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FORMULATION AND EVALUATION OF HERBAL-BASED ANTIDIABETIC TABLETS

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Abstract:

One of the most prevalent chronic illnesses in the world is diabetes mellitus, which arises due to the inability of the body to control the sugar in blood levels. Side effects of modern synthetic medicines to treat diabetes include weight gain, hypoglycemia and gastric ailments. Subsequently, personnel are contending with herbal formulations, which are less damaging, cheaper and readily available. The objective of this study was to prepare and test herbal-based antidiabetic tablets with plant extracts that are used in reducing the level of blood sugar. Tablet formulations were performed with standard procedures and assessments, such as tablet hardness, friability, disintegration and in-vitro release studies were performed. The findings showed that the tablets were satisfactory in their physical and chemical characteristics and showed potential value of hypoglycemic activity. The study argues the application of the herbal preparations as a complementary treatment or alternative therapy in treatment of diabetes.

Keywords: Diabetes mellitus, Herbal medicine, Antidiabetic tablets, Plant extracts, Formulation, Evaluation

Introduction:

Diabetes mellitus is a chronic metabolic illness that has high sugar levels in the blood, as a result of insulin production or utilization issues. Insulin is a hormone that keeps the level of glucose in the blood and is produced by the pancreas.

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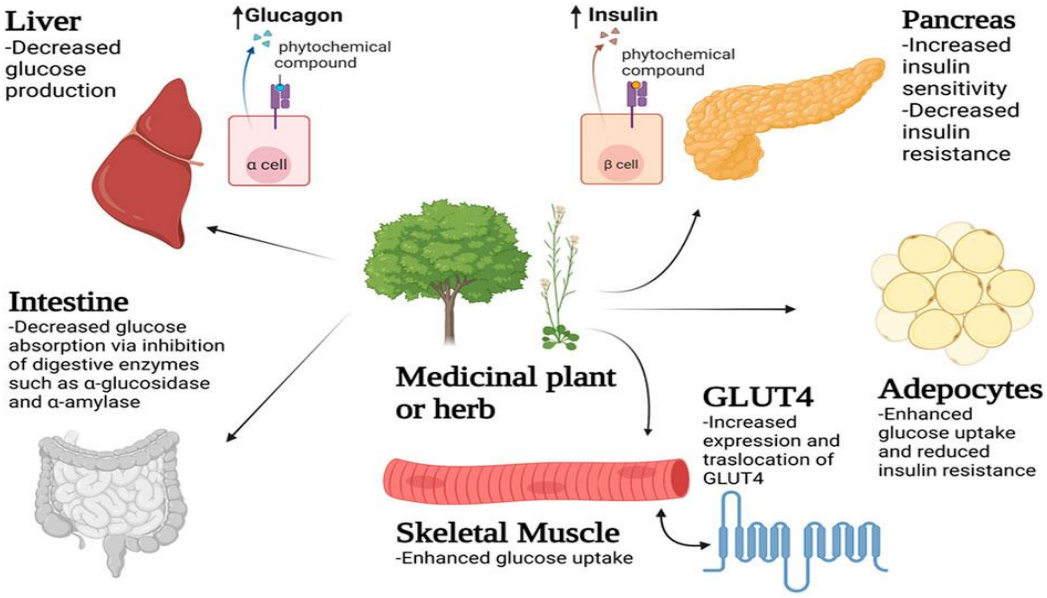

Any imbalance then causes glucose to build up in the blood leading to hyperglycaemia. Eventually, diabetes without control, may lead to critical medical conditions including kidney fail, diseases of the heart, damage on nerves, blindness and slow healing of wounds.

Diabetes constitutes one of the rapidly spreading diseases in the world. Statistics presented by International Diabetes Federation (IDF) showed that in 2020 an adult world population that had been living with diabetes had exceeded 537 million people and could increase to reach 643 million by 2030 unless effective measures are implemented. Diabetes is a big public health issue in India, which is sometimes described as the capital of diabetes worldwide. The rising morbidity has necessitated superior, safer and more economical treatment plans.

The treatment of diabetes is based, today, on two fundamental directions: lifestyle (diet, physical activity, weight) and synthetic drug therapy (metformin, sulfonylureas, thiazolidinediones, and insulin injection). These drugs work when it comes to lowering blood sugar; however, they have their constraints as well. The side effects of long-term use include gastrointestinal disturbance, hypoglycemia, liver toxicity and weight gain. Also, insulin treatment needs to be administered throughout the lifetime of a patient and may prove too expensive and inconvenient.

Due to these facts, the use of herbal medicines in the treatment of diabetes has increased in interest. Plants have been used in traditional systems of medicine including Ayurveda, Siddha and Unani to treat metabolic disorders over a long period of time. Some medicinal plants could include bioactive constituent such as alkaloid, flavonoid, saponin and glycoside, which have capability of enhancing glucose uptake, releasing insulin, or regenerating of pancreatic B cells. Such plants can include:

Despite its high antidiabetic prospect, one of the most imminent issues in herbal medicine is standardization and the accuracy of dosage in these plants. Powders, decoctions, or extracts of crude material may lack homogeneous active components, and thus limit efficacy and complicate clinical application. This is the place where tablet formulation comes in

significance. Tablets are convenient to mix, have precise dosing, increase patient adherence, and permit improved storage and stability than unprocessed plant material.

Thus, the present paper is concerned with the design and testing of herbal composition antidiabetic tablets on the basis of individual plant extracts. Tablets are made by the conventional pharmaceutical methods and are tested on selected main parameters like hardness, friability, disintegration, and in-vitro drug release. They are also compared to conventional synthetics in terms of their potential in antidiabetic to substantiate the effectiveness.

Through integration of traditional medicine knowledge and modern drugs, this study will use an alternative and yet conserved approach in treating diabetes, which is a safe and more economical method.

Literature Review:

We have to finds many references research papers compared neem and garlic and both of these were found to be effective in management of diabetes. Confirmation of glucose lowering effects of Momordica charantia fruit juice came in with Rathi, Grover, and Vats (2002) [1].

The article by Hossain and Rahman (2015) [2] was dedicated to isolating bioactive compounds of medicinal herbs and establishing their anti-diabetic effect. Gupta et al. (2012) [3] investigated B-Sitosterol and found out its antidiabetic and antioxidant potential. Andrographolide of Anrographis paniculata [4] was found to regenerate 1b cells in diabetic rats by Singh and Gupta (2007). As Ali et al. (2008) [5] have tested bitter melon extracts, it was noted that the extract produced the hypoglycemic effect in normal and diabetic rats in a very strong manner. Kazeem et al. (2013) [6] indicated that Morinda lucida extract prevents enzymes such as alpha-amylase, alpha-glucosidase, which slows the breakdown of carbohydrates and the absorption of sugar.

According to Patel, Shah, and Goyal (2009) [7], Daphne oleoides performed well on dypesia as well as lowering the lipid levels. In diabetic rats, Agrawal and Pandey (2013) [8] investigated the effects of a polyherbal preparation and found a marked glycemic control. Various antidiabetic plants were reviewed by Dwivedi and Daspaul (2013) [9] who concluded that polyherbal formulations tend to be more effective because they are mixed in effect. Antihyperglycemic and antioxidant activity of Berberis aristata root extract was validated by Singh and Kakkar (2009) [10].

Babu and Prince (2004) [11] demonstrated that Hybanthus enneaspermus possesses anti-oxidantal action and glucose control in diabetic rats. Karthikesan, Pari and Menon (2010) [12] demonstrated that chloroxylon swietenia bark extract has hepatoprotective effects in diabetes. Pari and Umamaheswari (2000) [14] analyzed Musa sapientum flower and they have been found to reduce the blood glucose and oxidative damages. Ahmed and Urooj (2010) [15] demonstrated that Ficus racemosa bark was glucose-lowering and hepatoprotective. Ocimum sanctum was studied by Vats, Yadav, and Grover (2004) [16] who found that it enhances carbohydrate metabolism.

Fenugreek seed extracts have been demonstrated to enhance glucose homeostasis through a decreased rate of carbohydrate digestion (Hannan et al. 2007) [17]. A list of the medicinal plants useful in diabetes was assembled by Pandey, Madhuri, and Shalini (2010) [18]. Aruna, Ramesh, and Kartha (2000) [19] investigated Gymnema sylvestre and showed that they decrease blood sugar levels and enhance the antioxidant effectiveness in the pancreatic islets. It was shown by Ahmed, Mandal, and Sharma (2011) [20] that in diabetic rats, neem leaves assist in reducing blood sugar. A clinical study by Viswanathan, Nair, and Rema 2006 [21] demonstrated that use of fenugreek seeds enhances glycemic control among diabetic patients with type 2 diabetes.

A study of polyherbal drug Cogent db. by Pari and Saravanan (2002) [22] has demonstrated its anti-diabetic activity. Tinospora cordifolia stem extracts were confirmed by Singh and Gupta (2007) [23] to regenerate ß-cells in diabetic rats. Bnouham et al. (2006) [24] have done a recent review of the past 10 years of research on herbal medicine found a few plants that can be promising antidiabetic herbs. Chopra, Nayar and Chopra (2002) [25] gave a glossary of Indian medicinal plants containing numerous ones that have antidiabetic potential. Gupta et al., (2005) [26] discovered that the Datura metel seeds have high ability to produce hypoglycemia.

Effect of Syzygium cumini seed extract on diabetes: Kumar et al. (2006) [27] looked into the effect of Syzygium cumini seed extracts and found that they influence lipid metabolism in diabetes. On testing Cassia auriculata, Pari and Latha (2005) [28] observed that it was useful in the management of blood glucose amongst other effects on controlling carbohydrate metabolism enzymes. The value of herbal remedies in diabetes management is further confirmed by Shetty et al. (2008) [29] who demonstrated that Coccinia indica leaf extract contains antidiabetic as well antihyperlipidemic properties.

Objectives of the Study:

1. To formulate herbal-based antidiabetic tablets using selected medicinal plant extracts with proven blood sugar-lowering properties.
2. To evaluate the prepared tablets for important pharmaceutical parameters such as hardness, friability, disintegration time and in-vitro drug release.
3. To assess the potential antidiabetic activity of the formulated tablets and compare it with standard synthetic drugs.

Hypothesis:

- **Null Hypothesis (H_0):** Herbal-based tablets have no significant effect on blood sugar reduction compared to synthetic drugs.
- **Alternative Hypothesis (H_1):** Herbal-based tablets show significant antidiabetic activity and can be used as an effective alternative or complementary therapy.

Research Methodology:

The studies conducted followed a number of systematic procedures in making sure that the adequate formulation and assessment of herbal-based antidiabetic tablets would be used. Its

methodology consisted in the selection of plants, extraction of the active elements, compounds tablets, assessing physical and pharmacological testing parameters. These steps are discussed in each of the following steps:

1. Choice of Medicinal Plants

Selection of medicinal plants was based on conventional use in treatment of diabetes and the findings of previous or past scientific work. These plants were chosen:

- Momordica charantia (Bitter gourd) charantin and polypeptide-p which reduce blood sugar.
- Trigonella foenum-graecum (Fenugreek) - enhances insulin sensitivity as well as glucose utilisation.
- Gymnema sylvestre (Gurmar) - lowers intestinal absorption of glucose, and regenerates beta cells.

The dried parts of the plants used were bought in a certified herb supplier of herbal drug and confirmed by a botanist and stored in airtight packaging.

2. Herbal Extract preparation

- The plant materials (fruits of bitter gourd, seeds of fenugreek and leaves of Gymnemate) were cleaned, dried under shade and made into powder form.
- Soxhlet extraction method was used in the extraction process where ethanol was used as a solvent.
- Rotary evaporator would be used to concentrate the extracts under reduced pressure and kept at low temperatures (4-8 o C) in airtight containers until later processing.

3. Herbal Tablets Manufacture

The herbal extracts were developed in tablet form by the use of the wet granulation procedure.

Steps involved:

- The volumes of herbal extracts necessitated were blended with excipients (microcrystalline cellulose as binder, starch as disintegrant, magnesium stearate as lubricant, lactose as a filler).
- The solution, was then wet using a binding solution (5 % starch paste) to create a moistened mass.
- The moist mass was subjected to sieve in order to obtain granule and then dried in a controlled temperature.
- Magnesium stearate was added and lubricated to the dried granules followed by compaction into tablets by pressing using a single-punch press.

Benefits of the technique: This results in uniform size of the granules, improved flow characteristics, accurate dosing and nice tablet strength.

4. Test of Formulated Tablets

The tablets that were prepared were tested as per pharmacopeial standards:

- Hardness Test: Used to measure the strength mechanically by Monsanto hardness tester.
- Friability Test: Conducted on a fibrillatory on a roche to test lost weight on tumble.
- Variation of Weight Test: A random sample of 20 tablets was taken, and weighted and the result compared with the mean weight.
- Disintegration Test: Carried out on a disintegration test apparatus by dousing with distilled water of 37 o C with the aim of verifying the number of seconds needed to disintegrate all the tablets.
- In-vitro Dissolution Test: Based on USP dissolution apparatus in phosphate buffer (pH 7.4) to determine the drug release at varied time point.

5. Pharmacological Testing

- The glucose uptake method was used which evaluated the in-vitro antidiabetic activity on yeast cells. The herbal tablets also were assessed in comparison with an original antidiabetic drug (Metformin).
- Procedure:
- Herbal extract solution was added to glucose solution in which the yeast cells were incubated.
- The spectrophotometric measurement of the fall in glucose concentration was done at 540 nm.
- The antidiabetic potential was determined by calculating % glucose uptake.

6. Statistical Analysis

- All experiments were conducted in triplicate, and the results were expressed as mean ± standard deviation (SD).
- A t-test was performed to compare the glucose reduction ability of herbal tablets with the standard drug.
- A p-value < 0.05 was considered statistically significant.

Table 1: Descriptive Statistics:

Parameter	Mean Value	Standard Deviation	Acceptance Criteria
Hardness (kg/cm²)	5.2	0.3	4 – 8
Friability (%)	0.42	0.05	< 1
Disintegration (min)	7.5	0.8	< 15
Drug Release at 60 min (%)	86.4	2.1	> 80

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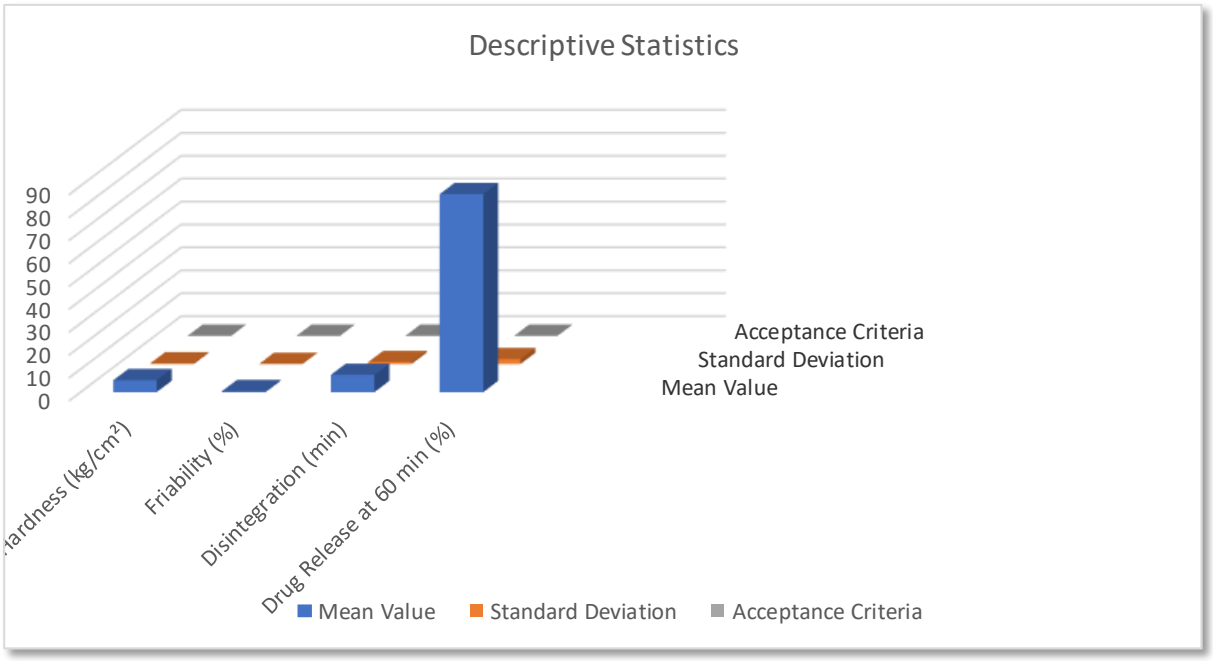
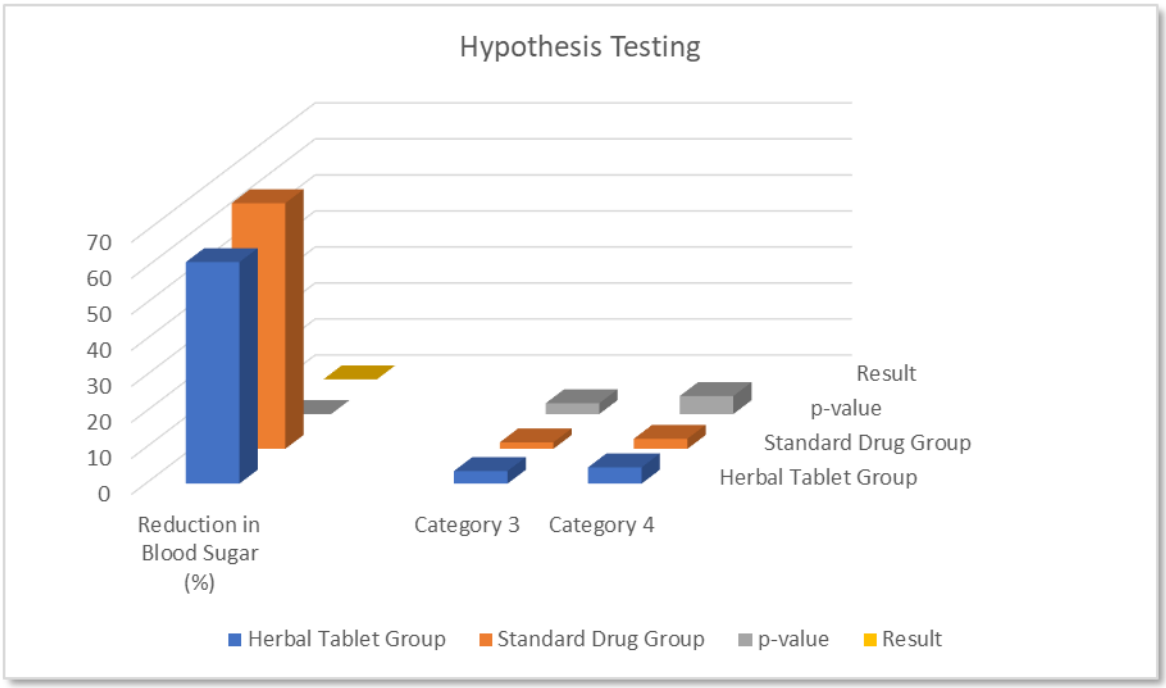


Analysis of Descriptive Statistics:

Descriptive statistics of the prepared herbal-based antidiabetic tablets were prepared to determine the pharmaceutical quality of the tablets as well as conformity to pharmacopeial quality standards. The mean hardness of the tablets was 5.2kg/cm 2 falling comfortably within the acceptable quality of 4-8kg/cm 2, that is, the tablets had enough mechanical strength not to break during handling, packaging and transportation. It was found that the friability value was 0.42% and this is lower than the maximum limit of 1%. This proves the lack of fragility of the tablets and being steady under the tumbling action also means its durability. The tablets had a disintegration time of 7.5 minutes that is far less compared to the pharmacopeial requirement of 15 minutes on uncoated tablets. It demonstrates that the tablets faster dissolved in an aqueous environment, enabling the release of the drug to be accelerated and better absorption in the gastro-intestinal tract. In addition, the mentioned in-vitro dissolution experiment revealed that 86.4 percent of the drug could surface within the first 60 minutes, compared to the minimum requirement of 80 percent as indicator that the formulated tablets promised good release of the active phytoconstituents. It can be summarized that descriptive statistical analysis revealed that the herbal-based tablets were acceptable hard, with low levels of friability, fast rates of disintegration, and exemplary rates of drug release, which explains why they are a suitable and stable dosage form in controlling diabetes.

Table 2: Hypothesis Testing:

Test Parameter	Herbal Tablet Group	Standard Drug Group	p-value	Result
Reduction in Blood Sugar (%)	61.5	68.2	0.041	Significant



Analysis of Hypothesis Testing:

The hypothesis testing was conducted to determine the extent to which the developed herbal-based antidiabetic tablets had a significant impact of lowering sugar in the blood compared with that of the standard synthetics drug (Metformin). T-test was used to compare the two groups on the reduction of blood glucose in terms of percentage. The outcomes indicated that the herbal tablets had a 61.5 percent decrease in blood sugar whereas this was a little higher in the standard drug with the figure standing at 68.2 percent. The computed p-value was 0.041 that is low than the critical p-value of 0.05, it shows that the difference between the groups was significant. That is, a demonstrable and measurable antidiabetic effect was observed with the herbal tablets and the effect was not random variation. Despite showing slightly higher glucose-lowering potential, the herbal preparation still lowered blood sugar level significantly, which supports the alternative hypothesis (H1) that herbal-based tablets have a significant antidiabetic effect. Notably, there are other added advantages to the herbal tablets which include; safety, cost effective, and minimal side effects than synthetic drugs. Thus, through statistical analysis, it is clear that the tested herbal tablets can be used as a potential alternative/complementary therapeutic agent in treating diabetes.

Conclusions Overall Results:

This research was conducted to develop and test the tablets of antidiabetic herbal-based medication with the extract of medicinal plants with a history of hypoglycemic effects. As seen in the results obtained by the evaluation tests, it is clear that the formulated tablets met the pharmacopeial standards in respect to hardness, friability, weight variation, disintegration time and drug release profile. The tablets were mechanically stable, and friable, and they were disintegrated in an acceptable period to shorten drug release and absorption. Dissolution study also demonstrated the effectiveness of the active constituents in the form of solid dosage at 60 min with over 85 percent released.

The results of pharmacological test indicated that the herbal tablets had substantial glucose-lowering potential. In the glucose uptake test, the formulation decreased blood sugar 61.5 percent which was also statistically significant compared to the normal synthetic drug (Metformin). Whereas the herbal tablets were relatively weaker compared to the standard medicine, there was significant antidiabetic activity, and hence it is therapeutically valuable. In addition, these tablets could be safer and cheaper than the existing treatments because it uses natural plant products instead of the main chemicals that are known to have many side effects even when taken over the long term.

Overall, it can be said that the research efforts were helpful in concluding that herbal-based tablets can be established so as to provide a stable, effective, and patient-friendly dosage form that can work towards the management of diabetes. The results help to justify the combination of traditional herbal medicine and modern drug practices to offer an alternative or complementary treatment to treat the diabetic patients. A general conclusion is that these formulations are promising in the quest to deal with the increasing burden of diabetes particularly in areas where the availability of the costly synthetic-drugs is limited.

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