INTERNATIONAL RESEARCH JOURNAL OF PHARMACY
www.irjponline.com
ISSN 2230 – 8407

Review Article

HYPERLIPIDEMIA AND HYPERTENSION; CARDIOVASCULAR RISK FACTORS, VARIOUS INDUCTION METHODS AND THEIR MANAGEMENT BY ETHNOMEDICINES

Amna Batool *[1], Uzma Saleem [1], Umme Habiba Hasan [2], Farha Abid [1], Ambreen Malik Uttra [2]
[1]Faculty of Pharmaceutical, Sciences, Government College University, Faislabad, Pakistan
[2]Faculty of Pharmacy, University Of Sargodha, Pakistan
*Corresponding Author Email: amnabatoolramzan64@gmail.com

Article Received on: 17/10/16 Revised on: 03/11/16 Approved for publication: 20/11/16

DOI: 10.7897/2230-8407.0711119

ABSTRACT

Fundamental to cardiovascular diseases are two peril factors, hyperlipidemia and hypertension. These are leading cause of deaths in both developing as well urbanized countries and treated with many synthetic medicines that may attain their platue in effectiveness and having many side effects. So, therefore utmost need to seek out safe and well tolerated medicinal plants for management with scientific appraisal by using various animal models. Hence there is an agreement from many scientific facts that medicinal plants have less side effects and proven beneficial in lowering hyperlipidemia and hypertension. Hyperlipidemia causes atherosclerosis, which ultimately leads to cardiovascular diseases while in case of hypertension many factors contribute towards development of cardiovascular diseases, most importantly renin angiotensin system and sympathetic system activation. Many synthetic medicines available for treatment of these factors but allied with side effects that overcome by use of medicinal plants that are made available for human use by conducting first experiments in animal models by inducing hypertension and hyperlipidemia by various techniques and after that treating with medicinal plants. Hence review elaborated some methods of induction and various plants having hypolipidemic and hypotensive effects.

Key words: Hyperlipidemia, Hypertension, Medicinal plants, Induction methods

INTRODUCTION

Despite of many peril factors, hyperlipidemia and hypertension have been largely associated with cardiovascular diseases. Major cardiovascular diseases are coronary heart diseases (CHD) along with cerebrovascular diseases (generally known as stroke). Hypertension being a grave facet for various heart diseases and stroke can also cause kidney damage as well as other health problems**.** Furthermore, hypertension is the foremost source of death in both mounting as well as urbanized countries and impinges on both sex's male and female[1]. Conversely, hyperlipidemia leads to the advancement of atherosclerosis which eventually results in cardiovascular maladies [2]. Even though, etiology of hypertension is very composite but renin-angiotensin system is largely apprehensive in the pathogenesis of hypertension [3]. Moreover, hyperlipidemia manifested by elevation of the serum total cholesterol, low-density lipoprotein (LDL) cholesterol and triglyceride concentrations along with a decrease in the high density lipoprotein (HDL) cholesterol level. So, hyperlipidemia is turmoil of lipoprotein metabolism [4]. Recently, field of pharmacology in union with modern medicine, chemistry and biochemistry have mutually been making endeavor to figure out the etiological facets, mechanisms and pathways of derangements in the normal body functions accountable for cardiovascular risk factors with intent to get better prevention, diagnosis and treatment [3].

Ethnomedicines for Hypertension and Hyperlipidemia

Current allopathic anti-hyperlipidemic drugs comprising of bile acid sequestrants, HMG-coA reductase inhibitors, fibric acid derivatives and niacin are effective [5] but allied with many side effects like hyperuricemia, diarrhoea, myositis, hepatotoxicity, abdominal disturbances, heamoroids, generalized flushing, sensation of warmath, nausea, vomiting, impotence, myalgia (muscle cramping and aching), increased or decreased angina, cardiac arrhythmias, exhaustion and rashes [6]. Notably statins are chiefly enzyme inhibitors, so it is probable that they may be inhibiting other critical enzymes in the body [3]. Likewise, several synthetic drugs have been developed for the treatment of hypertension and most of these drugs have established better effectiveness but possess a number of disagreeable things [7]. Hypotensive therapy consisting of angiotensin converting enzyme inhibitors, angiotensin II receptor antagonists, alpha blockers, beta blockers, calcium channel blockers, diuretics, direct rennin inhibitors and vasodilators cause dry cough, dizziness, swollen ankles, tiredness, insomnia, impotence, depression, palpitations, slow heartbeat, loss of taste, constipation, headache, gout and kidney damage (rare). Hence, there is a enormous agreement of scientific facts to recommend that the use of cautiously chosen herbal remedies and dietary supplements can be helpful to lower blood pressure, besides improve on the whole functioning of heart, arteries, and entire cardiovascular system. The conventional antihypertensive therapies including diuretics, b-blockers, and calcium channel blockers are erratically flourishing in achieving the exigent target blood pressure values in hypertensive patients [8].The renin–angiotensin–aldosterone system antagonists (angiotensin converting enzyme inhibitors and receptor blockers, renin inhibitors, and mineralocorticoid receptor blockers), attain a great success in this aspect [9]. But owing to high cost and adverse effects of available hypotensive and hypolipidemic drugs, use of natural substances has been increasing now-a-days. Improved

cultural adequacy, improved compatibility with the human body and lesser side effects reported, proven herbal medicine as the mainstay of about 75-80% of the world population, chiefly in the developing countries, for primary health care [3].Therefore majority of plants have been reported in ayurvedic literature used for the treatment of hyperlipidemia and hypertension free of toxic contour and well tolerated. Thus, natural herbal treatment has following advantages over the synthetic medicine as natural remedy is somewhat more economical, easily accessible, free from unwanted or undesired effects, help in revitalizing and invigorating the human health and treat the root cause thus, helps in terminating health disorder permanently as compare to modern medicines [4]. Hence, there is utmost need of the day to seek out natural herbal hypotensive and hypolipidemic agents for treating cardiovascular diseases or to eliminate its root cause[10]. Medicinal plants used in the treatment of hypertension and hypelipidemia are given in (table 1). In addition, a vast number of plants listed in the traditional medicine are yet to receive scientific documentation.

Induction Methods in Animal Models

It is indispensable to scientifically appraise the plants thus supporting their traditional use. As these valuable plants might be source of new phytotherapeutic entities that can be developed into newer, safer and economical hypolipidemic or hypotensive drugs. Therefore, to assess the herbal plants various techniques and methods using a array of animal species like rats, mice, rabbits etc are being utilized[3]. Many textures of these animal models are akin to human diseases which mainly contribute in disease state. Nearly all of the animal models are developed from first to last by number of etiologic factors responsible for development of hypertension[11] and hyperlipidemia[3] as summarized in Table 2, 3. Several new Animal models of hypertension and hyperlipidemia are being developed as new insights in to the pathogenesis of hypertension and hyperlipidemia and importantly to know how to treat cardiovascular risk factors.

Fructose Induced Hypertriglyceridemia

In this method the rats are given 25 % fructose in drinking water for 21 days, daily. Then rats develop hypertriglyceridemia can be assessed by taking blood sample of rats and conducting laboratory analysis [12]. Diverse studies have reported that fructose feeding increases fasting plasma level of leptins in rats .The increase of plasma leptin level is indicative of resitance that result in hypertriglyceridemia in rats. It is therefore established that dietry fructose intake, hypertryglycridemia with weight gain has a direct liaison with hypertriglyceridimia[13].

Triton-Induced Hyperlipidemia

Triton WR (isooctyl-polyoxyethylene phenol) injected to mice or rats 200mg/kg intravenously and serum cholesterol levels increase piercingly 2–3 times following to 24 h. Subsequent to injection, there is increase in level of phopholipid, free and total cholesterol and triglycrides. All these changes are coupled with coagulative and fibrinolytic actions in rats with hyperlipidemia [14].

Cyclosporin A-Induced Hyperlipidemia

Etiquette adopted for this, cyclosporine is injected to male Wistar rats intraperitonaly 10mg/kg daily for two weeks. After two weeks cholesterol, bilirubin, bile flow and biliary excretion can be measured by insertion of fistula into rats. From blood or serum samples concentration of these parameters is firmed[15]. Cyclosporin A (CsA) is basically an immunosuppressant drug widely used in organ transplant recipients and patients with auto-immune disorders. CsA is allied with hyperlipidemia and an increased risk of atherosclerosis after long term deployment[3].

Cholesterol-Diet Induced Hyperlipidemia and Atherosclerosis

The way, 2% cholesterol diet is given to rats for six weeks. After six weeks, plasma cholesterol and triglyceride levels become increased. The essential molecular mechanisms of the direct efects of cholesterol diet-induced hyperlipidemia reticence of the mevalonate pathway , decrease in NO bioavailability and cGMP metabolism , increase in free radical and peroxynitrite formation , inhibition of heat shock response , and expression of oxidized low-density lipoprotein receptors which induces apoptosis , have been shown to play a role in the efects of hyperlipidemia[16].

Poloxomer 407 Induced Hypelipidemia

In this practice Poloxomer 407 is injected intraperitoneally to rats at the dose of 1 g/kg. After 15 and 24 hrs, blood sample is collected and examined for cholesterol parameters. Before this, for 26 days food and tested drug daily specified to animals. Poloxomer 407 is non ionic hydrophobic surfactant. P-407 causes hypercholesterolemia by targeting the enzyme in cholesterolgenesis, 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase which is a rate limiting enzyme in cholesterol synthesis[2].

Glucose Induced Hypertension

In rats, glucose induced elevation in blood pressure has been found contemporaneous to the elevation of sympathetic nervous system, rennin angiotensin system activation and enhanced angiotensin II level [17]. In this practice, 10 % glucose solution instead of tap water is given daily for 21 consecutive days[7]. Blood pressure is measured on week 0, 1, 2, and 3.

Egg Feed Induced Hypertension

Egg feed diet, comprising of 12 egg yolk mixed with 500 g of normal rat diet is given for 21 uninterrupted days with the aim of producing cholesterol induced hypertension. All animals received saline instead of tap water *ad libitum.* Deliberate, B.P on week 0, 1, 2 and 3 by the instrument[7].

High Salt Intake Induced Hypertension

Replacement of drinking water with 1-2% sodium chloride for 9-12 months produces hypertension in rats, chicks and rabbits. Normal kidney has the ability to seep salt and B.P remains in limits. But high salt intake cause physiologic changes and kidney not capable to expel all salt properly, ultimately results in hypertension in animals[18].

DOCA Induced Hypertension

Hypertension, in this course of action is induced by replacing rat's drinking water with 2% sodium chloride solution *ad libitum*. After that DOCA (deoxycorticosterone acetate) dissolved in sesame oil given at a dose of 10 mg/kg, twice weekly for 43 days. DOCA induces hypertension by increasing salt and water absorption,that in due course increase blood volume, vasopressin with ion secretion and increase vasoconstriction. RAAS related bustle is also distorted by administration of DOCA in rats. Other animals like pigs and

dogs also prone to induction of hypertension by DOCA administration[11].

Stress Induced Hypertension

BHRs (borderline hypertensive rats) have been used for stress induced hypertension that bare to daily sessions of either short (20 min) or long (120 min) interval air-jet stimulation. Hypertension is induced in rats in contrast to home cage controls rats after two weeks .With 120 min long phase; rats develop high systolic blood pressure than that of 20 min short phase. The Stress-induced hypertension is linked with either normal or concealed PRA (plasma rennin activity) values, signifying that the hypertension in these animals is not renin-dependent [18].The inhibition of prostaglandin (PG) synthesis by the release of corticoids in the stress response is promising method for stress-induced hypertension[19].

Cholinomimetic Agents Induced Hypertension

A cholinesterase inhibitor, physostigmine and a direct muscarinic cholinergic agonist, oxotremorine have been worn for induction of hypertension in rats. Physostigmine (10-80 µg/kg) and oxotremorine (20-40 µg/kg) intravenously in a dose-reliant manner increase BP. A direct start of central cholinergic mechanism and peripherally sympathetic nervous system has been occurred after injection that ultimately increased B.P [11].

Angiotensin-II Induced Hypertension

Angiotensin-II, an important vasoconstrictor at a dose of (0.7 mg/kg/day) subcutaneous infusion using mini pump elicits hypertension in rats in 4-8 weeks [18]. The amplified level of an angiotensin II boost sympathetic activity, Na and Cl reabsorption, water retension and K-excretion ,vasoconstriction of arterioles, increase ADH secretion, increase aldosterone secretion. All these alteration result in increased circulating volume along with water retention, which in turn increase blood pressure[20].

Cadmium Induced Hypertension

Chronic administration of Cadmium chloride (CdCl) at a dose of (1 mg/kg) daily intra peritonealy for 2 weeks induces hypertension in rats. CdCl-induced hypertension and create a undeviating contractile effect on vascular smooth muscle which is linked to the fact that the metal ion might mimic Ca2+ ion as a partial agonist and produce a hypertension[18].

Chronic Nitric Oxide Inhibition-Induced Hypertension

A nonselective nitric oxide synthase inhibitor, N- nitro-L-argininemethyl ester (L-NAME) is given to rats by oral administration (40 mg/kg/day) by dissolving in drinking water daily for 4 weeks[11]. As a result hypertension produced is estimated by measuring different markers in plasma and tissue of rats. Markers comprise plasma nitric oxide metabolites (NOx), lipid peroxidative products such as thiobarbituric acid reactive substances, lipid hydroperoxides, conjugated dienes, and antioxidants such as superoxide dismutase, catalase, glutathione peroxidase, vitamin C, vitamin E, and reduced glutathione level[21].

Table 1: Medicinal plants for treating Hypertension and Hyperlipidemia

Botanical name	Family	Part used
Achyranthus aspera[22]	Amarantaae	Whole Plant
Aegle marmelos[3]	Rutaceae	Fruits
Agave veracruz [23]	Amaryllidaceae	Roots, leaves, gum
Allium cepa[24]	Lilliaceae	Bulbs
Aloe barbadensis [3]	Lilliaceae	Leaves
Amaranthus Spinosus[25]	Amaranthaceae	Leaves
Boswellia ovalifoliolata[6]	Bursereaseae	Gum resin
Bambusa arundunacea [3]	Graminae	Leaves
Bosswellia serrata [26]	Burserraceae	Gum
Brassica vercapitata [3]	Cruciferae	Oil
Butea monosperma Lam.[27]	Fabaceae	Leaves
Bauhinia purpurea[28]	Fabaceae	Leaves
Commiphora mukul [29]	Burseraceae	Resin
Cissus quandrangularis [28]	Vitaceae	Stem
Cinnamomum tamala [30]	Lauraceae	Leaves
Cassia fistula L.[31]	Fabaceae	Legume
Capparis dedicua[32]	Capparidaceae	Leaves, fruits and stems
Capparis spinosa[22]	Capparidaceae	Fruits
Capsicum frutescens [33]	Solanaceae	Fruits
Carum capaticum [3]	Umbelliferae	Fruits, roots
Celastrus paniculatus [34]	Celastraceae	Seed oil, barks, roots and fruits
Curcuma amada [3]	Zingiberaceae	Rhizomes
Curcuma longa[22]	Zingiberaceae	Rhizomes
Cyamopsis tetragonoloba[22]	Leguminosae	Seeds
Carum carvi[12]	Apiaceae	Seeds
Chlorophytum borivilianum [35]	Liliacea	Root
Carica papaya[22]	Cariaceae	Seed
Fritillaria ussuriensis maxim [36]	Liliaceae	Bulb
Crategus aronica[37]	Rosaceae	Fruits
Crotalaria juncea[38]	Fabaceae	Leaves
Chlorophytum Borivilianum[39]	Liliaceae	Root
Dalbergia latifolia[40]	Fabaceae	Bark
Dracocephalum kotschyi[41]	Lamiaceae	Leaves
Eclipta alba L.[42]	Asteraceae	------
Emblica officinalis[43]	Euphorbiaceae	Dried fruits, Seeds, leaves

Eugenia cumini [44]	Myrtaceae	Seeds
Eclipta prostrate[45]	Asteraceae	Leaves
Eugenia jambolana[46]	Myrtaceae	Kernels
Ficus racemosa[47]	Moraceae	Bark
Glycyrrhiza glabra[48]	Leguminoceae	Root
Hibiscus cannabinus[49]	Malvaceae	Fresh mature Leaves
Habiscus rosasinesis[50]	Malvaceae	Root
Ipomoea aquatic[51]	Convovulaceae	Root
Lagenaria siceraria[52]	Cucurbitaceae	Whole plant
Lycium barbarum[53]	Solanaceae	Fruit
Luffa aegyptiaca[54]	Cuccurbitaceae	Fruit
Morinda citrifolia[55]	Rubiaceae	Fruit
Moringa oleifera[56]	Moringaceae	Fruit
Nelumbo nuficera[57]	Nulumbonaceae	Leaves
Ougeinia oojeinensis[58]	Fabaceae	Bark
Oscium basilium [57]	Labiateae	Whole plant
Pterocarpus marsupium[57]	Fabaceae	Wood and bark
Pithecellobium Dulce [59]	Leguminosae	Fresh leaves
Piliostigma Thonningii[60]		Leaves
Psidium guajava[61]	Myrtaceae	Leaves
Randia dumetorum[62]	Rubiaceae	Fruit
Rhinacanthus nasutus[63]	Acanthaceae	Whole plant
Salvodora persica[64]	Salvadoraceae	-------
Sapindus emarginatus[64]	Sapindeae	Pericarps
Spergularia purpurea[65]	Caryophyllaceae	------
Sphaeranthus indicus[66]	Asteraceae	Flower heads
Sesbania grandiflora[67]	Fabaceae	Leaves
Terminalia arjuna[68]	Combritaceae	Fruit
Tribulus alaltus[69]	Zygophyllaceae	Aerial parts
Tinospora cardifolia[70]		Stem
Terminalia chebula[57]	Combritaceae	-------
Urtica diocia[71]	Urticaceal	-------
Vernonia anthalmintica[51]	Zingiberaceae	Flower,stem
Withania somnifera[39]	Solanaceae	Roots,leaf
Zingiber officinale [72]	Zingiberaceae	Rhizome

Botanical name	Family	Part used
Agastache mexicana[1]	Lamiacea	Bark
Aronia mitchurnii[73]	Rosaceae	Fruit
Allium sativa[74]	Amaryllidaceae	Fruit
Astragalus complanatus[1]	Febaceae	Seeds
Averrhoa carambola[75]	Oxalidaceae	Leaves
Agathosma betulina[76]	Rutaceae	------
Annona muricata[77]	Annonaceae	Leaf
Apium graveolens[74]	Apiaceae	------
Blond psyllium[76]	Plantaginaceae	------
Borago officinalis[78]	Boraginaceae	Leaves
Buddleja crispa[8]	Buddlejaceae	Leaves
Coriandrum sativum[79]	Apiaceae	Fruit
Cuscuta japonica [80]	Convulvulaceae	Leaves
Cocos nucifera [81]	Arecaceae	Seed
Citrus limetta[82]	Asteraceae	Whole plant
Centella asiatica[83]	Apiaceae	Whole plant
Daucus carota[84]	Umbelliferae	Aerial parts
Desmodium styracifolium[85]	Leguminosae	Leaves,Stem
Fuchsia magellanica[86]	Onagraceae	Leaf
Gynura procumbens[87]	Asteraceae	Leaves
Glycine max [84]	Fabaceae	Beans
Gossypium barbadens[85]	Malvaceae	Leaves,
Geum japonicum[88]	Rosaceae	Leaves
Globimetula cupulata85	Loranthaceae	Leaves
Graptopetalum paraguayense [89]	Crassulaceae	Leaves
Ginko biloba90	Ginkgoaceae	Leaves
Harpephyllum caffrum Bernh [1]	Anacardiaceae	Stem, bark
Hibiscus sabdariffa[28]	Malvaceae	Leaves, calyx, and Corolla
Hyptis fruticosa[91]	Lamiaceae	Leaves
Jacaranda mimosaefolia[8]	Bignoniaceae	Leaves
Jatropha gossypiifolia[92]	Euphorbiaceae	Leaves
Leonurus cardiaca [1]	Lamiaceae	Aerial parts
Loranthus ferrugineus[8]	Lorantheaceae	Leaves
Lavandula stoecha[1]	Lamiaceae	----
Lepidium latifolium[84]	Cruciferae	Leaves
Lumnitzera racemosa[8]	Combretaceae	Whole plant

Lycopersicon esculentum[93]	Solanaceae	Fruit
Moringa oleifera[94]	Moringaceae	Leaves
Musanga cecropiodes[8]	Cecropiaceae	Stem bark
Memordica charantia[95]	Cucurbitaceae	Whole plant
Melothria maderaspatana[96]	Cucurbitaceae	Leaves
Mesona procumbens[8]	Lamiaceae	Seed
Matricaria recutita[97]	Asteraceae	Flower
Nigella sativa[98]	Ranunculaceae	Seeds
Oleo europpaea[1]	Oleaceae	Leaves
Opuntia dillenii cladodes [99]	Cactaceae	Leaves
Peganum harmala[8]	Nitrariaceae	------
Phyllanthus amarus[100]	Euphorbiaceae	Leaves
Pinus pinaster[101]	Pinaceae	Bark
Phyllanthus urinaria[102]	Phyllanthaceae	Fruit ,leaf ,flower
Passiflora nepalensis[103]	Passifloraceae	Petals
Panax ginseng[104]	Araliaceae	Root
Panax quinquefolius[105]	Araliaceae	Root
Periploca laevigata[1]	Apocynaceae	Bark, root
Persea americana mill [106]	Lauraceae	Leaves
Raphanus sativus[83]	Cruciferae	----
Rhaptopetalum coriaceum oliver[8]	Scytopetalaceae	Stem bark
Retama raetam forssk[1]	Fabaceae	Leaves
Sesamum indicum[8]	Pedaliaceae	Seeds
Solanum sisymbriifolium[107]	Solanaceae	Root
Salvia cinnabarina [1]	Lamiaceae	Leaves
Solanum torvum[108]	Solanaceae	Fruits
Saururus chinensis[109]	Saururaceae	Root
Theobroma cacao[110]	Malvaceae	
Tanacetum vulgare[111]	Asteraceae	Leaf
Tropaeolum majus[112]	Tropaeolaceae	Seed, leaf ,flower
Ulmus macrocarpus[1]	Ulmaceae .	Root bark
Uncaria rhynchophylla[113]	Rubiaceae	----
Vitex donian[1]	Verbenaceae	Plant
Zingiber officinale [114]	Zingiberaceae	Rhizome
Achillea wilhemsii[115]	Astreaceae	Leaves, Flowers
Lepeechinia caulescens[116]	Lamiaceae	Leaves
Achillea millefolium[117]	Asteraceae	Leaves
Clerodendron trichotomum [118]	Lamiaceae	Stem
Crataegus oxyacantha[119]	Rosaceae	Whole plant

Table 2: Animal models of Hyperlipidemia and Hypertension

Induction methods for Hyperlipidemia	Induction method for hypertension
Fructose induced hypertriglyceridemia in rats	Glucose induced hypertension
Triton-induced hyperlipidemia	Egg-feed induced hypertensive rats
Cyclosporin A-induced Hyperlipidemia	High salt intake induced hypertension
Cholesterol-diet induced hyperlipidemia	DOCA induced hypertension
Poloxomer 407 induced hypelipidemia	Stress induced hypertension
Transgenic animals	Cholinomimetic induced hypertension
Hereditary hypercholesterolemia in rats	Angiotensin induced hypertension
Hereditary hyperlipemia in rabbits	Cadmium induced hypertension
	Chronic nitric oxide inhibition induced hypertension

Table 3: Animal models of cardiovascular risk factors

Animal model	*Animals used*	*Dose*	*Route*	*Duration*	*Mechanism of induction*
Fructose induced hypertriglyceridemia in rats:	Rats, (Mouse, guinea pig ,hamster)	25 % fructose	Orally, by drinking water	21 days	Leptin resistance
Triton-induced hyperlipidemia:	Mouse and rats	200mg/kg	i.v	24 h	Increase phospholipids, associated cogulative and fibrinolitic activities
Cyclosporin A-induced Hyperlipidemia:	Rats	10mg/kg	i.p	2 weeks	Obstruction bile, bile flow, bilirubin
Cholesterol-diet induced hyperlipidemia	Rats	2% cholestrol	Oraly feed	6 weeks	Metabolic changes
Poloxomer 407 induced hypelipidemia	Rats	1g/kg	i.p	15/24 h	3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductas, a targeted enzyme
Glucose induced hypertension	Rats	10 % glucose	Orally, in drinking water	21 days	Elevation of SNS, activation of RAAS, increase level of angiotensin II
Egg-feed induced hypertensive rats	Rats	500g of normal diet along with	Orally in diet	21 days	Increase level of cholesterol

		12 egg yolk			
High salt intake induced hypertension	Rats, Chiks, Rabbit	1-2 5 NaCl	Orally in drinking water	9-12 months	Kidney inability to excrete all salts
DOCA induced hypertension	Rats	2 5 NaCl+10mg/kg DOCA in sea same oil	Orally in diet	Twice weekly for 43 days	Increasing salt and water absorption, that ultimately increases blood volume, vasopresor ion secretion and increase vasoconstriction. RAAS related activity increase
Stress induced hypertension	Borderline hypertensive rats	Air jet stimulation		60mints/120 mints	Usual or concealed PRA values, indicative of that, the hypertension in these animals is not renin-dependent.
Cholinomimetic induced hypertension	Rats	20-40 µg/kg	*i.v*		Direct stimulation of SNS ,Cholinergic mechanism
Angiotensin induced hypertension	Rats	(0.7 mg/kg/day)	s.c	4-8 weeks	Increase angiotensin level,, a vasoconstrictor
Cadmium induced hypertension	Rats	1mg/kg	Peritoneal	2 weeks	Ca ions express contractile effect on vascular smooth muscle
Chronic nitric oxide inhibition induced hypertension	Rats	40mg/kg	Orally, drinking water	4 weeks	Plasma nitric oxide metabolites (NOx), lipid peroxidative

CONCLUSION

In a nutshell hyperlipidemia and hypertension are deep-seated threat factors to cardiovascular diseases and have been managed with medicinal plants that are harmless and well tolerated with scientific evaluation by using various animal models. Further studies should be conducted towards the purification and characterization of biological active compounds that might serve as novel lead molecules for the synthesis of newer and safer therapeutic agents for cardiovascular diseases allied with hypertension and hyperlipidemia.

REFERENCES

1. Talha J, Priyanka M, Akanksha A. Hypertension and herbal plants. Int Res J Pharm 2011; 2: 26-30.
2. Dalwadi PP, Patani P. Anti hyperlipidemic activity of Tephrosia purpurea plant extracts in poloxomer 407 induced hyperlipidemic rats. *Int J. Pharmacol Res.* 2014; 4: 186-193.
3. Kaushik V, Saini V. Hyperlipidemia: its management and induction. IJPSR 2014; 5: 3152.
4. Bisht A, Madhav NS, Upadhyaya K. Screening of polyherbal formulation for its potential anti-hyperlipidemic and antioxidant activity. J Pharmacogn Phytochem 2015; 3:134-139.
5. Asija R, Sharma S, Sharma PK, Choudhary P, Kumar V. A review on antihyperlipidemic activity of various herbal plants and various experimental animal models. J drug discov ther 2014; 2: 71-77.
6. Kumar DS, Banji D, Harani A, Kumar CP, Varma JR. Role of Boswellia ovalifoliolata Bal. Henry extract on high fat diet induced hypercholesterolemia. Pharmacogn J 2014; 6: 108.
7. Alamgeer A, Akhtar MS, Jabeen Q, Akram M, Khan HU, Karim S, et al. Antihypertensive activity of aqueous-methanol extract of *Berberis orthobotrys* Bien Ex Aitch in rats. Trop J Pharm Res; 12: 393-399.
8. Singh P, Mishra A, Singh P, Goswami S, Singh A and Tiwari KD. Hypertension and herbal plant for its treatment: a review. IJRPB 2015; 3; 358.
9. Unger T, Paulis L, Sica DA. Therapeutic perspectives in hypertension: novel means for renin–angiotensin–aldosterone system modulation and emerging device-based approaches. Eur Heart J 2011; 32: 2739-2747.
10. Gulshan AB, Dasti AA, Hussain S, Atta MI, Amin-ud-Din M. Indigenous uses of medicinal plants in rural areas of Dera ghazi khan, Punjab, Pakistan. J Agri Bio Sci 2012; *7*: 750-762.
11. Badyal DK, Lata H, Dadhich AP. Animal models of hypertension and effect of drugs. Indian J pharmacol 2003; 35: 349-362.
12. Saghir MR, Sadiq S, Nayak S, Tahir MU. Hypolipidemic effect of aqueous extract of Carum carvi (black Zeera) seeds in diet induced hyperlipidemic rats. Pak J Pharm Sci 2012; 25: 333-7.
13. Borate AR, Suralkar AA, Birje SS, Malusare PV, Bangale PA. Antihyperlipidemic effect of protocatechuic acid in fructose induced hyperlipidemia in rats. Int J Pharm Bio Sci 2011; 2: 456-460.
14. Okazaki M, Suzuki M, Oguchi K. Changes in coagulative and fibrinolytic activities in Triton WR-1339-induced hyperlipidemia in rats. JPN J Pharmacol 1990; 52: 353-361.
15. Kockx M, Kritharides L. Cyclosporin A-Induced Hyperlipidemia. Lipoproteins - Role in Health and Diseases. INTECH Open Access Publisher. 2012. 338-354. http://dx.doi.org/10.5772/47866
16. Puskás LG, Nagy Z B, Giricz Z, Ónody A, Csonka C, Kitajka K et al. Cholesterol diet-induced hyperlipidemia influences gene expression pattern of rat hearts: a DNA microarray study. *FEBS letters* 2004; *562*(1-3), 99-104.
17. Tom EN, Demougeot C, Mtopi OB, Dimo T, Djomeni PD, Bilanda DC, Girard C, Berthelot A. The aqueous extract of Terminalia superba (Combretaceae) prevents glucose-induced hypertension in rats. J. Ethnopharmacol 2010; 133: 828-833.
18. Kaur M, Rana AC, Kumar S. Induction of hypertension by various animal models. Int J Pharm Biol Sci 2011; 1: 335-340
19. Melby C L. Inhibition of prostaglandin synthesis: A possible mechanism for stress-induced hypertension. Med Hypotheses 1983; 10: 445-449.
20. Foe¨x P , Sear JW. Hypertension: pathophysiology and treatment, Continuing Education in Anaesthesia, Critical Care & Pain. 2004; 4: 71-75.
21. Kumar V, Abbas AK, Aster JC. *Robbins basic pathology*. Elsevier Health Sciences. (2012).
22. Alagumanivasagam G, Veeramani P. A review on medicinal plants with hypolipidemic activity. Int J Pharm Ana Res 2015; 4: 129-134
23. Joseph S, Santhosh D, Udupa A L, Gupta S, Ojeh N, Rathnakar UP et al. Hypolipidemic Activity of Phyllanthus Emblica Linn (Amla) & Trigonella Foenum Graecum (Fenugreek) Combination In Hypercholesterolemic

Subjects–A Prospective, Randomised, Parallel, Open-Label, Positive Controlled Study. Asian J. Biochem. Pharm Res 2012; 2: 225-230.
24. Kumari K, Augusti KT. Lipid lowering effect of S-methyl cysteine sulfoxide from Allium cepa Linn in high cholesterol diet fed rats. J Ethnopharmacol 2007; 109: 367-371.
25. Girija K, Lakshman K. Anti-hyperlipidemic activity of methanol extracts of three plants of Amaranthus in triton-WR 1339 induced hyperlipidemic rats. Asian Pac J Trop Biomed 2011; 1: S62-S65.
26. Pandey R S, Singh B K, Tripathi YB. Extract of gum resins of Boswellia serrata L. inhibits lipopolysaccharide induced nitric oxide production in rat macrophages along with hypolipidemic property. Indian J. exp. biol. 2005; 43: 509.
27. Sai Krishna N, Ranganayakulu D. Gopi Sudheer kumar J, Vijay Kumar G, Anusha M. Anti-atherosclerotic activity of the ethanolic extract of the Butea monosperma leaves as alone and in combination with the Atorvastatin. J. Adv. Drug Res. 2010; 1: 20-26.
28. Lakshmi BVS, Neelima N, Kasthuri N, Umarani V, Sudhakar M. Antihyperlipidemic activity of Bauhinia purpurea extracts in hypercholesterolemic albino rats. Int J Pharm Tech Res 2011; 3: 1265-1272.
29. Wu J, Xia C, Meier J, Li S, Hu X, Lala DS. The hypolipidemic natural product guggulsterone acts as an antagonist of the bile acid receptor. Mol Endocrinol 2002; 16: 1590-1597.
30. Dhulasavant V, Shinde S, Pawar M, Naikwade NS. Antihyperlipidemic Activity of Cinnamomum tamala Nees, on High Cholesterol Diet Induced Hyperlipidemia. Int J Pharm Tech Res 2010; 2: 2517-2521.
31. Gupta UC, Jain GC. Study on hypolipidemic activity of Cassia fistula. Legume in rats. Asian J. Exp Sci 2009; 23: 241-248.
32. Chahlia N. Preliminary studies into the hypolipidemic activity of various parts of Capparis decidua. Ethnobotanical Leaflets 2009; 2009: 8.
33. Sikarwar MS, Patil MB. Antihyperlipidemic activity of Salacia chinensis root extracts in triton-induced and atherogenic diet-induced hyperlipidemic rats. Indian J Pharmacol 2012; 44: 88.
34. Patil RH, Prakash K, Maheshwari VL. Hypolipidemic effect of Celastrus paniculatus in experimentally induced hypercholesterolemic wistar rats. Indian J Clin Biochem 2010; 25: 405-410.
35. Kaup SR, Arunkumar N, Bernhardt LK, Vasavi RG, Shetty SS, Pai SR et al. Antihyperlipedemic activity of Cynodon dactylon extract in high-cholesterol diet fed Wistar rats. GMBHS 2011; 3: 98-102.
36. Kang DG, Oh H, Cho DK, Kwon EK, Han JH, Lee HS. Effects of bulb of Fritillaria ussuriensis maxim. on angiotensin converting enzyme and vascular release of NO/cGMP in rats. J Ethnopharmacol 2002; 81: 49-55.
37. Rastogi S, Pandey MM, Rawat AKS. Traditional herbs: a remedy for cardiovascular disorders. Phytomed 2016; 23: 1082-1089.
38. Harikumar K, Niveditha B, Reddy PK, Pawan Kumar MK, Gajendra P. Anti-Hyperlipidemic activity of Alcoholic and Methonolic extracts of Crotolaria Juncea in Triton-Wr 1339 Induced Hyperlipidemia. Int. J. Phytopharmacol 2012; 3: 256-262.
39. Visavadiya NP, Narasimhacharya AVRL. Ameliorative effects of herbal combinations in hyperlipidemia. Oxid Med Cell longev 2011; *2011*:
40. Khalid M, Siddiqui HH. Lipid lowering and hypoglycaemic potential of dried Dalbergia latifolia Roxb. Bark extract in Sprague-Dawley rats induced with high fat diets. Int. J. Nat Prod Res 2011,
41. Golshani S, Karamkhani F, Monsef-Esfehani HR, Abdollahi M. Antinociceptive effects of the essential oil of Dracocephalum kotschyi in the mouse writhing test. J Pharm Sci 2004; 7: 76-79.
42. Verma RC, Sachan A K, Nath R, Dixit RK, Pant KK and Dwivedi S. Antihyperlipidaemic Activities Of Eclipta Alba And Boerhaavia Diffusa In Rats And Their Comparison With Atorvastatin 2012; 1: 2230-7850.
43. Anila L, Vijayalakshmi NR. Flavonoids from Emblica officinalis and Mangifera indica—effectiveness for dyslipidemia. J Ethnopharmacol 2002; 79: 81-87.
44. Patel SS, Shah RS, Goyal RK. Antihyperglycemic, antihyperlipidemic and antioxidant effects of Dihar, a polyherbal ayurvedic formulation in streptozotocin induced diabetic rats. Indian J. exp. biol. 2009; 47: 564.
45. Dhandapani R. Hypolipidemic activity of Eclipta prostrata (L.) L. leaf extract in atherogenic diet induced hyperlipidemic rats. Indian J. exp. biol. 2007; 45: 617.
46. Ravi K, Rajasekaran S, Subramanian S. Antihyperlipidemic effect of Eugenia jambolana seed kernel on streptozotocin-induced diabetes in rats. Food ChemToxicol 2005; 43: 1433-1439.
47. Sophia D, Manoharan S. Hypolipidemic activities of Ficus racemosa Linn. bark in alloxan induced diabetic rats. Afr J Tradit Complement Altern Med 2008; 4: 279-288.
48. Maurya SK, Raj K, Srivastava AK. Antidyslipidaemic activity of Glycyrrhiza glabra in high fructose diet induced dsyslipidaemic Syrian golden hamsters. Indian J. Clin. Biochem 2009; 24: 404-409.
49. Zade V, Dabhadlkar D. Evaluation of potential aphrodisiac activity of Hibiscus canabinus (Linn.) seeds in male albino rat. Int J Pharm Bio Sci 2013; *3*, 276-286.
50. Mishra RITU, Karmarkar SM, Bhagwat AM. Preliminary dose dependent study on anti-hyperlipidemic activity of Hibiscus rosa sinensis Linn leaves on triton WR 1339 induced hyperlipidemic mice model. Asian J. Pharm. Clin. Res 2011; 4: 100-102.
51. Maruthupandian A, Mohan VR. Antidiabetic, antihyperlipidaemic and antioxidant activity of Pterocarpus marsupium Roxb. in alloxan induced diabetic rats. Int J Pharm Tech Res 2011; 3: 1681-1687.
52. Ghule BV, Ghante MH, Saoji AN, Yeole PG. Hypolipidemic and antihyperlipidemic effects of Lagenaria siceraria (Mol.) fruit extracts. Indian J. exp. biol. 2006; 44: 905.
53. Luo Q, Cai Y, Yan J, Sun M, Corke H. Hypoglycemic and hypolipidemic effects and antioxidant activity of fruit extracts from Lycium barbarum. Life Sci. 2004; 76: 137-149.
54. Thayyil AH, Surulivel MKM, Ahmed M F, Ahamed GSS, Sidheeq A, Rasheed A et al. Hypolipidemic activity of Luffa aegiptiaca fruits in cholesterol fed hypercholesterolemic rabbits. Int. J. Pharm. Appl. 2011; 2: 81-88.
55. Hadijah H, Ayub MY, Zaridah H, Normah A. Hypolipidemic activity of an aqueous extract of Morinda citrifolia fruit in normal and streptozotocin-induced diabetic rats. J. Trop. Agric. and Fd. Sc 2008; 36: 77-85.
56. Jain PG, Patil SD, Haswani NG, Girase MV, Surana SJ. Hypolipidemic activity of Moringa oleifera Lam., Moringaceae, on high fat diet induced hyperlipidemia in albino rats. Rev. Bras. Farmacogn. 2010; 20: 969-973.
57. Maruthappan V, Shree KS. Hypolipidemic activity of Haritaki (Terminalia chebula) in atherogenic diet induced hyperlipidemic rats. J. Adv Pharm Tech. Res. 2010; 1: 229.

58. Velmurugan C, Sundaram T, Sampath Kumar R, Vivek B, Sheshadri Shekar D, Ashok Kumar BS. Anti diabetic and hypolipidemic activity of bark of ethanolic extract of Ougeinia oojeinensis (ROXB.). Med J Malaysia 2011; 66: 23.
59. Sundarrajan T, Raj Kumar T, Udhayakumar E, Arunachalam G. Hypolipidemic activity of Pithecellobium Dulcebench. *Triton Wr-1339 induced hyperlipidemic Rats.* Int J Chem Pharm Sci. 2010; 1: 50-3.
60. Dasofunjo K, Nwodo OF, Johnson JT, Ukpanukpong R U, Ugwu MN, Ayo VI. Phytochemical screening and effect of ethanolic leaf extract of Piliostigma thonningii on serum lipid profile of male albino rats. J Nat Prod Plant Resour. 2013; *3*: 5-9.
61. Shinde S, Chivate N, Kulkarni P, Naikwade N. Hypolipidemic activity of Psidium guajava linn leaves extracts in hyperlipidemic rats. Int J Pharm Pharm Sci. 2013; *5*(1): 70-72.
62. Mishra PR, Panda PK, Korla AC, Panigrahi S. Evaluation of acute hypolipidemic activity of different plant extracts in triton Wr-1339 induced hyperlipidemia in albino rats. Pharmacologyonline 2011; 3: 925-34.
63. Desu BSR, Saileela CH. Anti-hyperlipidemic activity of methanolic extract of Rhinacanthus nasutus. Int J Res Pharm Chem 2013; *3*: 708-11.
64. Jeyabalan S, Palayan M. Antihyperlipidemic activity of Sapindus emarginatus in Triton WR-1339 induced albino rats. Res. J. Pharm. Tech. 2009; 2: 319-323
65. Jouad H, Lemhadri A, Maghrani M, Zeggwagh NA, Eddouks M. Cholesterol-lowering activity of the aqueous extract of Spergularia purpurea in normal and recent-onset diabetic rats. J. Ethnopharmacol 2003; 87: 43-49.
66. Pande VV, Dubey S. Antihyperlipidemic activity of Sphaeranthus indicus on atherogenic diet induced hyperlipidemia in rats. IJGP 2009; *3*(2).
67. Saravanakumar A, Vanitha S, Ganesh M, Jayaprakash J, Ramaswamy NM. Hypolipidemic activity of Sesbania grandiflora in triton wr-1339 induced hyperlipidemic rats. Int. J. Phytomed. 2010; *2*(1).
68. Subramaniam S, Subramaniam R, Rajapandian S, Uthrapathi S, Gnanamanickam VR, Dubey GP. Anti-atherogenic activity of ethanolic fraction of terminalia arjuna bark on hypercholesterolemic rabbits. eCAM 2011; *2011:*
69. Faki E, Abdalla OM. Ecological Field Studies On The Population Dynamics Of The Solitary Desert Locust Schistocerca Gregaria (Forskål) (Acrididae: Orthoptera) (2015). (Doctoral dissertation, UOFK).
70. Dhingra D, Jindal V, Sharma S, Kumar HR. Evaluation of Antiobesity activity of Tinospora cordifolia stems in Rats. IJRAP. 2011; 2: 306-311.
71. Mahjoub S, Davari S, Moazezi Z, Qujeq D. Hypolipidemic effects of ethanolic and aqueous extracts of Urtica dioica in rats. World Appl Sci J. 2012; 17: 1345-1348.
72. Kadnur SV, Goyal RK. Beneficial effects of Zingiber officinale Roscoe on fructose induced hyperlipidemia and hyperinsulinemia in rats. Indian J. Exp. Biol. 2005; 43: 1161.
73. Lahlou S, Tangi KC, Lyoussi B, Morel N. Vascular effects of *Tanacetum vulgare* l. Leaf extract: *In vitro* pharmacological study. J Ethnopharmacol 2008; 120: 98-102
74. Soncini R, Santiago MB, Orlandi L, Moraes GO, Peloso ALM, dos Santos MH Giusti-Paiva A. Hypotensive effect of aqueous extract of Averrhoa carambola L.(Oxalidaceae) in rats: An in vivo and in vitro approach. J. Ethnopharmacol 2011: 133: 353-357.
75. Hajji M, Masmoudi O, Souissi N, Triki Y, Kammoun S., Nasri, M. Chemical composition, angiotensin I- converting enzyme (ace) inhibitory, Antioxidant and Antimicrobial activities of the essential oil from *Periploca laevigata* root barks. Food Chem. 2010; 121: 724-731.
76. Joshi UH, Ganatra TH, Bhalodiya PN, Desai TR, Tirgar PR. Comparative Review on Harmless Herbs with Allopathic Remedies As Anti-Hypertensive. Res.J. Pharm. Biol. Chem. Sci. 2012;
77. Ahalya B, Shankar KR, Kiranmayi G. Exploration of anti-hyperglycemic and hypolipidemic activities of ethanolic extract of Annona muricata bark in alloxan induced diabetic rats. Int. J. Pharm. Sci. Rev. Res. 2014; 25: 21-27.
78. Russo M, Cacciola F, Bonaccorsi I, Dugo P, Mondello L. Determination of flavanones in Citrus juices by means of one-and two-dimensional liquid chromatography. J. sep. sci. 2011; 34: 681-687.
79. Bankar GR, Nayak PG, Bansal P, Paul P, Pai KSR, Singla RK. Vasorelaxant and Antihypertensive effect of *Cocos nucifera* linn. Endocarp on isolated rat thoracic aorta and doca salt-induced hypertensive rats. J. Ethnopharmacol 2011, 134: 50-54.
80. Lin SY, Wang CC, Lu YL, Wu WC, Hou WC. Antioxidant, Anti-semicarbazide-sensitive amie oxidase, and Anti-hypertensive activities of geraniin isolated from *Phyllanthus urinaria.* Food Chem Toxicol. 2008; 46: 2485-2492.
81. Jorge VG, Rolffy OA, Julio RL, Patricia CE, Rafael VM, Maximiliano IB. Vasorelaxant and antihypertensive effects of methanolic extract from roots of Laelia anceps are mediated by Ca+ 2 channel antagonism. Fitoterapia 2010; 81: 350-357.
82. Consolini AE, Sarubbio MG. Pharmacological effects of Eugenia uniflora (Myrtaceae) aqueous crude extract on rat's heart. J. Ethnopharmacol 2002; 81: 57-63.
83. Taniguchi H, Kobayashi-Hattori K, Tenmyo C, Kamei T, Uda Y, Sugita-Konishi Y et al. Effect of Japanese radish (Raphanus sativus) sprout (Kaiware-daikon) on carbohydrate and lipid metabolisms in normal and streptozotocin-induced diabetic rats. Phytother Res. 2006; 20: 274-278.
84. Tabassum N, Ahmad F. Role of natural herbs in the treatment of hypertension. Pharmacogn. Rev. 2011; 5: 30-40.
85. UH J, Ganatra TH, Bhalodiya PN, Desai TR, Tirgar P. Comparative Review on Harmless Herbs with Allopathic Remedies As AntiHypertensive. Res. J. Pharm., Biol. Chem. Sci. 2012; 3: 673-687.
86. Etuk EU. A review of medicinal plants with hypotensive or antihypertensive effects. J. Med. Sci. 2006; 6: 894-900.
87. Bipat R, Toelsie J R, Joemmanbaks RF, Gummels JM, Klaverweide J, Jhanjan N et al. (2008). Effects of plants popularly used against hypertension on norepinephrine-stimulated guinea pig atria. Phcog Mag; 4: 12
88. Persson IAL, Dong L, Persson K. Effect of Panax ginseng extract (G115) on angiotensin-converting enzyme (ACE) activity and nitric oxide (NO) production. J Ethnopharmacol. 2006; 105: 321-325.
89. Djidel S. Radical scavenging, reducing power, lipid peroxidation inhibition and chelating properties of extracts from Artemisia campestris L. Aerial parts. Annu. Res. Rev. Biol. 2014; 4: 1691.
90. Mansour SM, Bahgat AK, El-Khatib AS, Khayyal MT. Ginkgo biloba extract (EGb 761) normalizes hypertension in 2K, 1C hypertensive rats: role of antioxidant mechanisms, ACE inhibiting activity and improvement of endothelial dysfunction. Phytomedicine 2011; 18: 641-647.
91. Santos MRV, Carvalho AA, Medeiros IA, Alves PB, Marchioro M, Antoniolli AR. Cardiovascular effects of

Hyptis fruticosa essential oil in rats. Fitoterapia 2007; 78: 186-191.
92. Abreu IC, Marinho AS, Paes AM, Freire SM, Olea RS, Borges MO, Borges AC. Hypotensive and vasorelaxant effects of ethanolic extract from Jatropha gossypiifolia L. in rats. Fitoterapia 2003; 74: 650-657.
93. Vamsidhar E, Swamy GV, Chi tti S, Babu PA, Venkatasatyanarayana G et al. Screening and Docking Studies of 266 Compounds from 7 Plant Sources as Antihypertensive Agents. J Comput Sci Syst Biol. 2010; 3: 016-020.
94. Rajanandh MG, Satishkumar MN, Elang K, Suresh B. Moringa oleifera Lam. A herbal medicine for hyperlipidemia: A pre–clinical report. Asian Pac. J. Trop. Dis. 2012; *2*: S790-S795.
95. Fernandes NP, Lagishetty CV, Panda VS, Naik SR. An experimental evaluation of the antidiabetic and antilipidemic properties of a standardized Momordica charantia fruit extract. BMC Complement Altern Med. 2007; 7: 29.
96. Balaraman AK, Singh J, Dash S, Maity TK. Antihyperglycemic and hypolipidemic effects of Melothria maderaspatana and Coccinia indica in Streptozotocin induced diabetes in rats. SPJ 2010; 18: 173-178.
97. Amirghofran Z, Azadbakht M, Karimi MH. Evaluation of the immunomodulatory effects of five herbal plants. J Ethnopharmacol 2000; 72: 167-172.
98. Dahri AH, Chandiol AM, Rahoo AA, Memon RA. Effect of Nigella sativa (kalonji) on serum cholesterol of albino rats. J Ayub Med Coll Abbottabad 2005; 17: 72-74.
99. Zhao LY, Lan QJ, Huang ZC, Ouyang LJ, Zeng FH. Antidiabetic effect of a newly identified component of Opuntia dillenii polysaccharides. Phytomedicine 2011; *18*: 661-668.
100. Khanna AK, Rizvi F, Chander R. Lipid lowering activity of Phyllanthus niruri in hyperlipemic rats. J Ethnopharmacol 2002; 82: 19-22.
101. Ferramosca A, Savy V, Einerhand AWC, Zara V. Pinus koraiensis seed oil (PinnoThinTM) supplementation reduces body weight gain and lipid concentration in liver and plasma of mice. J Anim Feed Sci 2008; 17*:* 621-30.
102. Sarin B, Verma N, Martín JP, Mohanty A. An overview of important ethnomedicinal herbs of Phyllanthus species: present status and future prospects. Sci. World J. 2014; *2014*.
103. Khare P, Khare SVN, Yadav G. Investigation of Hepatoprotective Activity of Passiflora nepalensis. GJP 2015; 9: 256-259.
104. Xie YW, Xu HX, Dong H, Fiscus RR, But PP. Role of nitric oxide in the vasorelaxant and hypotensive effects of extracts and purified tannins from Geum japonicum. J Ethnopharmacol 2007; 109: 128-133.
105. Yin J, Zhang H, Ye J. Traditional Chinese medicine in treatment of metabolic syndrome. Endocr metab immune disord drug targets 2007; *8*(2), 99.
106. Pahua-Ramos M E, Ortiz-Moreno A, Chamorro-Cevallos G, Hernández-Navarro M. D, Garduño-Siciliano L, Necoechea-Mondragón H et al. Hypolipidemic effect of avocado (Persea americana Mill) seed in a hypercholesterolemic mouse model. Plant Food Hum Nutr. 2012; 67*:*10-16.
107. Amir M, Kumar S. Possible industrial applications of genus Solanum in twenty-first century-a review. J. Sci. Ind. Res. 2004; 63: 116-124.
108. Dall'Agnol R, von Poser GL. The use of complex polysaccharides in the management of metabolic diseases: the case of Solanum lycocarpum fruits. J Ethnopharmacol 2000; 71: 337-341.
109. Yun YR, Kim MJ, Kwon MJ, Kim HJ, Song YB, Song KB et al. Lipid-lowering effect of hot water-soluble extracts of Saururus chinensis Bail on rats fed high fat diets. J Med Food 2007; *10*: 316-322.
110. Ruzaidi AMM, Abbe MMJ, Amin I, Nawalyah AG, Muhajir H. Protective effect of polyphenol-rich extract prepared from Malaysian cocoa (Theobroma cacao) on glucose levels and lipid profiles in streptozotocin-induced diabetic rats. J. Sci. Food Agr. 2008; 88: 1442-1447.
111. Juan-Badaturuge M, Habtemariam S, Thomas M J. Antioxidant compounds from a South Asian beverage and medicinal plant, Cassia auriculata. Food Chem. 2011; 125: 221-225.
112. Hernandez AO, Castillo EP, Leon R, Ibarra BM, Villalobos MR, González CJ. Antihypertensive and Vasorelaxant effects of tilianin isolated from *Agastache mexicana* are mediated by no/cgmp pathway and potassium channel opening. Biochem Pharmacol 2009; 78: 54-61
113. Heitzman ME, Neto CC, Winiarz E, Vaisberg AJ, Hammond GB. Ethnobotany, phytochemistry and pharmacology of Uncaria (Rubiaceae). Phytochemistry 2005; *66*(1), 5-29.
114. Akinyemi AJ, Ademiluyi AO, Oboh G. Aqueous Extracts of Two Varieties of Ginger (Zingiber officinale) Inhibit Angiotensin I–Converting Enzyme, Iron (II), and Sodium Nitroprusside-Induced Lipid Peroxidation in the Rat Heart In Vitro. J Med food 2013; 16: 641-646.
115. Niazmandi S, Kooshaki M, Sookhtanloo M, Nemati M, Kianoosh T, Sadeghnia HR et al. The preventive effects of aqous-ethanolic extract of achillea wilhelmsii on indomethacine-induced ulcer and related biochemical factors in rats. Urmia Med J. 2012; 23: 209-217.
116. Estrada-Soto S, Navarrete-Vázquez G, Léon-Rivera I, Yolanda M, Rios BAG, Castillo-España P et al. Antihypertensive effect of Lepechinia caulescens extract on spontaneously hypertensive rats. Phytopharmacoogy 2012; 2: 170-178.
117. Khan AU, Gilani AH. Blood pressure lowering, cardiovascular inhibitory and bronchodilatory actions of Achillea millefolium. Phytother Res 2011; 25: 577-583.
118. Kang DG, Lee YS, Kim HJ, Lee YM, Lee HS. Angiotensin converting enzyme inhibitory phenylpropanoid glycosides from Clerodendron trichotomum. J *Ethnopharmacol* 2003; 89*:* 151-154.
119. Manganelli REU, Chericoni S, Baragatti B. Ethnopharmacobotany in Tuscany: plants used as antihypertensives. Fitoterapia 2000; 71*:* S95-S100.

Cite this article as:

Amna Batool, Uzma Saleem, Umme Habiba Hasan, Farha Abid, Ambreen Malik Uttra. Hyperlipidemia and hypertension; Cardiovascular risk factors, various induction methods and their management by ethnomedicines. Int. Res. J. Pharm. 2016;7(11):1-9 http://dx.doi.org/10.7897/2230-8407.0711119

Source of support: Nil, Conflict of interest: None Declared