SYNERGETIC HYPOGLYCEMIC AND HYPOLIPIDEMIC EFFECT OF HERBAL FORMULATION OF FLAX SEED, FENUGREEK AND JAMUN SEEDS IN STREPTOZOTOCIN- NICOTINAMIDE INDUCED DIABETIC RATS

S.Latha*1, R.Vijayakumar1, *B.R.Senthil Kumar2, R.Srikumar3, G.Bupesh4

1Department of Physiology, Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry, India.
2Department of Physiology, National siddha institute, tambaram, chennai, India.
3Centre of research, Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry, India.
4Central Research Laboratory & Department of Physiology, Sree Balaji medical college and Hospital, Bharath University, BIHER, Chrompet, Chennai, India.

Email id: lathaviji.kumar@gmail.com

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Abstract:
The present study was designed to investigate the synergism in hypoglycemic and hypolipidemic effect of hydro alcoholic extract of Herbal Formulation of Flax seed, Fenugreek and Jamun seeds (FFJ) and their individual drugs in diabetic animals. Due to the sedentary life style there is a drastic increase in chronic metabolic diseases such as diabetes mellitus. Even though many synthetic allopathic drugs are in use, most of the affected individuals search for the effective Herbal formulations because of their high efficacy, less or no side effects. Anti diabetic activity was evaluated in Streptozocin-Nicotinamide induced diabetic wister rats. The hydro alcoholic extract of herbal formulation of FFJ (1:1:1) and their individual drugs are given by oral route at doses of 200mg/kgbw for 30 days. The animal weight and food consumption were measured for every 15 days. On 31st day blood were collected by retro orbital puncture and Blood glucose, insulin, blood lipids, Haemoglobin(Hb), Glycosylated Hb(HbA1c), were measured on 31st day. Diabetic rats treated with Herbal Formulation of FFJ (1:1:1) and their individual drugs shown significant (P<0.05) reduction in the food consumption, blood glucose, blood lipid except HDL cholesterol, glycosylated Hb level and increased body weight, serum insulin level and Hb level and when compared to diabetic group. The percentage changes occur in Herbal Formulation FFJ treated group was greater than their individual drugs treated groups. This study concluded the formulation of FFJ was found to have greater antidiabetic effect compared to individual drugs of FFJ.

Key words: Diabetic, Streptozotocin, Nicotinamide, Glycosylated Hb
Introduction:

Diabetes mellitus is a common present day problem, increasing at an alarming rate both in developing and developed countries. It is a chronic metabolic disease characterized by hyperglycemia, hyperlipidemia and negative nitrogen balance resulting from defects of insulin secretion, insulin action or both. The major complications of diabetes mellitus are high blood glucose levels which lead to serious diseases affecting the heart and blood vessels, eyes, kidneys, and nerves. People with diabetes are also at increased risk of developing infections. Type II DM which accounts 95% of the diabetic population.

According to IDF report Some 382 million people worldwide are estimated to have diabetes. It may rise to some 592 million people, by 2035. It is also a common cause of chronic morbidity and disability among the working population in the world. The treatment of DM in clinical practice has been confined to use of oral hypoglycemic agents and insulin, the former being reported to be endowed with characteristic profiles of serious side effects.

Plants have been commonly used to treat diabetes since ancient times and have served as a good source of medicine. Many different plants are used individually or in the formulations for the treatment of diabetes mellitus and for its complications.

The major problem with this herbal formulation is lack of scientific and clinical data providing their safety and efficacy. According to ayurveda, combination of plant drugs are used to get desired action and to eliminate unwanted side effects.

In traditional systems, diabetes is better managed by the herbal combination instead of single herb. most of the formulations contain eight or more drugs in combination, it is very difficult to standardize and dispense. Since FDA recommends the number of ingredients to be three or less than three in any combination, present study used three herbs namely flax seed, fenugreek and jamun seeds. Flaxseed (Linum Usitatissimum), popularly known as linseed. It has been used in various forms such as flour, oil and seed. The studies conducted on the flax seed proved that it reduces cardiovascular risks like hypertension, and blood cholesterol, triglycerides level, colon carcinogenesis and diabetes.

Fenugreek (trigonella foenum greacum) has been used for diabetes, particularly in India. It is used in atherosclerosis, rheumatism, sugar lowering, blood lipids lowering, appetizer and contain antioxidant activity. Syzygium Cuminii or Eugenia jambolana (black plum or jamun) belongs to the family Myrtaceae. Jamun has been reported to be used in numerous complementary and alternative medicine systems of India. The efficacy of Eugenia
*jambolana* has also been tested in preclinical and clinical studies for hypolipidemic, anti-inflammatory, neuropsychological, antiulcer, antibacterial, anti-HIV, antidiarrhoeal, and antihypertensive activities.\(^{16-21}\).

On the basis of the above evidence the present study was designed to evaluate the synergetic action in hypoglycemic and hypolipidemic effect of herbal formulation of FFJ and their individual drugs in STZ-nicotinamide induced diabetic rats.

**Materials and methods:**

**Collection and identification of plant:**

Seeds belonging to the herbal formulation of FFJ were collected from the local market, puducherry, India and authenticated by siddha physician and nodal officer, siddha unit, dept of ISM&H, puducherry. The seeds were dried under shade and powdered before use.

**Extraction of the plant material:**

1. **Extraction of flax seed:**

   Powdered flax seeds are defatted by petroleum ether (at 60-80°C) in the soxhlet apparatus. The merc was hydrolyzed with 1m sodium hydroxide for 1 hr at room temperature by constant rotation followed by extraction with 50% ethanol then acidified with 1m HCl upto the PH:2-4. dry the filtrate at 50°C.\(^{22}\)

2. **Extraction of fenugreek and jamun seeds:**

   Dried powdered seeds were extracted with 50% ethanol using soxhlet apparatus for 20-24 hrs. The extract was concentrated under vacuum.

**Experimental Animal**

Wister strain albino rats weighing 180-220gm were used for this study. Before the commencement of the experiments proper IACE permission was obtained (IAEC NO: JKKMRF/IAEC/2013/014). Rats were housed under standard laboratory conditions with food and water provided ad libitum.

**Induction of diabetes mellitus:**

Streptozotocin (STZ) was dissolved in citrate buffer (pH 4.5) and nicotinamide was dissolved in normal saline. Type II DM (NIDDM) was induced in overnight fasted Wistar strain albino rats by a single intraperitoneal injection of 60 mg/kg streptozotocin, 15 min after the i.p. administration of 120 mg/kg of nicotinamide.
Hyperglycemia was confirmed by the elevated glucose levels in plasma, determined at 72 hr after administration. Rats with fasting blood sugar levels around 160 to 300 mg/dl were selected for the study.  

**Experimental groups:**

- **Group 1:** Control Animals were administered saline (1ml) orally for 30 days
- **Group 2:** diabetic animal
- **Group 3:** diabetic Animals were administered flax seed extract 200mg/kg bw for 30 days
- **Group 4:** diabetic Animals were administered fenugreek extract 200mg/kg bw for 30 days
- **Group 5:** diabetic Animals were administered jamun seed extract 200mg/kg bw for 30 days
- **Group 6:** diabetic animals were administered herbal formulation of FFJ (1:1:1) of 200 mg/kg bw for 30 days
- **Group 7:** diabetic animals were administered metformin (200mg/kg bw) for 30 days

**Sample collection**

At the 31st day Blood samples were collected by of retero-orbital plexus puncture for the measurement of plasma glucose, insulin, serum lipids, haemoglobin and glycosylated hb levels.

Weight of the animal and food consumption were measured for every 15 days once. Measurement of blood glucose: By using GOD-PAP kit – purchased from agappe diagnostic Ltd, kerala. Plasma insulin levels were assayed by using rat Insulin ELISA enzyme immune assay kit by Mercodia, Sweden. Measurement of total cholesterol and HDL cholesterol and serum triglycerides are done by using the kit purchased from span cogent diagnostic Ltd. LDL cholesterol are measured by using friedewald’s equation (40)

\[(LDL-cholesterol=total\,cholesterol-triglycerides/5-HDL\,cholesterol)\]

Serum VLDL cholesterol concentration was calculated according to Nobert formula

\[VLDL\,cholesterol= Triglycerides/5\]


**Statistical analysis:**

All the data were analyzed using one way analysis of variance (ANOVA) followed by tukeys multiple comparison. Results were expressed as mean ±S.D and the values p<0.05 a were considered statistically significant.
Result:

Table 1: Effect of Herbal formulation and their individual drugs on weight and food consumption in STZ-Nicotinamide induced diabetic rats.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Weight of the animal (gm)</th>
<th>Food consumption (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st day</td>
<td>15th day</td>
</tr>
<tr>
<td>Group 1 (control)</td>
<td>206.16±10.5</td>
<td>212.33±10.5</td>
</tr>
<tr>
<td></td>
<td>a&lt;sup&gt;NS&lt;/sup&gt;</td>
<td>a'&lt;sup&gt;NS&lt;/sup&gt;</td>
</tr>
<tr>
<td>Group 2 (diabetic)</td>
<td>203±11.5</td>
<td>193.33±9.79</td>
</tr>
<tr>
<td></td>
<td>a'</td>
<td>a'&lt;sup&gt;NS&lt;/sup&gt;</td>
</tr>
<tr>
<td>Group 3 (Flax seed extract (200mg/kg bw))</td>
<td>210.16±10.8</td>
<td>212.8±10.5</td>
</tr>
<tr>
<td></td>
<td>a&lt;sup&gt;NS&lt;/sup&gt; b&lt;sup&gt;NS&lt;/sup&gt; c&lt;sup&gt;*&lt;/sup&gt;</td>
<td>a'&lt;sup&gt;NS&lt;/sup&gt; d&lt;sup&gt;NS&lt;/sup&gt; b&lt;sup&gt;NS&lt;/sup&gt; c&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Group 4 (Fenugreek Seed extract (200mg/kg bw))</td>
<td>202±10.8</td>
<td>205.5±9.0</td>
</tr>
<tr>
<td></td>
<td>a&lt;sup&gt;NS&lt;/sup&gt; b&lt;sup&gt;NS&lt;/sup&gt; c&lt;sup&gt;*&lt;/sup&gt;</td>
<td>a'&lt;sup&gt;NS&lt;/sup&gt; d&lt;sup&gt;NS&lt;/sup&gt; b&lt;sup&gt;NS&lt;/sup&gt; c&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Group 5 (Jamun seed Extract (200mg/kg bw))</td>
<td>206.5±10.8</td>
<td>210±11.1</td>
</tr>
<tr>
<td></td>
<td>a&lt;sup&gt;NS&lt;/sup&gt; b&lt;sup&gt;NS&lt;/sup&gt; c&lt;sup&gt;*&lt;/sup&gt;</td>
<td>a'&lt;sup&gt;NS&lt;/sup&gt; d&lt;sup&gt;NS&lt;/sup&gt; b&lt;sup&gt;NS&lt;/sup&gt; c&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Group 6 (Herbal formulation (FFJ) (200mg/kg bw))</td>
<td>208.5±10.7</td>
<td>210.33±11.2</td>
</tr>
<tr>
<td></td>
<td>a&lt;sup&gt;NS&lt;/sup&gt; b&lt;sup&gt;NS&lt;/sup&gt; c&lt;sup&gt;*&lt;/sup&gt;</td>
<td>a'&lt;sup&gt;NS&lt;/sup&gt; d&lt;sup&gt;NS&lt;/sup&gt; b&lt;sup&gt;NS&lt;/sup&gt; c&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Group 7 (Metformin (200mg/kg bw))</td>
<td>204.6±11.0</td>
<td>207.66±10.6</td>
</tr>
<tr>
<td></td>
<td>a&lt;sup&gt;NS&lt;/sup&gt; b&lt;sup&gt;NS&lt;/sup&gt; c&lt;sup&gt;*&lt;/sup&gt;</td>
<td>a'&lt;sup&gt;NS&lt;/sup&gt; d&lt;sup&gt;NS&lt;/sup&gt; b&lt;sup&gt;NS&lt;/sup&gt; c&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values are expressed mean±SD of six animals

Symbol * represents the statistical significance (p<0.05)      NS-no significance

a- compared with 1<sup>st</sup> day            d- compared with 15<sup>th</sup> day
b- compared with group 1                   c- compared with group 2

table 1 represented the effect of herbal formulation FFJ and their individual drugs on weight and food consumption in control, diabetic and treated groups at 1<sup>st</sup>, 15th, and 30<sup>th</sup> day. When compared with 1<sup>st</sup> day no significant weight reduction was observed in all the groups on 15<sup>th</sup> day and in the treated groups on 30<sup>th</sup> day. No significant weight reduction was observed in all the groups on the 30<sup>th</sup> day when compared with 15<sup>th</sup> day.

Diabetic group showed significant (p<0.05) weight reduction than control as well as with other treated groups on 15<sup>th</sup> and 30<sup>th</sup> day. Flax seed, fenugreek seed, jamun seed extract and herbal formulation FFJ treated diabetic animals showed
significant increase in weight of the animal when compared with diabetic animals on 15th and 30th day and the weight of the treated groups were almost similar to the control and standard drug metformin treated groups.

The food consumption were increased in control as well as diabetic group animals on 15th and 30th day when compared with 1st and 15th day but the Herbal formulation FFJ and their individual drug treated groups were shown significant(p<0.05) reduction in food consumption.

The percentage of food consumption was greater in diabetic group on 15th (26%) and 30th day (49.83%) than control group (11.3%, 23.15%). Changes in food consumption was observed in flax seed extract, fenugreek seed extract, jamun seed extract and Herbal Formulation FFJ treated diabetic animals were not significant when related to control animals.

The food consumption of the treated groups was nearly same as the control and the standard drug metformin treated groups.

**Table 2: Effect of Herbal formulation (FFJ) and their individual drugs on blood glucose and insulin level in STZ-Nicotinamide induced diabetic rats.**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Blood Glucose (mg/dl)</th>
<th>serum insulin (μU/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group1 (control)</td>
<td>111.83±6.08</td>
<td>31.62±1.85</td>
</tr>
<tr>
<td>Group2 (diabetic)</td>
<td>292.16±14.17 a*</td>
<td>18.41±1.01 a*</td>
</tr>
<tr>
<td>Group3 (Flax seed extract (200mg/kg bw))</td>
<td>165.16±9.0 a* b*</td>
<td>23.10±1.24 A* b*</td>
</tr>
<tr>
<td>Group4 (Fenugreek Seed extract (200mg/kg bw))</td>
<td>128.83±7.05 a* b*</td>
<td>25.13±1.1 a* b*</td>
</tr>
<tr>
<td>Group5 (Jamun seed Extract (200mg/kg bw))</td>
<td>135±6.57 a* b*</td>
<td>25.18±1.31 a* b*</td>
</tr>
<tr>
<td>Group6(Herbal formulation(FFJ) (200mg/kg bw))</td>
<td>116.3±5.75 aNS b*</td>
<td>29.55±1.93 aNS b*</td>
</tr>
<tr>
<td>Group7(Metformin (200mg/kg bw))</td>
<td>113.5±5.16 aNS b*</td>
<td>29.67±1.75 aNS b*</td>
</tr>
</tbody>
</table>

Values are expressed as mean±SD of six animals

Symbol * represents the statistical significance (p<0.05) NS-no significance

a –comparison with group 1 b-comparison with group 2
The table 2 shown that the blood glucose level has significantly increased in diabetic group than control. The treatment with herbal formulation FFJ and their individual drugs significantly reduced the blood glucose in diabetic induced rats, but there is significant difference present in the blood glucose level of flax seed, fenugreek seed and jamun seed extract treated groups when compared with control.

The greater percentage reduction of blood glucose in herbal formulation FFJ treated group than their individual drugs treated groups. The Flaxseed, Fenugreek, Jamun seed extract treated groups reduced 43.46%, 55.9%, 53.7% of blood glucose from the diabetic group but the herbal formulation FFJ reduces to 60.18% and which was similar to control and standard drug metformin treated groups.

Blood insulin level given in the table 2 showed significant reduction in the serum insulin level in diabetic group when compared with control. The treatment with herbal formulations FFJ and their individual drugs increases serum insulin level significantly (p<0.05).

Apart that there is significant difference present in the blood insulin level of flax seed, fenugreek seed and jamun seed extract treated animals when compared with control.

The percentage increase in insulin level of herbal formulation treated group (60.49%) was higher than the individual drugs such as flax, jamun seed (25.4%), fenugreek seed (36.4%) and jamun seed (36.7%) extract treated groups.

**Table: 3 Effect of Herbal formulation and their individual drugs on blood lipid level in stz-nicotinamide induced diabetic rats.**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Total cholesterol (mg/dl)</th>
<th>Triglycerides (mg/dl)</th>
<th>HDL cholesterol (mg/dl)</th>
<th>LDL-cholesterol (mg/dl)</th>
<th>VLDL-cholesterol (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (control)</td>
<td>106.83±4.53</td>
<td>80.83±4.21</td>
<td>65.33±4.03</td>
<td>25.33±1.36</td>
<td>16.16±0.8</td>
</tr>
<tr>
<td>Group 2 (diabetic)</td>
<td>200.16±9.98</td>
<td>133.66±7.2</td>
<td>30.33±1.36</td>
<td>143.1±8.3</td>
<td>26.73±1.4</td>
</tr>
<tr>
<td>Group3 (Flaxseed extract)</td>
<td>115±4.6</td>
<td>94.66±5.1</td>
<td>55.50±3.14</td>
<td>40.56±2.05</td>
<td>18.93±1.0</td>
</tr>
<tr>
<td>(200mg/kg b)</td>
<td>a* b</td>
<td>a*b</td>
<td>a*b</td>
<td>a*b</td>
<td>a*b</td>
</tr>
<tr>
<td>Group4 (Fenugreek Seed extract)</td>
<td>114.83±5.3</td>
<td>94.16±5.0</td>
<td>53.16±3.06</td>
<td>42.83±2.25</td>
<td>18.83±1.0</td>
</tr>
<tr>
<td>(200mg/kg bw)</td>
<td>a* b</td>
<td>a*b</td>
<td>a*b</td>
<td>a*b</td>
<td>a* b</td>
</tr>
<tr>
<td>Group5 (Jamunseed Extract)</td>
<td>114.66±5.12</td>
<td>98.5±5.08</td>
<td>54.66±3.20</td>
<td>40.30±2.38</td>
<td>19.70±1.0</td>
</tr>
<tr>
<td></td>
<td>a* b</td>
<td>a*b</td>
<td>a*b</td>
<td>a*b</td>
<td>a* b</td>
</tr>
</tbody>
</table>
Values are expressed as mean±SD of six animals, comparison between groups and the statistical significance are as in table 2.

The serum lipid level given in the table 3 shown that the Total cholesterol, Triglycerides, LDL and VLDL levels were significantly increased and HDL cholesterol was significantly decreased in diabetic group when compared with control.

The treatment with herbal formulation (FFJ) and their individual drugs treatment significantly reduced the Total cholesterol, Triglycerides, LDL and VLDL cholesterol and significantly increased the HDL cholesterol in diabetic induced animals. the percentage reduction of the Total cholesterol of the individual drugs such as flax seed, fenugreek, jamun seed extracts treated groups were 42.5%, 42.63% 42.71%, Triglycerides were 29.1%,29.55%,26.3%, LDL-Cholesterol were 71%,70.06%,71.83% and VLDL-Cholesterol were 29.17%,29.55%,26.30% and the percentage increase in HDL-cholesterol would be 82.9%,75.27%,80.21% respectively from the diabetic group animal. But the percentage reduction of total cholesterol, triglycerides, LDL, VLDL-cholesterol was high in herbal formulation treated animals (46.46%, 36.40%, 81.59%, 36.90%) and percentage increase of HDL cholesterol is 110.4% from the diabetic group animal and the changes were similar to the control and standard drug Metformin treated group.

Table 4: Effect of Herbal formulation FFJ and their individual drugs on Haemoglobin and Glycosylated haemoglobin.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Haemoglobin (mg/dl)</th>
<th>Glycosylated haemoglobin (HbA₁c) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group1 (control)</td>
<td>15.41±0.72</td>
<td>4.41±0.25</td>
</tr>
<tr>
<td>Group2 (diabetic)</td>
<td>12.70±0.69 a*</td>
<td>9.33±0.30 a*</td>
</tr>
<tr>
<td>Group3 (Flax seed extract)</td>
<td>14.70±0.69 aNS b*</td>
<td>5.9±0.31 a*</td>
</tr>
</tbody>
</table>

(200mg/kg bw)
<table>
<thead>
<tr>
<th>Group</th>
<th>Blood Glucose (mg/dl)</th>
<th>HDL Cholesterol (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 4 (Fenugreek Seed extract) (200mg/kg bw))</td>
<td>14.63±0.71 a&lt;sup&gt;NS&lt;/sup&gt; b*</td>
<td>4.98±0.30 a<em>b</em></td>
</tr>
<tr>
<td>Group 5 (Jamun seed Extract) (200mg/kg bw))</td>
<td>14.76±0.68 a&lt;sup&gt;NS&lt;/sup&gt; b*</td>
<td>4.95±0.32 a<em>b</em></td>
</tr>
<tr>
<td>Group 6 (Herbal formulation (FFJ) (200mg/kg bw))</td>
<td>14.98±0.73 a&lt;sup&gt;NS&lt;/sup&gt; b*</td>
<td>4.6±0.22 a&lt;sup&gt;NS&lt;/sup&gt; b*</td>
</tr>
<tr>
<td>Group 7 (Metformin (200mg/kg bw))</td>
<td>13.65±0.67 a&lt;sup&gt;NS&lt;/sup&gt; b*</td>
<td>4.9±0.26 a<em>b</em></td>
</tr>
</tbody>
</table>

Values are expressed as mean±SD of six animals, comparison between groups and the statistical significance are as in table 2.

Table 4 shown that the decreased Haemoglobin level and increased glycosylated Haemoglobin level in diabetic group than control and drug treated groups. Though the glycosylated haemoglobin level in flax seed, fenugreek seed and jamun seed extract treated groups and in the standard drug metformin treated group were decreased compared to Diabetic group, these groups also showed significant changes when compared with control. The changes in Hb, HbA<sub>1c</sub> level in the herbal formulation treated group was similar to control. The percentage increase of Hb (18.75%), and decrease of HbA<sub>1c</sub> (50.7%) in herbal formulation FFJ treated group was higher than the percentage increase of Hb (16.51%, 15.98%, 17.04%) and decrease of HbA<sub>1c</sub> (36.7%, 46.6%, 46.9%) in flaxseed extract, fenugreek extract and jamun seed extract treated groups.

**Discussion:**

The result of the present study shown flax seed, fenugreek, jamun seed extracts and herbal formulation FFJ reduces blood glucose, blood lipids, HbA<sub>1c</sub>, and increased plasma insulin and HDL cholesterol level. This indicating that the bioactive compounds present in these drugs might be responsible for the changes occur in glucose and lipid levels. The increase in HbA<sub>1c</sub> level is one of the common indicator of hyperglycemia. Treatment with herbal formulation and their individual drugs significantly reduces HbA<sub>1c</sub> which might be due to improved glycemic control by the treatment. The presence of bioactive constituents of flaxseeds have the potential of reducing the various diseases such as cardiovascular ailments, strokes, diabetes, cancer etc. evidences shows that SDG in the flax seed has the ability to prevent or delay the the development of type I and II diabetes in diabetes-prone rats, probably by decreasing lipid level and oxidative stress. It was observed that 4-hydroxyisoleucine in the fenugreek seeds has insulin tropic activity which exert hypoglycemic
effects by stimulating glucose-dependent insulin secretion from pancreatic beta cells, as well as by inhibiting the activities of alpha-amylase intestinal enzyme involved in carbohydrate metabolism. Studies also reported that an impaired secretion and sensitivity of insulin may be responsible for high triglycerides level as the insulin stimulated the synthesis of adipose tissue by lipoprotein lipase. The sapogenins in the fenugreek decrease the triglycerides and total cholesterol level by increasing biliary cholesterol excretion. Jamun Seeds contain glycosides, an alkaloid- jambosine, gallic acid, ellagic acid, corilagin and related tannins. The β-sitoterol and jambulin in syzygium cumini prevent the drastic conversion of starch into sugar. The reduction of body weight in diabetic rats observed in this study may be due to muscular atrophy and loss of tissue proteins and it is reversed by treatment with herbal formulations and their individual drugs this could be due to increased sensitivity of the cell to insulin that prevent protein catabolism. This study also shows hypolipidemic and hypoglycemic activity of the herbal formulation FFJ was more pronounced than the individual drugs this proved the synergetic activity exist between the active phytochemicals present in the individual drugs.

**Conclusion:** The Hydroalcoholic extract of the Herbal Formulation FFJ exert synergism in glucose and lipid lowering activity than the individual extracts in diabetic induced animals. It will be a effective alternative for treating diabetes mellitus than the individual drugs when they are used alone. Even though the synergetic activity exists between the individual drug extract when given combinely the exact mechanism of action is not known. So further study is recommended to elicit the exact mechanism.

**References:**


43. Tim Kr. Herbal support for diabetes management, Adva Nutr Public, 1998; Vol. 6, No. 8.


**Corresponding Author:**

S.Latha*,

**Email:** lathaviji.kumar@gmail.com