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COMPARATIVE IN VITRO RELEASE STUDY OF UBIQUINONE, UBIQUINOL ACETATE, AND DELT UBIQUINOL ACETATE

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Ubiquinone is the oxidized form of Coenzyme Q10 (CoQ10) and has been the industry standard for supplementation for decades. In the body's energy production cycle, Ubiquinone's primary role is to accept electrons.[1] However, it faces a significant biological hurdle: it is a large, fat-soluble molecule that is notoriously difficult for the digestive system to absorb. Furthermore, for the body to use it as an antioxidant, it must first be converted into its reduced form, Ubiquinol.[2] As we age or face chronic health stress, the body's efficiency in performing `this conversion typically declines, often making standard Ubiquinone less effective for older adults or those with metabolic concerns.[3]

Ubiquinol Acetate is a sophisticated evolution of the CoQ10 molecule. While pure Ubiquinol is the active antioxidant form the body craves, it is chemically unstable and turns back into Ubiquinone the moment it is exposed to air or stomach acid. By adding an acetate shield to the molecule, scientists created a version that remains stable during storage and ingestion.[4] Once it enters the digestive tract, your body's natural enzymes (esterases) easily strip away the acetate group, releasing high-quality Ubiquinol directly into the system. This version removes the burden of conversion from the body, providing a more direct path to cellular support.[5]

Liposomal Ubiquinol Acetate represents the current pinnacle of nutrient delivery technology. This form takes the stabilized Ubiquinol acetate and encapsulates it within microscopic spheres of phospholipids called liposomes. These tiny bubbles are made of the same material as your own cell membranes.[6] Because of this biological similarity the liposomes can pass through the harsh environment of the stomach and the intestinal wall with far greater ease than raw powder or oil. It essentially acts as a high-speed transport vehicle that delivers the CoQ10 payload directly to the bloodstream and, ultimately, the mitochondria.[7]

The primary advantage of liposomal Ubiquinol Acetate over Ubiquinone and standard acetate versions is its vastly superior bioavailability. While standard CoQ10 is often poorly absorbed and largely excreted, the liposomal shield protects the Ubiquinol Acetate from degradation by stomach acid and allows it to bypass the restrictive first-pass metabolism of the liver. This means that a smaller dose of a liposomal formula can achieve much higher blood plasma levels than a significantly larger dose of traditional Ubiquinone.[5,8]

But conventional liposomal formulations are prone to rapid clearance from the bloodstream and have other disadvantages that compromise the therapeutic efficacy of active biomolecules. Similarly, phospholipids may aggregate, changing the size of the vesicle, causing drug seepage due to the delicate lecithin membrane, or damaging the biomolecules that are enclosed. Most liposomal formulations have the tendency to degrade due to hydrolysis, lipid peroxidation, flocculation, and aggregation since liposomes break readily in stomach acids due to the delicate lipid surface.[9,10]

Therefore, Encapscifi Life Sciences introduce the concept of Dual Encapsulated Liposomal Technology (DELT) to provide an extra surface wall to the lecithin using processed plant proteins which would be a novel way to improve liposomal stability by modifying the lecithin's surface. This will also provide the liposomes more resilience against degradation and plant proteins provides an additional layer of protection for lecithin,

preventing biomolecules from leaking out of the liposomal core.

MATERIALS AND METHODS

Ubiquinone, Ubiquinol Acetate and DELT-Ubiquinol Acetate (branded as Wellplus®) were procured from Encapscifi Life Sciences (Bangalore, India), while analytical-grade solvents were sourced from Merck, India. For the diffusion studies, a Sigma Aldrich cellulose dialysis membrane—featuring a 12 kDa molecular weight cut-off (MWCO), a 17.5 mm diameter, and a 28.46 mm flat width—was activated according to the manufacturer's instructions. This setup was utilized to conduct a comparative *in vitro* release study of DELT-Ubiquinol Acetate, Ubiquinol, and Ubiquinone.

The experimental process began by equilibrating the dialysis membrane in phosphate-buffered saline (PBS, pH 7.4) for 12 hours. Subsequently, 50 mg of DELT-Ubiquinol acetate was suspended in 10 mL of PBS and transferred into the dialysis bag, representing the donor compartment. This bag was then submerged in a receptor compartment containing 100 mL of PBS and incubated at with a constant agitation of 120 rpm in a shaker incubator. To monitor the release kinetics over a 6-hour period, 1 mL aliquots were withdrawn from the receptor compartment at predetermined intervals (0, 1, 2, 3, 4, and 5 hours), with each withdrawal immediately replaced by an equal volume of fresh PBS to maintain sink conditions.

To quantify the active molecules, the absorbance of each sample was measured using a plate reader at 275 nm and 290 nm for for Ubiquinone and Ubiquinol Acetate respectively. The resulting data were analyzed using standard calibration curves derived from the linear equation. This allowed for the precise calculation of the total amount of active molecules released into the receptor medium. To ensure reproducibility and scientific rigor, all experiments were conducted in triplicate.
The % BRN release = Amount of BRN release (mg) x 100 / Dose (mg)

RESULTS AND DISCUSSION

The release rate in % of the Ubiquinone and Ubiquinol Acetate from different samples are given in the Table 1. The % release profile of all these samples at different time intervals are picturized in the Fig 1.

Table 1: Percentage of drug release of Ubiquinone, Ubiquinol Acetate and DELT Ubiquinol Acetate.

Time (h)	Ubiquinone (%)				Ubiquinol Acetate (%)				DELT Ubiquinol Acetate (%)			
	Set 1	Set 2	Set 3	Mean ± SD	Set 1	Set 2	Set 3	Mean ± SD	Set 1	Set 2	Set 3	Mean ± SD
0	0.00	0.00	0.00	0.00± 0.00	0.00	0.00	0.00	0.00± 0.00	0.00	0.00	0.00	0.00± 0.00
1	9.41	7.98	4.86	7.42± 2.33	1.26	0.00	12.59	4.61± 6.93	29.48	15.02	16.30	20.26± 8.00
2	15.88	15.78	12.56	14.74± 1.89	1.92	27.85	8.89	12.88± 13.42	24.46	25.89	29.39	26.58± 2.54
3	20.43	23.14	15.60	19.72± 3.82	17.83	36.13	14.09	22.68± 11.79	33.54	45.73	43.64	40.97± 6.52
4	24.51	23.66	21.76	23.31± 1.41	15.45	47.87	62.24	41.85± 23.97	74.81	58.41	82.39	71.87± 12.26
5	22.85	24.08	27.25	24.73± 2.27	47.77	45.11	54.78	49.22± 5.00	69.40	87.04	73.29	76.58± 9.27

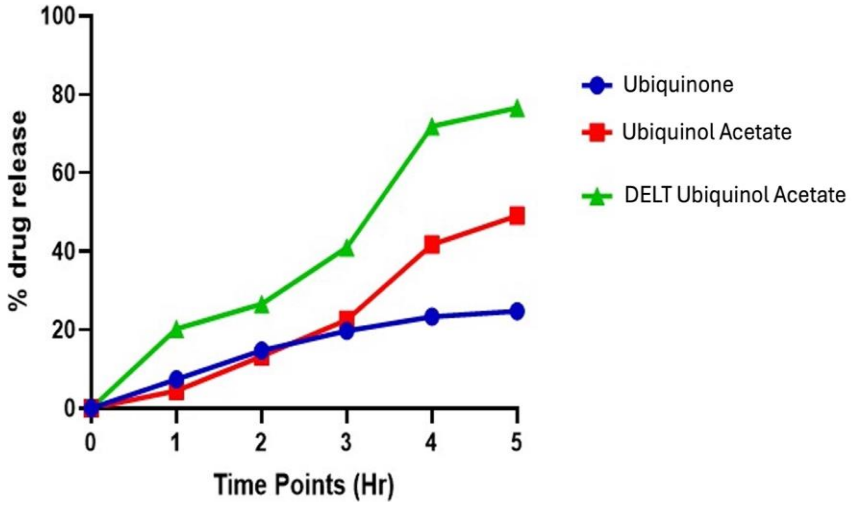

Fig. 1: In vitro release profile of Ubiquinone, Ubiquinol Acetate and DELT Ubiquinol Acetate (%) at different intervals.

The cumulative amount of drug released into the receptor compartment was tracked over a 5-hour period for the three test materials. DELT Ubiquinol Acetate (Wellplus®) consistently outperformed the other formulations, reaching a mean cumulative release of 76.58% by the final time point. In contrast, Ubiquinol Acetate and Ubiquinone showed significantly lower cumulative release amounts, with mean values

of 49.22% and 24.73%, respectively. The data suggests that the liposomal delivery system enhances sustained release compared to the non-liposomal versions.

When evaluating the percentage of drug release relative to the initial dose, the superior efficiency of the liposomal formulation becomes even more evident. Specifically, DELT Ubiquinol Acetate achieved its high mean release of 76.58% at 5 hours indicating the highest solubility among these formulations, whereas Ubiquinol Acetate reached a mean release of 49.22% in the same timeframe. Ubiquinone exhibited the lowest release efficiency at 24.73%. Notable variability was observed in the Ubiquinol Acetate formulation at the 4-hour mark, where it showed a standard deviation of 23.97, compared to the more consistent 2.27 for Ubiquinone at the final hour.

CONCLUSIONS

The study concludes that the liposomal Ubiquinol Acetate (Wellplus® brand) significantly improves drug release effects, providing a sustained and controlled release compared to Ubiquinone and Ubiquinol Acetate. This increased release profile suggests that the liposomal encapsulation likely improves the solubility and diffusion characteristics of the Ubiquinol Acetate and thereby higher bioavailability during the oral consumption.

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