Nano-sized spheres of poly(DL-lactide-co-glycolide) as drug carriers for water-soluble vitamins

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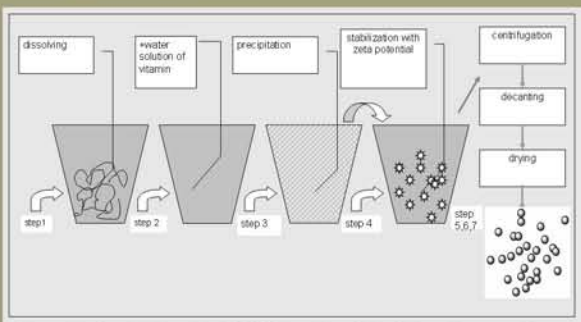
Introduction

Poly(DL-lactide-co-glycolide) (DLPLG) is a strong candidate as drug carrier for a drug delivery system because of its biocompatibility and biodegradability. Nanoparticles act as potential carries for several classes of drugs such as anticancer agents, antihypertensive agents, immunomodulators, hormones; vitamins, etc. DLPLG nanospheres could be a viable vehicle for transdermal medicine delivery.

Ascorbic acid acts as a reductant for many free radicals, thereby minimising the damage caused by oxidative stress which is a root cause of, or at least associated with, many diseases. Nevertheless, ascorbic acid is very unstable to air, light, heat, moisture, oxygen, and base, and it easily decomposes into biologically inactive compounds. Ascorbic acid introduced in the body in the greater portion is isolated from the body. On the other hand, the encapsulated ascorbic acid within the polymeric matrix should have significantly increased efficiency.

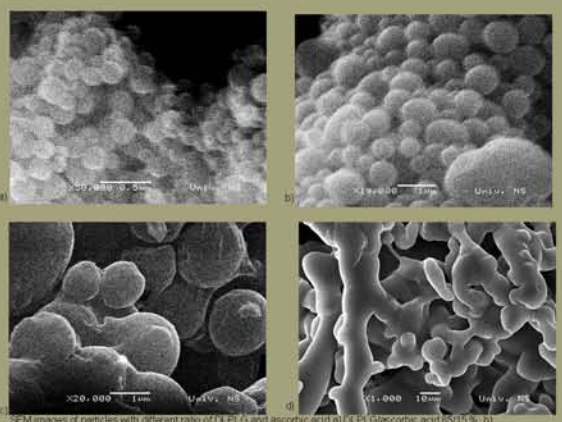
Folic acid (pteroyl-L-glutamic acid, vitamin B9) is also water soluble vitamin and is necessary for the production and maintenance of new cells. Both adults and children need folic acid to make normal red blood cells and prevent anemia. Folic acid also helps prevent changes to DNA that may lead to cancer. With this method we have followed the concept which we have already been applied successfully in the encapsulation of ascorbic acid in DLPLG nanoparticles.

Experimental

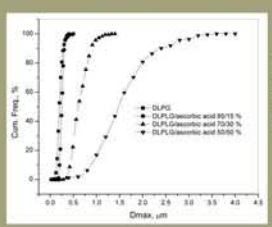


Schematics for obtaining of the DLPLG/ascorbic acid (or folic acid) nanoparticles

DLPLG powder is produced using physicochemical method with solvent/non-solvent systems where obtained solutions were centrifuged. The obtained DLPLG powder is non-agglomerated, unformatted and with particles sizes in the nanometer scale. The encapsulation of ascorbic acid in the polymer matrix is performed by homogenization of water and organic phases. The samples were characterized by Infrared Spectroscopy (IR), Ultraviolet Spectroscopy (UV),Scanning Electron Microscopy (SEM) and stereological analysis.



SEM images of particles with different ratio of DLPLG and ascorbic acid a) DLPLG/ascorbic acid 85/15 %; b) DLPLG/ascorbic acid 70/30 %; c) DLPLG/ascorbic acid 50/50 %; d) DLPLG/ascorbic acid 30/70 %;



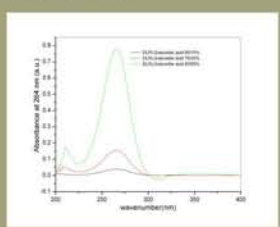
Comparative results of the stereological examining of a) DLPLG particles and particles with different ratio of DLPLG and ascorbic acid b) DLPLG/ascorbic acid 85/15 %; c) DLPLG/ascorbic acid 70/30 %; d) DLPLG/ascorbic acid 50/50 %; based on maximal diameter of the particle Dmax

Results

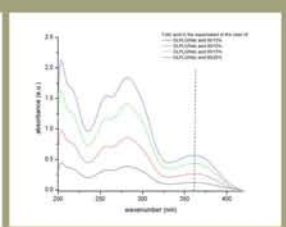
In the nanoparticles of DLPLG copolymer, different concentration of vitamin (ascorbic or folic acid) have been encapsulated and yield in preparation was calculated.

DLPLG/ascorbic acid (%)	Yield (%)
100/0	51.04
85/15	52.10
70/30	56.41
50/50	52.80
30/70	53.23

DLPLG/folic acid (%)	Yield (%)
95/5	53.0
90/10	51.9
85/15	51.0
80/20	52.3



UV spectra of ascorbic acid from the supernatant



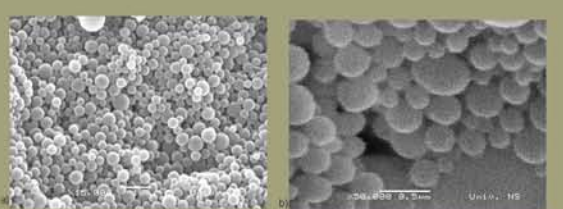
UV spectra of folic acid from the supernatant

Table Loading efficiency of DLPLG/ascorbic acid particles

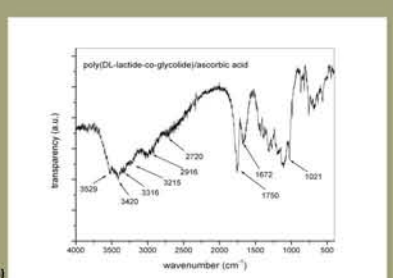
	supernatant absorbance (264nm)	amount of ascorbic acid in supernatant	loading efficiency (%)
DLPLG/ascorbic acid 85/15%	0.03942	0.1581	98.2
DLPLG/ascorbic acid 70/30%	0.24937	0.8214	97.1
DLPLG/ascorbic acid 50/50%	0.77581	3.1000	93.8

Table Loading efficiency of DLPLG/folic acid particles

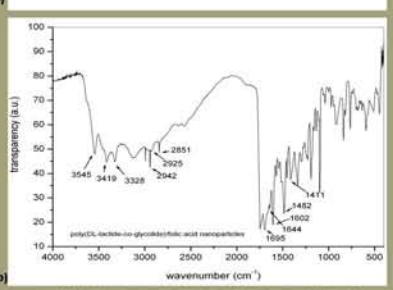
DLPLG/folic acid %	supernatant absorbance (362nm)	amount of folic acid in supernatant (mg)	loading efficiency (%)
95/5	0.11952	2.7849	78.9
90/10	0.26407	6.3936	77.0
85/15	0.43524	10.9368	75.2
80/20	0.57048	14.3750	77.0



SEM images of particles with different ratio of DLPLG and folic acid a) DLPLG/folic acid 95/5 %; b) DLPLG/folic acid 90/10 %; c) DLPLG/folic acid 85/15 %; d) DLPLG/folic acid 80/20 %

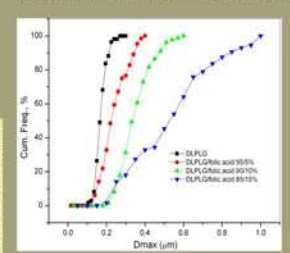


a)



b)

IR spectra of DLPLG/ascorbic acid 85/15% (a) and DLPLG/folic acid 95/5% (b) nanoparticles



Comparative results of the stereological examining of a) DLPLG nanospheres and nanoparticles with different ratio of DLPLG and folic acid b) DLPLG/folic acid 95/5 %; c) DLPLG/folic acid 90/10 %; d) DLPLG/folic acid 85/15 %; based on maximal diameter of the particle Dmax

Conclusion

It is possible to encapsulate water-soluble vitamins into DLPLG particles in various concentrations thus producing particles with different morphological characteristics. The particles of DLPLG/ascorbic acid (or folic acid) with lesser ratio of ascorbic acid (or folic acid) have higher uniformity, lower level of agglomeration and their sizes are smaller. The yields in preparation for various DLPLG/vitamin ratios were similar and they were greater than 50% and the loading efficiency was greater than 75%. The nanoparticles of DLPLG/ascorbic acid 85/15% have spherical shapes and their mean sizes are from 130 to 200 nm depending on the stereological perimeter taken in consideration (feret X, feret Y or Dmax). In the current research we are encapsulating folic acid in lesser ratios because the molecular weight of folic acid (441.1396g/mol) is lesser than the weight of ascorbic acid (176.13g/mol).

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