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FORMULATION AND EVALUATION OF POLYHERBAL TABLET FOR MANAGEMENT OF DIABETES MELLITUS

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Abstract: The main objective of this project is to formulate and evaluate polyherbal anti-diabetic tablet with enhanced disintegration time.The polyherbal tablet consist of five traditional herbs Gurmar (Gymnema sylvestre), Karela (Momordica charantia), Tulsi (Ocimum sanctum), Ginger (Gingiber officinate), Cinnamon (Cinnamum zelacicum). In the formulation the Gurmar (leaf powder dry) , Karela (dry fruit powder) , Tulsi (dry leaf powder), Ginger (dry root powder) , and Cinnamon (bark powder) were used. The polyherbal tablets were prepared by wet granulation method with excipients: Gum Acasia, Polyvinylpyrrolidine, Aerosil, Talc, and Magnesium Stearate.. The preliminary phytochemical analysis of powder mixture was done using the methanolic extract of powder mixture. The preformulation studies of tablets were performed including Angle of repose, tapped density, bulk density, carr's index, hausner's ratio. The dried polyherbal remove was streamlined for its quality measures and its cluster consistency by making 5 diverse preliminary clumps(Trial 1,2,3,4,5). The preliminaries were exposed to preformulation boundaries to confirm the consistency and quality. The outcome assumes that the initial **five** formulations demonstrated across all parameters, and were therefore utilized to create a detailed polyherbal tablet formulation. The developed polyherbal phytochemical study showed the presence of flavonoids, alkaloids, tannin, phenolic compound in the formulation by using phytochemical analysis. The laboratory scale preparation of polyherbal tablet can lead to new powerful and oral dosage formulation for diabetes mellitus and lighten by synergic area of action herbs.

I. INTRODUCTION

1.1 INTRODUCTION TO DISEASE

1.1.1 Diabetes mellitus

India is known as “Diabetes capital of world” because it has a very high number of people suffering from diabetes. Diabetes Mellitus(DM) is a systematic metabolic disorder which is characterized by hyperglycemia, insulin resistance, and insulin deficiency with the disturbance and impaired carbohydrate ,fats and protein metabolism. The incidence of DM is rapidly increasing worldwide leading to severe complications like neuropathy, nephropathy, retinopathy, cardiovascular disease and according to current reports about 90% of young indians are developing type 2 diabetes due to sedentary lifestyles, unhealthy diet and inadequate physical activity[1 to 4]. The plants have been used for medicinal purposes since 5000 years. In fact, about 70-90% population in developing countries still rely on traditional plant-based medicines. The most impactful and promising elements are the secondary metabolites present in the plant. These secondary metabolites are molecules or micromolecules biosynthesized in plant,including alkaloids, glycosides, tannins,etc. These secondary metabolites have a variety of beneficial therapeutic uses for humans, such as antiallergics, antitumor, antioxidants, anti-inflammatory and antidiabetic activity. There is a longer collection of plants with the antidiabetic potential and some of them are scientifically proven and many more have yet to be explored and tested. Herbal medicines are used in treating diabetes mellitus has become more popular throughout the world.The WHO has also suggested and authorized this, particularly in the countries where access to treating diabetes is not enough. There is widespread interest in using natural products to manage diabetes due to side effects of conventional insulin and oral hypoglycemic agents. The available literature shows that there are more than 400 species of plants that show hypoglycemic activity[9 to16].

1.1.2. Symptoms of diabetes mellitus

It is crucial for pharmacists to have a thorough understanding of the typical signs and symptoms associated with diabetes, as patients often seek assistance at community pharmacies for such issues.

In individuals with Type 1 diabetes, the disease typically begins suddenly and is characterized by significant weight loss (even with increased food intake), extreme tiredness, excessive thirst (polydipsia), and frequent urination (polyuria). Such patients require urgent medical referral due to the risk of acute metabolic decompensation, often necessitating hospitalization.

In contrast, Type 2 diabetes generally presents with milder symptoms, including fatigue, polyuria, and frequent urinary and veginal infections. The onset of Type 2 diabetes is usually gradual, and the classic symptoms may not be immediately noticeable. Consequently, diagnosis often occurs only after complications have developed. It is essential to promote early screening, particularly among high-risk individuals, focusing on measuring fasting and random blood glucose level [60].

1.1.3. Causes of Diabetes Mellitus

An increase in body weight is strongly linked with a higher risk of developing diabetes among the population. A decline in pancreatic beta cell function is a key factor in the gradual progression of type 2 diabetes. Factors such as aging, obesity, poor energy consumption, alcohol intake and smoking are recognized as independent risk factors involved in the development of type 2 diabetes mellitus.

Habits like overeating, smoking, excessive alcohol use, disruption in the nervous and endocrine systems, elevated cortisol levels, hormonal imbalances, reduced energy usage due to inactivity, and genetic

predispositions like aging, are all associated with the onset of diabetes mellitus(DM).

As indicated by elements such as aging, obesity, inadequate energy intake, smoking, and alcohol consumption significantly contribute to the pathogenesis of both type 1 and type 2 diabetes mellitus [61].

1.1.4. Complications

Persistent elevation of blood glucose levels over extended periods can lead to serious complications, resulting in dysfunction and eventual failure of various organs, notably the eyes, kidneys, nerves, heart, and blood vessels.

Chronic or irreversible complications arising from diabetes mellitus include vision loss due to eye abnormalities, kidney dysfunction, and peripheral nerve damage leading to organ impairment. Additionally, diabetes can effect the autonomic nervous system, causing irregular functioning of the gastrointestinal tract, urinary system, and cardiovascular system. Individuals with diabetes also face a heightened risk of developing atherosclerotic cardiovascular disease, peripheral artery disease, and cerebrovascular disorders. Further more conditions like hypertension and disruption in lipid and protein metabolism are frequently observed among diabetic patients.

1.1.5 Pathophysiology of Diabetes Mellitus

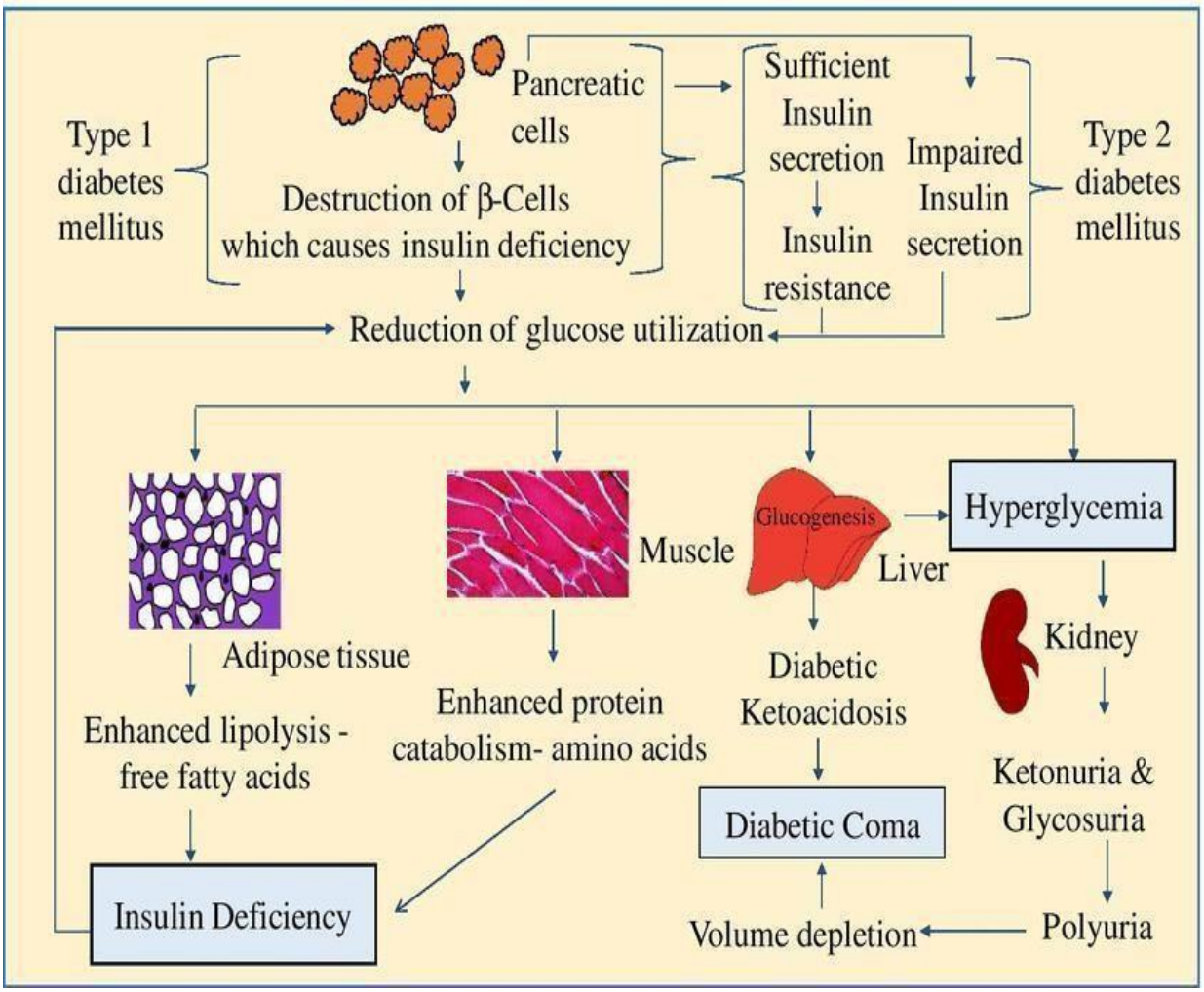

Figure 1.1 Pathophysiology of Type 1 and Type 2 Diabetes Mellitus (DM)

1.1.6 Analysis of Diabetes Mellitus

According to the World Health Organization (WHO) guidelines, diabetes mellitus can be diagnosed based on the following criteria:

1. A fasting blood glucose level exceeding 7.8 mmol/L, ideally confirmed on two separate occasions, or a random blood glucose measurement greater than 11.1mmol/L, also verified twice.
2. A blood glucose level of 11.1 mmol/L or higher two hours after an oral glucose tolerance test (OGTT). If the two-hour glucose value falls between 7.8 and 11.1 mmol/L, the individual is classified as having impaired glucose tolerance (IGT). This condition indicates and an increased likehood of developing atherosclerotic cardiovascular disease.

1.1.7 Management of Diabetes Mellitus

Effective diabetes mellitus management relies heavily on patient education and dietary adjustments, both of which are essential for successful treatment outcomes. Additional interventions include the use of oral hypoglycemic drugs and insulin therapy. In patients with type 2 diabetes who do not adequately respond to diet modifications alone, second-generation sulfonylureas are generally the treatment of choice. For significantly obese type 2 diabetics, biguanides may be prescribed, provided there are no contraindications. In cases where insulin is necessary, such as type 1 diabetes, human insulin formulations are preferred due to their minimal antibody response. Maintaining tight glycemic control-monitored through home glucose testing, glycosylated hemoglobin (HbA1c) levels, or fasting glucose levels in type 2 diabetes helps prevent acute symptoms and diabetic coma, and also reduces the risk of long- term vascular complications.

1.2 INTRODUCTION TO POLYHERBAL TABLET

A Polyherbal tablet is a pharmaceutical formulation that combines two or more different herbs into a single dosage form, typically a tablet. These tablets are often used in traditional medicine systems and are also gaining recognition in modern medicine as complementary or alternative therapies.

The combination of multiple herbs (polyherbal) in specific properties can produce the desired therapeutic effects, as the active phytochemical components of individuals plants may not be sufficient on their own to achieve optimal benefits. Polyherbal formulations, consisting of two or more herbs with either similar or different therapeutic properties, work synergistically to enhance the management of various human disease. These formulation have gained significant popularity due to their broad therapeutic window, being effective even at lower doses and remaining safe at higher doses, while also causing minimal side effects even in cases of misuse.

1.2.1 Advantages of Diabetes Mellitus

1. Wider Therapeutic coverage:

Polyherbal formulations can effectively target a broader spectrum of health conditons due to the presence of various biologically active contituents from different medicinal plants.

2. Improved effectiveness:

The combined use of herbs often results in a synergistic effect, where their joint action surpasses the effectiveness of each herb used individually.

3. Minimized adverse effects:

By incorporating herbs with complementary actions, polyherbal formulations may help reduce the risk of side effects through mutual balancing of their pharmacological properties.

4. Synergistic interactions:

The herbs within a polyherbal blend can interact in a way that amplifies their therapeutic benefits. For instance, certain herbs may enhance the absorption or bioavailability of others, or contribute distinct mechanisms of action that collectively improve treatment outcomes.

5. Economic advantage:

These formulations may offer a more economical alternative compared to using several single -herb remedies separately.

6. Ease of use:

Polyherbal combinations offer a simplified and user friendly dosage form, making them a practical option for managing a variety of health conditions.

II. LITERATURE REVIEW

2.1 Literature review

2.1.1. Literature Review related to diseases

1. American Diabetes Association (2014)

According to the American Diabetes Association (2014), diabetes mellitus is a group of metabolic disorders marked by chronic hyperglycemia due to defects in insulin secretion, insulin action, or both. Over time, sustained high blood sugar levels lead to significant damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels.

2. Forbes and Cooper (2013)

Forbes and Cooper (2013) reported that oxidative stress plays a pivotal role in the development and progression of diabetic complications. Elevated glucose levels increase the production of free radicals, causing cellular injury and inflammation, which contribute to complications such as nephropathy, retinopathy, and neuropathy.

3. Chawla et al. (2016)

Chawla and colleagues (2016) explained that Type 2 diabetes mellitus results largely from insulin resistance combined with relative insulin deficiency. Lifestyle factors like obesity, lack of physical activity, and unhealthy dietary patterns are major contributors to the increasing incidence of Type 2 diabetes across the globe.

4. Tripathi and Srivastava (2006)

Tripathi and Srivastava (2006) highlighted that medicinal plants have been traditionally used for managing diabetes, offering therapeutic effects through multiple mechanisms such as stimulating insulin secretion, enhancing peripheral glucose uptake, and protecting pancreatic beta cells against oxidative damage.

5. Marles and Farnsworth (1995)

Marles and Farnsworth (1995) stated that over 800 plant species have been reported to possess antidiabetic properties. The interest in plant-based treatments has grown due to the limitations of synthetic drugs, including side effects, high costs, and decreasing patient compliance.

2.1.2. Literature Review related to Drug

1. Persaud et al. 1999

Gymnema slylvestre is reffered to as “Gurmar”, meaning “Sugar destroyer”, owning to its ability to suppress the sweet taste sensation and modulate carbohydrate metabolism. The primary active constituents, gymnemic acids, are responsible for inhibiting glucose absorption in the intestine and regenerating pancreatic beta cells .

2. Tiwari et al., 2014

Animal studies and clinical trials have shown that gymnema increases insulin secretion and decreases fasting blood glucose levels .

3. Shanmugasundaram et al., 1990

It also enhances insulin sensitivity and may help reduce insulin dependency in type 2 diabetes.

4. Joseph & Jini, 2013

Bitter gourd contains charantin, vicine, and polypeptide-p, all of which have been associated with glucose lowering properties. These compounds exert insulin like effects, improve glucose uptake, and inhibit enzymes involved in carbohydrate digestion.

5. Grover yadav,2004

In clinical settings, Karela has demonstrated significant reductions in blood glucose and improvement in glucose tolerance. Its antioxidants properties also help protect pancreatic tissue.

6. Chandrasekaran et al., 2008

Tulsi also known as holy basil, is known for its adaptogenic and anti-hyperglycemic effects. The herb contains eugenol, ursolic acid, and various flavonoids that stimulates insulin secretion and reduce insulin resistance.

7. Khan et al., 2003

Cinnamon is rich in cinnamaldehyde and polyphenols that act by enhancing insulin receptor activity and increasing glucose uptake in peripheral tissues.

8. Al-Amin et al., 2006

Ginger contains gingerols and shogaols which improve glucose uptake and enhance insulin sensitivity.

2.1.3. Literature Review related to Polyherbal Tablet

1. Patel et al. (2012),

combining multiple herbs enhances therapeutic efficacy and minimizes the dose of individual components, leading to better patient compliance and safety. Their study emphasized that polyherbal therapy offers a comprehensive approach by targeting different pathophysiological factors associated with diabetes.

2. Gupta et al. (2014)

highlighted that medicinal plants like Gymnema sylvestre (gurmar), Momordica charantia (karela), Ocimum sanctum (tulsi), Zingiber officinale (ginger), and Cinnamomum verum (cinnamon) possess distinct antidiabetic mechanisms, such as stimulating insulin secretion, enhancing glucose uptake, and modulating carbohydrate metabolism enzymes. When combined, these herbs provide a multi-faceted control over blood sugar levels.

3. Saini et al. (2015),

the formulation of polyherbal tablets demonstrated improved pharmacological activity compared to single-herb preparations. Their work supported the idea that polyherbal combinations could produce a synergistic effect, enhancing antioxidant status, β-cell regeneration, and insulin sensitivity.

4. Bnouham et al. (2006)

also reported that polyherbal therapies could simultaneously target insulin resistance, oxidative stress, and impaired β-cell function, making them more effective than monotherapy in diabetes management. They concluded that herbal combinations can provide better glycemic control and offer additional benefits such as lipid profile improvement.

5. Rao and Gopi (2017)

discussed the advantages of using polyherbal formulations in tablet form. They suggested that tablets ensure accurate dosing, improve stability, and enhance patient compliance, especially important for chronic conditions like diabetes where long-term therapy is needed.

III. AIM AND OBJECTIVE

3.1 AIM

Formulation and evaluation of polyherbal tablet for management of diabetes mellitus

3.2 OBJECTIVE

- The main objective of this project is to formulate and evaluate a polyherbal antidiabetic with enhanced disintegration time.
- To provide a holistic approach to managing diabetes by leveraging the synergistic effects of these natural ingredients.
- Combine therapeutic effect of multiple herbs in single dosage form.
- Patient convenience and compliance.

MATERIAL AND METHODOLOGY

4.1. Materials used in these research work

4.1.1 Gymnema slylvestre

Gymnema slylvestre belongs to the Asclepiadaceae family, commonly known as ‘Gurmar’ or ‘Sugar destroyer’ is a woody, climbing traditional medicinal herb which has many therapeutic applications in ayurvedic system of medicine. It is used to lower the cholesterol , triglycerides and blood sugar level. It’s flowers , leaves, contains the alkaloid, flavones, saponins, sapogenins, anthraquinone, resins, tartaric acid,formic acid, butyric acid, lupeol and having main principle bioactive compound viz. Gymnemic acids, gymnemasides, gymnemagenin, gumarin, gymnamosides, gymnemanol, gymnemasins which act as therapeutic agent and play a vital role in many therapeutic applications. Gymnemic acids are thought to be responsible for its antidiabetic activity and it is the major component of an extract shown to stimulate insulin release from the pancreas. In gurmar another anti-sweet agent gumarin is utilized as pharmacological tool in sweet-taste transduction study.[17 to 19].

Figure 4.1: Gymnema slylvestre

4.1.2 Momordica charantia

Momordica Charantia also known as ‘Karela’ and ‘bitter melon’ has a long history of beneficial use as a food and hypoglycemic agents. The modern scientific studies analyses of its antidiabetic property shows that it has the capacity to regulate vitiated carbohydrate digestion, glucose metabolism and utilization possesses insulin mimetic and secretagogue activities and correct the impaired antioxidant defence in

diabetes. Momordica charantia contain the secondary metabolites such as alkaloids,flavonoids,saponins,triterpenoids and phenolic compounds. Momordica charantia also contains the bioactive compound polypeptide-p, a peptide with potential hypoglycemic effect[19, 20].

Figure 4.2: Momordica charantia

4.1.3 Ocimum Sanctum

Ocimum sanctum or Ocimum tanuiflorum belongs to the family of Lamiaceae. It is also known as holy basil or tulsi. It has the pharmacological properties such as antioxidant, anti- inflammatory, antidiabetic, antihypertensive, cardio protective, hepatoprotective and renoprotective. It is highly recommended and one of the most effective traditional plant to manage diabetes. Extract of tulsi leaf has been shown to enhance the insulin secretion from isolated islets, perfused pancreas and clonal pancreatic beta cells and thus possess antihyperglycemic property[21, 22].

Figure 4.3: Ocimum Sanctum

4.1.4 Cinnamomum Zeylanicum

Cinnamomum zeylanicum commonly known as dalchini belongs to the family pf lauraceae. It has been shown to exhibit insulin potentiating effect in glucose. Cinnamon control diabetes by insulin release and insulin receptor signaling. It is reported that it enhance the glucose uptake by activating the insulin receptor kinase, Auto phosphorylation of the insulin receptor and glycogen synthase activity[23, 24].

Figure 4.4: Cinnamomum Zeylanicum

4.1.5 Zingiber Officinale

Zingiber officinale also known as ginger belongs to the family of Zingiberaceae. It is most consumed used spices worldwide. The recent evidence revealed the potential of ginger for treatment of diabetes mellitus. The mechanism of actions are associated with the insulin release and action, and improved carbohydrate and lipid metabolism. The active ingredients in ginger which are responsible for antidiabetic property are gingerols and shogaol. Ginger has shown the prominent protective effect of the diabetic liver, kidney, eye and neural system complications. The phytochemical studies on the part of plant showed the presence of bioactive compounds such as alkaloid, flavonoids, saponins, triterpenoids, glycosides, tannins, phenolic compounds and volatile oils[25, 26].

Figure 4.5: Zingiber Officinale

The present investigation was conducted for formulation and evaluation of polyherbal tablet containing the methanolic extract of Gymnema slylvestre, Momordica charantia, Ocimum sanctum, Cinnamomum zeylanicum, Zingiber officinale by wet granulation method for effective management of diabetes mellitus.

4.2 PREFORMULATION STUDY

The mixed powder of all five batches had been analysed for its waft traits like angle of repose, bulk density, tapped density, carr's index and hausner's ratio.The waft belongings of the herbal mixed powder is an vital parameter to be measured since it affects the uniformity of dose.

4.2.1 Angle of repose

To determine the angle of repose a precisely measured powder blend was poured in the funnel.The height of the funnel has been adjusted so that the tip of funnel touches the apex of powder blend. The powder was allowed to flow freely through the funnel to surface, forming a conc. The cone's diameter was measured and the angle of repose was calculated using the formula[33, 34, 44]:

$\mathbf{Tan\theta = h/r}$

Where, h= Pile height , r = Pile radius

Table 4.1: Angle of repose

Sr No.	Angle of repose	Type of flow
1	<25	Excellent
2	25-30	Good
3	30-40	Passable
4	>40	Poor

4.2.2 Bulk Density

The bulk density was determined by using a granulated cylinder with a pre-weighed powder blend and measuring the volume occupied. The bulk density was then calculated by dividing the weight of powder blend by the volume it occupied[36,37,45].

Formula: **pb = M/V**

Where, pb = bulk density, M = weight of powder,
V = volume of powder

4.3.3 Tapped Density

The tapped density was determined by pouring a powder blend into a granulated cylinder and tapping it on a hard surface until the volume no longer changed. The tapped density was calculated by dividing the weight of the powder blend by the final tapped volume[33,34,46].

Formula: **ρt = M/Vt**

Where, ρt = Tapped density, M = Weight of powder,
Vt =Minimum volume occupied after tapping

4.3.4 Carr's index

It is also known as the Carr's compressibility index, is a measure how easily a powder can be compressed and flow. Carr's index can be calculated using the bulk density and tapped density of a powder[33,34,47].

Formula: **Compressibility Index = 100× (ρ tapped - ρ bulk / ρ tapped)**

Table 4.2: Compressibility Index

Sr No	% Compressibility index	Type of flow
1	5-15	Excellent
2	12-16	Very good
3	18-21	good
4	23-25	Passable
5	33-40	poor
6	>40	Very poor

4.3.5 Hausner's Ratio

Hausner's ratio is size frictional resistance of the powder or granular material. It is the measure of powder flowability. It is calculated by dividing tapped density by the bulk density, with values closer to 1 indicating better flow properties and higher values suggesting poorer flowability[36,37,48].

Formula: **Hausner's Ratio = (ρ tapped /ρ bulk)**

4.3. Development of Formulation:

The wet granulation method and the appropriate excipients gum accacia, polyvinylpyrrolidone, aerosil, talc, magnesium stearate were used to prepare the polyherbal tablet which contains the methanolic extract of Gymnema slylvestre, Momordica charantia, Ocimum sanctum, Zingiber officinale, Cinnamomum zeylanicum.Five trial batches of the tablets had been formulated through various composition of ingredients proportion for excellent waft belongings.

Table 4.3: Development of Formulation

MATERIAL		F1	F2	F3	F4	F5
Herbal Extract	Gymnema slylvestre	120	120	120	120	120
	Momordica charantia	100	110	110	80	110
	Ocimum sanctum	100	90	100	100	110

	Zingiber officinale	80	80	90	90	60
	Cinnamomum zeylanicum	80	80	60	90	80
Excipients	Gum Acacia	5	5	5	5	5
	Polyvinylpyrrolido ne	5	5	5	5	5
	Aerosil	5	5	5	5	5
	Talc	2.5	2.5	2.5	2.5	2.5
	Magnesium stearate	2.5	2.5	2.5	2.5	2.5
Total Weight		500mg	500mg	500mg	500mg	500mg

4.4. Preliminary phytochemical analysis of extract

The following extracts are Gymnema slylvestre (dried leaves powder), Momordica charantia (dried fruit powder), Ocimum sanctum (dried leaves powder), Zingiber officinale(dried ginger powder), Cinnamomum zeylanicum(bark powder) subjected to preliminary phytochemical screening for detection of secondary metabolites and primary metabolites[27 to 29].

4.4.1. Preparation of extract

Using methanol as solvent the dried powders of the ingredients were Soxhlet-processed to prepare the extract.When the extraction process was complete the extract was concentrated and kept in a desiccator for later use [30, 31, 35].

4.5. EVALUATION OF POST COMPRESSION POLYHERBAL TABLET:

The post compression evaluation of tablets involved assessing various parameters, including:

4.5.1. General appearance

The general appearance of the tablets from all five formulation batch become observed. The general appearance parameters like size and shape, colour, presence or the absence of odour and taste had been evaluated[38,39].

4.5.2. Uniformity of weigh

Twenty tablets were randomly selected, weighed individually and their average weight was calculated. The percentage deviation was calculated and compared to standard specifications[40].

4.5.3. Thickness and Diameter

The diameter and thickness was measured to decide the uniformity of size and shape. The thickness and diameter of the tablets were measured using a vernier caliper[41].

4.5.4. Hardness test of tablet

The hardness of the tablet refres to the pressure needed to break the tablet, as measured by diametric compression test, also known as tablet crushing strength. To determine the hardness, the prepared formulations were evaluated using a Monsanto tablet hardness tester with the result expressed in units of kg/cm^2[41,42].

4.5.5. Friability

The friability of the formulated tablets was assessed using a Roche Friabilator. A pre-weighed sample of tablets was placed in the friabilator tester and subjected to 100 revolutions. After dust removal, the tablets were reweighed and the friability percentage was calculated using the formula[34,42,43]:

Friability (%) = (Initial weight - Final weight) / Initial weight × 100

4.5.6. Disintegration time

The disintegration time test was conducted to determine how long it takes for the tablet to break down in the body. This test assesses whether the tablet disintegrates within the specified time when submerged in a liquid medium under controlled experimental conditions. To perform the test, one tablet was placed in each of the six tubes of the basket, along with a disc, and then submerged in a 0.1N HCL solution maintained at 37°C[44,46].

V. RESULT AND DISCUSSION

5.1 Preliminary phytochemical analysis of extract

Table 5.1: Preliminary phytochemical analysis of extract

Sr. No	Phyto-constituents	Gymnema slylvestre	Momordica charantia	Ocimum sanctum	Zingiber officinale	Cinnamomum zeylanicum
1	Carbohydrate	(-)	(+)	(+)	(+)	(+)
2	Protein	(+)	(+)	(+)	(+)	(+)
3	Alkaloids	(-)	(-)	(-)	(-)	(-)
4	Phenolic	(+)	(+)	(+)	(+)	(+)
5	Tannins	(+)	(+)	(+)	(-)	(-)
6	Flavonoids	(+)	(+)	(+)	(+)	(+)
7	Glycosides	(+)	(+)	(+)	(+)	(-)
8	Sterols	(+)	(+)	(-)	(-)	(-)
9	Terpenoids	(+)	(+)	(+)	(+)	(+)
10	Volatile oils	(-)	(-)	(+)	(+)	(+)
11	Gums and Resin	(+)	(+)	(-)	(-)	(-)

[(+)indicate the presence of the metabolites and (-) indicate the absence of secondary metabolites]

5.2 Physiochemical Evaluation

Table 5.2: Physiochemical Evaluation

PARAMETERS	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Bulk density ($g/cm^{2)}$	0.428	0.42	0.41	0.41	0.42
Tapped density(g/cm^2)	0.58	0.57	0.58	0.57	0.56
Compressibility index (%w/w)	28.8	28	27.5	27	**21**

Hausner's ratio	1.36	1.40	1.39	1.40	1.38
Angle of repose(degree)	40.09	40.86	42.8	43.5	**29.9**

[Trial 5 was found best in all criteria than other trial batches]

5.3 EVALUATION OF POLY HERBAL TABLET

Table 5.3: Evaluation of polyherbal tablet

S.NO	PARAMETERS	OBSERVATION
1.	Description	Light brown colour tablet, round shape
2.	Colour	Brownish
3.	Odour	Characteristic
4.	Taste	Bitter

5.4 EVALUATION FLOW PROPERTIES OF POLY HERBAL TABLET VARIOUS BATCHES

Table 5.4: Evaluation flow properties of poly herbal tablet various batches

PARAMETERS	F1	F2	F3	F4	F5
Average weight	500	500	500	500	500
Hardness	3.1	3.2	3.23	3.15	3.3
Thickness	5	5	5	5	5
Friability	0.33%	0.34%	0.33%	0.35%	0.35%
Disintegration time	30	31	30	32	30

Figure 5.1: Formulated herbal tablets

CONCLUSION

Herbal medicine, the oldest known form of healthcare, has been utilized for centuries to diagnose, prevent, and treat various ailments. Following an extensive review of existing literature, five herbal ingredients were carefully selected and combined to create a poly-herbal formulation for the development of Anti-Diabetic tablets. The pharmaceutical industry is shifting its focus from single-component combinations. There is growing evidence that medicinal plants contain synergistic combinations that not only enhance efficacy but also mitigate side effects. Building on this knowledge, this study investigated the synergistic activity of Polyherbal formulation combining Gymnema slylvestre, Momordica charantia, Ocimum sanctum, Zingiber officinale and Cinnamomum zeylanicum. Future studies are needed to unravel the underlying mechanisms responsible for the Anti-Diabetic effects observed in this Polyherbal tablet.

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