# To study the influence of different grades of Ethylcellulose ether derivative polymer Ethocel® and co-excipient on drug release profile of controlled release matrix tablet of acarbose

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**Abstract**: The aim of the study presented is to formulate and evaluate Acarbose controlled release matrix tablets by means of different grades of polymer Ethocel and different co-excipients with the intention to see their effects on drug release profile during in vitro dissolution studies. Controlled release dosage forms is gaining rapid popularity due to its positive aspect of reduction in dosage frequency and curtailing side effects. Controlled released tablets of Acarbose were prepared by direct compression method, using Ethocel® Standard 7 Premium and Ethocel® Standard 7 FP premium polymer. The effect of co-excipients including hydroxypropyl methylcellulose (HPMC), Carboxymethyl cellulose (CMC) and starch on the drug placing 30% lactose were also examined. In-vitro studies were carried out with the help of phosphate buffer (PH 7.4) as dissolution medium. Drug release mechanism was assessed by applying various kinetic models. Similarly / dissimilarity factor $f_2$/ $f_1$ were applied for determination of dissolution profile of the test and reference formulations. Physiochemical characteristics were in the USP satisfactory limits. Conventional Acarbose tablet released 97% of the drug within 2 hrs. Ethocel® Standard 7 premium and Ethocel® standard 7 FP released 59.9% and 47.01% of the drug within 6 and 99.9% and 97% within 24 hours, respectively. This effect possibly has been aceived owing to the smaller particle size of the Ethocel® Standard 7 FP premium which show evidence of anomalous, non-fickian release kinetics. Co-excipients like HPMC, CMC and starch augment the drug release rates from the matrices which may be attributed to their hydrophilic nature. Ethocel® Standard 7 Premium and Ethocel® Standard premium 7 FP polymers show a promising response in fruitful production of controlled release tablets by direct compression method.

**Keywords**: Acarbose, HPMC, Ethocel, CMC, Starch, ACR, zero order equation, Higuachi equation, Hixon Crowel's equation, Korsmeyer and Peppas.

## INTRODUCTION

The present study was envisaged to reduce the dosing frequency and improve patient compliance by designing and evaluating controlled release matrix tablet of acarbose for effective control of type-II diabetes mellitus (Aditya, Gudas *et al*., 2010). Drug entity to the site of action during a required period of time and in this manner accomplishing the desired bioavailability (Malam, Loizidou *et al*., 2009) . Controlled release drug delivery systems sustain optimum and constant drug concentration in blood, resulting in reduce dose frequency, enhancing the activity of short half-life drugs, minimization of drug wastage and optimizing drug therapy with progress in patient compliance. Polymer science happen to be the backbone for the establishment or advancement of new formulation from the past few decades and its progress have led to the development of numerous applications, as coating agent, emulsifying agent, suspending agent, adhesive and adjuvant. Polymer have achieved greater importance in the pharmaceutical industry as drug encapsulates, and vehicles of drug carriage and protecting drug during its passage through the body. In order to achieve this(Orive, Hernandez *et al*., 2003). Ethyl cellulose ether derivatives polymer has been utilized as controlled release excipients and also as a film coating for tablets beads to provide a controlled release or taste masking effect(Katikaneni, Upadrashta *et al*., 1995). As Ethocel polymer water insoluble excipients can efficiently control the release of drug by altering the size and length of the diffusion path. Ethocel standard premium and Ethocel standard FP premium both are derivatives of ethyl cellulose (Brouwers, 1996), and are widely used in the preparation of controlled release matrix tablets. Ethocel standard premium is the conventional granular product, while Ethocel standard FP premium is the latest product, available in finely milled form, thus permitting its direct compression into the controlled-release matrix (Park and Mrsny, 2000).On the contrary CMC being water soluble results in greater release rate when used as co-excipient (Khan and Rhodes, 1975). Starch is swell able in water and increase drug release from matrix tablets when used

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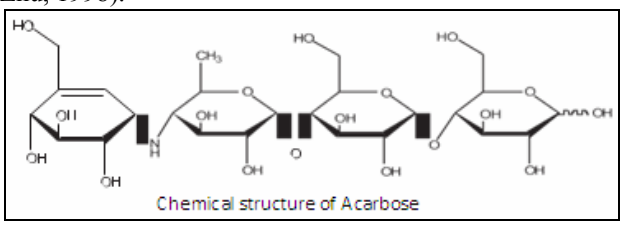
in small quantity possibly owing to breaking up the polymeric membrane resulting in tremendous increase in the release rates of drug. HPMC when used in small quantities can act as channeling agent and enhances the drug release rates (Khan and Meidan, 2007)(Khan and Zhu, 1998).




*O*-4, 6-Dideoxy-4-[[(1*S*, 4R, 5S, 6S)-4, 5, 6-trihydroxy-3-(hydroxymethyl) cyclohex-2- enyl]amino]-α-D-glucopyranosyl-(1→4)-*O*-α -D-glucopyranosyl -(1→4)-D-gluco- pyranose.

Acarbose anorala-glycosidase inhibitor is commonly used for management of Non-Insulin dependent diabetes. It primarily acts via reduction in plasma glucose level through sluggish absorption of starches and sugars from intestine (dictionary). It is obtained from fermentation processes of a microorganism, Actinoplanesutahensis, and is structurally comparable to an oligosaccharide derived from starch digestion. As a result of presence of the intermolecular nitrogen, acarbose binds to the carbohydrate site of the a-glycosidase enzyme with an affinity exceeding that of the normal substrate thus resulting in haulting the enzymatic reactionas the C-N linkage cannot be cleaved. Therefore, glucose absorption is delayed and consequently the post prandial rise in blood glucoseis decreased (Gopinath, HimaBindu *et al*., 2013; Sockan, kavitha, Tamizh Mani, 2010).

## MATERIALS AND METHODS

### *Chemical used*

Acarbose (Bayer international, Karachi, Pakistan), Monobasic potassium phosphate, NaOH (Merck, Germany), Ethocel standard 7 premium, Ethocel standard 7 FP premium, Methocel *K100 M Premium EP (HPMC) (Dow chemical Co., Midland USA), CMC, Lactose, Magnesium stearate (BDH chemical Ltd, Pool England) and Starch ( Merck, Germany) were procured from the local market.

### *Instruments used*

UV-Visible spectrophotometer model No. 1601 (Shimadzu, Japan), Pharma Test Dissolution Apparatus PTWS-11/P, TPT (Germany), PH-meter (Denver, USA), Syringes ( Otsuka Pakistan) , Electronic balance Model N, AX-200 (Shimadzu, Japan) Beakers, Test tubes and volumetric flasks ( Pyrex, Japan), single punch machine model No. AR 400 (Erweka GMBH, Germany), Friabilator (Erweka, Germany), Verniar Caliper (Germany) and Harness tester (Erweka, Germany).

### *Tablet formulation*

The composition of test tablet is illustrated in Table 1. Each blend of Ethocel® was thoroughly mixed with Acarbose, lactose in polythene bags. Afterward, the lactose was replaced with co-excepients (30% each), including hydroxy propyl methyl cellulose (HPMC), corboxy methyl cellulose (CMC) and starch. The powder mixture was sieved through # 40 and then compressed into slugs with a manually run tablet press ZP 17, Shinghai China, using 17 mm flat face tooling. Initially the slugs were crushed in mortar and pestle and then for fine grinding in an oscillating granulator equipped with 20 mesh screen for sizing 200µm<x<1mm. Later, magnesium stearate was blended with the granules in a polythene bag. The granules were then compressed again with the help of same table press ZP 17 equipped with 2x4 mm biconcave tooling.

### *Physiochemical evaluation of tablets*

Physiochemical properties for core ingredients takes into account bulk density, tapped density, Hausner's ratio, angle of repose (AR) and compressibility index (CI), while for tablets it includes thickness, diameter, hardness, weight variation, friability and drug content. These were calculated and reported as their means and SDs. Briefly, angle of repose was determined by a fixed cone and funnel method, while Hausner's ratio and compressibility index were determined by cylinder method as per Unites States Pharmacopoeia, USPXXXI procedure. Hardness of the tablets was determined by hardness tester (Erweka, Germany) and friability by friability testing apparatus (Roche Friabilator, Erweka Germany). Weight deviation and drug content were determined according to the standard procedures of United States Pharmacopoeia, USPXXXI (Abdelkader, 2007; Abdelkader, 2008).

### *In-vitro Dissolution study*

Measurement of drug was carried out according to USP method 1, using dissolution apparatus Pharma Test (Hunburg, Germany). Phosphate buffer (PH 7.4) used as dissolution medium was added to each station and rotation speed of basket was 100rpm and temperature was maintained at 37±0.2C. Samples of 5 ml each were taken at specific time intervals (0,0.5, 1, 1.5,2,3,4,5,6,8,10,12,18 and 24 hours) and were filtered through a membrane filter (0.45µm) in order to remove any impurities or particles present in the sample. Equal volume of the dissolution medium was added as replacement solution after each sampling. Each sample was analyzed at 216nm spectrophotometically using UV-visible spectrophotometer Model No. 1601 (Shimadzu, Japan).

### *Drug release kinetics*

To study the release kinetics of matrix tablets of model drug Acarbose, the following Kinetic models were applied: Eq. 1 Zero-Order Kinetics ($W=k_1$ t), eq. 2 First-order Kinetics (ln (100-W) = ln100-$k_2$t), Eq. 3 Hixon Crowel's Equation or Erosion Model $(100-W)^{1/3}$-$k^3$ t), Eq.

4 Higuchi's Square Root of time equation of Diffusion Model ($W=k_4 t^{1/2}$) and Eq. 5 Diffusion Model ( $M_t /M_\infty=k_5 t^n$ ).

Dissolution equivalency testing (similarity factor (f2) / difference factor $f_1$) was applied for the comparison of the dissolution behavior from the test formulations (Ethocel Standard 7 premium and Ethocel Standard 7 FP) and reference standard formulations. Generally, $f_1 \leq 15$ and $f_2 \geq 50$ indicates an average difference of not more than 10% at the sample time points. (Gohel and panchal, 2002: Shah *et al*., 1998; US FDA, 1997) and values that are not occurring in this range shows difference between the two opposite profiles. The difference factor $f_1$ and similarity factor $f_2$ was calculated by the below mentioned formula:

$$f^1 = \frac{\sum_t^n -1|Rt - Tt|}{\sum Rt} \times 100$$

$$f_2 = 50Log\left\{\left[\frac{1+1}{n} W_t \sum_{t-1}^{n} (R_t - T_t)^2\right]^{-0.5} \times 100\right\}$$

## RESULTS

### *Physiochemical evaluation of tablets*

Model Active drug Acarbose showed poor flow ability and compressibility as compared to their physical mixture (table 1). Angle of repose was measured as 32.56 degree for Acarbose powder, while that for test formulations ranged from *21*$^o$ degree to *29*$^o$ indicating fair flow properties. HF for Acarbose powder was found to be 2.*709,* which might be contributed to the poor flow properties because of inter-particular friction of powdered acarbose. While HF for test formulations was found to be in the range of 1.*015*±0.02 to 1.*029*±0.10, indicating good flow properties of powder with reduced friction. Percent compressibility of Acarbose powder was found to be 51.96% which was in close agreement with angle of repose, while % compressibility for all the three formulations ranged 16.*209*±0.*20*to 20.*29*±0.*08*. The % drug content was found to be in the range of *99.90±0.01 to 100.9±0.20*.

Due to its fine granular property Acarbose Ethocel® FP 7 matrix tablets were found to be elegant in appearance having smooth surfaces with negligible tableting problems. Thickness (table 2) of Acarbose and Ethocel® standard 7 premium matrices without co-excipients and with co-excipients (HPMC, CMC and starch) ranged from 2.6±0.*07mm* to 2.6±0.*21mm*. Thickness of Acarbose and Ethocel® standard 7 FP matrices without co-excipients and with co-excipients (HPMC, CMC and starch) ranged from 2.5±0.*04mm* to 2.4±0.*31mm*. Tablets containing Ethocel standard 7 FP were more compressible producing harder tablets as compared to that of Ethocel® standard 7 Premium. The reason can be attributed to the smaller particle size of Ethocel standard® 7 FP as compared to that of Ethocel standard 7 premium hence, producing more compressible tablets. These results validates the finding of (Khan and median, 2007) that Ethocel® standard FP were more compressible as compared to Ethocel standard Premium due to its smaller particle size. Diameter of Acarbose and Ethocel® standard 7 Premium and Ethocel® standard 7 FP matrices with and without co-excipients ranged from 8±0.*13mm* to 8±0.*11mm* (table 2). Hardness of Acarbose and Ethocel® standard 7 premium matrices with and without co-excipients (HPMC, CMC and starch) ranged from 6.8±0.*04* to 6.7±0.*09*kg/cm2 (table 2). Hardness of Acarbose and Ethocel® standard 7 FP matrices with and without co-excipients was in the range of 6.8±0.*08* to 6.8±0.*14*kg/cm$^2$ (table 2). Friability test result showed that the percentage weight loss of Acarbose and Ethocel® standard 7 premium without and with co-excipients (HPMC, CMC and starch) ranged from 0.08± 0.*23* to 0.09±0.*20*% (table 2). The percentage weight loss of Acarbose and Ethocel® standard 7 FP premium without and with co-excipients (HPMC, CMC and starch) ranged from 0.08±0.*11* to 0.08±0.*05*% (table 2) and all the formulations were within the USP acceptable friability range (0.079%).

### *Drug release studies*

Acarbose reference conventional tablet (Glucobay) released 97% of the drug within 1.5 hr. Ethocel® standard 7 Premium and Ethocel® standard 7 FP released 99.01% and 47.09% of the drug within 6 hours and 24 hours, respectively. It can be stated that Ethocel® Standard 7 FP Premium polymer extends the Acarbose release rate more efficiently than Ethocel® standard 7 premium and conventional marketed formulation of Glucobay tablet which may be attributed to the smaller particle size of the Ethocel® Standard 7 FP as shown in the fig. 1

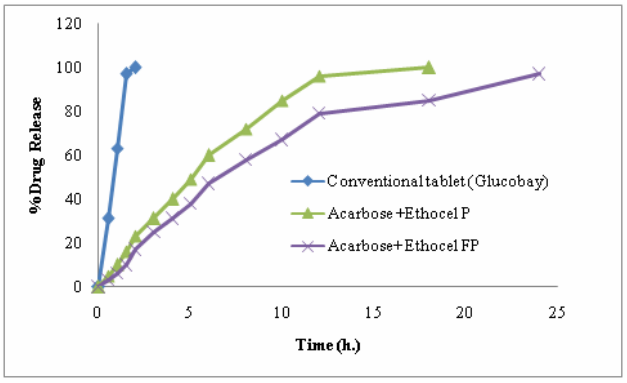



**Fig. 1**: Drug release profile of Acarbose from conventional formulation, Acarbose with Ethocel® standard 7 Premium and Ethocel® 7FP Premium matrices.

### *Influence of co-excipient (HPMC) on drug release rate*

Ethocel® standard 7 Premium and Ethocel® standard 7 FP released 52.01% and 42.03% of the drug within 6 hrs and 99.9% and 97% of the active drug within 24 hrs, respectively. After the addition of co-excipient (HPMC),

Ethocel® Standard 7 Premium and Ethocel® standard 7 FP released 98.68% and 99.81% of the drug with in 2hrs, respectively.

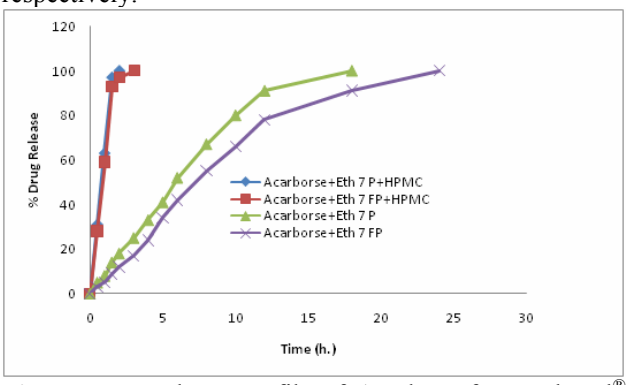



**Fig. 2**: Drug release profile of Acarbose from Ethocel® standard premium, Ethocel® standard FP premium, Ethocel® standard premium with HPMC and Ethocel® standard FP premium with HPMC.

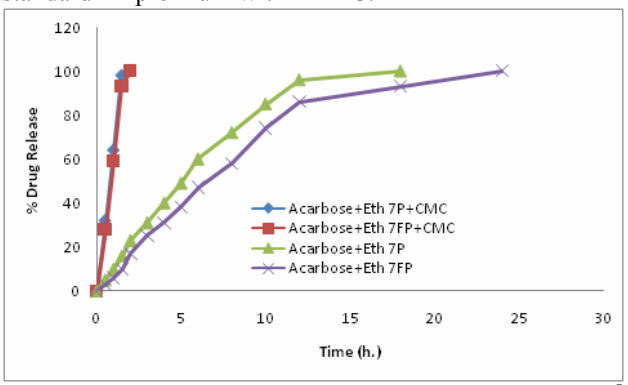



**Fig. 3**: Drug release profile of Acarbose from Ethocel® standard premium, Ethocel® standard FP premium, Ethocel® standard premium with CMC and Ethocel® standard FP premium with CMC.

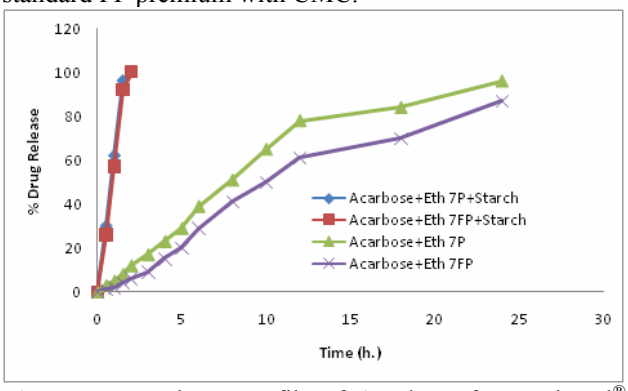



**Fig. 4**: Drug release profile of Acarbose from Ethocel® standard premium, Ethocel® standard FP premium, Ethocel® standard premium with Starch and Ethocel® standard FP premium with Starch.

***Influence of co-excipients (CMC) on drug release rate***

Fig. 3 shows that the partial replacement of lactose with 30% CMC resulted in somewhat higher release rate. Ethocel® standard 7 premium and Ethocel® standard 7 FP tablets released *52.01%* and*42.03%* of the drug within 6 hrs and *99.9%* and *97%* of the active drug within 24 hrs, respectively. After the addition of co-excipient (CMC), Ethocel® standard 7 Premium and Ethocel® standard 7 FP tablets released 99.*01*% and 98.*76*% of the drug in 2 hrs, respectively. CMC is water soluble in nature. When used as co-excipient it may cause enhancement in the release rate of Acarbose from the tablets(Shah, Tsong *et al*., 1998).

***Influence of Starch on drug release rate***

Ethocel® standard 7 premium and Ethocel® standard 7 FP tablets released *51.91%* and *41.96%* of the drug within6 hrs and 99.43% and *96.97%* of the active drug within 24 hrs, respectively. After the addition of Starch, Ethocel® standard 7 Premium and Ethocel® standard 7 FP released 98.*69*% and 98.*92*% of drug within 2 hrs, respectively..

***Drug release kinetics***

Various kinetics models were applied to the tablet formulations, as shown in table 2. The kinetic models (equation 1-5) were suitably fitted to drug release data attained from the dissolution profile and were found to have the linearity ranging from 0.905-0.991. Conventional reference tablet and test formulations containing co-excipients (HPMC, CMC and starch) showed lower release exponents. The diffusion model (eq.5) gave the release exponent "n" for Ethocel® standard 7 premium and for Ethocel® standard 7 FP 0.686 and 0.659, both exhibiting anomalous release behavior (coupled with diffusion and erosion). Release exponent "n" for Ethocel® standard 7 premium and for Ethocel® standard 7 FP containing HPMC was 0.074 and 0.0894, respectively. The Ethocel® standard premium containing CMC as co-excipient resulted in "n" value of 0.0798. Ethocel® standard 7 FP premium containing CMC as co-excipient exhibited "n" value of 0.180 showing non-fickian release behavior. Ethocel® standard 7 premium containing starch as co-excipient gave the release exponent "n" value as 0.0879 when diffusion law was applied. Ethocel® Standard 7 FP premium containing starch show evidence of the release exponent "n" as 0.538. The release exponent "n" for Acarbose conventional tablet was calculated 0.011, while that for test SR formulation 0.189, thereby exhibiting non-fickian release behavior.

***Dissolution equivalency***

The drug release profiles obtained from the test reference conventional tablet were compared and shown in table 3. It has been concluded from the data that the higher polymer concentration (10:3) have shown f2 values lower than 50 indicating noteworthy difference from the reference formulation.

***Stability studies***

The stability studies of the above mentioned test formulations revealed that there was no significant change

**Table 1**: Composition of tablet formulations

| Formulations | Drug | Polymer | lactose | HPMC | CMC | Starch | Magnesium stearate |
|---|---|---|---|---|---|---|---|
| Acarbose-Ethocel 7 premium matrices | 100 | 50 | 49 | -- | -- | -- | 1.0 |
| Acarbose-Ethocel 7 premium matrices with co-excipient (HPMC) | 100 | 50 | 28.3 | 20.7 | -- | -- | 1.0 |
| Acarbose-Ethocel 7 premium matrices with co-excipient (CMC) | 100 | 50 | 28.3 | -- | 20.7 | -- | 1.0 |
| Acarbose-Ethocel 7 premium matrices with co-excipient (Starch) | 100 | 50 | 28.3 | -- | -- | 20.7 | 1.0 |
| Acarbose-Ethocel 7 FP matrices | 100 | 50 | 49 | -- | -- | -- | 1.0 |
| Acarbose-Ethocel 7 FP matrices with co-excipient (HPMC) | 100 | 50 | 28.3 | 20.7 | -- | -- | 1.0 |
| Acarbose-Ethocel 7 FP matrices with co-excipient (CMC) | 100 | 50 | 28.3 | -- | 20.7 | -- | 1.0 |
| Acarbose-Ethocel 7 FP matrices with co-excipient (Starch) | 100 | 50 | 28.3 | -- | -- | 20.7 | 1.0 |

**Table 2**: Kinetic models applied to release data obtained from dissolution of acarbose controlled release tablets

| $W = k_1t$ | | $(100-w) = \ln 100-k_2t$ | | $(100-w)^{1/3} = 100^{1/3}-k_3t$ | | $W = k_4t^{1/2}$ | | $M_t / M_{\infty} = k_5 t^n$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $k_{1 \pm SD}$ | $r_1$ | $k_2 \pm$ SD | $r_2$ | $k_{3 \pm SD}$ | $r_3$ | $k_4 \pm$ SD | $r_4$ | $k_5 \pm$ SD | $r_5$ | n |
| Acarbose and Ethocel® 7Premium Controlled Release Matrices | | | | | | | | | | |
| 7.946±0.609 | 0. 949 | 0.159±0.239 | 0. 989 | 0.216±0.296 | 0.979 | 7.309±0.028 | 0.951 | 0.089±0.240 | 0.949 | 0.685 |
| Acarbose and Ethocel® 7 FP controlled release matrices | | | | | | | | | | |
| 3.499±2.799 | 0. 949 | 0.055±0.080 | 0. 901 | 0. 083±0.110 | 0. 920 | 3.497±0296 | 0.950 | 0.069±1.399 | 0.899 | 0.658 |
| Acarbose and Ethocel® 7 Premium Controlled Release Matrices Having Co-excipient HPMC | | | | | | | | | | |
| 5.968±0.847 | 0.219 | 1.135±0.870 | 0.249 | 1.069±0.809 | 0.239 | 4.395±2.198 | 0.219 | 0.000±1.179 | 0.509 | 0.069 |
| Acarbose and Ethocel® 7 FP Controlled Release Matrices Having Co-excipient HPMC | | | | | | | | | | |
| 6.996±0.014 | 0.210 | 0.899±0.709 | 0.211 | 0.944±0.720 | 0.209 | 4.997±2.689 | 0.211 | 0.000±2.9 | 0.49 | 0.0889 |
| Acarbose and Ethocel® 7 Premium Controlled Release Matrices Having Co-excipient CMC | | | | | | | | | | |
| 6.799±0.509 | 0.259 | 0.989±0.770 | 0.340 | 0.989±0.756 | 0.310 | 4.795±2.340 | 0.259 | 0.000±4.069 | 0.550 | 0.0789 |
| Acarbose and Ethocel® 7 FP Controlled Release Matrices Having Co-excipient CMC | | | | | | | | | | |
| 10.049±1.69 | 0.339 | 0.799±0.059 | 0.349 | 0.819±0.659 | 0.359 | 6.977±3.149 | 0.339 | 0.000±1.419 | 0.699 | 0.179 |
| Acarbose and Ethocel® 7 Premium Controlled Release Matrices Having Co-excipient Starch | | | | | | | | | | |
| 5.589±1.299 | 0.319 | 0.969±0.688 | 0.429 | 0.988±0.758 | 0.387 | 3.996±1.799 | 0.319 | 0.000±2.996 | 0.648 | 0.0879 |
| Acarbose and Ethocel® 7 FP Controlled Release Matrices Having Co-excipient Starch | | | | | | | | | | |
| 6.798±0.469 | 0.468 | 0.189±0.037 | 0.919 | 0.237 ±0.002 | 0.956 | 6.567±0.675 | 0.979 | 0.003±0.0069 | 0.985 | 0.528 |
| Acarbose reference Conventional Formulation | | | | | | | | | | |
| 0.269±5.128 | 0.219 | 1.429±1.019 | 0.897 | 1.319 ±0.938 | 0.279 | 0.187±0.089 | 0.268 | 0.000±2.496 | 0.609 | 0.009 |

in hardness, friability, drug content and physical appearance at accelerated storage conditions (40°C±2 & 75±5% RH) after storage for 30, 60, 120 and 180 days (table 5).

## DISCUSSION

The results of the present study indicate that the formulations Ethocel® Standard 7 premium and Ethocel® Standard 7 FP polymers can be used successfully to develop directly compressed controlled release tablets of water-soluble drugs such as Acarbose. Polymer particle size is the major determining factor in release rate of tablets. Tablets containing Ethocel® Standard 7 FP were more compressible hence it produced harder tablets as compared to that of Ethocel® Standard 7 Premium (Khan and Jiabi, 1998). This phenomena is also endorsed by(Khan, 2001). Hence, it seems the polymer particle size is the key factor in modifying drug release(Shah, Zhang *et al*., 1993; Shah, Tsong *et al*., 1998; Costa, Sousa *et al*., 2003).

Ethocel® Standard 7 FP polymer extended the release rate of Acarbose more efficiently than the conventional granular form of the Ethocel® (Ethocel Standard 7 premium). All the co-excipients used in the study, such as HPMC K100M, starch and CMC, produced an enhancement in the drug release rate. However Starch and CMC have more enhancement in drugs release rate as compare to HPMC K100M. Starch being insoluble in water, may cause non-uniformity of polymeric membranes, leading to quick release of drug from the tablets. Starch is water swellable in nature and might cause rupture of the polymeric membrane causing increase in the drug release rate(Shah, Tsong *et al*., 1998;Khan and Meidan, 2007) .The faster release may be owed to the water soluble property of HPMC as it dissolve faster in the dissolution medium subsequently

**Table 3**: Dissolution equivalency between the Caboose test and reference release profile

| S. No | Acarbose conventional formulation as reference | F1- metric values | F2- metric values |
|---|---|---|---|
| 1 | SR Formulation/Ethocel 7 formulation | 85.43 | 22.65 |
| 2 | SR Formulation/Ethocel 7 formulation with co-excipient CMC | 53.54 | 34.73 |
| 3 | SR Formulation/Ethocel 7 formulation with co-excipient HPMC | 60.23 | 38.72 |
| 4 | SR Formulation/Ethocel 7 formulation with co-excipient Starch | 57.10 | 41.16 |
| 5 | SR Formulation/Ethocel 7 FP Formulation | 89.39 | 11.36 |
| 6 | SR Formulation/Ethocel 7 FP formulation with co-excipient CMC | 65.48 | 44.05 |
| 7 | SR Formulation/Ethocel 7 FP formulation with co-excipient HPMC | 59.03 | 39.48 |
| 8 | SR Formulation/Ethocel 7 FP formulation with co-excipient Starch | 56.77 | 34.724 |

**Table 4**: Stability parameters of Acarbose tablets formulation Acr+Eth P and Acr+ Eth FP (Mean ± SEM, n=3).

| Periods of Sampling | Drugs Content (%) | Friability (%) | Hardness (KG) | Appearance (Colour) |
|---|---|---|---|---|
| Pre-storage (0 time) | 101.09±1.76 | 0.21±0.08 | 6.6±0.15 | Whitish |
| After 30 days | 100.01±1.31 | 0.16±0.11 | 6.7±0.12 | Whitish |
| After 60 days | 99.79±1.97 | 0.18±0.14 | 6.9±0.17 | Whitish |
| After 120 days | 98.91±2.01 | 0.19±0.32 | 7.09±0.55 | Whitish |
| After 180 days | 97.96±1.76 | 0.17±0.21 | 7.19±0.75 | Whitish |

creating osmotic forces within the polymer matrix(Shah, Shah *et al*., 2011;Gohel, Soni *et al*., 2008) . The release exponent "n" for test SR formulation was exhibiting non-fickian release behavior (Boyapally, Nukala *et al*., 2010;Tiwari, Murthy *et al*., 2003;Shah, Zhang *et al*., 1993). The dissolution equivalency studies confirmed that there was no similarity between the conventional formulation and prepared test formulations. The lower f1 values and higher f2 values in the formulations with co-excipients (Starch and CMC) are most likely because of the higher dissolution rate of these formulations (Asim 2014).

The f2-metric technique used for dissolution equivalency revealed that f2 values of all the formulations were less than 50, pointing that the release rates from the test formulations were markedly different from that of the reference conventional formulations.

## CONCLUSION

It is concluded that a good controlled release formulation of Acarbose can be prepared without risk of possible interactions using Ethocel® standard 7FP and Ethocel® 7 Premium polymer to avoid risk of side effects of Acarbose and to improve patient compliance. Hence it is determined that acarbose can be loaded to controlled release matrix tablet for the treatment of diabetes mellitus with better compliance and improve efficacy.

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