such as β-carotene. Moreover, the compositions should be autosterilic and do not require sterilization. Last but not least, the compositions should be easy to produce, especially without the need for artificial emulsifiers or the production of liposomes.

It was surprisingly found that these objectives are met by the liquid compositions, which contain the following components a) to h) and optionally contain further ingredients, such as carotenoids, e.g. ß-carotene, and/or zinc salts.

In an aspect, there is provided a liquid composition containing the following components a) to h):

a) at least one of vitamin A and esters of vitamin A;
b) at least one of vitamin D and provitamin D;
c) at least one of vitamin E and esters of vitamin E;
d) at least one of vitamin K and provitamin K;
e) 40 to 95% by weight, based on the total weight of the liquid composition, of at least one water miscible polyol;
f) 1 to 40% by weight, based on the total weight of the liquid composition, of at least one edible triglyceride;
g) 3 to 30% by weight, based on the total weight of the liquid composition, water; and
h) 0.5 to 10% by weight, based on the total weight of the liquid composition, of a phospholipid composition containing phosphatidylcholine;

wherein the total amount of components a) to d) is at least 0.3% by weight, based on the total weight of the liquid composition.

The liquid compositions of the disclosure contain the following components a) to h):

a) at least one of vitamin A and esters of vitamin A,
b) at least one of vitamin D and provitamin D,
c) at least one of vitamin E and esters of vitamin E,
d) at least one of vitamin K and provitamin K,
e) 40 to 95% by weight, in particular 45 to 90% by weight, especially 50 to 85% by weight, based on the total weight of the liquid composition, of at least one water miscible polyol,
f) 1 to 40% by weight, in particular 2 to 40% by weight, especially 5 to 35% by weight, based on the total weight of the liquid composition, of at least one vegetable triglyceride;

g) 3 to 30% by weight, in particular 6 to 25% by weight, especially 7 to 20% by weight, based on the total weight of the liquid composition, water; and

h) 0.5 to 10% by weight, in particular 0.8 to 8% by weight, especially 1 to 7% by weight, based on the total weight of the liquid composition, of a phospholipid composition containing phosphatidylcholine;

i) optionally one or more carotenoids or esters thereof, e.g. ß-carotene;

wherein the total amount of components a) to d) is at least 0.3% by weight, in particular at least 0.4% by weight, especially at least 0.5% by weight, based on the total weight of the liquid composition, e.g. in an amount in the range of 0.3 to 20% by weight, in particular in the range of 0.3 to 15% or in the range of 0.4 to 15% by weight, especially in the range of 0.4 to 10% by weight or the range of 0.5 to 10% by weight, based on the total weight of the liquid composition.

The compositions of the present disclosure are stable upon storage and do not form inhomogeneity, such as phase separation, creaming, sediments or other inhomogeneity even after prolonged storage. The compositions can be easily diluted with water, whereby translucent oil-in-water emulsions are formed with very small oil droplets dispersed in the

a good bioavailability of the vitamins. Due to the good bioavailability of the ingredients a) to d) and the optionally present carotenoid, the compositions of the present invention are particularly useful for the treatment of an existing or impending vitamin deficiency condition concerning at least one of vitamin A, D, E or K. Therefore, a further aspect relates to the use of the compositions as defined herein in the treatment of an existing or impending vitamin deficiency condition concerning at least one of vitamin A, D, E or K.

Further examples of the present disclosure are:

- A formulation comprising a liquid composition as described herein and a vehicle or carrier, in particular formulation for oral administration, for topical administration or for parenteral administration, e.g.
  - A dosage form for oral administration comprising a liquid composition as described herein;
  - A formulation for topical application comprising a liquid composition as described herein and a vehicle suitable for topical application;
  - A formulation for parenteral administration, in particular for subcutaneous administration or intramuscular administration, the formulation comprising a liquid composition as described herein and a liquid vehicle or carrier suitable for parenteral administration.
- The use of the compositions as described herein in a medical treatment of a disease or condition of a mammal, in particular in a human being, where the disease or condition is associated with or caused by an existing or impending vitamin deficiency condition in a mammal;
- The use of the compositions as described herein in the co-treatment of a disease in a mammal, in particular in a human being, with a therapeutic agent different from vitamin A, D, E and K, where the disease or the treatment with the therapeutic agents causes or may cause vitamin deficiency condition concerning at least one of vitamin A, D, E or K;
- The use of the compositions as described herein for dietary purposes, such as food supplementation or in food for special medical purposes, such as food for a balanced diet of a mammal, in particular of a human being;
- The use of the compositions as described herein in cosmetic formulations;
- A method of treatment of a disease or condition of a mammal, in particular of a human being, which comprises administering a composition of the invention to a mammal in need thereof, where the disease or condition is associated with or caused by an existing or impending vitamin deficiency condition in a human;

- A method of co-treatment of a disease in a mammal, in particular in a human being, where the mammal is treated with a therapeutic agent different from vitamin A, D, E and K, where the disease or the treatment with the therapeutic agents causes or may cause vitamin deficiency condition concerning at least one of vitamin A, D, E or K, which comprises administering a composition of the invention to a mammal in need thereof, i.e. to the mammal, which has been treated with a therapeutic agent different from vitamin A, D, E and K.

In another aspect, there is provided a method for producing a liquid composition as defined above, which comprises

a) mixing the components of the liquid composition and
b) homogenizing the mixture obtained in step a).

In another aspect, there is provided the use of a composition as defined above in the manufacture of a medicament for the treatment of an existing or impending vitamin deficiency condition concerning at least one of vitamin A, D, E or K.

In another aspect, there is provided the use of the composition as defined above in the manufacture of a medicament for a medical co-treatment of a disease with a therapeutic agent different from vitamin A, D, E and K, where the disease or the treatment with the therapeutic agents causes or may cause vitamin deficiency condition concerning at least one of vitamin A, D, E or K.

In another aspect, there is provided the use of a composition as defined above for dietary purposes or cosmetic purposes.

In another aspect, there is provided a composition as defined above for use in therapy.

Here and in the following, the term “use for medical purposes” includes both the use of the compositions of the invention as a component of a medicinal product and its use as a component of a pharmaceutical product.

Here and in the following, the term “use for dietary purposes” includes both the use of the compositions of the invention, either as such or as a component of a formulation, for food supplementation and use of the compositions of the invention, either as such or as a component of a formulation, as a food for special medical purposes, such as a balanced diet.

Although the compositions of the present invention have multiple phases due to the different polarities of the ingredients e) and g) on one hand and the components a) to d), f) and optional component i) on the other hand, they are translucent liquids and not turbid. In other words, the compositions are virtually homogeneous.

As mentioned above, the compositions of the invention will form a translucent oil-in-water emulsion when they are diluted with water. In particular, the compositions of the present invention are characterized in that a dilution of the liquid composition in deionized water at 25° C and at a concentration of 1% by weight forms droplets having a Z average particle diameter of at most 500 nm, in particular at most 350 nm, e.g. in the range of 50 to 500 nm, in particular in the range of 50 to 350 nm, as determined by dynamic light scattering.

The component a) is selected from vitamin A including retinol (vitamin A1), retinoic acid (vitamin A acid, e.g., all-trans-retinoic acid and 13-cis-retinoic acid) and retinals (vitamin A aldehyde e.g., all-trans-retinal and 11-cis-retinal) and retinol esters, i.e. esters of retinol with fatty acid, in particular C_2 to C_{20} fatty acids, such as retinol acetate, retinol propionate and retinol palmitate. Preference is given to retinol esters as component a). The concentration of the component a) in the composition of the invention is preferably in the range of 0.001

We claim:

1. A liquid composition containing the following components a) to h):
   a) at least one of vitamin A and esters of vitamin A;
   b) at least one of vitamin D and provitamin D;
   c) at least one of vitamin E and esters of vitamin E;
   d) at least one of vitamin K and provitamin K;
   e) 40 to 95% by weight, based on the total weight of the liquid composition, of at least one water miscible polyol;
   f) 1 to 40% by weight, based on the total weight of the liquid composition, of at least one edible triglyceride;
   g) 3 to 30% by weight, based on the total weight of the liquid composition, water; and
   h) 0.5 to 10% by weight, based on the total weight of the liquid composition, of a phospholipid composition containing phosphatidylcholine;

   wherein the total amount of components a) to d) is at least 0.3% by weight, based on the total weight of the liquid composition.

2. The liquid composition of claim 1 which is translucent.

3. The liquid composition of any one of the preceding claims, wherein the total amount of components a) to d) is in the range of 0.2 to 20% by weight, based on the total weight of the composition.

4. The liquid composition of any one of the preceding claims, where the concentrations of components a) to d) are as follows:

   a) 0.001 to 0.4% by weight, based on the total weight of the liquid composition, of component a),
   b) 0.00005 to 0.3% by weight, based on the total weight of the liquid composition, of component b),
   c) 0.1 to 19% by weight, based on the total weight of the liquid composition, of component c),
   d) 0.001 to 0.4% by weight, based on the total weight of the liquid composition, of component d);

   where the total concentration of components a), b), c) and d) is range of 0.2 to 20% by weight, based on the total weight of the composition.

5. The liquid composition of any one of the preceding claims further containing at least one carotenoid and/or an ester thereof as a component i).

6. The liquid composition of claim 5, wherein the carotenoid comprises ß-carotene.

7. The liquid composition of any one of claims 5 or 6, wherein the concentration of the carotenoid in the liquid composition is in the range of 0.01 to 10% by weight, in particular in the range of 0.02 to 5% by weight, based on the total weight of the liquid composition.

8. The liquid composition of any one of the preceding claims, wherein the components a), b) c) and d) and optionally the component i) is essentially present in dissolved form.

9. The liquid composition of any one of the preceding claims further containing a zinc salt, which is suitable for nutritional or dietary purposes or pharmaceutically acceptable.

10. The liquid composition of claim 9, wherein the zinc salt is selected from zinc sulfate, zinc gluconate, zinc bisglycinate, zinc acetate, zinc hydroxide carbonate, zinc lactate, zinc ascorbate, in particular zinc L-ascorbate, zinc hydrogen ascorbate, zinc aspartate, zinc hydrogen aspartate, such as zinc DL-hydrogen aspartate or zinc L-hydrogen aspartate, zinc citrate, zinc oxide, zinc stearate, zinc orotate, zinc picolinate and the hydrates thereof.

11. The liquid composition of any one of claims 9 or 10, wherein the concentration of the zinc salt in the liquid composition is in the range of 0.01 to 0.2% by weight, based on the total weight of the liquid composition and calculated as elemental zinc.

12. The liquid composition of any one of the preceding claims, wherein the weight ratio of the phosphatidylcholine to the triglyceride is in the range of 1:20 to 1:1.

13. The liquid composition of any one of the preceding claims, wherein the triglyceride is selected from the group consisting of oils of seed-oil plants, MCT oils, LCT oils

and oils of marine organisms and combinations thereof, and where the triglyceride comprises a medium chain triglyceride as a main constituent.

14. The liquid composition of any one of the preceding claims, which has at least one of the following features a) to d), wherein

a) the weight ratio of component f) to the total weight of components a), b) c) and d) and optionally the component i) is in the range of 1:1 to 100:1, in particular in the range of 2:1 to 50:1;

b) the phospholipid composition contains phosphatidylcholine in an amount of at least 45% by weight, based on the total weight of the phospholipid composition;

c) the liquid composition is characterized in that a dilution of the liquid composition in deionized water at 25° C and at a concentration of 1% by weight forms droplets having a Z average particle diameter of at most 500 nm, as determined by dynamic light scattering;

d) the liquid composition additionally contains a water-soluble organic anti-oxidant, which is in particular ascorbic acid or sodium ascorbate.

15. A method for producing a liquid composition of any one of the preceding claims, which comprises

e) mixing the components of the liquid composition and

f) homogenizing the mixture obtained in step a).

16. A formulation comprising a liquid composition according to any one of claims 1 to 14 and a carrier or vehicle, which is a formulation for topical administration or for oral administration.

17. Use of a composition according to any one of claims 1 to 14 in the manufacture of a medicament for the treatment of an existing or impending vitamin deficiency condition concerning at least one of vitamin A, D, E or K.

18. Use of the composition of any one of claims 1 to 14 in the manufacture of a medicament for a medical co-treatment of a disease with a therapeutic agent different from vitamin A, D, E and K, where the disease or the treatment with the therapeutic agents causes or may cause vitamin deficiency condition concerning at least one of vitamin A, D, E or K.

19. The use of a composition of any one of claims 1 to 14 for dietary purposes or cosmetic purposes.

20. A composition according to any one of claims 1 to 14 for use in therapy.