The blending will be described below. Although an aqueous phase and an oil phase are separately prepared, finally the blending is performed at the following blending ratio so that the total amount is 100 parts by mass. While it is difficult to prepare an oil-in-water emulsion which is a nanoemulsion when it is out of the blending, it is possible to obtain an oil-in-water emulsion having a smaller particle size when the blending is preferable.

The amount of the oil phase is from 0.5 to 35 parts by mass, preferably from 1 to 30 parts by mass, and more preferably from 2 to 15 parts by mass in terms of an oily material.

The aqueous phase has the following composition. The amount of the protein material is from 30 to 1200 mass%, preferably from 60 to 400 mass% in terms of crude protein content relative to the oily material. It is also preferable that the following conditions are satisfied as the crude protein content. The crude protein content is from 1 to 20 parts by mass, preferably from 5 to 15 parts by mass, and more preferably from 10 to 12 parts by mass based on 100 parts by mass of the total amount of the emulsion.

The amount of water is from 5 to 70 parts by mass, preferably 65 parts by mass or less, more preferably 35 parts by mass or less, and most preferably 20 parts by mass or less. The amount of the readily water-soluble substance is from 1 to 80 parts by mass, preferably from 10 to 70 parts by mass, and more preferably from 40 to 65 parts by mass. The total amount of the readily water-soluble substance and water is preferably 2 times by mass or more, more preferably 4 times by mass or more, and most preferably 6 times by mass or more, relative to the protein material.

In addition to the oily material, the protein material, and the readily water-soluble substance, various substances can be added as long as they do not affect the present invention. On the other hand, it is preferable that a substance having a boiling point lower than that of water, for example, a lower alcohol or a lower hydrocarbon is not contained. Considering the use for foods and the like, it is desirable to avoid these uses as much as possible.

Various emulsifiers dissolved in each of the aqueous phase and the oil phase may be added to the aqueous phase and the oil phase. However, as with lower alcohols, it is one of the characteristics of the present invention that an oil-in-water emulsions which is a nanoemulsion can be prepared without using these, and considering the use for foods and the like, it is desirable to avoid these uses as much as possible.

[0022]

Preparation of stock solution of emulsion

A preparation method will be described below, and first, the preparation of the aqueous phase will be described. The protein material and the readily water-soluble substance are added to water, and the aqueous phase is dissolved by stirring or the like. The temperature of water to be used is not particularly limited, and warm water is preferable, and from 60 to 80°C is suitable. When the temperature is low, the viscosity increases and workability deteriorates, and when the temperature is high, an oil-soluble component to be blended may deteriorate. The protein material used in the present invention is characterized by having a low viscosity after heating,

b) An oily material was added to the aqueous phase of step a) in the formulation shown in Table 1, and the mixture was preliminarily emulsified at 65°C for 5 minutes to an emulsion particle size of from 10 to 60 μm using a homomixer.

c) An oil-in-water emulsion as a nanoemulsion was prepared by treating the mixture in step b) with a high pressure homogenizer (Microfluidizer available from Microfluidics International Corporation) at a predetermined pressure.

As the readily water-soluble substance, the following were used: glycerin (food additive, available from Kishida Chemical Co., Ltd., solubility in water: arbitrary, boiling point: 290°C), sorbitol (available from B Food Science Co., Ltd., solubility in water: arbitrary, boiling point 296°C), maltose ("Sunmalt" available from Hayashibara Co., Ltd., solubility in water: 1.08 g/ml·20°C, no boiling point data), sodium chloride (available from FUJIFILM Wako Pure Chemical Corporation, solubility in water: 35.9 g/100 g·25°C, boiling point: 1413°C), sodium L-ascorbate (available from FUJIFILM Wako Pure Chemical Corporation, solubility in water: 62 g/100 ml·25°C, boiling point: 235°C).

[0044]

Measurement of emulsion particle size

A sample oil-in-water emulsion was diluted with ion-exchanged water so that the oily material was 0.03%. The particle size of an oil droplet in water was measured as Z-average (nm) to be calculated by Zetasizer nano-ZS (MODEL ZEN3600) available from Malvern Instruments. The measurement was performed three times at 25°C using 2 g of a sample in a glass cell having an optical path of 1 cm, and the average value thereof was taken as an average emulsion particle size. The setting conditions were as follows.

RI (Material) 1.47, Absorption (Material) 0, Temperature (Dispersant) 25 (°C), Viscosity (Dispersant) 0.887 (cp), RI (Dispersant) 1.33, Equilobration time 60 (sec), Number of runs 10, Run duration 10, Number of measurements 1, Dela between measurements 0 (sec).

[0045]

Study on blending of water and readily water-soluble substance

In order to confirm the blending amounts of water and the readily water-soluble substance and the properties of the emulsion, the following studies were conducted, and the results were summarized in Table 1. The emulsion particle size was evaluated according to the following criteria. Those having a particle size of 100 nm or less were regarded as acceptable, and these had a transmittance of more than 50%. 4 points: very good when particle size is 50 nm or less, 3 points: good when particle size is 60 nm or less, 2 points: acceptable range when particle size is 100 nm or less, 1 point: unacceptable when particle size exceeds 100 nm.

[0046]

(Table 1) Study on blending of water and readily water-soluble substance