International Journal of Pharmacy and Pharmaceutical Sciences

ISSN- 0975-1491 Vol 3, Suppl 2, 2011

Research Article

FORMULATION DEVELOPMENT OF PATIENT FRIENDLY DOSAGE FORM: ALL IN ONE NATURAL EXCIPIENT AS BINDER, DILUENT AND DISINTEGRANT

PRABAKARAN L[1,*], SENDHIL D[1]

[1]Department of Pharmaceutics, School of Pharmaceutical Sciences, Karpagam University, Coimbatore 641 021, India
Email: prabakar75@gmail.com

Received: 13 Nov 2010, Revised and Accepted: 13 Dec 2010

ABSTRACT

The purpose of this research was to introduce and evaluate natural excipient that has versatile property in the oral disintegrant and immediate release formulations. This natural excipient was used as disintegrant, binder, and diluent in the formulation of orodispersible tablets of some model drugs such as Ondansetron HCl (OND), Propranolol (PNL) and Gabapentin (GP). Physicochemical studies such as swelling power and solubility, particle size distribution and some other physical evaluations was done on the natural excipient to ensure the suitability to incorporate for such formulation. Five formulations of each drug were formulated in different ratios of natural excipient and Croscaramellose (Superdisintegrant) and the final formulation of all drug used natural excipient alone as binder, diluent and disintegrant. All the formulations are subjected for *in-vitro* evaluations such as wetting time, water absorption ratio, *in-vitro* dispersion time and disintegration time, etc. Almost same results were obtained on formulations with or without the super disintegrant. Therefore, we conclude that the natural excipient proposed can be used as binder, diluent and disintegrant in oral disintegrating tablets and immediate release dosage forms. Mainly the natural excipient used is biocompatible, cost effective and provides as nutrition supplements.

Keywords: Natural excipient, Patient friendly dosage form, Diluent, Disintegrant, Binder, *In vitro* study.

INTRODUCTION

Recent advances in novel drug delivery systems aimed to enhance safety and efficacy of drug molecule by formulating a convenient dosage form for ease of administration and to achieve better patient compliance[1]. Oral drug delivery has been known for centuries as the most widely utilized route of administration among all the routes that have been explored for the systemic delivery of drugs via various pharmaceutical products of different dosage forms[2]. The reason behind that the oral route achieved such popularity may be in part attributed to its ease of administration as well as the traditional belief that by oral administration, the drug is as well absorbed as the food stuffs that are ingested daily[3]. Rapid disintegrating Tablets (RDT) are gaining prominence as new drug delivery systems[4], that, these dosage forms dissolve or disintegrate in the oral cavity within a minute without the need of water or chewing[5-10] and the RDTs are also called as orodispersible, mouth dissolving, oral disintegrating, fast melting, quick dissolving and freeze dried wafers[11]. These are not only useful in administration of drugs in pediatric and geriatric patients but in patients suffering from dysphagia, leading to improved patient compliance[12,13]. Often times people experience inconvenience in swallowing conventional tablets and capsules[14,15]. In the case of motion sickness (kinetosis) and sudden continuation of cough during the common cold, allergic conditions and bronchitis, tablets which can rapidly dissolve or disintegrate in the oral cavity have attracted a great attention. In ODTs formulations, the commonly used mixture of excipients comprising at least one disintegrant (1-15%), a diluent (10-85%), a binder (1-10%), a lubricant, and optionally, a swelling agent, a permeabilizing agents, sweeteners, and flavoring agents to achieve the effectiveness of the formulation[16,17].

No literature was found that a single natural excipient was tried and used as binder, diluents and disintegrant in the formulation development of ODTs. Instead of using synthetic excipients that are the foreign substances, if a natural excipient is opted for formulation of ODTs and immediate release formulations that have versatile properties which might reduce number of excipients used in formulations, unwanted toxic effects, economic to the patients and also provides nutritional supplements to the patients.

Banana fruit is economically one of the most important fruit produced and consumed in the world[18]. In some parts of the world, banana is called plantain. The soft and sweet fruit of this tropical plant (not tree) is enjoyed by people from around the world. There is hundreds of variety of banana found growing in different parts of the world. Palayam kodan, Annaan, Ethan or nenthran (nenthra vazha), Morris or Robusta, Poovan, Kappa vazha (red banana), Monthan are few cultivars of banana in Kerala (all names in Malayalam)[19]. The DBP, which prepared from the banana especially from the variety called Ethan or nenthran (nenthra vazha), belongs to the family Musaceae which is a natural, commonly used as nutritional supplement[12,20-24] as it contains many essential nutrients, including minerals and vitamins, and has a high energetic value in the range of 90–100 kcal per 100g edible portion[25]. Fully ripe banana pulp contained 33.6% reducing sugars, 53.2% sucrose, 5.52% protein, 0.68% fat, 0.30% fiber, 2.58% starch and 4.09% ash. These results are in approximate agreement with those of other workers analyzing different bananas[26]. It is considered to be good for the treatment of gastric ulcer and diarrhea because they contain vitamin A. Due to their high content of B6 vitamin, they help to reduce stress and anxiety, the high content of carbohydrates makes a very good source of energy, and potassium helps to better brain functioning[27-30].

Therefore, the research is aimed to formulate Oral Disintegrant Tablet (ODT) of some highly water soluble drugs with the dose range from 10-100mg using a natural excipient i.e., dehydrated banana powder (DBP), which have versatile property. So that, the avoidance of many excipients in the ODTs formulations is may be achieved. Moreover, superdisintegrants, binders and diluents plays a main role in ODTs and immediate release formulations[23], hence, this research also mainly focused on the evaluation of the said properties.

The drugs, such as Ondansetron HCl (OND), Propranolol (PNL), and Gabapentin (GP) are selected as model drugs to formulate as ODTs [31-33]. Ondansetron HCl is a selective blocking agent of the serotonin 5-HT3 receptor type, primarily used to treat and prevent chemotherapy-induced nausea and vomiting, effective in controlling post-operative nausea and post-radiation vomiting and nausea, and is a possible therapy for nausea and vomiting due to acute or chronic medical illness or acute gastroenteritis. Propranolol, a synthetic beta-adrenergic receptor blocking agent, used to treat high blood pressure, irregular heartbeats, shaking (tremors), and other conditions. It is used after a heart attack to improve the chance of survival. It is also used to prevent migraine headaches and chest pain (angina). Lowering high blood pressure helps prevent strokes, heart attacks, and kidney problems. Gabapentin is indicated for the management of post herpetic neuralgia in adults and it is indicated

as adjunctive therapy in the treatment of partial seizures with and without secondary generalization in patients over 12 years of age with epilepsy.

MATERIALS AND METHODS

Ondansetron HCl (Zydus Cadila, Ahmedabad, India), Propranolol (Shashan Pharmaceuticals, Puducheri, India), and Gapapentin (Aurbindo Pharma Ltd, Hydrabad, India), was chosen as model active principles incorporated for the study. Croscaramellose sodium (Karnataka Antibiotics, Karnataka, India) as gift sample, Dehydrated Banana Powder (Safety food Pvt Ltd, Kerala, India), colloidal silicium dioxide (Aerosil 200, Degussa, Frankfurt/M., Germany), and Magnesium state (LobaChem, Mumbai, India) were used as tablet excipients. The other ingredients were used of analytical grade.

Fourier Transform Infra Red (FTIR) analysis

The FTIR spectrum of DBP, OND, PNL and GP was recorded between the scanning range of 4000 – 400 against wave number (cm^{-1}) and % Transmittance. Samples were prepared in KBr discs (2mg sample in 200mg KBr) with a hydrostatic press at a force of 5ι cm^{-2} for 5min and the resolution was 4 cm^{-1}. Experiments were duplicated to check the reproducibility.

Drug-excipients interaction study

Infra red spectrometry is a useful analytical technique utilized to check the chemical interaction between the drug and the other excipients used in the formulations. The samples (drugs blended with DBP and stored at room temperature for a week) were powdered and intimately mixed with dry powdered potassium bromide. The powdered mixture was taken in a diffuse reflectance sampler and the spectra recorded by scanning in the particular wavelength region (4000 – 400 cm^{-1}) using Shimadzu FTIR spectrometer. The IR spectrum of drug was compare with that of the physical mixture of the drug and excipients used to check for any possible drug-excipients interaction.

Dehydrated banana powder evaluations

a. Swelling of powder (SP) and solubility (S)

Swelling power (SW) and solubility (S) were measured according to a modified method of Schoch et al., Leach, H. W et al., and Leach, H.W and Schoch, T. J[22, 34, 35]. A 0.1 g (dry basis) ground sample was placed in a centrifuge tube, make up the volume up to 10 ml using distilled water, and mixed by using a vortex mixer to get a suspension (1%w/v). The suspension was kept for 4h for complete swelling and wetting at room temperature. Thereafter, the suspension was heated at different temperatures such as 40, 60, 80 and 100°C for 30min individually using electric water bath and centrifuged at 3000xg for 15 min. The supernatant was decanted and dried in an oven for 3 h at 100°C ± 5°C. The residue obtained after drying the supernatant represents the amount of solubilized materials in water. The solubility was calculated as g per 100 g of sample on dry weight basis. All determinations were done in triplicate. The SW and S indices were determined by following the formulas;

$$SW = \frac{\text{Weight of sediment}}{\text{weight of dry sample solids}}$$

$$S = \frac{\text{weight of dissolved solids in supernatant}}{\text{weight of dry sample solids in the original sample}} \times 100$$

b. Powder characterization

The banana powder was evaluated for the parameters such as percent compressibility, Hausner ratio, moisture content, particle size distribution, etc. The compressibility index and Hausner ratio was calculated based on the untapped and tapped density results. Moisture loss was estimated by heating (at 105°C for 5min) the known quantity of the banana powder using moisture balance. The particle size distribution of the powder was determined by microscopic technique.

Preparation of orodispersible tablets by wet granulation method

Five formulations of OND (OF1 - OF5), PNL (PF1 - PF5) and GP (GF1 - GF5) were developed by varying concentration of super disintegrating agent (2.5% - 15%) and the final formulation of each drug (OF5, PF5, GF5) was formulated using DBP alone without addition of superdisintegrant. The presieved (# 60 mesh) drug and other excipients were mixed using planetary mixer (32 rpm) and then subjected to wet granulation by using purified warm water (60-70°C) as a granulating fluid. The cohesive mass is passed through sieve (#18 mesh) and dried until get the moisture content of 3-5%. Again the mass was passed through sieve (#10 mesh), lubricated using double cone blender at the rate of 16 rpm and compressed in to tablets using 8 station rotary tablet machine with 6mm punch. The formulations were made according to the formulas showed (Table 1).

Table 1: Formula for orodispersible tablets formulation of the drugs

Formulations/ Ingredients	OND (mg)	PNL (mg)	GP (mg)	Banana powder (mg)	Croscara-melose sodium (mg)	Aerosil (%)	Magnesium sterate (%)	Purified water
OF1	10	-	-	72	15	2	1	Qs
OF2	10	-	-	77	10	2	1	Qs
OF3	10	-	-	82	5	2	1	Qs
OF4	10	-	-	84.5	2.5	2	1	qs
OF5	10	-	-	87	-	2	1	qs
PF1	-	40	-	42	15	2	1	qs
PF2	-	40	-	47	10	2	1	qs
PF3	-	40	-	52	5	2	1	qs
PF4	-	40	-	54.5	2.5	2	1	qs
PF5	-	40	-	57	-	2	1	qs
GF1	-	-	10	72	15	2	1	qs
GF2	-	-	10	77	10	2	1	qs
GF3	-	-	10	82	5	2	1	qs
GF4	-	-	10	84.5	2.5	2	1	qs
GF5	-	-	10	87	-	2	1	qs

Pre-compression parameters

The granules were evaluated for the parameters such as Angle of Repose, Bulk density, Carr's index, % compressibility, Hausner ratio for their suitability to execute further process.

Post-compression parameters

Hardness of six tablets at all compression force level was determined using a Pfizer type hardness tester. Friability of all the formulations was performed by using Roche Friablator with the

revolution speed at 30rpm on 10 tablets from each batch. Weight variation test was performed with 20 tablets and mouth feel was checked with the placebo tablets by following the conventional method.

***In-vitro* dispersion and disintegration time**[36]

In vitro dispersion time was measured by dropping a tablet in a measuring cylinder containing 10ml of simulated saliva fluid of pH 6.4. After dropping a tablet in the simulated saliva fluid, the tablet started to swell quickly, broke and followed by dispersed. Another method was also tried to determine the *in vitro* dispersion time, in this method, the tablet was dropped in a beaker containing 50 ml of Sorenson's buffer pH 6.4. The time of breakdown of tablet followed by dispersion was noted. Three tablets from each formulation were randomly selected for this study and the *in vitro* dispersion time is expressed in seconds.

In vitro disintegration time, modified dissolution apparatus was used[5], instead of the actual disintegration apparatus due to several limitations and they do not suffice the measurement of very short disintegration times (actual disintegration time that patience can experience ranges from 5 to 30s. In this experiment, 900 ml of water maintained at 37°C as the disintegration fluid and the paddle at 100 rpm as stirring element was used. Disintegration time was noted when the tablet disintegrated and passed completely through the screen of the sinker (3–3.5 mm in height, 2–2.5 mm in width and having #10 mesh), immersed at a depth of 8.5cm from the top with the help of a hook. This method was useful in providing discrimination among batches which was not possible with the conventional disintegration apparatus.

Wetting time

A conventional method was followed to measure wetting time and capillarity of the orodispersible tablets. A pinch of amaranth powder was placed at the upper surface of tablet and it was carefully placed in a petridish of 9.0cm in diameter, containing tissue paper which was completely wet (10 ml of water) at room temperature. Tablet absorbs water through tissue paper, penetrates inside the tablet and moves quickly upward and after complete wetting, spreading of colour occurs due to the presence of amaranth powder. The time for time for complete wetting was recorded. To check for reproducibility, the measurements were carried out six times and the mean value calculated.

Water absorption ratio

Tablet was carefully placed in a petridish of 9.0cm in diameter, containing tissue paper which was completely wet (excess with 25 ml of water) and maintained at room temperature. Tablet absorbs water through tissue paper, penetrates inside the tablet and loses its integrity. Then, the tablet was carefully withdrawn from the surface of the tissue paper with help of spatula and weighed. The water absorption ration of the tablets was calculated using the following formula;

$$\text{Water absorption ratio} = \frac{\text{Wt. of the Tablet after studies} - \text{Wt. of the Tablet before studies}}{\text{Wt. of the Tablet before studies}} \times 100$$

***In-vitro* dissolution studies**

Dissolution study of OF1–OF5 formulations was performed using USP II standard dissolution apparatus maintained at 37°C ± 1°C using 500ml of 6.4 pH phosphate buffer as dissolution medium and the paddle speed was maintained at 50 rpm. A 5ml of aliquate was withdrawn every 5 min for 45min and replaced 5 ml of the fresh medium every time and the absorbance was measured using double beam UV-spectrophotometer at 250 nm.

Moisture uptake studies

Moisture uptake studies on the formulations conducted to assess the stability of the formulation. Tablets of each batch were kept in at room temperature and 60% RH and maintained for 2h. Tablets were weighed and the percentage increase in weight was recorded.

Stability studies

The purpose of stability testing is to provide evidence on how the quality of a drug substance or drug product varies with the time under the influence of variety of environmental conditions such as temperature, humidity and light. Stability studies of the formulations were carried out at room temperature (25°C ± 2°C and 60±5% RH) and refrigerated condition (2-5°C) for 3 month period.

RESULTS AND DISCUSSION

Orodispersible tablets belong to oral drug delivery system that are capable of disintegrating in the oral cavity and thus rapidly releases the drug. The dehydrated banana powder was evaluated for their physicochemical properties such as Swelling power and Solubility, moisture content, particle size and size distribution and some powder characterisations.

In FTIR study, DBP showed some characteristic bands between 4000 – 400 cm^{-1} range like the broad band between 3390 – 3429, sharp peak between 2940 – 2910, 2380 – 2330, 1650 – 1630, and 1635 – 1615, which identifies the presence of free -OH, C-H Stretching, C-N Stretching, C=O Stretching, and N-H bending respectively. OND showed broad peak between 4000 – 2700 and sharp peak between 3500 – 3200 identifies the presence of amine group and N-H Stretching. The sharp peaks at 2960, 1710, and 1180 identifies the presence of C=C Stretching, C=O Stretching, and C-N Stretching respectively. PNL showed broad peak between 3800 – 2700, sharp peak between 3360 – 3380, 2830 – 2815, and 2350 – 2340 which identifies the presence of free hydroxyl group, N-H Stretching, C-H Stretching of ether linkage, and C-N Stretching respectively. GP showed sharp peak between 2960 – 2940, 2880 – 2860, 2350 – 2340, 1650 – 1630, and 1635 – 1615 which identifies the presence of C-H Stretching, N-H Stretching, C-N Stretching, and C=O Stretching respectively and the presence of broad peak between 4000 – 2500 indicated the presence of free –OH and amine group.

FTIR spectra of the physical mixture of all the drugs with DBP exhibited all the characteristic bands as in the spectrum of the individual DP, OND, PNL, and GP excluding the possibility of any interaction, chemical and functional group change during the processing of the formulation of ODTs.

In particle size evaluation, almost uniform, round and oval shape particles ranged from 5 to 25 µm was observed. Moisture content was found to be approximately 2% which states that it is not a hygroscopic powder which may results good stability to the formulations. The poor compressibility (28.04%) was found in the powder of DBP and required to go for granulation to improve the flow and better compression during the process.

Swelling and solubility study, at 40°C, swelling power and percent solubility was in the range from 2.4 – 2.9 fold and 8.2 – 9.4 % respectively, and in addition, DBP exhibits rapid increases in swelling power from 9.2 – 9.6 fold and percent solubility from 22.4 – 24.1 7% when the temperature increased to 80 and 100°C. This may be due to the deformation and surface cracking of the starch which is present in the DBP and thus making DBP useful for the formulation with various properties. The Swelling and solubility study profile of DBP is showed (Figure 1).

The lubricated granules of Ondensetron, Propronolol, and Gabapentin were evaluated for their suitability to compress in to tablets. In this study, almost all the formulations showed the angle of repose less than 30°, which reveals good flow property. The loose bulk density and tapped bulk density of all the formulation granules varied from 0.410 gm/cm^3 to 0.450 gm/$cm^3$and 0.410 gm/cm^3 to 0.530 gm/cm^3 respectively. The results of Carr's consolidation index

or percentage compressibility index of the all formulations blend ranged from 10 to 20 showed excellent compressibility index result in good to excellent flow properties. The granule evaluation results are showed (Table 2).

Table 2: Physical evaluation of the granules blend of the drug formulations

Formulations/ Parameters	Angle of repose (°)	Bulk density gm/cm³	Tapped density gm/cm³	Compressibility Index (%)	Hausner ratio
OF1	28.58 ± 0.34	0.449 ± 0.29	0.510 ± 0.32	12.0 ± 0.14	1.136 ± 0.15
OF2	27.24 ± 0.65	0.432 ± 0.45	0.515 ± 0.51	16.0 ± 0.19	1.190 ± 0.18
OF3	30.34 ± 0.47	0.422 ± 0.36	0.502 ± 0.22	16.0 ± 0.23	1.903 ± 0.12
OF4	26.01 ± 0.32	0.420 ± 0.15	0.500 ± 0.24	16.0 ± 0.31	1.904 ± 0.12
OF5	27.42 ± 0.44	0.414 ± 0.32	0.518 ± 0.39	20.0 ± 0.37	1.250 ± 0.17
PF1	24.12 ± 0.12	0.359 ± 0.22	0.424 ± 0.12	15.3 ± 0.12	1.181 ± 0.12
PF2	22.23 ± 0.24	0.452 ± 0.35	0.516 ± 0.42	12.0 ± 0.38	1.141 ± 0.20
PF3	25.36 ± 0.18	0.352 ± 0.38	0.404 ± 0.26	15.3 ± 0.24	1.147 ± 0.14
PF4	26.26 ± 0.34	0.420 ± 0.19	0.522 ± 0.32	19.5 ± 0.16	1.242 ± 0.19
PF5	24.24 ± 0.29	0.432 ± 0.42	0.532 ± 0.22	18.7 ± 0.12	1.231 ± 0.16
GF1	32.12 ± 0.52	0.349 ± 0.19	0.412 ± 0.32	15.29 ± 0.24	1.180 ± 0.18
GF2	29.34 ± 0.24	0.402 ± 0.25	0.465 ± 0.51	13.54 ± 0.16	1.156 ± 0.12
GF3	31.22 ± 0.64	0.426 ± 0.22	0.492 ± 0.22	13.41 ± 0.24	1.154 ± 0.16
GF4	30.65 ± 0.12	0.410 ± 0.18	0.476 ± 0.24	13.86 ± 0.21	1.160 ± 0.16
GF5	30.23 ± 0.42	0.412 ± 0.32	0.488 ± 0.39	15.57 ± 0.17	1.184 ± 0.17

In post compression evaluation, hardness values ranged between 2.5 to 3.5 kg/cm² for all formulations which is almost acceptable range for ODTs and the tablet hardness is not as absolute strength. The entire tablet passes weight variation test as the average percentage weight variation was within the pharmacopoeia limit of 10%. It was found to be 97.0 ± 0.70 mg to 101.0 ± 0.45 mg. Moreover, weight of all the tablets was found to be uniform with low standard deviation. The friability values were found to be within the limit (0.1 – 0.9%). These evaluation parameters reveal there is no significant difference between the formulation batches. The results are showed (Table 3).

Wetting time is closely related to the inner structure of tablet. This experiment mimics the action of saliva in contact with the tablet to illustrate the water uptake and subsequent wetting of tablet. This study showed the wetting process was very rapid, almost in all the formulations which may be due to the ability of swelling followed by breaking and also capacity of water absorption causes swelling. It was found to be in the range of 10 sec to 20 sec. The wetting time of formulation using DBP alone is better when compared to formulations used superdisintegrant with DBP. The wetting time measurement result of all the formulation is showed (Table 3).

Water absorption ratio which is important criteria for understanding the capacity of the disintegrants to swell in the presence of little amount of water was calculated. It was found to be in the range of 120 to 140 i.e., more the weight of the tablet weight which showed all the formulations have good water absorption capacity. The water absorption ratio of all the formulations is showed (Table 4).

The *in vitro* dispersion and disintegration time was found to be in the range between 15sec to 25 sec and 20sec to 35 sec of almost all the batches respectively. The results showed that the in *vitro* dispersion and disintegration time of formulations with DBP alone is almost equal and better than the formulations along with superdisintegrant. The *in vitro* dispersion and disintegration time of all the formulations is showed (Table 4).

In moisture uptake study, there was no significant variation of the tablets weighed before and after the moisture uptake studies was found to be almost equal.

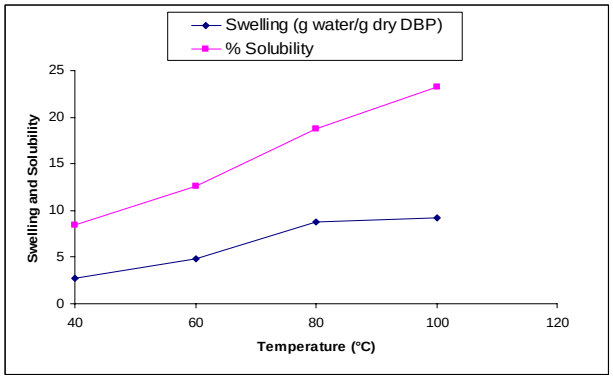

Fig. 1: Swelling and solubility profile of DBP.

Table 3: Physical evaluations of the ODTs formulations

Formulations/ Parameters	Hardness kg/cm²	Weight variation (n = 20) (mg)	% Friability	Wetting time (sec) (n=3)
OF1	2.8 ± 0.20	100.2 ± 0.45	0.609	14.52 ± 1.48
OF2	3.2 ± 0.34	97.1 ± 0.70	0.407	17.04 ± 1.14
OF3	2.5 ± 0.19	98.1 ± 0.25	0.309	13.00 ± 2.04
OF4	2.8 ± 0.22	98.25 ± 0.13	0.551	18.42 ± 2.36
OF5	3.0 ± 0.14	97.9 ± 0.50	0.85	13.40 ± 1.16
PF1	3.2 ± 0.12	99. 4 ± 0.2	0.702	16.12 ± 2.24
PF2	2.5 ± 0.14	99.1 ± 0.4	0.527	15.24 ± 1.08
PF3	3.0 ± 0.12	100.2 ± 0.3	0.349	17.10 ± 2.16
PF4	2.5 ± 0.24	99.25 ± 0.1	0.452	16.44 ± 1.42
PF5	2.5 ± 0.24	99.4 ± 0.4	0.624	16.20 ± 1.12
GF1	2.8 ± 0.20	100.2 ± 0.45	0.609	14.52 ±1.24
GF2	3.2 ± 0.34	97.1 ± 0.70	0.407	17.04 ±1.42
GF3	2.5 ± 0.19	98.1 ± 0.25	0.309	13.00 ±2.06
GF4	2.8 ± 0.22	98.25 ± 0.13	0.551	18.42 ± 1.26
GF5	3.0 ± 0.14	97.9 ± 0.50	0.85	13.40 ±2.12

Table 4: *In vitro* dispersion time and water absorption time of ODTs

Formulations	Dispersion time (sec)	Disintegration time (sec)	Water absorption ratio		
			Before studies (mg)	After studies (mg)	Ratio (%)
OF1	18	21	100	220	120
OF2	22	24	98	215.3	119.3
OF3	16	19	100	240	140
OF4	20	25	100	224	124
OF5	17	23	99	234	135
PF1	18	23	100	240	140
PF2	16	21	100	246	146
PF3	17	20	100	230	130
PF4	16	21	100	260	160
PF5	16	19	100	240	140
GF1	29	30	100	190	90
GF2	30	32	99	184	95
GF3	32	35	100	206	106
GF4	26	32	100	196	96
GF5	28	31	99	202	103

Dissolution study of OF1 to OF5 was carried out using USP II apparatus at 50rpm in the volume of 500ml dissolution media (phosphate buffer pH 6.4) for 45minutes. At the end of 45min almost 80% of the drug is released from the formulations prepared by the wet granulation method. The % drug release of OF5 was almost equal to OF1 to OF4 in 45 min. The dissolution profile is showed (Figure 2).

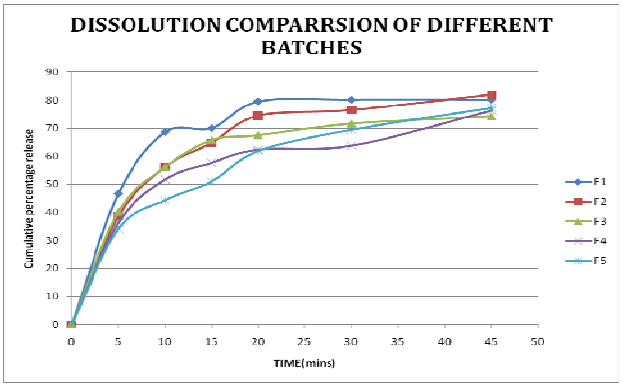

Fig. 2: Dissolution profile of Ondensetron HCl ODT formulations.

CONCLUSION

The OF5, PF5, and GF5 batches were formulated using DBP alone which showed almost equal and better results in terms of the evaluations such as wetting time, water absorption ratio, *in vitro* dispersion time and percent drug release with the formulation contain superdisintegrant (corscaramellose). Swelling and Solubility study showed that the DBP have enough swelling and solubility properties and from the results obtained from the formulations indicated that the DBP can be incorporated alone as binder, diluent and disintegrant in the conventional oral dosage form especially ODTs. The hardness of the tablets were increased when warm water (60-80°C) was used as granulating fluid due to more swelling of the DBP which showed good binding property. Therefore, warm and normal water could be used as granulation fluid for immediate release and ODTs formulations respectively. The DBP is "cost effective" than the other commonly used excipients to achieve the said versatile property. Moreover, banana powder is a "Natural excipient" with nutritional supplement which normally do not have any toxic to the consumers that to in less quantity (less than 100mg/Tablet). Thus, DBP could alone be used as a natural binder, diluent and disintegrant in the formulation and development of Patient friendly and immediate release dosage forms.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the Management, Karpagam University, and Principal, Karpagam College of Pharmacy for providing technical assistance and facilities to carry out the research. Furthermore, this work was supported by providing gift samples of Ondesetron HCl, Propranolol, Gapapentin, and Croscaramellose sodium by Zydus Cadila, Shashan Pharmaceuticals, Aurbindo Pharma Ltd and Karnataka Antibiotics respectively.

REFERENCES

1. Ravi Shankar S. New Drug Delivery Techniques, Aim to Improve Overall Drug Performance and Efficacy. Frost and Sullivan, 2005. (http://technicalinsights.frost.com).
2. Nagendrakumar D, Raju S A, Shirsand S B, Para M S, Rampure M V. Fast Dissolving Tablets of Fexofenadine HCl by Effervescent Method, Indian J Pharm Sci 2009; 71(2): 116–119.
3. Yie W Chien. Oral drug delivery systems. In: Novel Drug Delivery Systems, 2nd edn, Drugs and the pharmaceutical sciences 1992; 50: 139.
4. Parakh S R, Gothoskar AV. A review of mouth dissolving tablet technologies. Pharm Tech 2003; 27(11): 92-98.
5. Bi Y, Sunada H, Yonezawa Y, Danjo K, Otsuka A, Iida K. Preparation and evaluation of a compressed tablet rapidly disintegrating in the oral cavity. Chem Pharm Bull 1996; 44: 2121–2127.
6. Bi Y, Sunada H, Yonezawa Y, Danjo K. Evaluation of rapidly disintegrating tablets prepared by a direct compression method. Drug Dev Ind Pharm 1999; 25; 571–581.
7. Chang R K, Guo X, Burnside B A, Couch R A. Fast-dissolving tablets. Pharm Technol Eur 2000; 12(6); 52–58.
8. Dobetti L. Fast-melting tablets: developments and technologies. Pharm Technol Eur 2000; 12 (9): 32–42.
9. Simone S, Peter C S. Fast dispersible ibuprofen tablets. Eur J Pharm Sci 2002; 15: 295–305.
10. Watanabe Y, Koizumi K, Zama Y, Kiriyama M, Matsumoto Y, Matsumoto M. New compressed tablet rapidly disintegrating in saliva in the mouth using crystalline cellulose and a disintegrant. Biol Pharm Bull 1995; 18: 1308–1310.
11. Guidance for industry oral disintegrating tablets. Centre for drug evolution and research (CDER). http://www.fda.gov/cder/guidance/index.htm
12. Dobetti L. Fast disintegrating tablets. US patent 2003; 6: 311.
13. Gafitanu A, Dumistracel I, Antochi S, Formulation and Bioavailability of Propyphenazone in lyophilized tablets, Rev Med Chir Soc Med Nat Lasi 1991; 95: 127-28.
14. Dinesh Bhandari, Abhinav Agarwal, Himanshu Gupta. Recent trends - Fast dissolving tablets, Pharmaceutical Review 2008; 6: 6.
15. Rakesh Pahwa, Mona Piplani, Prabodh C. Sharma, Dhirender Kaushik and Sanju Nanda. Orally Disintegrating Tablets - Friendly to Pediatrics and Geriatrics. Arch App Sci Res 2010; 2(2): 35-48.

16. Schiermeier S, Schmidt P C. Fast dispersible ibuprofen tablets, Eur J Pharm Sci 2002; 15: 295-305.
17. Caramella C. Disintegrants in solid dosage forms. Drug Dev Ind Pharm 1990; 16(17): 2561-2577.
18. Arias P, Dankers C, Liu P, Pilkauskas P. The world banana economy (1985–2002) Rome, Italy: FAO, 2003.
19. http://www.thelocal.se/discuss/index.php?showtopic=11227
20. Panigrahi D, Baghel S, Mishra B. Mouth dissolving tablets: An overview of Preparation techniques, Evaluation and Patented technologies, J Pharm Research 2005; 4(3): 33.
21. Gohel M, Patel M, Amin A, Agarwal R, Dave R, Bariya N. Formulation design and optimization of mouth dissolving tablets of nimusulide using vaccum drying technique, AAPS Pharm Sci Tech 2004; 5: 36.
22. Schoch T J. Swelling power and solubility of starch granules, in *Methods in Carbohydrate Chemistry*, *Vol. IV* (Ed. R. L. Whistler) Academic Press, New York: 1964;106–108.
23. Sunita A.Chaudhary, Ankit B.Chaudharya, Tejal A Mehta. Excipients Updates for Orally Disintegrating Dosage Forms, Int J Res Pharm Sci 2010; 1(2): 103-107.
24. www.banana.com/medicinal.html - 2009.
25. Kotecha P M, Desai B B. Banana. In S. S. Kadam & D. K. Salunkhe (Eds.), Handbook of fruit science and technology. Boca Raton; FL: CRC Press. 1995; 171–199.
26. Pingyi Zhang, Roy L Whistler, James N BeMiller, Bruce R Hamaker. Banana starch: production, physicochemical properties, and digestibility - a review, Carbohydrate Polymers 2005; 59: 443–458.
27. Baumann T, Forschner-Boke H. Studies on the Therapeutic Action of Apple and Banana Diet. Ztschr f Kinderh 1934; 56: 545.
28. Fanconi G. Fruit Diet for Acute Digestive Disturbances in Children. Monatschr f Kinderh 1931; 49: 232.
29. Haas S V. The Value of the Banana in the Treatment of Celiac Disease. Am J Dis Child 1924; 28: 421.
30. Von Reuss A. Raw Fruit Diet in Digestive Disturbances in Childhood. Wien Med Wchnschr 1938; 88: 1023.
31. Center for Drug Evaluation & Research (FDA) letter of tentative approval for Ondansetron NDA by Baxter Healthcare Corp.
32. (http://www.fda.gov/cder/foi/appletter/2006/021915s000TAltr.pdf).
33. Arcioni R, della Rocca M, Romanò R. Anesth Analg 2002; 97: 1553-1557.
34. www.rxlist.com, 2009.
35. Leach H W, McCowen L D, Schoch T J. Structure of the starch granule. I. Swelling ad solubility patterns of various starches. Cereal Chemistry 1959; 36: 534–544.
36. Leach H W, Schoch T J. Structure of the starch granule. II. Action of various amylases on granular starches. Cereal Chemistry 1961; 38: 34–46.
37. Shinde Dinesh D, Surabh Gupta,Gowthamarajan K, Kulkarani G T, Samanta M K, Suresh B. Investigation of banana powder as disintegrant, Presented in II International Conferences and Indo-Canadian Satellite Symposium on Pharmaceutical Science, Techonology, Practice and Natural Products, JSS College of Pharmacy, Ooty 2007.