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Inhibitory Effect of Some Plant Extracts on Pancreatic Lipase

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Abstract: Pancreatic Lipase (PL) is the most important enzyme in digestion of triglycerides. One of the strategies in prevention or treatment of obesity is altering metabolism of lipids by inhibition of dietary fat absorption. One hundred plant extracts were prepared and botanically identified. The air dried plants were extracted with methanol. Anti lipase activity of each plant was determined by turbidimetric assay. *Quercus infectoria*, *Eucalyptus galbie*, *Rosa damascena* and *Levisticum officinale* showed more than 50% inhibition on the enzyme activity. Kinetic study of the enzyme was performed in the presence of effective extracts. *Levisticum officinale* showed mixed inhibition and *Rosa damascena*, *Quercus infectoria* and *Eucalyptus galbie* showed non-competitive inhibition by double-reciprocal Lineweaver-Burk plot analysis. Under the controlled condition, Km value for enzyme was 0.3 mM and V_{max} was 0.078 mM min^{-1}; V_{max} in the presence of *Quercus infectoria*, *Eucalyptus galbie*, *Rosa damascena* and *Levisticum officinale* extracts were 0.051, 0.056, 0.049 and 0.068 mM min^{-1}, respectively. Because of mixed inhibition, *Levisticum officinale* showed a different Km value of 0.617 mM. Further studies needed to elucidate the effectiveness of these active extracts *in vivo* and attempt should be made to purify their active components to be used as safer and cheaper therapeutic agents in future.

Key words: Pancreatic lipase, *Quercus infectoria*, *Eucalyptus galbie*, *Rosa damascena*, *Levisticum officinale*

INTRODUCTION

Plants are one of the most important sources of drugs and their medicinal use has a long history. Literature review indicate that therapeutic use of plants goes back to 4000-5000 B.C. (Prakash and Gupta, 2005). Plants also play a principal role in the introduction of new therapeutic agents (Xie *et al*., 2007; Kumar *et al*., 2008). Obesity in addition to be a health problem is a social problem and the number of people suffering from this disease are increasing rapidly in the world and it has become the center of much attention by public and especially health-related institutions, whose aim is to reduce its prevalence (Moro and Basile, 2000; Han *et al*., 2007). There are more than 1 billion overweight adults that among them at least 300 million are clinically obese (Birari and Bhutani, 2007). The effect of dietary fat on hyperlipidaemia is well known as it is associated with various diseases like obesity, diabetes, hypertension, cardiovascular problems, metabolic syndrome and cancer (Moreno *et al*., 2003; Sharma *et al*., 2005; Han *et al*., 2007). Digestion of dietary triglycerides, which represent 90-95% of the total ingested fat, is driven to completion in the intestine by pancreatic lipase, in conjunction with pancreatic co-lipase and bile that accelerate triglyceride absorption from the small intestine to the enterocytes. If somehow this initial movement of triglycerides from the intestinal lumen be blocked, hyperlipidaemia can be prevented (Ros, 2000; Sebban-Kreuzer *et al*., 2003; Sharma *et al*., 2005; Moreno *et al*., 2006).

The most common anti-obesity drug is Orlistat, a hydrogenated derivative of lipstatin derived from *Streptomyces toxitricini*, a potent inhibitor of gastric, pancreatic and carboxyl ester lipase and it has been proved to be effective for the treatment of human obesity by 35 percent reduction in fat absorption (Moreno *et al*., 2003; Sebban-Kreuzer *et al*., 2003; Sharma *et al*., 2005). Management of hyperlipidaemia without any side effect is still a challenge to the medical system (Xie *et al*., 2007). For instance, consumption of synthetic drugs leads to hyperuricemia, diarrhea, nausea, nyositis, gastric irritation, flushing, dry skin, oily spotting, flatus with discharge, fecal incontinence and abnormal liver function (Greenway, 1999; Kumar *et al*., 2008). While, plant products are considered to have less toxic and side effects than synthetic ones (Xie *et al*., 2007; Kumar *et al*., 2008). The existence of lipase inhibitors has been demonstrated in different plant species including *Marine algae*, soy bean, wheat, teasaponin, *Cassia mimosoides*, *Camelia sinensis*, *Platycodon grandiflorum*, *Ambrosia*

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artemisiaefolia, *Calluna vulgaris*, *Citrus limon*, *Platycodin* D, *Dioscorea nipponica*, *Salacia reticulate*, *Salix matsudara*, *Licochalcone* A from *Glycyrrhiza uralensis*, Grape seed extract and *Scabiosa tschiliensis* (Han *et al*., 2001; Zhao and Kim, 2004; Sharma *et al*., 2005; Moreno *et al*., 2006; Huerta *et al*., 2007; Won *et al*., 2007). However, more searches for finding more effective lipase inhibitors from natural sources are needed. In the present study, we have screened methanol extracts of various plants for their anti-lipase activity to find safer and cheaper medicines in prevention and control of hyperlipidaemia related diseases.

MATERIALS AND METHODS

Plants: Flowers, aerial parts, fruits, roots and seeds of different plants were collected from various provinces of Iran or purchased from the medicinal herbal markets in Kerman city. Scientific names of the plants were authenticated by Dr. Mirtajaldini, Department of Botany, Bahonar University and Kerman, Iran (Table 1). A voucher specimen from each plant was deposited at the herbarium of the Herbal Medicines Research Center, Faculty of Pharmacy and Kerman University of Medical Sciences, Iran. Each plant material was air dried and grounded into fine powder. The powdered material (20 g) was extracted with 200 mL of absolute methanol for 24 h. The suspensions were filtered and air-dried; these air-dried samples were stored at -20°C until use (Sharma *et al*., 2005). Solution of 5 mg mL^{-1} of each extracts in 0.05 M phosphate buffer was prepared just before enzyme assay.

Enzyme assay: Pancreatic lipase activity was measured by turbidimetric method, used by Vogel and Zieve (Shihabi and Bishop, 1971; Burtis *et al*., 2006). The assay was based on the reduction in turbidity of a triolein emulsion by porcine pancreatic lipase (5 unit, Sigma, USA) at 340 nm, pH 8.9 and 37°C (Carrere *et al*., 1987; Han *et al*., 2001; Yamada and Fujita, 2007). Ten microliter of each preparations containing 50 µg crude extract was added to the reaction mixture including; Triolein (0.3 mmol L^{-1}), sodium deoxycholate (16.7 mmol L^{-1}), colipase (4 mg L^{-1}), calcium chloride (0.04 mmol L^{-1}) and 0.05 M tris buffer (final volume of 1 mL). The mixture was incubated at 37°C for 15 min and absorbance at 340 nm was determined spectrophotometrically (Han *et al*., 2001; Yamada and Fujita, 2007). Triolein was solubilized in 0.2% Triton X100 (Rocha *et al*., 1999; Tashiro *et al*., 1992). The active extracts re-examined by commercial lipase assay kit (Randox, Laboratories. LTD. UK).

Pancreatic lipase inhibitory activity was calculated according to the following formula (Huerta *et al*., 2007):

Table 1: Anti porcine pancreatic lipase activity of plants extracts

Plants name	Family	Used part	Inhibition (%)
Quercus infectoria	Fagaceae	Galls	85.0
Eucaliptus galbie	Myrtaceae	Leaves	64.0
Rosa damascene	Rosaceae	Floret	57.0
Levisticum officinale	Apiaceae	Roots	55.0
Urtica urens	Urticacea	Aerial parts	44.7
Alhagi camelorum	Fabaceae	Aerial parts	44.5
Otostegia persica	Lamiaceae	Aerial parts	44.0
Rheum ribes	Polygonaceae	Rhizomes	43.0
Pistacia vera	Anacardiaceae	Fruits hull	42.0
Myrtus communis	Myrtaceae	Leaves	40.0
Cinnamomum zeylanicum	Lauraceae	Derm	39.0
Ficus carica	Moraceae	Leaves	34.2
Nigella sativa	Ranunculaceae	Seeds	31.4
Pimpinella anisum	Apiaceae	Seeds	31.0
Trigonella foenum graecum	Fabaceae	Seeds	30.0
Bunium persicum	Apiaceae	Seeds	28.0
Carthamus oxyacantha	Asteraceae	aerial parts	28.0
Arctium lappa	Asteraceae	Roots	26.8
Zingiber officinale	Zingiberaceae	Rhizomes	23.4
Convolvulus pilosellaefolius	Concolvulaceae	Aerial parts	23.3
Origanum majorana	Lamiaceae	Whole the plant	23.0
Rubia tinctorium	Rubiaceae	Roots	23.0
Camellia sinensis	Theaceae	Leaves	22.0
Peucedanum aucheri	Apiaceae	Roots	22.0
Outreya carduiformis	Asteraceae	Aerial parts	21.3
Cordia mixa	Boraginaceae	Fruits	21.0
Ocimum basilicum	Lamiaceae	Seeds	21.0
Olea europaea	Oleaceae	Leaves	21.0
Punica granatum	Lythraceae	Fruits hull	21.0
Laurus nobilis	Lauraceae	Leaves	20.5
Ducrosia asadii	Apiaceae	Aerial parts	20.0
Ferula oopoda	Apiaceae	Aerial parts	20.0
Teucrium scordium	Lamiaceae	Aerial parts	20.0
Urtica dioica	Urticacea	Aerial parts	19.6
Artemisia santolina	Asteraceae	Aerial parts	19.0
Cardaria draba	Brassicaceae	Aerial parts and flowers	19.0
Foeniculum vulgare	Apiaceae	Fruits	19.0
Sanguisorba minor	Rosaceae	Aerial parts	19.0
Linum usitatissimum	Liliaceae	Seeds	17.0
Salix alba	Salicaceae	Aerial parts	17.0
Althaea officinalis	Malvaceae	Flowers	16.0
Vaccinium arcto-staphylus	Ericaceae	Fruits	16.0
Sophora alopecuroides	Fabaceae	Aerial parts	15.2
Gundelia tournefortii	Asteraceae	Aerial parts	14.3
Eremostachys laciniata	Lmiaceae	Whole the plant	14.0
Ferula assafoetida	Apiaceae	Aerial parts and flowers	14.0
Scorphularia frigid	Scorophulariaceae	Aerial parts	14.0
Malva sylvestris	Malvaceae	Flowers	13.0
Crocus sativa	Iridaceae	Leaves	12.1
Stachys inflate	Lmiaceae	Aerial parts	12.1
Acantholepis orientalis	Asteraceae	Aerial parts	12.0
Eremurus persicus	Liliaceae	Aerial parts	12.0
Mentha longifolia	Lamiaceae	Aerial parts	12.0
Verbascum songaricum	Scrophulariaceae	Aerial parts	12.0
Biebersteinia multifida	Berberdaceae	Aerial parts and fruits	11.4
Terminalia chebulla	Combretaceae	Fruits	11.4
Echium amoenum	Boraginaceae	Flowers	11.0
Fumaria parviflora	Fumariaceae	Aerial parts	11.0
Alpinia officinarum	Zingiberaceae	Rhizomes	10.0
Ziziphus spina-christi	Rhamnaceae	Leaves	10.0
Cannabis sativa	Cannabaceae	Seeds	9.5
Salvadora persica	Salvadoraceae	Wood	9.2

Table 1: Continued

Plants name	Family	Used part	Inhibition (%)
Francoeuria undulata	Asteraceae	Aerial parts	9.0
Verbascum kermanensis	Scrophulariaceae	Leaves	9.0
Matricaria aurea	Asteraceae	Flowers	8.0
Glycyrrhiza glabra	Fabaceae	Aerial parts	7.0
Bryonia aspera	Cucurbitaceae	Aerial parts	7.0
Solanum dulcamara	Solanaceae	Fruits	7.0
Zataria multiflora	Lamiaceae	Aerial parts	7.0
Euphorbia hebecarpa	Euphorbiaceae	Aerial parts and flowers	6.7
Marrubium anisodon	Lamiaceae	Aerial parts	6.3
Apium graveolens	Umbelliferae	Leaves	6.1
Heracleum persicum	Apiaceae	Fruits	6.0
Onobrychis viciifolia	Fabaceae	Aerial parts	6.0
Thymus serpyllum	Lamiaceae	Aerial parts	6.0
Hibiscus gossypifolius	Malvaceae	Flowers	5.3
Sonchus asper	Asteraceae	Aerial parts	5.1
Rosmarinus officinalis	Lamiaceae	Aerial parts	5.0
Zhumeria majdae	Lamiaceae	Leaves	5.0
Acroptilon repens	Asteraceae	Aerial parts	4.6
Sizigium aromaticus	Caryophyllaceae	Floret	4.3
Chaerophyllum khorassanicum	Apiaceae	Aerial parts	4.0
Hyoscyamus senecionis	Solanaceae	Aerial parts and flowers	3.5
Achillea wilhelmsii	Asteraceae	Aerial parts	3.3
Citrus sinensis	Rutaceae	Fruits hull	3.0
Teucrium polium	Lamiaceae	Aerial parts	3.0
Citrus aurantium	Rutaceae	Flowers	2.6
Peganum harmala	Nitrariaceae	Aerial parts	2.4
Piper nigrum	Pipereaceae	Fruit	1.9
Cichorium intybus	Asteraceae	Roots	0.0
Cuminum cyminum	Apiaceae	Seeds	0.0
Eremurus persicus	Liliaceae	Flowers	0.0
Eremurus persicus	Liliaceae	Fruits	0.0
Ferulago angulata	Apiaceae	Aerial parts	0.0
Lawsonia inermis	Lythraceae	Leaves	0.0
Mentha piperita	Lamiaceae	Leaves	0.0
Nepeta crispa	Lamiaceae	Aerial parts	0.0
Nepeta saccharata	Lamiaceae	Whole the plant	0.0
Salvia rhytidea	Lamiaceae	Whole the plant	0.0
Stachys lavandulifolia	Lamiaceae	Aerial parts	0.0

The enzyme activity was measured by turbidimetric assay. Reaction mixture was contained triolein as the substrate, sodium deoxycholate, colipase, calcium chloride and tris buffer. Reduction in turbidity was assayed in 340 nm

$$\text{Inhibition (\%)} = [A_{Control}\text{-}A_{Extract}/A_{Control}]\times 100$$

Kinetic study: In order to measure the inhibition mode by mathanolic extract of *Quercus infectoria*, *Eucalyptus galbie*, *Rosa damascena* and *Levisticum officinale*, pancreatic lipase activity was assayed with increasing concentrations of triolein as substrate (0.15, 0.3, 0.625 and 1.25 mM) in the absence and presence of two different concentrations of the extracts (0.05 and 0.15 mg mL^{-1}). Inhibition mode was determined by double-reciprocal Lineweaver-Burk plot analysis of the data resulted from enzyme assays containing various concentrations of triolein and extracts according to the Michaelis-Menten kinetics (Zhao and Kim, 2004; Won *et al*., 2007).

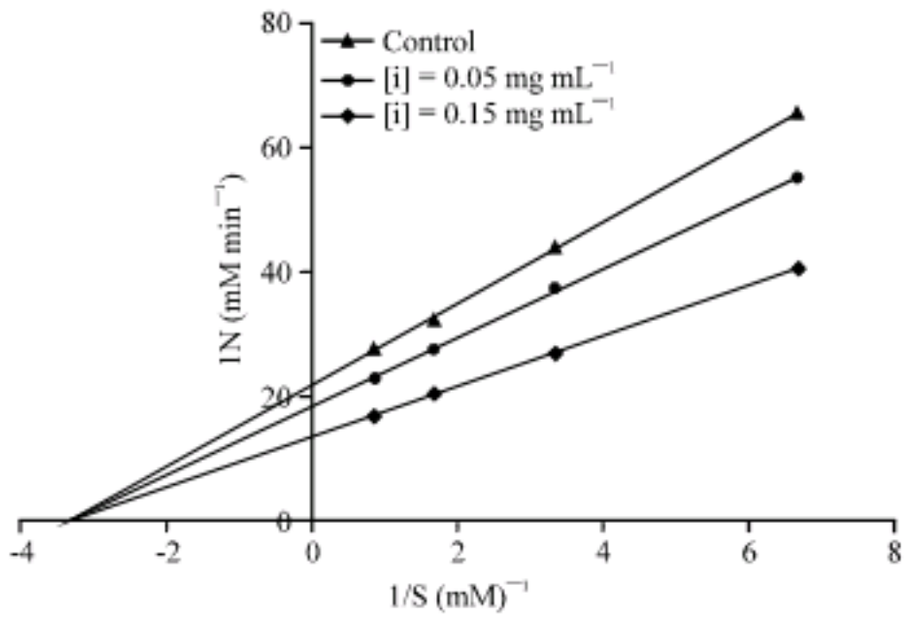

Fig. 1: The Lineweaver-Burk plot of kinetic analysis for porcine pancreatic lipase at two different concentrations of *Quercus infectoria* (0.05 and 0.15 mg mL^{-1}) in the presence of four different triolein concentrations

RESULTS

Plants with Pancreatic lipase inhibitory effect: Among one hundred extracts; *Quercus infectoria*, *Eucalyptus galbie*, *Rosa damascena* and *Levisticum officinale* showed 85, 64, 57 and 55% inhibitory effect on pancreatic lipase, respectively.

Extracts prepared from *Pistacia vera*, *Myrtus communis*, *Otostegia persica*, *Urtica urens*, *Cinnamomum zeylanicum*, *Rheum ribes*, *Pimpinella anisum*, *Alhagi camelorum*, *Nigella sativa*, *Carthamus oxyacantha*, *Arctium lappa*, *Trigonella foenum graecum*, *Ficus carica* and *Buninm persicum* showed an inhibitory effect between 25-50% on pancreatic lipase. The rest of plant extracts showed less than 25% or no inhibition on the activity of the enzyme in this study (Table 1).

Kinetic analysis of porcine pancreatic lipase inhibition: The inhibition mode of the four most active plant extracts was analyzed by double-reciprocal Lineweaver-Burk plot. The enzyme kinetics demonstrated non-competitive inhibition on porcine pancreatic lipase activity by *Quercus infectoria* (Fig. 1); *Eucalyptus galbie* (Fig. 2) and *Rosa damascene* (Fig. 3) and mixed inhibition by *Levisticum officinale* (Fig. 4). The Km value of triolein for porcine pancreatic lipase was 0.3 mM and V_{max} value was 0.078 mM min^{-1}. The V_{max} values of the enzyme in the presence of *Quercus infectoria* (Table 2), *Eucalyptus galbie* (Table 3), *Rosa damascene* (Table 4) and *Levisticum officinale* (Table 5) extracts were 0.051, 0.056, 0.049 and 0.068 mM min^{-1}, respectively. The Ki value of 0.341, 0.383, 0.335 and 0.930 mg mL^{-1} was found for *Quercus infectoria*, *Eucalyptus galbie*, *Rosa damascena* and *Levisticum officinale*, respectively.

Table 2: Kinetics analysis of porcine pancreatic lipase under different concentrations of triolein and Quercus infectoria extract

	Velocity of enzyme activity in different concentrations of substrate [S] (mM)					
[I] (mg mL^{-1})	0.15	0.3	0.625	1.25	Vmax (mM min^{-1})	Km (mM)
0	0.0247	0.0370	0.0494	0.0599	0.075	0.305
0.05	0.0182	0.0267	0.0366	0.0441	0.054	0.304
0.15	0.0152	0.0227	0.0312	0.0362	0.051	0.302

The enzyme activity was measured by turbidimetric assay. Reaction mixture contained of triolein, deoxycholate, colipase, calcium chloride and tris buffer. Turbidity determined by measuring the absorbance at 340 nm

Table 3: Kinetics analysis of porcine pancreatic lipase under different concentrations of triolein and Eucalyptus galbie extract

	Velocity of enzyme activity in different concentrations of substrate [S] (mM)					
[I] (mg mL^{-1})	0.15	0.3	0.625	1.25	Vmax (mM min^{-1})	Km (mM)
0	0.0256	0.0392	0.0512	0.0625	0.078	0.308
0.05	0.0212	0.0325	0.0425	0.0515	0.065	0.306
0.15	0.0185	0.0277	0.0374	0.0442	0.056	0.302

The enzyme activity was measured by turbidimetric assay. Reaction mixture contained of triolein, deoxycholate, colipase, calcium chloride and tris buffer. Turbidity determined by measuring the absorbance at 340 nm

Table 4: Kinetics analysis of porcine pancreatic lipase under different concentrations of triolein and Rosa damascena extract

	Velocity of enzyme activity in different concentrations of substrate [S] (mM)					
[I] (mg mL^{-1})	0.15	0.3	0.625	1.25	Vmax (mM min^{-1})	Km (mM)
0	0.0238	0.0351	0.0465	0.0588	0.075	0.300
0.05	0.0196	0.0303	0.0400	0.0458	0.059	0.301
0.15	0.0167	0.0259	0.0333	0.0391	0.049	0.297

The enzyme activity was measured by lipaturbidimetric assay. Reaction mixture contained of triolein, deoxycholate, colipase, calcium chloride and tris buffer. Turbidity determined by measuring the absorbance at 340 nm

Table 5: Kinetics analysis of porcine pancreatic lipase under different concentrations of triolein and Levisticum officinale extract

	Velocity of enzyme activity in different concentrations of substrate [S] (mM)					
[I] (mg mL^{-1})	0.15	0.3	0.625	1.25	Vmax (mM min^{-1})	Km (mM)
0	0.0264	0.0402	0.0534	0.0623	0.079	0.300
0.05	0.0192	0.0317	0.0434	0.0541	0.073	0.433
0.15	0.0133	0.0227	0.0344	0.0435	0.068	0.617

The enzyme activity was measured by turbidimetric assay. Reaction mixture contained of triolein, deoxycholate, colipase, calcium chloride and tris buffer. Turbidity determined by measuring the absorbance at 340 nm

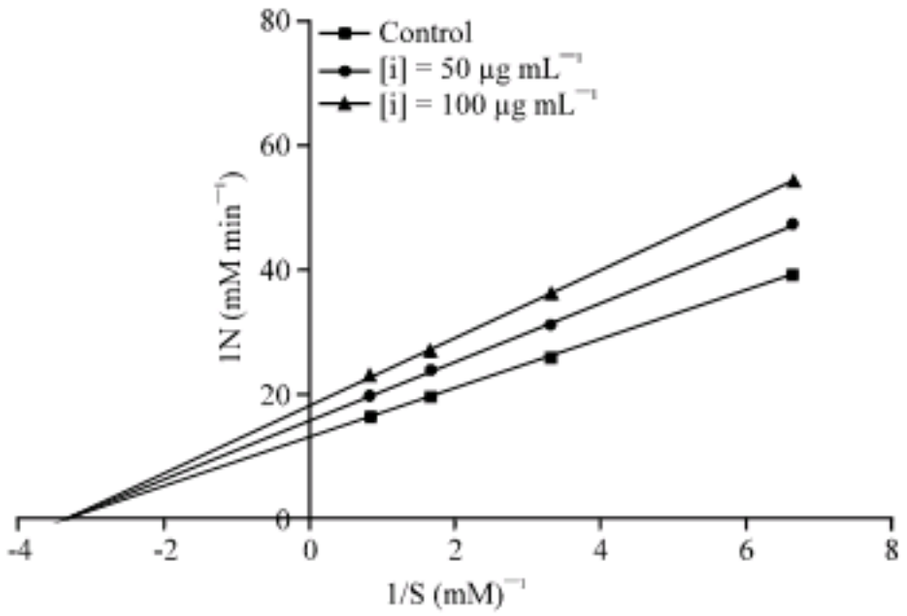

Fig. 2: The Lineweaver-Burk plot of kinetic analysis for porcine pancreatic lipase at two different concentrations of *Eucalyptus galbie* (0.05 and 0.15 mg mL^{-1}) in the presence of four different triolein concentrations

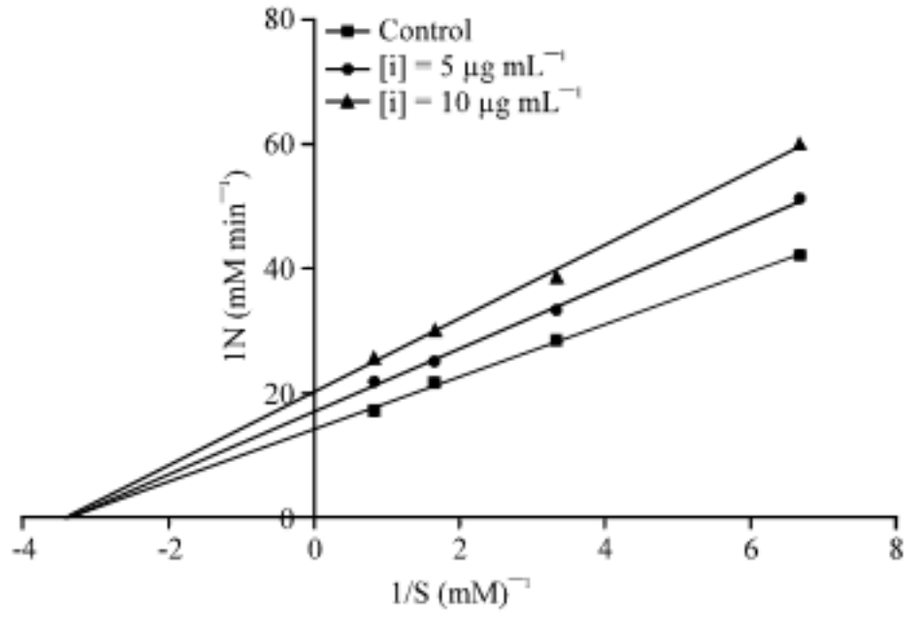

Fig. 3: The Lineweaver-Burk plot of kinetic analysis for porcine pancreatic lipase at two different concentrations of *Rosa damascena* (0.05 and 0.15 mg mL^{-1}) in the presence of four different triolein concentrations

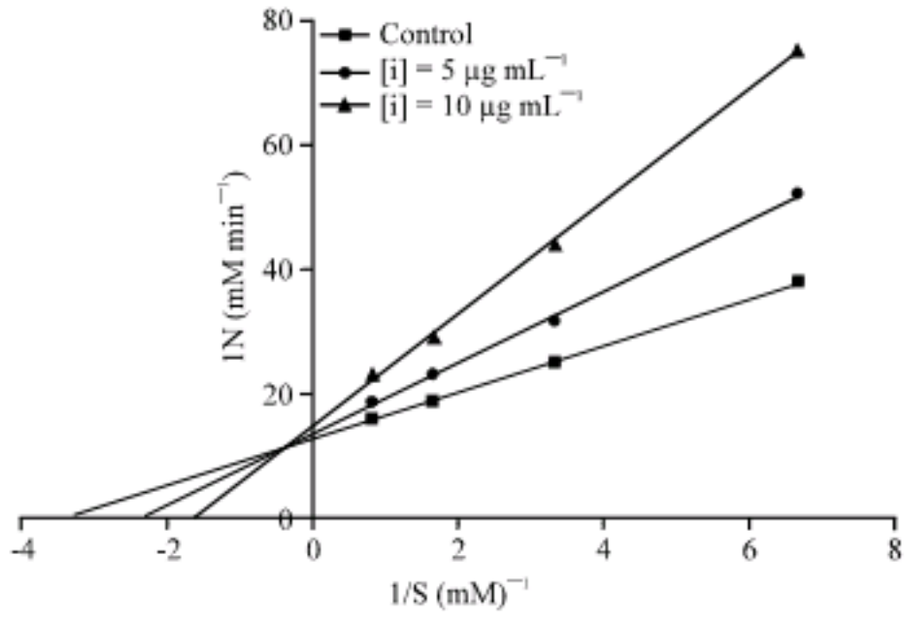

Fig. 4: The Lineweaver-Burk plot of kinetic analysis for porcine pancreatic lipase at two different concentrations of *Levisticum officinale* (0.05 and 0.15 mg mL^{-1}) in the presence of four different triolein concentrations

DISCUSSION

Obesity is becoming one of the biggest complications to global health in this millennium (Birari and Bhutani, 2007). Pancreatic lipase is the key enzyme for lipid absorption that hydrolysis triacylglycerols in the gastrointestinal tract (Jang *et al*., 2008). Pancreatic lipase inhibitors which help to limit intestinal fat absorbtion at the initial stage, have been proved as useful medications for the treatment of hyperlipidaemia and a great promise as anti-obesity agents (Sharma *et al*., 2005). Presence of pancreatic lipase inhibitors has been reported in some natural resources (Han *et al*., 2001; Zhao and Kim, 2004; Sharma *et al*., 2005; Moreno *et al*., 2006; Huerta *et al*., 2007; Won *et al*., 2007) but due to the problem arisen by these extracts, further investigations for finding new and better pancreatic lipase inhibitors in the nature is a necessity. In this study we demonstrated that galls of *Quercus infectoria*, leaves of *Eucalyptus galbie*, flowers of *Rosa damascene* and roots of *Levisticum officinale* have strong anti porcine pancreatic lipase activity. We determined their kinetics properties that have not done so far. The most common anti obesity drug available in the market is Orlistate, which was shown to be irreversible inhibitor of pancreatic lipase (Greenway, 1999; Sharma *et al*., 2005). Platycodin D and tea-saponin have inhibited the pancreatic lipase activity in a competitive manner which is in contrast to our results suggesting a non-competitive or mixed inhibition of pancreatic lipase by our extracts (Han *et al*., 2001; Zhao and Kim, 2004). However, in accordance with our results, some studies reported non-competitive inhibition of pancreatic lipase (Won *et al*., 2007; Huerta *et al*., 2007). A mixed-inhibitor binds at a distinct site from the active site but it can binds to the enzyme or enzyme-substrate complex as well. It will affect Km and Vmax of the reaction. Components of *Levisticum officinale*, extract which showed mixed type of inhibition (Table 5), can bind to the enzyme or Enzyme-Substrate (ES) complex and block its activity. When inhibitor bind to the enzyme and/or ES complex it defined as non-competitive inhibition which inhibitor affects only on the V_{max} of the reaction but has no effect on complex formation between the enzyme and the substrates (Nelson and Cox, 2005). Therefore, the three extracts which showed non-competitive inhibition on PL activity, probably have components that bind to E or ES complex (Table 2-4). It had been shown that, Crocin a glycosylated carotenoid, is the major active constituents of *Gardenia jasminoids*. This compound exhibited potent hypo-triglyceridemic activity. Crocin competitively and reversibly inhibited PL and Crocin's metabolite, crocetin, also potently inhibited PL. Crocin and crocetin also showed potent hypolipidemic activity in Triton WR-133 or corn oil induced hyper-lipidemic mice. Another compound, Dioscin isolated from methanol extract of *Dioscorea nipponica* was shown to inhibit PL (Birari and Bhutani, 2007). Similar inhibitors might be responsible for anti lipase activities in our study. The active constituents of these plants have not been completely known and further investigation needed to be done.

Afromomum meleguetta is an African plant which its extract has shown the most potent inhibitor of PL (Ekanem *et al*., 2007). The methanol extract from the pericarps of *Sapindus rarak* was found to have pancreatic lipase inhibitory activity (Morikawa *et al*., 2009). Pribitkin and Boger (2001) asserted that *Zingiber officinale* inhibits platelets function and *Apium graveolens*, *Foeniculum vulgare*, *Levisticum officinale* and *Ficus carica* have photosensitizing effect. Here we showed the anti PL activity of these plants (Table 1). Jang *et al*. (2008) isolated a new pancreatic inhibitor from roots of *Actinidia arguta*. Slanc *et al*. (2009) showed that *Crocus sativa* did not show any inhibition on PL and *Menha piperita* showed below 40% inhibition on activity of PL. This is in contrast with our results. Also, they asserted that *Pimpinella anisum*, *Arctium lappa*, *Origanum majorana*, *Althaea officinalis*, *Ficus carica*, *Citrus sinensis* and *Urtica dioica* showed PL inhibitory activity below 40% that are along with our results. *Arctium lappa* and *Linum usitatissimum* showed slight PL inhibition in our study while Peter *et al*. (2009) showed that *Arctium lappa* and *Linum usitatissimum* have strong inhibitory effect on PL.

The galls of *Quercus infectoria* and flowers of *Rosa damascenea* had shown non-competitive inhibitory effect

on Alpha mannosidase activity (Gholamhoseinian *et al*., 2008a). *Quercus infectoria*, *Rosa damascena* and *Levisticum officinale* showed anti Alpha glucosidase activity, a target enzyme with therapeutic potential in the treatment of diabetes, metastasic cancer and lysosomal storage disease and also showed antiviral effects against human immunodeficiency virus and hepatitis C virus infection (Matsui *et al*., 2004; Chapel *et al*., 2006; Gholamhoseinian *et al*., 2008b). Galls of *Quercus infectoria* possess many therapeutic activities such as antidiabetic, anti-parkinsonian, anti-tremorine, anti-inflammatory, antiviral, anti- microbial, antifungal and larvicidal activity (Kaur *et al*., 2004; Basri and Fan, 2005) and showed high potential in skin whitening and antioxidant properties (Pin *et al*., 2006). We showed that *Eucalyptus galbie* is one of the porcine pancreatic lipase inhibitors. It had shown that *Eucalyptus galbie* is an effective agent in reducing the growth of fungus and also has anti diabetic activity (Grover *et al*., 2002; Joseph *et al*., 2008). These plants could represent active source of new anti-lipase activity. Further *in vivo* study on animal model must be done in order to confirm these results. These four plants will be examined in order to isolate, identify and characterize the active ingredients to establish the nature of their lipid lowering activity. This study may serve as a foundation for comprehensive and safe therapeutic strategies to the management of obesity and other related diseases.

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