

CENT PERCENT SAFE CENTUM PLANTS FOR ANTI OBESITY

Dr. Philomena George* and O.S.Nimmi

Department of Biotechnology, Karunya University, Coimbatore, Tamil Nadu, India 641114

Abstract: This paper is an over view of 100 medicinal plants commonly used as dietary supplements for obesity found in Asian countries particularly in India, China, Taiwan, Korea and Africa. Synthetic drugs are effective but have potential harmful side effects. Nutraceuticals and herbal supplements are used by people worldwide to promote health, wellness, maintain weight and fight diseases. Our project is to formulate a nutraceutical product having antiobesity prepared in the form of fancy food items like estruded products, biscuits, noodles, etc and the PolyHerbal Formulation (PHF) product is combined with base materials such as cereals, millets, pulses, and fibre rich products. The product evaluation can be done in animal models such as mice, rat, rabbits, chicks and human volunteers. Some of the phyto constituents such as inulin, pectin, flavonoids, saponins, tannins, dietary fibres, phytosterols/stanols, dietary carotenoids, polyphenols, plant indoles, have potential hypolipidemic properties by different mechanisms such as reducing atherosclerosis by inhibiting platelet aggregation, increasing fibrinolysis, enhancing antioxidant activity, reducing serum lipids in general to lower cholesterol levels, controlling appetite, fat metabolism, adipocyte differentiation, fat absorption, energy metabolism, etc. The present study is to find out the antiobesity effects of few herbals such as *Allium sativum*, *Coriandrum sativum*, *Mentha arvensis*, *Camellia sinensis*, *Foeniculum vulgare*, *Commiphora mukul*, *Zingiber officinale*, *Nelumbo nucifera*

Keywords: Herbal supplements, hypolipidemic, antiobesity, anthropometric, metabolic syndrome, nutraceutical product.

INTRODUCTION

Obesity is one of the greatest health threats which has become a global issue of this century. It is a state of excess adipose (lipid storing adipose cell) tissue mass. It has an important impact on lifestyle-related diseases such as coronary heart disease, dyslipidemia, glucose intolerance, diabetics, hypertension and some cancers [25]. Several factors such as lack of exercise, sedentary lifestyle, consumption of energy rich diets etc, are contributory to the

etiology of obesity [19] Obesity can result from increased energy intake, decreased energy expenditure, or a combination of the two. While all causes are considered, major attention is given to behavioural and societal changes that have increased the energy density of diets, overwhelmed sophisticated regulatory systems that control appetite and maintain energy balance, and reduced physical activity [43]. It is found that intra abdominal and abdominal subcutaneous fat have more significance than subcutaneous fat present in buttocks and lower extremities. This distinction is most easily made clinically by determining the waste-to-hip ratio and the ratio >0.9 in women and >1.0 in men is considered as abnormal. Many of the most complication of obesity, such as insulin resistance, diabetes, hypertension, hyperlipidemia and hyperandrogenism in women, are linked most strongly to intraabdominal and/or upper body fat than to overall fat adiposity. The vast majority of obese persons have an increased leptin levels. A BMI between 25 and 30 should be viewed as medically significant and worthy of therapeutic intervention, especially in the presence of risk factors that are influenced by adiposity such as hypertension and glucose intolerance. There is an urgent need for safe and efficient remedies for obesity. Herbal medicine is a major component in all traditional medicine systems, and a common element in siddha, ayurvedic, homeopathic, naturopathic, traditional chinese medicine, and Native American medicine.

Metabolic syndrome (also known as insulin Resistance syndrome and Syndrome X, Reaven's syndrome) is a common disorder arising as a result of obesity. Metabolic syndrome is a combination of medical disorders that increase the risk of developing cardiovascular disease and diabetes. It affects one in five people; prevalence increases with age and can affect anyone at any age. It is most frequently seen in those who are significantly overweight - with most of their excess fat in the abdominal area - and inactive. All of the factors associated with metabolic syndrome are interrelated. Obesity and lack of exercise tend to lead to insulin resistance. Insulin resistance has a negative effect on lipid production, increasing VLDL (very

low-density lipoprotein), LDL (low-density lipoprotein – the "bad" cholesterol), and triglyceride levels in the bloodstream of

and decreasing HDL (high-density lipoprotein – the "good" cholesterol)[37].

Increased waist circumference	
Men: > 102 cm (40 in)	Fasting plasma glucose: ≥ 110 mg/dl
Women: > 88 cm (35 in)	
Elevated blood pressure	
Systolic ≥ 130 mm Hg	Serum triglyceride level: ≥ 150 mg/dl
Diastolic ≥ 85 mm Hg	
Decreased high-density lipoprotein (HDL) cholesterol level	
Men < 40 mg/dl	
Women < 50 mg/dl	

TABLE-1: Criteria for Metabolic Syndrome

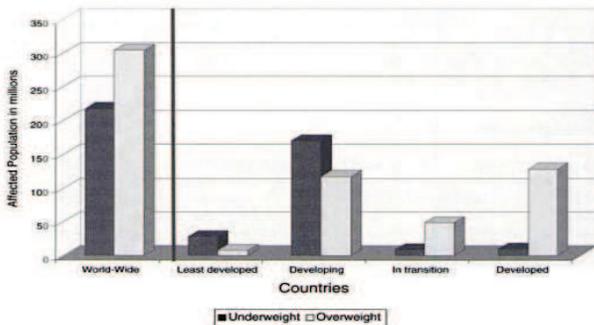


FIGURE 2 Underweight and Overweight World Wide

GLOBAL SCENARIO OF OBESITY

The World Health Organisation (2000:14) estimated for the first time in human history that the number of overweight people is higher than the number of starving or undernourished people of the world as shown in the figure 1.

WHO's latest projections indicate that globally in 2005:

- approximately 1.6 billion adults (age 15+) were overweight;
- at least 400 million adults were obese.

WHO further projects that by 2015, approximately 2.3 billion adults will be overweight and more than 700 million will be obese. At least 20 million children under the age of 5 years are overweight globally in 2005.

INDIAN SCENARIO

Statistics point to an increase in overweight or obese citizens by 20% between 1998 and 2005. Presently, one in 6 women and one in 5 men are overweight in India. Obesity figures are bulging dangerously at a staggering 70 million in India. Another study published in the Lancet, has revealed that "by 2030, non communicable disease will account for nearly 70% of all global deaths and 80% of these deaths will occur in developing countries like India"[6]

The latest obesity statistics shows that 75 percent of Indian women and 58 percent of Indian men are obese. Estimated prevalence (%) of Overweight & Obesity (BMI ≥ 25 kg/m²) females and males (Aged 15+) is 18 and 20.1 respectively [60].

FACTORS AFFECTING OBESITY[42]

1. Genetic & environmental factors :

Studies indicate that from 40% to as much as 80% of the variance of BMI can be attributed to genetic factors. It is estimated that heritability is as high as 30-40% for factors relevant to energy balance such as body fat distribution, resting metabolic rate, energy expenditure after overeating, lipoprotein lipase activity and basal rates of lipolysis. Over 250 genetic markers have been described in association with obesity-related variables in humans (e.g., BMI, skin-fold thickness, waist-to-hip ratio, fat mass, and percent fat mass).

2. Endocrine & metabolic Factors :

Both metabolic and endocrine factors rarely cause obesity and complex interactions between the endocrine and metabolic systems are found to be contributing factors to obesity.

3. Psychological Factors :

Few causative personality characteristics such as e.g., externality, depression, orality are seen related to obesity and research evidence strongly suggests that obesity is not a unitary syndrome (i.e., obesity appears to be the end result of a complex interaction within and between both physical and psychological factors).

4. Food intake :

Some patients eat more during periods of heavy exercise or during pregnancy and are unable to get back to their former eating habits. The increase in obesity can usually be related to the type of food consumed (i.e. food containing sugar and fat).

5. Control of appetite :

Appetite is the desire to eat and this usually initiates food intake. Following a meal, cholecystokinin (CCK), bombesin, glucagons-like peptide 1 (GLP1), enterostatin, and somatostatin are released from the small intestine, and glucagons and insulin from the pancreas. All of these hormones have been implicated in the control of satiety.

6. Energy expenditure & thermogenesis :

Basal metabolic rate (BMR) in obese subjects is higher than in lean subjects, which is not surprising since obesity is associated with an increase in lean body mass. Obese patients tend to expend more energy during physical activity as they have a larger mass to move. On the other hand, many obese patients decrease their amount of physical activity. The energy expended on walking at 3 miles per hour is only 15.5 kJ/min (3.7 kcal/min) and therefore increasing exercise plays only a small part in losing weight.

SYNTHETIC DRUGS FOR ANTI-OBESITY

The Food and Drug Administration has approved several prescription medications for the treatment of obesity . These medications fall into two categories: (a) centrally acting drugs, which suppress appetite, (b) and peripherally acting drugs, which reduce fat

absorption. For example, phentermine and sibutramine act centrally, reducing appetite by promoting the release of norepinephrine from presynaptic terminals (phentermine) and inhibiting the uptake of both norepinephrine and serotonin (sibutramine) in central nuclei. Orlistat acts peripherally, inhibiting the action of lipases in the brush border of the intestine and thereby reducing lipid absorption. Such drugs could aim to suppress food intake, increase energy expenditure or increase lipolysis. At present, only two drugs have been shown to reduce the body weight of obese individuals like orlistat (which decreases fat absorption by preventing the breakdown of dietary fat in the gastrointestinal tract) and sibutramine (which is mainly an inhibitor at the CNS sites that stimulate food intake)[42]. Under the guidelines of the US Food and Drug Administration, botanical drugs can be developed faster and cheaper than conventional single-entity pharmaceuticals. Many botanicals may provide safe, natural, and cost-effective alternatives to synthetic drugs.

TABLE- 1 : Indian plants with known anti obesity properties

S. No	PLANTS	THERAPEUTIC PROPERTIES	DOSAGE RECOMMENDED	BIOACTIVE PRINCIPLES
1.	<i>Allium sativum.L</i> (Garlic)	Antimicrobial, hypolipidemic , antioxidant , antineoplastic , antithrombotic , anti-atherogenic effects.	Cloves:2 to 5 g fresh; 0.4 to 1.2 g of dried powder;	Allicin.allin [55]
2.	<i>Citrus aurantium .L</i> (Bitterorange)	Stimulates the action the central nervous system , assistance in weight loss.	Fruit:60-120 mg	Synephrine ,an alkaloid [3]
3.	<i>Cissus quadrangularis Linn</i> (<i>Hadjora</i>)	Anti-inflammatory, anti obesity , analgesic, antibiotic, anthelmintic , antimicrobial, hypoglycemic.	Stem:100 -500 mg	Phytosterols and fibre [1, 16,26 ,44]
4.	<i>Coleus forskohlii (Willd.) Briq.</i> (Coleus)	Treating disorders such as glaucoma , heart failure , bronchial asthma	Root: 50-300 mg	Labdane diterpene forskolin [39]
5.	<i>Commiphora mukul Engl.</i> (Indian Belellium Tree)	Hypolipidemic, anti-inflammatory, antitumor.	Resin: 50-100 mg	Z-guggalsterone, a ketosteroid [38, 58]
6.	<i>Coriandrum sativum L.</i> (Coriander)	Hypotensive, hyperglycemia,hyperlipid emia	Leaf:5 mg	Essential oil containing linalool as well as furanocoumarins (coriandrine, dihydrocoriandrine)[14
7.	<i>Costus igneus.Nak</i> (<i>Fiery spiral ginger</i>)	Diuretic, hypotensive, hypoglycaemic.	Leaf:5000 mg	Saponins [9]
8.	<i>Cyperus Rotundus L.</i> (Nutgrass)	Ant-inflammatory, antidiabetic, hypocholesterolaemia.	Leaf:1-3g	Alkaloids [16, 58]

9.	<i>Foeniculum vulgare</i> .Mill (Fennel seeds)	Antispasmodic, secretolytic, secretomotor , anti-bacterial, galactagogue , anti-inflammatory.	Seeds:1-7g	Essential oil contains anethole, camphene, cuminic, limonene mythyl chavicol, dipentene, [20]
10	<u><i>Garcinia Cambogia</i></u> (Malabar Tamarind)	Antiobesity, anti-inflammatory, anti-ulcer, antimicrobial.	Fruits:200 to 500mg	(-) Hydroxy citric acid (HCA) [51,56]
11	<i>Glycyrrhiza glabra</i> Linne (Licorice)	Anti-allergic, anti-inflammatory, antistress, antidepressive, antiulcer, antidiabetic, antidepressant effects.	Root:2-4 g.	Licorice flavonoid oil (LFO [28]
12	<i>Gymnema sylvestre</i> r.br. Ex schult (Gurmar)	Antidiabetic ,anti - inflammatory activities, anti-obesity, antimicrobial , antihypercholesterolemic , hepatoprotective .	Leaves :75-150 mg	Gymnemic acids [46 ,45, 10]
13	<i>Nelumbo nucifera</i>.Gaertn (Indian Lotus)	Antidiabetic, antipyretic, anti-inflammatory, anticancerous, antiviral antimicrobial, and anti-obesity properties .	Sees:6-15g Leaf :3-6 g	Alkaloids(liensinine, neferine, nuciferine, remrefidine and isoliensinine) and flavonoids ((+)-1(R)-coclaurine, (-)-1(S)-norcoclaurine and quercetin 3-O-b-D-glucuronide) [11]
14	<i>Piper nigrum</i>.L (Black pepper)	anti-inflammatory, antioxidant, analgesic effects, Aromatic, stimulant, carminative ,febrifuge,cholagogue, emmenagogue	Seeds: 2-5g	Crystalline alkaloids piperine, [2]
15	<i>Piper longum</i>.L (Long papper, Pipali)	Immunomodulatory, antiasthamatic, antioxidant,	Seeds: 500mg-1g	Alkaloids piperine and piperlongumine

		hypocholesteremic , antiinflammatory, negative chronotropic and negative inotropic activities.		[31, 2, 58]
16	<i>Phyllanthus emblica.L</i> (Amla)	Anabolic, antibacterial, antipyretic, antiviral, antioxidative, antihepatic, immunomodulator .	Seeds:3 to 6g	Ascorbic acid, fiber, pectin, zinc [48]
17	<i>Souropus androgynusL.Merr.</i> (Sweet leaf bush)	Antioxidative,antiobesity	Leaves: 18 mg	Saponin, alkaloids and tannin [53]
18	<i>Vitis vinifera L.</i> (Grape)	Antioxidant, antithrombotic, cardioprotective effects, antiobesity properties .	<u>Skin Extract</u> 50 mg <u>Seed Extract</u> 100 mg-350 mg	Resveratrol (trans-3, 40, 5-trihydroxystilbene) , a phytopolyphenol [19,59]
19	<i>Zingiber officinale</i> Roscoe (Ginger)	Antioxidant, antihypolipidaemic.	Rhizome: 10mg	_Gingerols, 6-shogaol and galanolactone [49]
20	<i>Lagerstroemia speciosa.L</i> (Queen's flower , Banaba , Pride of India)	Antidiabetic, anti- adipogenic.	Leaves:32and48 mg	triterpenoid , corosolic acid and the ellagitannins like lagerstroemin, flosin B, and reginin A. [21]

TABLE 2:Chinese herbs with known antiobesity properties[12,6, 27,40,62]

No.	Scientific name	Plant part	Family
1.	<i>Achyranthes bidentata</i> Bl.	Root	Amaranthaceae
2.	<i>Alisma oriental</i> (Sam.) Juzep	Tuber	Alismataceae
3.	<i>Angelica sinensis</i> (Oliv.) Diels.	Root	Umbelliferae

4.	<i>Astragalus membranaceus</i> (Fisch.) Bunge	Root	Leguminosae
5.	<i>Atractylodes macrocephala</i> Koidz.	Rhizome	Asteraceae
6.	<i>Bupleurum chinense</i> DC.	Root	Umbelliferae
7.	<i>Camellia sinensis</i> (L.) O. Kuntze	Leaves	Theaceae
8.	<i>Carthamus tinctorius</i> L.	Flower	Asteraceae
9.	<i>Citrus aurantium</i> L.	Young fruit	Rutaceae
10.	<i>Coptis chinensis</i>	Root	Ranunculaceae
11.	<i>Cornus officinalis</i> Sieb. Et Zucc.	Fruit	Cornaceae
12.	<i>Dioscorea opposita</i> Thunb.	Rhizome	Dioscoreaceae
13.	<i>Eclipta prostrata</i> L.	Whole grass	Asteraceae
14.	<i>Ephedra sinica</i> Stapf	Herbaceous stem	Ephedraceae
15.	<i>Epimedium brevicornum</i> Maxim.	Aerial part	Berberidaceae
16.	<i>Forsythia suspensa</i> (Thunb.) Vahl	Fruit	Oleaceae
17.	<i>Grifola frondosa</i> (Dickson ex Fr.) S. F. Gray	Fruit body	Polyporaceae
18.	<i>Grataegus pinnatifida</i> Bunge	Fruit	Rosales
19.	<i>Leonurus japonicus</i> Houtt.	Fruit	Labiatae
20.	<i>Ligusticum chuanxiong</i> Hort.	Rhizome	Umbelliferae
21.	<i>Ligustrum lucidum</i> Ait.	Fruit	Oleaceae
22.	<i>Lycium chinense</i> Mill	Leaf	Solanaceae
23.	<i>Millettia reticulata</i> Benth.	cane	Leguminosae
24.	<i>Morus alba</i> L.	Ear	Moraceae
25.	<i>Paeonia lactiflora</i> Pall.	Root	Ranunculaceae

26.	<i>Panax notoginseng</i> (Burk.) F.H.Chen	Root	Plantaginaceae
27.	<i>Phragmites communis</i> Trin.	Rhizome	Poaceae
28.	<i>Pinellia ternata</i> (Thunb.) Breit.	Tuber	Araceae
29.	<i>Plantago asiatica</i> Linn.	Whole grass	Araliaceae
30.	<i>Polygonum cuspidatum</i> Sieb. et Zucc	Root and rhizome	Polygonaceae
31.	<i>Polygonum multiflorum</i> Thunb.	Root	Polygonaceae
32.	<i>Poria cocos</i> (Schw.) Wolf	Fruit body	Polyporaceae
33.	<i>Portulaca oleracea</i> Linn.	Aerial part	Portulacaceae
34.	<i>Prunella vulgaris</i> L.	Ear	Labiatae
35.	<i>Pueraria lobata</i> (Willd.) Ohwi	Root	Leguminosae
36.	<i>Radix Angelica Sinensis</i>	Root	Umbelliferae
37.	<i>Raphanus sativus</i> L.	Seed	Cruciferae
38.	<i>Rheum palmatum</i> L.	Root and rhizome	Polygonaceae
39.	<i>Rubus suavissimus</i> S.K.Lee	Leaf	Rosaceae
40.	<i>Salvia miltiorrhiza</i> Bge.	Root and rhizome	Labiatae
41.	<i>Saposhnikovia divaricata</i> (Turcz.) Schischk.	Root	Umbelliferae
42.	<i>Sophora tonkinensis</i> Gapnep.	Root and rhizome	Leguminosae
43.	Trigonella foenum-graecum Linn.	Seed and Leaf	Leguminosae
44.	<i>Taxillus chinensis</i> (DC.) Danser	Aerial part	Loranthaceae
45.	<i>Uncaria macrophylla</i> Wall.	Aerial part	Alismataceae
46.	<i>Medicago sativa</i>	Leaves and Tender shoots	Fabaceae

TABLE -3: Korean medicinal plants used for the management of obesity [61]

S.No	Plant Name	Family	Bioactivities
1.	<i>Fraxinus rhynchophylla</i> Hance (Chimese ash)	Oleaceae	Lipoxygenase inhibition, HMG-Co A reductase inhibition activities [22]
2.	<i>Eleutherococcus sessiliflorus</i> (Rupr. et Maxim.) S.Y.Hu(Acanthopanax)	Araliaceae	Anti-inflammatory and antioedemic , adaptogenic, lipid lowering [63]
3.	<i>Crataegus pinnatifida</i> Bunge (Hawthorn, Thorn apple)	Rosaceae	Hypotensive,cholesterol level lowering activities , platelet aggregation inhibition [24]
4.	<i>Angelica dahurica</i> (Fisch.) Benth. et Hook.f.	Umbelliferae	Lipolysis and lipogenesis [35, 36]
5.	<i>Akebia quinata</i> Decne.	Lardizabalaceae	Diuretic, anti-inflammatory, lowers serum cholesterollevel , antiulcer [34] Spasmolytic, sedative, hypocholesterolaemic

6.	<i>Acorus gramineus</i> Sol.	Araceae	andcholelytiasic [47]
7.	<i>Acorus calamus var. angustatus</i> Besser	Araceae	Antibacterial , sedative , spasmolytic , hypocholesterolaemic [47]
8.	<i>Typha orientalis</i> J.Presl	Typhaceae	Hypercholesteremia, haematemesis [52]
9.	<i>Scutellaria baicalensis</i> Georgi	Labiatae	Choleretic , arteriosclerotic , hyperlipaemia lowering activities [54]
10.	<i>Rosa rugosa</i> Thunb.	Rosaceae	Antihypercholesterolaemic [64]
11.	<i>Pyrrhosia lingua</i> (Thunb.) Farw.	Polypodiaceae	Antibacterial, antitussive, expectorant, antiasthmatic , hypolipidaemic [59]
12.	<i>Pinus koraiensis</i> Siebold et Zucc.	Pinaceae	Hypolipidaemic , analgesic, anti-inflammatory , antibacterial [13 ,33]

13.	<i>Panax ginseng</i> C.A.Mey.	Araliaceae	Antioxidant, antifatigue , immunostimulating ,increasing HDL cholesterol,stimulation of ADH , hypoglycaemic [15]
14.	<i>Morus stylosa</i> var. <i>ovalifolia</i> Ser. (pro parte)	Moraceae	HMG Co-A reductase inhibition , antitumour activity [22]

TABLE -4: South African medicinal plants used for the management of obesity [4]

S. No	Plant name	Family	Local /English name	Part used	Purpose of use	Preparation/administrati on
1.	<i>Agathosma apiculata</i> G.Mey	Rutaceae	Ibuchu / Buchu	Roots	Used to reduce body weight and fluid retention	A mixture of powdered root, vinegar and camphor is taken ½ glass cup twice daily.
2.	<i>Alepidea amatymbica</i> Eckl. & Zeyh	Apiaceae	Igwili / Umvuthuza/ Larger tinsel flower	Roots	Used for weight loss, stomach pain and wound healing	The powder root is soaked in water and infusion taken orally twice daily
3.	<i>Aloe ferox</i> Mill	Aloaceae	Ikhala-lasekoloni /Bitter aloe	Leaves	Used for weight loss and as anti-diabetic. It enhances body healthiness, and treats arthritis and constipation	The liquid from the boiled leaves is taken ½ glass cup daily

4.	<i>Asparagus africana</i> Lam	Asparagaceae	Umthunzi/ Climbing asparagus	Leaves	Used to reduce body weight, to increase urination and to treat diabetes	The leaves are crushed and soaked in water. ½ glass cup of the extract is taken twice daily
5.	<i>Bulbine alooides</i> (L.) Willd	Asphodelaceae	Irooiwater	Roots	Used for weight loss, as anti-hypertensive, treats heart problems, and skin burns	2 litres of boiled root infusion is taken ½ glass cup twice daily for 2weeks
6.	<i>Cannabis sativa</i> L.	Cannabaceae	Isangu /Marijuana	Leaves	It is used for weight loss, as psychoactive and stimulates energy.	Fresh leaves are crushed, soaked in water and extract is mixed with vinegar.
7.	<i>Catharanthus roseus</i> L G.Don.	Apocynaceae	Epinkie/ Madagascar periwinkle	Leaves	Used for body weight loss and to treat diabetics	Infusion from boiled leaves is usually taken ½ glass cup twice daily for 2weeks.
8.	<i>Cucumis africanus</i> L.f.	Curcubitaceae	Ithangazana/ Scaret guord	Whole plant	Used for body weight loss and wound healing	Cold Infusion of whole plant is taken ½ glass cup three times daily
9.	<i>Cissampelos capensis</i> L.f.	Menispermaceae	Umayisake /David root	Roots	Used for weight loss, stimulates body energy and arrests stomach aches.	2 litres of mixture called “isiwasho” is made from crushed root and vinegar, roo pepper,cayane salt and methylated spirit. It is taken ½ glass cup daily or two spoonfuls twice daily.
10.	<i>Curtisia dentata</i> (Burm.f.) C.A.Sm	Cornaceae	Umlahleniselefile /Capelancewood	Bark	Used to reduce body weight, as anti-diabetic, anti-hypertensive and to treat stomach ailments	Powered root is boiled in water and taken ½ glass cup for a start and two spoonfuls twice daily for a period of 1½ weeks
11.	<i>Exomis microphylla</i> (Thunb.) Aellen	Chenopodiaceae	Umvawenyathi /Sugarbeet	Leaves	Used for body weight loss, as anti-diabetic and for wound	Decoction is taken ½ glass cup three times daily. Healing

					healing	
12.	<i>Kedrostis africana</i> L.Cogn	Cucurbitaceae	Uthuvishhe /Uthuvana /Baboons cucumber	Bulb	Used for body weight loss	Decoction from crushed fresh bulb is taken twice daily
13.	<i>Leonotis leonurus</i> L.R.Br	Lamiaceae	Umunyamunya/ Wild dagga	Whole plant	Used for body weight loss, as anti-diabetic and for wound healing	A fresh plant is crushed, boiled in water and infusion is taken ½ glass cup twice daily.
14.	<i>Leonotis ocyimifolia</i> Burm.f Iwarsson	Lamiaceae	Umuncwane /wild dagga	Whole plant	Used for body weight loss, and to treat stomach ache	A fresh plant is crushed, boiled in water and infusion is taken ½ glass cup twice daily.
15.	<i>Mimosops obovata</i> Nees ex Sond.	Sapotaceae	Umntunzi/ Red milkwood	Bark	Used for body weight loss, and to treat stomach ache	It is crushed and soaked in water. Infusion is taken twice daily.
16.	<i>Phytolacca dioica</i> L.	Phytolaccaceae	Idolo I enkonyane /Phytolacca	Leaves	Used for body weight loss and as purgative	A mixture is made from boiled leaves and vinegar which is taken ½ glass three times
17.	<i>Rosmarinus officinalis</i> L	Lamiaceae	Rosmaryn /Rosemary	Leaves	Used for weight loss, reduces body fluid, as digestive, and anti-hypertensive. It is also used for flavor	Decoction is made from boiled fresh leaves and taken severally
18.	<i>Rubia petiolaris</i> D.C	Rubiaceae	Impendulo /madder	Roots	Used to reduce body weight, treat stomach-ache and body weakness	The infusion is made from root decoction and taken ½ glass cup twice daily

19.	<i>Schotia latifolia</i> Jacq	Fabaceae	Umaphipa /Forest boer-bean	Bark	Used for body weight loss, as anti-diabetic and antihypertensive. Used in the treatment of chest pain and arthritis	The bark is crushed to powder and 2 spoonfuls of infusion is taken orally twice daily for 2weeks
20.	<i>Vernonia mesphilifolia</i> Less	Asteraceae	Ulunguhlungu /Iron weed	Whole plant	Used for weight loss, as anti-hypertensive, and removes body liquid	Decoction from ground fresh plant is taken ½ glass cup twice daily

MATERIALS AND METHODS

1. ANTHROPOMETRIC MEASUREMENTS FOR OBESITY

Assessment of obesity and overweight involves using the key measures[7]:

i. Body Mass Index (BMI)

Although not a direct measure of adiposity, the most widely used method to gauge obesity is the body mass index which is equal to weight/Height² (kg/m²) (Underweight- below 18.5, Normal-18.5 to 24.9 ,Overweight- 25.0 to 29.9 ,Obesity- 30.0 and above)

ii. Waist- to- Hip Ratio (WHR)

WHR is the ratio of a person's waist circumference to their hip circumference, and is also used to determine risk for weight-related illnesses. A WHR greater than 1.0 in men or greater than 0.8 in women is considered obese.

iii. Waist Circumference

Measuring waist circumference is a good indicator of abdominal fat, which is another predictor of your risk for developing risk factors for heart disease and other diseases. This risk increases with a waist measurement of over 40 inches in men and over 35 inches in women.

iv. Skin fold thickness

Using a skin fold caliper to measure percent body fat is another way to determine obesity. Generally, men with more than 25% body fat and women with more than 30% are considered obese. The caliper takes measurements of fat lying just below the skin from several parts of the body (such as the triceps, or back of upper arm) to estimate percentage of body fat.

Other methods for measuring body fat include using electronic impulses densitometry (under water weighing), CT or MRI and electrical impedance, measurements that use modern imaging such as magnetic resonance, X-ray and computerized tomography are proven to be the best and the most accurate.

2. Experimental Models

Different animal models can be used such as Adult Balb/c albino mice (15± 5 g) , Ob/Ob mice, White male albino rats(80-90gm, 60 day old)[29], Male Wistar albino rats (150-170g,90 days old) [41], Male Sprague –Dawley (307±30g) , male ICR mice (20±2g), female ICR mice (8weeks old), C57BL/6J mice (4 weeks old) [57], Albino rats of porter strain of either sex[38] Male albino Wistar rats (150-200g).

Rabbits (6-9 months old, 1.3-2.7kg) [18]

Birds such as Broiler Chicken (21 days old) [53].

Human Subjects (test volunteers) covering a wide range of adiposity such as overweight (mean body mass index , approximately 32 kg/m², and a waist circumference >85.5cm) , obese (at most 38 kg/m²) and also normal weight but otherwise healthy adults 18 to 65 years can be selected based on their willingness to participate . Subjects are asked to give a written consent form before their participation and the proceedings should be fully explained.

Subjects who are pregnant ,have any clinically significant medical condition, are taking prescription medications or appetite suppressants on a regular basis, have a history of alcohol or other drug abuse, or allergic to any of the study products or have dieted with weight loss in the past 6 months are to be exempted for the study.

3. Study Design

Experimental diets for animals are prepared and the feed intake has to be measured daily and at the same time the amount of food left over has to be calculated by subtracting from the measured amount of food in each cage barrier for each mice provided the previous day (gm/day/mice) and body weight should be recorded weekly.

The animals are grouped into normal control and treatment groups with six in each group (n=6) .The treatment groups are induced to become obese (about 30 days) prior to the experiment.The treatment groups can be with the polyherbal formulation product and synthetic treatment. The dosage of administration of the PHF and the synthetic drug is calculated after the toxicity studies (L₅₀).

Human test volunteers are grouped randomly into obese and overweight and normal groups which are divided into placebo- controlled and treatment groups [26].The treatment groups can either be formulation with diet or without diet. Experimental period is to be carried out for 3 months.

4. Weight Measurements

The weight of the experimental animals has to be noted before and after the experiment and also on a weekly basis using an electronics balance to have clear information about the effect of the anti-obesity effect of PolyHerbal Formulation product (PHF).

The net weight loss can be calculated as:

$$\text{Net weight loss} = \text{Initial weight (W}_0\text{)} - \text{New weight (W}_1\text{)}$$

$$\% \text{ of weight loss} = \frac{\text{Total Weight loss} \times 100}{\text{Initial weight}}$$

5. Biochemical Parameters:

5.1. Blood sample collection

The blood has to be collected from the animals initially and terminally to the experiments by the following techniques mentioned in Table 5:

TABLE -5: Techniques of Blood Collection

S.No	Techniques	Site of Collection
1.	Blood collection not requiring anesthesia	Saphenous vein, Dorsal pedal vein
2.	Blood collection requiring anesthesia	Tail vein ,Orbital sinus, Jugular vein
3.	Terminal procedures	Cardiac puncture ,Posterior vena cava, Axillary vessels,Orbital sinus

On day 42 ,blood can be collected after sacrificing them either by cardiac puncture /retro-orbital sinus. Blood samples collected are to be centrifuged at 3500 rpm for 15 mins at room temperature for separation of serum. The clear, non-haemolysed supernatant sera will be separated using clean dry disposable plastic syringes and stored at - 20°C for subsequent biochemical measurements shown in Table 6

TABLE-6: Biochemical Measurements and Hormonal parameters

Blood analysis 1. Blood analysis(Complete Haemogram)2.	Glucose RBC, WBC (TC/DC) , ESR, Blood platelet , Haemoglobin , Haematocrit , MCV(Mean Corpuscular Haemoglobin) , MCH(Mean Corpuscular Volume) , MCHC(Mean Corpuscular Haemoglobin Concentration
Hormonal Assay	Insulin concentration and Leptin concentration
Lipid profile	Total cholesterol. LDL, HDL, VLDL, total triglycerides

Liver Function Test (LFT)	SGOT-Serum glutamic oxaloacetic transaminase, SGPT- serum glutamic pyruvic transaminase, ALP- Alkaline phosphatase, Serum bilirubin, Total protein
Kidney function	Urea, creatinine, uric acid
Heart biomarkers	CK-MB (Creatine kinase myocardial type), CK- NAC (N- <u>acetylcysteine</u>) and LDH (lactate dehydrogenase activity),lipoprotein A
Oxidative stress markers	Malonyldialdehyde (MDA), Glutathione S-transferase (GST), Reduced glutathione (GSH) Superoxide dismutase (SOD), Catalase.

5.2. Tissue Samples

Animals have to be sacrificed and separation of spleen, kidneys, fat pads (hepatic, perirenal, and visceral adipose tissues) has to be done. They are to be blotted on filter paper and weighed (g). The liver should be immediately excised and weighed (g) and is homogenized for GSH (reduced glutathione) and MDA (Malondialdehyde) catalase measurements.

5.3. Human Studies considering the anti-obesity effects of PHF

Change in anthropometric measures such as body weight and waist – hip circumference, body fat (weight or mass of visceral adipose tissue, fat mass or percent),triceps skin fold thickness , appetite or amount of food intake has to be noted. Blood sampling and clinical analysis has to be done at baseline and after the treatment period.

SUMMARY AND CONCLUSION

Some herbs act on digestion, metabolism, or appetite to impact weight loss. Certain substances can increase thermogenesis (generation of heat), or metabolism, which may lead to weight loss .Herbal weight loss products are a great safe option for the people who want to lose weight naturally.

Various herbal supplements have proved to be effective against obesity and its related diseases. Allicin, the major component of garlic is mainly responsible for the hypolipidemic [5,55] activity. Garlic reduces atherosclerosis by inhibiting platelet aggregation, increasing fibrinolysis, enhancing antioxidant activity, and reducing serum lipids in general to lower cholesterol levels and other significant risk factors for CAD (coronary artery disease). Steroids like Z-Guggulusteron and E-Guggulusterone found in *Commiphora mukul* [38,58] possesses lipid lowering activity. Fibre extracts of *Cissus quadrangularis* have been shown to have anti-lipase properties that reduce absorption of dietary fats and enhance satiation [1,16,26,44]. The major constituents alkaloids (liensinine, neferine, nuciferine, remrefidine and isoliensinine) and flavonoids (+)-1(R)-coclaurine, (-)-1(S)-norcoclaurine and quercetin 3-O-b-D- glucuronide) of *Nelumbo nucifera* have cholesterol-lowering and anti-obesity effects [11]. The active ingredient around 20-30% of (-) hydroxy citric acid (HCA) in *Garcinia cambogia*, works by ATP citrate lyase converts, excess calories from food into fat for storage [51,56]. Anti obesity properties of *Phyllanthus emblica* are due to ascorbic acid, fiber, pectin and zinc [50]. *Panax ginseng* proved for anti-hyperglycemia, insulin sensitization, islet protection, anti-obesity and anti-oxidation in many model systems. Energy expenditure is enhanced by ginseng through thermogenesis. Ginseng-specific saponins (ginsenosides) are considered as the major bioactive compounds for the metabolic activities of ginseng [23]. *Vitis vinifera* (oligomeric proanthocyanidins (OPCs) or procyanidins from grape seed are theorized to be beneficial to prevent and treat cardiovascular and circulatory conditions due to antioxidant and potential antilipoperoxidant activity [17,57]. *Citrus aurantium* (Synephrine) stimulates peripheral tissue thermogenesis [3]. *Grifola frondosa* (fibers) helped in lowering VLDL and serum cholesterol [43]. *Cyperus rotundus* (tertiary sesquiterpene alcohol, isocyperol) suresha [16,58], exhibits lipolytic action. *Irvingia gabonensis* (polyphenols such as epigallocatechin gallate [26] favourably impacts adipogenesis through a variety of critical metabolic pathways.

This paper is an overview of plants screened globally for antiobesity and ours is an attempt to develop a nutraceutical product for antiobesity. In our study different combinations of herbal supplements for antiobesity are chosen from Table 1 for the preparation of a polyherbal formulation (PHF) product.

Ingredients for Poly Herbal formulation product (PHF) and the calorific value of PHF were calculated. Fine tuning of various food formulations such as extruded products, biscuits, noodles, foodles etc is in progress. Studies on animal models and human volunteers are in progress.

REFERENCES:

1. Achal Thakur, Vandana Jain, L Hingorani, KS Laddha, Phytochemical Studies on *Cissus quadrangularis* Linn 2009;1(4) : 213-215.
2. Acharya.D and Shrivastava. A, Indigenous Herbal Medicines: Tribal Formulations and Traditional Herbal Practices. Aavishkar Publishers Distributors, Jaipur. 2008 ISBN 978-81-7910-252-7.
3. Adriane Fugh-Berman and Adam Myers, *Citrus aurantium*, an Ingredient of Dietary Supplements Marketed for Weight Loss: Current Status of Clinical and Basic Research, Exp Biol Med (Maywood). 2004;229(8):695-7.
4. Afolayan A J and Mbaebie B O, Ethnobotanical study of medicinal plants used as anti-obesity remedies in Nkonkobe Municipality of South Africa, Pharmacognosy Journal, Research Article 2010; 2(11): 368-373.
5. Amagase H, Petesch BL, Matsuura H, Kasuga S and Itakura Y, Intake of garlic and its bioactive components, Journal of Nutrition, 2001 ; 131(3s):955S-62S.
6. Anti-Obesity Day 2010 - The Big Fat Problem Plaguing India
<http://www.medindia.net/news/healthfocus/Anti-Obesity-Day-2010-The-Big-Fat-Problem-Plaguing-India-77204-1.htm#ixzz17yYeoDq4>
7. Anthropometric Measurements - nutrition, body, fat, weight <http://www.faqs.org/nutrition/A-Ap/Anthropometric-Measurements.html#ixzz17ykTCUBy>
8. Ava Jiangyang Guo, Roy Chi-yan Choi, Anna Wing-han Cheung, Jun Li, Ivy Xiaoying Chen, Tina Tingxia Dong, Karl Wah-keung Tsim and Brad Wing-chuen Lau, Stimulation of Apolipoprotein A-IV expression in Caco-2/TC7 enterocytes and reduction of triglyceride formation in 3T3-L1 adipocytes by potential anti-obesity Chinese herbal medicines, Chinese Medicine 2009, 4:5
9. Bhat Vishnu, Asuti Naveen, Kamat Akshay, Sikarwar Mukesh. S., Patil M. B. *Vishnu Bhat et al*, Antidiabetic activity of insulin plant (*Costus igneus*) leaf extract in diabetic rats, *Journal of Pharmacy Research* 2010 ;3(3):608-611.
10. Bishayee, A. and Chatterjee, M., Hypolipidaemic and antiatherosclerotic effects of oral *Gymnema sylvestre* R. Br. Leaf extract in albino rats fed on a high fat diet, *Phytotherapy Research* (1994);8:118-120.
11. Brindha.D, D.Arthi, Antimicrobial Activity of White and Pink *Nelumbo nucifera* Gaertn flowers, *Journal of Pharmaceutical Research and Health Care*, 2010 ;2(2):147-155.
12. Cheng-Dong Zheng, Ya-Qing Duan, Jin-Ming Gao, Zhi-Gang Ruan, Screening for Anti-lipase Properties of 37 Traditional Chinese Medicinal Herbs, *J Chin Med Assoc*

- a. 2010;73(6):319–324.
13. *Chi, H.J. Kor. J. Pharmacog. (1986) ; **17**, 73;Cited from WHO Western Pacific Region - Publications and documents Series No21- Medicinal plants in the Republic of Korea 1998, 316 pages
 14. Chithra, V. and Leelamma, S. "Hypolipidemic Effect of Coriander Seeds (*Coriandrum Sativum*): Mechanism of Action," Plant Foods Human Nutrition, 1997;51(2):167-72.
 15. *C.N. ,Joo Kor. J. Biochem. , (1977); **10**, 109. Cited from WHO Western Pacific Region - Publications and documents Series No21- Medicinal plants in the Republic of Korea 1998, 316 pages.
 16. David Bruce Leonard, L.Ac. Roast Duck Production ,Medicine at your Feet:Healing Plants of the Hawaiian Kingdom *Cyperus rotundus* (Xiang fu) 1998 – 2006. J Ethnopharmacol. 76(1):59-64.
 17. Diego A. Moreno, Nebojsa Ilic, Alexander Poulev, Dawn L. Brasaemle,Susan K. Fried, and Ilya Raskin,Inhibitory Effects of Grape Seed Extract on Lipases, Nutrition 2003;19:876–879.
 18. Ebtesam A, Al- Suhahaimi, Effect of *Coriandrum sativum* , a common herbal medicine, on endocrine and reproductive organ structure and function, the Internet of Alternative Medicine , 2009 ;(7) 2.
 19. Ekanem AP, Wang M, Simon JE, Moreno DA. Antiobesity properties of two african plants (*Fromomum meguetta* and *Spilanthes acmella*) by pancreatic lipase inhibition. Phytother. (2007); Res.21: 1253-1255.
 20. Gholamhoseinian A , B. Shahouzehi, F. SharififarInternational , Inhibitory effect of some plants extracts on pancreatic lipase,Journal Of Pharmacology 2010 :6(1);18-24.
 21. Guy Klein , Jaekyung Kim , Klaus Himmeldirk , Yanyan Cao , and Xiaozhuo Chen ,Antidiabetes and Anti-obesity Activity of Lagerstroemia speciosa, Advance Access Publication 2007.
 22. *Han, G.Q. Int. J. Chinese Med. (1991) ; **16**,1. Cited from WHO Western Pacific Region - Publications and documents Series No21- Medicinal plants in the Republic of Korea 1998, 316 pages.
 23. Hongwei Wang, Dacheng Peng and Jingtian Xie ,Ginseng leaf-stem: bioactive constituents and pharmacological functions *Chinese Medicine* 2009, 4:20.
 24. *Hsu, H.-Y. Oriental Materia Medica, (1986) : 727. . Cited from WHO Western Pacific Region - Publications and documents Series No21- Medicinal plants in the Republic of Korea 1998, 316 pages.
 25. Hu; Tricia Y. Li, Frank B, Graham A. Colditz, , PH; Walter C. Willett, , Dr PH; JoAnn E. Manson, , Dr PH Television Watching and Other Sedentary Behaviors in Relation to Risk of Obesity and Type 2 Diabetes Mellitus in Women *JAMA*. 2003;289:1785-1791.
 26. Julius .E, Oben Judith .L ,Ngondi Claudia N ,Momo Gabriel A, Agbor and Caroline S ,Makamto Sobgui ,The use of a *Cissus quadrangularis/Irvingia gabonensis* combination in the management of weight loss: a double-blind placebo-controlled study ,*Lipids in Health and Disease* 2008, 7:12.
 27. Jun Yin, Hanjie Zhang, and Jianping Ye Traditional Chinese Medicine in Treatment of Metabolic Syndrome .Endocr Metab Immune Disord Drug Targets. 2008 June; 8(2): 99–111
 28. Kaku nakagawa, Hideyuki kishida, Naoki arai, Tozo nishiyama, and Tatsumasa mae ,Licorice Flavonoids Suppress Abdominal Fat Accumulation and Increase in Blood Glucose Level in Obese Diabetic KK-Ay Mice, *Biol. Pharm. Bull.* (2004); 27(11): 1775—1778 .
 29. Kamal A Amin and Mohamed A Nagy ,Effect of carnitine and Herbal mixture extract on obesity induced by high fat diet in rats_ Diabetol Metab Syndr. 2009; 1: 17.
 30. Kang MH, Park WJ, Choi MK , Anti-obesity and hypolipidemic effects of *Lycium chinense* leaf powder in obese rats ,*J Med Food*. 2010;13(4):801-7.
 31. Khushbu Chauhan, Lalkrishna Parmar, Roshni Solanki, Virendra Kagathara, Dhaval Madat, Timir Patel , Effect of *Piper longum* linn on histopathological and biochemical changes in isoproterenol induced myocardial infarction in rats ,Research Journal of Pharmaceutical, Biological and Chemical Sciences 2010; (1): 759.
 32. Kim MS , Anti-adipogenic effects of *Garcinia* extract on the lipid droplet accumulation and the expression of transcription factor. *Biofactors*. 2004; a. 22(1-4):193-6
 33. *Kimura, *Planta Med.* (1983) ; **49**, 51. Cited from WHO Western Pacific Region - Publications and documents Series No21- Medicinal plants in the Republic of Korea 1998, 316 pages.
 34. Kimura,Intern. Collation of Trad. and Folk Med. 1996;Part I, p. 35. Cited from WHO Western Pacific Region - Publications and documents Series No21- Medicinal plants in the Republic of Korea 1998, 316 pages.
 35. *Kimura, Intern. Collation of Trad. and Folk Med., World Sci. Pub. Co.,Singapore. , 1996; Part I :p 117, . Cited from WHO Western Pacific Region - Publications and documents Series No21- Medicinal plants in the Republic of Korea 1998, 316 pages.

36. *Komura, Y. *et al.* *Planta Med.* (1982) ; **45**, 183. Cited from WHO Western Pacific Region - Publications and documents Series No21- Medicinal plants in the Republic of Korea 1998, 316 pages.
37. Lab Tests Online, American Association for Clinical Chemistry, 2010.
38. Lata S. Saxena KK, Bhasin V, Saxena RS, Kumar A, Srivastava VK.: Beneficial effects of *Allium sativum*, *Allium cepa* and *Commiphora mukul* on experimental hyperlipidemia and atherosclerosis - a comparative evaluation, 1991; 37-3:132-5
39. Marcin Krotkiewski, Radosław Janiak, Comparison of the weight-decreasing effects of different herbs with a mixture of herbal extracts exerting a probable synergistic effect, 2008; www.endokrynologia.viamedica.pl :137–142.
40. Mark Mayell, Maitake extracts and their therapeutic potential- a review, *Altern Med Rev.* 2001;6(1): 48-60.
41. Maruthappan.V, K. Sakthi Shree, Antihyperlipidemic potential of a phyherbal drug (Geriforte) on atherogenic diet induced hyperlipidemia: A Comparison with Ayurslim, *International Journal of Chemical and Analytical Science* 2010 ; Vol 1, No 3
42. Mosa Mohammad A. Qasheesh1424 AH - 2004 AD ,Herbs used for the treatment of obesity, <http://faculty.ksu.edu.sa/18856/Articles/herbs%20used%20for%20obesity.pdf>
43. Obesity: Preventing and Managing the Global Epidemic Report on a WHO Consultation Technical Report Series, No 894
44. Oben, Kuate, Agbor, Momo, Talla , The use of a *Cissus quadrangularis* formulation in the management of weight loss and metabolism. *Lipids in Health and Disease* 2006, 5:24 .
45. Osman, M., Fayed, S.A., Ghada I. Mahmoud and Romeilah, R.M , Protective Effects of Chitosan, Ascorbic Acid and *Gymnema Sylvestre* Against Hypercholesterolemia in Male Rats ,*Australian Journal of Basic and Applied Sciences* 2010 ; 4(1): 89-98.
46. Parijat Kanetkar, Rekha Singhal and Madhusudan Kamat: Recent Advances in Indian Herbal Drug Research, Guest Editor: Thomas Paul Asir Devasagayam , *Gymnema sylvestre*: A Memoir . *J. Clin. Biochem. Nutr* 2007; **41**: 77-81.
47. *Patra and Mitra, A.K. *J. Nat. Prod.* (1981) ; **44**, 668. Cited from WHO Western Pacific Region - Publications and documents Series No21- Medicinal plants in the Republic of Korea 1998, 316 pages.
48. Rasheda Ahmed , Sharmin Jahan Moushumi, Humayaun Ahmed, Mohammad Ali. Md. Has Reza, Wahid Mozammel Haq, Rownak Jahan , Mohammeded Rahmatullah, Astudy of Serum Total Cholesterol and Triglyceride Lowering Activities of *Phyllanthus Emblica L.* (Euphorbiaceace) Fruits in Rats *Advances in natural and Applied Sciences* 2010; 4 (2): 168-170.
49. Rihana kamal and Shagufta Aleem, Clinical evaluation of the efficacy of a combination of *Zanjabeel(Zingiber officinale)* and *amla(Emblica officinalis)* in Hyperlipidaemia , *Journal of Traditional knowledge* 2009;8 (3): 413-416.
50. Ritu, Mathur, Arti Sharma, V. P. Dixit and Mira Verma Title: Hypolipidemic effect of fruit juice of *Emblica officinalis* in cholesterol-fed rabbits , *Journal of Ethnopharmacology* 1996 ;50, 2 :61-68.
51. Saito M, High dose of *Garcinia cambogia* is effective in suppressing fat accumulation in developing male Zucker obese rats, but highly toxic to the testis. *Food Chem Toxicol.* 2005;43(3):411-9.
52. *Sakurai, Tetrahedron (1983) ;**39**, 883. Cited from WHO Western Pacific Region - Publications and documents Series No21- Medicinal plants in the Republic of Korea 1998, 316 pages.
53. Santoso.U , Kusussiyah and Y. Fenita, The effect of *Souropus androgynous* Extract and Lemuru oil on Fat deposition and fatty acid Composition of Meat in Broiler Chickens , *J. Indonesian Trop. Anim. Agric.* .2010 ;35(1).
54. *Shin, K.H., *Kor. J. Pharmacog.* (1994) ; **25**, 41, Cited from WHO Western Pacific Region - Publications and documents Series No21- Medicinal plants in the Republic of Korea 1998, 316 pages.
55. Soon Ah Kang, Ho Jung Shin , Ki-Hyo Jang, Sung Eun Choi, Kyung Ah Yoon, Jin Sook Kim, Hye Kyung Chun and Yoongho Lim, Effect of Garlic on Serum Lipids Profiles and Leptin in Rats Fed High Diet, *J Food Sci Nutr* (2006) ;Vol II :48-53.
56. Steven B. Heymsfield, MD; David B. Allison, PhD; Joseph R. Vasselli, PhD; Angelo Pietrobelli, MD; Debra Greenfield, MS, RD; Christopher Nunez, MEd , *Garcinia cambogia* (Hydroxycitric Acid) as a Potential Antiobesity Agent ,A Randomized Controlled Trial ,*JAMA.* 1998;280:1596-1600.
57. Su-Hui, Park, Tae-Sun, Park, and Youn-Soo, Cha Grape seed extract (*Vitis vinifera*) partially reverses high fat diet-induced obesity in C57BL/6J mice *Nutrition Research and Practice* (2008), 2(4), 227-233.
58. Suresha .B., M. G. Hariprasad, R. Rema & U. Imran : Antiobesity effect of Lipovedic formulation in rats fed on atherogenic diet. *The Internet Journal of Nutrition and Wellness.* 2009; Vol 8 No 2.