d. Drug- Excipient Interaction study by FT-IR Spectrometry

FTIR spectra are important record which gives sufficient information about the structure of a compound. Unlike UV spectrum which comprises of relatively few peaks, this technique provides a spectrum containing a large number of absorption bands from which structural information are revealed. FTIR spectra of the pure drug were obtained using FTIR spectrometer (FTIR-8400S spectrophotometer, Shimadzu, Japan). The interpretation of FTIR spectra of drug and blend is shown in Table 4.

Table 4: Interpretation of FTIR spectra of Ondansetron Hydrochloride and blend

S. no.	Functional group	Observed frequency (cm^{-1}) Pure Sample	Observed frequency (cm^{-1}) Blend
1.	C=O, C=N in six membered ring	1638	1524
2.	H_2O	3410	3289
3.	C-C ring vibration	1526	1501
4.	CH_3	1461	1397
5.	O distributed Benzene	781	674

e. Stability Studies

A stability studies were performed for three months at 40±2° C and 75±5% RH. After three months storage, the formulation (F3) was checked for drug content and percent drug release (shown in Table 5). The similarity index of F3 percent drug release profiles when compared before and after storage was found to be 85.91. The result from paired t-test ($P<0.05$) revealed that there is no significance difference in drug content and percent drug release values before and after storage.

Table 5: Stability studies of F3 formulation before and after 3 months

Time (Hrs) CPR (%)	Before Storage	After 3 Months storage
0	0	0
1	6.8± 1.7	5.4 ±1.28
2	11.3± 2.2	12.6 ±1.13
3	19.5± 1.62	20.8 ±1.65
4	27.8± 2.61	25.2 ±2.16
5	35.7± 2.4	33.8 ±1.8
6	43.6± 1.17	42.9 ±1.9
7	50.4± 1.53	51.3 ±2.2
8	61.3± 0.98	59.4 ±1.9
9	66.2± 1.3	64.8± 2.3
Drug Content (%)	99.31±0.24	98.12±0.32

*(Mean=Standard Deviation, n=3)

Discussion

The present work focuses on the development of transdermal patches containing Ondansetron HCl by solvent casting method using combination of hydrophilic and hydrophobic polymers. The prepared patched were subjected to various evaluation parameters. Standard curve of pure drug was prepared using phosphate buffer pH 7.4 at 310 nm by UV-VIS spectrophotometer. Results of physical characterization revealed uniformity in all formulations in terms of thickness, weight variation and drug content whereas folding endurance observation represented formulations flexibility and integrity with general skin folding. The folding endurance was found to be highest in formulation F3, containing combination of PVA, EC and PVP in the ratio of 1:1:2. The moisture content (%) and Moisture uptake (%) of all formulations were found in acceptable limits i.e. below 5% (18). The low moisture content showed the more stability of prepared formulations during storage with respect to reduced brittleness and microbial contamination. The hydration of polymers is important parameter as concerned with the regulation of drug release mechanism from release matrix (controlled/sustained). From the film evaluation, the values of moisture uptake and % moisture content of all formulations were in the acceptable range. The study of hydration of polymers is an important finding that regulates the drug release from controlled/sustained

release matrix. *In-vitro* drug release study showed that F3 was found to have more controlled release pattern than other formulations. The controlled drug release involves the diffusion mechanism as polymer matrix restricts the movement of drug molecules due to its three dimensional network. The drug release in all formulations followed zero-order kinetics that represented the release in concentration independent manner. The FT-IR interpretations of pure and blend (drug +polymers) explained no such significant interactions between them. Results from stability study of F3 revealed no significant change ($P<0.05$) in drug content and percent drug release before and after 3 months storage. In addition to that, the value of similarity index was found to be above 50 % which represents the similarity between release profiles before and after storage (31).

Conclusion

In the present study, an effort was made to provide transdermal delivery of Ondansetron HCl with combination of hydrophilic and hydrophobic polymers. The transdermal patch was prepared using solvent casting method using polymers such as PVA, EC, PVP and HPMC in different ratios and eugenol as penetration enhancer. Smooth surfaced, thin and transparent matrix patches were obtained and thickness of all the formulations remained almost similar with low SD values. Physical characterizations of patches were also done and the results found within limits. The *in-vitro* release study showed that all the formulations exhibited uniform and diffusion-controlled release and followed zero order kinetics. Based on combined results from physical parameters and *in-vitro* percent drug release and release kinetics, F3 showed the optimum performance. Stabilities studies was conducted for F3 formulations and found stable before and after the storage at 40±2°C and 75±5% RH. From the results, it can be concluded that ondansetron HCl, drug with shorter half life and undergoes first pass metabolism, is a suitable candidate for transdermal delivery system. In addition to that, Ondansetron HCl is considered to be safe in pregnant women and thus prescribed by the medical practitioner in the early stages of pregnancy and also to those patients with hyperemesis gravidarum condition. Hence, transdermal delivery of Ondansetron HCl will benefit more in the patients facing problems with oral delivery. Besides, it offers a proper way to manage hyperemesis gravidarum condition leading to more patient compliance. Further, this study open up the scope of pharmacokinetic studies and controlled clinical studies on humans in future.

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Conflict of Interest

There is no conflict of interest among authors.

Declaration

The research work was carried out by Snigdha Bhardwaj, Ph.D Scholar (First and corresponding author) under the kind guidance of Dr. Sonam Bhatia, Assistant Professor (Co-author). We confirmed that the manuscript has been read and approved by all named authors. The content of manuscript have not been published before or submitted elsewhere for publication.

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