Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/14459
DOI URL: http://dx.doi.org/10.21474/IJAR01/14459

ISSN NO. 2320-5407

RESEARCH ARTICLE

IN VITRO AND IN VIVO ANTIDIABETIC EFFECTS OF *SALACIA OBLONGA* WALL LEAF AND ROOT EXTRACTS

Racha Srikanth[1], Murali Krishna Thupurani[2], Harish Rao B.[3] and Challa Surekha[1]

1. Department of Biochemistry and Bioinformatics, Institute of Science, GITAM (Deemed to be University), Visakhapatnam-530 045, Andhra Pradesh, India.
2. Department of Biotechnology, Chaitanya (Deemed to be University), Kishanpura, Hanamkonda, Warangal, Telangana, India.
3. Department of Biochemistry, Vijayanagar Institute of Medical Sciences, Ballari, Karnataka, India.

Manuscript Info

Manuscript History
Received: 22 January 2022
Final Accepted: 24 February 2022
Published: March 2022

Key words:-
S. Oblonga, Leaf, Root, Alpha Amylase, Alpha Glucosidase, Ethyl Acetate, Toluene

Abstract

The present study was framed out to evaluate the antidiabetic effects of S. *oblonga* Wall leaf and root ethyl acetate and toluene extracts *in vitro* and *in vivo*. The root ethyl acetate extract found significant inhibition of alpha amylase and alpha glucosidase enzyme functions *in vitro*. The *in vivo* studies are carried out according to the guide line of CPCSEA and IAEC. The acute toxicity test of the extracts resulted in the no effect on the animals. The ethyl acetate extract of root showed the increase in body weight of animals at the end of the experiment. The blood glucose levels of diabetic rats are significantly reduced after the treatment of root ethyl acetate extract. The leaf toluene and ethyl acetate extract exhibited average antidiabetic activity. We conclude that root extract exhibited good antidiabetic activity comparing to leaf extract.

Introduction:-

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by an abnormal increase in blood glucose level, disturbance in carbohydrate metabolism (Kumar *et al.*, 2013; Rahimi, 2015). It is linked with micro and macro complications like retinopathy, nephropathy, coronary heart disease, and peripheral vascular disease (Rao *et al*, 2010). Diabetes mellitus is commonly observed as a disease related to "sweet urine" and muscle loss. Unbalanced hepatic glucose output and reduced glucose absorption by skeletal muscle and long-term failure or organ damage lead to hyperglycemia and chronic hyperglycemia (American Diabetes Association, 2009). Diabetic complications lead to reduced quality of life and death. Diabetes complications have several effects on various organs of the body and increase many serious health problems. Reduced testosterone levels, erectile dysfunction, and low emotional factors are the common diabetic complications found in men. In women who do not have Diabetes may also be at higher risk because of Gestational Diabetes. According to American Diabetes Association, cardiovascular problems are the major leading concern for the death of women who are especially suffering from Diabetes. Moreover, women with Diabetes also get complications related to their sexual health. People with diabetic complications may also affect other parts of the body.

With the rapid increase in population with Diabetes around the globe and a decrease in the efficiency and synthetic drug-associated hazardous effects, the research has been shifted towards discovering ethnomedicine. The use of

Corresponding Author:- Challa Surekha
Address:- Department of Biochemistry and Bioinformatics, Institute of Science, GITAM (Deemed to be University), Visakhapatnam-530 045, Andhra Pradesh, India.

medicinal plants for the treatment of Diabetes mellitus is in existence since ancient times. However, due to the side effects, cost affordability of contemporary anti-diabetic drugs, there is a continuity of search for new medicines with immense therapeutic function. Even though many plant-derived drugs are proved well in the management and control of Diabetes mellitus, none of them are yet to be developed as an ideal remedy. Hence, there is a need to explore few more medicinal plants for their attributed anti-diabetic properties and increase the opportunities for discovering novel therapeutic agents against Diabetes mellitus.

Salacia oblonga (*S.oblonga*) belonging to Celastraceae possess different pharmacological activities, especially anti-diabetic property. In a recent report, the authors published that the *S.oblonga* roots collected from other regions exhibited significant enzyme inhibition and reduced fasting blood glucose levels anti-diabetic activity (Deepak *et al.*, 2020). Kazue *et al.* (2011) reported that the combination of *S.oblonga* tea and an IP-PA1iexhibitedda rapid decrease in the blood plasma glucose. Matsudaa*et al.* (1999) isolated α glucosidase inhibitors from roots of *S. oblonga.* It is reported that *S. oblonga* root lowered diabetic renal fibrosis in rats (Lan *et al.*, 2009). It is also reported that the *S. oblonga* extract reduces acute hyperglycemia in patients who have type 2 Diabetes (Jennifer *et al.*, 2007).

The present study was aimed to evaluate anti-diabetic potentials of ethyl acetate and toluene extracts of leaf and root of *S. oblonga.*

Materials and Methods:-

Collection of Plant samples

S. oblonga leaf and root were collected from the East Godavari district of Andhra Pradesh, India, from the natural habitat of Yeleswaram forest, situated at 17.28^{o}N 82.10^{o}E. The plant material was authenticated by taxonomist Prof. M. Venkataratnam (Retd. Professor, Department of Botany, Andhra University, Visakhapatnam). *S. oblonga* plants are maintained in the greenhouse in GITAM, Visakhapatnam. Fresh raw green leaves were collected from the GITAM greenhouse.

Extraction Procedure

The fresh plant parts of *S. oblonga* were brought to the laboratory, and then they were washed with distilled water and subsequently wiped with a soft cloth; after that, the plant parts were shade dried on the laboratory working benches. A mechanical blender powdered the dried plant parts. Further, approximately 100 grams of powder obtained from different parts like leaves and root of *S. oblonga* was extracted with 1000ml of (n-hexane, Ethyl acetate, Chloroform, Acetone, toluene, and Methanol) for 48 hours (until the change in the color of the solvent) by Soxhlet extraction apparatus. The crude extracts of the *S. oblonga* wall were concentrated in a vacuum at 40^{0} C using a rotary evaporator apparatus. The crude extracts of *S. oblonga* thus obtained are preserved in a freezer at -20^{0} C until further use.

In vitro anti-diabetic activity

Inhibitory effects of *S. oblonga* extracts against Alpha-amylase

The inhibition of the alpha-amylase enzyme by the *S. oblonga* extracts was determined using the method reported by Kim *et al.* (2005). The *S. oblonga* extracts at 50, 150, andd250 µg/ml concentrations are incubated with 5 U/ml of 0.25µl of alpha-amylase at 37^{o} C for 10-20 min in a water bath. Following 0.3 µl of 0.5% potato starch is solubilized using 20mM PBS (pH 6.9) is added and maintained at room temperature for 15 min. To this reaction mixture, 2.0 ml of DNS reagent is added and subjected for heating for 10 min at 100^{o}C. The readings were taken at 540 nm. Reagent without plant extract is used as blank.

Inhibitory effects of *S. oblonga* extracts against Alpha-glucosidase.

The inhibitory effect of *S. oblonga* leaf and root extracts was determined against alpha-glucosidase using the method reported by Kim *et al.* (2005). The substrate p-nitrophenyl glucopyranoside was prepared using 20 mM phosphate buffer of pH 6.9. 5U/ml of alpha-glucosidase was mixed with various *S. oblonga* extracts 50, 150, and 250 µg/ml. To this mixture, 3mM of pNPG (substrate freshly prepared) was added and incubated at room temperature for 15 min. The reaction was terminated by adding 2 ml of 0.1 M Na_2CO_3, and the absorbance of the samples was measured at 400 nm. The reading of the blank was taken without the extract.

In vivo antidiabetic activity

*In vivo0*antidiabetic activity of *S. oblonga* extracts was conducted using albino rats. Animal studies were performed according to the guidelines of CPCSEA and IAEC. (**768/03/ac/CPCSEA).** Animals are procured from the National Institute of Nutrition, Hyderabad. Animals weighing 80-200g of male gender were brought and quarantined. Animals were fed with food and water during quarantine.

Experimental design

The animals used *in vivo* antidiabetic activity of *S. oblonga* leaf and root extracts were made 15 groups and treated for 28 days (Table 1.0).

Table 1.0:- In vivo antidiabetic activity of the S. oblonga plant extracts.

Group*	Treatment
I	Animals (normal control) given only distilled water
II	Animals (diabetic control) and were given distilled water only.
III	Animals (glibenclamide standard) at 4 mg/kggbody weight (B/W) daily.
IV	Animals (fed with Ethyl acetate leaf extract) at 100 mg/kggB/W daily.
V	Animals (fed with Ethyl acetate leaf extract) at 150 mg/kggB/W daily.
VI	Animals (fed with Ethyl acetate leaf extract) at 200 mg/kggB/W daily.
VII	Animals (fed with Toluene leaf extract) at 100 mg/kggB/W daily.
VIII	Animals (fed with Toluene leaf extract) at 150 mg/kggB/W daily.
IX	Animals (fed with Toluene leaf extract) at 200 mg/kggB/W daily.
X	Animals (fed with Ethyl acetate root extract) at 100 mg/kggB/W daily.
XI	Animals (fed with Ethyl acetate root extract) at 150 mg/kggB/W daily.
XII	Animals (fed with Ethyl acetate root extract) at 200 mg/kggB/W daily.
XIII	Animals (fed with Toluene root extract) at 100 mg/kggB/W daily.
XIV	Animals fed with Toluene root extract) at 150 mg/kggB/W daily.
XV	Animals (fed orally with Toluene root extract) at 200 mg/kggB/W daily.

Acute toxicity studies

Acute oral toxicity study was carried out in Wistar rats of either sex. The animals were kept in starvation for 12h or overnight by giving only water. Then the leaf and root extracts of *S. oblonga* were orally given at the dose of 2000 mg/kg B/W and noted for gross behavioural change or death.

Body weight determination

The animals were evaluated for their body weight using mouse balance for the whole period of experiment and observations are noted.

Effects on blood glucose levels

As mentioned in the table 1.0 the different concentrations of extracts were suspended in 1% bentonite and administrated for diabetic albino rats (150 – 250 g). Alloxan monohydrate (100 mg/kg) was used to induce diabetes in the anesthetic (ethyl ether was used for anesthesia) experimental rats. 1 mL f blood was collected *via* orbital sinus and transferred to anticoagulant coated tubes. Estimation of blood glucose was performed using (Vivek *et al.*, 2007).

Statistical analysis

Excel 9.0 was used to calculate the results. The results are represented in Mean ± SD.

Results:-

Inhibitory effects of *S. oblonga* extracts against Alpha amylase and Alpha glucosidase

The *in vitro* antidiabetic activity of *S. oblonga* ethyl acetate and toluene extracts were determined against α-amylaseeand α-glucosidase enzymes. The ability of the extracts to inhibit the function of breaking down of the starch by both enzymes used in the study was evaluated. The extracts of leaf and root were screened at three different concentrations (50,150, 250µg/ml). It was observed that the results are concentration dependent. The leaf and root ethyl acetate extracts inhibited both the enzymes at all tested concentrations. Root extract exhibited 77.7% of inhibition percentage against-amylase and 66.6% against α-glucosidase at 250µg/ml whereas, leaf ethyl acetate extract inhibited 66.6% α-amylase and 72.2% of α-glucosidase at 250µg/ml (Figure 1 A & B). The IC_{50} values 16.0,

15.5, 17.1, 17.7µg/ml were recorded against α-amylaseeand α-glucosidase by leaf and root ethyl acetate extract respectively.

On the other hand, the toluene extracts of leaf and root fractions also exhibited *in vitro* antidiabetic activity by inhibiting the functions of α-amylase and α-glucosidase. However, the result found with this solvent extract was found less active on both tested enzymes. The highest inhibition percentage 47.2% was noted against α-amylase and 52.7% was noted against α-glucosidase at 250µg/ml (Figure 2.0 A & B). The IC_{50} values 26.2, 24.9, 22.5, 22.5µg/ml was noted for α-amylase and α-glucosidase of leaf and root toluene fractions respectively. The IC_{50} values 26.2, 24.9, 22.5, 22.5µg/ml was noted against α-amylase and α-glucosidase by leaf and root toluene extracts respectively.

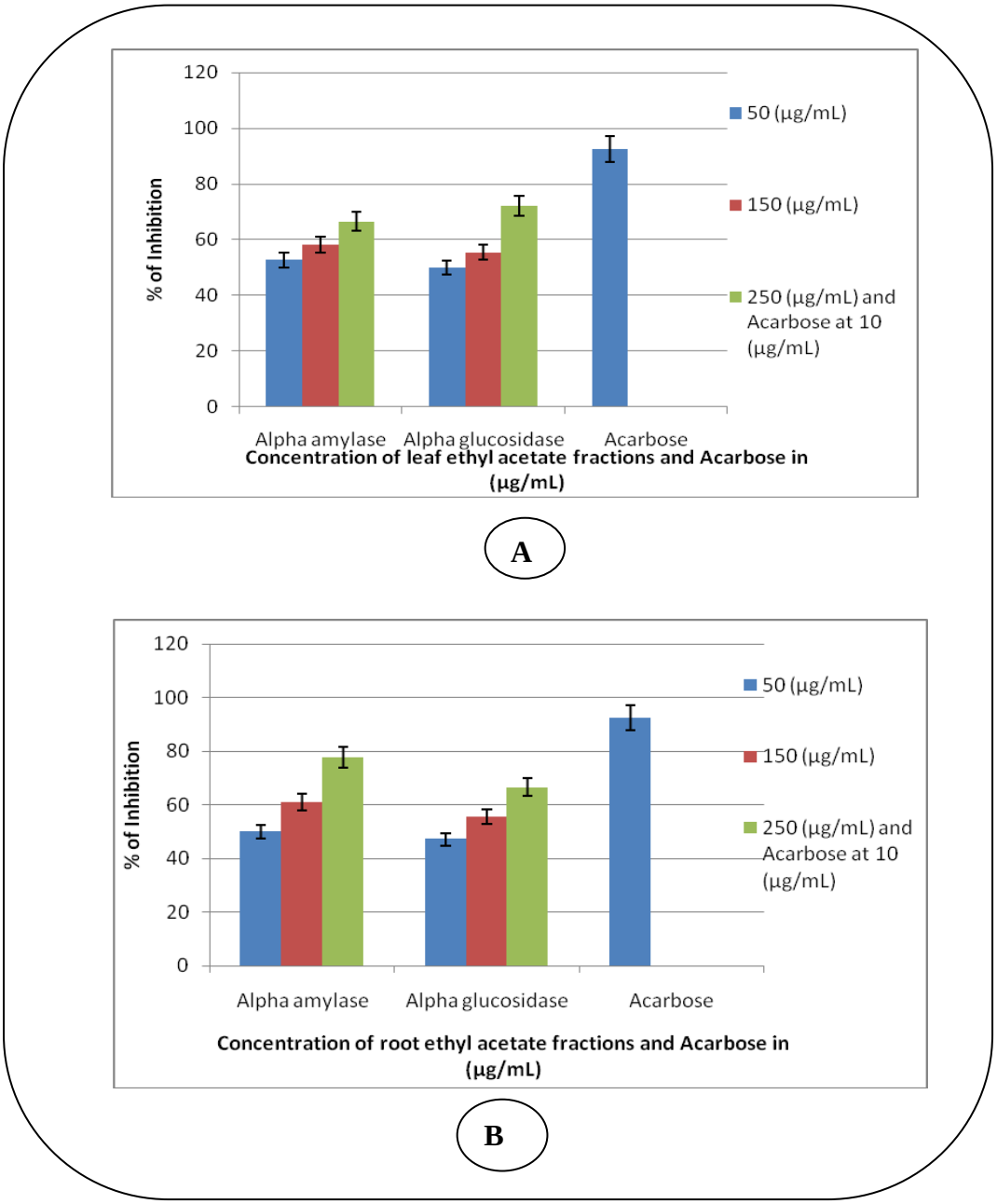

Figure 1.0:- A- In vitro Anti-diabetic activity of S. oblonga Wall Leaf ethyl acetate extract, B- In vitro Antidiabetic activity of S. oblonga Wall Root ethyl acetate extract.

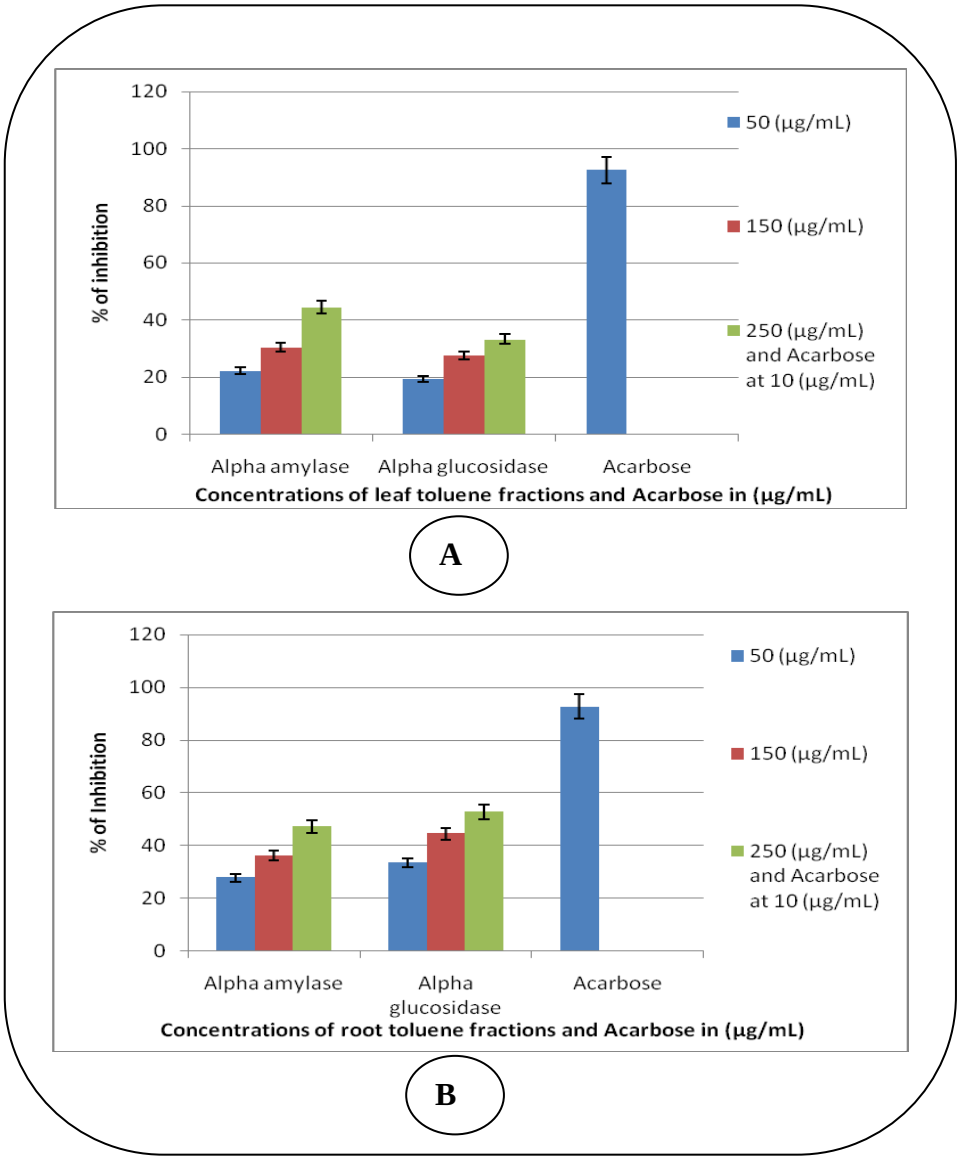

Figure 2.0:- A- *In vitro*0Antidiabetic activity of *S. oblonga* Wall Toluene Leaf extract, B- In vitro Antidiabetic activity of S. oblonga Wall Toluene Root extract

***In vivio* anti-diabetic activity**

Acute toxicity studies

During acute toxicity studies there were no toxic symptoms noted for all the extracts tested up to dose 2000 mg/kg body weight. All animals showed normal behaviour. No mortality was observed up to 7 days study. The results of various effects shown during the study are shown in Table 1.1.

Determination of body weight

The determination of body weight was carried out after the termination period (28 days). According to the results, we observed that diabetic rats treated with plant extracts at different concentrations, immensely gained their weight. However, rats of diabetic negative control showed gradual loss of weight (Table 1.2). The weight gain of rat is found to be concentration dependent. Among the extracts tested, root ethyl acetate extract remarkably (90%) increased the body weight of rats compared (80%) with the rats treated with leaf and root toluene extracts. The rats treated with glibenclamide gained their body weight by 95% where as the rats of diabetic control served with only

distilled water lost their body weight by 40%). On the other hand, the body weight of normal rats did not vary till the end of the experiment (Table 1.2).

Determination of blood Glucose levels

It was observed that, decrease in blood glucose levels by the plant extracts was found after 7 days of treatment. The reduction in blood glucose levels is noted is concentration dependent. Among the extracts tested, ethyl acetate extract of root exhibited remarkable reduction of blood glucose 150.7±0.2 (P<0.001) compared to leaf ethyl acetate and toluene extract. Root toluene extract also showed good reduction of fasting blood glucose 152.1±0.6 (P<0.001) at 200 mg/ml. On the other hand, the blood glucose levels in the rats treated with glibenclamide showed consistent decrease with 98.7.±2.6 at 250 mg/ml (Table 1.3). The leaf ethyl acetate and leaf toluene extract showed 178.1±1.5 and 178.7±0.5 (P<0.5) respectively.

Table 1.1:- Acute toxicity studies of *S. oblonga* extract at 2000 mg/kg B/W of albino rats.

Ethyl acetate and Toluene leaf and root extracts							
Effects	**Dayy1**	**Dayy5**	**Dayy10**	**Dayy15**	**Dayy20**	**Dayy25**	**Dayy28**
Breathing (Normal, Fast, Slow)	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Paralytic effects of hind limbs (NO/Yes)	No	No	No	No	No	No	No
Climbing slide (NO/Yes)	No	No	No	No	No	No	No
Aggressiveness (NO/Yes)	No	No	No	No	No	No	No
Touch response (Good/ Pain)	Good	Good	Good	Good	Good	Good	Good
Fits (NO/Yes)	No	No	No	No	No	No	No
(Allergy No allergy/ Reddishness/ Swelling)	No allergy	No allergy	No allergy	No allergy	No allergy	No allergy	No allergy
Over activity (NO/Yes)	No	No	No	No	No	No	No
Died (NO/Yes)	No	No	No	No	No	No	No

Table 1.2:- Body weight measurement albino rats treated with Ethyl acetate, Toluene leaf and root extracts of *S. oblonga.*

	Days in Number				
	0 hour	**7th Day**	**14th Day**	**21st Day**	**28th Day**
Normal	222.3±0.5	222±1.2	222±0.5	222±1.9	222±0.3
Diabetic	222.1±0.3	193.0±1.1	175.3±1.1	154.1±0.4	131.0±1.3
LTE (100)*	166.4 ±0.5	195.3±1.5	198.2±1.5	201.7±0.5	209.1±1.5
LTE (150)*	179.6±0.1	197.5±0.5	206.3±0.5	209.9±1.2	214.0±0.5
LTE (200)*	193.3±1.2	204.1±0.3	207.7±0.5	212.3±1.1	215.6±0.2
REE (100)*	219.2±0.1	195.6±0.5	202.6±1.1	210.5±0.5 [a]	219.2±0.5 [a]
REE (150)*	225.7±0.5	198.0±1.3	205.4±1.5	213.3±0.7 [a]	224.8±1.6 [a]
REE (200)*	228.8±0.1	202.1±1.1	210.9±0.3	225.3±0.9 [a]	230.5±0.1 [a]
LEE (100)*	184.0±0.6	194.6±1.0	197.7±1.1	202.6±0.5	211.2±1.4
LEE (150)*	195.2±0.1	196.6±1.2	200.2±0.1	203.0±0.1	217.1±0.6
LEE (200)*	205.4±1.1	198.4±0.5	203.1±1.5	209.5±1.3	218.6±1.2
RTE (100)*	202.1±0.7	195.9±1.1	203.3±1.2	212.2±0.7 [a]	219.0±0.1 [a]
RTE (150)*	213.4±1.5	199.2±0.6	208.8±1.1	216.6±0.5 [a]	223.8±0.1 [a]
RTE (200)*	223.8±0.2	205.5±0.8	213.3±0.1	222.9±0.3 [a]	229.4±0.9 [a]
Glibenclamide*	232.9±0.5	228.1±1.2	233.2±0.5	239.8±1.1	242.1±1.3
LTE-Leaf Toluene Extract, LEE- Leaf Ethyl Acetate Extract, REE-Root Ethyl Acetate Extract, RTE- Root Toluene Extract, *Conc. of plant extracts mg/ml					

Table 1.3:- Fasting blood glucose determination in diabetic rats treated with Ethyl acetate, Toluene leaf and root extracts of *S. oblonga.*

	Days in Number				
	0o hour	**7th Day**	**14th Day**	**21st Day**	**28th Day**
Normal	87.24±0.3	98.72±0.9	98.05±1.5	98.21±0.5	98.63±1.1
Diabetic	202.4±2.2	239.4±2.2	241.7±0.3	250.9±2.1	259.5±0.3
LTE (100)*	224.1±0.4	220.6±2.3	214.3±0.2	205.3±0.1	197.1±1.1
LTE (150)*	219.3±0.2	213.4±0.6	201.7±1.1	192.5±2.3	185.8±1.1
LTE (200)*	219.1±0.3	201.5±0.3	192.2±1.1	184.6±1.2	178.7±0.5
REE (100)*	219.8±2.5	213.1±1.2	201.1±0.2	192.5±0.5 [a]	186.1±2.2 [a]
REE (150)*	219.3±1.2	201.6±0.5	188.7±1.2	176.1±0.3 [a]	160.4±1.0 [a]
REE (200)*	219..1±2.2	194.8±0.5	181.1±2.6	165.4±0.2 [a]	150.7±0.2[a]
LEE (100)*	218.9±0.5	213.6±1.2	203.2±0.4	191.7±0.5	183.9±2.2
LEE (150)*	219.5±1.3	203.5±0.5	194.5±1.7	186.2±1.2	181.6±2.5
LEE (200)*	219.3±0.5	202.6±0.7	193.4±2.1	184.1±0.3	178.1±1.5
RTE (100)*	219.7±2.1	213.2±1.1	202.5±2.5	194.6±1.3 [a]	187.3±0.3 [a]
RTE (150)*	219.3±0.2	202.4±0.4	193.1±1.2	177.2±0.5 [a]	163.1±0.2 [a]
RTE (200)*	219.2±1.7	198.3±0.5	184.1±2.1	161.4±0.1 [a]	152.1±0.6 [a]
Glibenclamide*	219.1±0.5	176.4±1.1	153.6±2.2	123.7±0.3	98.7±2.6

LTE-Leaf Toluene Extract, **LEE**- Leaf Ethyl Acetate Extract, **REE**-Root Ethyl Acetate Extract, **RTE**- Root Toluene Extract *Conc. of plant extracts mg/ml

Discussion:-

Several reports are published on anti-diabetic activity of *S. oblonga* plant extracts. Bhat *et al.* (2012) determined the blood glucose, insulin, triglycerol, and fatty acids levels using hydroalcoholic root extract of *S. oblonga* att50 and 100 mg/Kg body weight of rat. According to their dose-dependent study, 50 mg/Kg of the extract was found significant in reducing extra blood glucose and increased insulin levels. This suggests that the extract may induce the regeneration of β-cells and help in the healthy levels of insulin secretion. Augusti *et al.* (1995) demonstrated significant hypoglycemic activity of a fluorescent compound isolated from chloroform fraction of root bark of *S. oblonga*. The compound and reference drug were orally administrated at 200 mg/Kg body weight of albino rat. The hypoglycaemic potency of the compound was reported as 60%, which is comparable with the standard drug tolbutamide 76%. Thus the work of Augusti *et al.* (1995) shows that the *S. oblonga* extracts are a potent source of anti-diabetic agents with immense function for reducing extra blood glucose level by stimulation of sufficient insulin production. Rajanyamalakadi (an ayurvedic medicine formulated with three different plant extracts). Faizal *et al.* (2009) evaluated the anti-diabetic potency of Rajanyamalakadi tested at 500 mg/Kg body weight. Based on their report, it is noted that Rajanyamalakadi is significant in the reduction of extra blood glucose levels. The major reason is that *S. oblonga* root powder is among three formulations used at 250 mg. Thus *S. oblonga* gained significant importance in the treatment of type II Diabetes mellitus. It is reported that *S. oblonga* extract in combination with mangiferin exerts anti-diabetic activity by increased expression of GLUT-4 in L6 rat myotubes. *S.oblonga* extract and mangiferin showed increased glucose transporter 4-mediateddglucoseeuptake and translocation through the muscle cells (Giron *et al.,* 2009). Matsudaa *et al.,* (1999) demonstrated serum glucose levels in diabetic sucrose and maltose-loaded Wistar rats using *S. oblonga* root extract. Sucrose-loaded rats administrated with 200 mg/kg methanolic extract exhibited high reduced serum glucose levels. In another study, *S. oblonga* extracts showed postprandial hypoglycemic activity conducted in 43 healthy experimental subjects. Deepak *et al.* (2020) also studied *in vitro0*antidiabetic activity of methanol roots extracts of *S. oblonga* collected from Yeleswaram, Karwar, and Thoothukudi forests Andhra Pradesh, Karnataka, and Tamil Nadu, respectively. According to their report, methanol extract of *S. oblonga* root collected from Yeleswaram forest showed maximum α-amylase and α-glucosidase inhibitory property. In addition, extracts significantly reduced glucose levels in induced type II diabetes mellitus Albino Wistar rats.

Most of the anti-diabetic activity of *S. oblonga* reported was found with only root extract. Therefore the current investigation aims to do a comparative study of the anti-diabetic activity of leaf and root extracts of *S. oblonga*. In the present analysis, the anti-diabetic effect of *S. oblonga* leaf and root was examined using *in vitro* and *in vitro* methods. Ethyl acetate and toluene solvents were used for extraction. The crude extracts were active in the inhibition

of alpha-amylase and alpha-glucosidase at different concentrations tested. The *in vitro0*antidiabetic activity of the extracts revealed that the leaf and root ethyl acetate extract exhibited paramount inhibition of both enzymes tested.

It is hypothesized that plant extracts generally bind to the α-amylase and α-glucosidase and inhibit the function of these enzymes involved in the catabolism of carbohydrates. Perhaps in our preliminary study, the *S. oblonga* extracts possess a high binding capability to the intestinal enzymes, thereby inhibiting the excess release and Maintenance of optimum glucose levels in the blood (Sekiguchi *et al.,* 2010). Another important reason is that S. *oblonga* plant extracts effectively inhibit both intestinal enzymes because of reported compounds Salicinol and Kotalanol, which act as significant inhibitors of α-amylaseeα-glucosidase release (Matsuda *et al.*,1999).

On the other hand, studies on *in vivo* anti-diabetic activity also noted a high decrease in the percentage of fasting blood glucose. Among ethyl acetate and toluene extracts, ethyl acetate extract showed increased activity *in vitro* and *in vivo0*methods of screening. It is well known that ethyl acetate extract is highly potent of all extraction compounds, which attribute anti-diabetic activity (Tanko *et al.,* 2013; Njogu *et al.,* 2016; Heba *et al.,* 2019).

Conclusion:-

In conclusion, *S. oblonga* leaf and root extract highly inhibited both the intestinal enzymes α-amylase and α-glucosidase. The ethyl acetate of root and leaf showed good inhibitory activity. However, toluene extracts of root and leaf also exhibited *in vitro* anti-diabetic activity. In the acute toxicity study, the extracts did not show any effects on animal breathing, fits, allergy, etc. The potential of the *S. oblonga* leaf and root extracts to decrease extra blood glucose is also found significant. Apart from the most reported anti-diabetic activity of root extract *S. oblonga,* the leaf extract of *S. oblonga* also showed significant activity. Thus it is concluded by our studies that leaf extract is also a major source of anti-diabetic compounds. Studies may be conducted to isolate the actual compounds that are responsible for the activity in the future.

Acknowledgement:-

RS, CS would like to thank GITAM (Deemed to be University) for providing necessary facilities and support.

Conflicts Of Interest

The authors declare no conflict of interest.

References:-

1. Kumar, A., Goel, MK., Jain, RB., Khanna, P., Chaudharym V., India towards diabetes control: Key issues. Australasian Medical Journal, 2013; 6: 524–531.
2. Rahimi, M., A Review: Anti Diabetic medicinal plants used for diabetes mellitus. Bulletin of environmental, pharmacology and life sciences. 2015; 4: 163–180.
3. Rao MJP and Giri., Anti-microbial activity of the extracts of *Salacia oblonga* Wall, Recent Research in Science and Technology. 2010; 2:1-4.
4. American Diabetes Association., Diagnosis and classification of diabetes mellitus. Diabetes Care. 2009; 32: S62-S67.
5. Deepak, KGK., Surekha, Challa., Ganta, Suhasin., Neelapu, Nagesewara Rao Reddy., Hosam O, Elansary., Diaa, O El, Ansary., Antidiabetic and Antilipidemic Activity of Root Extracts of *Salacia oblonga* against Streptozotocin-Induced Diabetes in Wistar Rats. Processes. 2020; 8: 1-12.
6. Kazue, Nakata., Yoshie, Taniguchi., Noriko, Yoshioka., Aya, Yoshida., Hiroyuki, Inagawa., Takeru, Nakamoto., Hiroshi, Yoshimura., Shin-ichiro, Miyake., Chie, Kohchi., Masahide, Kuroki., Gen-Ichiro, Soma., A mixture of *Salacia oblonga* extract and IP-PA1 reduces fasting plasma glucose (FPG) and low-density lipoprotein (LDL) cholesterol levels. Nutrition Research and Practice. 2011; 5:435-442.
7. Matsuda, H., Murakami, T., Yashiro, K., Yamahara, J., Yoshikawa, M., Antidiabetic principles of natural medicines. IV. Aldose reductase and qlphaglucosidase inhibitors from the roots of *Salacia oblonga* Wall. (Celastraceae): structure of a new friedelane-type triterpene, kotalagenin 16-acetate. Chemical and Pharmaceutical Bulletin. 1999; 47: 1725-1729.
8. Lan, He., Yanfei, Qi., Xianglu, Rong., Jianmin, Jiang., Qinglin, Yang., Johji, Yamahara., Michael, Murray., Yuhao, Li., The AyurvedicMedicine Salacia oblonga, Attenuates Diabetic Renal Fibrosis in Rats: Suppression of Angiotensin II/AT1 Signaling. Evidence-Based Complementary and Alternative Medicine. 2009; 2011: 1-12.

9. Jennifer, AW., Yong, SC., Michael, JN., Carl, JB., Vikkie, AM., Extract of *Salacia oblonga* lowers acute glycemia in patients with type 2 diabetes1–4. American Journalof Clinical Nutrition. 2007;86: 124-130.
10. Kim, YM., Jeong, YK., Wang, MH., Lee, WY., Rhee, HI., Inhibitory effects of pine bark extract on alpha-glucosidase activity and postprandial hyperglycemia. Nutrition. 2005; 21: 759-761.
11. Vivek, T., Akanksha, G., Navneet, G., Sharma, P.K., Antidiabetic and evaluation of combination of different commonly used herbal drug. The antiseptic. 2007; 104: 476-479.
12. Augusti, KT., Joseph, P., Babu, TD., Biologically active principles isolated from *Salacia oblonga wall.* Indian Journal of Physiology and Pharmacology. 1995; 39: 415-417.
13. Faizal, P., Suresh, S., Satheesh, KR., Augusti, KT., A study on the hypoglycemic and hypolipidemic effects of an ayurvedic drug Rajanyamalakadi in diabetic patients. Indian Journal of Clinical Biochemistry. 2009;24: 82-87.
14. Giron, MD., Sevillano, N., Salto, R., Haidour, A., Manzano, M., *Salacia oblonga* extract increases glucose transporter 4-mediated glucose uptake in L6 rat myotubes: role of mangiferin. Clinical Nutrition. 2009; 28: 565-574.
15. Sekiguchi, Y., Mano, H., Nakatani, S., Shimizu, J., Wada, M., Effects of the Sri Lankan medicinal plant, Salacia reticulata, in rheumatoid arthritis. Genes and Nutrition.2010; 5: 89-96.
16. Tanko, Y., Muhammad, A., Elaigwu, J., Mohammed, KA., Jimoh, A., Sada, NM., Dallatu, MK., Yerima, M., Mohammed, A., Anti-diabetic effects of ethyl acetate and n-butanol fractions of Acacia nilotica leaves methanolic extract on alloxan-induced diabetic wistar rats. Journal of Applied Pharmaceutical Science. 2013; 3: 089-093.
17. Njogu, SM., Arika, WM., Nyamai, DW., Ngugi, MP., Machocho, AK., Ngeranwa, JJN., Njagi, ENM., Hypoglycemic Effect of Aqueous and Ethyl Acetate Leaf Extract of Maytenus putterkloides in Alloxan Induced Diabetic Mice. Journal of Diabetes Metabolism. 2016; 7: 1000685.
18. Heba, AH., Eman, AEW., Eman, AM., Characterization of ethyl acetate and methanol extracts of Commiphora myrrha and evaluating in vitro anti-diabetic and anti-obesity activities. Journal of Applied Pharmaceutical Science. 2019; 9: 038-044.