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Review on the Hypolipidemic Effects of Amla (*Emblica officinalis*) Extract Supplementation

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Abstract: ***The lifestyle changes including dietary changes has been associated with the development of cardiovascular diseases. In view of dietary importance in reducing the cardiovascular risks, the review of amla extract supplementation in lowering lipid levels is taken. This article is reviewed using ten original research articles relating supplementation of amla extract and its hypolipidemic effect. This review determined the hypolipidemic effect of amla supplementation on lipid profile, viz, TC, TG, LDL-C, HDL-C, VLDL-C, in healthy subjects and subjects with type 2 diabetes, dyslipidemia and metabolic syndrome. The review involves the supplementation of amla extract in the dosage of 250mg, 500mg, 1g, 2g, 3g and 5g which are given in the form of powder itself or capsule form and is advised to take once or two times a day. The duration of the study in the ten original research articles ranged from 21 days to 6 months. The findings of the ten original research articles concluded that irrespective of the duration of the supplementation, the higher the dosage of amla extract, significant changes on lipid profile is observed. Therefore, amla extract can be used as an alternative therapy in lowering the cardiovascular risks.***
Keywords: Cardiovascular risk, lipid profile, amla extract, supplementation, hypolipidemic effect

I. INTRODUCTION

Human nutrition is a multifaceted complex scientific domain which indicates how substances in foods will provide essential nourishment for the maintenance of life. It is important to realize that many other environmental and lifestyle factors, in addition to nutrition, other factors may influence health and well-being, but nutrition plays a vital role as a major, modifiable, and powerful factor in promoting health, preventing and treating disease, and improving quality of life [1]. Compared with the advances against communicable diseases, there has been inadequate progress in preventing and controlling premature death from non-communicable diseases (NCDs). An estimated 41 million people worldwide died of NCDs in 2016, equivalent to 71 per cent of all deaths. Four NCDs caused most of those deaths: cardiovascular diseases (17.9 million deaths), cancer (9.0 million deaths), chronic respiratory diseases (3.8 million deaths), and diabetes [1.6 million deaths] [2].

Globally, the leading cause of death is cardiovascular diseases; their prevalence is incessantly progressing in both developed and developing nations [3]. An estimated 17.9 million people died from CVDs in 2016, represents about 31 per cent of all global deaths. Of these deaths, 85 per cent are due to heart attack and stroke [4]. In rural adult population, the prevalence of clustering of NCD risk factors was found to be ≥ 2 risk factors 81.0 per cent, ≥ 3 risk factors 56.3 per cent, ≥ 4 risk factors 33.6 per cent, ≥ 5 risk factors 14.5 per cent and ≥ 6 risk factors 4.8 per cent in South India. The inadequate intake of fruits and vegetables (82.3%), physical inactivity (46.8%) and central obesity (46.4%) are the most common NCD risk factors. Clustering NCD risk factors were significantly associated with increased age, males and lower levels of education [5]. Three prospective studies demonstrated a continuous, graded relationship of serum cholesterol level to long-term risk of CHD, CVD and all-cause mortality, substantial absolute risk and absolute excess risk of CHD and CVD death for younger men with elevated serum cholesterol levels, and longer estimated life expectancy for younger men with favourable serum cholesterol levels [6]. Persistently low HDL-C levels over 8 years of follow-up were a risk factor (RF) for the development of CVD events in the elderly [7]. A strong, graded, independent, inverse relationship between HDL-C and both CVD and CHD mortality was demonstrated in a study which reported that the relationship is stronger in women of all age groups [8]. Non-HDL-C is a non-high-density lipoprotein cholesterol which contains all the known and potential atherogenic lipid particles. So the level of non-HDL-C can be a better predictor of CVD mortality than LDL-C level. Screening for non-HDL-C level may be useful for CVD risk assessment [9].

Dyslipidemia can be defined as an elevated total or low-density lipoprotein (LDL) cholesterol levels, or low levels of high-density lipoprotein (HDL) cholesterol. It is an important risk factor for coronary heart disease and stroke. The incidence of dyslipidemia is high. In 2000, approximately 25 per cent of adults in the United States had total cholesterol greater than 239.4 mg per dL (6.20 mmol per L) or were taking lipid-lowering medications [10]. Dyslipidemia is the most important atherosclerotic risk factor. An increase in mean total cholesterol levels has been shown in the review of population based studies in India.

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Recent studies have reported that high cholesterol is present in 25 - 30 per cent of urban and 15 - 20 per cent rural subjects. This prevalence is lower than high-income countries. The dyslipidemia in India are most commonly borderline high LDL cholesterol, low HDL cholesterol and high triglycerides. Over a 20-year period, total cholesterol, LDL cholesterol and triglyceride levels have increased among urban populations as reported by the studies. There is significant association of coronary events with raised apolipoproteinB, total cholesterol, LDL cholesterol and non-HDL cholesterol and inverse association with high apolipoproteinA and HDL cholesterol as reported by case-control studies [11].

The pattern and prevalence of dyslipidemia has been studied in a large representative sample of four selected regions in India. The study conducted by Phase I of the Indian Council of Medical Research–India Diabetes (ICMR-INDIAB) in a representative population of three states of India [Tamil Nadu, Maharashtra and Jharkhand] and one Union Territory [Chandigarh]. Using stratified multistage sampling design, the study covered a population of about 213 million people and recruited individuals ≥20 years of age. According to National Cholesterol Education Programme (NCEP) guidelines, dyslipidemia was diagnosed among the population. Of the subjects (n=16,607) studied, 13.9 per cent had hypercholesterolemia, 29.5 per cent had hypertriglyceridemia, 72.3 per cent had low HDL-C, 11.8 per cent had high LDL-C levels and 79 per cent had abnormalities in one of the lipid parameters. Regional disparity exists with the highest rates of hypercholesterolemia observed in Tamilnadu (18.3%), highest rates of hypertriglyceridemia in Chandigarh (38.6%), highest rates of low HDL-C in Jharkhand (76.8%) and highest rates of high LDL-C in Tamilnadu (15.8%). Except for low HDL-C in the state of Maharashtra, in all other states, urban residents had the highest prevalence of lipid abnormalities compared to rural residents. Low HDL-C was the most common lipid abnormality (72.3%) in all the four regions studied; in 44.9 per cent of subjects, it was present as an isolated abnormality. Obesity, diabetes, and dysglycemia are the common significant risk factors for dyslipidemia. The prevalence of dyslipidemia is extremely high in India, where the immediate lifestyle intervention strategies arise to prevent and manage this important cardiovascular risk factor [12].

The supplementation of the diet with raw form of amla (*Emblica officinalis, Gaertn.,* the Indian gooseberry) for a period of 28 days showed a decrease in cholesterol levels in both normal and hypercholesterolaemic men aged 35-55 years. The total serum cholesterol levels of the hypercholesterolaemic subjects rose significantly to initial levels after two weeks withdrawal of the supplement [13]. *Emblica officinalis* is commonly known as amla. In India, Amla is arguably one of the most important plants in various traditional and folk systems of medicine. Amla is considered to be an immunomodulator and potent rejuvenator which is effective in stalling degenerative processes and senescence, and to promote longevity, enhance digestion, treat constipation, reduce fever and cough, alleviate asthma, strengthen the heart, benefit the eyes, stimulate hair growth, enliven the body, and enhance intellect in Ayurveda [14]. The plant (*Emblica officinalis)* has shown anti-atherogenic, anticoagulant, hypolipidemic, anti-hypertensive, antioxidant, anti-platelet, and vasodilatory effects as well as lipid deposition inhibitory properties. *Emblica officinalis* influences various cardiovascular risk-factors [15].

II. ROLE OF AMLA (*Emblica officinalis*) IN THE PREVENTION AND TREATMENT OF DISEASES

Emblica officinalis is a deciduous tree of medium sized belonging to the family Euphorbiaceae (family of flowering plants). These species of plant is a native of India but also found in Sri Lanka, Uzbekistan, South East Asia, and China [16]. *Phyllanthus emblica Linn.* is the synonym of Amla [17]. *Phyllanthus emblica* is a small to medium sized tree with greenish gray or red bark, growing to a height of about 8-18 m. The flowering occurs in March to May and September to November are the months of fruiting [16]. The scientific classification of amla is shown in Table I [16] and the chemical constituents in amla is shown in the Table II [18].

TABLE I
SCIENTIFIC CLASSIFICATION OF AMLA

Class	Dicotyledonae
Division	Angiospermae
Family	Euphorbiaceae
Genus	Emblica
Kingdom	Plantae
Order	Geraniales
Species	Officinalis Geartn

Table II
CHEMICAL CONSTITUENTS IN AMLA

Type	Chemical Constituents
Hydrolysable Tannins	Emblicanin A and B, Punigluconin, Pedunculagin, Chebulinic acid (Ellagitannin), Chebulagic acid (Benzopyran tannin), Corilagin (Ellagitannin), Geraniin (Dehydroellagitannin), Ellagotannin
Alkaloids	Phyllantine, Phyllembein, Phyllantidine
Phenolic compounds	Gallic acid, Methyl gallate, Ellagic acid, Trigallayl glucose
Amino acids	Glutamic acid, Proline, Aspartic acid, Alanine, Cystine, Lysine
Carbohydrates	Pectin
Vitamins	Ascorbic acid
Flavonoids	Quercetin, Kaempferol
Organic acids	Citric acid

A. Bioactive Components And Effects

Amla (*Phyllanthus emblica*) is also known as Indian gooseberry. Amla is a deciduous tree that commonly grows in the subtropical and tropical regions of Southeast Asia which also includes southern India and China. Various parts of the amla plant, especially its fruit, are used as folk remedies for numerous ailments in traditional Chinese and Indian (Ayurvedic) medicinal systems traditionally. The major bioactive compounds present in amla fruits are phenolics including hydrolyzable tannins (both ellagitannins and gallotannins), anthocyanins, flavonoids, flavonols, and phenolic acids as reported by previous phytochemical studies. Ten phenolics (1-10) were isolated and identified with compounds 8-10 being reported from amla for the first time which includes gallic acid (1), five gallic acid derivatives (2-6), ellagic acid (7), and three ellagic acid derivatives (8-10). Ten isolates were identified as gallic acid (1), methyl gallate (2), 1-O-galloyl-glucoside (3), mucic acid 3-O-gallate (4), corilagin (5), 1,6-di-O-galloylglucoside (6), ellagic acid (7), ellagic acid-4-O-glucoside (8), ellagic acid-4-O-xyloside (9), and ellagic acid-4-Orhamnoside (10) [19].

Several parts of the medicinal plant, amla are used to treat a variety of diseases, but the most important is the fruit. The fruit is used to treat many ailments which can be used either alone or in combination with other plants. The ailments include common cold and fever; as a laxative, diuretic, refrigerant, stomachic, restorative, alterative, anti-inflammatory, antipyretic, liver tonic, hair tonic; to prevent peptic ulcer and dyspepsia, and as a digestive. Amla possesses antiatherogenic, antihypercholesterolemic, adaptogenic, cardioprotective, gastroprotective, antipyretic, antianemic, antidiarrheal, antiatherosclerotic, analgesic, antitussive, hepatoprotective, wound healing, nephroprotective, and neuroprotective properties as demonstrated in numerous preclinical studies [20].

B. Nutritive Value Of Amla

Amla (*E. officinalis*) is well known for its nutritional qualities. Amla is rich in minerals, polyphenols, and is specifically regarded as one of the richest source of vitamin C (200-900 mg per 100 g of edible portion). Major components of nutritional importance in amla fruit are presented in Table III [21].

Table III
NUTRITIONAL VALUE OF FRUIT OF *Phyllanthus emblica* (% OR PER 100G)

Chemical components	Nutritional value (%)
Fruits: Moisture	81.2
Protein	0.5
Fat	0.1
Mineral matter	0.7
Fibre	3.4
Carbohydrate	14.1
Calcium	0.05
Phosphorous	0.02
Bulk elements Mg/100g,	Net weight
Iron	1.2 mg/100g
Vitamin C	600mg/100g
Nicotinic acid	0.2mg/100g

C. Hypolipidemic Effect of Amla

Hyperlipidemia can be defined as elevations of fasting total cholesterol concentration swhich may or may not be associated with elevated triglyceride concentration. The performance of a cardiovascular risk assessment is an important step in the interpretation of lipid screening results. It is strongly emphasized in the report of ATP-III and in numerous peer reviewed journal articles reviewing the topic of lipid management. The basic principle in aggressively treating all modifiable risk factors, including hyperlipidemia, is that the higher a person's CVD risk, the greater the benefit [22].

Though there is an emphasis on control of LDL-C, a number of cardiac events occur in people without clinically abnormal LDL-C concentrations. This is often referred to as residual risk. The lipoprotein fractions will contribute to the formation of atherosclerosis so to improve risk prediction and treatment, it can be focussed on non-HDL cholesterol levels rather than on just LDL-C. The lipoprotein particles are intermediate or end products of triglyceride rich lipoprotein (TGRL) catabolism, specifically very low density lipoprotein (VLDL) and chylomicrons. The particles become denser as triglycerides are removed from TGRLs by intravascular lipases, and have a greater portion of their composition as cholesterol. Chylomicrons transport dietary fat. The end product of triglyceride lipolysis is a small, dense Apo-B48 containing particle known as a chylomicron remnant. VLDL transports endogenously produced triglyceride, which has a more complex catabolism. In a simplified way, the catabolic steps can be thought of as a conversion of very low density lipoprotein (VLDL) to intermediate density lipoproteins (IDL), which are then converted to low density lipoprotein (LDL). The particles can be defined by their different densities and ratios of triglyceride to cholesterol, but all of them contain apoB-100. These remnant particles are the significant contributors to CVD because these particles not eliminated by the liver (the preferred disposal site) are taken up in arterial walls which can eventually become lipid laden macrophages, the well-known foam cells that are a hallmark of early atherosclerosis. The Classification of hyperlipidemias given by NCEP-ATP-III is presented in the Table IV [22].

TABLE IV
CLASSIFICATION OF HYPERLIPIDEMIAS (NCEP-ATP-III)

LDL Cholesterol (mg/dL)	
< 100	Optimal
100 – 129	Near or above optimal
130 – 159	Borderline high
160 – 189	High
≥ 190	Very high
Total Cholesterol (mg/dL)	
<200	Desirable
200 – 239	Borderline high
≥ 240	High
HDL Cholesterol (mg/dL)	
<40	Low
≥ 60	High
Triglycerides (mg/dL)	
<150	Normal
150 – 199	Borderline high
200 – 499	High
≥ 500	Very high

Amla is an Ayurvedic herb used to treat hypercholesterolemia. The supplementation of 50 g of raw Amla was found to lower cholesterol in 35 men (only some of whom were hypercholesterolemic) in an uncontrolled study. A significant reduction in TC and LDL-C levels was found after a month [23].

The supplementation of one medium size Amla (35g) for sixty days in type 2 diabetes mellitus subjects (n=28) showed a significant changes in the lipid profile which included the parameters TC, LDL-C, and non-HDL-C were decreased by 5.7 per cent, 9.4 per cent and 8.3 per cent. The lipid parameter, HDL-C had been increased by 5.5 per cent. The diabetic subjects showed a favourable response in TC > 200 mg/dl as compared to those having TC< 200 mg/dl.

In those diabetic subjects who had TG> 150 mg/dl (p< 0.001) showed 23.4 per cent reduction in TG. The favourable redistribution of lipoproteins with Amla supplementation had a significant positive impact on the atherogenic indices lowering the risk of CHD in the diabetic subjects [24].

D. Other Health Benefits of Amla

1) *Diabetes Mellitus:* Phyllanthus species were found to involve in regeneration and rejuvenation of cells leading to an increased insulin production and secretion [25]. This decreases the blood sugar. Supplementation of one medium size Amla (35g) for 6 months led to a significant decrease in the FBS, PPBS, HBA1C, Lipid profile values in the experimental group. There were no significant changes in the control group [26].
2) *Anticancer Effects:* The aqueous fruit extract of P. emblica has the potential anticancer effects which was tested in several different human cancer cell lines such as A549 (lung), HepG2 (liver), HeLa (cervical), MDA-MB-231 (breast), SKOV3 (ovarian) and SW620 (Colorectal). P. emblica extract significantly inhibited the growth of several human cancer cell lines at doses of 50-100 µg/ml. Research found that amla is beneficial to treat different types of cancers.
3) *Enhances Food Absorption:* Amla can strengthen digestion, absorption and assimilation of food if taken regularly. Also, it helps to improve assimilation of iron for healthy blood.
4) *Balances stomach acids:* Amla improves digestion but does not heat the body, it is ideal for calming mild to moderate hyperacidity.
5) *Fortifies The Liver:* Amla strengthens the liver, helping it in eliminating toxins from the body.
6) *Nourishes the brain and mental functioning:* Amla is good for the brain. It nurtures the mind and enhances coordination among acquisition, retention, and recall. It helps sharpen the intellect and mental functioning. Amla has the ability to support the nervous system and strengthens the senses.
7) *Strengthens The Lungs:* Amla is a wonderful tonic for strengthening and nourishing the lungs. A fruit with seeds can be used for asthma, bronchitis and biliousness.
8) *Regulates Elimination:* Amla keeps the function of elimination regular and ease constipation. The fruit can be pickled or preserved in sugar occasionally. When dry it is said to be gently laxative, according to some sources the fresh fruit is also laxative. The fresh ripe fruits are used as a laxative extensively in India, one or two fruits being sufficient for a dose.
9) *Enhances Fertility:* Amla keeps menstruation regular and healthy. It supports the reproductive systems of both men and women and can help overcome difficulty in conceiving. This herb nurtures the ovaries and sperm, and enhances fertility and the possibility of conception and in particular it nurtures women, strengthens the uterus and supports reproductive health.
10) *Helps The Urinary System:* Amla is especially supportive to the urinary system and can be helpful if experiencing a mild burning sensation while urinating. Though amla has a natural diuretic action, it does not force water from the body like diuretic pills. In other words, amla helps to eliminate waste from the body but does not over-stimulate the urinary system.
11) *Good For The Skin:* Amla helps the liver detoxify and is rich in Vitamin C and other minerals, it is very good for the complexion. Amla can moisturize the skin, cleanse the tissues of toxins, and supports immunity of the skin against bacterial infection and helps to enhance glow and luster.
12) *Promotes Healthier Hair:* Amla boosts absorption of calcium, thus creating healthier bones, teeth, nails and hair. It also helps maintain youthful hair color and retards premature greying, and supports the strength of the hair follicles, so there is less thinning with age. The crushed fruits have a good effect on hair growth and prevent hair greying.
13) *Acts As A Body Coolant:* It has been described as a fruit having sour taste with cooling potency in Tibetan medicine.
14) *Flushes out toxins:* Individuals who are consuming "junk" food for a while may tend to have accumulated deposits of preservatives and additives in the liver. Amla helps support the liver in flushing out chemicals and additives from the physiology.
15) *Increases Vitality:* Amla increases energy and removes fatigue. It supports regeneration of cells which is the process by which tired old cells are replaced by vital, new ones.
16) *Strengthens The Eyes:* The dried fruit immersed in water in a new earthen vessel a whole night yields a decoction which is used as a medical lotion applied to the eye as eyewash in ophthalmia. It may be applied cold or warm. In another treatment an infusion of the seeds is also used as a medical lotion and applied with benefit to recent inflammations of the conjunctive and other eye complaints.

17) *Improves Muscle Tone:* Intake of amla enhances protein synthesis so it is good for strengthening muscles and building lean muscle mass. The unique ayurvedic action of amla offers a natural way to tone muscles and build lean mass for athletes and body-builders.
18) *Acts As An Antioxidant:* Amla is an effective broad spectrum antioxidant and free radical scavengers, helping to reduce disease and slow the aging process.
19) *Enhances Immunity:* Amla is a strong immunity booster. Antibacterial, antifungal, antiviral medical studies conducted on amla fruit suggest that it has antiviral properties and also functions as an antibacterial and anti-fungal agent.
20) *Chelating Agent:* Pre-mature aging of the skin is a complex biologic process affecting various layers of the skin with major changes seen in the connective tissue within the dermis. Amla can act as a chelating agent.
21) *Diuretic:* The fresh fruit is diuretic. It is used as an anti-inflammatory and unusually as an anti-diuretic.
22) *Inflammation: Phyllanthus emblica* has been used for anti-inflammatory and antipyretic treatments by rural populations in its growing areas [21].

III. REVIEW OF THE HYPOLIPIDEMIC EFFECT OF AMLA ON 10 STUDIES

The methodology used in the ten studies reviewed is presented in Table V.

Table V
METHODOLOGY OF THE STUDIES REVIEWED

S. No.	Study design	Sample size	Place of study	Duration of the study	Parameters assessed	Periods of evaluation	Supplement used in the study	Dosage	Statistical analysis
1	Title of the study 1: Effect of Amla fruit (*Emblica officinalis Gaertn.*) on blood glucose and lipid profile of normal subjects and type 2 diabetic patients [27]								
	Experim-ental study	N = 32	Pakistan	21 days	Total lipids, Triglycerides, Total cholesterol, HDL-cholesterol, LDL-cholesterol	Day 0 Day 8 Day 15 Day 21	Powdered *E. officinalis* fruit orally with 30 ml water once daily in the morning after breakfast was given	1g, 2g, 3g	One way analysis of variance (ANOVA)
2	Title of the study 2: Clinical evaluation of *Emblica officinalis Gatertn* (Amla) in healthy human subjects: Health benefits and safety results from a randomized, double-blind, crossover placebo-controlled study [28]								
	Randomiz-ed, double-blind, crossover placebo-controlled study	N = 15	Japan	18 weeks	Triglycerides, Total cholesterol, HDL-C, and LDL-C	Week 1 Week 4 Week 6 Week 9 Week 10 Week 13 Week 15 Week 18	Hard gelatin capsules containing amla formulation (125 mg) and dextrin (125 mg)	250 mg	One way analysis of variance (ANOVA)
3	Title of the study 3: A pilot clinical study to evaluate the effect of *Emblica officinalis* extract (Amlamax^{TM}) on markers of systemic inflammation and dyslipidemia [29]								
	Two	N = 49	Ernakul	6	Total	3 months	Amlamax^{T}	500 mg	Multi

	centre two dosage study		-am, Kerala, India	months	cholesterol, Triglyceride, HDL-C, LDL-C, VLDL-C	6 months	M		factor ANOVA
4	Title of the study 4: Hypolipidemic potential of *Emblica officinalis* (amla) powder and nutrition counselling on hyperlipidemic Subjects [30]								
	Experim e-ntal design	N = 60	Ludhia n-a, Punjab, India	90 days	Total cholesterol, HDL-C, LDL-C, Triglyceride, and VLDL-C	Day 0 Day 90	*E. officinalis* powder sachets (5 g zip sachets)	5g zip sachets	Student's 't' test
5	Title of the study 5: Evaluation of the effects of a standardized aqueous extract of *Phyllanthus emblica* fruits on endothelial dysfunction, oxidative stress, systemic inflammation and lipid profile in subjects with metabolic syndrome: a randomised, double blind, placebo controlled clinical study [31]								
	Prospecti v-e, randomis e-d, double-blind and placebo-controlle d study	N = 59	Hydera b-ad, India	12 weeks	Total cholesterol, HDL-C, LDL-C, and Triglyceride	Day 0 Week 12	CAPROS (Tablet of Standardiz ed aqueous extract of *Phyllanthu s emblica*)	250mg, 500 mg	t-test, one way analysis of variance (ANOV A)
6	Title of the study 6: An open label single arm study to evaluate the therapeutic effect of Amla (*Emblica officinalis*) in cardiovascular health [32]								
	Open label study	N = 45	Jaipur, Rajasth a-n, India	16 weeks	Total cholesterol, Triglyceride s, HDL-C, LDL-C and VLDL-C	Day 0 Week 4 Week 8 Week 12 Week 16	Tablet of Amla extract (*Emblica officinalis*)	500 mg	-
7	Title of the study 7: A randomized, double blind, placebo controlled, multicenter clinical trial to assess the efficacy and safety of *Emblica officinalis* extract in patients with dyslipidemia [33]								
	Randomi -zed, multicent r-e study	N = 98	South India	12 weeks	Total cholesterol, Triglyceride, HDL-C, LDL-C and VLDL-C	Day 0 Day 28 Day 56 Day 84	Amla extract	500 mg	Chi square test, t-test, ANOVA
8	Title of the study 8: A comparative clinical study of hypolipidemic efficacy of Amla (*Emblica officinalis*) with 3-hydroxy-3-methylglutaryl-coenzyme-A reductase inhibitor simvastatin [14]								
	Clinical trial	N = 60	Vadoda r-a, Gujarat	42 days	Total cholesterol, Triglyceride s,	Day 0 Day 42	One capsule of Amla	500 mg	Student's t test, One-way Analysis

					HDL-C, LDL-C and VLDL-C				of Variance (ANOVA)
9	Title of the study 9: Supplementation of a standardized extract from *Phyllanthus emblica* improves cardiovascular risk factors and platelet aggregation in overweight/class-1 obese adults [34]								
	Experim e-ntal study	N = 15	United States of Americ a	14 weeks	Total cholesterol, HDL-C, LDL-C, and Triglyceride	Day 0 Week 12 Week 14	Oral supplemen ta-tion of CAPROS (standardiz e-d aqueous extract of the edible fruit of *Phyllanthu s emblica* (amla))	500 mg	Random-effects linear regressio n models
10	Title of the study 10: Effects of *Phyllanthus emblica* extract on endothelial dysfunction and biomarkers of oxidative stress in patients with type 2 diabetes mellitus: a randomized, double-blind, controlled study [35]								
	Prospecti v-e, randomiz e-d, double-blind, placebo-controlle d study	N = 80	Hydera b-ad, India	12 weeks	Total cholesterol, Triglyceride, HDL-C, LDL-C and VLDL-C	Day 0 Week 12	One capsule of *E. officinalis*	250 mg, 500 mg	t-test

IV. DISCUSSION AND CONCLUSION

This review was carried out to determine the effect of amla (*Emblica officinalis*) extract supplementation on lipid profile (TC, TG, LDL-C, HDL-C and VLDL-C) in healthy subjects and subjects with type 2 diabetes, dyslipidemia and metabolic syndrome. The ten original research articles included in this review involves supplementation of amla extract in the dosage of 250 mg, 500 mg, 1 g, 2g, 3g and 5g given in the form of capsule or in the powdered form itself and advised to take one or two times a day. The study duration of ten original research articles ranged from 21 days to 6 months.

A. Highlights of the studies reviewed

The highlights of the ten studies reviewed are given below.

1) Supplementation with 2 g or 3 g of powdered E. officinalis fruit for 21 days suggested that it has lipid-lowering properties in normal subjects and type 2 diabetic human patients.

2) The amla formulated capsules supplementation of 250 mg for 18 weeks showed a decrease but no significant improvement in lipid profile in healthy human subjects.

3) The treatment with Amlamax™ at doses of 500 mg/day or 1000 mg/day for 6 months showed a significant reduction in the level of risk factors of CVD arising from dyslipidemia in mildly hypercholesterolemic humans.

4) Amla powder (5 g zip sachets) supplementation and nutrition counselling for 90 days showed a significant effect in the improvement of lipid profile of the hyperlipidemic subjects.

5) The standardized aqueous extract of *Phyllanthus emblica* with the capsule supplementation of PEE250 twice daily or PEE500 twice daily for 12 weeks significantly improved the lipid profile in Metabolic Syndrome.
6) A significant improvement in lipid profiles of subjects with CHD risk factors has been shown with supplementation of 2 tablets of Amla (500 mg) daily for 16 weeks.
7) A very significant reduction in total cholesterol, triglycerides, and other lipid parameters was observed with the supplementation of amla extract 500 mg which strongly supports the efficacy of amla extract in patients with dyslipidemia who are at risk for CVD.
8) Supplementation of one capsule of Amla (500 mg) daily brought about significant hypolipidemic effects in patients with type II hyperlipidemia.
9) A significant decrease in LDL-C by 500mg of CAPROS supplement intake for 12 weeks suggests that it may provide beneficial effects to overweight/class-1 obese individuals who are at high risk for CVD.
10) All three active treatments of P. emblica 250 mg, P. emblica 500 mg and atorvastatin 10 mg, for 12 weeks had shown a significant improvement in lipid profile in patients with type 2 diabetes mellitus.

B. Conclusion

The ten amla extract supplementation research articles included the supplement in the form of capsules and powder given once or twice a day and the duration of the study ranged from 21 days to 6 months at different dosages to determine the hypolipidemic effect of amla and efficacy of the dosage.

The results of each research study has clearly indicated a significant change in lipid parameters in individuals who are at risk for CVD. Hence, it can be concluded from the findings of the study reviewed that the supplementation of amla extract exerted a hypolipidemic potential in individuals who are at risk for cardiovascular diseases. The higher the dosage of amla extract, more enhanced significant changes in lipid parameters was observed irrespective of the duration of supplementation. Based on these findings, amla extract can be recommended as an effective hypolipidemic agent to combat dyslipidemia which is the leading cause of CHD mortality among all age groups. The use of alternative therapies in the prevention, treatment and management of cardiovascular risk factors can be beneficial in lowering the financial burden caused by the disease.

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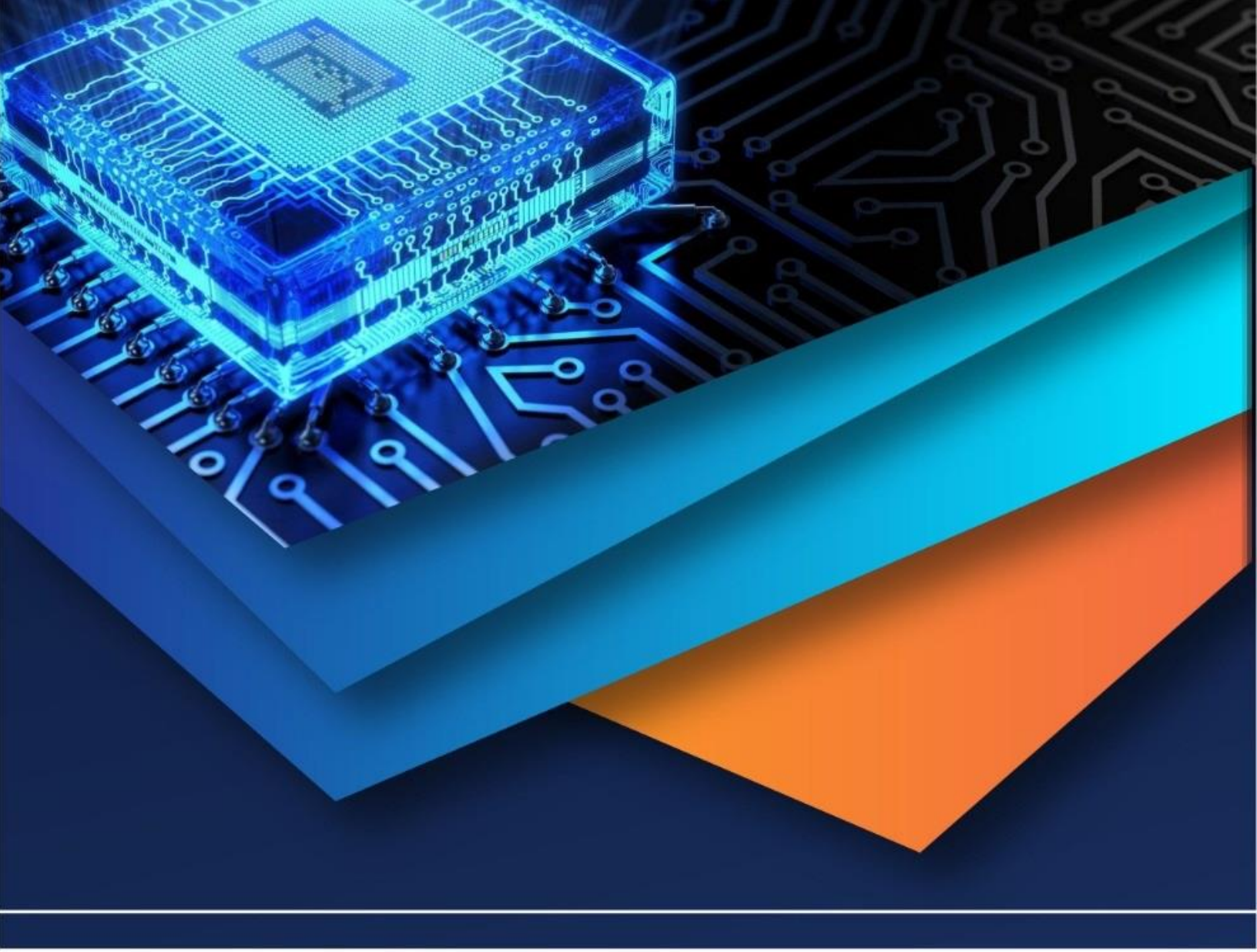

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