Phytochemical properties, total antioxidant status of acetone and methanol extract of *Terminalia arjuna* Roxb. bark and its hypoglycemic effect on Type-II diabetic albino rats.

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In the present study, acetone and methanol extract of *T. arjuna* Roxb. bark was evaluated for its phytochemical properties and antioxidant status by FRAP method. The result indicated that tannin, alkaloid, triterpenoid, flavonoid, phytosteroids and saponin are present in both the acetone and methanol extract. Total antioxidant status was found to be significantly (*P*<0.01) higher in acetone extract (212.5±11.55 µM) as compared to methanol extract (35.50±4.70 µM). This indicates higher antioxidative property of *T. arjuna* bark acetone extract in comparison to methanol extract and selected for *in vivo* study. *In vivo* study, showed protective effect of acetone extract of *T. arjuna* bark towards blood glucose, oral glucose tolerance (OGTT) and insulin tolerance test in STZ treated rats. Feeding 500 mg/kg bw arjuna bark extract to rats showed significantly (*P*<0.05) lower parameters as compared to rats of diabetic control rats and 250 mg/kg bw arjuna bark fed rats and was non-significant with glimepiride fed rats. Feeding 500 mg/kg bw extract showed significantly (*P*<0.05) higher anti-hyperglycemic and anti-diabetic effects as compared to 250 mg/kg bw extract. It is concluded that the acetone extract of *Terminalia arjuna* bark exhibit antioxidant power and hypoglycemic properties.

**Keyword:** *Terminalia arjuna* bark, FRAP assay, Phytochemical properties, Blood glucose, OGTT, Insulin tolerance, Hypoglycemia.

1. **Introduction**

Diabetes mellitus is a chronic metabolic disorder and is also a syndrome identified by a raised glucose level in the blood (hyperglycemia) due to deficiency or diminished effectiveness of insulin with a strong hereditary basis. It is usually associated with passage of sugar in the urine and is also initially characterized by a loss of glucose homeostasis with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both[11]. There are two major forms of diabetes, type-I (consequence of destruction of pancreatic β-cells, which leads to insulin deficiency) and type-II diabetes (characterized by insulin resistance and relative, rather than absolute, insulin deficiency) which contribute about 10% and 90% of diabetic population, respectively. Diabetes mellitus (DM) refers to a group of common metabolic disorders that share the phenotype of hyperglycemia resulting from defects in insulin secretion or insulin action or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction and failure of various organs especially the eyes, kidneys, nerves, heart, and blood vessels. In the last few years there has been
an exponential growth in the field of herbal medicine and these drugs are gaining popularity both in developing and developed countries because of their natural origin and less side effects. Many traditional medicines in use are derived from medicinal plants, minerals and organic matter. India is the largest producer of medicinal herbs and is called as Botanical garden of the world\textsuperscript{[2]}. Although several therapies are in use for treatment of diabetes, there are certain limitations due to high cost and side effects such as development of hypoglycemia, weight gain, gastrointestinal disturbances, liver toxicity\textsuperscript{[3]}. Terminalia arjuna Roxb. bark is one such ayurvedic remedy that has been mentioned in many ancient Indian medicinal literature including Charaka Samhita and Astang Hridayam, to possess cardio protective property. It is an important cardiotonic plant described in the Ayurveda\textsuperscript{[4]}. It is commonly known as Arjun plant in Hindi language. Terminalia arjuna is a large, evergreen deciduous tree found throughout India in plenty throughout Indo sub Himalayan tracts of Uttar Pradesh, Jharkhand, South Bihar, Madhya Pradesh, Delhi, Deccan region mainly along riverside, riverlets and ponds and belongs to Combrataceae family. The tree is about 60-80 feet height often buttressed trunk and horizontally spreading branches. The bark is smooth in texture. Leaves are sub opposite, oblong or elliptic usually 4-6 inch in length, suddenly narrowed at the base, often cordate, obtuse or very shortly acute at the apex. The upper part of the leaf is light green in color and lower part is dark in color. Flowers are small, sessile with panicked spikes and occur all round white or yellow stalk. Flowering stage of arjuna is in summer whereas fruiting stage is in winter. Fruits are ovoid, fibrous woody, 2.3-3.5 cm long, globrous with 5-7 hard wings, straighted with numerous curved veins. Arjuna seeds are hard germinating, usually takes 50-76 days. It is generally cultivated on variety of soils but prefers fertile alluvial loam and deep sandy well drained soil\textsuperscript{[5]}. 

Table-1: Qualitative Phytochemical Properties of Acetone and Methanol Extract of Terminalia arjuna Bark Extract. (Values are Mean± S.E.M. of three Experiments, Means with Different Letters are Significantly differ at (P<0.01).)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T. arjuna acetone extract</th>
<th>T. arjuna methanol extract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antioxidant power (µM)</td>
<td>212.5±11.55\textsuperscript{a}</td>
<td>35.50±4.70\textsuperscript{b}</td>
</tr>
<tr>
<td>Tannins</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Triterpenoids</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Alkaloids</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Phytosteroids</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Saponin</td>
<td>Present</td>
<td>Present</td>
</tr>
</tbody>
</table>

The bark T. arjuna has many therapeutic or medicinal values from ancient time and is mostly used by rural tribal people for treatment of diarrhea, dysentery, tubercular caugh, asthma, earache, cleansing sores, ulcers and syphilitic infection, sex stimulation, skin disorder, relieving excessive menstrual bleeding and leucorrhea, angina and heart disease. The leaves of this plant have analgesic and anti-inflammatory properties studied in mice\textsuperscript{[6]}. The bark extract contains acids (arjunic acid, arjunolic acid, arjungenin acid and arjunglycesides and terminic acid), glycosides (argentine arjunosides I-IV), strong antioxidants (flavonoids, tannins, oligomeric proanthocyanidins), minerals etc. A number of experimental and clinical studies have proved that dried bark powder of this plant have potent hypolipidemic and cardioprotective activity. The pharmacological studies have shown antibacterial, antiviral, anti mutagenic, antiplague, anticancer, antiacne and hypotensive properties of the bark of T. arjuna. The use of Terminalia arjuna bark in the management of
hypercholesterolaemia has been widely reported due to its high antioxidative properties. The present study was thus taken up with the objective of understanding the phytochemical properties and antioxidant status of *Terminalia arjuna* Roxb. Bark for the study of antihyperglycemic activity of *T. arjuna* bark on Type-II diabetic albino rats.

![Fig 1](image1.jpg)

**Fig 1**: Quantitative Comparison Study of Total Antioxidant Status of Acetone and Methanol Extract of *Terminalia arjuna* bark Extract by FRAP Assay (Values are Mean± S.E.M. of three Experiments, Means with Different Letters are Significantly Different at (*P*<0.01)).

![Fig 2](image2.jpg)

**Fig 2**: Effect of Acetone Extract of *Terminalia arjuna* bark on Blood Glucose Level at the 8th week of Treatment Indicating its Anti-Hyperglycemic Effects. (Values are Mean± S.E.M. of three experiments, Means with Different Letters are Significantly Different at (*P*<0.05)).

## 2. Material and Methods

### 2.1 Animals:

Only male albino wistar rats (*Rattus norvegicus*) of weight approx. 125gm/rat were used in this study and housed in stainless steel cages (10 rats/cage). They were acclimatized under laboratory conditions (24 ± 1°C of ambient temperature and relative humidity 55±10%, with a 12:12 h light-dark cycle). Animals were fed on standard chow and Aqua-guard filtered water *ad libitum* for whole period of the experiment (8 weeks).

### 2.2 Grouping of animals:

Sixty animals were distributed into 6 groups (ten rats in each group) as follows-

**Group-I**: normal non-diabetic rats,

**Group-II**: diabetic control rats.

**Group-III**: diabetic rats fed with arjuna bark acetone extract (250 mg/kg body wt.).

**Group-IV**: diabetic rats fed with arjuna bark acetone extract (500 mg/kg body wt.).

**Group-V**: diabetic rats fed with Glimepiride (2 mg/kg body wt.) in diet.

**Group-VI**: Runner group (normal rats fed with arjuna bark extract @ 500 mg/kg body wt.) for study of bark toxicity.
All rats were sacrificed at 8th weeks of experimental period and assessed for various biochemical parameters.

2.3 Induction of Type-II Diabetes in Rats:
All animals were acclimatized for two weeks before onset of experiment in laboratory. Type-II Diabetes was induced to all animals except rats of group-I and VI by feeding 21% fructose with standard chow for four weeks before a single dose of intra-peritoneal injection of 40 mg/kg body weight streptozotocin\[^7\], those were fasted for 12 hours before STZ injection. STZ was freshly prepared in 0.1M citrate phosphate buffer (pH 6.3).

2.4 Composition of Standard Chow:
All rats were fed with standard chow containing Wheat (259gm/kg), Bengal gram (463gm/kg), Groundnut (195gm/kg), Refined oil (67gm/kg), Vitamin mixture (01gm/kg) and Mineral mixture (15gm/kg). Total nutrient value of standard chow was calculated as Carbohydrate (59.47%), Protein (16.64%) and Fat (6.39%) determined by Kjeldahl method\[^8\].

2.5 Collection of Terminalia arjuna Bark
The *Terminalia arjuna* Roxb. plant specimen was identified by K. Karthigeyan, Scientist-‘C’, Central National Herbarium, Botanical Survey of India, Howrah, Kolkata via memo no.- CNH/8/2012/Tech.II/680. After that wet bark of *Terminalia arjuna* plant was collected from Tasar silkworm (*Antheraea mylitta* D.) food plant farm of ‘Central Tasar Research & Training Institute (CTR&TI), Nagri, Ranchi’ during September month.

![Fig 3: Effect of Acetone Extract of *Terminalia arjuna* bark and Performance of all Groups of rats for Oral Glucose Tolerance Test (OGTT) on 8th week of Experiment. (Values are Mean± S.E.M. of three Experiments, Means with Different Letters are Significantly Different at \(P<0.05\).)](image)

![Fig 4: Effect of Acetone Extract of *Terminalia arjuna* Bark on Insulin Tolerance Test at Last Day (8th Week of Treatment) (Values are Mean± S.E.M. and Significantly Different at \(P<0.05\).)](image)
2.6 Preparation of Acetone and Methanol Extract of *Terminalia arjuna* Bark: 
*Terminalia arjuna* bark were shade dried for 45 days and powdered using mixer grinder. One hundred gram of shade dried *T. arjuna* bark powder was soaked for 48 hours in extraction flask containing 400 ml of absolute acetone (or methanol for methanol extract). The flask was kept at room temperature with continuous mixing in every 2 hours. Next day the mixture was filtered with whatman’s filter paper no-1 and filtrate was collected. Unfiltered plant material was again soaked in equal volume of acetone for two times. All the filtrate were pooled and dried using vacuum evaporator and residue bark acetone extract were coarsely powdered with the help of mixer grinder. Both acetone and methanol extract were stored separately at 4°C in refrigerator for further use.

d) Shinoda Test for Flavonoid: 5 drops of diluted HCl was added in 0.5 ml of bark extract and then a small piece of magnesium was added on it in a test tube. Appearance of reddish pink colouration indicates the presence of flavonoid in test sample.

e) Salkowski’s Test for Phytosteroid: 1ml of extract was treated with chloroform and a drop of concentrated sulfuric acid was added to the solution in a test tube. Formation of reddish brown color indicates the presence of phytosteroid.

f) Foaming test for Saponin: 300mg of extract was boiled with 5 ml of distilled water in a test tube and filtered. About 3ml of distilled water was further added to the filtrate and shaken vigorously for about 5 minutes. Frothing which persist on warming indicates the presence of saponin[9].

2.8 Total Antioxidant Status of Acetone and Methanol Extract (FRAP Method):
Total antioxidant status was measured using ferric reducing antioxidant power (FRAP) assay[10]. FRAP reagent was prepared by mixing 300mM acetate buffer, pH 3.6, 10mM 2,4,6-tripyridyl-S-triazine (TPTZ) in 40mM HCl and 20mM FeCl$_3\cdot$6H$_2$O in the ratio of 10:1:1. Aqueous solution of freshly prepared pure antioxidant solution such as ascorbic acid (1000µM) was used as standard. Acetone and Methanol extract were made 1g/ml in acetate buffer and its 100 µl was mixed with 3ml of working FRAP reagent separately (for test solution). Then it was vortex mixed and absorbance at 593nm was measured at 0 min and at 5 min. against a reagent blank (FRAP solution). The change in absorbance was translated into FRAP value (µM) by relating A$_{593}$ of test sample with that of standard solution (ascorbic acid 100µl+FRAP solution 3ml) of known FRAP value using formula:

\[
\text{FRAP value of 1000 µM ascorbic acid is 2000, which was taken as standard.}
\]
2.9 Blood Glucose Test:
Glucose levels were determined by using one drop of blood samples (drawn from tail vein of rats) in Bayer Contour TS Glucometer (Bayer Healthcare Ltd., Hong Kong) as per manufacturer instructions.

2.10 Oral Glucose Tolerance Test:
OGTT was performed between 0900-1400 h on 8th week as per the method described by Tran et al., 2003. The rats were deprived of food for 12-14 h before the administration of an oral glucose @ 2 g/kg body weight (200g/l solution). Blood samples were collected from the tail vein at 0 (before administration), 60 min and 120 min after glucose administration. Glucose levels were determined by using one drop of blood samples in Bayer Contour TS Glucometer (Bayer Healthcare Ltd., Hong Kong).

2.11 Insulin Tolerance Test:
After an overnight fast, rats were orally ingested with 2 g/ kg body weight of glucose solution and simultaneously injected (I.V.) with 2 U/ kg body weight human regular insulin (M.J. Biopharm Pvt. Ltd., Rajgad, India). Blood samples were taken at various time intervals i.e. 0, 15, 30, 60 and 120 min, and blood glucose concentrations were measured by using one drop of blood samples in Bayer Contour TS Glucometer (Bayer Healthcare Ltd., Hong Kong).

3. Result
3.1 Phytochemical Analysis:
The qualitative assessment of T. arjuna bark extract indicates that tannin, alkaloid, triterpenoid, flavonoid, phytosteroids and saponin are present in both the acetone and methanol extract (Table-1).

3.2 Total Antioxidant FRAP Test:
Acetone and methanol extract of T. arjuna bark was compared for its total antioxidant status by FRAP assay. Total antioxidant status was found to be significantly ($P<0.01$) higher in acetone extract (212.5±11.55 µM) as compared to methanol extract (35.50±4.70 µM). This indicates higher antioxidative property of T. arjuna bark acetone extract in comparison to methanol extract (Table-1 and figure-1).

3.3 Blood glucose test:
Blood glucose level was found to be 78.00±4.04 and 273.33±7.21 respectively in rats of normal and diabetic control group (figure-2). Feeding 500 mg/Kg BW arjuna bark (group-IV) acetone extract to diabetic rats showed significantly ($P<0.05$) lower (124.33±6.64) blood glucose as compared to diabetic control rats (273.33±7.21) and rats fed with 250 mg/Kg BW arjuna bark (group-III) extract (184.66±9.82). Blood glucose in arjuna bark fed rats were comparable with glimepiride (122.33±6.93) fed rats but it was significantly ($P<0.05$) higher than rats of normal (78.00±4.04) and runner group (78.66±3.75).

3.4 Oral Glucose Tolerance Test:
At the 8th weeks of treatment (Figure-3), blood glucose concentration was restored back to normal (79.00±6.72) in rats of 500 mg/Kg BW arjuna (group-IV) or glimepiride (group-V) group. Rats fed with 500 mg/Kg BW arjuna bark acetone extract showed significantly ($P<0.05$) better oral glucose tolerance as compared to rats fed with 250 mg/Kg BW arjuna bark extract. Effects of arjuna bark at the concentration of 500 mg/Kg BW was found to be comparable with glimepiride fed (group-V) and rats of normal (group-I) and runner group (group-VI). In diabetic control group-III rats, blood glucose level (mg/dl) at 120 minutes (273.00±12.52) of administration was significantly ($P<0.05$) higher than blood glucose level at 0 minute (316.66±7.21).

3.5 Insulin Tolerance Test:
An insulin tolerance test is a diagnostic procedure to assess pituitary function. Rats of diabetic control group (group-II) showed resistance towards insulin treatment. A non-significant ($P>0.05$) decrease in blood glucose (mg/dl) was observed in rats of diabetic control group (group-II) at 30 min (318±11.81) and 90 min (304±11.46) of insulin administration (figure-4). Rats of non-diabetic normal (group-I, 138±5.61 vs. 82±5.76) and runner (group-VI, 140±11.11
vs. 85±7.16) groups showed statistically significant (P<0.05) decrease in blood glucose at 30 min and 60 min. Feeding arjuna acetone extract bark to diabetic rat group improved the insulin tolerance and showed blood glucose back to normal. Arjuna bark acetone extract at the concentration of 500 mg/Kg BW (162±9.33 Vs 90±8.36) and glimepiride (156±12.73 Vs 89±7.76) showed significantly better insulin tolerance at 30 min and 60 min as compared to rats fed with that of 250 mg/Kg BW (258±8.11 Vs 142±8.26).

4. Discussion
The uses of traditional medicines as an alternative therapy for the treatment of diabetes have been evolved in certain ethnic groups with a high prevalence of disease among Native Americans, Hispanics, and Asians[12]. The active principles of many plant species are isolated for direct use as drugs, lead compounds or pharmacological agents. Different species of medicinal plants are used in the treatment of diabetes mellitus. For diabetes treatment, before the discovery of insulin by Banting and Best in 1922[13], the only options were those based on traditional practices[14]. In the present study, tannin, alkaloid, flavonoid, triterpenoid, phytosteroids and saponin were reported in both the acetone and methanol extract of T. arjuna bark. In the similar line of study, Mythili P. et. al., 2012[15] have found phytosterols (b-sitosterol), flavonoids (arjunic acid, arjunolone, and luteolin), terpenes, triterpenoid saponins (arjunic acid, arjunolic acid, arjungenin, arjunglycosides) in Terminalia arjuna bark triterpenoids extract. Flavonoids (Arjunic acid, arjunonic acid, arjungenin acid and arjunlycic acid) being powerful antioxidants are reported to play a role in antihyperglycemic and analgesic activity by targeting pancreas and prostaglandins since stem bark of T. arjuna plant contain flavonoids and glycosides. The phytochemical screening of the plant T. arjuna stem bark showed the presence of flavonoids, alkaloid, triterpenoids, saponins and tannins shown in Table-1. Amino acid and resins are absent in bark of T. arjuna. Triterpenoids, flavonoids, tannins and phytosteroids possess significant (P<0.05) antioxidant antihyperglycemic[16] and cardioprotective effect[17]. Triterpenoids have same effect as vitamin-C. Saponin compound may be responsible for intropic effects of T. arjuna. Arjunic acid maintained the intracellular concentration of Ca^{2+} and Ca^{2+} homeostasis; in turn regulates the Ca^{2+} involved single transduction pathways[18]. Triterpenoids extract of T. arjuna have ability to prevent myocardial abnormalities and pathological changes in biochemical marker, which are induced by cyclosporine A.

In a study, Singh et. al., 2012[18] found higher antioxidant power of acetone extract T. chebula fruits which were followed by methanol extract. They reported antioxidant power at low concentrations (6×10^{-4} g/l) of ethyl acetate and acetone extracts were possess highest scavenging power as compared to methanolic and aqueous extracts. In the present study, we have found similar type of result in which total antioxidant power of acetone extract (212.50±11.55) of T. arjuna bark were found to be significantly (P<0.05) higher as compared to methanol extract (35.50±4.70). In a recent study, Amira et.al., 2013[19] found comparable antioxidant power of acetone and methanol extract of bitter melon (Momordica charantia) as measured by FRAP method. The present investigation established that the stem bark of the plant T. arjuna have bioactive principles with anti-diabetic potential (figure-1).

High fructose diet followed by STZ injection constantly increased in blood glucose in rats which were came to normal after feeding T. arjuna bark acetone extract (500 mg/kg BW) for 8 weeks, in the present studies (figure-2). Similar results were obtained by Wilson and Islam, 2012[20] showed increased blood sugar in normal rats after HF-STZ treatment. Ragavan and Krishnakumari, 2006[21] showed 500mg/kg BW oral administration of ethanol extract of T. arjuna bark for 30 days results in significant (P<0.05) reduction in blood glucose (mg/dl) from 302.67±22.35 to 113.17 ± 14.25. Similarly, Nagappa et.al., 2003[22] reported that
administration of alloxan (150 mg/kg, i.p.) to wistar albino rats led to 1.5-fold elevation of fasting blood glucose levels. Workers has given daily treatment of various extract of Terminalia catappa for three weeks and found a dose-dependent fall in blood sugar levels by 25–62%. Rats of type-II diabetic as compared to normal group showed lower tolerance towards oral administration of glucose and higher blood glucose even after 120 min of glucose administration in OGTT (figure-3). Feeding 500 mg/kg BW T. arjuna bark acetone extract or glimeperide to diabetic rats for 8 weeks restored the OGTT potential. In a similar line of study, Murali et al., 2004[22] fed water extract of dry fruits of Terminalia chebula to STZ induced diabetic rats at a dose of 200 mg/kg BW for 2 weeks and found improved glucose tolerance as indicated by 44% of reduction in the peak blood glucose at 2nd hour in glucose tolerance test. In the present study diabetic rats fed with 500 mg/kg BW acetone extract of T. arjuna bark or glimepiride, for 8 weeks, improved glucose utilization during GTT (44.3% reduction in blood glucose at 2hrs) within 90 min after administration of the extract. Recently, Govinda et al. (2012[23]) reported improved OGTT of STZ induced diabetic male albino wistar rats after oral administration of hydro-alcoholic bark extract of Terminalia Paniculata Roxb. at a dose of 200, 400 and 600 mg/kg BW for 21 days. Authors showed that 400mg/kg and 600mg/kg alcoholic bark extract result in a significant reduce in the blood glucose levels in oral glucose tolerance test whereas 200mg/kg showed little effect. So, good effect of T. arjuna oral administration at a concentration of 500 mg/kg BW in comparison of 250mg/kg BW is logical.

Insulin tolerance test is an effective diagnostic marker for type-I and II diabetes. In type-II diabetes, the insulin resistance is the main characteristic, as the outer source of insulin will not rapidly normalize the oral load of glucose due to the non-functionality/ non-response of insulin and consequently, blood glucose will increase with time after oral administration of glucose. A similar pattern was observed in the present study, when glucose was administered orally with simultaneous injection of insulin, it was not restricted to post-prandial hyperglycemia in type-II diabetic control rats, which confirms the insulin-resistant characteristics of the type-II diabetic animals. Feeding acetone extract of T. arjuna bark exhibited a higher response to the outer source insulin and inhibited the postprandial hyperglycemic peak in these animals. The effects of feeding 500mg/Kg BW of T. arjuna bark acetone extract were more efficacious in comparison to the 250mg/Kg BW. Moreover, the feeding of glimepiride also showed higher efficacy in delaying the attainment of insulin-resistant stage in comparison to 250mg/Kg BW of T. arjuna bark extract treatments. These results clearly indicated that the feeding of 500mg/Kg BW of T. arjuna bark acetone extract significantly (P<0.05) attenuated the achievement of insulin resistance in type-II diabetic rats. Similarly, Lian et al., 2007[24] reported impaired glucose tolerance of diabetic control mice in comparison to the normal. Authors reported after the insulin injection, normal mice showed a sensitive response which was reflected in immediate decrease of blood glucose level but in contrast diabetic control mice showed a distinct delay decrease of the blood glucose level. Satoh et al., 2005[25] performed insulin tolerance test on 6 h fasted wistar rats and indicated glucose-lowering effect in Adv-Adipo (high viral dosage) rats compared with Adv-LacZ controls at 30, 45, and 60 min. In the present study diabetic rats showed the higher resistance towards exogenous insulin suggest low expression of insulin receptor impairment in insulin receptor. This could be one of the reasons of observed higher blood glucose level in diabetic control rats as compared to normal rats. Feeding arjuna bark acetone extract to diabetic rats increased pancreatic beta cell activity and blood insulin level. Increased plasma insulin level in diabetic rats could participate in increased glucose uptake by cells and decreased cytotoxicity and increased receptor expression. This could be one of the reasons of better insulin tolerance of diabetic rats fed with arjuna bark acetone extract.
5. Conclusion
From the present study it has been concluded that acetone extract of *T. arjuna* bark have higher antioxidative power than the methanolic extract and it exhibits anti-hyperglycemic activity on Type-2 diabetic albino rats. The blood glucose level was found to be significantly (P<0.05) low in rats fed with 500mg/Kg body weight arjuna bark extract as compared to 250mg/Kg body weight arjuna bark extract for 60 days which reduces the diabetic complications in albino rats. The acetone extract of *Terminalia arjuna* bark have tannins, alkaloids, triterpenoids, flavonoids which exhibit antioxidiant power and hypoglycemic properties.

6. References