Bioavailability of Liposomal-Encapsulated Curcumin

April 2020

1. Study Objective

To evaluate the bioavailability of a liposomal curcumin supplement (liposomal) compared to a non-liposomal curcumin supplement (standard).

2. Methods

The current study was a two-group, randomized controlled trial of the effect of liposomal versus standard curcumin supplements on plasma curcuminoids measured for six hours after administration of a single dose.

2.1. Participants

Twenty metabolically healthy participants enrolled in the study. They were randomly and evenly assigned to either the liposomal or standard supplementation group. Participant exclusion criteria included:

- <20 and >50 years of age
- Any diagnosis of chronic condition(s)
- BMI outside of the normal category range (18.5-24.9kg/m^2)
- Presence of acute illness
- Use of drugs or dietary supplements on a frequent and/or mandatory basis

2.2. Active Substances

a. **Liposomal Product:**
Purazell Liposomal Curcumin
Company:
Roh Vegan am Limit / Patrick Strobach
Sandstrasse 104
40789 Monheim am Rhein

b. **Standard Product:**
GN Laboratories Unencapsulated Curcumin

2.3. Dosage and Blood Collection

An oral dose of 250mg of the liposomal or standard curcumin supplement was administered to fasted participants. Plasma was collected at baseline (B0), 120 minutes (T1), 240 minutes (T2), and 360 minutes (T3) after administration. Plasma was microcentrifuged for 12 minutes, cooled at 2°C and measured for plasma curcumin and demethoxycurcumin (curcuminoid) levels using High Performance Liquid Chromatography-Mass Spectrophotometry (HPLC/MS-MS) techniques at the laboratories of Surya Research Clinics.

2.4. Statistics

Pharmacokinetic parameters of max concentration (C_{max}) and time to max concentration (T_{max}) are presented. Area under the curve from baseline to the final measurement (AUC_{0-t}) was calculated using the trapezoidal rule and oral bioavailability value (OBV) was determined as liposomal AUC_{0-t} /standard AUC_{0-t}.

Between group and within group analyses were conducted to determine significant changes in plasma curcuminoid levels. A two-way ANOVA was performed to determine the difference between groups in mean plasma curcuminoid levels at B0, T1, T2, and T3. Significant differences were found using Bonferonni's simple main effects model. A one-way repeated measures ANOVA with Tukey's pairwise comparisons was used to determine the within group changes in mean plasma curcuminoid levels from B0 to T3 in both the liposomal and the standard group.

3. Results

All enrolled participants completed the study. Participants were in their late twenties, predominately male (65%) and had a healthy BMI (21.55kg/m^2) and blood pressure (120.02/74.75 mmHg). Participant anthropometric data is presented in *Table 1.* A graphical representation of plasma curcuminoid levels over time is available in *Figure 1.*

C_{max} was 32.75 µg/L in the liposomal group and 0.86 µg/L in the standard group. Both the liposomal and standard group had a T_{max} of 240 minutes. AUC_{0-t} was 161.44 µg*hr/L in the liposomal group and 3.45 µg*hr/L in the standard group resulting in an OBV of 46.79. These pharmacokinetic data are presented in *Table 2.*

A two-way ANOVA was conducted that examined the effect of supplement type (treatment) and time of blood draw on plasma curcuminoid levels. There was a statistically significant interaction between the treatment and time of blood draw on the plasma curcuminoid levels, $F(3,72) = 25.391$, $p=0.000$, $R^2=0.843$. Simple main effects analysis showed that the liposomal group had significantly higher levels of plasma curcuminoid levels at T1 (p=0.000), T2 (p=0.000), and T3 (p=0.000) when compared to the standard group. There were no significant differences between groups at B0 (p=0.995). The results from the post hoc test are presented in *Table 3.*

A one-way repeated measures ANOVA was conducted to examine the effects of time on supplementation within both the liposomal and standard groups. There was a statistically significant effect of time on plasma curcuminoid levels in the liposomal group, $F(3,7) = 22.38$, $p=0.001$. Tukey's comparison of means test revealed a significant increase in plasma curcuminoid levels from, B0-T1 (p=0.000), B0-T2 (p=0.000), and B0-T3 (p=0.000). There were no significant differences between plasma curcuminoid levels from T1-T2 (p=0.353), T1-T3 (p=0.093), and T2-T3 (p=0.068). These results are presented in *Table 4.* There were no significant increases over time in the standard group $F(3,7) = 2.10$, $p=0.188$. The comparisons of means results are presented in *Table 5.*

Table 1. Participant Anthropometric Data

	Liposomal[ab]	Standard[ab]
Age (years)	27.10 (5.00)	27.90 (7.00)
Females (%)	38.00	32.00
BMI (kg/m2)	21.60 (1.50)	21.50 (16.80)
Systolic BP (mmHg)	120.90 (15.90)	119.20 (16.80)
Diastolic BP (mmHg)	74.60 (8.90)	74.90 (8.90)

[a] Mean (SD)
[b] n=10

Table 2. Pharmacokinetic Parameters

	Liposomal	Standard
Cmax (µg/L)	32.75	0.86
Tmax (minutes)	240	240
AUC_{0-t} (µg*hr/L)	161.44	3.45
OBV	46.79	

Table 3. Between-Group Change in Mean Plasma Curcuminoid Levels[a]

Time Point	Liposomal[bcd]	Standard[bcd]	Difference of Means[bcd]	95% Confidence Interval	P-Value
B0	0.10 (2.20)	0.08 (2.20)	0.02 (3.12)	-6.19, 6.23	0.995
T1	32.41 (2.20)	0.48 (2.20)	31.93 (3.12)	25.72, 27.01	0.000*
T2	32.76 (2.20)	0.86 (2.20)	31.90 (3.12)	25.69, 38.11	0.000*
T3	31.00 (2.20)	0.69 (2.20)	30.31 (3.12)	24.10, 36.52	0.000*

[a] Data analyzed using two-way ANOVA with Bonferroni Simple Main Effects
[b] n=10
[c] Mean (SE)
[d] Unit µg/L
* P-Value <0.05 is statistically significant

Table 4. Within-Group Change in Mean Plasma Curcuminoid Levels in Liposomal Group[a]

Time Point	Difference of Means[bcd]	95% Confidence Interval	P-Value
T1-B0	32.31 (3.57)	24.23, 40.39	0.000*
T2-B0	32.66 (3.69)	24.31, 41.00	0.000*
T3-B0	30.90 (3.38)	23.24, 38.56	0.000*
T2-T1	0.350 (0.36)	-0.46, 1.16	0.353
T3-T1	-1.41 (0.75)	-3.11, -0.29	0.093
T3-T2	-1.76 (0.75)	-3.68, 0.16	0.068

[a] Data analyzed using one-way repeated measures ANOVA with Tukey's pairwise comparisons
[b] n=10
[c] Mean (SE)
[d] Unit µg/L
* P-Value <0.05 is statistically significant

Table 5. Within-Group Change in Mean Plasma Curcuminoid Levels in Standard Group[a]

Time Point	Difference of Means[bcd]	95% Confidence Interval	P-Value
T1-B0	0.40 (0.22)	-0.09, 0.89	0.106
T2-B0	0.78 (0.40)	-0.12, 1.68	0.083
T3-B0	0.61 (0.38)	-0.26, 1.48	0.146
T2-T1	0.38 (0.21)	-0.10, 0.86	0.106
T3-T1	0.21 (0.18)	-0.21, 0.63	0.283
T3-T2	-0.17 (0.08)	-0.36, 0.02	0.071

[a] Data analyzed using one-way repeated measures ANOVA with Tukey's pairwise comparisons
[b] n=10
[c] Mean (SE)
[d] Unit µg/L
* P-Value <0.05 is statistically significant

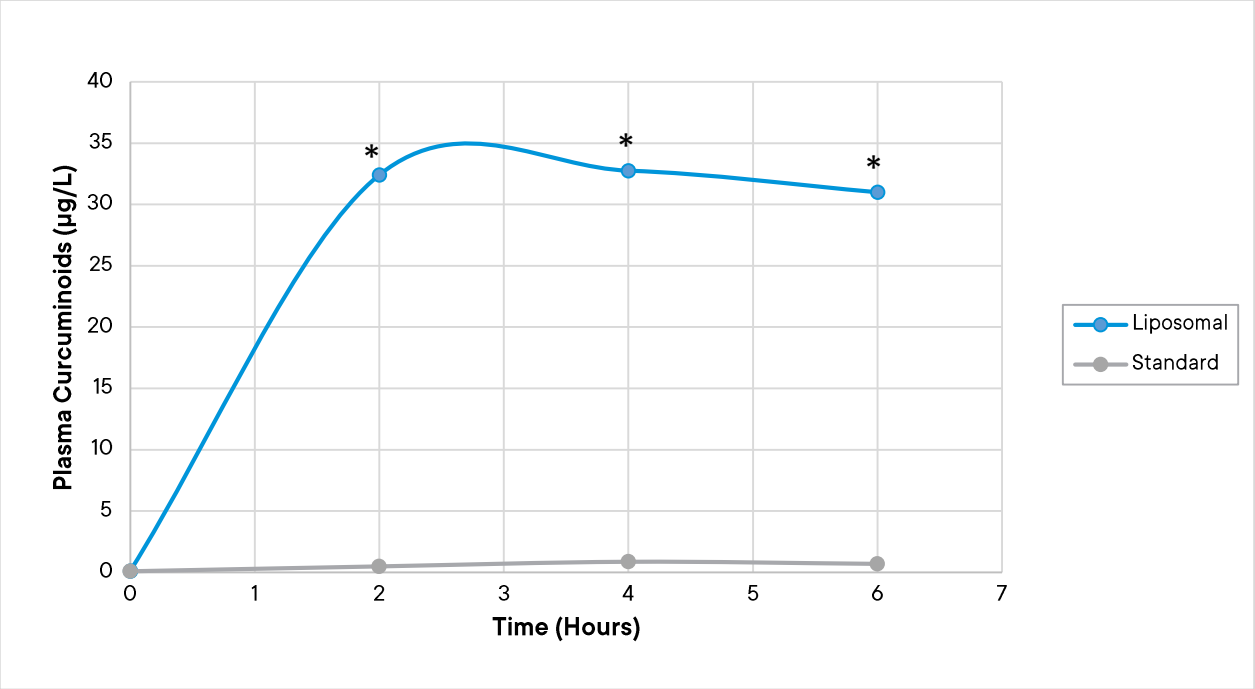

Figure 1. *Plasma curcuminoid levels over time after administration of 250mg Curcumin supplement in liposomal or standard form*
** Indicates a significant difference (p<0.05)*

4. Conclusion

The liposomal curcumin supplement significantly raised plasma curcuminoid levels from baseline after 120, 240, and 360 minutes when compared to a standard curcumin supplement. Within group analysis showed that the liposomal supplement was able to maintain plasma curcuminoid levels significantly higher than baseline for the full six hours of testing. The AUC for the liposomal supplement was greater than that of the standard formulation resulting in an oral bioavailability value of 46.79. This suggests that the amount absorbed from a single dose of liposomal curcumin is higher and thus the liposomal formulation is more bioavailable than a standard supplement at the same dose. These study results are aligned with previous studies that show lecithin based mixtures improve bioavailability of curcumin.[1] Study limitations include a small sample size, a limited number of blood draws, and the lack of a placebo group. Future studies should consider the addition of a placebo group, a larger sample and blood draws for a full 24 hours after supplement administration.

References

[1] Comparative Absorption of a Standardized Curcuminoid Mixture and Its Lecithin Formulation. John Cuomo, Giovanni Appendino, Adam S. Dern, Erik Schneider, Toni P. McKinnon, Mark J. Brown, Stefano Togni, and Brian M. Dixon. Journal of Natural Products 2011 74 (4), 664-669. DOI: 10.1021/np1007262

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