IJPPR
INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH
An official Publication of Human Journals
ISSN 2349-7203
HUMAN

Human Journals
Research Article
July 2021 Vol.:21, Issue:4

Novel Delivery for Diabetes: Development and Characterization TDP Saxagliptins

IJPPR
INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH
An official Publication of Human Journals
ISSN 2349-7203
HUMAN

Tushar Verma[1*], Gayatri Daheriya[2]

[1]Department of Pharmaceutics, Assistant Professor ISBM UNIVERSITY, Nawapara, Chhura, Gariyaband (C.G) India.*

[1]M. pharmacy, Department of Pharmaceutics, Lakshmi Narain College of Pharmacy Bhopal (M.P), India

Submitted: 21 June 2021
Accepted: 27 June 2021
Published: 30 July 2021

Keywords: Novel delivery system, Transdermal patch, Type 2 diabetes, Saxagliptin

ABSTRACT

The spark investigational study is topically novel delivery system Transdermal patch (TDP) development and characterization of Saxagliptin is achieved novel topical instant and prolong delivery system for systemic circulation under the specific manner innovative formulation. The majestic TDP system is important executing this goal and the drug achieved absolute systemic circulation by the topical route with lack of skin related (irritation, penetration affected area, drug concentration absorption) discomfort and therapeutic quantity of dose. The development of TDP with hydrophilic polymer which is intended to increase the bioavailability by penetrating poorly water-soluble drug through the surface of the skin and also making possible to avoid hepatic first pass metabolism. The entrapment of Saxagliptin in TDP consisting insulin dependent antidiabetic for type 2 diabetes selectively DPP4 Inhibition with half maximal inhibitory concentration (IC50) is 0.5nmol/L. The formulation has developed with scientific laboratory code numbering F1 to F6 all the formulation determination active dose with FTIR study under the interaction and purity of drug. All films evaluate for their physical parameters of general TDP and stability study done according to ICH Guideline further conformed by spectral data conformational. During investigational study formulation F4 show positive evaluation (Moisture content, Moisture uptake, Folding endurance, Maximum drug content) results.

INTRODUCTION[1, 2, 3, 4]

In diabetic type-2 condition, the active drug dosing is more complex associate with conventional dosage form and patient has also discomfort resulting the active drug study state level disturbed and dose frequency is high. The multiple dosage, first pass metabolism, discomfort painful medication, patient condition also the common problem associate with other conventional dosage form. Poor bioavailability, tendency to produce rapid blood level spikes and leads to frequent dosing their all problem needs to suitable drug delivery system. The present innovative study consummates this problem TDP having the capability to treat the slow-release pattern it provides sustained release, suitable bioavailability and systemic circulation through skin at predetermine rate with minimal inter and interpatient variation with use friendly. The Saxagliptin TDP has prepare by solvent casting method with hydrophilic polymer drug release according to conducted by Franz diffusion apparatus compare low to high concentration polymer, HPMC and Eudragit L-100 low concentration polymer and increase the moisture absorption capacity and less moisture contain and the polymer suitable for TDP.

Solvent Casting Method[5]

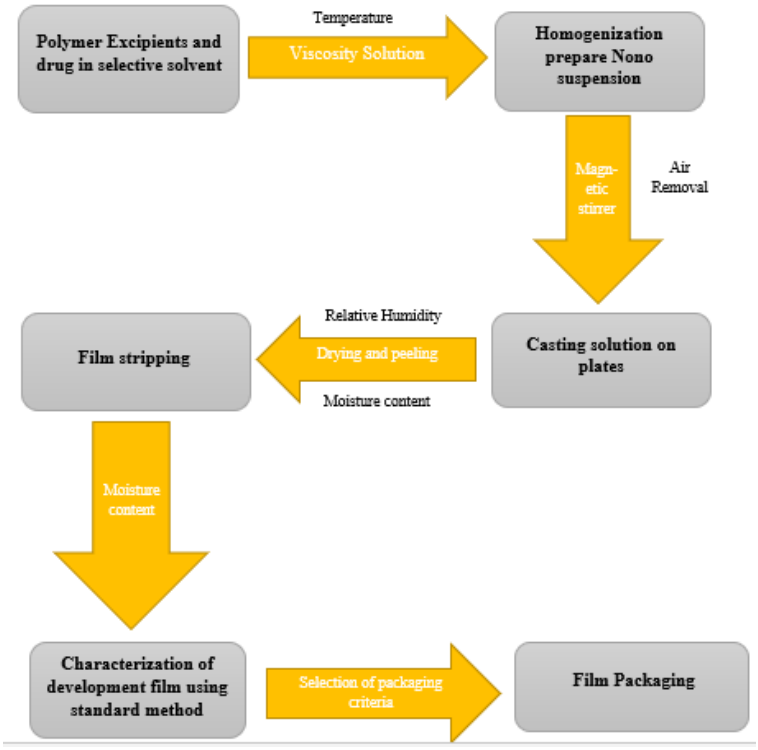

Figure No. 1: General Method of Solvent Casting

❖ **Merits of Solvent casting Method**

✓ Provides new inert texture suspension/solution in aseptic condition

✓ Useful for dilute as high concentration suspension/solution

✓ Poor soluble drug treats both aqueous and organic media

✓ Provide good concentration of suspension/ solution

✓ No problem with large batches

✓ Increase physical and chemical stability

❖ **Merits of TDP for Diabetic diseases**

✓ Reduce or Limited multi dosing system

✓ Provide multi day dosing

✓ Easy to active drug receptor binding

✓ Lack of lag time

✓ Increase bioavailability of drug

✓ Easy to administrate the active drug on body and self-medication

❖ **METHODS AND MATERIALS**

Saxagliptin[6,7,8,9]

Saxagliptin is an active hypoglycaemic (anti-diabetic drug) of the new dipeptidyl peptidase-4 (DPP-4) inhibitor class of drugs. FDA approved on July 31, 2009; we get the saxagliptin as active agent gift sample from Aurobindo pharmaceutical company.

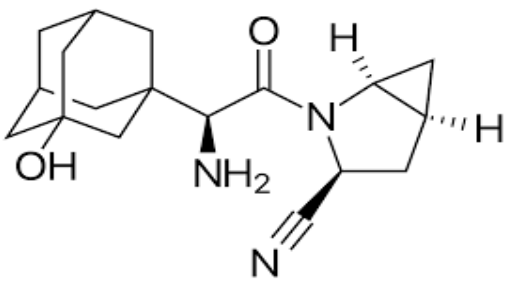

Figure No. 2: Structure of Saxagliptin

Post-administration of saxagliptin, GLP-1 and GIP levels rise up to 2- to 3- fold. Because it is very selective of DPP-4 inhibition, there are fewer systemic side effects. Saxagliptin inhibits DPP-4 enzyme activity for a 24-hour period. It also decreased glucagon concentrations and increased glucose-dependent insulin secretion from pancreatic beta cells. The half maximal inhibitory concentration (IC50) is 0.5 nmol/L. Saxagliptin did not prolong the QTc interval to a clinically significant degree. Incretins decrease blood sugar by increasing consumption of sugar by the body, mainly through increasing insulin production in the pancreas, and by reducing production of sugar by the liver. [Bristol-Myers Squibb Press Release] DPP-4 is a membrane associated peptidase which is found in many tissues, lymphocytes and plasma. DPP-4 has two main mechanisms of action, an enzymatic function and another mechanism where DPP-4 binds adenosine deaminase, which conveys intracellular signals via dimerization when activated. Saxagliptin forms a reversible, histidine-assisted covalent bond between its nitrile group and the S630 hydroxyl oxygen on DPP-4. The inhibition of DPP-4 increases levels active of glucagon like peptide 1 (GLP-1), which inhibits glucagon production from pancreatic alpha cells and increases production of insulin from pancreatic beta cells. Adverse reactions reported in ≥5% of patients treated with saxagliptin and more commonly than in patients treated with placebo are: upper respiratory tract infection, urinary tract infection, and headache.

Hydroxypropyl methyl cellulose[10,11]

Hypromellose is a solid, slightly off-white Powder; It's a Nontoxic Ingredient, Semisynthetic polymer. We get HPMC form Loba Chemie Pvt Ltd Mumbai.

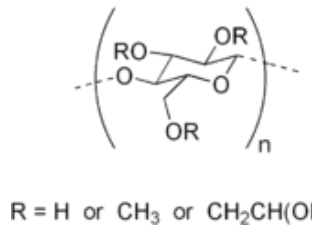

Figure No. 3: Hydroxypropyl methylcellulose

Hypromellose, short for hydroxylpropyl methylcellulose (HPMC), is a semisynthetic, dormant, viscoelastic polymer utilized as an ophthalmic oil, and additionally an excipient and controlled-conveyance segment in oral medicaments, found in an assortment of business items. As a nourishment added substance, hypromellose is an emulsifier, thickening and

suspending operator, and another option to creature gelatin. Its Codex Alimentarius code (E number) is E464. It is by and large perceived as sheltered by the FDA.

Eudragit S100[12, 13]

It is a solid substance in form of a white powder with a faint characteristic odour.We get Eudragit S100 form Loba Chemie Pvt Ltd Mumbai. Eudragit s 100 is anionic copolymer based on methacrylic acid and methyl methacrylate.

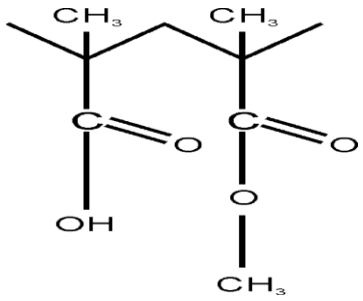

Figure No. 4: Structure of Eudragit S100

1 g of EUDRAGIT® L 100 or EUDRAGIT® S 100 dissolves in 7 g methanol, ethanol, in aqueous isopropyl alcohol and acetone (containing approx. 3 % water), as well as in 1 N sodium hydroxide to give clear to cloudy solutions. EUDRAGIT® L 100 and EUDRAGIT® S 100 are practically insoluble in ethyl acetate, methylene chloride, petroleum ether and water.

- **Identification Test**

FTIR Spectroscopy

Identification of Saxagliptin was done by FTIR Spectroscopy (Brucker, Alpha, Germany) with respect to marker compound. Saxagliptin was obtained as white powder. It was identified from the result of IR spectrum as per specification. Sample of pure Saxagliptin.

Determination of λ_{max} of Saxagliptin

The λ_{max} of Saxagliptin was determined by running the spectrum of drug solution in double beam ultraviolet spectrophotometer (Labindia 3000+ Mumbai) From stock solutions of Saxagliptin 1 ml was taken and diluted up to 10 ml. from this solution 0.2, 0.4, 0.6, 0.8 and 1 ml solutions were transferred to 10ml volumetric flasks and make up the volume up to 10 ml

with phosphate buffer, pH 7.4, gives standard drug solution of 2, 4, 6, 8, 10µg/ ml concentration.

Preparation and characterization of transdermal patches

Saxagliptin containing transdermal patch was prepared utilizing method given by with slight modification. The casting solution was prepared by dissolving weighed quantities of HPMC and ethylcellulose, Eudragit L-100 in 10 mL of methanol and dichloromethane mixture in ratio 1:2. To the resulting solution, 0.5% w/w of propylene glycol as plastisizer and 10% w/w penetration enhancer was added in this solution. Then drug (60mg) was added and mixed thoroughly to form a homogeneous mixture. The casting solution was then poured into glass mould/Petri dish specially designed to seize the contents. The glass mould containing the casting solution was dried at room temperature for 24 hours in vacuum oven. The patch was removed by peeling and cut into round shape of 1 cm^2. These patches were kept in desiccators for 2 days for further drying and enclose in aluminum foil and then packed in self-sealing cover.

Table No. 1: Formulation used for Optimization TDP

Formulation Code	Drug (mg)	HPMC (mg)	Eudragit L-100 (mg)	Ethyl cellulose (mg)	Total polymer weight (mg)	Propylene glycol (Plasticizer) % w/w	Permeation Enhancer % w/w
F1	60	450	-	50	500	0.5	10
F2	60	425	-	75	500	0.5	10
F3	60	400	-	100	500	0.5	10
F4	60	450	50	-	500	0.5	10
F5	60	425	75	-	500	0.5	10
F6	60	400	100	-	500	0.5	10

- **Characterization of transdermal patches**

Microscopic pictures of transdermal patches

Microscopic pictures of all the formulations were observed using an electronic microscope with digital camera to determine the surface of the films formed and uniform dispersion of

drug and polymer. In addition to microscopic study, transdermal patches were evaluated for their physicochemical characteristics.

Thickness

Patch thickness was measured using digital micrometer screw gauge at three different places, and the mean value was calculated.

Percent moisture content

Weighed individually the films ($1cm^2$) and kept them in desiccators containing calcium chloride at room temperature for at least 24 hours. Film was weighed again; the difference in weight (initial and final weight) gives moisture content.

$$\%\ Moisture\ content = \frac{Intial\ weight - final\ weight}{\text{Intial weight}} \times 100$$

Percent moisture uptake

Weighed individually the films and kept them in desiccator containing calcium chloride at room temperature for at least 24 hours. Remove the films from desiccators and exposed to 4% relative humidity (Rh) using saturated solution of potassium chloride in another desiccator until a constant weight is achieved.

$$\%\ Moisture\ content = \frac{Final\ weight - Intial\ weight}{final\ weight} \times 100$$

Folding endurance

This was determined by repeatedly folding one film at the same place until it broken. The number of times the film could be folded at the same place without breaking / cracking gave the value of folding endurance.

Tensile Strength

The tensile strength of the patch was evaluated by using the tensiometer. It consists of two load cell grips. The lower one was fixed and upper one was movable. Film strips with dimensions of 2×2cm were fixed between these cell grips, and force was gradually applied till the film broke. The tensile strength was taken directly from the dial reading in kg.

$$Tensile\ Strength\ (s) = \frac{Applied\ force\ (m * g)}{Cross\ sectional\ area(b * t)}$$

Where, S = tensile strength, m = mass in grams, g = acceleration due to gravity, b = breadth of strip in centimetres, t = thickness of strip in centimetres

Drug Content

The patches 2.5×2.5 cm (Equivalent to 25 mg of drug) were taken into a three separate 10 ml volumetric flask and dissolved in methanol (10ml) with the help of shaker. The solution was centrifuged to separate out any particulate matter. 1ml of sample was withdrawn and transferred in volumetric flask (10 ml of capacity). The sample was dilute up to the mark with methanol and dilute suitably and analyzed by UV spectrophotometer at 210.0 nm.

Stability Studies

Stability studies were carried out with optimized formulation which was stored for a period of one, two and three months at 40±2ºC temperature and 75±5% relative humidity for a period 3 months. The % Assay of formulation was determined by U.V. spectrophotometer using calibration curve method. The % assay was found to slightly decrease at higher temperature. Minor difference was found between evaluated parameters before and after ageing/storage and all was in acceptable limits. Therefore, formulation remains stable for sufficient time.

❖ RESULTS AND DISCUSSION

Identification Test using FTIR Spectroscopy

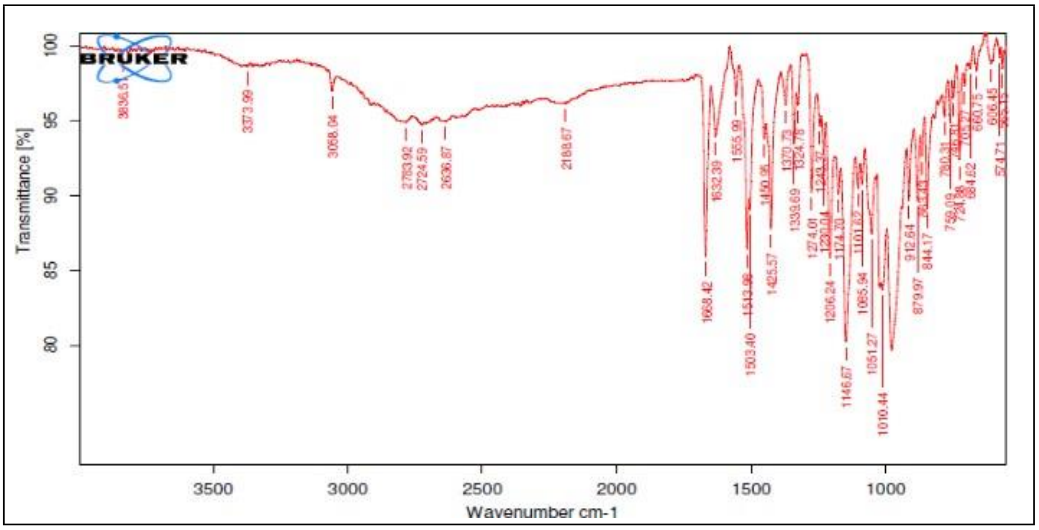

Figure No. 5: FT-IR Spectrum of Pure Drug (Saxagliptin)

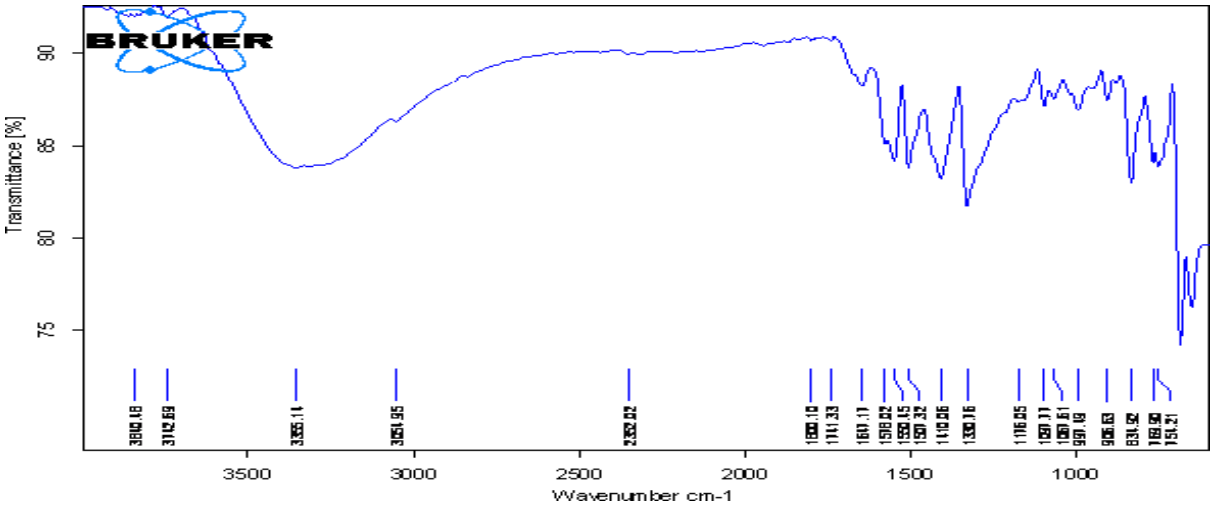

Figure No. 6: FT-IR Spectrum of sample (Saxagliptin)

Determination of λ max of Saxagliptin

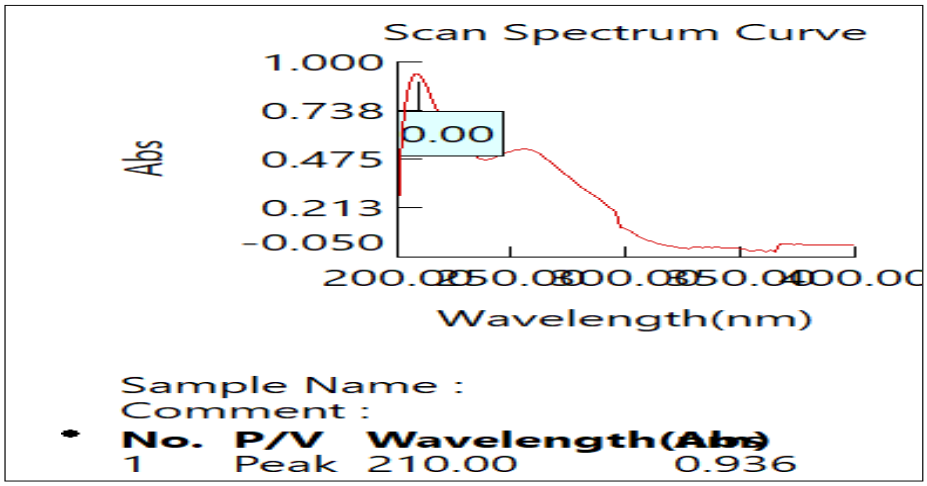

Figure No. 7: U.V. Spectra of Pure Drug (Saxagliptin)

Calibration curve of Saxagliptin at λ max210nm

Table No. 2: Calibration curve of Saxagliptin in phosphate buffer pH 7.4

S. No.	Conc. µg/ml	Absorbance* (Mean ±SD)
1.	2	0.165 ± 0.001
2.	4	0.357 ± 0.002
3.	6	0.559 ±0.001
4.	8	0.729 ±0.002
5.	10	0.936 ±0.001

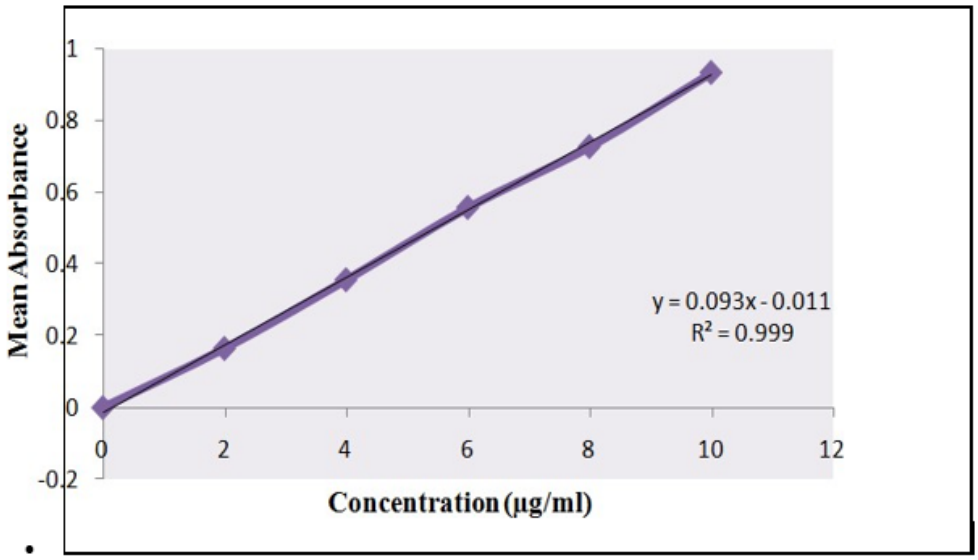

Figure No. 8: Calibration Curve of Saxagliptin in phosphate buffer pH 7.4 at 210 nm

Statistical Data for Linearity

Table No. 3: Statistical Data for Linearity

S.No.	Parameter	Remark
1.	Linearity Range	2-10 µg/ml
2.	Regression Equation	Y = 0.093x - 0.011
3.	Correlation Coefficient	0.999

Characterization of transdermal patches

Microscopic View of transdermal patches

Microscopic View of all the formulations (F-1 to F6) were observed using an electronic microscope with digital camera to determine the surface of the films formed and uniform dispersion of drug and polymer.

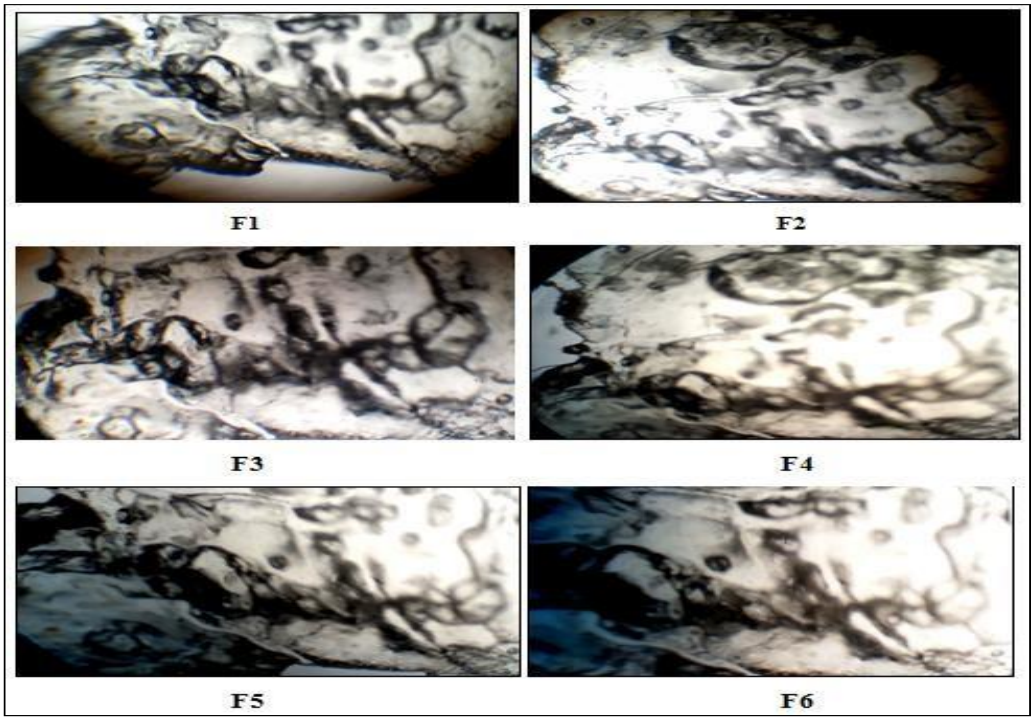

Figure No. 9: Microscopic View of all the formulations (F-1 to F6)

Thickness

Table No. 4: Thickness of all formulation

S. No.	Formulation Code	Thickness*(mm) (Mean ± S.D)
1.	**F1**	26.65±0.45
2.	**F2**	29.98±0.32
3.	**F3**	30.25±0.65
4.	**F4**	32.25±0.58
5.	**F5**	32.14±0.41
6.	**F6**	30.65±0.27

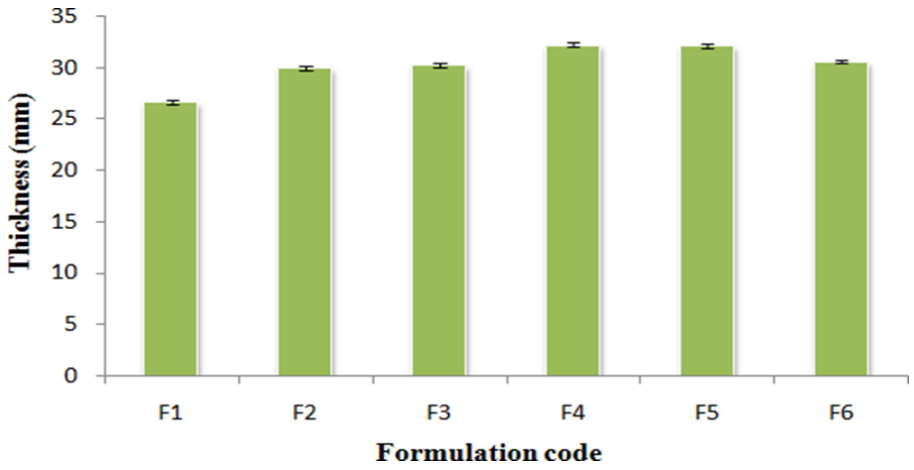

Figure No. 10: Thickness of transdermal patches

Percent moisture content

Minimal moisture absorption rates ranging from 0.65±0.05 to 0.35±0.03% thus ensuring general stability and protection from microbial contamination and increase in the HPMC concentration increased the moisture absorption capacity. All the formulation show lowest moisture content i.e. less than 01%. Moisture in this value is required to provide strength and flexibility to the patches. Formulations F1, F2, F3, F4, F5 and F6 were found to be contains 0.65±0.05, 0.56±0.04, 0.45±0.06, 0.35±0.03, 0.45±0.05 and 0.39±0.04% of moisture content respectively. Therefore, formulation F4 which is having HPMC (450mg) and Eudragit L-100 (50mg) showed significantly less moisture content.

Percent moisture uptake

The weighed films were kept in desiccators (Borosil Hyderabad, India) at room temperature for 24 hours and then exposed to 4% relative humidity using a saturated solution of potassium chloride. Finally, the films were weighed and the percentage of moisture uptake is calculated as the difference between the final and initial weight with respect to initial weight. Formulations F1, F2, F3, F4, F5 and F6 were found to be contains 1.85±0.25, 1.23±0.36, 1.65±0.45, 0.89±0.65, and 1.32±0.32 and 1.45±0.47% of moisture uptake respectively. Therefore, formulation F4 (0.89±0.65) showed significantly less moisture uptake.

Table No. 5: Results of % Moisture Content &% Moisture Uptake

S. No.	Formulation Code	% Moisture Content	% Moisture Uptake
1.	**F1**	0.65±0.05	1.85±0.25
2.	**F2**	0.56±0.04	1.23±0.36
3.	**F3**	0.45±0.06	1.65±0.45
4.	**F4**	0.35±0.03	0.89±0.65
5.	**F5**	0.45±0.05	1.32±0.32
6.	**F6**	0.39±0.04	1.45±0.47

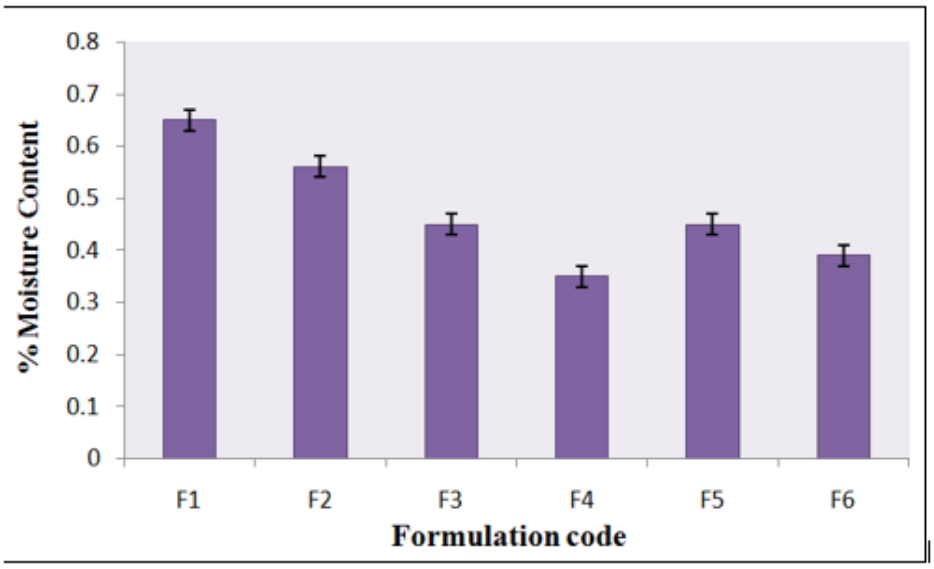

Figure No. 11: % Moisture content in transdermal patches

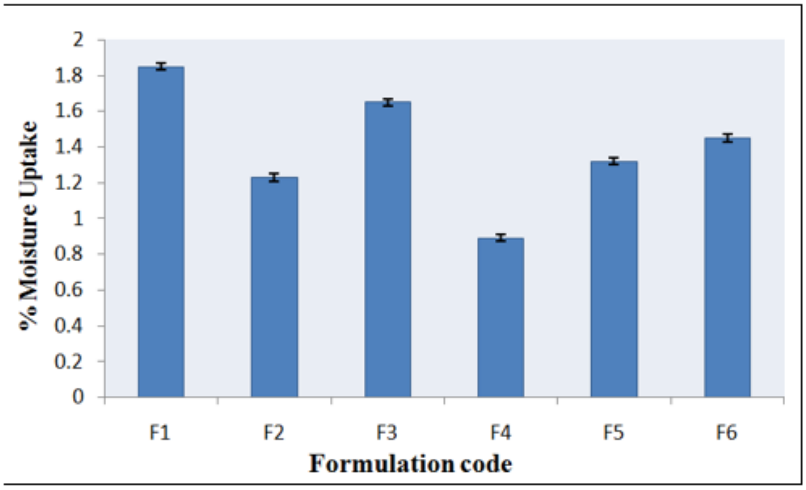

Figure No. 12: % Moisture uptake in transdermal patches

Folding endurance

The folding endurance of patches was determined by repeatedly folding a strip of film at the same place till it tends to break. It is determined as the number of times the film is folded at the same place either to break the film or to develop visible cracks. The maximum folding endurance was found 156±4 in formulation F4.

Table No. 6: Results of folding endurance

S. No.	Formulation Code	Folding Endurance (Number of fold)
1.	**F1**	125±4
2.	**F2**	135±3
3.	**F3**	135±5
4.	**F4**	156±4
5.	**F5**	125±7
6.	**F6**	130±4

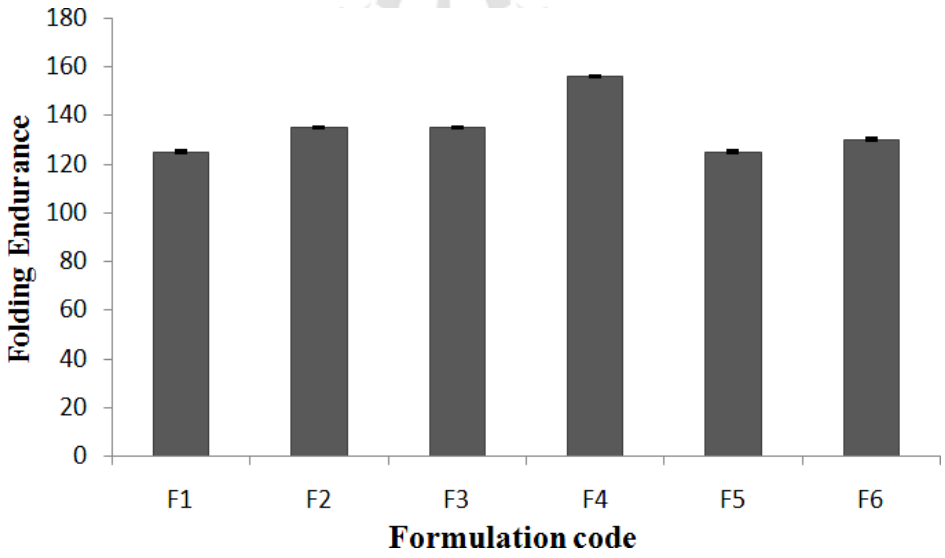

Figure No. 13: Folding endurance of transdermal patches.

Tensile Strength

The tensile strength was taken directly from the dial reading in kg/cm.

Table No. 7: Results of tensile strength

S. No.	Formulation Code	TensileStrength (kg/cm)
1.	F1	0.895±0.002
2.	F2	0.658±0.006
3.	F3	0.789±0.010
4.	F4	0.589±0.056
5.	F5	0.874±0.025
6.	F6	0.852±0.041

Drug Content

Table No. 8: Percentage drug content of all the formulations

S. No	Formulation Code	% Drug Content
1	F1	98.85±0.65
2	F2	98.69±0.56
3	F3	99.12±0.21
4	F4	99.65±0.45
5	F5	98.98±078
6	F6	98.74±041

Values are represented as mean ±SD (n=3).

***In Vitro* skin permeation study**

Table No. 9: *In Vitro* cumulative % drug release from optimized batch of transdermal patches F4

S. No.	Time (Hrs.)	Square Root of Time	Log Time	Cumulative* Percentage Drug Release ± SD	Log Cumulative Percentage Drug Release	Cumulative Percent Drug Remaining	Log cumulative Percent Drug Remaining
1	0.5	0.707	-0.301	15.56±0.85	1.192	84.44	1.927
2	1	1	0	23.32±0.32	1.368	76.68	1.885
3	2	1.414	0.301	36.65±0.45	1.564	63.35	1.802
4	4	2	0.602	42.25±0.65	1.626	57.75	1.762
5	6	2.449	0.778	56.65±058	1.753	43.35	1.637
6	8	2.828	0.903	69.98±0.42	1.845	30.02	1.477
7	10	3.162	1	79.85±0.15	1.902	20.15	1.304
8	12	3.464	1.079	98.98±0.78	1.996	1.02	0.009

Values are represented as mean ±SD (n=3)

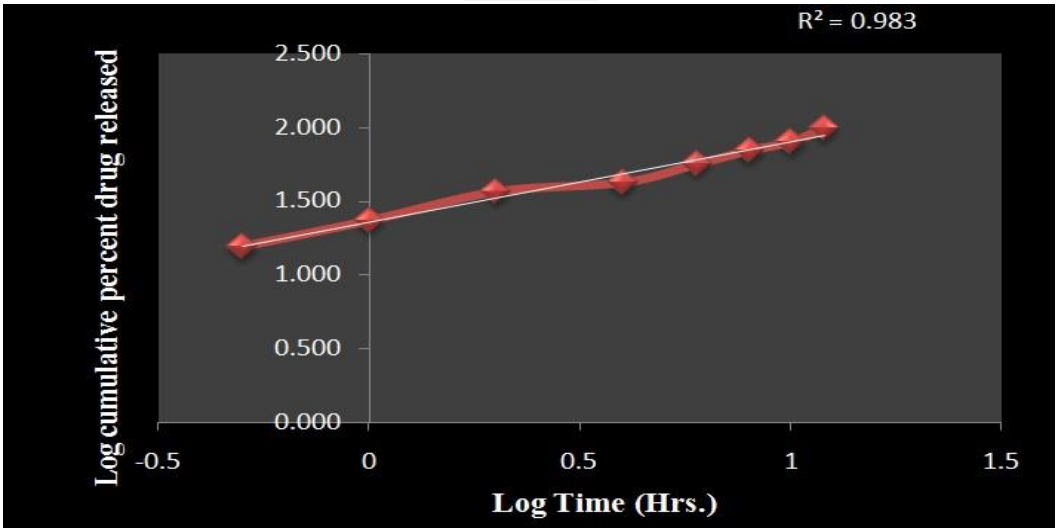

Figure No. 14: Log Cumulative Percent Drug Released Vs Log Time (Peppas Plots)

Stability Studies

Stability studies were carried out with optimized formulation which was stored for a period of one, two and three months at 40±2ºC temperature and 75±5% relative humidity for a period 3 months. The % Assay of formulation was determined by U.V. spectrophotometer using

calibration curve method. The % assay was found to slightly decrease at higher temperature. Minor difference was found between evaluated parameters before and after ageing/storage and all was in acceptable limits. Therefore, formulation remains stable for sufficient time. Transdermal patch preparations were observed for any change in appearance or color for the period of 3 weeks. There was no change in appearance in formulation throughout the period of study. The stability of drug was further confirmed by spectral data and there was no change observed.

❖ CONCLUSION

The saxagliptin transdermal patches were fabricated by the solvent evaporation technique with an aim to improve the bioavailability of saxagliptin. The fabricated film was found to be uniform, flexible, smooth, and transparent. The thickness of the patches of different formulations ranged from 26.65±0.45 mm to 32.25±0.58mm. The thickness of the transdermal patches was found to be proportional to the concentration of the polymers. The value of low standard deviation represented that the preparation of transdermal formulation is quite reproducible with similar thickness. All the fabricated films were evaluated for their physical parameters (Percent moisture content, thickness, Percent moisture uptake, folding endurance, Tensile Strength, Drug Content, and in vitro diffusion).

The prepared patches showed minimal moisture absorption rates ranging from 0.65±0.05 to 0.35±0.03% thus ensuring general stability and protection from microbial contamination and increase in the HPMC concentration increased the moisture absorption capacity. All the formulation shows lowest moisture content i.e., less than 0.1%. Moisture in this value is required to provide strength and flexibility to the patches. Formulations F1, F2, F3, F4, F5 and F6 were found to be contains 0.65±0.05, 0.56±0.04, 0.45±0.06, 0.35±0.03, 0.45±0.05 and 0.39±0.04% of moisture content respectively. Therefore, formulation F4 which is having HPMC (450mg) and Eudragit L-100 (50mg) showed significantly less moisture content. Finally, the films were weighed and the percentage of moisture uptake is calculated as the difference between the final and initial weight with respect to initial weight. Formulations F1, F2, F3, F4, F5 and F6 were found to be contains 1.85±0.25, 1.23±0.36, 1.65±0.45, 0.89±0.65, and 1.32±0.32 and 1.45±0.47% of moisture uptake respectively. Therefore, formulation F4 (0.89±0.65) showed significantly less moisture uptake.

The folding endurance of patches was determined by repeatedly folding a strip of film at the same place till it tends to break. It is determined as the number of times the film is folded at

the same place either to break the film or to develop visible cracks. The maximum folding endurance was found 156±4 in formulation F4. The drug content analysis of different formulations was done according to the procedure given in section. The drug content ranged between 98.69±0.56 and 99.65±0.45. The percentage drug content of all formulations the maximum drug content was found in formulation F4, 99.65±0.45%.

As we assume that with increase in concentration of polymer it may attain higher drug release. But according to drug release studies conducted by Franz diffusion apparatus, the low concentration gave better drug release compared to increasing concentrations of polymers. But finally, we would like to conclude that for preparation of transdermal patches low concentration of polymers will be suitable. Hence the patch with F4 formulation (HPMC and Eudragit L-100) drug release was 98.98±0.78% hence it was the optimized batch. The cumulative amount of drug permeated per square centimetre of patches through membrane was plotted against time was fitted to zero, first, and peppas kinetic model. As indicated based on release profile it followed zero-order kinetics in all formulations. However, the release profile of the optimized formulation F4 (r^2 = 0.985 for zero order) indicated that the drug from the patches was governed by a diffusion mechanism. Transdermal patch preparations were observed for any change in appearance or color for the period of 3 weeks. There was no change in appearance in formulation throughout the period of study. The stability of drug was further confirmed by spectral data and there was no change observed. In conclusion, the transdermal patch of saxagliptin was prepared successfully by solvent casting method the present data confirm the feasibility of developing saxagliptin transdermal patches on an industrial scale.

REFERENCES

1. Abdulfatai B. Olokoba, Olusegun A. Obateru, Lateefat B. Olokoba, Type 2 Diabetes Mellitus: A Review of Current Trends, Oman Medical Journal, (2012) Vol. 27, No. 4: 269-273.
2. Saroha Kamal, Yadav Bhavna and Sharma Benika: Transdermal patch: A discrete dosage form. International Journal of Current Pharmaceutical Research 2011;3(3):98-108.
3. Soni, S. and Dixit, V.K., Indian Drugs, 1992, 29(11), 466-467.
4. Swarbrick, J. and Boylan, J.C., Eds. Encyclopedia of Pharmaceutical Technology, 2nd ed. New York: Marcel Dekker, Inc., 953,2002.
5. Laura Modica De Mohac, Roberto Caruana et.al, Spray-Drying, Solvent-Casting and Freeze-Drying Techniques: a Comparative Study on their Suitability for the Enhancement of Drug Dissolution Rates, Pharm Res, (2020) 37:57
6. Marc Evans, Saxagliptin a review, The British Journal of Diabetes & Vascular Disease, 2010 10: 1,14-20
7. Akshay Dahiwele, Dinesh Kansal, Saxagliptin induced bilateral knee arthralgia: a rare case report, Saxagliptin induced bilateral knee arthralgia: a rare case report, 2016.5:5 2283-2285
8. Sohita Dhillon and Juliane Weber, Saxagliptin, Adis Drug Profile, 2009; 69 (15): 2103-2114
9. Jay Shubrook, Randall Colucci, Saxagliptin: A Selective DPP-4 Inhibitor for the Treatment of Type 2

Diabetes Mellitus, Clinical Medicine Insights: Endocrinology and Diabetes 2011:4 1–12.
10. Majumder Tamasree, Biswas Gopa Roy, Majee Biswas Sutapa, Hydroxy Propyl Methyl Cellulose: Different Aspects in Drug Delivery, Journal of Pharmacy and Pharmacology, 2016; 4:381-385
11. R Enayatifard, M Saeedi, Effect of Hydroxypropyl Methylcellulose and Ethyl Cellulose Content on Release Profile and Kinetics of Diltiazem HCl from Matrices, Tropical Journal of Pharmaceutical Research, 2009; 8 (5): 425-432.
12. Amrita Kumaria, B, Ankit Jainc Eudragit S100 coated microsponges for Colon targeting of prednisolone, Drug Development and Industrial Pharmacy, 2017, 1520-5762.
13. Meenakshi Joshi, Role of Eudragit in Targeted Drug Delivery, International Journal of Current Pharmaceutical Research, 2013. 5:2 58-62