent significant (P < 0.05) reductions in the total serum lipid and total serum cholesterol of diabetic rats. The most effective percentage reduction in total serum lipids and total serum cholesterol were observed at 300mg/kg bw ip and this was the same for the three extracts studied. A. cepa and A. sativum at 300mg/kg bw ip caused significant reductions in total serum lipids more effective than the diabetic control drug glibenclamide at 5.0 mg/kg bw ip. A. cepa at 300mg/kg bw ip was the most effective in reducing total serum lipids, reducing it by 44.4% (184.3 ± 8.4 to 129.7 ± 5.7). A. sativum at 300mg/kg bw ip was the most effective in reducing total serum cholesterol, 39.8%, that was from (128.7 ± 2.7 to 77.2 ± 4.9), A. cepa followed 27.2% (130.1 ± 3.7 to 94.7 ± 4.2) and Z. Officinale was next , 16.1% from (130.7 ± 4.4 to 109.7 ± 7.5). From our experimental findings, it can be concluded that the three plant extracts studied exhibited promising hypolipidaemic activity in alloxan-diabetic rats. The hypolipidaemic effect presents a protective mechanism against the development of atherosclerosis and hyperlipidaemia common in diabetes mellitus. Further studies on the extracts, their composition, mode of action and active ingredients are suggested. A research on the combined effects of the three plant extracts on hyperlipidaemia was recommended for future investigations.

Keywords: Hypolipidaemic effects, *Allium cepa, Allium sativum,* Zingiber *officinale* Alloxan-Induced diabetic *Rattus novergicus*

Introduction

The term diabetes mellitus describes a metabolic disorder of multiple aetiology characterized by chronic hyperglycaemia (high blood sugar) with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both (WHO, 1999). The effect of diabetes mellitus includes long-term damage, dysfunction and failure of various organs. Diabetes mellitus may present characteristic symptoms such as thirst, polynuria, blurring of vision and weight loss (WHO, 1999). In its most severe forms, ketoacidosis or non-ketotic hyperosmolar state may develop and lead to stupor, coma and in absence of effective treatment death (WHO, 1999). Diabetes mellitus was characterized by recurrent or persistent hyperglycaemia and other signs, as distinct from a single illness or condition. WHO (1999) reported that diabetes mellitus can be diagnosed by demonstrating any one of the following:

I. fasting plasma glucose level at or above 126mg/dl (7.0mmol/l).
II. plasma glucose at or above 200mg/dL or 11.1mmol/l two hours after a 75g oral glucose load as in a glucose tolerance test.
III. random plasma glucose at or above 200mg/dl or 11.1mmmol/l.

In 2006, according to the World Health Organization, at least 171 million people world wide suffer from diabetes (ADA, 2005). Its incidence was increasing rapidly and it was estimated that by the year 2030, this number will double (ADA, 2005). Diabetes was a common and very prevalent disease affecting the citizens of both developed and developing countries (Erasto *et al.,* 2005). The greatest increase in prevalence was however expected to occur in Asia and Africa, where more patients will likely be found by 2030. In 2005, there are about 20.8 million people with diabetes in the United States alone. ADA (2005) reported that there are about 6.2 million people undiagnosed and about 41 million people that would be considered pre-diabetic. The national diabetes information clearing house estimates that diabetes costs 132 billion dollar in the United States alone every year. ADA

(2005) pointed out that 1 in 3 Americans born after year 2000 will develop diabetes in their lifetime. Statistical projections from India suggested that the number of diabetes will rise from 15 million in 1995 to 57million in the year 2025 making India the country with the highest number of diabetics in the world (King *et al.,* 1998; Boyle *et al., 2001)*. Although there was a paucity of data on the prevalence of diabetes in Nigeria and other African countries, available data suggested that diabetes was emerging as a major health problem in Africa (Mbanya *et al*., 1996). The prevalence of diabetes in Nigeria was estimated to be between 1.4 to 2.7% of the population (Erasmus *et al.,* 1988; Ngumah, 1995; Bakari *et al*., 1999) and over 90% of these are non–insulin dependent diabetes mellitus (Ohwworiole et *al*., 1988). Diabetes mellitus has been reported to be the major cause of blindness, kidney failure, lower-extremity amputation, cardiovascular diseases and premature mortality (Gohdes, 1995).

Diabetes has increasing cases in rural and poor populations throughout the world, despite major investigation into understanding the pathophysiology and treatment of diabetes mellitus, it has continued to be a major health problem worldwide (Osinubi *et al.,* 2006).The possibility of its management by the oral administration of hypoglycaemic agents has stimulated great research interest in recent years. Though different types of oral hypoglycaemic agents are available along with insulin for the management of diabetes mellitus, there was increased demand by patients for the use of herbal preparations with anti-diabetic activity (Osinubi *et al., 2006*).

The use of herbal medicine was wide spread (Habib et *al.,* 2005). The use of herbs has more than tripled over the last 10 years (Eisenberg *et al.,* 1998). Estimates of use of herbal preparation range from 40 to 60 % among the United States population (Slesinski *et al.,* 1995). The growing public interest and awareness of herbal medicine have led the pharmaceutical industry and biomedical researchers to pay more attention to medicinal plants (Day, 1998). The annual sale of medicinal herbs and related commodities in the United States now exceeds two billion dollars (Craig, 1999). The current shift to the use of herbal preparations may therefore be due to presumed effectiveness, relatively low cost, presumed less side effects and low toxicity even though the biologically active constituents may be often unknown (Osinubi *et al.,* 2006). Recently, there has been a resurgent interest in the herbal treatments of diabetes. For a long time diabetes have been treated orally with several medicinal plants or their extracts based on herbal medicine (Akhtar and Ali, 1984). Little scientific evidence exists to support the numerous herbs used to improve diabetes related metabolic disorder (Lo *et al.,* 2004). The use of herbal products for medicinal benefits has played an important role in nearly every culture on earth and for many years, the search for anti-diabetic products will continue to focus on plants and other natural resources (Osinubi *et al.,* 2006). The cost of administrating modern antidiabetic drugs was beyond the reach of most people in the low income group and those living in the rural areas, hence the use of plants for the treatment of common diseases such as diabetes are very common. Herbal medicine therefore can solve the economic problem of the poor. Investigators have consistently found that several plant products showed unique hypoglycaemic activities in diabetic animal model (Kusano and Abe, 2000). West Africa has several thousand of such plants (Gbile, 1980). Nigeria was blessed with medicinal plants which are used for the treatment of various diseases.

In line with the WHO (1980) expert committee on diabetes which recommends that traditional methods of treatment of diabetes should be further investigated. Also considering the economic resource constraints and cheapness of these herbal products, this present study was designed to determine the effect of increasing dosage of plant extracts on total serum cholesterol and total serum lipids of alloxan - induced diabetic *R. novergicus* for possible use of the most effective hypolipidaemic dosage in the prophylaxis and treatment of atherosclerosis and hyperlipidaemia commonly found in diabetes mellitus. These will thus provide a pharmacological basis for the use of the most hypolipidaemic dosage of the plant extracts in adult onset Type 2 diabetes mellitus in some parts of Nigeria, Africa and the World at large. This was more so as many modern pharmaceuticals used in conventional medicine today also have natural plant origin. Example Metformin was derived from the flowering plant *Galya officinalis* (Goat's Rue or French lilac) which was a common traditional remedy for diabetes. There was therefore no doubt that antidiabetic medicinal plant might provide an important source of new oral hypolipidaemic compounds for development as pharmaceutical entities or as simple dietary adjuncts to existing therapies. Against this background, this paper seek to ascertain the comparative hypolipidaemic effects of *Allium cepa, Allium sativum* and *Zingiber officinale* aqueous extracts on alloxan-induced diabetic *Rattus novergicus*

Materials and Methods

Plant material: The A*. sativum*, Z*. officinale* and A*. cepa used for the experiment were* bought from the Ogige market in Nsukka from a trader who has the health ones. The plants were identified to species level (Gbile, 1980) at the herbarium unit of the department of Botany University of Nigeria, Nsukka where voucher specimen were kept.

Animal model: A hundred and seventeen (117) male adult white Wistar strain albino rats (*R. norvegicus*) weighing 200 to 250g, bred in the animal house of the Faculty of Veterinary Medicine, University of Nigeria, Nsukka were used for the study. They were fed *ad labium* with 30% crude protein (Guinea feed) commercial feed. They were allowed to acclimatize under standard photoperiodic condition in a clean rat cage in the Postgraduate Research Laboratory, Department of Zoology, University of Nigeria, Nsukka. All animals were maintained under the standard laboratory condition

for temperature 26 ± 2^0C, humidity and light and were allowed free access to food and water.

Extract preparation of plant materials: The methods of Akah *et al*. (2004) and Habib *et al*. (2005) were used for extraction of the aqueous plant extracts. Fresh health plant each of *A. cepa, A. sativum* and *Z. officinale* (2000g) were washed, cut into small pieces and homogenized in a waring blender. The resulting mixture was soaked in 2L of distilled water. The mixture was allowed to stand for twenty four hours with intermittent shaking. Following filtration, the filtrate was boiled to dryness over a water bath and the weight of the crude extract determined. The extract was kept in refrigerator (4^0 C) thereafter. The extract was later reconstituted in normal saline (0.85% NaCl) at a concentration of 1g/ml before administration on each day of the experiment.

Induction of diabetes mellitus: The methods of Battu *et al*. (2007) and Osinubi *et al*. (2006) were used to induce diabetes in the rats. Two grams of crystalline powdered alloxan monohydrate was dissolved in 50mls of normal saline to yield a concentration of 40mg/ml.150mg/kg body weight of alloxan were administered intraperitoneally to the rats after overnight fast (access to only water) of twelve hours to make them more susceptible to developing diabetes. Only rats with serum glucose levels between (250 – 400 mg/dl) after two weeks were considered diabetic and used for the experiment.

Experimental design: The study was carried out on alloxan- induced diabetic rats for six weeks (Kumari *et al*., 1995). The animals were fasted for sixteen hours before each experiment and blood sample collected from the eye of the rats. All physiological parameters assessed were determined before the extract treatments of the animals (initials) and subsequently evaluated weekly for six weeks. The experimental design was the three by three Latin square design. The hundred and seventeen rats used were divided into two major groups: Group I: nine non diabetic rats (non diabetic control). Group II: a hundred and eight alloxan induced diabetic rats.

The group I rats were divided into 3 subgroups (Ia, Ib and Ic) of 3 rats each in different cages and receives 1.0ml of normal saline intraperitoneally daily. The Group II rats (alloxan induced diabetic) were divided into 4 subgroups (IIa, IIb, IIc and IId). Subgroups IIa, IIb and IIc were divided into 3 replicates (IIa_1, IIa_2, IIa_3, IIb_1, IIb_2, IIb_3 and IIc_1, IIc_2, IIc_3) respectively, each replicate (3 rats each) receiving 200 mg/kg, 250 mg/kg or 300 mg/kg of *A. cepa, A. sativum and Z. officinale* aqueous extracts intraperitonially daily which were replicated thrice. The subgroups IId was the diabetic control (twenty- seven rats) and were divided into 3 replicates (IId1, IId2 and II3) each replicate had three rats and were administered 2.5mg/kg/, 3.8mg/kg and 5.0mg/kg of antidiabetic drug (glibenclamide).

Total serum cholesterol determination: The cholesterol of the serum was oxidised to a tetraene derivative by ferric ions derived from ferric perchlorate, and the absorbance of the mixture at 590 nm was read using spectrophotometer and compared with that of a pure solution of cholesterol (Sood, 1999).

Total serum lipid determination: Serum 0.05ml, was pipetted into a test tube (15ml), containing 2.00ml of concentration Sulphuric acid (d= 1.84). The tube was swirled carefully, closed with a glass ball and placed in a bath of boiling water for 10 minutes. After cooling in cold water, o.1ml was transferred into another test tube (15ml) containing 2.5ml of phosphoric acid- vanillin reagent acid the solution was mixed carefully. The intensity of the pink colour that develops reaches its maximum after 30 minutes; it begins to fade after about 50minutes. The absorbance of the sample was measured at 530 or 546 nm against the blank. The amount of lipid was read off an analytical care, which was obtained by analyzing four different amounts of total lipid of serum. Instead of total lipids, triolein were used as reference material. In this case, the values must be multiplied by a factor of 0.76. A standard solution of triolein (10g/L) was used (Sood, 1999).

Data analysis: The data collected were pooled and analyzed for their central tendencies using descriptive statistic, values were given as mean ± standard deviation of the observations. F-LSD was employed to test the significant differences ($P < 0.05$) among treatment means. All analyses were performed using Genstat (2007) for windows.

Results

Total serum lipids: The increasing dosage (200, 250 and 300mg/kg bw ip) of *A. cepa, A. sativum* and *Z. officinale* aqueous extracts produced dose-dependent, significant ($P < 0.05$) reductions in the total serum lipids of diabetic rats after 6 weeks of treatment when compared with that of the control rats. The comparative effects of the increasing dosage of plant extracts on total serum lipids compared with glibenclamide and normal saline in alloxan diabetic and normal rats indicated that *A. cepa* at 200mg/kg reduced total serum lipids by 27.7% (184.0±9.9 to 133.1±5.8) after six weeks of treatment (Table 1). *A. cepa* at 250mg/kg reduced total serum lipids level by 29.4% (183.0±7.9 to 129.7±5.7). *A. cepa* at 300mg/kg reduced the total serum lipids by 44.4 % (184.3±8.4 to 129.7±5.7). A. sativum at 200mg/kg reduced the total serum lipids by 35.5% (183.6±8.8 to 118.4±1.8). *A. sativum* at 250mg/kg reduced the serum lipids by 38.8 % (183.2±8.8 to 111.9±5.1) *A. sativum* at 300mg/kg reduced total serum lipids by 39.5 % (183.4±8.9 to 111.0±2.6*). Z. officinale* at 200mg/kg reduced total serum lipids by 15.6% (183.3±8.1 to 154.9±6.4) after six weeks of treatment (Table 1). *Z. officinale* at 250mg/kg reduced total serum lipids by 18.0% (184.1±8.8 to 150.9±7.9). *Z. officinale* at 300mg/kg reduced total serum lipids by 19.8 % (183.0±8.3 to 146.7±6.9).

Table 1: Comparative effects of the increasing dosage of plant extracts on total serum lipids of alloxan-induced diabetic *Rattus novergicus*

Treatment	Dosage	Total serum lipids(mg/dl) per weeks							% reduction
		WK 0	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	after 6 weeks
NS	1.0ml	144.1±6.9	144.1±6.8	144.2±6.3	144.1±6.9	144.1±6.9	144.1±6.5	144.1±6.7	0.02
AC	200mg	184.0±9.9	167.7±2.6	160.0±2.6	155.2±1.4	152.3±1.7	147.3±1.9	133.1±5.8	27.7
AC	250mg	183.0±7.9	164.3±1.9	158.0±2.6	152.8±1.9	149.3±1.3	143.9±2.2	129.7±5.7	29.4
AC	300mg	184.3±8.4	161.8±3.0	154.1±2.9	146.3±1.6	141.9±2.5	137.9±0.9	102.4±1.9	44.4
AS	200mg	183.6±8.8	165.9±2.5	152.4±6.3	39.0±3.8	130.4±3.4	123.8±2.7	118.4±1.8	35.5
AS	250mg	183.2±7.5	164.8±2.5	155.3±3.4	143.3±4.1	134.9±2.3	123.0±5.0	111.9±5.1	38.8
AS	300mg	183.4±8.9	161.6±4.8	150.4±3.3	139.6±3.9	123.4±4.3	110.6±3.4	111.0±2.6	39.5
ZO	200mg	183.4±8.1	176.3±7.0	176.1±4.7	170.6±4.3	165.8±3.0	163.8±2.0	154.9±6.4	15.6
ZO	250mg	184.1±8.8	174.7±5.1	169.4±4.8	168.4±2.1	164.8±1.1	158.7±1.9	150.9±7.9	18.0
ZO	300mg	183.0±8.3	173.0±4.0	166.9±1.5	163.7±1.4	160.3±1.2	156.1±0.8	146.7±6.9	19.8
GL	2.5mg	183.7±7.4	166.1±2.1	161.3±2.7	151.8±2.2	144.9±2.9	135.8±2.6	141.6±4.9	22.9
GL	3.8mg	183.3±7.7	164.8±2.3	158.7±2.6	154.6±2.7	141.0±1.4	137.8±3.7	133.7±3.7	27.1
GL	5.0mg	182.9±8.3	163.6±1.8	155.0±3.1	146.1±2.9	136.0±3.8	126.8±3.9	122.4±4.4	33.1

Key: *Values given represent the Mean ± SD of 9 observations. Wk = weeks, NS = Normal saline represents Non Diabetic Control, AC = Allium cepa, AS = Allium sativum, ZO = Zingiber officinale and GL = glibenclamide represents Diabetic control. P < 0.05, F-LSD =4.42*

Table 2: Comparative effect of the increasing dosage of plant extracts on serum cholesterol of alloxan-induced diabetic *Rattus novergicus*

Treatment	Dosage	Total serum cholesterol(mg/dl) per weeks							% reduction
		WK0	WK1	WK2	WK3	WK4	WK5	WK6	after 6 weeks
NS	1.0ml	91.0±4.2	91.0±4.4	91.0±4.2	91.0±4.3	91.0±4.2	91.0±4.1	91.0±4.1	0.1
AC	200mg	127.1±6.7	121.9±2.6	116.8±1.9	112.1±1.9	111.9±2.0	107.8±2.2	101.2±3.3	20.4
AC	250mg	131.0±4.4	119.4±1.9	113.4±3.4	102.6±2.4	102.6±3.5	101.6±4.7	102.2±2.3	21.9
AC	300mg	130.1±3.7	117.4±2.1	111.2±2.4	99.4±3.6	100.4±3.4	96.4±5.9	94.7±4.2	27.2
AS	200mg	129.1±5.1	120.9±1.8	114.1±1.9	111.3±2.9	102.0±4.5	94.9±5.2	83.1±3.1	35.6
AS	250mg	128.7±4.2	117.6±1.9	112.4±1.7	109.0±2.0	101.2±4.5	92.1±5.2	80.2±3.5	37.7
AS	300mg	128.2±2.7	116.7±3.4	110.8±1.7	104.3±2.8	99.3±3.0	92.4±5.2	77.2±4.9	39.8
ZO	200mg	129.1±6.0	132.2±5.6	130.4±0.4	125.7±3.5	122.3±2.9	120.2±4.7	119.4±2.9	7.5
ZO	250mg	129.4±5.6	130.3±4.1	129.4±4.1	124.1±3.4	121.8±2.4	114.6±4.6	112.7±3.9	12.9
ZO	300mg	130.7±4.4	128.2±6.0	125.2±5.1	123.2±4.5	123.0±5.2	113.0±9.5	109.7±7.5	16.1
GL	2.5mg	129.4±4.4	121.8±3.5	112.9±2.6	111.9±3.4	105.7±2.0	104.7±6.7	99.7±3.2	22.9
GL	3.8mg	129.1±4.3	119.1±2.9	110.8±2.4	105.8±2.1	101.6±3.5	97.3±2.5	91.0±3.7	29.5
GL	5.0mg	129.4±3.7	115.8±2.8	109.3±2.0	102.9±2.3	96.0±3.4	97.6±5.3	86.8±3.1	32.9

Key: *Values given represent the Mean ± SD of 9 observations. WK = weeks, NS = Normal saline represents Non Diabetic Control, AC = Allium cepa, AS = Allium sativum, ZO = Zingiber officinale and GL = glibenclamide represents Diabetic control. P < 0.05, F-LSD = 4.93*

Glibenclamide at 2mg/kg bw reduced total serum lipids by 22.9% (183.7±7.4 to 141.6±4.9) after six weeks of treatment where as at 3.8mg/kg reduced total serum lipids by 27.1 % (183.3±7.7 to 133.7±3.7) (Table 1) and at 5.0mg/kg reduced total serum lipids by 33.1 % (182.9±8.3 to 122.4±4.4). The most effective percentage reduction in total serum lipids was observed at 300mg/kg bw ip and this was the same for the three extracts studied. Normal saline at 1ml/kg bw ip had no effect on total serum lipids (144.1± 6.9 to 144.1±6.7) (Table 1). These values were statistically different when their F-LSD value (4.43) was used to test the significant differences between the means (P = 0.05). Among the extracts studied, after 6 weeks of treatment, *A. cepa* at 300mg/kg bw ip was the most effective in reducing total serum lipids. The comparative effects of the increasing dosage of the extracts on total serum lipids. *A. cepa* and *A. sativum* at 300mg/kg bw ip caused percentage reductions in total serum lipids more effective than the diabetic control drug glibenclamide at 5.0mg/kg bw ip after the 6 weeks of treatment.

Total serum cholesterol: The increasing dosage (200, 250 and 300mg/kg bw ip) of *A. cepa, A. sativum* and *Z. officinale* aqueous extracts produced dose-dependent significant (P< 0.05) reductions in the total serum cholesterol of diabetic rats after 6 weeks of treatment when compared with that of the control rats. The comparative effects of the increasing dosage of plant extracts on total serum cholesterol compared with glibenclamide and normal saline in alloxan diabetic and normal rats indicated that *A. cepa* at 200mg/kg reduced total serum cholesterol by 20.4% (127.0±6.7 to 101.2±3.3) after six weeks of treatment. *A. cepa* at 250mg/kg reduced the serum cholesterol level by 21.9% (131.0±4.4 to 102.2±2.3). *A. cepa* at 300mg/kg reduced the total serum cholesterol by 27.5 % (130.1±3.7 to 94.7±4.2) and *A. sativum* at 250mg/kg reduced the serum cholesterol by 37.7 % (128.7±4.2 to 80.2±3.5). *A. sativum* at 300mg/kg reduced total serum cholesterol by 39.8 % (128.7±2.7to 77.2±4.9). *Z. officinale* at 200mg/kg reduced total serum cholesterol by 7.5% (129.1±6.0 to 119.4±2.9) after six weeks of treatment. *Z. officinale* at 250mg/kg reduced total serum cholesterol by 12.9% (129.4±5.6 to 112.7±3.9). *Z. officinale* at 300mg/kg reduced it by 16.1 % (130.7±4.4 to 109.7±7.5) (Table 2). Glibenclamide at 2.5mg/kg reduced total serum cholesterol by 22.9% (129.4±4.4 to 99.7±3.2) after six weeks of treatment. Glibenclamide at 3.8mg/kg reduced the total serum cholesterol level by 29.5 % (129.1±4.3 to 91.0±3.7). Glibenclamide at 5.0mg/kg reduced the serum cholesterol by 32.9 % (129.4±3.7 to 86.8±3.1) (Table 2). The most effective percentage reduction in total serum cholesterol was observed at 300mg/kg bw ip and this was the same for the three extracts studied. Normal saline at 1ml/kg bw ip had no effect on the total serum cholesterol (91.0 ± 4.2 to 91.0 ± 4.1).These values were statistically different when their F-LSD value (3.67) was used to test for the significant difference between the means (P = 0.05). Among the extracts studied, after 6 weeks of treatment, A. *sativum* at 300mg/kg bw ip was the most effective in reducing total serum cholesterol (39.8%), *A. cepa* follows with 27.2% and *Z. Officinale* with 16.1% reductions. The comparative effects of the increasing dosage of plant extracts on total serum cholesterol indicated that *A. sativum* at 300mg/kg bw ip more effective than the diabetic control drug glibenclamide at 5.0mg/kg bw ip after the 6 weeks of treatment in reduction of serum cholesterol, where as *A. cepa* at 300mg/kg bw ip reduced serum cholesterol in a manner similar to glibenclamide.

Discussion

Alteration in serum lipids profile are known in diabetes , which are likely to increase the risk of coronary heart disease (Laakso, 1996; Steiner, 1999; Massing *et al*., 2001). Hypercholesterolemia has been reported to occur in alloxan - diabetic rats (Sharma et *al*., 1996; Pushparaj *et al*., 2000). A significant reduction in serum cholesterol and total lipids as observed in this experiment (Table 1 and 2) were in agreement with the findings of these researchers. The marked hyperlipidaemia that characterizes the diabetic state may therefore be regarded as a consequence of the uninhibited actions of lipolytic hormones on the fat depots (Hardman and Limberd, 2001). S-allyl cysteine sulfoxide contained in garlic has been used in controlling hypercholestermia (Dahanukar *et al* ., 2000). This could account for garlic ability to reduced serum cholesterol and total serum lipids in dose- dependent manner as shown by the outcome of this research work (Table 1 and 2). Both garlic protein and garlic oil (100mg/kg b wt) exhibited significant lipid lowering effects in rats fed with cholesterol diet (Dahanukar *et al* ., 2000). The hypolipidaemic action was primarily due to a decrease in hepatic cholesterogenesis in the treated rats. These beneficial effects of garlic has been reported to be partly due to its inhibitory effects on transaminases, alkaline phosphatase, lipogenic enzymes and HMG COA reductase and partly due to stimulatory effects on plasma lecithin cholesterol acid transferase lipolytic enzymes and fecal excretion of sterols and bile acids (Dahanukar *et al* ., 2000). It has been reported in rat, chicken and monkey hepatocytes that garlic paste, garlic oil, allicin and ajoene significantly reduced cholesterol biosynthesis by inhibiting HMG COA reductase and 11-alpha-demethylase (Kemper, 2000). Some researchers postulated that garlic's trace minerals such as tellurium also inhibited hepatic cholesterol synthesis but most attribute garlic's antilipemic effects to disulfide, a decomposition product of allicin (Kemper, 2000). Total lipid contents and cholesterol levels in liver were decreased in rats after chronic garlic consumption (Banerjee and Maulik, 2002). Onions was becoming better known for its established effects on cholesterol levels (Blumenthal, 1998). With onions proven hypocholesterlemic properties, onions may have a promising future in the treatment of diabetes and heart disease (Blumenthal, 1998).

Onions lowering effect on lipid profile of diabetic rats have been confirmed by the findings of this research work (Table 1 and 2). It reduced total serum lipids and cholesterol in a dose dependent manner. This hypolipidaemic effect of onions may be connected to its active ingredient allyl propyl disulfide (APDS) , even though other active sulphurous compounds may be involved. Long term feeding of allyl propyl disulfide isolated from onions to normal growing rats led to significant decreases in serum and liver lipids (Blumenthal, 1998). Ginger was a cholesterol lowering herb (Kemper, 1999). In rabbit fed high cholesterol diet, ginger extracts had antilipemic effects reducing serum cholesterol and high lipid level (Bhandari *et al*., 1998). In experimental mice, ginger extract had significantly impaired cholesterol biosynthesis and lowered serum cholesterol concentrations (Tanabe *et al*., 1993). The findings of this research on hypolipidaemic effect of ginger (Table 1 and 2) were in line with earlier reports. The hypolipidaemic effect may be due to decreased oxidative load. It may also act by either directly scavenging the reactive oxygen metabolites, due to the presence of various antioxidant compounds (Gupta *et al* ., 2002) or by increasing the synthesis of antioxidant molecules. The prevalence of atherosclerosis among diabetics was on the increase in the world and recently in Nigeria (Nwanjo and Oze, 2006). Lipid profile which was altered in serum of diabetic patients (Orchard, 1990; Betteridge, 1994) appeared to be a significant factor in the development of premature atherosclerosis though increase in serum triglyceride and total cholesterol levels. A reduction in lipid profile could be beneficial in preventing diabetic complications as well as improving lipid metabolism in diabetics (Cho *et al* ., 2002). Considering extracts effects on lipid components, it can be assumed a potential hypolipidaemic agent which will be a great advantage both in diabetic conditions as well as the associated atherosclerosis or hyperlipidaemic conditions.

Conclusions: It can be concluded from this study that the levels of total serum cholesterol and total serum lipids which were actually raised in alloxan - diabetic rat can be lowered by garlic , onions and ginger aqueous extracts. The hypolipidaemic effects are thus protective mechanism s against the development of atherosclerosis and hyperlipidaemia common in diabetes mellitus. This study may provide a basis for dietary supplementation of garlic, onions and ginger compounds in diabetics to reduced over dependence on drug. A combination of the three plant extracts may be most effective for hyperlipidaemic managements. Further research on the combined effects of the three plant extracts on hyperlipidaemia was highly suggested as each of the three plant extracts exhibited promising hyperlipidaemic activity in alloxan - diabetic rats.

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