JOURNAL OF NATURAL REMEDIES
DOI: 10.18311/jnr/2022/28557
RESEARCH ARTICLE

Development and Evaluation of a Polyherbal Tablet for Polycystic Ovarian Syndrome (PCOS)

Disha Prajapati[1]*, Madhavi Patel[2] and Abhay Dharamsi[2]

[1]Parul Institute of Pharmacy and Research, Parul University, Vadodara - 391110, Gujarat, India; disha.prajapati@paruluniversity.ac.in
[2]Parul Institute of Pharmacy, Parul University, Vadodara - 391110, Gujarat, India

Abstract

The main objective of the present study was to develop and evaluate polyherbal tablet for the treatment of Polycystic Ovarian Syndrome (PCOS). For the formulation of tablet, the herbs were selected based on the concepts of pathophysiology and Ayurvedic perspective of the disease. The extracts of *T. foenum graceum*, *C. longa*, *B. aristata*, *S. asoka*, *B. variegata* and Guggul purified in cow's urine was used for the preparation of polyherbal tablet. The physicochemical, phytochemical evaluation and quantification of markers by HPTLC of crude drugs and extracts were performed. The guggul was used as binder in different proportion for the preparation of tablet. Pre-formulation study of the powder blend and post compression evaluation of tablet was done by various parameters like weight variation, friability, hardness, thickness, diameter, disintegration time, in-vitro dissolution and accelerated stability study. The physicochemical evaluations of crude drugs yielded results which were in accordance with the monograph's standard values. The phytochemical analysis of the extracts revealed the presence of variety of phytoconstituents. From the results of HPTLC quantification the amount of curcumin (7.14%) in *C. longa*, diosgenin (40.6%) in *T. foenum graceum*, *T. foenum graceum*, berberine hydrochloride (4.83%) in *B. aristata,* catechin (3.48%) in *S. asoka*, lupeol (0.11%) in *B. variegata* and Z-guggulsterone (0.140%) and E-guggulsterone (0.146%) in purified guggul was found. The micrometrics of the powder blend of all the formulations showed good flow properties. Formulation F3 showed better results compared to other formulations in post compression evaluation. Accelerated stability study showed that the formulation F3 was stable during the course of study.

Keywords: Micromeritics, Polyherbal Formulation, Polycystic Ovarian Syndrome, Physicochemical Evaluation

Abbreviations

PCOS: Polycystic Ovarian Syndrome
BV: *Bauhinia variegata*
SA: *Saraca asoka*
BA: *Berberis aristata*
CM: *Commiphora wightii*
CL: *Curcuma longa*
TFG: *Trigonella foenum graceum*
WHO: World Health Organization
ICH: International Council for Harmonisation
HPTLC: High performance thin layer chromatography
TLC: Thin layer chromatography

1. Introduction

Polycystic Ovary syndrome (PCOS) has become a major area of concern as it is affecting 12-21% of reproductive-aged women causing infertility. This syndrome is characterized by multiple disorders such as hyperandrogenism,

*Author for correspondence

Article Received on: 03.09.2021 Revised on: 19.10.2021 Accepted on: 02.02.2022

hyperinsulinemia, dyslipidemia, obesity, insulin resistance, anovulation, and cystic follicles in the ovary[1]. PCOS being a disease with complex etiopathogenesis with combination of reproductive, metabolic and genetic factors. No single prognostic element can strongly explain the pathophysiology and occurrence of PCOS. Chemical based medication used for the treatment of disease causes many side effects therefore the natural therapies was preferred to re-establish the normal rhythm of the menstrual cycle by balancing the hormones and also, they are found to restore the imbalance of *doshas* occurring due to ovulation. Moreover, there are herbs having phytoestrogens that can also be helpful in the treatment of disease. The plants maintaining the level of insulin and lipid lowering herbs can also be incorporated in the therapy for PCOS[2]. Based on etiology and pathogenesis of PCOS and also from Ayurvedic perspective of PCOS, a polyherbal tablet which is a combination of *Bauhinia variegate* (BV), *Trigonella foenum graceum* (TFG), *Berberis aristata* (BA), *Curcuma longa* (CL), *Commiphora wightii* (CM) and *Saraca asoka* (SA) was planned to prepare. The extracts of the herbs were mixed in right proportion as per the disease etiology considering modern and Ayurvedic perspectives to obtain a blend which can be targeted against multiple manifestations of PCOS. The individual herbs used in the polyherbal tablet are reported to have significant relevance to the pathophysiology of PCOS[3].

TFG is used as insulin sensitizer to control the occurrence of diabetes and is also used in PCOS[4-6]. SA is used for estrogenicity effect as well as to control menorrhagia and other female reproductive dysfunction which are some of the symptoms of PCOS[7-10]. BV corrects the pathophysiology of PCOS by reducing the size of cysts and arrests the further growth of the cysts in the ovaries[11,12]. CM reduces the morphological abnormalities of the ovarian follicles and helps in regulating the normal hormonal levels[13]. BA containing berberine as an active constituent which improves clinical, metabolic and reproductive features in PCOS women[14-16]. CL containing curcumin showed beneficial effects in PCOS by restoring the abnormally in serum steroid profile, lipid profile, glucose and glycosylated hemoglobin levels and depletion in antioxidant activity. It shows anti-inflammatory activity in granulosa layer of the corpus luteum[17,18].

2. Materials and Methods

2.1 Plant Materials

The dried roots of BA, bark of SA and BV, dried rhizomes of CL, seeds of TFG and gum of CM were purchased from Yucca enterprises, Mumbai. The plant material was authenticated from CSIR-National Institute of Science Communication and Information Resources (NISCAIR), New Delhi. The plant material was evaluated morphologically, microscopically and by using various physicochemical parameters according to WHO guidelines on quality control methods for herbal medicines.

2.2 Preparation of Extracts

The hydro alcoholic extracts (50% Ethanol and 50% Water) of SA and BV and alcoholic extract of TFG, BA and CL were prepared using Soxhlet extraction method (75-80°C). All the extracts were concentrated by distilling the solvent and the extracts were lyophilized and stored for further use. The percentage yield of the individual drug extracts was determined as %w/w and reported.

2.3 Shodhana of Guggul

Guggul was bundled in a strong cloth (pottali) and boiled in dolayantra containing 4 parts of fresh gomutra (cow urine). When all the guggul dissolved in cow urine, pottali was removed and the liquid was evaporated to collect purified guggul[19].

2.4 Physicochemical Investigation

The crude drug material was subjected to physicochemical investigation according to WHO guidelines for herbal medicines[20,21]. The ash values were determined by three different methods which measures the total ash, acid insoluble ash and water-soluble. Extractable matter determines the amount of active constituents extracted with solvents from crude drug material. It is usually calculated as alcohol soluble and water-soluble extractable matter. The moisture content of the crude drug material was determined by loss on drying method.

2.5 Phytochemical Investigation

The prepared extracts were tested by various qualitative chemical tests to determine the presence of various

phytoconstituents like alkaloids, glycosides, carbohydrates, phenolics and tannins, proteins and amino acids, saponins and phytosterols using reported methods[22].

2.6 Evaluation of Extracts

The colour, consistency, appearance, pH and presence of phytoconstituents in the extracts was done. The HPTLC quantification of the marker compound in the extracts was carried out at Vasu Research Centre, Vadodara, using CAMAG Linomat-5 applicator using Merck - TLC/HPTLC Silica gel 60 F_{254} aluminium sheets as stationary phase. The marker compound used for the quantification of crude drugs and extracts were lupeol for BV, catechin for SA, berberine hydrochloride for BA, curcumin for CL, diosgenin for TFG and Z and E guggulsterone for CM. The development of the plates was done in CAMAG TLC Twin trough chamber containing mobile phase. The mobile phase consisted of Toluene: Ethyl acetate (5:1.5. v/v) (for BV); Toluene: Ethyl acetate: Formic acid: Methanol (3:3:0.8:0.2, v/v/v/v) (for SA); n-Butanol: Ethyl acetate: Acetic acid: Water (3:5:1:1. v/v/v) (for BA); Toluene: Ethyl acetate: Formic acid (5:1.5:0.5, v/v/v) (for CL); n- Hexane: Ethyl acetate (8:2, v/v) (for TFG); Petroleum ether: Ethyl acetate: Methanol (6:2:0.5, v/v/v) (for CM). Densitometric scanning of the HPTLC plate was performed at 200 nm (BV); 254 nm (SA); 278 nm (BA); 366 nm (CL); 560 nm after derivatization in Anisaldehyde sulphuric acid reagent (TFG); 254 nm (CM) respectivlely[19,23].

2.6.1 Preparation of Standard Solution of Chemical Marker Compound

Accurately weighed 10 mg of berberine, diosgenin, curcumin and catechin was dissolved in 10 ml of methanol, while 5 mg of Z-guggulsterone and E-guggulsterone and 10 mg lupeol were dissolved in 10 ml chloroform separately to yield the standard stock solutions.

2.6.2 Preparation of Sample Solutions

Accurately weighed 1 g powder of BA, CL, TFG, SA and CM and their extracts were refluxed in methanol while BV and its extract were refluxed in chloroform for 15 minutes. The filtrate was evaporated till the complete removal of solvent. The residue was dissolved in 1 mL of methanol/chloroform for powder & 10 mL methanol/chloroform for extract. The resultant solution thus obtained was used for HPTLC fingerprinting.

2.7 Development and Preparation of Polyherbal Tablet

The polyherbal tablet was formulated using free flowing lyophilized extracts and purified guggul as a binder. Prior to the formulation of the tablet, the lyophilized extracts were checked for the presence of residual solvents by Gas chromatography to ensure that the solvents have completely evaporated. For the preparation of tablet, the purified guggul and the lyophilized extracts of crude drug materials were mixed and gently heated. The mixture was allowed to cool and dry completely. After drying, the mixture was sieved to get uniform particle sized powder. The tablet was punched by direct compression method on tablet compression machine (Rimek-Minipress-I). According to the modern pharmaceutical practices various excipients are used which are inert and act as binders, lubricants, disintegrants, etc. On the contrary, guggulu formulations are special since guggulu is having medicinal properties as well as it acts as a binding agent.

Table 1. Formulation of tablet

Ingredients (Ratio)	F1	F2	F3	F4	F5
Purified guggul	4	6	8	10	12
Saraca asoka	2	2	2	2	2
Bauhinia variegata	2	2	2	2	2
Trigonella foenum graceum	1	1	1	1	1
Curcuma longa	2	2	2	2	2
Berberis aristata	1	1	1	1	1

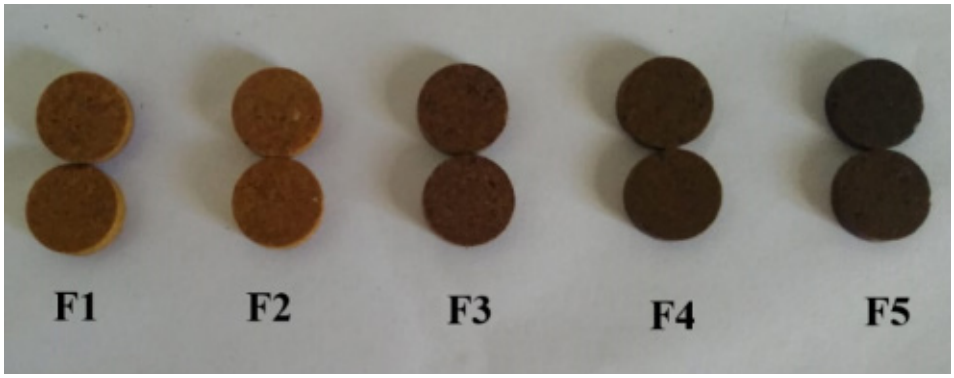


Figure 1. Polyherbal tablets (Formulation F1, F2, F3, F4 and F5).

So, considering the medicinal properties it is chosen as a gum for binding the tablet. As per general guidelines of Ayurveda the quantity of guggulu is 50 % and that of other ingredients are 50 %. So, considering this fact the composition of various extracts of the drug and guggulu was varied and tried for the preparation of the tablet. The composition of various combinations for polyherbal tablet is given in the Table 1 and the tablets in Figure 1[24-27].

2.8 Evaluation of Tablet

2.8.1 Precompression Studies

The powder blend was evaluated for various parameters before compression[28,29].

2.8.2 Angle of Repose

The angle of repose was determined using fixed funnel method. In this method the funnel is fixed at a definite height above the graph paper placed on a flat horizontal surface. Accurately weighted amount of powder was poured through the funnel to form a conical heap which touches the tip of the funnel. The diameter of the base of the conical heap is then determined to calculate the angle of repose by following formula

$\tan \theta = h/r$

where, θ= angle of repose, h=height of powder cone formed, r= radius of the cone formed.

2.8.3 Bulk Density

Bulk density was determined by passing a weighed quantity of powder into a graduated measuring cylinder and determining the volume occupied. The bulk density is determined by following formula.

Bulk density (BD) = weight of powder/volume occupied by powder

2.8.4 Tapped Density

It was determined by placing a known weight of powder in a measuring cylinder. The cylinder was allowed to fall under its own weight onto a hard surface of 10 cm at two seconds interval. The tapping was continued till no further change in volume was noted.

Tapped density (TD) = weight of powder/volume occupied by powder

2.8.5 Carr's Compressibility Index and Hausner's Ratio

Hausner's ratio and Carr's compressibility index are related to interparticle friction and can be used to determine flow properties of the powder. It was calculated by the following formula.

Hausner's ratio= TD/BD

Carr's compressibility index= (TD - BD)/ TD X 100

2.8.6 Post Compression Studies

After compression, the evaluation of the tablet was carried out using following parameters[30-33].

2.8.7 Weight Variation Test

For determining weight variation, 20 tablets were taken from each batch and weighed individually and noted. The average weight of the tablet was calculated and then further substituted in the formula for calculation of percentage weight variation.

Weight variation = (individual weight of tablet / average weight of tablet) X 100

2.8.8 Hardness

The hardness of the tablet was measured using the Monsanto hardness tester and recorded as kg/cm^2 unit.

2.8.9 Thickness and Diameter

The diameter and thickness of the 20 tablets from each batch was measured using the vernier calliper.

2.8.10 Friability

The friability was measured using Roche friabilator. 20 tablets of each formulation were weighed and tested at a speed of 25 rpm for 4 minutes (100 rotations). After removal of dust, tablets were re-weighed and friability percentage was calculated by following formula,

% Friability = (Wb - Wa / Wa) X 100

Where Wb= Weight before friability

Wa= Weight after friability

2.8.11 Disintegration

The disintegration time of the tablets was determined using Electro lab disintegration tester (USP). One tablet was introduced into each tube and the disc was placed on it. The whole assembly was suspended in a 1000 ml beaker filled with water. The apparatus operated at 37±2 °C. The time taken by all tablets to disintegrate and pass through the wire mesh was noted.

2.8.12 Invitro Dissolution

The in-vitro dissolution study was carried out using paddle type of dissolution test apparatus. 900 ml of 0.1 M Hydrochloric acid was used as the dissolution medium and filled into the apparatus vessel and temperature maintained at 37±1 °C. The speed of the paddle was adjusted to 50 rpm for 2 hours. 10 ml of aliquots were withdrawn from a zone midway between the surface of the dissolution medium and top of the paddle at specific time interval and replaced with equal amount of fresh dissolution medium. The samples were analysed at 240 nm by UV-visible spectrophotometer (UV-1800 Shimadzu). The cumulative percentage drug release was calculated using an equation derived from standard curve of the E- guggulsterone and Z-guggulsterone as the standard. The concentration of the E and Z guggulsterone was determined for reviewing the drug release from the polyherbal tablet.

2.8.13 Accelerated Stability Study

Various environmental factors like temperature, light, air and humidity affect the storage conditions of drugs as well as the package components. The optimized formulation was subjected to accelerated stability study for the period of 3 months. The conditions are maintained as per ICH guidelines as 40±2 °C/75 ±5 % RH was used for the study. The different parameters such as colour, odour, texture of tablet, average weight, hardness, friability, disintegration time and content of markers in the tablet were studied after accelerated conditions.

3. Results

The present study was undertaken to formulate and evaluate polyherbal tablet for the treatment of polycystic ovarian syndrome. The tablet was formulated using the alcoholic extracts of TFG, BA and CL and hydroalcoholic extract of SA and BV. The colour, consistency, pH and % yield of the extract done is reported in Table 2.

Table 2. Evaluation of extracts of crude drugs

Parameter	BV	SA	TFG	CL	BA	CM (Raw)	CM (Purified)
Colour	Brownish	Reddish Brown	Light yellow	Yellow	Pale yellow	Brownish	Dark Brown
Consistency	Dry	Dry	Dry	Dry	Dry	Dry	Dry
% Yield	12	14	13	15	12	-	86.67
pH	5.70	4.86	7.30	9.00	4.65	5	6

3.1 Physicochemical Investigation

The results of physicochemical investigation of the crude drugs are reported in the Table 3.

3.2 Phytochemical Investigation

The results of phytochemical investigation of the extracts of crude drugs are reported in the Table 4.

3.3 Residual Solvent Analysis

The residual solvent analysis of the lyophilized extracts of the crude drugs which was carried out using Gas chromatography showed absence of residual solvent (alcohol) in the extracts.

Table 3. Physicochemical evaluation of extracts of crude drugs

Parameter	BV	SA	TFG	CL	BA	CM (Raw)	CM (Purified)
Total ash (%)	8.5	9	3	6	11	4.72	12.69
Acid insoluble ash (%)	0.2	0.85	0.4	6	4.2	2.30	3.90
Water soluble ash (%)	14	5	7.5	4.2	0.25	-	-
Alcohol soluble extractive (%)	16	16	8	8	16	38.83	25.49
Water soluble extractive (%)	16	16	24	24	24	45.65	63.86
Loss on drying (%)	6	8	6	10	4	12.76	15.33

Table 4. Phytochemical evaluation of extracts of crude drugs

Phytoconstituents	BV	SA	TFG	CL	BA	CM (Raw)	CM (Purified)
Alkaloids	+	-	+	+	+	-	-
Amino acids	+	-	+	-	-	+	+
Carbohydrates	+	+	+	-	+	+	+
Flavonoids	+	+	+	+	-	+	+
Anthraquinone glycosides	-	-	+	+	-	-	-
Cardiac glycosides	-	+	+	-	-	-	-
Saponin glycosides	-	+	+	+	+	-	-
Tannins	+	+	-	+	+	-	-
Proteins	-	-	+	-	-	-	-
Steroids and Terpenoids	+	+	+	+	+	+	+

'+'- present, '-'- absent

3.4 Quantification of Marker in Extracts by HPTLC

The results of percentage of markers in the extracts of the crude drugs are reported in Figure 2. The HPTLC plates (Figure 3) shows the presence of markers in crude drugs and extracts. The HPTLC chromatogram of the crude drugs and extracts are represented in Figures 4 and 5 respectively.

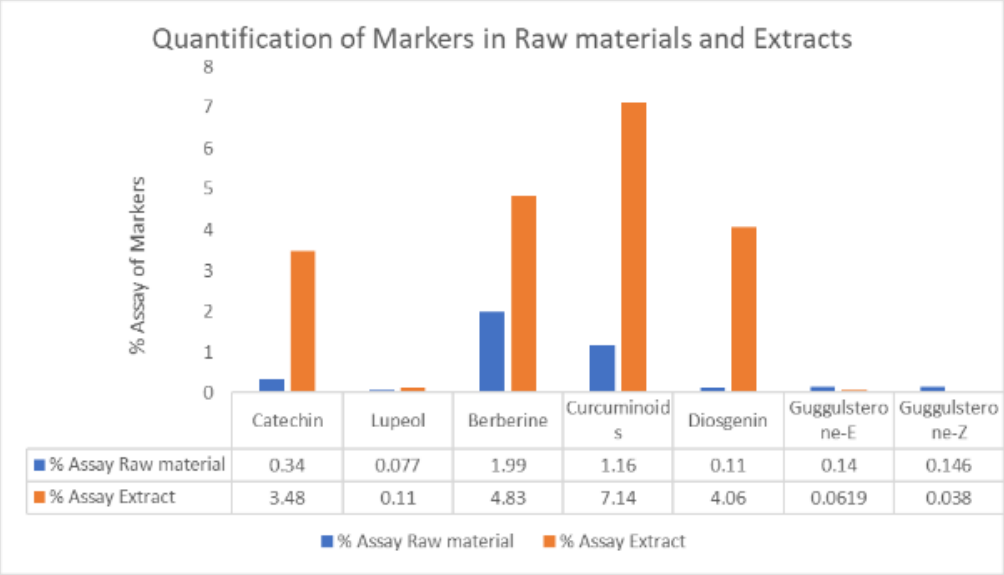


Figure 2. HPTLC quantification of markers in raw materials and extracts.

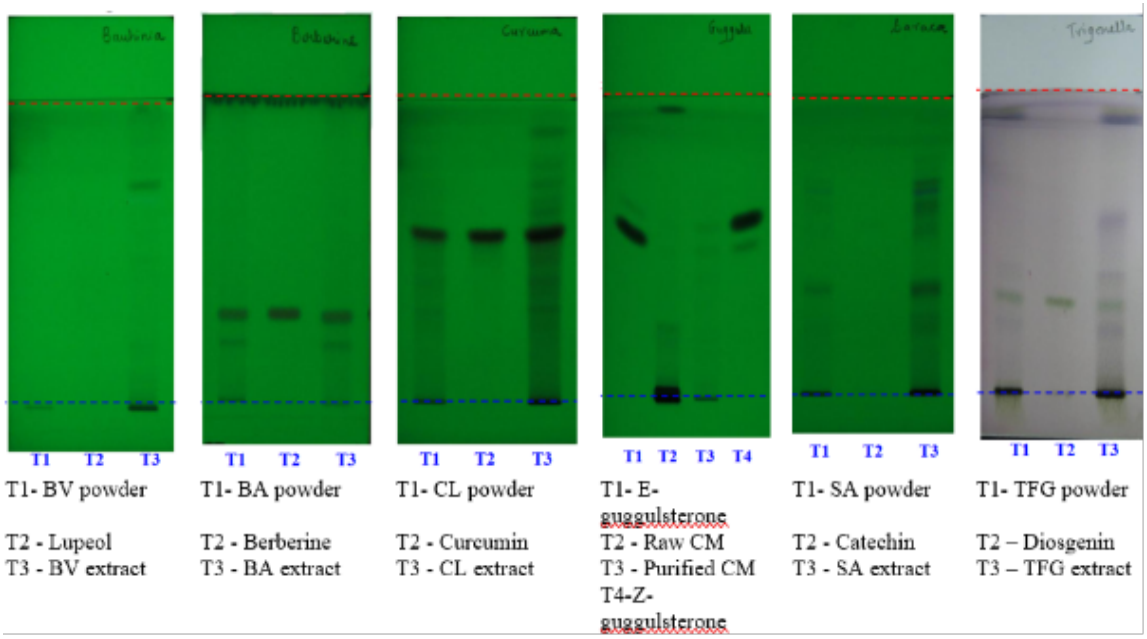
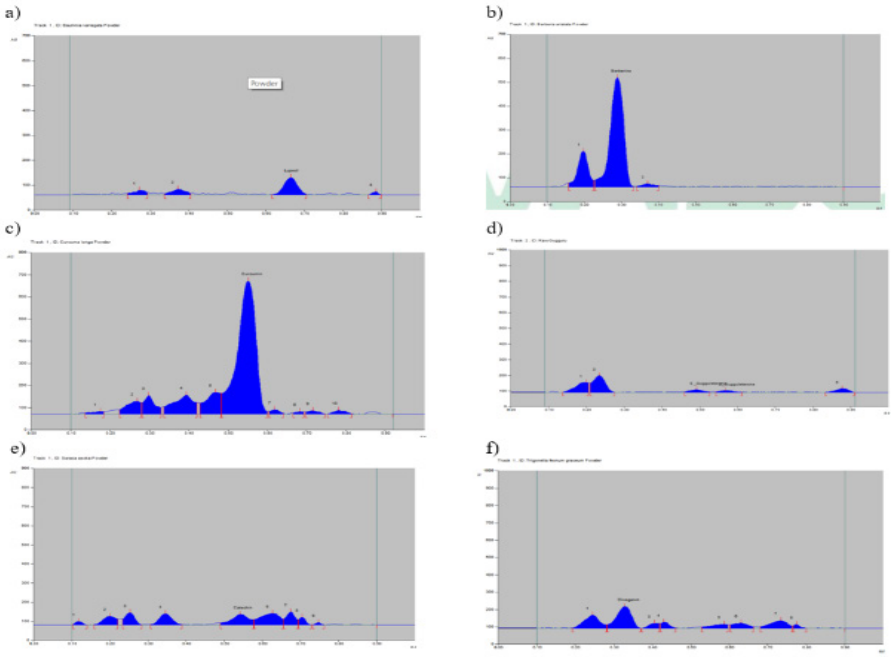
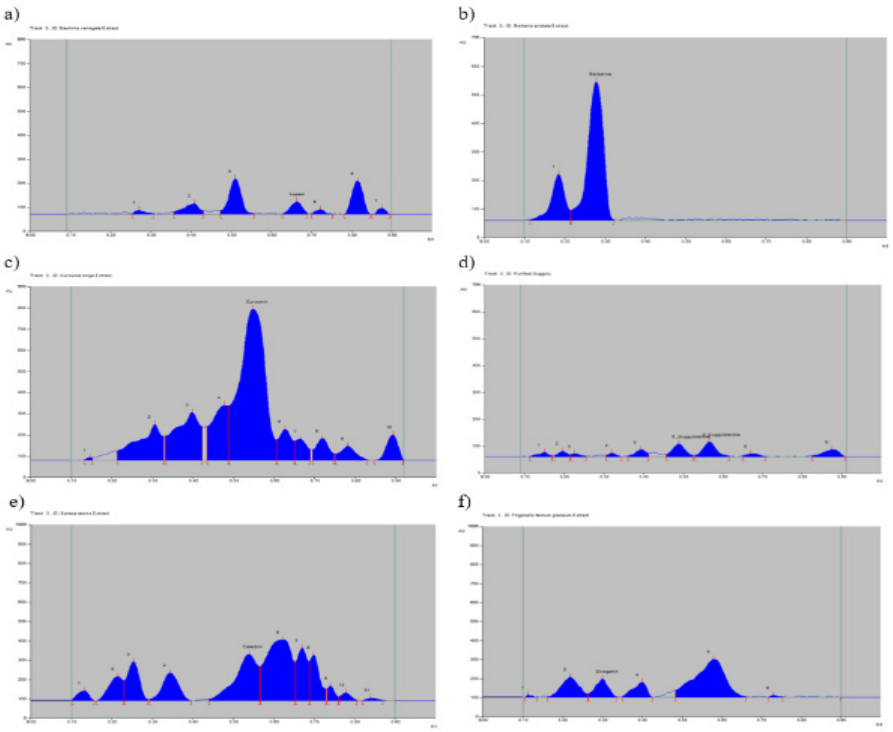


Figure 3. HPTLC plates of raw materials, extracts and marker compounds.



(a) BV, (b) BA, (c) CL, (d) Raw CM, (e) SA, (f) TFG

Figure 4. Chromatogram of raw material of crude drugs.



(a) BV, (b) BA, (c) CL, (d) Purified CM, (e) SA, (f) TFG

Figure 5. Chromatogram of extracts of crude drugs.

3.5 Pre-compression Parameters

The results of pre-compression parameters of the powder blend of various formulations like bulk density, tapped density, angle of repose, Hausners ratio and Carrs compressibility index are reported in the Table 5. The standard value of precompression parameters is reported in Table 6.

3.6 Post-compression Parameters

The tablet was evaluated for weight variation, hardness, thickness, diameter, friability, disintegration. The results are reported in the Table 7.

3.7 Accelerated Stability Study

The results of physical characters of the tablet formulation F3 were subjected to accelerated stability study at the interval of one, two and three months are reported in the Table 8.

Table 5. Pre-compression study data of powder blend

Parameters	F1	F2	F3	F4	F5
Bulk density	0.83±0.005	0.82±0.005	0.80±0.005	0.83±0.005	0.85±0.005
Tapped density	1.25±0.029	1.19±0.021	0.96±0.016	1.07±0.052	1.14±0.005
Angle of repose	38.6±0.082	34.2±0.163	33.7±0.082	35.4±0.163	36.2±0.163
Hausners ratio	1.14±0.533	1.46±0.009	1.19±0.022	1.28±0.066	1.34±0.012
Carrs compressibility index	38.77±6.248	40.77±8.844	16.29±1.149	22.15±4.346	25.50±0.631

*data represented as mean ± SD, n=3

Table 6. Standard values of evaluation parameters for flow properties of powder blend

Angle of Repose	Carr's compressibility index	Hausner's ratio	Flow Properties
≤ 20	5-15	< 1.25	Excellent
20-25	12-16		Good
25-30	18-23	>1.25	Fair to passable
30-40	23-35		Poor
≥40	≥40		Extremely poor

Table 7. Post compression study data of tablet

Parameters	F1	F2	F3	F4	F5
Weight Variation (mg)	506.00±3.05	504.70±3.105	504.50±0.87	503.87±3.35	505.30±1.91
Diameter (mm)	10.027±0.006	10.023±0.006	10.027±0.006	10.027±0.006	10.023±0.006
Thickness (mm)	3.02±0.006	3.03±0.006	3.02±0.006	3.03±0.006	3.01±0.006
Hardness (kg/cm^2)	0.53±0.06	0.63±0.06	1.53±0.06	2.87±0.06	3.33±0.15
Friability (%)	3.44±0.11	2.92±0.03	0.58±0.02	0.52±0.02	0.50±0.01
Disintegration time (minutes)	22±2	26.67±1.53	30±1	61±1	90.33±1.53

*data represented as mean ± SD, n=3

Table 8. Accelerated stability study data

Parameters	Initial	Accelerated Temperature (40±2°C/RH 75±5 %)		
		1st Month	2nd Month	3rd Month
Hardness ($kg/cm^{2)}$	1.53	1.51	1.52	1.52
Friability (%)	0.58	0.58	0.58	0.57
Disintegration time (min)	30	30	31	30

4. Discussion

4.1 Phytochemical Investigation

In the phytochemical investigations the extracts of all crude drugs, the presence of various phytoconstituents like alkaloids, glycosides, tannins, flavonoids and steroids were found. The results of the phytochemical investigation revealed the presence of alkaloids, flavonoids, tannins and steroids in BV; presence of flavonoids, cardiac glycosides, saponin glycosides, tannins and steroids in SA; presence of alkaloids, saponin glycosides and steroids in BA; presence of alkaloids, flavonoids, anthraquinone glycosides, saponin glycosides, tannins and steroids in CL; presence of alkaloids, flavonoids, glycosides and steroids in TFG; presence of flavonoids and steroids in CM.

4.2 Physicochemical Investigation

The physicochemical investigation is the important test for herbs and extracts which are a part of pre formulation study according to WHO guidelines. Various physicochemical parameters like loss on drying, extractive values, ash values were carried out separately for all the crude drug materials. The results represented that all the parameters were within the limits as per the pharmacopeial specifications.

4.3 Quantification of Markers

From the HPTLC results the amount of curcumin in CL raw material was found to be 1.16 % and in the alcoholic extract it was found to be 7.14 %; in SA raw material the amount of catechin was found to be 0.34 % whereas hydroalcoholic extract contained 3.48 %. While the BV raw material had 0.077 % of lupeol and its hydroalcoholic extract contained 0.11 % of lupeol. The raw material of TFG had 0.11 % diosgenin and the alcoholic extract had 4.06 % of diosgenin. The amount of berberine hydrochloride in *Berberis aristata* raw material was 1.99 % and alcoholic extract was 4.83 %. The raw and purified CM showed 0.0619 % and 0.140 % of Z-guggulsterone whereas 0.038 % and 0.146 % of E- guggulsterone respectively. Extract of crude drugs were found to be rich in amount of the marker compounds as compared to the raw materials of the respective drugs. Thus, we can conclude that the extracts being more potent can be used for the preparation of the polyherbal formulation.

4.4 Precompression Parameters of Prepared Blend

For the polyherbal tablet the precompression parameters evaluated are angle of repose, bulk density, tapped density, Hausner's ratio and Carr's compressibility index. The angle of repose for all the formulation blend was found in the range of 33-38°. The Hausner's ratio and Carr's index were in the range of 16-38 and 1.17-1.54 respectively. The pre-compression parameters results showed excellent flow properties, moisture content and compressibility etc.

4.5 Post Compression Parameters of Tablet

The quality of the polyherbal tablet can be accessed from the post compression evaluation parameters. The tablet was prepared using guggul as the binder. The amount of extracts added in the tablet was decided considering the concept of dravyaguna (*spatadhatu*) of the crude drugs from the Ayurvedic perspective as well as considering

the efficacious dose of the extract from the modern pharmacological principles for the effectiveness of the tablet in the treatment of PCOS. The amount of the guggul was varied as the variation in the amount of the binder is responsible for the variation in response to hardness, friability and disintegration. The other parameters like thickness, diameter and weight variation are reported. The hardness of the tablet was found to be between 0.5 to 3.3 kg/cm^2 for the formulation F1 to F5. The friability of the tablet was found ranging between 1-3 %. The disintegration time of all the batches was found in the range of 22-90 minutes. On the basis of post compression parameters, the formulation F3 having the hardness value 1.5 kg/m^3, disintegration time of 30 minutes and friability 0.58 % was selected as the optimized batch. In vitro dissolution study was carried out, this non-specific dissolution was intended to be diagnostic of batch-to-batch variation. The operative assumption inherent in this procedure was that if the extracts are demonstrated to have dissolved within the time frame and under specified conditions the tablets do not suffer from formulation related problems. It has been observed that the cumulative drug release of optimized formulation 3 was more than 90 % at the end of 2 hour (Figure 6)[34,35].

4.6 Accelerated Stability Study

Stability studies for the optimized formulation 3 shows no significant change in the physical parameters at accelerated

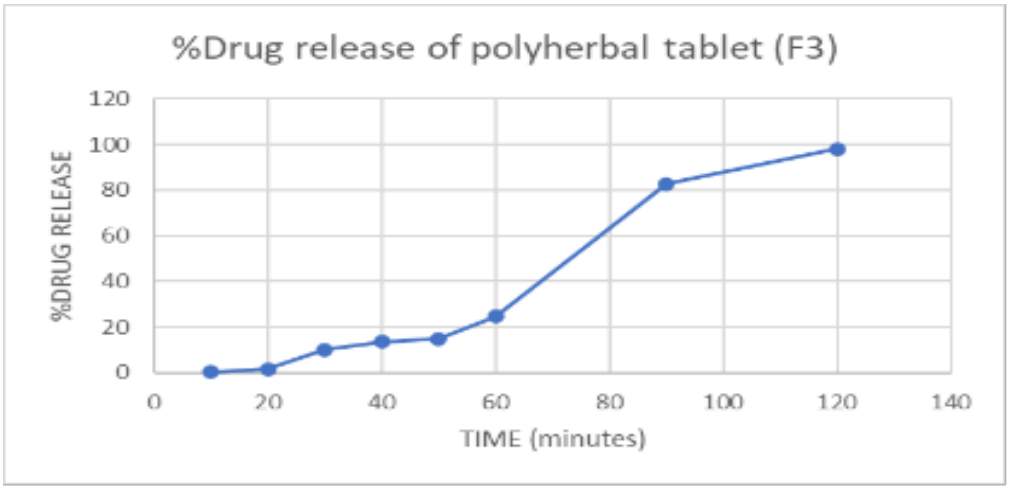


Figure 6. Drug release profile of polyherbal tablet.

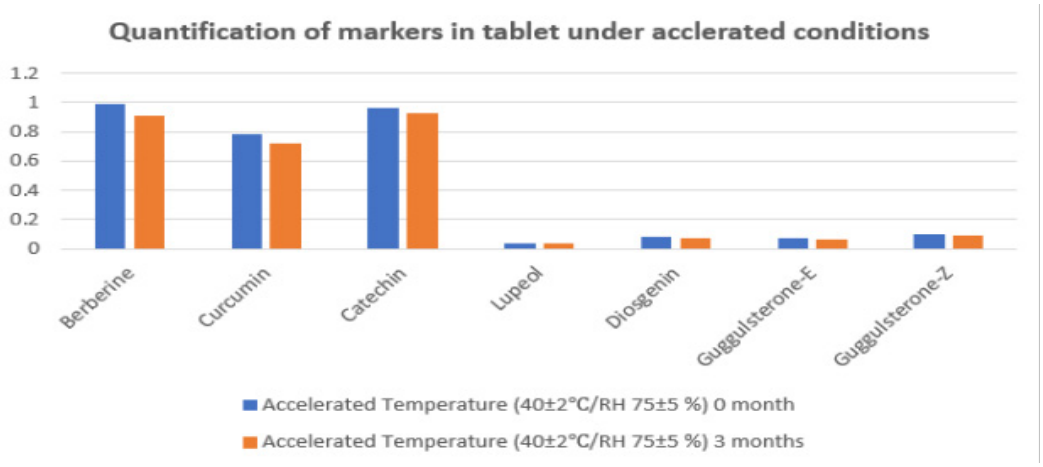


Figure 7. Quantification of markers in tablet at accelerated condition.

conditions and the results showed that the polyherbal tablets were stable. The content of the markers in the tablet were quantified by HPTLC to ensure the stability of the tablet formulation at an interval of 0 month and 3 month and reported in the Figure 7. The results shows that the content of markers in the tablet after exposing to the accelerated conditions does not deviate more than ± 10 % of the initial content of the tablet indicating the stability of the tablet[36].

5.Conclusions

The laboratory scale preparation of polyherbal tablet may be used as a stable solid dosage form for the treatment of PCOS. The results showed that the formulation F3 had good post compression parameters as compared to other formulations. The present study revealed that the composition ratio of ingredients of polyherbal tablet does not affect the stability parameters. Thus, from the study it can be concluded that by blending of traditional knowledge and modern technologies, formulations like tablets can be developed which have better stability, consumer compliance and appropriateness.

6. Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

7. Acknowledgement

The authors are thankful to Student Startup Innovation Policy, Education Department, Government of Gujarat for providing grant and Parul University, Vadodara for providing fund & facilities for carrying out the research work. Authors would also like to acknowledge Vasu Research Center, Vadodara for doing the HPTLC analysis of the samples.

8. References

1. Azeemuddin M, Anturlikar SD, Onkaramurthy M, Baig MR, Ashok BK, Rao RP, *et al.,* Effect of "dXB-2030," a polyherbal formulation, on Experimental polycystic ovary syndrome associated with hyperandrogenism. Adv Pharmacol Sci. 2019; 2019. https://doi.org/10.1155/2019/8272850. PMid:30863446. PMCid:PMC6378078
2. Patel MG, Prjapathi DP. Concept of polycystic ovarian syndrome: Perspectives of Ayurveda and Modern Science. Int J Pharmacogn Phytochem Res. 2017; 9(10):1363-72. https://doi.org/10.25258/phyto.v9i10.10462
3. Arentz S, Abbott J, Smith C. Herbal medicine for the management of Polycystic Ovary Syndrome (PCOS). BMC Complim Altern Med. 2014; 14(2015):511-30. https://doi.org/10.1186/1472-6882-14-511. PMid:25524718. PMCid:PMC4528347
4. Moorthy R, Prabhu KM, Murthy PS. Anti-hyperglycemic compound (gII) from fenugreek (*Trigonella foenum-graecum* linn.) seeds, its purification and effect in diabetes mellitus. Indian J Exp Biol. 2010; 48(11):1111-8.
5. Renuka C, Ramesh N, Saravanan K. Evaluation of the antidiabetic effect of *Trigonella foenum-graecum* seed powder on alloxan-induced diabetic albino rats. Int J Pharm Tech Res. 2009; 1(4):1580-4.
6. Mohammadi A, Gholamhosseinian A, Fallah H. *Trigonella foenum-graecum* water extract improves insulin sensitivity and stimulates PPAR and γ gene expression in high fructose-fed insulin-resistant rats. Adv Biomed Res. 2016; 5(1):54. https://doi.org/10.4103/2277-9175.178799. PMid:27110551 PMCid:PMC4817393
7. Swar G, Shailajan S, Menon S. Activity based evaluation of a traditional Ayurvedic medicinal plant: *Saraca asoka* (Roxb.) de Wilde flowers as estrogenic agents using ovariectomized rat model. J Ethnopharmacol. 2017; 195:324-33. https://doi.org/10.1016/j.jep.2016.11.038. PMid:27884717
8. Cibin TR, Devi DG, Abraham A. Chemoprevention of two-stage skin cancer in vivo by *Saraca asoca*. Integr Cancer Ther. 2012; 11(3):279-86. https://doi.org/10.1177/1534735411413264. PMid:21771821
9. Jadhav AN, Bhutani KK. Ayurveda and gynecological disorders. J Ethnopharmacol. 2005; 97(1):151-9. https://doi.org/10.1016/j.jep.2004.10.020. PMid:15652289
10. Shahid AP, Salini S, Sasidharan N, Padikkala J, Raghavamenon AC, Babu TD. Effect of *Saraca asoka*

(Asoka) on estradiol-induced keratinizing metaplasia in rat uterus. J Basic Clin Physiol Pharmacol. 2015; 26(5):509-15. https://doi.org/10.1515/jbcpp-2014-0124. PMid:25915082

11. Dhiman K. Ayurvedic intervention in the management of uterine fibroids: A Case series. AYU (An Int Q J Res Ayurveda). 2014; 35(3):303. https://doi.org/10.4103/0974-8520.153750. PMid:26664240. PMCid:PMC4649577
12. Rajkapoor B, Jayakar B, Murugesh N. Antitumour activity of *Bauhinia variegata* on Dalton's ascitic lymphoma. J Ethnopharmacol. 2003; 89(1):107-9. https://doi.org/10.1016/S0378-8741(03)00264-2
13. S R, H. P. Alternative therapies in polycystic ovarian syndrome. Insulin. 2010; 1(2):3.
14. Upwar N, Patel R, Waseem N, Mahobia NK. Hypoglycemic effect of methanolic extract of *Berberis aristata* DC stem on normal and streptozotocin induced diabetic rats. Int J Pharm Pharm Sci. 2011; 3(1):222-4.
15. Orio F, Muscogiuri G, Palomba S, Savastano S, Volpe A, Orio M, *et al.,* Berberine improves reproductive features in obese Caucasian women with polycystic ovary syndrome independently of changes of insulin sensitivity. ESPEN J. 2013; 8(5):e200-4. https://doi.org/10.1016/j.clnme.2013.07.002
16. Razzaq FA, Khan RA, Feroz Z, Afroz S. Effect of *Berberis aristata* on lipid profile and coagulation parameters. African J Pharm Pharmacol. 2011; 5(7):943-7.
17. Sidhu GS, Mani H, Gaddipati JP, Singh AK, Seth P, Banaudha KK, *et al.,* Curcumin enhances wound healing in streptozotocin induced diabetic rats and genetically diabetic mice. Wound Repair Regen. 1999; 7(5):362-74. https://doi.org/10.1046/j.1524-475X.1999.00362.x. PMid:10564565
18. Reddy PS, Begum N, Mutha S, Bakshi V. Beneficial effect of Curcumin in Letrozole induced polycystic ovary syndrome. Asian Pacific J Reprod. 2016; 5(2):116-22. https://doi.org/10.1016/j.apjr.2016.01.006
19. Edition F. the Pharmacopoeia of the Pharmacopoeia of. 2016;
20. on Traditional Medicine WHOP. Guidelines for the assessment of herbal medicines. World Health Organization; 1991.
21. Organization WH. WHO guidelines on good manufacturing practices (GMP) for herbal medicines; 2007. p. 72.
22. Khandelwal K. Practical pharmacognosy. Pragati Books Pvt. Ltd.; 2008.
23. Gupta AK, Tondon N, Sharma M. Quality standards of Indian medicinal plant medicinal plants unit: Published by Indian Council of Medical Research. New Delhi. 2008;3:99-105.
24. Chaube A, Dixit SK, Sharma P V. On improving the disintegration of ayurvedic pills containing guggulu. Anc Sci Life. 1995; 14(3):161-7.
25. Savarikar SS, Barbhind MM, Kulkarni AP. Pharmaceutical and analytical evaluation of *Triphala guggul* kalpa tablets J Ayurveda Integr Med. 201; 2(1):21-25.
26. Mohini U, Pallavi R, Shashikant D, Nilesh K. Assessment of guggul gum as a binding agent in tablet formulations. Res J Pharm Technol. 2013; 6(3): 238-9.
27. M Hedaoo M, Patil Bhole TPB. Narrative review of guggulu formulations of ayurveda reflecting their percentage of guggulu, pharmaceutics and pharmacology. IP Int J Compr Adv Pharmacol. 2021; 5(4):151-7. https://doi.org/10.18231/j.ijcaap.2020.031
28. Khar RK. Lachman/liebermans: the theory and practice of industrial pharmacy. Cbs Publishers & Distribu; 2013.
29. Aulton ME, Taylor KMG. Aulton's pharmaceutics. Des Manuf Med. 2007; 3:176-8.
30. Pharmacopoeia I. Government of India. Minist Heal Fam Welf. 2007; 2:1020-1.
31. Kushwaha SK, Kori ML. Development and evaluation of polyherbal syrup from some hepatoprotective medicinal plants. 2014; 1(1):5-11.
32. Balekundri A, Shahapuri A, Patil M. Poly-herbal tablet formulation by design expert tool and in vitro anti-lipase activity. Futur J Pharm Sci. 2020; 6(1). https://doi.org/10.1186/s43094-020-00131-0

33. Maurya H, Kumar T. Formulation, standardization, and evaluation of polyherbal dispersible tablet. Int J Appl Pharm. 2019; 11(1):158-67. https://doi.org/10.22159/ijap.2019v11i1.30113
34. Mamatha D. Formulation and evaluation of poly herbal anti-diabetic tablet dosage form. Int J Ayurvedic Herb Med. 2018; 6:2956-62. https://doi.org/10.18535/ijahm/v7i6.06
35. Puri D, Bhandari A, Sharma K, Sharma P. Formulation and evaluation of antihelminthic polyherbal tablets. Int J Green Pharm. 2011; 5(1):39-42.
36. Guideline ICHHT. Stability testing of new drug substances and products. Q1A (R2), Curr step. 2003; 4:1-24.