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Formulation And Evaluations Of Herbal Tablet Containing *Solanum Viarum* Leaves For Analgesic And Antipyretic Activity.

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Abstract-

The family Solanaceae consist of many plants, one of them is *solanum viarum* dunal. This plant contains chemical constituents like solasodine, alkaloids, flavonoids and fatty acid. The plant has many medicinal properties and used cardiotonic, anti-fungal, ant spermatogenic, antiandrogenic, immunomodulatory, anticancer, anti-inflammatory and antipyretic activity. Herbal tablet prepared by wet granulation method. The drug used in this study were *Solanum viarum*, talc, lactose, starch, gelatin and magnesium stearate. Then the granules were evaluated for pre-formulation study. Formulated tablet was evaluated for post compression parameter. The tablet was evaluated for weight variation, hardness, thickness, friability, disintegration test. Their dissolution was assessed by using UV visible spectrophotometer at 274 nm wavelength. From the above study, we conclude that the herbal tablet was prepared by wet granulation method and gave the acceptable and adequate results. The tablet shows instantaneous drug release due to compressed tablet.

Keywords- *Solanum viraum*, herbal tablet, analgesic activity, antipyretic activity.

INTRODUCTION-

The progress of Ayurveda in India is dependent on the healing properties of plant-based medicines [1]. The traditional medical system is also based on Ayurvedic medicine in the form of home remedies [2]. Due to their low toxicity, various herbal plants are being routinely used for medicinal purposes. Our studies also confirm that it is quite effective. *Solanum viarum (S. viarum)*, while being an aggressive shrub or herb, its fruit is highly toxic, potentially fatal. This plant has recently become problematic in the U.S. due to its invasive growth; it originated in Brazil and Argentina and migrated to Mexico, the U.S. and Honduras.[4]. The plant is called locally Sodom apple and tropical soda apple. The Solanaceae family contains the genus

Solanum viarum. Solanaceae contains more than 2000 species and 75 genera [5]. Mature fruits of *S. viarum* are eaten by cows, white-tailed deer, feral hogs, among other animals. The morphology and physiology of xerophytes have evolved to preserve water and store large amounts of water for storage during the dry period [6]. *Solanum viarum* (aka S. khasianum) is a xerophytic perennial shrub that is elliptically distributed in Brazil, Argentina, and India [7].

In India, this species is predominantly known from Manipur, Assam, Sikkim, Arunachal Pradesh, West Bengal, Khasi and Orissa, Jaintia and Naga Hills including the higher Gangetic plains [8]. Its known locations in Himachal Pradesh are the Solang Valley, Hamirpur, Kullu, and Solan regions [9]. Gujjar and Gaddi lines from the Chamba and Kangra regions utilise this shrub to treat many human and animal ailments [10]. The *Solanum viarum* originates in Brazil and Argentina, and was first identified in the United States, in 1988, likely due to being introduced via contaminated seeds or other agricultural products. It competes with native species and probes for animal.[11]

MATERIALS AND METHODS-

Collection and authentication of plant-

This work was carried out in Department of Pharmaceutics, Abhilashi University, Mandi. Plant was collected from allied hills of Himachal during the month of October 2023. The plant was preserved in the advanced pharmaceutics laboratory of Abhilashi University. The plant specimen was authenticated by **Mr. Jagdeep Verma, Assistant Professor** Sardar Patel University Mandi Himachal Pradesh letter number **BOT-346/2**

Extraction Of Plant Extract (Soxhlet extraction)-

Procedure:

Step-I: Preparation of Plant Material-Collect the plant and wash thoroughly with the water. Shade dries for the weeks and then grind into coarse powder (350g).

Step- II: Loading the Sample-Weigh specific quantity of powdered plant and packed into the thimble (40g in each thimble). Placed the thimble in Soxhlet extractor, attached the extractor to the round bottom flask containing solvent.

Step-III: Extraction Process-Gently heat the solvent in the round-bottom flask. The solvent evaporates and moves upward through the Soxhlet apparatus. It then condenses in the condenser and drips onto the thimble containing the plant material. Once the chamber fills up, the solvent siphons back into the round-bottom flask with the extracted compounds. This repeated cycle of evaporation, condensation, and siphoning continues for several time until the solvent in the siphon turns nearly colourless, showing that the extraction process is complete.

Step-IV: Extract Recovery-Once the extraction process is finished, the round bottom flask is removed from the assembly and extracted compounds are collected. The solvent is removed to obtain concentrated extract and stored in desiccator.[12]

Phytochemical screening-

Phytochemical screening of plant extract is conducted to identify the biochemical compounds, which contributes to its medicinal properties.[13]

Phytoconstituents-

S. viarum is a medicinal condiment which contains colourful chemical ingredients like solasodine, solasonine, solamargine, diosgenin, khasianine, saponins-solakhasianin, natigenin, etc. All are steroidal glycoalkaloid in nature.

The plant also contains phenolic composites along with flavonoids, tannins, glycosides, steroids, etc. It also has affeoylquinic acid (CQA) derivations, quinic acid and 5- caffeoyl and 3-malonyl-5-caffeoyl- [4-(1beta-[6-(5-caffeoyl) quinate] glucopyranosyl).[14]

DESIGNING OF FORMULATION OF ORAL TABLET-

Herbal tablets prepared by using wet granulation method.

(Preparation of granules)-

The granules of *Solanum viarum* were prepared by wet granulation method. The solutions were prepared in distilled water by taking appropriately quantities of starch & talc and dissolving in 5% distilled water. This emulsion of starch along with preservatives was heated on a water bath until translucent semisolid mass was formed. The wet mass of gelatine/Carbopol was prepared by using required quantity of water separately. The drug powder was transferred to motor and appropriate amount of lactose and magnesium stearate was added to it. The solution was added to the blend and mixed properly to make dough. This was passed through sieve no. # 22. The granules so obtained were dried at 40.c for 1 hour. After drying granules were sized by sieving them through sieve no. # 20 and subjected to evaluation. All quantity of drug and the other ingredients were kept constant [15].

EVALUATION PARAMETERS OF POWDER BLEND

The blend of powders was evaluated for the following parameters:

Angle of Repose. Angle of repose was determined by using fixed funnel method. The funnel was set perpendicular to the axis of symmetry and its tip was kept at a given height (h) above a graph paper that was placed on a left horizontal surface. The blend of powder was poured through the funnel and a maximum cone height (h) of powder blend was obtained. The diameter (2r) of the base of the powder cone was determined and the tangent of the angle of repose was calculated by following given equation**:**

$$\text{Angle of repose } \Theta = \tan^{-1}(h/r)$$

Bulk density-It is the ratio of bulk mass of powder to the bulk volume. It is denoted by ρb. Bulk density is used to find out homogeneity.

Bulk density(ρb)=M/V

Where, M is the mass of the sample, V bulk volume.

Tapped Density-It is the ratio of the weight of powder to the minimum volume occupied in measuring cylinder. Tapped density is determined by placing a graduated cylinder containing a known mass of drug or formulation on a mechanical tapper apparatus which is operated at fixed no. of taps until the powder bed reached a minimum volume.

Tapped density (ρt) =Weight of powder blend/minimum volume occupied by cylinder. [16-18].

ρt= M/V

Compressibility Index (Carr's index).

Compressibility index is also known as Carr's index and can be obtained by employing the poured density and tapped density values of a material. Theoretically it can be said that the less compressible a material the more flowable it is [19]. It can be determined by substituting the values of poured density and tapped density in the equation given below.

Carr's index=Tapped density-bulk density /Tapped density×100

Hausner's Ratio

It is an indirect index of ease of measuring of powder flow. Lower Hausner's ratio (<1.25) indicates better flow properties than higher ones (>1.25)

Hausner's ratio=Tapped density/bulk density.

FORMULATION ORAL TABLET CONTAINING *SOLANUM VIARUM* EXTRACT-

The tablets were prepared as per the formulation described in table no.1. Each tablet of F1 was 300 mg consisting of 200 mg of drug and rest excipients and tablet F2 was 200mg consisting of 100 mg drug and rest excipients. The granules were then blended with appropriate quantities of magnesium stearate (as lubricant & anti-adherent) mentioned in table no1. These were compressed into tablets using tablet punching machine employing 9.7mm of punch and die. Five five batches of tablets were prepared and were evaluated.

Table 1. Composition of unit dose of oral tablet of *solanum viasrum.*

Sr.no.	Ingredients	Quantity per Tablet (mg)	
		F1300mg	F2 200mg
1	Plant extract	200 mg	100mg
2	Gelatin	40mg	40mg
3	Strach	20mg	20mg
4	Lactose	20mg	20mg
5	Talc	10mg	10mg
6	Magnesium stearate	10mg	10mg

F1-300MG **F2-2OOMG**

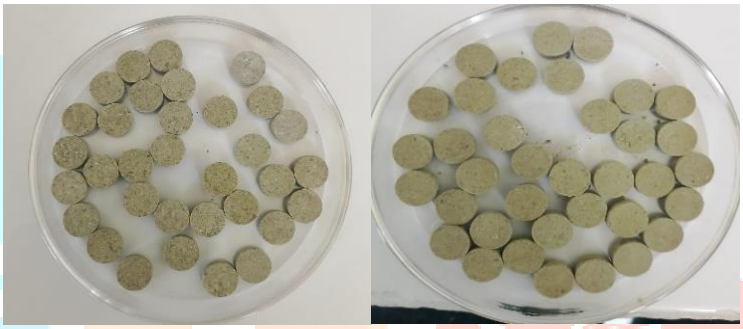


Fig-1. *Solanum viarum* leaves herbal tablet 300mg and 200mg.

POST FORMULATION STUDIES OF PREPARED HERBAL TABLETS-

The Polyherbal tablets were evaluated for various parameters like appearance, thickness, weight variation, hardness and friability.

Physical Appearnce-

The general appearance of tablet was studies visually in shape, colour, texture and odour.

Evaluation of prepared Tablets-

Prepared tablets were evaluated on the basis of following parameters

Thickness: -

It can be determined by randomly selecting ten tablets from each batch using vernier callipers [20]. All readings were taken thrice.

Hardness: -

It can be determined by randomly selecting ten tablets from each batch using a Monsanto Hardness Tester. the tablet was placed lengthwise between the lower plunger and force applied by turning a threaded bolt until the tablet fracture. The hardness of about 4 to 20 kg/cm2 is considered to be satisfactory for uncoated tablets [21].

Friability: -

Friability of the sample was measured using a Roche Friabilator. Ten pre-weighed tablets were rotated at 25rpm for 4 minutes. The tablets were then dusted and reweighed. Friability is generally the loss of weight of tablet in the container due to the removal of fine particles from the surface [22].

According to the standard limit friability should be <1% is calculated by formula:

% friability= (initial weight- final weight/initial weight) x 100

Acceptable limit = <1%

Weight variation: -

Ten tablets were randomly selected from each batch, individually weight; the average weight and percentage deviation from the average were calculated. It is done in order to ensure uniformity in the weight of tablets in a batch [23].

Disintegration time: -

Disintegration test was performed according to the Indian Pharmacopoeia specification. Six tablets were taken for the test and water was as the disintegration medium. The temperature of the medium was kept at 37°C, the beakers were filled at a volume of 800 ml and care was taken that the tablets were always below the level of the water at the highest and lowest position of basket-rack assembly. The discs were introduced over each tablet to avoid their floating of the tablets in the medium. The apparatus was operated until all the tablets were disintegrated [24].

Invitro dissolution study: -

in vitro dissolution study was performed by using a united state pharmacopoeia (USP) type-2 paddle apparatus at a rotational speed 50rpm. Exactly 900ml of 0.1N HCL is used as the dissolution medium and the temperature was maintained at 37° **c** + 0.5°c a sample of the solution was withdrawn from the dissolution apparatus at a specific time interval for 6 hrs and the same volume aced with pre-warmed fresh dissolution media.

Agitation speed :50rpm

Medium :0.1N HCL, 900ml

Temperature :37±0.5°C

Time :30 min of interval

Wavelength :274-356 nm

The sample were withdrawal at predetermined time point, diluted 10 mins, and were analysed spectrophotometrically at 274-356 nm invitro dissolution drug release was performed.[25]

INVIVO STUDY-

Analgesic Activity-

Tail immersion Method-. The Wistar rats (female sex) weighing between 200-250gm were divided into three groups each group having 4 animals. The animals were weighed and numbered appropriately. The group first considered as standard group and received Diclofenac sodium 10mg/kg. Second and Third groups received *Solanum viarum Dunal* leaf extract (T1 200mg/kg and T2 300mg/kg herbal tablet) respectively and the animals was vertical positioned to hang the tail, which was up to 5cm into a pot of hot water maintained at 55±0.5°C. the time in seconds to withdraw the tail out of water was taken as the reaction time. The reading was taken after 0, 30, 60, 120 and 180 minutes of administration of the test drugs.[26]

% analgesia = test latency-control latency x 100

(Cut-off time- control latency)

Antipyretic activity Brewer's yeast induced pyrexia in rats-Antipyretic activity on Wistar rats was performed with Brewer's yeast induced pyrexia. The rats (weight 150-200gm) were divided into three groups each containing four animals. Firstly, basal rectal temperature was taken by inserting 1-2cm of digital thermometer in rat rectum. After taking the basal rectal temperature, intraperitoneally 15% of Brewer's yeast injection in normal saline was injected to induce temperature at a dose of 10ml/kg of body weight. Later than 18hrs of injection, rats which showed a rise in temperature of at least 1ºc were taken for the study. Animals were treated with test and standard drugs after 18 hrs of yeast injection and temperature of rat's rectum was measured for 1, 2, 3 and 4 hrs after treatment.[27]

We can represent percentage reduction in rectal temperature as; eq.1

Where, Z represents initial rectal temperature (in0 c).

Y represents rectal temperature after 18hrs of administration of yeast (in0 c).

X represents rectal temperature after administration of extract (in0 c).

Result and Discussion-

Extraction Yield of Drug- The yield of methanol-water 50:50 extract was obtained 21.9 gm from the 500gm plant powder.

The percentage yield to be obtained from powder is 4.2 %.

Phytochemical Screening-

Table1. Phytochemical screening of *solanum viarum* plant extract

(+) present reaction **(-) absent reaction**

Phytochemical constituents	Test	Result
Test for alkaloids	• Dragandroff's test • Mayer's test	+ve +ve
Flavonoids	• Lead acetate test • Alkaline reagents	+ve +ve
Tannins	• Gelatin test • 10%NaoH • Ferric chloride	+ve +ve +ve
Saponin	• Foam examines • Bromine water	+ve +ve
Cardiac glycosides	• Kelerkelani • Bromine water examines	-ve -ve
Protein Amino acids	• Millions test • Ninhydrin test	-ve +ve
Carbohydrates	• Fehling's test	-ve

Evaluation of Granules- The angle of repose was found to be range of **32.07-29.25.** angle of repose was found to be best for formulation F2. Which showed the excellent flow, and lowest for which showed the good flow, since the angle of repose for all formulation was less than 30º exhibited excellent to good flow. (table no. 2) The bulk density was found to be in range of **0.42-0.37** as in table III. HT2 possessed the greatest bulk density followed by HT1. The tapped density was found to be in range of **0.48-0.47** as in table II. It was observed that there was not much difference between the tapped and bulk densities. This result helps in calculating the % compressibility of the granule. Then % compressibility of granule

was determined using Carr's compressibility index and was found to be range of **10.41-16.66** (Table III). compressibility index below 15% is a characteristic of good flow but reading above 25% indicate poor flow ability, HT2 formulation possesses excellent flow characteristic and F1 possesses fair characteristics. The Hausner ratio found to be range of **1.25- 1.2.** As the results were obtained within the limit so, granules will not cause any problem during tablet compression.

Evaluation of prepared Tablets-

Evaluation of prepared tablets. The tablets were described for their physical characteristic like general appearance, thickness, hardness, friability, weight variation, disintegration time, and in vitro drug release. The results of these studies are presented in Table IV. The tablets were elegant and standard concave in shape with the absence of any physical flaws or unpleasant odour. Tablets containing gelatin and magnesium stearate and pure form of solanum viarum were in greenish colour. The thickness varied from 3.0-4.0 mm for various formulations and did not show much variation amongst each other of the same formulation. The hardness varied from **6.7 Kg/cm^2± 0.20-6.9 Kg/cm^2± 0.40.** The values of standard deviation indicate that the hardness of all the formulation was almost uniform and the tablets possessed good mechanical strength to withstand shocks of handling, packaging and shipping without having negative effect on disintegration. The friability was found to be range of **5.7-6.1**, the highest shown by formulation HT2 and lowers formulation HT1. All the values were below 1% indicating that all the tablets possessed good formulation, showing enough resistance to the mechanical shock and abrasion. The % weight variations for all formulation were given in table IV. The entire formulation passed weight variation test since the results obtained were within the pharmacopoeia limits and hence, they passed weight variation test.

Table2. Data of different parameters of granules.

BATCH CODE	ANGLE OF REPOSE (Degree)	BULK DENSITY (gm/cm2)	TAPPED DENSITY (gm/cm2)	%CAR'S INDEX	HAUSNER'S RATIO
F1	32.07±0.02	0.42±0.1	0.48±0.02	16.66±0.06	1.25±0.1
F2	29.25±0.03	0.37±0.1	0.47±0.01	10.41±0.01	1.2±001

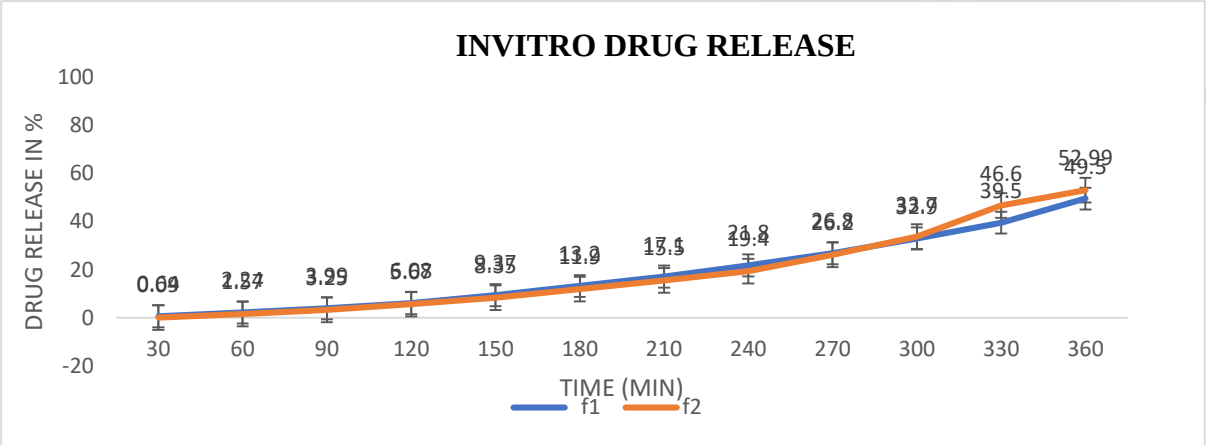
Table 3. Data of various tests of oral tablet of *Solanum viarum* tablets.

BATCH CODE	%WEIGHT VARIATIONS	THICKNESS (mm2)	HARDNESS (kg/cm2)	% FRIABILITY	DISINTEGRATION TIME
F1	0.014±0.001	0.4mm±0.1	6.7 Kg/cm^2± 0.20	5.7±0.1	28min6sec ±0.30
F2	0.015±0.001	0.3mm±0.1	6.9 Kg/cm^2± 0.40	6.1±0.1	22 min56sec± 0.40

Table4. Results of dissolution study test of herbal tablets

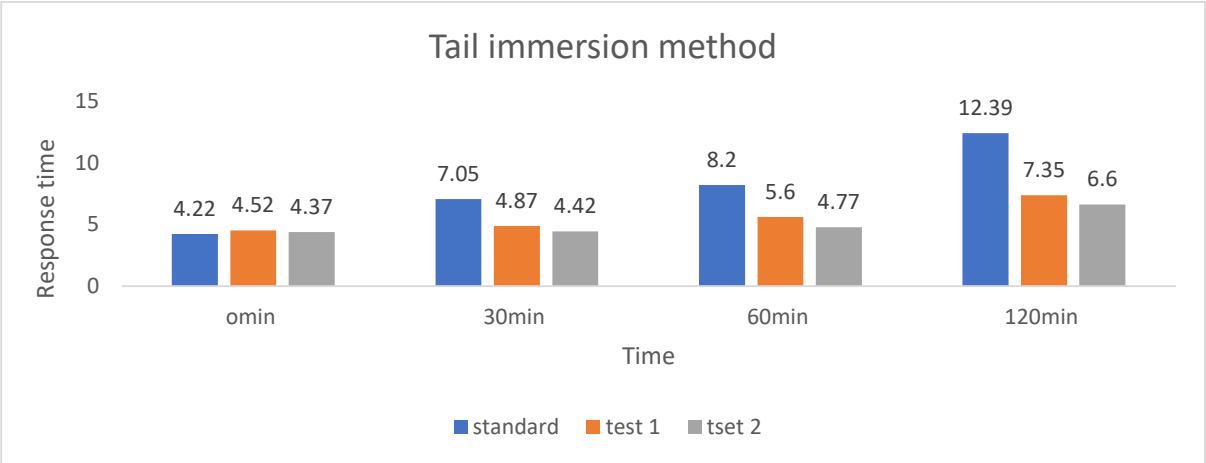
SR.NO	TIME	F1	F2
1.	30	0.64±0.015	0.99±0.01
2.	60	2.24±0.030	1.57±0.025
3.	90	3.99±0.144	3.35±0.026
4.	120	6.08±0.045	5.67±0.035
5.	150	9.37±0.025	8.35±0.015
6.	180	13.28±0.026	11.93±0.035
7.	210	17.19±0.030	15.51±0.030
8.	240	21.84±0.023	19.45±0.032
9.	270	26.88±0.025	26.28±0.030
10.	300	32.97±0.051	33.72±0.026
11.	330	39.53±0.015	40.68±0.020
12.	360	46.26±0.026	52.99±0.045

Graph 1. The percentage drug release record mentioned in graph.



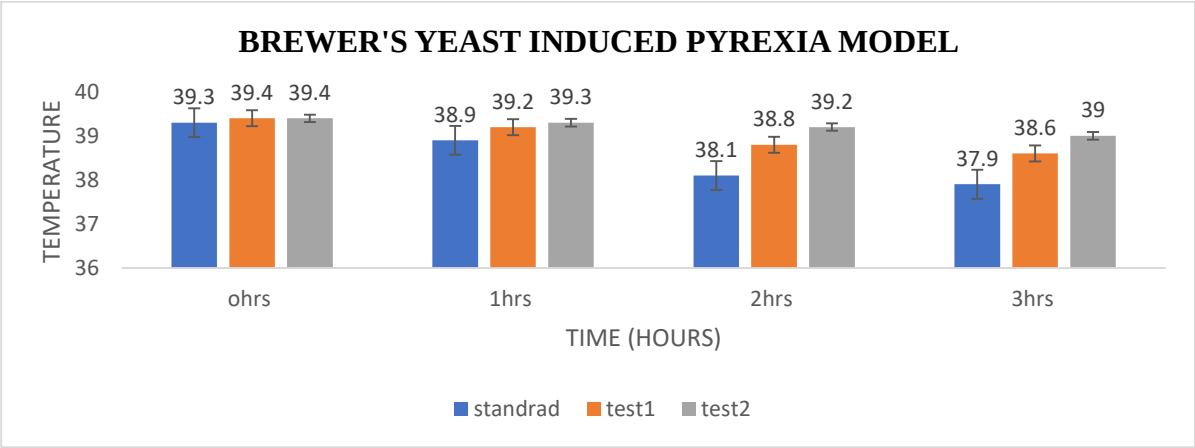
In-vivo study results-

N0. 2 Graphical representations of pain by tail immersion method-



In the analgesic activity significant difference was observed between the herbal tablet and diclofenac sodium treated groups. Graph 2 shows diclofenac sodium give **75%** pain inhibition in 120minutes and elicit significant analgesic activity within 30 minutes after administration and analgesic activity gradually increased with time. Similarly, the extract also shows significant analgesic activity within 30 minutes and activity also gradually increases with time. the test group1 showed **30%** minimum pain inhibition after 120 minutes while the test group2 showed **22%** minimum pain inhibition after 120 minutes of drug administration.

N0.3 Graphical representations of Fever by Brewer's Yeast Induced Pyrexia Model-



The result of antipyretic activity of the herbal tablet of the leaves of *Solanum viarum* dunal by Brewer's yeast induced pyrexia test are shown in Table 3 and graphically presented as Fig 3. The standard group showed **39.5 ℃** elevation in body temperature after 18h of brewer's yeast administration which was became **37.9 ℃** after 3h of (paracetamol) standard drug administration. Similarly, the test group1and 2 showed **39.4℃** elevation in body temperature after 18 h of brewer's yeast injection which was become **38.6℃** and **39℃** in 3 hrs after drug administration respectively.

Conclusion -

From the above study, we conclude that the herbal tablets were prepared by the wet granulation method and gave satisfactory and acceptable results. The results from the angle of repose, bulk density, tapped density, Carr's index and Hausner's ratio showed that the powder mixtures excipients we found that it also possesses good flow properties and does not cause any effect in tablet punching. The Physicochemical properties show satisfactory results which are within the range of prescribed standards required for investigation of the study. The general appearance of the tablet was found to be in proper shape, colour, texture. The results from different physical parameters like thickness, hardness, weight variations, diameter, friability and disintegration etc were within the acceptable range of prescribed standards. The study revealed that the composition ratio of ingredients of herbal tablets, not affect the stability parameters. The developed herbal formulation from *solanum viarum* and other excipients is a better formulation for Fever and pain. Phytochemical screening of all plant's extracts was found to be within specified limits. The physical properties of HT-1 to HT-2 were determined for the uniformity in weight, hardness, drug content and

friability which have complied with the official requirements, and comply with the official limits mentioned in USP. Their dissolution was assessed by using UV visible spectrophotometer.

In this study herbal tablet shows significant analgesic activity within 30 minutes and activity also gradually increases with time. The test group1 showed 30% minimum pain inhibition after 120 minutes while the test group2 showed 22% minimum pain inhibition after 120 minutes of drug administration. And, for antipyretic activity the test group1and 2 showed 39.4℃ elevation in body temperature after 18 h of brewer's yeast injection which was become 38.6 and 39℃ in 3 hrs after drug administration respectively. Based in the result of this study, it was concluded that *Solanum viarum* have analgesic and antipyretic activity when used orally at the dose of 300 and 200mg/kg.

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