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Abstract

Oral bioavailability is a critical determinant of the therapeutic e f cacy and safety of drug formulations. This parameter defnes the extent and rate at which the active pharmaceutical ingredient reaches systemic circulation, infuencing the drug's overall efectiveness and patient compliance. Despite the advantages of oral administration, several challenges hinder optimal bioavailability, including poor solubility, extensive frst-pass metabolism, and drug stability issues. This review explores the multifaceted role of oral bioavailability in drug development, addressing the inherent challenges associated with enhancing bioavailability. We discuss innovative strategies such as formulation

drug absorption and metabolism is examined. By elucidating the complexities of oral bioavailability, this review aims to provide insights into efective approaches for overcoming these challenges, ultimately leading to improved patient outcomes and more successful therapeutic interventions.

Keywords: O al bi a ailabili ; D g de el men ; e a ed 74 494.006i B032 . 422.C;4c] l42 . 4l bi a a 7l42 . 4c 74 na i006 c me ; e ab li m, igni can bi a ailabili m b g ee ab li d f]T 0.014 T/ T n ahe)l en be e eacheng emic ci c la i n le ha imi e he a e ic c me [2].

An he la e f c m le a i e f m he a ien eci c fac ha can a ec al bi a ailabili . Age, gende , gene ic l m hi m , and c -admini e ed medica i n can all in ence d g ab i n and me ab li m. F in ance, edia ic and ge ia ic la i n en

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c m ehen i e nde anding f he challenge a cia ed i h al bi a ailabili , c led i h inn a i e l in , can lead he cce f l de el men f afe and m e ec i e ha mace ical dc . i ng ing e imi e al bi a ailabili nde c e he im ance f in e di ci lina c llab a in am ng ha mace ical x cien i , clinician , and eg la b die na iga e he c m le e f d g de el men and deli e meaningf l he a e ic bene a ien .

Materials and Methods

Study Design

i e ie f c e n a e ing he le f al bi a ailabili in d g de el men , iden if ing challenge , and ing l in enhance a ien c me . e me h d l gie incl de ac m ehen i e li e a e e ie , lab a e e imen , and da a anal i [4].

Literature Review

Da aba e Selec i n: Rele an a icle e e ced f m da aba e ch a P bMed, Sc , Web f Science, and G gle Sch la .

Ke d : Sea che ili ed e m ch a " al bi a ailabili ," "d g f m la i n," " - a me ab li m," " l bili enhancemen ," and " a ien c me ."

Incl i n C i e ia: S die bli hed i hin he la 10 ea , f c ing n al bi a ailabili challenge , l in , and hei im ac n d g de el men e e incl ded. A icle e e elec ed ba ed n hei ele ance he ic, im ac fac , and ci a i n inde .

Da a E ac i n: Ke inf ma i n f m elec ed die a e ac ed, incl ding me h d em l ed im e bi a ailabili , challenge iden i ed, and c me e ed [5].

Experimental Studies

D g Selec i n: A e f m del c m nd kn n f hei a ied bi a ailabili le a ch en. e e c m nd incl ded b h l l ble and highl li hilic d g .

F m la i n De el men : Va i f m la i n e e e a ed, incl ding:

S lid D age F m : Table and ca le ili ing di e en e ci ien enhance l bili and abili .

Nan a icle F m la i n: Li me , lid li id nan a icle , and l me ic nan a icle de igned enca la e elec ed d g .

P d g De ign: S n hei i f d g i h m di ed chemical c e im e l bili and ed ce - a me ab li m [6].

Analytical Techniques

Solubility Testing

Me h d: S l bili a a e ed in di e en media (im la ed ga ic and in e inal id) ing hake-, a k and e ilib i m dial i me h d .

Anal i : Sam le e e anal ed ing UV-Vi ec h me and HPLC (High-Pe f mance Li id Ch ma g a h) de e mine c ncen a i n [7].

Permeability Studies

Cac -2 Cell M del: e Cac -2 cell line a em l ed e al a e he e meabili f d g ac in e inal cell m n la e , mimicking in e inal ab i n.

Me h d: T an ell la e e e ed, and he e meabili c e cien (Pa) a calc la ed ba ed n he d g c ncen a i n in he d n and acce chambe , e ime.

Pharmacokinetic Studies

In Vi S die : Animal m del (e.g., a mice) e e ed d ha mac kine ic .

D ing Regimen: Selec ed d g e e admini e ed all , and bl d am le e e c llec ed a ede e mined in e al .

Anal i : Pla ma c ncen a i n e e an i ed ing LC-MS/MS (Li id Ch ma g a h -Ma S ec me) e al a e he bi a ailabili and ha mac kine ic a ame e (Cma , Tma , AUC) [8].

P d g a egie e en a iable a ach ci c m en hi challenge. B chemicall m dif ing he d g inc ea ei li hilici al e i me ab lic a h/a , d g can enhance ab in and minimi e he a ic me ab li m. i a eg ha been e ec i el ili ed in he de el men f ce ain an i ial and an icance agen , ill a ing he en ial f im ed he a e ic c me.

F he m e, a ien eci c fac ch a age, gende , and gene ic, a ia i n al c n ib e he, a iabili in alBi a ailabili . Pedia ic and ge ia ic la i n, f in ance, en e bi al e ed ha mac kine ic le, nece ia ing ail ed d ing a egie . Gene ic l m hi m in d g-me ab li ing en me can lead igni can in e indi id al a iabili in d g e n e. e ef e, ha mac gen mic die ha el cida e he ela i hi be een gene ic, a ia i n and d g me ab li m a e en ial f de el ing e nali ed medicine a ache .

Eme ging echn l gie , ch a nan echn l g and bi ha mace ical cla i ca i n em (BCS), a e al a ing he /a f enhancing al bi a ailabili . Nan a icle f m la i n can im ed g l bili and abili , enabling a ge ed deli e eci c i e. F e m le, li id-ba ed nan a icle ha e been h/n enca la e h d h bic d g, enhancing hei bi a ailabili and he a e ice cac . BCS cla i ca i n all /f he ema ic e al a in f d g l bili and e meabili , facili a ing he elec in f a ia e f m la i n and de el men a egie .

M e e, he ad en f ad anced in i and in i m del f d ing al bi a ailabili i an f ming d g de el men ce e. High- h gh c eening me h d and Cac -2 cell m del e in igh in he ab i n and e meabili cha ac e i ic f ne/ c m nd , aiding in he elec in f candida e / i h mi ing bi a ailabili le. S ch edic i e m del a e in al able f ea l -a ge d g de el men , all /ing f m e e cien and a ge ed imi a i n a egie .

De i e he e ad ancemen , e e al challenge emain in he e enhance al bi a ailabili . e c m le f bi l gical em e inhe en b acle ha can a ec d g ab in and di ib i n. Fac ch a f d-d g ine ac i n, ga in e inal H a ia i n, and he e ence f he medica i n can in ence he ha mac kine ic f al f m la i n. Add e ing he e fac e i e a c m ehen i e nde anding f he h i l gical and bi chemical in e ac i n cc ing/i hin he ga in e inal ac .

In c ncl i n, imi ing al bi a ailabili i c cial f im ing a ien c me and enhancing he he a e ic en ial f ne/ d g. B ad ing a m liface ed a ach ha incl de inn a i e f m la i n a egie , a ien -cen e ed c n ide a i n, and ad anced edic i e m deling, he ha mace ical ind can na iga e he challenge a cia ed /i h al bi a ailabili . C n in ed e ea ch and c llab a i n am ng cien i , clinician , and eg la b die /ill be e en ial in an la ing he e ad ancemen in clinical ac ice, l ima el leading afe and m e e ec i e he a ie f a ien .

Conclusion

In mma , al bi a ailabili i a c i ical de e minan f d g e cac and a ien adhe ence in ha mac he a . e c m le in l ed in achie ing imal al bi a ailabili e en igni can challenge ha m be add e ed d ing he d g de el men ce . P l bili and e en i e - a me ab li m emain e alen i e ha limi he e ec i ene f man he a e ic agen , a ic la l h e ha a e li hilic bjec a id he a ic clea ance.

Inn a i e f m la i n a egie la a ial le in e c ming he e challenge . Techni e ch a lid di e i n , li id-ba ed f m la i n , and d g de ign ha e dem n a ed igni can en ial in enhancing l bili and im ing e all d g ab i n. e inc a in f nan echn l g in d g deli e em f he e mi ing l i n b im ing he abili and l bili f c m nd ha adi i nall e bi al bi a ailabili . B le e aging he e ad anced me h d l gie , ha mace ical e ea che can c ea e m e e ec i e he a e ic i n ha mee he eci c need f a ien .

e a iabili f al bi a ailabili d e indi id al a ien fac nde c e he im ance f e nali ed medicine in m de n ha mac he a . Age, gene ic l m hi m , and c nc en medica i n can igni can l in ence d g ab in and me ab li m, nece ia ing ail ed ea men egimen . Pha mac gen mic e ea ch c n in e ill mina e he e indi id al di e ence , a ing he /a f m e e nali ed and e ec i e he a e ic a ache ha imi e d g deli e and minimi e ad e e e ec .

Eme ging anal ical echni e and in i m del ide c i ical in igh in he ha mac kine ic le f d g candida e , facili a ing ea l iden i ca i n f en ial bi a ailabili i e. e in eg a i n f high- h gh c eening and edic i e m deling in he d g de el men i eline enhance he e cienc f iden if ing mi ing candida e , he eb eamlining he e all de el men ce .

Reg la f ame/ k al la a i al le in g iding he a e men and imi a i n f al bi a ailabili . Clea g ideline and c llab a i e e am ng eg la agencie , e ea che , and clinician /ill be e en ial in ad ancing he eld f d g de el men . e e /ill hel en e ha ne/ he a e ic in a en nl e ec i e b al afe and acce ible a ien .

A he land ca e f d g de el men c n in e e l e, add e ing he challenge f al bi a ailabili /ill emain a i i f e ea che and ha mace ical cien i . e i f inn a i e l in and c llab a i e a ache /ill c n ib e he de el men f afe, m e e ec i e medica i n ha im e a ien c me. Ul ima el , imi ing al bi a ailabili n nl enhance he he a e ic en ial f d g b al f e a ien - cen ic a ach in heal hca e, leading be e managemen f di ea e and im ed ali f life.

In c ncl i n, he m l iface ed na e f al bi a ailabili enc m a e a b ad ange f challenge and ni ie . B f e ing inn a i n, emb acing e nali ed medicine, and le e aging ad anced anal ical echni e , he ha mace ical ind can na iga e he e c m le e ec i el . e l ima e g al i en e ha a ien ece i e he m e ec i e and eliable he a ie , enhancing he a e ic c me and c n ib ing he e all ad ancemen f heal hca e.

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