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Effect of different drying methods on quality parameters of Gymnema (*Gymnema sylvestre* R.Br)

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Abstract
Gymnema sylvestre is an important medicinal woody climber belonging to the family Asclepidaceae. The leaves of this plant are in use for over 2000 years to treat diabetes, giving it a prominent place in the indigenous system of medicine. Sun drying is followed conventionally for drying Gymnema leaves. As sun drying has different varied environmental condition and contamination problem. Hence, to standardize the drying method with different type of dryers *viz.*, sun, shade, polyethylene solar tunnel dryer, mixed mode compound parabolic solar dryer (CPSD) and solar biomass hybrid. The result revealed that polyethylene solar tunnel dryer records lowest drying time (6h) and highest drying rate (0.62 g/h). Compound parabolic solar dryer (CPSD) recorded highest value for phenol (16.96 mg/g), flavonoid (2.28 mg/g), protein (15.70 mg/g), Chlorophyll A (1.15 mg/g), chlorophyll B (0.562 mg/g) and total chlorophyll (1.712 mg/g). Bioactive compound of Gymnema i.e., gymnemagenin was (29.03µg/ml). Though, polyethylene tunnel dryer showed the lowest drying time but mixed mode CPSD captitulate the best quality standards.

Keywords: *Gymnema sylvestre*, HPTLC, bioactive compound, drying

1. Introduction

Gymnema sylvestre is one of the anti diabetic plant. It has a prominent place in Indian system of medicine, over 2000 year. Gurmar and madhunashni are other popular names of the plant, it's main peculiar character is "inhibiting the taste of sweetness". It comes up well in Southern Western Region of China and India. In India it was found in the Forest's of Andhra Pradesh, Chhattisgarh, Kerala, Karnataka, Maharashtra, Madhya Pradesh, Tamil Nadu, Uttar Pradesh and West Bengal. It is a woody perennial slow growing climber of asclepediaceae family (Gulab *et al.*, 2012).

Leaves are the economic part, which are simple, opposite, hairy, ovate or elliptic. It contains numerous bioactive compounds mixture of tri-terpenoids and saponins such asgymnemic acid and gymnemagenin, which are the major component (Pandey, 2012) [15]. Leaves is used for stomachic, stimulant, laxative, diuretic, anti-sweetener, antibacterial, antiviral and antiinflammatory activities (Manohar *et al.*, 2009) [10]. It stimulates insulin release of pancreatic regeneration or mend and manage the glucose uptake and utilization (Manika *et al.*, 2013) [9]. Dried leaf power of Gymnema are used in formulation different product and composition of medicine.

Drying is an important fundamental and postharvest operation for medicinal crops. Moisture content should be 8-12% which is recommended by European pharmacopeia for various medicinal plants (Slipa *et al.*, 2019) [14]. By reducing the moisture control mould growth, fungal attack and retuning can be avoided. Besides it will occupy less space than fresh leaves, easy to transport and storage (Mahapatra *et al.*, 2007) [8]. During drying enzymatic and non-enzymatic process leads to changes in phytochemicals (Manika *et al.*, 2013) [9]. Drying technique mainly focus on qualitychacteristics such as colour, aroma as well as increase the efficiency of drying process (Thamkaew *et al.*, 2020) [16].

Traditionally open sun and shade drying are being practiced in Gymnema. These methods take more time for drying and quality inconsistent because of varied environmental conditions and contamination issues. Standardization of drying method is essential to obtain quality produce. It can be achieved by conducting experiment with different drying method. Since very less research work has been focused on Gymnema drying. Solar dryers are ecofriendly technology with economic benefits and the produce protects from environment, insect, pest and mould growth. Short time, high nutrient retention and superior quality such as texture, flavor and colour can be obtained by other conventional methods (Dwivedy *et al.*, 2012) [5].

Using solar dryers with forced air flow, quality and prevent losses of bioactive compound can be prevented to an extent and increasing the shelf life. Compartively, dried sample showed improved biochemical activity at low temperature drying than fresh leaves. It is inevitable to standardize the drying method for Gymnema. With this background the experiment conducted with different dryers.

2. Materials and Methods

The experiment was carried out at the Department of Medicinal and Aromatic Crops and Department of Renewable Energy Engineering, TNAU, Coimbatore. The plant material was collected from Gymnema field. Drying was carried out from 9.00 AM to 5.00 PM. During this period, the plant sample were weighted at every one hour interval. After 5.00 PM the sample were packed in air tight polythene bag and next day morning the drying is continued, till the produce reaches safe moisture. Drying experiment was carried out with five type of drying sun, shade, polyethylene solar tunnel dryer, mixed mode compound parabolic solar dryer (CPSD) and solar biomass hybrid dryer. Three replications were used in this study with completely randomized block design (CRB).

2.1 Drying methods

Five different type of drying was followed sun drying, shade drying, polyethylene solar tunnel dryer, CPSD mixed mode dryer and solar biomass hybrid dryer.

2.1.1 Sun drying

Sun drying is carried out in open environmental condition. Samples are placed in aluminum tray bored with wire mesh to protect the sample from wind.

2.1.2 Shade drying

Shade drying is carried out under shade at Department of Medicinal and Aromatic Crops. The samples are evenly spread in plastic trays and kept for drying.

2.1.3 Polyethylene solar tunnel dryer

Solar tunnel dryer works based on the principle of "greenhouse effect". It mainly consists of a semi-cylindrical tunnel structure, covers with ultra violet stabilized low-density Polyethelene (LDPE) as collector material. Absorber surface is made up of cement concrete floor coated with special black to increase the absorptivity. It results to 15-20°C increase in temperature above ambient temperature inside the solar tunnel dryer which is quite sufficient to dry various produce to the level of safe storage moisture.

2.1.4 CPSD mixed mode dryer

Compound Parabolic Solar Dryer (CPSD) i.e., Compound Parabolic Collector (CPC) combined with vertical drying chamber is mixed mode dryer was a combination of direct and indirect method of drying. The produce is dried concurrently by both direct radiation and by natural convection from the collector heating the entering air. The mixed-mode dryer has been found to be the most effective in terms of the time it takes to dry the produce. It contain cylindrical vertical chamber made up of polycarbonate sheet and indirect dryer has a compartment called collector, in which the air from outside passes through that and heated. The hot air blown into the drying chamber. Increasing the collector area increases the area available for insolation and thus reduces the drying time.

2.1.5 Solar biomass hybrid dryer

The Solar Biomass Hybrid Dryer is a hybrid source of drying, in which solar mode can be used during day hours and biomass mode can be used during off-sun shine hours and is especially useful for drying during rainy periods of the year. The locally available biomass can be used as fuel in the dryer *viz.*, coconut husk, coconut shell, coconut rachies and wood. The dryer comprised mainly of evacuated tube collectors, biomass furnace, heat exchanger, drying chamber equipped with a forced blower and chimney, and perforated aluminium trays.

2.2 Performance evaluation of various drying methods

2.2.1 Drying parameters

The performance evaluation of various drying methods is carried out by portable solar radiation meter, temperature and humidity meter. The drying temperature and RH observed in the middle tray of all the dryers and solar intensity, ambient temperature (Fig. 1) and relative humidity (Fig. 2) also recorded. The drying time was calculated by time taken to reduce the moisture content upto the resired safe moisture. Drying rate is calculated for all the drying method by considering the weight reduction in the sample (5g) for every one hour using by weighing balance. Moisture content was estimated by electronic moisture analyzer (Sartorius MA 35) and expressed in percent (Silpa *et al.*, 2019) [14]. Lovibond colour meter is used for measurement (Lovibond LC 100, model RM 200 portable spectrometer, Tintometer limited, Salisbury, UK). The system of colour representation are L* a*b* as per the commission. The *L** value corresponds to a dark-bright scale and represents the relative lightness of colors with a range from 0 to 100 (0=black, 100=white). Values of *a** and *b** represents hue (colour). The *a** and *b** values extend from -60 to 60; *a** negative is for green and *a** positive is for red, and *b** negative is for blue and positive for yellow (Silpa *et al.*, 2019) [14].

2.2.2 Biochemical analysis
Total chlorophyll content, total phenol content, total flavonoid content, protein content and gymnemagenin content (HPTLC) were analysed.

chlorophyll A, chlorophyll B content were determined by following the procedure of Durga *et al.*, 2015 [4] using formula and total chlorophyll estimated from that. The estimation of protein was done by lowry's method for Gymnema powder (Lowry *et al.*, 1951) [7]. It was expressed in mg/ g. The phenol content in the extract was determined by folin ciocalteau procedure (Dwivedy *et al.*, 2012) [5]. The absorbance was taken at 660nm using spectrophotometer. Gallic acid is used for standard curve and expressed in mg/g. The flavonoid content of dried power sample is evaluated by aluminum chloride colorimetric methodas per in (Chandra *et al.*, 2014) [3].

2.2.3 Quantitative analysis (Gymnemagenin by HPTLC)
2.2.3.1 Sample extraction
The sample was grinded to powder for and 1g of powdered sample was taken with 10 ml of methanol and sonicated for 10 minute followed by centrifuge. Supernatant was collected and used as extract. The extract were analyzed in High Performance Thin Layer Chromatography (HPTLC). Standard gymnmagenin was purchased from sigma Aldrich. All other chemicals used in this experiment were analytical grade.

2.2.3.2 HPTLC analysis
Sample was applied on the Merck pre coated silica gel aluminum (10*10) plate 60 F254 with automated TLC sampler linomat V (camag, muttenz, Switzerland) and controlled by Win CATS software 3.0.

After application of sample on plate, it was dipped in 10*10 twin trough glass chamber with mobile phase of toluene-ethyl acetate-methnol-formic acid (60:20:15:05 v/v). The length of chromatogram run was 70mm. Then, the plate again dipped into derivatization reagent (5% modified vanillin sulphuric acid reagent) and heated with 110 °c for 3 mins in a preheated oven. A TLC scanner III with Win CATS software was used for scanning the TLC plate and observed at 366nm (Figure 5)

3. Result and Discussion
The experiment conducted on different drying method on quality parameter of *Gymnema sylvestre* revealed that significant difference was observed for various drying parameters *viz.*, drying time, drying rate and colour measurement and biochemical parameter *viz.*, chlorophyll A, chlorophyll B, total chlorophyll content, phenol, flavonoid, protein and gymnemagenin.

3.1 Effect of different drying methods on drying time
The effect of different drying method on Gymnema showed that polyethylene solar tunnel dryer recorded minimum time of 6 hours for drying, while shade recorded maximum time 56 hour (Fig. 3). Similar result was obtained by Dwivedy *et al.*, (2012) [5] for borage leaves, drying in mechanical dryer (5 min). Reduction in drying time with good quality retention was obtained in solar dryer due to uniform drying environment. The result was in accordance with Bala and Serm (2009) [1].

3.2 Effect of different drying method on drying rate
Drying rate was maximum in polyethylene solar tunnel dryer (0.62g/h) followed by solar biomass hybrid dryer (0.43 g/h) while shade dry (0.06g/h) recorded the minimum value (Fig.4). The result accordance with drying rate of coleus (0.370 g/mins). The increased drying rate in polyethylene solar tunnel dryer due to high temperature flavored the increased rate of moisture removal (Padmapriya and Rajamani, 2016) [11].

3.3 Colour meter
Colour meter value was represented by L*, a*, b*. In this experiment, there is no significant different for L value among the drying methods. Greenness was maximum was in CPSD mixed mode dryer (-6.52)) and minimum in sun drying (-7.58). The b* value indicates yellowness in sample which was high in polyethylene tunnel dryer (24.14) and lowest in shade dry method (17.04). Even though the a* value reduced, they are still in greenness and high b* value indicates sample were in greenish yellow colour. The result was accordance with Dwivedy *et al.*, (2012) [5] conformed to borage leaves. The reason for colour change in different drying method due to high temperature, oxidation, non enzymatic reaction (Lakshmi *et al.*, 2019) [14] and by magnesium ion (Buchaillot *et al.*, 2009) [2].

3.4 Effect of different drying method on total chlorophyll content
The maximum chlorophyll (A, B, Total) content retained in CPSD mixed mode drier (1.15 mg/g, 0.562 mg/g and 1.712 mg/g) but which on par with Solar biomass hybrid dryer(Table 2). The lowest value was found at polyethylene solar tunnel dryer which was 0.733, 0.374 and 1.107 mg/g. For chlorophyll (A, B, Total) may due to high temperature in drying to change to pheophytin from chlorophyll. The result was accordance with silpa *et al.* (2019) [14].

3.5 Effect of different drying method on Phenol, Flavonoids and Protein
Phenolic and flavonoid component of plant are main for natural antioxidant. CPSD mixed mode dryer retained maximum value for phenol (16.96 mg/g), flavonoid (2.28 mg/g), protein (15.70 mg/g) and lowest value observed for phenol (6.59 mg/g), flavonoid (0.66 mg/g), protein(10.87) in sun drying. Depending on covering material, temperature and ultraviolet radiation affect the sample during solar drying. Consequently, bioactive compounds degradation will be dependent on drying temperature, UV radiation, drying time and moisture content (Juan *et al.*, 2021). In this experiment,

CPSD mixed mode dryer has food grade plastic (polycarbonate, code-6) which protect the sample from high solar irradiation. Uniform hot air flow was supplied through two mixing fan one at bottom of tray stacked and top of tray stacked.

3.6 Effect of different drying method on gymnemagenin

CPSD showed high value (29.03 µg/ml) followed by shade dry (26.28 µg/ml) and sun dry shows lowest value (10.77 µg/ml). This is due to controlled temperature which has not exceed 31°C (Fig. 1) and had uniform drying in all over the dryer. The findings is accordance with Slipa *et al.*, (2019) [14] that cabinet dryer recorded high bacoside A content (2.02%) in brahmi.

Table 1: Effect of different drying method on drying parameters

Methods of drying	Initial wt (g)	Final wt (g)	Initial moisture (%)	Final moisture (%)	Time (hour)	Drying ratio
Sun drying	250	70.92	74	7	20 h	3.5
Shade drying	250	70.92	74	7	56 h	3.5
Polyethylene solar tunnel dryer	250	70.92	74	7	6h	3.3
CPSD mixed mode dryer	250	75.97	74	7	12 h	3.5
Solar biomass hybrid dryer	250	72.18	74	7	7 h	3.5

Table 2: Effect of different drying methods on biochemical parameter

Methods of drying	Chlorophyll A (mg/g)	Chlorophyll B (mg/g)	Total Chlorophyll (mg/g)	Colour value			Phenol (mg/g)	Flavonoid (mg/g)	Protein (mg/g)
				L*	A*	B*			
Sun dry	0.9	0.415	1.341	70.18	-7.58	17.5	6.59	0.66	10.87
Shade dry	0.926	0.481	1.381	71.83	-7.11	17.04	13.78	1.34	14.22
Polyethylene solar tunnel dryer	0.733	0.374	1.107	75.32	-7.34	24.14	16.22	1.64	14.63
CPSD mixedmode solar dryer	1.15	0.562	1.712	71.18	-6.59	17.72	16.96	2.28	15.70
solar biomass hybrid drier	1.179	0.492	1.671	72.94	-6.52	20.84	11.78	1.53	13.91

Table 3: Effect of different drying on gymnemagenin

Different drying method	Gymnemagenin (µg/ml)
Sun dry	**10.77**
Shade dry	**26.28**
Polyethylene solar tunnel dryer	**15.03**
CPSD mixed mode solar dryer	**29.03**
solar biomass hybrid drier	**19.73**

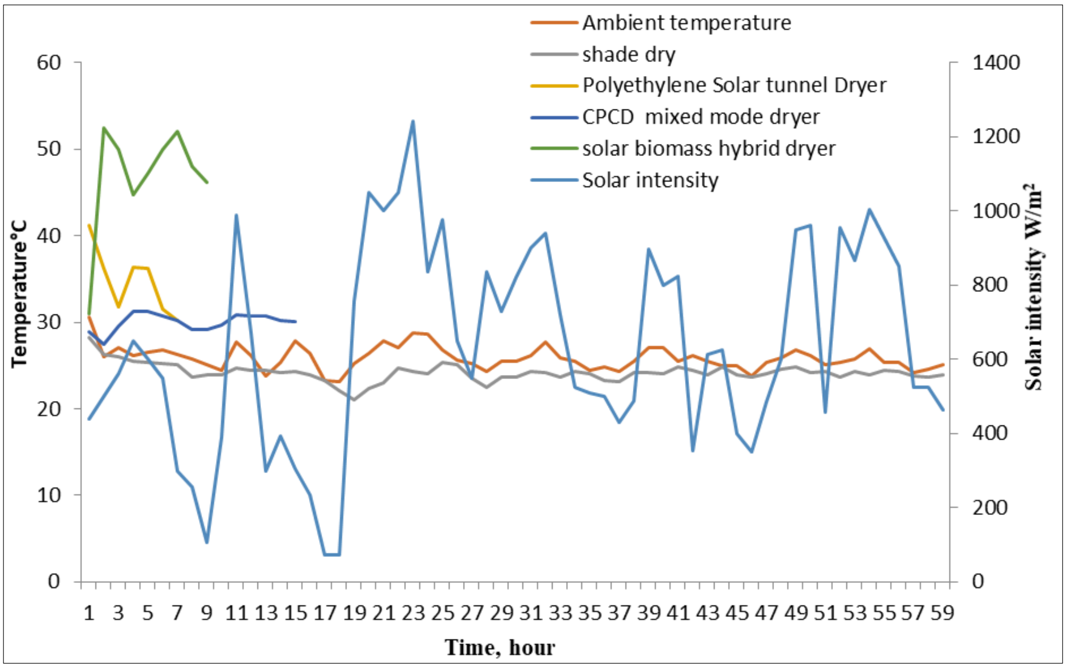

Fig 1: Solar intensity and drying temperature under different drying method

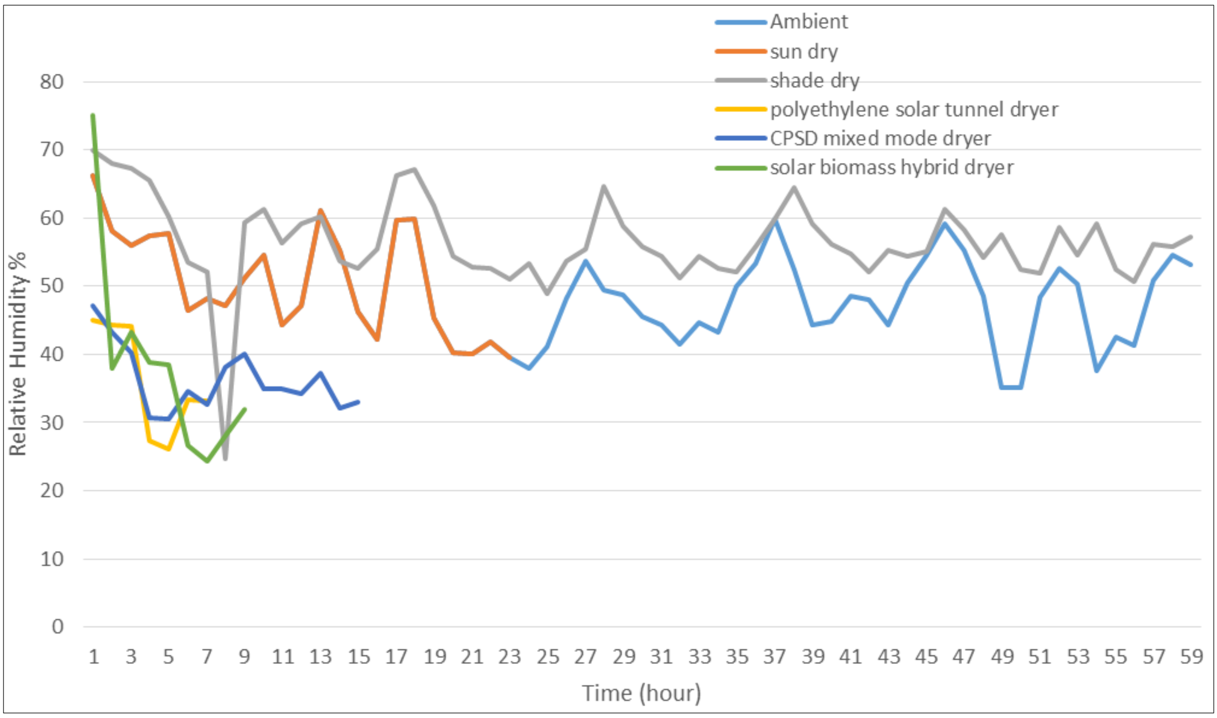

Fig 2: Experimental weather parameters under various drying methods (Relative Humidity %)

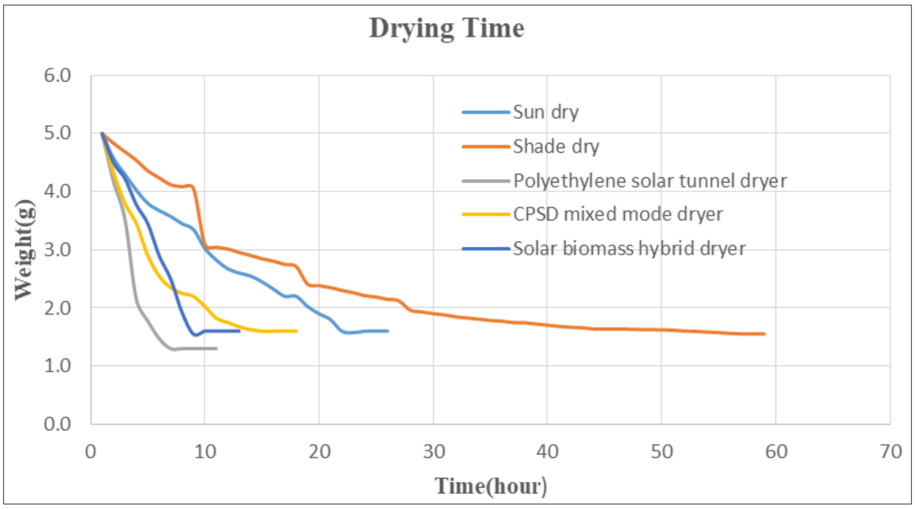

Fig 3: Weight reduction over a period of drying time

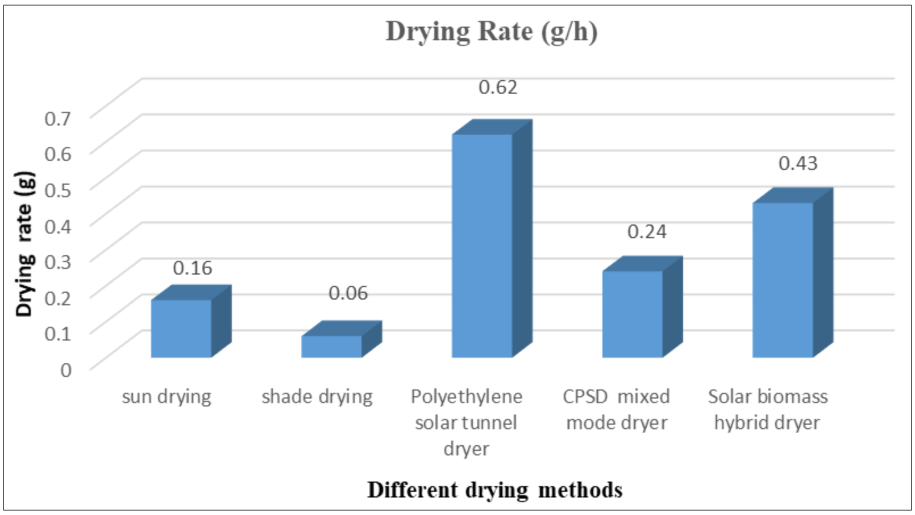

Fig 4: Drying rate of different drying methods

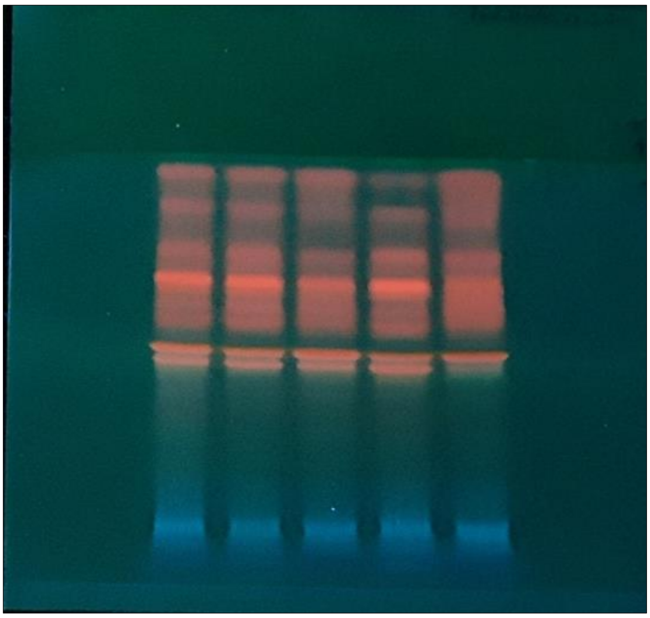

Fig 5: HPTLC 366 wave length chromatogram

4. Conclusion

The study conducted on effect of different drying methods on quality parameters of Gymnema revealed that CPSD mixed mode solar was found to be best. In drying parameters vi drying time, drying rate high value found at polyethylene solar tunnel dryer but colour retention was good at CPSD. In biochemical analysis phenol, flavonoid, protein and bioactive content gymnemagenin also high in CPSD mixed mode solar dryer. This is due to uniform drying, controlled temperature, humidity and using food grade plastic as covering material these things reduced the degradation of component.

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