

INTRODUCTION

Nanoparticles can be useful in pharmacology to deliver medicines to cells and other biomaterials efficiently. Particularly, we want to learn to use milk nanoparticles to transfer medicines to cells or other biomaterials. Nanoparticles from milk were first precipitated with the ExoQuick reagent from ThermoFisher. Using dynamic light scattering we measured the average size of the nanoparticles to be 376 nm in diameter. These nanoparticles are being used in further studies to examine transfer of molecules to cells. Our current emphasis is to use milk-derived nanoparticles to transfer fluorescent Curcumin to hydroxyapatite disks as a model of drug delivery.

METHODS

- To harvest nanoparticles from milk, 1.0 mL of skim milk was treated with 0.5 mL of ExoQuick reagent
- To attempt to make curcumin-loaded vesicles, 0.003 g curcumin (Thermo Scientific) was added to 1.3 mL of skim milk and incubated for 10 minutes over ice prior to treatment
- Nanoparticles were recovered in the precipitate after centrifugation for five minutes in a tabletop centrifuge
- Samples are routinely resuspended in 400 μ L of phosphate buffer (PBS)
- For light scattering measurements, samples were diluted to 1:10 concentration with phosphate-buffered saline solution
- Nanovesicles were measured using the ZetaSizer Nano-ZS90 (Malvern, UK)

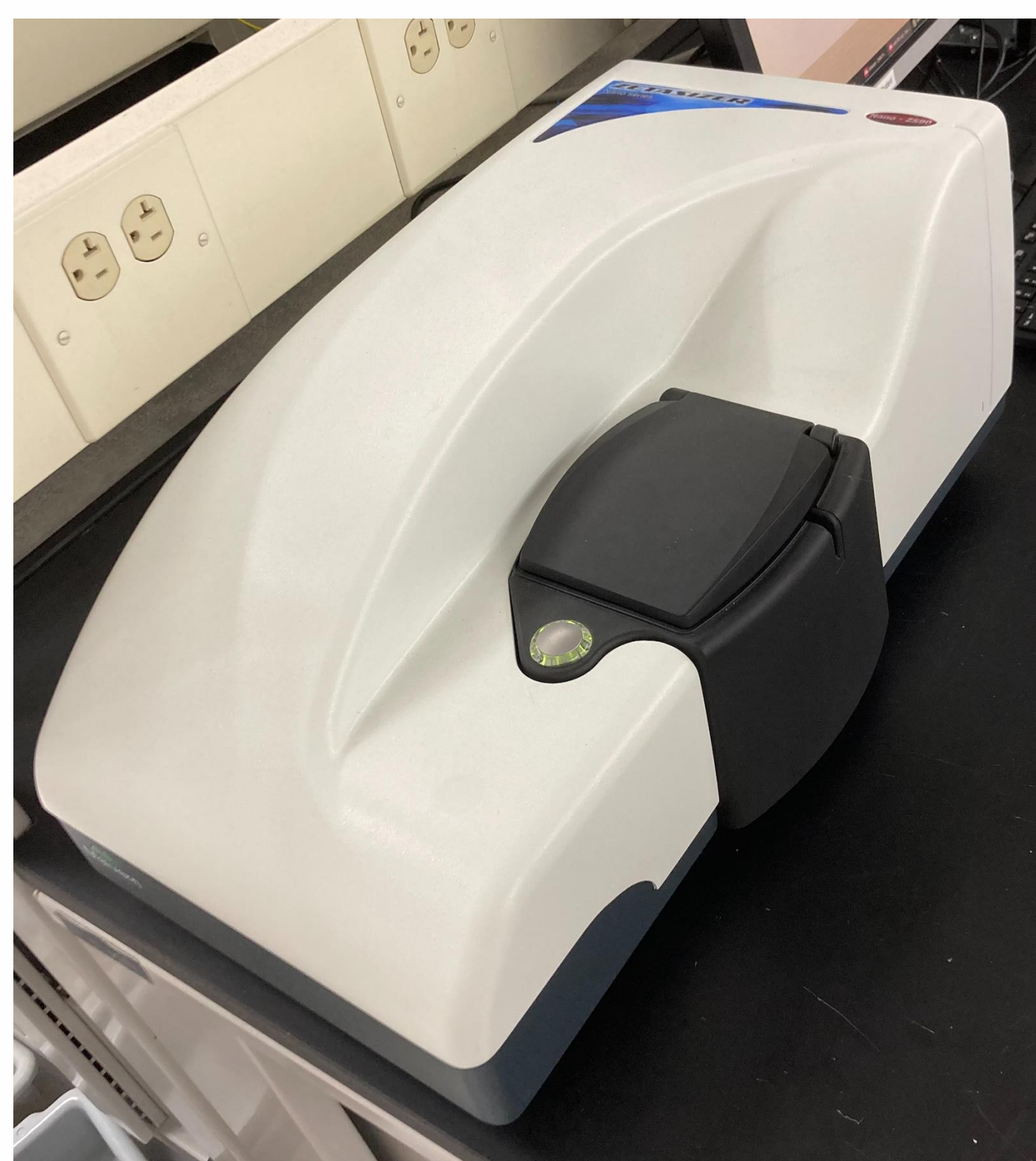
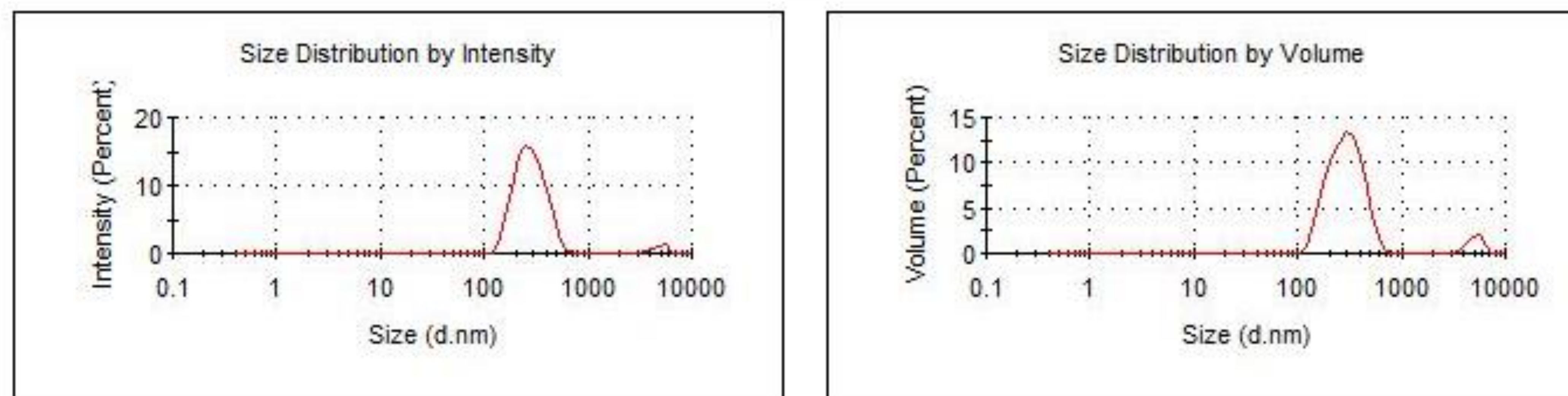


Figure 2. Zetasizer Nano-ZS90. Model ZEN3690

RESULTS

A.



B.

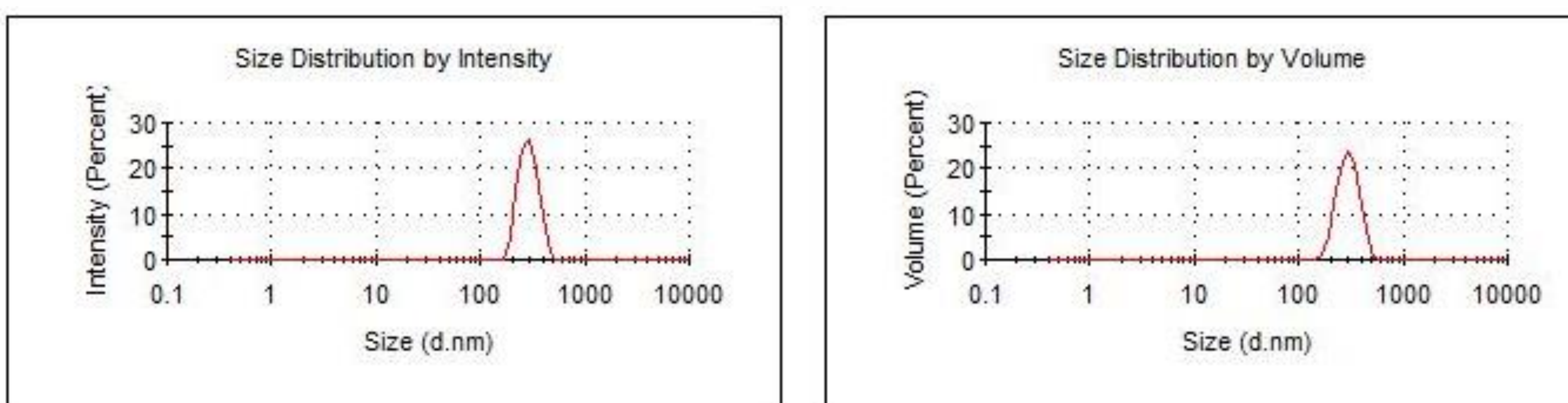


Figure 1. (A.) Size distribution of milk nanovesicles by intensity and volume for a control sample without curcumin fluorescence. (B.) Size distribution of milk nanovesicles incubated with curcumin prior to nanoparticle harvesting by intensity and volume.

Observations

Dynamic light scattering relies upon the ability of particles in solution to scatter light, with the light-scattering properties correlating with particle size. D_z is the hydrodynamic diameter, which is a measure of particle size. Calculated from the Stokes-Einstein equation, it assumes a smooth, spherical geometry to the particle. In the control experiment the hydrodynamic diameter of the milk nanoparticles was measured as having an average value of 281.2 \pm 0.4 nm, where the average value was determined by taking three full-run Zetasizer measurements (280.9, 281.0, and 281.6nm).

When the milk was incubated with curcumin prior to precipitation of the nanoparticles, the average hydrodynamic diameter increased to 286 \pm 6 nm, representing the average value of three runs (279.8, 284.8, and 292.6 nm, respectively).

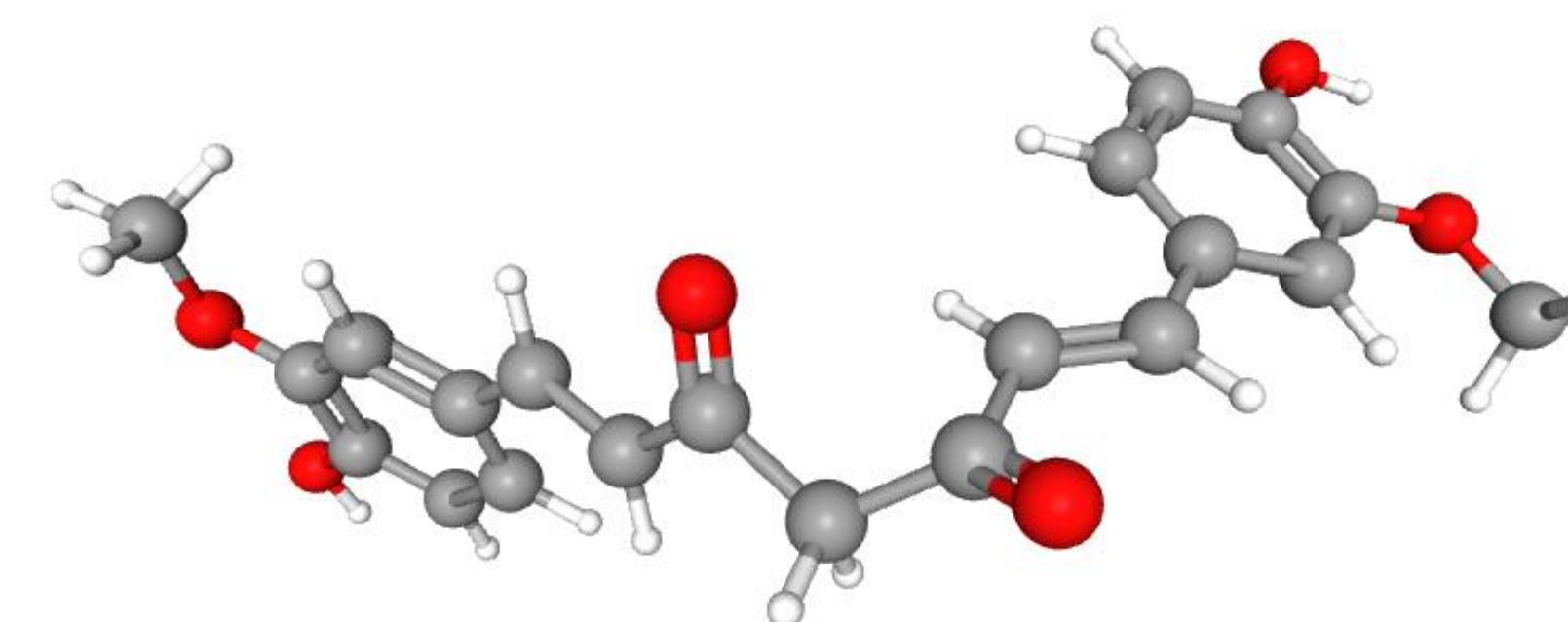
Summary

The resuspended nanoparticle fraction was observed to have retained fluorescent properties.

Vesicles treated with curcumin were observed to yield a higher D_z value, albeit with a higher standard deviation.

About Curcumin

Curcumin is the yellowish ingredient in turmeric that is thought to have antioxidant effects. Curcumin is also actively being evaluated for antioxidant and anticancer effects, among other properties. Sparingly soluble in water, there is much interest in using nanoparticles to make curcumin more highly bioavailable to the human body. Curcumin is known to bind to milk nanoparticles. Coincidentally, curcumin is fluorescent.



COMPARISON TO LITERATURE

We looked at literature to see how these nanoparticles compared to others.

Sahu article had a nanoparticle average of 166nm. González article had an average of 184nm. Taha article had a range from 275-334nm. Carobolante article had a range from 278-390nm.

CONCLUSIONS

A future avenue to pursue could be researching if and how nanoparticles from eggs can be made and if they could be used to transfer curcumin fluorescence similarly to milk nanovesicles.

Others have used milk vesicles to transfer curcumin to live cells such as bacteria.

However, we could evaluate if the milk nanoparticles could be used to transfer curcumin or other drugs to a hydroxyapatite tooth model.

Use of other fluorescent tags or medicines could be evaluated for binding to milk nanoparticles.

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