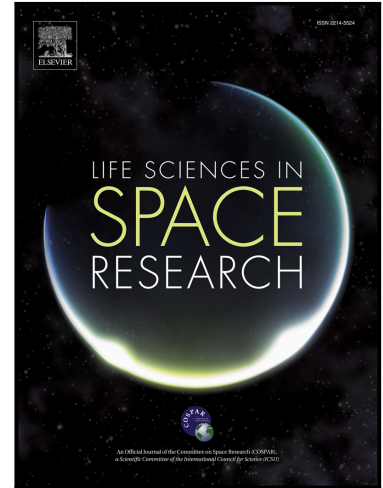


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## Microgels for Long-Term Storage of Vitamins for Extended Spaceflight

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### Abstract

Biocompatible materials that can encapsulate large amounts of nutrients while protecting them from degrading environmental influences are highly desired for extended manned spaceflight. In this study, alkaline-degradable microgels based on poly(*N*-vinylcaprolactam) (PVCL) were prepared and analysed with their regard to stabilise retinol which acts as a model vitamin (vitamin A<sub>1</sub>). It was investigated whether the secondary crosslinking of the particles with a polyphenol can prevent the isomerisation of biologically active all-trans retinol to biologically inactive cis-trans retinol. Both loading with retinol and secondary crosslinking of the particles was performed at room temperature to prevent an early degradation of the vitamin. This study showed that PVCL microgels drastically improve the water solubility of hydrophobic retinol. Additionally, it is demonstrated that the highly crosslinked microgel particles in aqueous solution can be utilised to greatly retard the light- and temperature-induced isomerisation process of retinol by a factor of almost 100 compared to pure retinol stored in ethanol. The use of microgels offers various advantages over other drug delivery systems as they exhibit enhanced biocompatibility and superior aqueous solubility.

**Key words:** vitamin storage; nutrients; retinol protection; manned space flight; microgels; degradable polymers.

### Introduction

The next goal in manned spaceflight of bringing humans to Mars will add a new and exciting step to the history of human spaceflight with regard to the travel distance and duration. This interplanetary mission presents many unique challenges from the technical, psychological and physiological point of view that need to be addressed prior to the launch of the first space vessel. One of the problems inadequately solved is the storage of food for the astronauts and maintaining an intact nutrient supply on this long mission (Zwart et al., 2009). After certain amounts of time, food can go stale or develop a strange taste. On a molecular level this means that nutrients such as vitamins, amino acids or fatty acids are isomerised or

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