[0004] These high fortification rates may lead to increased production costs and potential complications in formulating the final product without providing additional consumer benefits. Furthermore, the over fortified formulations may overwhelm the digestive tract with non-soluble lipophilic compounds leading to indigestion.

[0005] Accordingly, there is a need for nutritional compositions for infants, toddlers, children and adults that provide necessary lipophilic compounds in a more stable soluble form.

SUMMARY OF THE INVENTION

[0005a] In one aspect, the disclosure may be directed to a method of preparing a nutritional composition having at least one lipophilic compound having improved bioavailability, the method comprising the steps of:

providing a premix comprising an assembly that comprises at least one hydrophobic protein, a combination of monoglycerides and diglycerides ("MDG") and at least one lipophilic compound, wherein the assembly is (i) water soluble; and (ii) has a size of 60 kD to 1000 kD;

adding the premix to an aqueous solution to form an activated premix; and

adding the activated premix to the nutritional composition.

[0005b] In one aspect, the disclosure may be directed to a method of preparing a nutritional composition having at least one lipophilic compound having improved bioavailability, the method comprising the steps of:

providing a protected premix comprising an assembly that comprises at least one hydrophobic protein, a combination of monoglycerides and diglycerides ("MDG"), at least one lipophilic compound, and a surfactant, wherein the assembly (i) is water soluble; and (ii) has a size of 60 kD to 1000 kD;

adding the protected premix to a fat-containing solution to form an MDG-protectedcomponent; and

adding the MDG-protected component to the nutritional composition.

[0006] In one aspect, the disclosure may be directed to a nutritional composition having at least one protein, at least one fat, and at least one lipophilic compound, the composition comprising: an activated assembly comprising at least one hydrophobic protein, at least one

[0007] combination of monoglycerides and diglycerides ("MDG") and at least one lipophilic compound, wherein at least 1% of the total MDG in the nutritional composition remains in the aqueous phase after centrifugation at 100,000 x g for 1 hour at 20 °C.

[0008] In another aspect, the disclosure may be directed to a nutritional composition having at least one protein, at least one fat, and at least one lipophilic compound, the composition comprising: an activated assembly comprising at least one hydrophobic protein, at least one combination of monoglycerides and diglycerides ("MDG") and at least one lipophilic compound, wherein at least 1% of the total MDG in the nutritional composition remains in the aqueous phase after centrifugation at 100,000 x g for 1 hour at 20 °C, wherein the assembly is (i) water soluble; and (ii) has a size of 100 kD to 1000 kD.

[0009] In another aspect, the disclosure may be directed to a nutritional composition having at least one protein, at least one fat, and at least one lipophilic compound, the composition comprising: an activated assembly comprising at least one hydrophobic protein, at least one combination of monoglycerides and diglycerides ("MDG") and at least one lipophilic compound, wherein at least 1% of the total MDG in the nutritional composition remains in the aqueous phase after centrifugation at 100,000 x g for 1 hour at 20 °C, wherein the assembly is (i) water soluble; and (ii) has a size of 100 kD to 1000 kD, wherein MDG increases the concentration of protein of the assembly by at least 2% compared to a nutritional composition without MDG.

[0010] In another aspect, the disclosure may be directed to a nutritional composition having at least one protein, at least one fat, and at least one lipophilic compound, the

[00138] MDG may be in the aqueous phase at about 0.001% to about 50% of the total MDG in the nutritional composition, following centrifugation at 1,000 x g for 1 hour at 20 °C. MDG may be in the aqueous phase at about 0.5% to about 40% of the total MDG in the nutritional composition, following centrifugation at 1,000 x g for 1 hour at 20 °C. MDG may be in the aqueous phase at about 5% to about 30% of the total MDG in the nutritional composition, following centrifugation at 1,000 x g for 1 hour at 20 °C. MDG may be in the aqueous phase at about 15% to about 25% of the total MDG in the nutritional composition, following centrifugation at 1,000 x g for 1 hour at 20 °C. For example, MDG may be in the aqueous phase at about 0.001%, 0.05%, 0.1%, 0.15%, 0.2%, 0.25%, 0.3%, 0.35%, 0.4%, 0.45%, 0.5%, 0.55%, 0.6%, 0.65%, 0.7%, 0.75%, 0.8%, 0.85%, 0.9%, 0.95%, 1%, 1.25%, 1.5%, 1.75%, 2%, 2.25%, 2.5%, 2.75%, 3%, 3.25%, 3.5%, 3.75%, 4%, 4.25%, 4.5%, 4.75%, 5%, 5.25%, 5.5%, 5.75%, 6%, 6.25%, 6.5%, 6.75%, 7%, 7.25%, 7.5%, 7.75%, 8%, 8.25%, 8.5%, 8.75%, 9%, 9.25%, 9.5%, 9.75%, 10%, 10.25%, 10.5%, 10.75%, 11%, 11.25%, 11.5%, 11.75%, 12%, 12.25%, 12.5%, 12.75%, 13%, 13.25%, 13.5%, 13.75%, 14%, 14.25%, 14.5%, 14.75%, 15%, 15.25%, 15.5%, 15.75%, 16%, 16.25%, 16.5%, 16.75%, 17%, 17.25%, 17.5%, 17.75%, 18%, 18.25%, 18.5%, 18.75%, 19%, 19.25%, 19.5%, 19.75%, 20%, 20.25%, 20.5%, 20.75%, 21%, 21.25%, 21.5%, 21.75%, 22%, 22.25%, 22.5%, 22.75%, 23%, 23.25%, 23.5%, 23.75%, 24%, 24.25%, 24.5%, 24.75%, 25%, 25.25%, 25.5%, 25.75%, 26%, 26.25%, 26.5%, 26.75%, 27%, 27.25%, 27.5%, 27.75%, 28%, 28.25%, 28.5%, 28.75%, 29%, 29.25%, 29.5%, 29.75%, 30%, 30.25%, 30.5%, 30.75%, 31%, 31.25%, 31.5%, 31.75%, 32%, 32.25%, 32.5%, 32.75%, 33%, 33.25%, 33.5%, 33.75%, 34%, 34.25%, 34.5%, 34.75%, 35%, 35.25%, 35.5%, 35.75%, 36%, 36.25%, 36.5%, 36.75%, 37%, 37.25%, 37.5%, 37.75%, 38%, 38.25%, 38.5%, 38.75%, 39%, 39.25%, 39.5%, 39.75%, 40%, 40.25%, 40.5%, 40.75%, 41%, 41.25%, 41.5%, 41.75%, 42%, 42.25%, 42.5%, 42.75%, 43%, 43.25%, 43.5%, 43.75%, 44%, 44.25%, 44.5%, 44.75%, 45%, 45.25%, 45.5%, 45.75%, 46%, 46.25%, 46.5%, 46.75%, 47%, 47.25%, 47.5%, 47.75%, 48%, 48.25%, 48.5%, 48.75%, 49%, 49.25%, 49.5%, 49.75%, or 50% of the total MDG in the nutritional composition, following centrifugation at 1,000 x g for 1 hour at 20 °C.

[00139] MDG may be in the aqueous phase at about 0.001% to about 30% of the total MDG in the nutritional composition, following centrifugation at 31,000 x g for 1 hour at 20 °C. MDG may be in the aqueous phase at about 0.1% to about 20% of the total MDG in the nutritional composition, following centrifugation at 31,000 x g for 1 hour at 20 °C. MDG may be in the aqueous phase at about 1% to about 5% of the total MDG in the nutritional composition, following centrifugation at 31,000 x g for 1 hour at 20 °C. For example, MDG may be in the aqueous phase at about 0.001%, 0.05%, 0.1%, 0.15%, 0.2%, 0.25%, 0.3%, 0.35%, 0.4%, 0.45%, 0.5%, 0.55%, 0.6%, 0.65%, 0.7%,

0.75%, 0.8%, 0.85%, 0.9%, 0.95%, 1%, 1.25%, 1.5%, 1.75%, 2%, 2.25%, 2.5%, 2.75%, 3%, 3.25%, 3.5%, 3.75%, 4%, 4.25%, 4.5%, 4.75%, 5%, 5.25%, 5.5%, 5.75%, 6%, 6.25%, 6.5%, 6.75%, 7%, 7.25%, 7.5%, 7.75%, 8%, 8.25%, 8.5%, 8.75%, 9%, 9.25%, 9.5%, 9.75%, 10%, 10.25%, 10.5%, 10.75%, 11%, 11.25%, 11.5%, 11.75%, 12%, 12.25%, 12.5%, 12.75%, 13%, 13.25%, 13.5%, 13.75%, 14%, 14.25%, 14.5%, 14.75%, 15%, 15.25%, 15.5%, 15.75%, 16%, 16.25%, 16.5%, 16.75%, 17%, 17.25%, 17.5%, 17.75%, 18%, 18.25%, 18.5%, 18.75%, 19%, 19.25%, 19.5%, 19.75%, 20%, 20.25%, 20.5%, 20.75%, 21%, 21.25%, 21.5%, 21.75%, 22%, 22.25%, 22.5%, 22.75%, 23%, 23.25%, 23.5%, 23.75%, 24%, 24.25%, 24.5%, 24.75%, 25%, 25.25%, 25.5%, 25.75%, 26%, 26.25%, 26.5%, 26.75%, 27%, 27.25%, 27.5%, 27.75%, 28%, 28.25%, 28.5%, 28.75%, 29%, 29.25%, 29.5%, 29.75%, or 30% of the total MDG in the nutritional composition, following centrifugation at 31,000 x g for 1 hour at 20 °C.

[00140] MDG may be in the aqueous phase at about 0.001% to about 20% of the total MDG in the nutritional composition, following centrifugation at 100,000 x g for 1 hour at 20 °C. MDG may be in the aqueous phase at about 0.01% to about 15% of the total MDG in the nutritional composition, following centrifugation at 100,000 x g for 1 hour at 20 °C. MDG may be in the aqueous phase at about 0.1% to about 10% of the total MDG in the nutritional composition, following centrifugation at 100,000 x g for 1 hour at 20 °C. MDG may be in the aqueous phase at about 1% to about 5% of the total MDG in the nutritional composition, following centrifugation at 100,000 x g for 1 hour at 20 °C. For example, MDG may be in the aqueous phase at about 0.001%, 0.05%, 0.1%, 0.15%, 0.2%, 0.25%, 0.3%, 0.35%, 0.4%, 0.45%, 0.5%, 0.55%, 0.6%, 0.65%, 0.7%, 0.75%, 0.8%, 0.85%, 0.9%, 0.95%, 1%, 1.1%, 1.2%, 1.3%, 1.4%, 1.5%, 1.6%, 1.7%, 1.8%, 1.9%, 2%, 2.1%, 2.2%, 2.3%, 2.4%, 2.5%, 2.6%, 2.7%, 2.8%, 2.9%, 3%, 3.1%, 3.2%, 3.3%, 3.4%, 3.5%, 3.6%, 3.7%, 3.8%, 3.9%, 4%, 4.1%, 4.2%, 4.3%, 4.4%, 4.5%, 4.6%, 4.7%, 4.8%, 4.9%, 5%, 5.1%, 5.2%, 5.3%, 5.4%, 5.5%, 5.6%, 5.7%, 5.8%, 5.9%, 6%, 6.1%, 6.2%, 6.3%, 6.4%, 6.5%, 6.6%, 6.7%, 6.8%, 6.9%, 7%, 7.1%, 7.2%, 7.3%, 7.4%, 7.5%, 7.6%, 7.7%, 7.8%, 7.9%, 8%, 8.1%, 8.2%, 8.3%, 8.4%, 8.5%, 8.6%, 8.7%, 8.8%, 8.9%, 9%, 9.1%, 9.2%, 9.3%, 9.4%, 9.5%, 9.6%, 9.7%, 9.8%, 9.9%, 10%, 10.1%, 10.2%, 10.3%, 10.4%, 10.5%, 10.6%, 10.7%, 10.8%, 10.9%, 11%, 11.1%, 11.2%, 11.3%, 11.4%, 11.5%, 11.6%, 11.7%, 11.8%, 11.9%, 12%, 12.1%, 12.2%, 12.3%, 12.4%, 12.5%, 12.6%, 12.7%, 12.8%, 12.9%, 13%, 13.1%, 13.2%, 13.3%, 13.4%, 13.5%, 13.6%, 13.7%, 13.8%, 13.9%, 14%, 14.1%, 14.2%, 14.3%, 14.4%, 14.5%, 14.6%, 14.7%, 14.8%, 14.9%, 15%, 15.1%, 15.2%, 15.3%, 15.4%, 15.5%, 15.6%, 15.7%, 15.8%, 15.9%, 16%, 16.1%, 16.2%, 16.3%, 16.4%, 16.5%, 16.6%, 16.7%, 16.8%, 16.9%, 17%, 17.1%, 17.2%, 17.3%, 17.4%, 17.5%, 17.6%, 17.7%, 17.8%, 17.9%, 18%, 18.1%, 18.2%, 18.3%, 18.4%, 18.5%, 18.6%, 18.7%, 18.8%, 18.9%, 19%, 19.1%,

19.2%, 19.3%, 19.4%, 19.5%, 19.6%, 19.7%, 19.8%, 19.9%, or 20% of the total MDG in the nutritional composition, following centrifugation at 100,000 x g for 1 hour at 20 °C.

[00141] MDG may be in the assembly at about 0.001% to about 20% of the total MDG in the nutritional composition, following centrifugation at 31,000 x g for 1 hour at 20 °C. MDG may be in the assembly at about 0.01% to about 15% of the total MDG in the nutritional composition, following centrifugation at 31,000 x g for 1 hour at 20 °C. MDG may be in the assembly at about 0.1% to about 10% of the total MDG in the nutritional composition, following centrifugation at 31,000 x g for 1 hour at 20 °C. MDG may be in the assembly at about 1% to about 5% of the total MDG in the nutritional composition, following centrifugation at 31,000 x g for 1 hour at 20 °C. For example, MDG may be in the assembly at about 0.001%, 0.05%, 0.1%, 0.15%, 0.2%, 0.25%, 0.3%, 0.35%, 0.4%, 0.45%, 0.5%, 0.55%, 0.6%, 0.65%, 0.7%, 0.75%, 0.8%, 0.85%, 0.9%, 0.95%, 1%, 1.1%, 1.2%, 1.3%, 1.4%, 1.5%, 1.6%, 1.7%, 1.8%, 1.9%, 2%, 2.1%, 2.2%, 2.3%, 2.4%, 2.5%, 2.6%, 2.7%, 2.8%, 2.9%, 3%, 3.1%, 3.2%, 3.3%, 3.4%, 3.5%, 3.6%, 3.7%, 3.8%, 3.9%, 4%, 4.1%, 4.2%, 4.3%, 4.4%, 4.5%, 4.6%, 4.7%, 4.8%, 4.9%, 5%, 5.1%, 5.2%, 5.3%, 5.4%, 5.5%, 5.6%, 5.7%, 5.8%, 5.9%, 6%, 6.1%, 6.2%, 6.3%, 6.4%, 6.5%, 6.6%, 6.7%, 6.8%, 6.9%, 7%, 7.1%, 7.2%, 7.3%, 7.4%, 7.5%, 7.6%, 7.7%, 7.8%, 7.9%, 8%, 8.1%, 8.2%, 8.3%, 8.4%, 8.5%, 8.6%, 8.7%, 8.8%, 8.9%, 9%, 9.1%, 9.2%, 9.3%, 9.4%, 9.5%, 9.6%, 9.7%, 9.8%, 9.9%, 10%, 10.1%, 10.2%, 10.3%, 10.4%, 10.5%, 10.6%, 10.7%, 10.8%, 10.9%, 11%, 11.1%, 11.2%, 11.3%, 11.4%, 11.5%, 11.6%, 11.7%, 11.8%, 11.9%, 12%, 12.1%, 12.2%, 12.3%, 12.4%, 12.5%, 12.6%, 12.7%, 12.8%, 12.9%, 13%, 13.1%, 13.2%, 13.3%, 13.4%, 13.5%, 13.6%, 13.7%, 13.8%, 13.9%, 14%, 14.1%, 14.2%, 14.3%, 14.4%, 14.5%, 14.6%, 14.7%, 14.8%, 14.9%, 15%, 15.1%, 15.2%, 15.3%, 15.4%, 15.5%, 15.6%, 15.7%, 15.8%, 15.9%, 16%, 16.1%, 16.2%, 16.3%, 16.4%, 16.5%, 16.6%, 16.7%, 16.8%, 16.9%, 17%, 17.1%, 17.2%, 17.3%, 17.4%, 17.5%, 17.6%, 17.7%, 17.8%, 17.9%, 18%, 18.1%, 18.2%, 18.3%, 18.4%, 18.5%, 18.6%, 18.7%, 18.8%, 18.9%, 19%, 19.1%, 19.2%, 19.3%, 19.4%, 19.5%, 19.6%, 19.7%, 19.8%, 19.9%, or 20% of the total MDG in the nutritional composition, following centrifugation at 31,000 x g for 1 hour at 20 °C.

[00142] Lutein, a lipophilic compound discussed below, may be in the aqueous phase at about 0.001% to about 50% of the nutritional composition, following centrifugation at 1,000 x g for 1 hour at 20 °C. Lutein may be in the aqueous phase at about 0.5% to about 40% of the nutritional composition, following centrifugation at 1,000 x g for 1 hour at 20 °C. Lutein may be in the aqueous phase at about 5% to about 30% of the nutritional composition, following centrifugation at 1,000 x g for 1 hour at 20 °C. Lutein may be in the aqueous phase at about 15% to about 25% of the nutritional composition, following centrifugation at 1,000 x

CLAIMS

What is claimed is:

1. A method of preparing a nutritional composition having at least one lipophilic compound having improved bioavailability, the method comprising the steps of:

providing a premix comprising an assembly that comprises at least one hydrophobic protein, a combination of monoglycerides and diglycerides ("MDG") and at least one lipophilic compound, wherein the assembly is (i) water soluble; and (ii) has a size of 60 kD to 1000 kD;

adding the premix to an aqueous solution to form an activated premix; and

adding the activated premix to the nutritional composition.

2. The method of claim 1, wherein the assembly has a size of 60 kD to 400 kD.

3. The method of claims 1 or 2, wherein the lipophilic compound is a carotenoid, a lipid soluble vitamin, a lipophilic antioxidant or combinations thereof.

4. The method of claims 1-3, wherein the lipophilic compound is lutein, vitamin A, vitamin D, vitamin E, vitamin K, docosahexaenoic acid (DHA) or combinations thereof.

5. The method of claims 1-4, wherein the premix is heated to a temperature of 120 °F for about 10 minutes.

6. A method of preparing a nutritional composition having at least one lipophilic compound having improved bioavailability, the method comprising the steps of:

providing a protected premix comprising an assembly that comprises at least one hydrophobic protein, a combination of monoglycerides and diglycerides ("MDG"), at least one lipophilic compound, and a surfactant, wherein the assembly (i) is water soluble; and (ii) has a size of 60 kD to 1000 kD;

adding the protected premix to a fat-containing solution to form an MDG-protectedcomponent; and

adding the MDG-protected component to the nutritional composition.

7. The method of claim 6, wherein the assembly has a size of 60 kD to 400 kD.

8. The method of claims 6 or 7, wherein the lipophilic compound is a carotenoid, a lipid soluble vitamin, a lipophilic antioxidant or combinations thereof.

9. The method of claim 8, wherein the lipophilic compound is lutein, vitamin A, vitamin D, vitamin E, vitamin K, docosahexaenoic acid (DHA) or combinations thereof.

10. The method of claims 6-9, wherein the premix is heated to a temperature of 120 °F for about 10 minutes.