flow. The viscosity was found to be increased with the concentration of PVP. It may be due to the thickening effect of the polymer on possible hydration of the aqueous polymer PVP.

The viscosity was found to be increased with the concentration of PEG.

Viscosities of all the formulations were found to be in the range between 1.38 and 8.7 Cp. The acceptable viscosity for capsulatable mixture should be in between 0.222 and 3000 Cp. Thus, these values were found to be suitable to fill into hard gelatin capsules. The results are given in Table 2.

Content uniformity

The capsules comply with the test if not >1 of the individual values thus obtained is outside the limits 85-115% of the average value and none is outside the limits 75-125 per content. The results were varied from 99.15% to 99.85% as shown in Table 2. The obtained results are within the limits so passed the test.

Table 2: Physical parameters observed from the capsulatable mixtures containing candesartan cilexetil

Formulations	Appearance	pH	Content uniformity (%)	Viscosity (c_p)
F1	Colorless clear	5.8±0.002	99.56±0.005	17.6±0.2
F2	Colorless clear	5.7±0.004	99.42±0.008	17.15±0.4
F3	Colorless clear	5.5±0.001	99.35±0.004	15.46±0.3
F4	Colorless clear	5.7±0.003	99.18±0.006	13.3±0.5
F5	Colorless clear	5.5±0.001	99.33±0.008	19.5±0.2
F6	Colorless clear	5.5±0.001	99.25±0.002	19.5±0.4
F7	Colorless clear	5.6±0.002	99.35±0.004	13.53±0.1
F8	Colorless clear	5.7±0.02	99.62±0.005	14.15±0.3
F9	Colorless clear	5.54±0.03	99.15±0.008	15.23±0.4
F10	Colorless clear	5.4±0.001	99.85±0.005	17.3±0.2
F11	Colorless clear	5.3±0.002	99.35±0.002	15.69±0.3
F12	Colorless clear	5.4±0.04	99.62±00.7	15.23±0.5

Studies on characterization of finished capsules

The hard gelatin capsules were filled with the capsulatable mixture as these mixtures satisfied the preliminary requirements. The finished capsules were subjected to various quality control tests.

Average weight

Prepared formulations were subjected to weight variation test as per I.P. the acceptance criteria for weight variation test is as follows.

The results are given in Table 3. The observed weight variation was found to be within the acceptable range 629.9 ± 0.006-695.4 ± 0.006 and thus all the finished capsules satisfied the weight variation requirement.

Drug content

The content of active ingredient test was determined from 20 capsules which were selected randomly. As per I.P requirement, the limits are between 90% and 110% of labeled claim. The observed drug content values are found to be between 96.39 and 99.48%. The observed data indicated that the finished capsules satisfied the drug content requirement. The results are shown in Table 3.

Disintigration test

The disintegration test determines for capsules disintegrate within a prescribed time when placed in a liquid medium under the prescribed experimental conditions, According to Indian pharmacopeia, disintegration time for the hard gelatin capsules was 30 min. Disintegration time for all the formulations was varied from the range between 20 and 30 min. For all the formulations, disintegration time is depicted in Table 3. The dosage form satisfied the disintegration requirement.

In vitro drug release studies

All the dissolution studies were carried out in triplicate and each case mean values and standard deviation values were calculated.

Table 3: Physical characters of hard gelatin capsules filled with capsulatable mixtures containing candesartan cilexetel

Parameters	Average weight (mg)	Disintegration time (min)	Absorbed moisture content (%)	Drug content (%)
F1	683.3±0.002	23±0.04	17.17±0.05	98.62±0.004
F2	660.9±0.003	25±0.06	19.6±0.04	97.69±0.003
F3	695.4±0.006	22±0.02	18.2±0.01	98.92±0.008
F4	661.2±0.008	26±0.07	17.25±0.02	98.81±0.009
F5	674.13±0.02	24±0.02	17.29±0.002	97.39±0.007
F6	674.12±0.06	28±0.02	17.2±0.002	96.39±0.002
F7	629.9±0.002	25±0.05	13.9±0.001	98.73±0.003
F8	653.9±0.003	26±0.03	19.8±0.007	97.69±0.005
F9	652.2±0.004	28±0.07	17.1±0.005	98.31±0.006
F10	674.12±0.004	29±0.03	16.8±0.007	99.48±0.001
F11	629.9±0.006	25±0.04	18.2±0.004	97.73±0.005
F12	653.9±00.28	26±0.02	16.1±0.006	96.69±0.002

In vitro dissolution studies were carried out for the formulations prepared with 0-2% concentrations of SLS and the results are shown in Figure 1. These studies revealed that the concentration of surfactant significantly influences the dissolution rate of candesartan and 2%w/w of SLS was found to be suitable for enhancing the dissolution rate of candesartan.

In vitro dissolution studies were carried out for the formulations prepared with 10-17.5% concentrations of PVP and the results are shown in Figure 2. The concentration of PVP significantly influences the dissolution rate of candesartan, and 17.5%(w/w) of PVP was found to be suitable for enhancing the dissolution rate of candesartan. *In vitro* dissolution studies were carried out for the formulations prepared with 15-25% concentrations of PEG and the results are shown in Figure 3. The drug release with 15% PEG was significantly higher than other concentrations of PEG formulations. Time required for the dissolution of 50% (T50) and the 90% (T90) of the labeled claim were observed for all the formulations and reported in Tables 4-6.

Moisture absorption studies

The properties of the active pharmaceutical ingredient (API) and suitable excipients are studied to check whether it is a good candidate for liquid filling and evaluated so that neither the API nor excipient should cause the gelatin shell to gain or lose excessive moisture. Due to the presence of 12-15% moisture, plasticizer effect can be maintained for gelatin in hard gelatin capsules. So when a hygroscopic material is filled into the capsule that could extract moisture from the shell thereby inducing embrittlement.

Prepared formulations having the candesartan drug is totally hydrophobic; so no problem about embrittlement of capsule shell. However, the components of capsulatable mixture like PEG, PVP are hygroscopic and are able to absorb moisture from the surrounding environment. Hence, there is a need to determine the moisture content as it may affect the physical and chemical stability of the capsules. The moisture absorption studies were found to be in an acceptable range for all formulations indicating their stability.

If the moisture content absorption is increased, it may interfere in filling capacity of capsule shell. All the formulations of absorbed moisture content were found to be in the range between 11.9 ± 0.001 and 15.8 ± 0.008. The results were found to be within the limits, so the test was passed. Obtained results are given in Table 3.

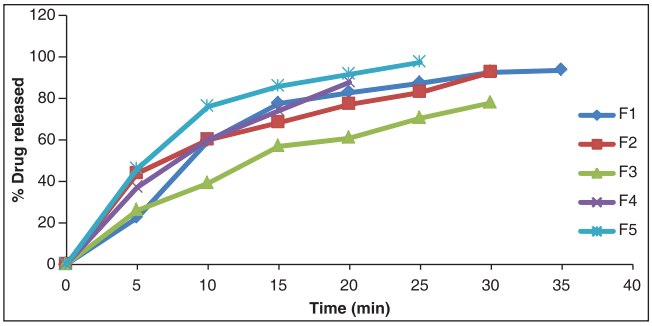

Figure 1: *In vitro* release data of hard gelatin capsules filled with capsulatable mixtures containing different concentration of surfactant sodium lauryl sulfate (0-2%)

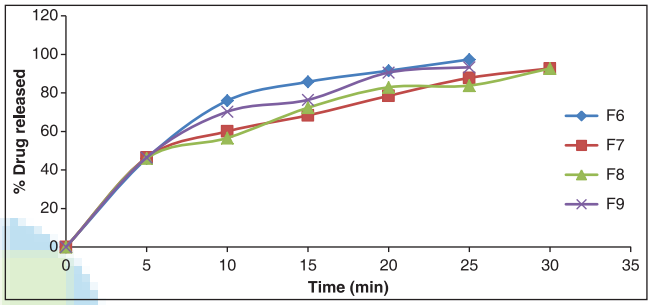

Figure 2: *In vitro* release profiles of hard gelatin capsules filled with capsulatable mixtures containing different concentrations of Polyvinylpyrrolidone (10-17.5%)

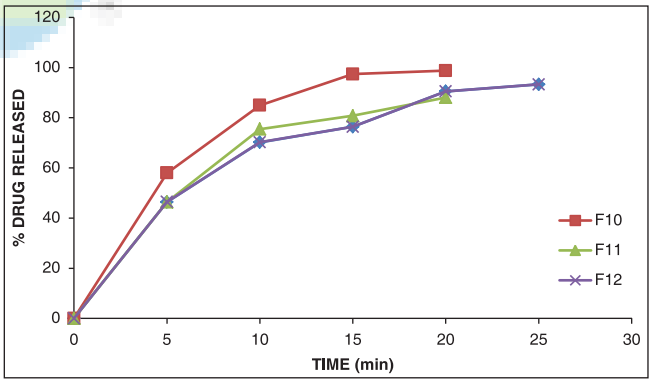

Figure 3: *In vitro* release profiles of hard gelatin capsules filled with capsulatable mixtures containing different concentrations of polyethylene glycol (15-25%)

Table 4: Release kinetics of hard gelatin capsules filled with capsulatable mixtures containing different concentrations of surfactant SLS (0-2%)

Formulation	Correlation coefficient values			Half life	Shelf life
	Zero order (r)	First order (r)	*K* values (min^{-1})	T_{50} (min)	T_{90} (min)
F1	0.8537	0.9906	0.0841	8.2	27.3
F2	0.8349	0.9809	0.0798	8.7	28.8
F3	0.9339	0.9948	0.049	13.9	46.1
F4	0.9870	0.9924	0.0985	7.0	23.3
F5	0.8432	0.9919	0.1362	5.1	16.8

SLS: Sodium lauryl sulfate

Table 5: Release kinetics of hard gelatin capsules filled with capsulatable mixtures containing different concentrations of PVP (10-17.5%)

Formulation	Correlation coefficient values		Half life	Shelf life
	Zero order (*R*)	First order (*R*)	*K* values (min^{-1})	T_{50} (min)	T_{90} (min)
F6	0.8432	0.9919	0.313	5.1	16.8
F7	0.982	0.9904	0.0843	7.9	26.4
F8	0.8304	0.9853	0.0836	8.0	26.7
F9	0.854	0.9914	0.1105	6.3	20.8

PVP: Polyvinylpyrrolidone

Table 6: Release kinetics of hard gelatin capsules filled with capsulatable mixtures containing different concentrations of PEG (15-25%)

Formulation	Correlation coefficient values			Half life	Shelf life
	Zero order	First order	*K* values	T_{50} (min)	T_{90} (min)
F10	0.849	0.9902	0.513	3.1	10.2
F11	0.874	0.982	0.113	6.1	20.4
F12	0.854	0.9914	0.254	6.3	20.8

PEG: Poly ethylene glycol

CONCLUSION

The formulation containing SLS-(2%), ethanol-(0.9), 4.8 acetate buffer-(0.1%) PVP-(17.5%), PEG-(15%), and PG-(53.4%) offered higher percentage of drug release.

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