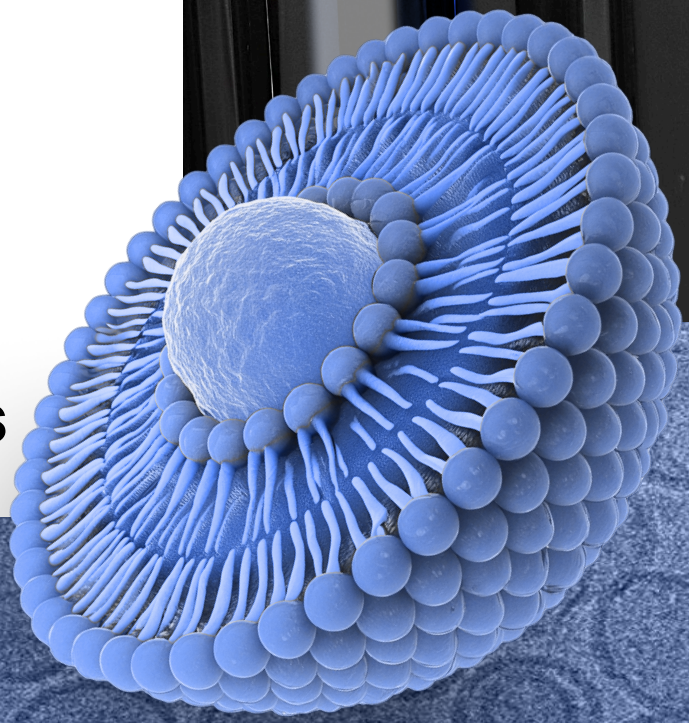
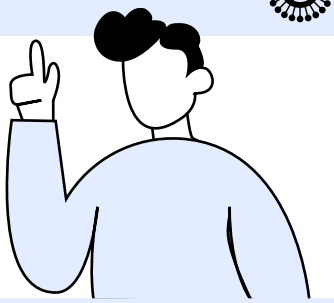
PlantaCORP
advanced liposomal technology

Human Clinical Study on the Comparative Bioavailability of Various D3 and K2 Supplementation Forms



Summary of the Study[1]



Abstract

The purpose of this study was to compare the bioavailability of vitamins D3 and K2 in liquid liposomal supplementation form provided by PlantaCorp with other non-liposomal form provided by competitors. Twenty metabolically healthy volunteers were enrolled in the study.

Overall, **the PlantaCorp liposomal vitamin D3 + K2 supplement had the highest bioavailability, up to 37 times more,** compared to other non-liposomal vitamin D3 + K2 in tablet supplementation form tested.

KEYWORDS: Vitamin D3, Vitamin K2, Cholecalciferol, Menaquinone, Liposomes, Bioavailability, Dietary Supplements.

Product Groups

LLDK
Liquid Liposomal
vitamin D3 + K2
1000 IU + 200 µg

Manufactured by PlantaCorp in Hamburg, Germany

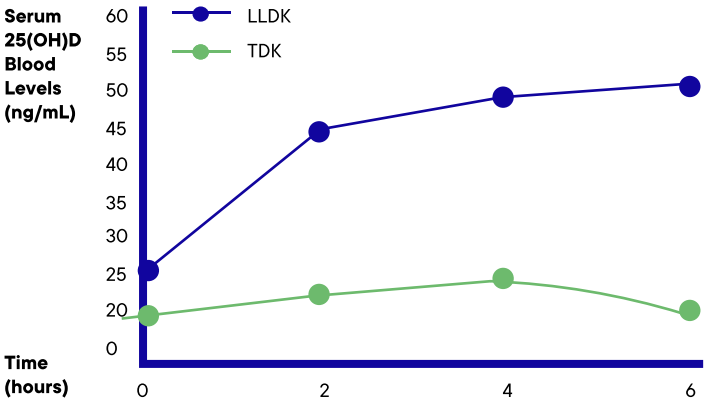
TDK
Non-liposomal tablet
vitamin D3 + K2
1000 IU + 200 µg

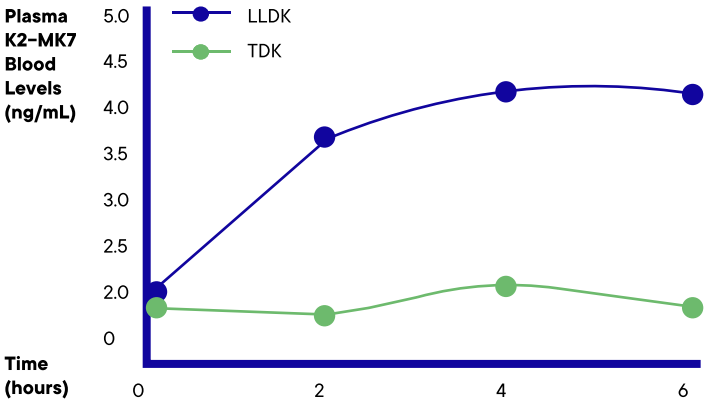
Manufactured by Competitor in the UK

Results

During the study, vitamin D3 and K2 blood levels were measured over time after the intake of 1000 IU of vitamin D3 and 200 µg of vitamin K2-MK7 in two supplementation forms, namely LLDK and TDK.

The results have shown that the PlantaCorp liquid liposomal vitamin D3, detected as 25-hydroxyvitamin D, or 25(OH)D, has **12.84 times** higher bioavailability than the competitor's non-liposomal tablet, and liquid liposomal vitamin K2 has **37 times** higher bioavailability than the competitor's non-liposomal tablet. Liposomal vitamin D3 + K2 also **maintained elevated blood levels throughout the entire study period,** proving sustained highest concentrations during daily supplementation.





[1]See the full study from page 2.

Introduction

Vitamin D3 and vitamin K2 are essential nutrients involved in various biological functions, including bolstering the immune system, regulating calcium absorption, and stabilizing mood, among other key metabolic and psychological processes.[1][2] However, the primary challenge to their effectiveness lies in their absorption, as these fat-soluble vitamins often exhibit limited bioavailability, making it difficult to optimize their functional benefits.[2][3] **Liposomal encapsulation have emerged as a highly effective solution for improving these vitamins supplementation.**[4][5] The current study confirms that **PlantaCorp's unique advanced liposomal technology, LipoSone™**, maximizes vitamin D3 and vitamin K2 bioavailability, outperforming conventional supplementation forms such as tablets.

Method

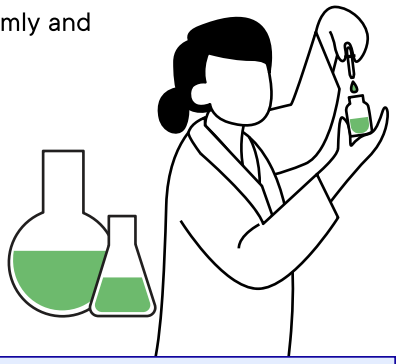
The current study was a randomized, controlled, two-group trial investigating the effect of 1000 IU of vitamin D3 and 200 µg of vitamin K2-MK7 in two different formulations: liquid liposomal form provided by PlantaCorp (LLDK) and non-liposomal tablet form provided by competitor (TDK).

Participants

Twenty (20) metabolically healthy volunteers were enrolled in the study. They were randomly and evenly assigned to one of the two supplementation groups.

Exclusion criteria for participants were:

- ✖ <20 and >50 years of age
- ✖ Any diagnosis of chronic condition(s)
- ✖ BMI outside of the normal category range (18.5–24.9kg/m2)
- ✖ Presence of acute illness
- ✖ Use of drugs or dietary supplements on a frequent and/ or mandatory basis



Measurements	LLDK*	TDK*
Age (years)	26 ± 4	27 ± 4
Females (%)	40	30
BMI (kg/m2)	21 ± 2	22 ± 2
Systolic BP (mmHg)	118 ± 15	120 ± 14
Diastolic BP (mmHg)	75 ± 8	76 ± 9

Table 1. Participant Anthropometric Data

** Mean standard deviation n=10*

Active Substances & Supplementation Groups

a. Liquid liposomal D3 + K2 (LLDK): PlantaCorp's vitamin D3 1000 IU and vitamin K2-MK7 200 µg in liposomal liquid form, manufactured in Hamburg, Germany.

b. Non-liposomal tablet D3 + K2 (TDK): Competitor's vitamin D3 1000 IU and vitamin K2-MK7 200 µg in tablet form, manufactured in London, the United Kingdom.

Dosage and Blood Collection

Participants in the designated supplement groups, while in a fasted state, received an oral dose **1000 IU (25 µg) of vitamin D3 and 200 µg of vitamin K2-MK7** supplements. Blood samples were taken initially before the supplement was consumed (baseline) and then at intervals of 2, 4, and 6 hours following the intake. These samples were microcentrifuged, cooled to 4°C, and analysed for serum 25(OH)D and plasma K2-MK7 levels quantification by Liquid Chromatography-Tandem Mass Spectrophotometry (LC-APCI-MS/MS) techniques.

Data

All participants successfully completed the study. They were predominately in their late twenties. All were characterized by healthy Body Mass Index (BMI) and blood pressure levels, detailed by both systolic and diastolic measurements. Participant anthropometric data is provided in **Table 1.**

Each group's average blood serum 25(OH)D levels for vitamin D3 and blood plasma K2-MK7 levels for vitamin K2 over time are graphically represented in **Figure 1** and **Figure 2**. Pharmacokinetic parameters, such as the peak plasma concentration of 25(OH)D and K2-MK7 (C_{max}) and the time to reach this peak (T_{max}), are documented in **Table 2** and **Table 3**.

The area under the concentration-time curve (AUC_{0-t}) was calculated from dosing to the last measurable concentration using the trapezoidal rule, indicating the total exposure to the active ingredient over time. The incremental area under the curve (iAUC) adjusts the AUC for baseline variations. The Oral Bioavailability Value (OBV) was determined by comparing the liposomal and non-liposomal $iAUC_{0-t}$ values.

Results

A temporal analysis of vitamin D3 evaluated as level of serum 25(OH)D and for vitamin K2 evaluated as level of plasma K2-MK7 reveals that:

At baseline, the blood levels of both vitamin D3 and vitamin K2 across the two supplementation groups were comparable.

After 2 hours, the LLDK group demonstrated significantly higher levels of both serum 25(OH)D and of plasma K2-MK7 compared to the non-liposomal tablet group.

After 4 hours, the LLDK group has reached a **statistically significant increase** of the serum 25(OH)D levels and **the maximum concentration** of plasma K2-MK7 levels in comparison to the tablet group, which exhibited only a minimal increase.

After 6 hours, the LLDK group sustained consistently high and stable levels of both serum 25(OH)D and plasma K2-MK7, whereas the TDK group showed no significant changes from baseline levels.

Considering the **iAUC** values, the outcomes suggest:

The liposomal vitamin D3 in LLDK group has an OBV **12.84 times** greater than that of the TDK group, and the liposomal vitamin K2 in LLDK group has an OBV **37 times** greater than that of the TDK group.

Measurements	LLDK	TDK
C_{max} (ng/mL)	52.94	25.60
T_{max} (hours)	360	240
AUC_{0-t} (ng*h/mL)	140.49	72.87
$iAUC_{0-t}$ (ng*h/mL)	60.81	4.74
OBV	12.84	

Table 2. Vitamin D3 Pharmacokinetic Parameters Data

Measurements	LLDK	TDK
C_{max} (ng/mL)	4.26	2.39
T_{max} (hours)	240	240
AUC_{0-t} (ng*h/mL)	11.37	6.96
$iAUC_{0-t}$ (ng*h/mL)	4.32	0.12
OBV	37.00	

Table 3. Vitamin K2 Pharmacokinetic Parameters Data

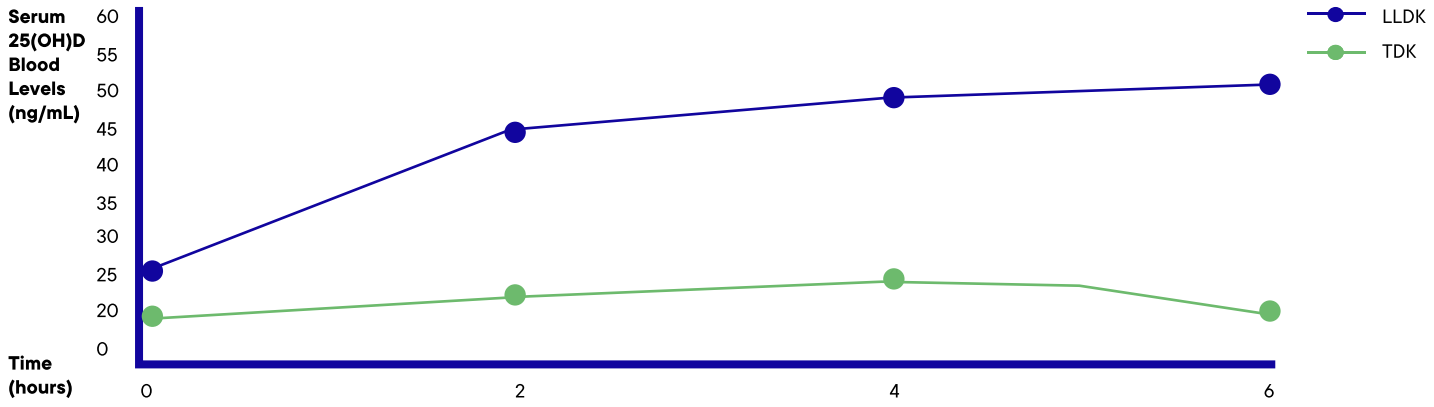


Figure 1. Serum 25-Hydroxyvitamin D levels measured over time after the intake of 1000 IU vitamin D3 in two supplementation groups, namely LLDK liquid liposomal form manufactured by PlantaCorp, and TDK tablet product manufactured by competitor.

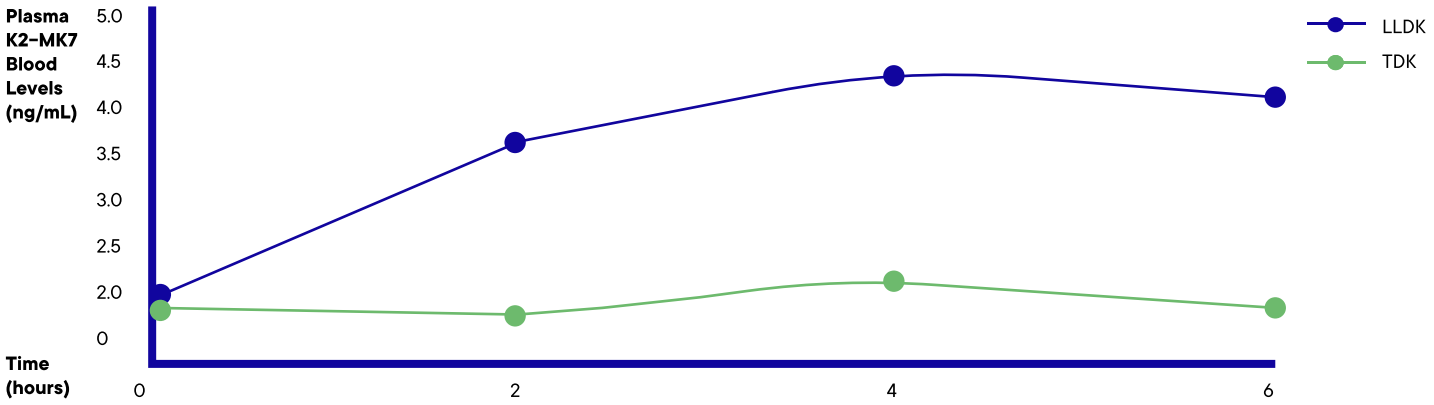


Figure 2. Plasma K2-MK7 levels measured over time after the intake of 200 µg vitamin K2 in two supplementation groups, namely LLDK liquid liposomal form manufactured by PlantaCorp, and TDK tablet product manufactured by competitor.

Discussion and Conclusion

The present study demonstrates that PlantaCorp's liposomal D3 + K2 exhibits **the highest bioavailability** among the tested groups. Specifically, vitamin D3 in LLDK group, measured as serum 25-Hydroxyvitamin D levels, has **12.84 times** higher bioavailability than the competitor's non-liposomal tablet form (TDK), and vitamin K2 in LLDK group, measured as plasma K2-MK7 levels, has **37 times** higher bioavailability than the competitor's non-liposomal tablet form (TDK).

Additionally, LLDK group **maintained elevated serum D3 and plasma K2 levels** throughout the **entire 6-hour** duration of the study. In contrast, the tablet group exhibited a slight increase in serum D3 and plasma K2 levels after 4 hours, which returned to baseline levels after 6 hours.

The results of thi study are particularly relevant when compared to existing literature on the bioavailability of various vitamin D3 supplementation forms. PlantaCorp's liquid liposomal technology achieved a C_{max} of 52.94 ng/mL for serum 25(OH)D levels after a single dose of its 1000 IU D3 liposomal product. This value exceeds those reported in the literature for other vitamin D3 formulations, even when administered in extremely high doses, such as 60000 IU of D3.[6] Common vitamin D3 supplements available on the market, including gummies,[7] oral solutions, and capsules,[6] fail to achieve a C_{max} greater than 40.02 ng/mL. Even formulations that combine vitamin D3 with oil have not matched the remarkable bioavailability demonstrated by the liposomal form.[8]

These findings underscore the substantial impact of liquid liposomes on vitamin D3 and vitamin K2 bioavailability and highlight the superior performance of PlantaCorp's liposomal formulations.

Overall, PlantaCorp's unique advanced liposomal technology, LipoSone™, is the most effective way to deliver vitamin D3 and vitamin K2 to the bloodstream while maintaining the highest blood plasma levels for over 6 hours.

Note on the study:
During the study, the laboratory of analysis reported some complication in accurately measuring the plasma K2-MK7 levels. It was indicated that the values measured were probably inferior to the real values. Since the same issue was reported uniform across all samples, the comparison of the plasma levels between groups is still valid.

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Study conducted in collaboration with: Surya Research Clinics C-6, Sujan Singh Park Cornwallis Road New Delhi, Delhi 110003 J62H+CF New Delhi, Delhi, India

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