(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 January 2014 (03.01.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/001030 A1

(51) International Patent Classification:
A23L 1/0522 (2006.01) *A23L 1/48* (2006.01)
A23L 1/20 (2006.01)

(21) International Application Number:
PCT/EP2013/061453

(22) International Filing Date:
4 June 2013 (04.06.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
12173813.2 27 June 2012 (27.06.2012) EP

(71) Applicant *(for all designated States except AE, AG, AU, BB, BH, BN, BW, BZ, CA, CY, EG, GB, GD, GH, GM, IE, IL, IN, KE, KN, LC, LK, LS, MT, MW, MY, NA, NG, NZ, OM, PG, QA, RW, SC, SD, SG, SL, SZ, TT, TZ, UG, US, VC, ZA, ZM, ZW)*: **UNILEVER N.V.** [NL/NL]; Weena 455, NL-3013 AL Rotterdam (NL).

(71) Applicant *(for AE, AG, AU, BB, BH, BN, BW, BZ, CA, CY, EG, GB, GD, GH, GM, IE, IL, IN, KE, KN, LC, LK, LS, MT, MW, MY, NA, NG, NZ, OM, PG, QA, RW, SC, SD, SG, SL, SZ, TT, TZ, UG, VC, ZA, ZM, ZW only)*: **UNILEVER PLC** [GB/GB]; Unilever House, 100 Victoria Embankment, London EC4Y 0DY (GB).

(71) Applicant *(for US only)*: **CONOPCO, INC., D/B/A UNILEVER** [US/US]; 800 Sylvan Avenue, AG West, S. Wing, Englewood Cliffs, New Jersey 07632 (US).

(72) Inventors: **BENJAMIN, Mia, Claire**; Unilever R&D Vlaardingen B.V., Olivier van Noortlaan 120, NL-3133 AT Vlaardingen (NL). **BIALEK, Jadwiga, Malgorzata**; Unilever R&D Vlaardingen B.V., Olivier van Noortlaan 120, NL-3133 AT Vlaardingen (NL). **KO, Meliana**; Unilever R&D Vlaardingen B.V., Olivier van Noortlaan 120, NL-3133 AT Vlaardingen (NL). **NIJSSE, Jacob**; Unilever R&D Vlaardingen B.V., Olivier van Noortlaan 120, NL-3133 AT Vlaardingen (NL). **SILVA PAES, Sabrina**; Unilever R&D Vlaardingen B.V., Olivier van Noortlaan 120, NL-3133 AT Vlaardingen (NL). **VREEKER, Robert**; Unilever R&D Vlaardingen B.V., Olivier van Noortlaan 120, NL-3133 AT Vlaardingen (NL).

(74) Agent: **CORSTEN, Michael, Allan**; Unilever Patent Group, Olivier van Noortlaan 120, NL-3133 AT Vlaardingen (NL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report (Art. 21(3))*

WO 2014/001030 A1

(54) **Title**: EDIBLE OIL-IN-WATER EMULSION

(57) **Abstract**: One aspect of the invention relates to and oil-in-water emulsion comprising 5-60 wt.% of a dispersed oil phase and 40-95 wt.% of a continuous aqueous phase having a pH of 2.0 to 5.5, said emulsion containing by weight of aqueous phase: • 0.5-8 wt.% of gelatinized starch; • 0.1-3.5 wt.% of pulse seed albumin; and • 0.03-3.0 wt.% of a polysaccharide thickener selected from xanthan gum, pectin (DE>40) and combinations thereof. The acidified oil-in-water emulsions according to the invention have a very smooth texture and excellent stability and can be produced by employing a combination of heat treated pulse seed flour and polysaccharide thickener.

EDIBLE OIL-IN-WATER EMULSION

TECHNICAL FIELD OF THE INVENTION

The present invention relates to an acidified edible oil-in-water emulsion that comprises gelatinized starch, pulse seed albumin and a thickener polysaccharide selected from xanthan gum, pectin (DE>40) and combinations thereof. Examples of edible emulsions encompassed by the present invention include mayonnaise and dressings.

The invention also provides a process for the manufacture of the aforementioned oil-in-water emulsion.

BACKGROUND OF THE INVENTION

The emulsion stability of oil-in-water emulsions is affected adversely by a number of different changes that may occur in the structure of these emulsions as time progresses.

There are basically five ways in which the structure of an emulsion of liquid droplets in a continuous medium can change:

1. *Creaming/Sedimentation*: No change in droplet size (or droplet size distribution), but build-up of an equilibrium droplet concentration gradient within the emulsion. This phenomenon results from external force fields, usually gravitational, acting on the system. "Creaming" is the special case in which the droplets collect in a concentrated layer at the top of an emulsion. “Sedimentation” occurs when the droplets collect in a concentrated layer at the bottom of the emulsion.

2. *Flocculation*: Again, no change in basic droplet size or distribution but the build-up of aggregates of droplets within the emulsion. The individual droplets retain their identity. This process of flocculation results from the existence of attractive forces between the droplets.

3. *Coalescence*: Flocculated droplets in the bulk of the emulsion, or alternatively, droplets within a close-packed array resulting from sedimentation or creaming, coalesce

to form larger droplets. This results in a change of the initial droplet size distribution. The limiting state here is the complete separation of the emulsion into the two immiscible bulk liquids. Coalescence thus involves the elimination of the thin liquid film (of continuous phase) which separates two droplets in contact in an aggregate or a close-packed array. The forces to be considered here are therefore the forces acting within thin-liquid films in general.

4. *Ostwald ripening*: An alternative way in which the average droplet size in an emulsion can increase, without the droplets coalescing, occurs if the two liquids forming the disperse phase and the continuous phase, respectively, are not totally immiscible. This is the case in reality because all liquid pairs are mutually miscible to some finite extent. If one starts with a truly monodisperse emulsion system, then no effects arising from this mutual solubility will arise. However, if the emulsion is polydisperse, larger droplets will form at the expense of the smaller droplets owing to the process known as Ostwald Ripening. In principle, the system will tend to an equilibrium state in which all the droplets attain the same size (this may be, of course, that state when we have just one single large drop). The process of Ostwald ripening results from the difference in solubility between small and large droplets.

5. *Phase inversion*: A further way in which the structure of an emulsion may change is for the emulsion to "invert", e.g. for an o/w emulsion to change to a w/o emulsion. This may be brought about by a change in temperature or concentration of one of the components or by the addition of a new component to the system.

6. *Syneresis*: Yet another way in which emulsions may change is the separating off of one of the main liquid components of the emulsion. In oil-in-water emulsions both oil syneresis and water syneresis may occur.

When oil-in-water emulsions are stored for prolonged periods of time under varying temperature conditions, as is the case for retail products such as dressings and mayonnaise, the aforementioned destabilizing processes have to be slowed down. In order to achieve this, emulsifiers and water structuring agents are commonly employed in these emulsions.

In case oil-in-water emulsions are heated to elevated temperatures, e.g. when used in oven cooking, destabilization processes usually proceed at a very high rate, leading to e.g. phase separation or syneresis.

Phospholipids are an example of an emulsifier that is widely used to stabilize oil-in-water emulsions. Egg yolk contains appreciable levels of phospholipids and is widely used as an oil-in-water emulsifier, e.g. in mayonnaise and dressings.

Examples of water structurants include modified celluloses, starches (modified or non-modified), gums such as xanthan, agar, gelatin, carrageenan (iota, kappa, lambda), Gellan, galactomannans (guar, tara, cassia, locust bean gum), konjac glucomannan, gum arabic, pectins, milk proteins, alginate, chitosan and cellulosic fibres.

WO 01/52670 describes a food product comprising a starch and protein derived from a pea or lentil flour, wherein the flour starch has been at least partially gelatinized and the flour protein has been at least partially denatured and coagulated. Protein coagulation is achieved by inclusion of a protein coagulating agent, especially a calcium or magnesium salt. It is stated that thickening agents may be added to enhance texture characteristics, minimise syneresis and to prevent sedimentation. Beta-glucans, carrageenan, xanthan and other gums, pectin, guar, locust and kon-jac are mentioned as examples of thickening agents.

US 2007/0269580 describes a food composition comprising: a legume product; and an ingredient selected from the group consisting of a monoglyceride, a soluble fiber, a sweetener, sodium stearoyl lactylate, glucono delta lactone, calcium citrate, and combinations of any thereof. Example 1 describes a dip containing oil, soluble fiber, monglycerides, sweeteners, whole soybean powder, methyl cellulose, pectin, xanthan gum, sodium citrate, salt, wheat starch and food acids.

EP-A 0 319 064 describes a process for the preparation of an oil-in-water emulsion comprising:

- at least partly gelatinizing a native starch based thickening agent;
- incorporating a phospholipoprotein containing material which has been modified by phospholipase A;
- incorporating the required amount of oil or fat; and
- homogenizing.

Papalamprou et al. (J Sci Food Agric 85:1967–1973 (2005)) describe the effect of medium molecular weight xanthan gum on rheology and stability of oil-in-water emulsions (pH 5.5 or 7.0) stabilized with legume proteins. The article describes a study that compared and evaluated the emulsifying properties of oil-in-water (30:70 v/v) emulsions stabilized with lupin and soya protein isolates and medium molecular weight xanthan gum. The addition of xanthan gum in the emulsion formulation was found to enhance emulsion stability through the phenomenon of thermodynamic incompatibility with the legume protein, resulting in an increase of the adsorbed protein at the interface. The emulsion stability is also enhanced by a network structure built by the polysaccharide in the bulk phase.

SUMMARY OF THE INVENTION

The inventors have found that acidified oil-in-water emulsions having a very smooth texture and excellent stability can be produced by employing gelatinized starch, pulse seed albumin and a polysaccharide thickener selected from xanthan gum, pectin (DE>40) and combinations thereof. More particularly, the inventors have developed a storage stable oil-in-water emulsion having a very smooth texture, said emulsion comprising 5-60 wt.% of a dispersed oil phase and 40-95 wt.% of a continuous aqueous phase having a pH of 2.0 to 5.5, said emulsion containing by weight of aqueous phase:

- 0.5-8 wt.% of gelatinized starch;
- 0.1-3.5 wt.% of pulse seed albumin; and
- 0.03-3.0 wt.% of a polysaccharide thickener selected from xanthan gum, pectin (DE>40) and combinations thereof.

Although the inventors do not wish to be bound by theory, it is believed that the gelatinized starch provides water structuring properties; that the pulse seed albumin provides emulsifying properties; and that interaction of the thickener polysaccharde with the pulse seed albumin enhances stability and smoothness of the emulsion. Due to the acidic pH of the aqueous phase the positively charged pulse seed albumin may undergo associative interaction with the negatively charged polysaccharide thickener. The resulting protein-polysaccharide complex will accumulate at the oil-water interface thereby stabilising the emulsion.

Attraction and repulsion are the two major types of interactions that occur between proteins and polysaccharides in solution and can result in complex formation or immiscibility of the two biopolymers (thermodynamic incompatibility). Owing to polyelectrolyte interactions in solutions, these interactions and their consequences on the mixture are dependent on pH, ionic strength, conformation, charge density and the concentration of the biopolymers.

A blend of two different biopolymers in aqueous solution behaves in mainly three ways:

1) co-solubility
2) incompatibility
3) complex coacervation

In case biopolymers are thermodynamically incompatible, demixing of the biopolymers occurs. In case of the present emulsion, demixing of the polysaccharide thickener and the pulse seed albumin causes the protein to settle at the oil-water interface whereas the polysaccharide thickener together with the gelatinized starch occupies the interstitial aqueous phase. This demixing can fixate the pulse seed albumin at the oil-water interface in such a strong way that the emulsion does not even destabilize when it is heated to very high temperatures, e.g. in an oven.

The present invention also provides a process of preparing the aforementioned oil-in-water emulsion, said process comprising combining:

- finely ground pulse seed;
- a polysaccharide thickener selected from xanthan gum, pectin (DE>40) and combinations thereof;
- water;
- oil; and
- optionally further ingredients.

In the present process the finely ground pulse seed provides both the seed pulse albumin and at least a part of the gelatinized starch.

DETAILED DESCRIPTION OF THE INVENTION

Accordingly, one aspect of the invention relates to and oil-in-water emulsion comprising 5-60 wt.% of a dispersed oil phase and 40-95 wt.% of a continuous aqueous phase having a pH of 2.0 to 5.5, said emulsion containing by weight of aqueous phase:

- 0.5-8 wt.% of gelatinized starch;
- 0.1-3.5 wt.% of pulse seed albumin; and
- 0.03-3.0 wt.% of a a polysaccharide thickener selected from xanthan gum, pectin (DE>40) and combinations thereof.

The term “starch” as used herein, unless indicated otherwise, refers to native, non-modified, starch. Starch consists of two types of molecules: the linear and helical amylose and the branched amylopectin.

The term “gelatinized starch” as used herein refers to starch that has undergone gelatinization. Starch gelatinization is a process that breaks down the intermolecular bonds of starch molecules in the presence of water and heat, allowing the hydrogen bonding sites to engage more water. This irreversibly dissolves the starch granule. Penetration of water increases randomness in the general starch granule structure and decreases the number and size of crystalline regions. Under the microscope in polarized light starch loses its birefringence and its extinction cross during gelatinization. Some types of unmodified native starches start swelling at 55 °C, other types at 85 °C. The gelatinization temperature depends on the degree of cross-linking of the amylopectin.

The term “protein” as used herein refers to a linear polypeptide comprising at least 10 amino acid residues. Preferably, said protein contains more than 20 amino acid residues. Typically, the protein contains not more than 35,000 amino acid residues.

The term “albumin” as used herein refers to a protein that is soluble in water and in moderately concentrated salt solutions and that experiences heat coagulation. Reference is made to the Osborne protein classification system (T.B. Osborne, *The Vegetable Proteins, Monographs in Biochemistry* (London; Longmans, Green and Co., 1924.

The term “globulin” as used herein refers to a protein that is insoluble in water, but soluble in saline solutions.

The term “xanthan gum” as used herein refers to a polysaccharide that can be derived from the bacterial coat of *Xanthomonas campestris*. It is produced by the fermentation of glucose, sucrose, or lactose by the *Xanthomonas campestris* bacterium. After a fermentation period, the polysaccharide is usually precipitated from a growth medium with isopropyl alcohol, dried, and ground into a fine powder.

The term “pectin” as used herein refers to polysaccharides, that are rich in galacturonic acid including:

- Homogalacturonans: linear chains of α-(1-4)-linked D-galacturonic acid.
- Substituted galacturonans: characterized by the presence of saccharide appendant residues (such as D-xylose or D-apiose in the respective cases of xylogalacturonan and apiogalacturonan) branching from a backbone of D-galacturonic acid residues.

- Rhamnogalacturonan I: contain a backbone of the repeating disaccharide: 4)-α-D-galacturonic acid-(1,2)-α-L-rhamnose-(1. From many of the rhamnose residues, sidechains of various neutral sugars branch off. The neutral sugars are mainly D-galactose, L-arabinose and D-xylose, with the types and proportions of neutral sugars varying with the origin of pectin.
- Rhamnogalacturonan II: a less frequent complex, highly branched polysaccharide. Rhamnogalacturonan II is classified by some authors within the group of substituted galacturonans since the rhamnogalacturonan II backbone is made exclusively of D-galacturonic acid units.

In nature, around 80 percent of carboxyl groups of galacturonic acid are esterified with methanol. This proportion is decreased to a varying degree during pectin extraction. Pectins are classified as high- vs. low-ester pectins (short HM vs. LM-pectins), with more or less than half of all the galacturonic acid esterified.

The term “pectin (DE>40)” as used herein refers to a pectin in which at least 40% of the galacturonic acid groups are esterified.

The term “pulse” as used herein refers to an annual leguminous crop yielding from one to twelve seeds of variable size, shape, and colour within a pod and is reserved for crops harvested solely for the dry seed. This excludes fresh green beans and fresh green peas, which are considered vegetable crops. Also excluded are crops that are mainly grown for oil extraction (oilseeds like soybeans and peanuts), and crops which are used exclusively for sowing (clovers, alfalfa). Just like words such as "bean" and "lentil", the word "pulse" may also refer to just the seed, rather than the entire plant.

The term “oil” as used herein refers to lipids selected from the group of triglycerides, diglycerides, monoglycerides, phospholipids and free fatty acids. The term “oil” encompasses lipids that are liquid at ambient temperature as well as lipids that are partially or wholly solid at ambient temperature.

The term “dietary fiber” as used herein refers to indigestible non-starch polysaccharides such as arabinoxylans, cellulose, lignin, pectins and beta-glucans.

The term “sugars” as used herein refers to mono- and disaccharides.

The term “diameter” as used herein in relation to the droplet size of the dispersed oil phase, unless otherwise specified, refers to the diameter as determined with the help of confocal laser scanning microscopy.

The “finely ground pulse seed” of the present invention is suitably produced by milling or grinding dehulled or non-dehulled pulse seeds. The pulse seeds may be milled or ground as such, or they may be milled or ground in the presence of water, e.g. to produce an aqueous slurry or paste.

The term “phospholipid” as used herein refers to a lipid comprising a glycerol bound to one or two fatty acids and a phosphate group.

Xanthan gum is preferably applied in the present emulsion in a concentration of 0.03-1.0%, more preferably of 0.05-0.8% and most preferably of 0.06-0.6% by weight of the aqueous phase.

Pectin is preferably applied in the present emulsion in a concentration of 0.2-3.0%, more preferably of 0.3-2.5% and most preferably of 0.35-2.4% by weight of the aqueous phase.

According to a particularly preferred embodiment the pectin employed in accordance with the present invention is high methoxyl pectin, i.e. a pectin in which at least 50% of the galacturonic acid groups are esterified.

Starch and xanthan gum are typically contained in the present emulsion in a weight ratio xanthan:starch of 1:200 to 1:1. Even more preferably, said ratio is 1:100 to 1:2, most preferably 1:80 to 1:4.

Starch and pectin are typically contained in the present emulsion in a weight ratio pectin:starch of 1:40 to 1:1. Even more preferably, said ratio is 1:20 to 2:3, most preferably 1:8 to 1:2.

According to a particularly preferred embodiment, the acidified oil-in-water emulsion of the present invention contains 0.05-1.0 wt.% of phospholipids. More preferably, phospholipids are contained in the present emulsion in a concentration of at least 0.1%, more preferably of at least 0.15 wt.% and most preferably of at least 0.2 wt.%.

According to a further preferred embodiment a substantial part of the phospholipids contained in the emulsion are provided by egg or an egg component. Accordingly, the emulsion preferably contains at least 0.05 wt.%, more preferably 0.15-1.0 wt.% egg lecithin. Here the term “egg lecithin” refers to phospholipids that originate from egg.

Advantageously, the emulsion comprises 0.06-1.4 wt.%, more preferably 0.1-1.0 wt.% and most preferably 0.16-0.8 w t.% of egg proteins.

Egg proteins and egg lecithin may suitably be provided in the emulsion by adding egg yolk. Preferably, the emulsion contains 0.4-8.4 wt.%, more preferably 1.0-5.0 wt.% of egg yolk.

Examples of phospholipids that may suitably be employed in the present wherein the emulsion include phosphatides (phospholipids containing two fatty acids bound to the glycerol moiety) as well as lysophosphatides (phospholipids containing one fatty acid bound to the glycerol moiety). Lysophosphatides can be produced by hydrolyzing phosphatides e.g. under the influence of phospholipase.

The phospholipids in the present emulsion may suitably be provided by non-modified egg yolk and/or modified (e.g. hydrolysed) egg yolk.

The oil-in-water emulsion of the present invention advantageously contains 0.5-9%, more preferably 1.0-7.0% and most preferably 1.5-6.0% by weight of the aqueous phase of salt selected from NaCl, KCl and combinations thereof.

According to another preferred embodiment, the oil-in-water emulsion contains 1-12%, more preferably 2-10% and most preferably 3-9% sucrose by weight of the aqueous phase.

Starch (gelatinized and non-gelatinized) and the pulse seed albumin are typically contained in the present emulsion in a weight ratio of 30:1 to 1;1, more preferably in a weight ratio of 20:1 to 2:1 and most preferably in a weight ratio of 15:1 to 3:1.

The starch contained in the oil-in-water emulsion preferably is largely gelatinized. Typically, 50-100 wt.%, more preferably 70-100 wt.% and most preferably 90-100 wt.% of the starch contained in the emulsion is gelatinized. Gelatinized starch is believed to enhance the emulsion stability by structuring the continuous aqueous phase of the emulsion. The extent to which the starch present in the emulsion is gelatinized can suitably be determined by cross polarised light microscopy.

The present emulsion typically contains 0.15-3.0%, preferably 0.2-2.0% and most preferably 0.3-1.0% pulse seed albumin by weight of aqueous phase.

Besides pulse seed albumin the present emulsion may suitably contain other pulse seed proteins. Typically, the emulsion contains 0.3-5%, more preferably 0.4-4% and most preferably 0.6-3.5% of pulse seed proteins by weight of aqueous phase.

Globulin is a pulse seed protein that is preferably contained in the emulsion besides pulse seed albumin. Preferably, the emulsion contains 0.3-7.5%, more preferably 0.6-6.0% and most preferably 0.9-3.0% pulse seed globulin by weight of aqueous phase.

Typically, starch (gelatinized and non-gelatinized) and pulse seed protein are contained in the present emulsion in a weight ratio of 1:2 to 6:1, more preferably in a weight ratio of 1:1 to 3:1.

The combination of oil, water, starch, pulse seed protein and polysaccharide thickener typically constitutes at least 85 wt.%, more preferably at least 90-99 wt.% and most preferably 92-97 wt.% of the present emulsion.

According to a particularly preferred embodiment of the invention, the gelatinized starch and the pulse seed albumin contained in the emulsion originate from the same pulse seed. Even more preferably, the pulse seed protein and the gelatinized starch contained in the emulsion originate from the same pulse seed.

The finely ground pulse that is employed in accordance with the present invention may be obtained from dehulled and/or non-dehulled pulse seed. The water-structuring and emulsifying properties of the finely ground pulse seed are believed to be largely attributable to the starch and protein components. Since the hulls of pulse seed predominantly consist of dietary fibre, dehulling does not significantly affect the functionality of the finely ground seed in the present emulsion. Preferably, the finely ground pulse seed employed is obtained from dehulled pulse seed.

Typically, the (ground) pulse seed employed in accordance with the present invention contains less than 25%, most preferably less than 20% of dietary fiber by weight of dry matter.

The oil content of the pulse seed preferably lies in the range of 0.8-8 wt.%.

Globulins and albumins typically represent a major part of the protein contained in the pulse seed. Accordingly, in a preferred embodiment, globulins and albumins represent at least 50 wt.%, more preferably 55-95 wt.% and most preferably 60-90 wt.% of the protein contained in the pulse seed.

Emulsions of particular good quality can be obtained if the pulse seed contains globulins and albumins in a weight ratio that lies within the range of 10:1 to 1:1, or even more preferably in a weight ratio of 7:1 to 2:1.

In accordance with another preferred embodiment the globulins legumin and vicilin together represent at least 35 wt.%, more preferably 40-75 wt.% and most preferably 45-70 wt.% of the protein comprised in the pulse seed.

The protein glutelin preferably represents 5-30 % by weight, more preferably 8-25 % by weight of the protein comprised in the pulse seed.

The content of globulin, albumin, legumin, vicilin, and glutelin in the pulse seeds of the present invention is suitably determined by the method described by Gupta & Dhillon [Gupta, R., & Dhillon, S. 1993. Characterization of seed storage proteins of Lentil (*Lens culinaris* M.). *Annals of Biology*, 9, 71-78].

The protein provided by the finely ground pulse seed preferably comprises not more than a minor amount of sizeable coagulated protein aggregates. Typically, the finely ground pulse seed comprises 0-1 wt.% of coagulated protein aggregates having a hydrated diameter of at least 1.0 µm. The hydrated diameter can suitably be determined by Confocal Scanning Laser Microscopy with Nile Blue as fluorescent dye.

The protein contained in the emulsion preferably is largely denatured, e.g. as a result of heat treatment. Preferably, 60-100 wt.%, more preferably at least 90-100 wt.% of the protein comprised in the finely ground pulse seed is denatured.

It is important that the pulse seed employed in the present emulsion is finely ground in order to release starch, protein and dietary fiber from the seed material. Advantageously, the finely ground pulse seed contains less than 10 wt.%, more preferably less than 5 wt.% and most preferably less than 1 wt.% of particles having a hydrated diameter of 200 µm or more. The hydrated diameter of the finely ground pulse seed is suitably determined by means of Confocal Scanning Laser Microscopy, using the fluorescent dye Acridine Orange.

According to yet another preferred embodiment, the emulsion contains 2-18%, calculated as dry matter by weight of the aqueous phase of finely ground pulse seed. The requirement that the present emulsion contains 1-10% of finely ground pulse seed, calculated as dry matter, by weight of aqueous phase should be construed as:

1% < (parts by weight of dry matter of finely ground pulse seed)/(parts by weight of aqueous phase) < 10%; wherein the aqueous phase, besides water, includes the part of the finely ground pulse seed that is contained therein, as well as other components (e.g. acidulant) that are contained therein.

Even when used in relatively low concentrations, the finely ground pulse seed of the present invention is capable of substantially improving the stability of the oil-in-water emulsion. Accordingly, the finely ground pulse seed preferably represents not more than 15, more preferably not more than 13%, most preferably not more than 12% of the oil-in-water emulsion, calculated as dry matter by weight of aqueous phase. Typically, the finely ground pulse seed is employed in a concentration of at least 3%, even more preferably of at least 4% and most preferably of at least 5%, where the percentages are again calculated as dry matter by weight of the aqueous phase.

The pulse seed from which the albumin and starch originate typically contains starch and protein in a weight ratio of 1:2 to 5:1, more preferably of 1:1 to 5:2.

The aforementioned pulse seed typically has the following composition, calculated on dry matter:

30-60 wt.% of starch;
1-40 wt.% of dietary fiber;
0.5-12 wt.% of sugars;
15-35 wt.% of protein;
0.8-12 wt.% of oil;

wherein the pulse seed contains starch and protein in a weight ratio of 2:3 to 3:1. Typically, starch, dietary fiber, sugars, protein and oil together make up 90-100 wt.%, more preferably 95-100 wt.% of the dry matter contained in the pulse seed.

The finely ground pulse seed comprised in the present emulsion is advantageously obtained from a pulse selected from lentils, chickpeas, beans and combinations thereof. Even more preferably, the finely ground pulse seed is obtained from a pulse selected from lentils, chickpeas, mung beans and combinations thereof. Most preferably, the finely ground pulse seed is finely ground lentils.

The present emulsion typically has a pH in the range of 2.5-5.0. More preferably, the pH of the emulsion is the range of 2.7 to 4.5, most preferably of 3.0 to 4.2.

The present emulsion preferably contains at least 0.1 wt.%, more preferably at least 0.15 wt.% and most preferably 0.2-10 wt.% of an acidulant selected from acetic acid, citric acid, lactic acid, malic acid, phosphoric acid, hydrochloric acid, glucono-delta-lactone and combinations thereof. Even more preferably, the emulsion contains 0.2-10 wt.% of an acidulant selected from acetic acid, citric acid and combinations thereof. Most preferably, the emulsion contains 0.2-10 wt.% of acetic acid.

As described in WO 01/52670, divalent metal ions, such as Ca^{2+} and Mg^{2+} may induce protein gelation. In order to prevent this kind of protein gelation, it is preferred that the aqueous phase of the present emulsion comprises less than 1.0 mmol per gram of protein, more preferably less than 0.5 mmol per gram of protein of divalent metal cation selected from Ca^{2+}, Mg^{2+} and combinations thereof. According to another preferred embodiment the present emulsion is not in the form of a gel (as opposed to the products described in WO 01/52670).

The emulsion of the present invention preferably contains no modified starch or modified cellulose. The term “modified starch” as used herein refers to an enzymatically or chemically modified starch. Likewise, the term “modified cellulose” as used herein refers to an enzymatically or chemically modified cellulose.

The emulsions according to the present invention typically are pourable or spoonable as opposed to solid. In case the present emulsion is non-pourable, it is preferred that the consistency of the emulsion is such that it cannot be cut into two parts that remain separate but will confluence after the cutting.

The present emulsion typically has a Stevens value at 20 °C of 35-300, more preferably of 50-250 and most preferably of 70-200. The Stevens value, expressed in grams, can be determined by using a typical mayonnaise grid in a Stevens LFRA Texture Analyzer (ex. Stevens Advanced Weighing Systems, UK) with a maximum load/measuring range of 1000 grams and by applying a penetration test of 20 mm at 1 mm/s penetration rate in a cup having a diameter of 65 mm. The mayonnaise grid comprises square openings of appr. 3x3 mm, is made up of wire with a thickness of appr. 1 mm and has a diameter of 40 mm.

The oil-in-water emulsion of the present invention preferably has a shear storage modulus G’, measured at 20°C, within the range of 100-3,500 Pa, most preferably in the range of 800-2,000 Pa.

The viscosity of the present emulsion typically lies in the range of 100-80,000 mPa.s, more preferably in the range of 200-30,000 mPa.s at 10 s^{-1} and 20°C.

The G’ and viscosity of the emulsion are measured using a standard protocol with the following 3 consecutive steps:

- The sample is rested for 3 minutes after the introduction into the rheometer to allow relaxation of the stresses accumulated due to the loading of the sample.
- A stress sweep as applied in which the oscillatory stress is increased from 0.1 to 1768 Pa in logarithmic steps (15 per decade). This step is terminated when the phase angle exceeds 80°. From this step the G’ (shear storage modulus) is taken as described below.
- A viscosity measurement is done at a shear rate of 50 s^{-1} for a total of 1 minute. A viscosity point is measured every 10 seconds. Typically the last point is reported. The test is carried out at 20°C using a cone and plate rheometer. The cone used has a diameter of 4 cm and a cone angle of 2° degrees.

The shear storage modulus G’ is the mathematical description of an object’s or substance's tendency to be deformed elastically (i.e., non-permanently) when a force is applied to it. The term “storage” in shear storage modulus refers to the storage of the energy applied to the sample. The stored energy is recovered upon the release of the stress. The shear storage modulus of an oil-in-water emulsion is suitably determined by a dynamic oscillatory measurement, where the shear stress is varied (from low to high stress) in a sinusoidal manner. The resulting strain and the phase shift between the stress and strain is measured. From the amplitude of the stress and the strain and the phase angle (phase shift) the shear storage modulus is calculated. Herein, the G' (Pa) is taken at the plateau value at low stress (linear viscoelastic region). For these measurement a suitable state of the art rheometer is used (e.g. a TA AR2000EX, United Kingdom).

The dispersed oil phase typically contains 50-100 wt.%, more preferably 70-100 wt.% and most preferably 90-100 wt.% of triglycerides. The oil phase advantageously contains a high level of unsaturated fatty acids. Typically, 40-100 wt.%, more preferably 50-100 wt.% and most preferably 60-100 wt.% of the fatty acids contained in the dispersed oil phase are unsaturated fatty acids. The melting point of the dispersed oil phase typically does not exceed 30°C, more preferably it does not exceed 20°C and most preferably it does not exceed 10°C.

Examples of oils that may be employed in the oil phase of the present emulsion include those which are liquid at ambient temperature like avocado, mustard, cottonseed, fish, flaxseed, grape, olive, palm, peanut, rapeseed, safflower, sesame, soybean, sunflower, mixtures thereof and the like. Examples of oils that solid at ambient temperature and suitable for use in accordance with this invention include butter fat, cocoa butter chicken fat, coconut oil, palm kernel oil mixtures thereof and the like. The present invention also encompasses the use of olein and/or stearin fractions of the aforementioned oils.

The dispersed oil phase comprised in the present emulsion preferably represents at least 10-60 wt.%, more preferably at least 12-55 wt.% and most preferably at least 15-52 wt.% of the emulsion. The continuous aqueous phase preferably represents not more than 90 wt.%, more preferably not more than 88 wt.% and most preferably not more than 85 wt.% of the emulsion.

Typically, 80-100 vol.% of the oil droplets contained in the present emulsion have a diameter of less than 15 µm, more preferably of 0.5-10 µm.

The edible emulsion may suitably contain one or more additional ingredients besides water, oil and ground pulse seed. Examples of such optional ingredients include acidulant, salt, spices, vitamins, flavouring, colouring, preservatives, antioxidants, chelators herbs and pieces of meat, vegetable or cheese. Such optional additives, when used, collectively, do not make up more than 40%, more preferably not more than 20% by weight of the emulsion.

Examples of edible oil-in-water emulsions according to the present invention include dressings, mayonnaise, soups, sauces and drinks. Preferably, the present emulsion is a dressing or a mayonnaise. Most preferably, the emulsion is a mayonnaise.

The emulsion according to the present invention typically have a shelf-life of at least 4, more preferably at least 8 weeks under ambient conditions (20°C).

Another aspect of the invention relates to a process of preparing an acidified oil-in-water emulsion as defined herein before, said process comprising combining:

- finely ground pulse seed;
- a polysaccharide thickener selected from xanthan gum, pectin (DE>40) and combinations thereof;
- water;
- oil; and
- optionally further ingredients.

According to a particularly preferred embodiment, the finely ground pulse seed is obtained from a pulse seed selected from lentils, chickpeas, beans and combinations thereof. Even more preferably, the ground pulse seed is obtained from a pulse seed selected from lentils, chickpeas, mung beans and combinations thereof. Most preferably, the ground pulse seed is ground lentil.

It was found that a particularly stable emulsion can be produced by combining the finely ground pulse seed and water and heating the resulting combination to denature the protein before adding the oil. Thus, in accordance with a particularly preferred embodiment, prior to the addition of oil, the combination of the finely ground pulse seed and water is heated to a temperature of more than 60°C for at least 30 seconds. Preferably the heating conditions employed are sufficient to denature at least 50 wt.%, more preferably at least 70 wt. and most preferably 90 wt.% of the pulse seed protein contained therein.

The inventors have further found that it is advantageous to add the polysaccharide thickener component before the oil is added. The polysaccharide thickener may be added to the finely ground pulse seed and water before or after heating. In case the dispersed oil phase represents less than 40 wt.% of the emulsion, it is preferred to add the polysaccharide thickener after the heating.

The oil-in-water emulsion of the present invention is suitably produced by:

- providing an aqueous dispersion containing at least 1 wt.% of finely ground pulse seed and at least 0.03 wt.% of polysaccharide thickener,

- adding oil to the aqueous dispersion to produce an oil-and-water mixture; and
- mixing the oil-and-water mixture to produce an oil-in-water emulsion comprising 80-100 vol.% of oil droplets having a diameter of less than 20 µm.

Preferably, the present process comprises the addition of an acidulant to adjust the pH of the aqueous dispersion to a pH within the range of less than 5.5, preferably to a pH of 2 to 5.5, more preferably to a pH of 3.0 to 5.0. According to a particularly preferred embodiment, the acidulant is added, after the oil has been added to the aqueous dispersion, even more preferably after the oil-in-water emulsion has been produced by the mixing.

The starch provided by the pulse seed component may suitably be gelatinized by heating the aqueous dispersion containing finely ground pulse seed to a temperature in excess of 60°C for a sufficiently long period of time. It is also possible to prepare the aqueous dispersion of finely ground pulse seed from a pulse flour that has been pretreated to gelatinize the starch.

Preferably, the present process comprises the step of heating the aqueous dispersion containing the finely ground pulse seed to gelatinize the starch contained therein. Depending on the heating temperature, the preferred times are as follows:

60-70°C:	10-120 minutes
70-80°C:	1-80 minutes
80-100°C	1-70 minutes
100-120°C:	30-1200 seconds
120-150°C:	10-480 seconds

According to a particularly preferred embodiment 50-100 wt.%, more preferably 70-100 wt.% of the starch comprised in the aqueous dispersion is gelatinized prior to the addition of the oil.

The pulse flour that is mixed with water to prepare the aqueous dispersion preferably has the same composition as described herein before in relation to the pulse seed that is contained in the edible oil-in-water emulsion of the present invention.

In the present process the aqueous dispersion is suitably prepared by mixing pulse flour with water and optionally further ingredients. Preferably, the pulse flour employed has a mass weighted average particle size of 10-500 µm, more preferably of 15-120 µm, and containing more than 90 wt.% of particles, preferably more than 95 wt.% of particles having a diameter of 150 μm or less. The particle size distribution of the pulse flour is suitably determined with the help of sieves.

The invention is further illustrated by means of the following non-limiting examples.

EXAMPLES

Example 1

A mayonnaise containing 30% oil was prepared on the basis of the recipe shown in Table 1.

Table 1

	Wt.%
Water	54.5
Lentil flour	5
Xanthan RD	0.2
Sugar	2
NaCl	1.4
Sunflower oil	30
Vinegar (12% a.a.)	4.5
Egg yolk - stab.	2.4

- Milled dehulled red lentil (Turkey) having a particle size of less than 200 μm
- The xanthan gum (Keltro RD) was obtained from CP Kelpo
- The stabilised egg yolk (92-8 free range) was obtained from Bouwhuis Enthoven, the Netherlands

The mayonnaise was prepared by the following procedure:

- Mix lentil flour and xanthan powder together with sugar.
- Disperse this mixture using Silverson at high shear, no head attachment.
- When fully dispersed, add salt.
- Heat to 85-90°C in water-bath, using paddle to prevent cooking onto base and sides.
- Heat for 5 min at 85-90°C, using paddle to prevent cooking onto base and sides.
- Re-weigh to determine water loss & compensate by adding water
- Cool the heated slurry to 30-40°C.
- Slowly add oil while mixing with Silverson at 7000rpm (no head attachment)
- Add vinegar (to acidify).
- Add stabilised egg-yolk
- Adjust to pH 3.7 by adding extra vinegar

The mayonnaise so prepared was evaluated after 3 days storage at 5°C. The product was found to be pourable with a consistency similar to that of thick pouring cream. The product had a creamy, smooth texture.

Example 2

Example 1 was repeated except that this time xanthan gum, sugar and salt were added after the heated lentil flour slurry had been cooled down to 30-40°. First the xanthan gum and sugar were added under mixing with a Silverson at 1000 rpm and next the salt was added.

The mayonnaise so prepared was evaluated after 3 days storage at 5°C. The product was found to have the consistency and texture of a smooth creamy soft mayonnaise.

Example 3

Example 1 was repeated except that the egg yolk was replaced by water.

The mayonnaise so prepared was evaluated after 3 days storage at 5°C. The product was found to be spoonable and quite firm. Gentle mixing of the product by hand with a spoon for a few seconds produced a mayonnaise with a smooth, soft, creamy mayonnaise-like texture.

Example 4

A mayonnaise containing 20% oil was prepared on the basis of the recipe shown in Table 2, using the same ingredients as in Example 1.

Table 2

	Wt.%
Water	64.2
Lentil flour	6.4
Xanthan gum	0.07
Sugar	2
NaCl	1.4
Sunflower oil	20
Vinegar (12% a.a.)	3.5
Egg yolk - stab.	2.4

The mayonnaise was prepared by the following procedure:

- Disperse lentil flour into cold demineralised water with a paddle stirrer, 200 rpm.
- Heat the lentil flour slurry on a cooking plate to 85°C, and hold at 85°C for 5 minutes.

- Cool down to 60°C and keep at this temperature.
- Prepare an aqueous xanthan gum solution (1 wt.%) by cold dispersal using a paddle stirrer (200 rpm, 30 min).
- Introduce Lentil slurry in a Silverson mixer.
- Add the 1% xanthan gum solution (2,000 rpm).
- Add NaCl + sugar (2,000 rpm).
- Add oil to the slurry (3,000 rpm, app 5 min.).
- After the oil has been taken up by the slurry, increase speed to 7,000 rpm (5 min).
- Homogenize the emulsion in a high pressure homogenizer at 250 bar.
- Introduce homogenized emulsion in Silverson mixer and add the vinegar (1,000 rpm, 1 min.).
- Add the stabilized egg yolk (400 rpm, 1 min.).

The mayonnaise so obtained was stored at 5°C. After 18 days the product was evaluated. The emulsion was found to be stable.

Rheological analyses of the mayonnaise after 7 days storage at 5°C yielded the data shown in Table 3.

Table 3

Stevens hardness (20°C) in grams	75
Viscosity (5°C, 10 s^{-1}) in mPa.s	5,600
G'(5°C) in Pa	626
G' (85°C) in Pa	219
G' (5°C after heating to 85°C) in Pa	338

Example 5

A mayonnaise containing 50% oil was prepared on the basis of the recipe shown in Table 4, using the same ingredients as in Example 1, except for the HM pectin.

Table 4

	Wt.%
Water	37.2
Lentil flour	3
HM pectin	0.5
Sugar	2
NaCl	1.4
Sunflower oil	50
Vinegar (12% a.a.)	3.5
Egg yolk - stab.	2.4

➢ The HM pectin (Grindsted Pectin AMD 783, DE 72%) was obtained from Danisco.

The mayonnaise was prepared by the following procedure:

- Disperse pectin powder into cold water
- Disperse lentil flour into pectin/water mixture, using whisk to mix in
- Heat to 85-90°C in water-bath, using paddle to prevent cooking onto base and sides
- Heat for 5 min at 85-90°C, using paddle to prevent cooking onto base and sides
- Re-weigh to determine water loss & compensate by adding water
- Cool to 30-40°C
- Add in sugar & salt at 1000rpm for 30 sec.
- Add oil slowly with Silverson, about 7000rpm, moving container to help mixing of oil
- Add vinegar (to acidify)
- Add stabilised egg-yolk
- Adjust to pH 3.7 as needed

The mayonnaise was analysed after 1, 2 and 4 weeks storage at 5°C. The results obtained from the analysis are shown in Table 5.

Table 5

	1 week	**2 weeks**	**4 weeks**
Stevens hardness (20°C) in grams	157	147	150
Syneresis in grams *	0	0	0.09
G'(20°C) in Pa	1,311	1,222	1,243

* Syneresis is measured by way of collecting liquid from the mayonnaise sample over time. The mayonnaise (170-180g) is stored in 200ml glass jars at 5°C. The day after production, a PMMA tube (internal dimensions of 21 mm diameter, external 25 mm, 44 mm height, covered with VWR qualitative filter paper 415, particle retention 12-15 μm taped to the base) is inserted into the mayonnaise until the top of the tube is slightly above the level of the mayonnaise. If syneresis occurs, these tubes will be filled with

liquid. This released fluid is sucked up with pipettes and weighed. After weighing, syneresis fluid is put back into the tubes.

Example 6

Example 5 was repeated, except that HM pectin levels were adjusted to 0 wt.%, 0.3 wt.% and 0.6 wt.% respectively, by altering the water content of the emulsion.

Again the emulsions were stored for 7 days at 5°C before they were analyzed. The results of the analyses are shown in Table 6.

Table 6

	Pectin content		
	0 wt.%	**0.3 wt.%**	**0.6 wt.%**
Stevens hardness (20°C) in g	168	174	155
Syneresis in g	4.7	2.6	0
G' (20°C) in Pa	1,422	1,479	1,291

Example 7

Example 5 was repeated except that this time HM pectin, sugar and salt were added after the heated lentil flour slurry had been cooled down to 30-40°.

The mayonnaise so prepared was evaluated after 1, 2 and 4 weeks storage at 5°C. The results obtained from the analysis are shown in Table 7.

Table 7

	1 week	**2 weeks**	**4 weeks**
Stevens hardness (20°C) in grams	220	237	244
Syneresis in grams	0	0	0.03
G'(20°C) in Pa	1,975	2,156	2,237

Example 8

Example 7 was repeated, except that HM pectin levels were adjusted to 0 wt.%, 0.3 wt.% and 0.6 wt.% respectively, by altering the water content of the emulsion.

Again the emulsions were stored for 7 days at 5°C before they were analyzed. The results of the analyses are shown in Table 8.

Table 8

	Pectin content		
	0 wt.%	**0.3 wt.%**	**0.6 wt.%**
Stevens hardness (20°C) in g	168	231	204
Syneresis in g	4.7	0.4	0
G' (20°C) in Pa	1,422	2,092	1,803

Example 9

Example 5 was repeated, except that the HM pectin (DE 72%) was replaced by a pectin having a DE of 48% (Grindsted Pectin LC 710, ex Danisco).

The mayonnaise was analysed after 1, 2 and 4 weeks storage at 5°C. The results obtained from the analysis are shown in Table 9.

Table 9

	1 week	**2 weeks**	**4 weeks**
Stevens hardness (20°C) in grams	145	136	149
Syneresis in grams *	0	0.10	0.19
G'(20°C) in Pa	1,186	1,105	1,229

Example 10

Example 9 was repeated except that this time the pectin, sugar and salt were added after the heated lentil flour slurry had been cooled down to 30-40°.

The mayonnaise so prepared was evaluated after 1, 2 and 4 weeks storage at 5°C. The results obtained from the analysis are shown in Table 10.

Table 10

	1 week	**2 weeks**	**4 weeks**
Stevens hardness (20°C) in grams	198	210	216
Syneresis in grams *	0	0.12	0.18
G'(20°C) in Pa	1,738	1,857	1,932

Comparative Example A

Example 5 was repeated, except that the HM pectin (DE 72%) was replaced by an LM pectin having a DE of 32%. (Grindsted Pectin LC 950, ex Danisco)

The mayonnaise was analysed after 1, 2 and 4 weeks storage at 5°C. The results obtained from the analysis are shown in Table 11.

Table 11

	1 week	2 weeks	4 weeks
Stevens hardness (20°C) in grams	110	124	145
Syneresis in grams *	0.10	0.42	0.77
G'(20°C) in Pa	851	983	1,188

Unlike the mayonnaises described in Examples 5-10, this particular mayonnaise did not have a creamy mouthfeel.

<u>Comparative Example B</u>

Comparative Example A was repeated except that this time the LM pectin, sugar and salt were added after the heated lentil flour slurry had been cooled down to 30-40°.

The mayonnaise so prepared was evaluated after 1, 2 and 4 weeks storage at 5°C. The results obtained from the analysis are shown in Table 12.

Table 12

	1 week	2 weeks	4 weeks
Stevens hardness (20°C) in grams	189	203	227
Syneresis in grams *	0.05	0.30	0.64
G'(20°C) in Pa	1,642	1,785	2,043

Again, unlike the mayonnaises described in Examples 5-10, this mayonnaise did not have a creamy mouthfeel.

Claims

1. An oil-in-water emulsion comprising 5-60 wt.% of a dispersed oil phase and 40-95 wt.% of a continuous aqueous phase having a pH of 2.0 to 5.5, said emulsion containing by weight of aqueous phase:
   - 0.5-8 wt.% of gelatinized starch;
   - 0.1-3.5 wt.% of pulse seed albumin; and
   - 0.03-3 wt.% of a polysaccharide thickener selected from xanthan gum, pectin (DE>40) and combinations thereof.

2. Emulsion according to claim 1, wherein the emulsion contains 0.05-1.0 wt.% of phospholipids.

3. Emulsion according to claim 2, wherein the emulsion contains at least 0.05 wt.% of egg lecithin.

4. Emulsion according to any one of the preceding claims, wherein the emulsion has a shear storage modulus G' at 20°C of 100-3,500 Pa.

5. Emulsion according to any one of the preceding claims, wherein the emulsion contains 0.5-9% by weight of the aqueous phase of salt selected from NaCl, KCl and combinations thereof.

6. Emulsion according to any one of the preceding claims, wherein the gelatinized starch and the pulse seed albumin originate from the same pulse seed.

7. Emulsion according to any one of the preceding claims, wherein starch and the pulse seed albumin are contained in the emulsion in a weight ratio of 30:1 to 1:1.

8. Emulsion according to any one of the preceding claims, wherein the emulsion contains 2-18% by weight of the aqueous phase of finely ground pulse seed.

9. Emulsion according to claim 8, wherein the pulse seeds are selected from lentils, chickpeas, beans and combinations thereof.

10. Emulsion according to any one of the preceding claims, wherein the emulsion contains 0.03-1.0% xanthan gum by weight of the aqueous phase.

11. Emulsion according to any one of the preceding claims, wherein the emulsion contains 0.2-3.0% pectin (DE>40) by weight of the aqueous phase.

12. A process of preparing an oil-in-water emulsion according to any one of the preceding claims, said process comprising combining:
    - finely ground pulse seed;
    - a polysaccharide thickener selected from xanthan gum, pectin (DE>40) and combinations thereof;
    - water;
    - oil; and
    - optionally further ingredients.

13. Process according to claim 12, wherein the finely ground pulse seed is obtained from a pulse seed selected from lentils, chickpeas, beans and combinations thereof.

14. Process according to claim 12 or 13, wherein the finely ground pulse seed is combined with water and heated to at least 60°C for at least 30 seconds before the oil is added.

15. Process according to claim 14, wherein the polysaccharide thickener is added after the heating and prior to the oil addition.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2013/061453

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/061453

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23L1/0522 A23L1/20 A23L1/48
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A23L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, BIOSIS, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 01/52670 A1 (NZ INST FOR CROP & FOOD RES [NZ]; THRESHER WAYNE CARL [NZ]) 26 July 2001 (2001-07-26) cited in the application Abstract; Page 16 lines 24-35; Page 13 lines 33-36; claimss 5-50 -----	1-15
Y	KASPER L R: "Chickpea mayonnaise with sweet-tart onions and basil", INTERNET CITATION, 13 August 2008 (2008-08-13), page 1, XP002632920, Retrieved from the Internet: URL:http://www.startribune.com/lifestyle/taste/recipes/26906864.html [retrieved on 2011-04-14] the whole document -----	1-15
	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 September 2013	18/09/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Moonen, Peter

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	MCWATTERS K H ET AL: "EMULSIFICATION FOAMING AND PROTEIN SOLUBILITY PROPERTIES OF DEFATTED SOYBEAN PEANUT FIELD PEA AND PECAN FLOURS", JOURNAL OF FOOD SCIENCE, vol. 42, no. 6, 1977, pages 1444-1447, XP002682063, ISSN: 0022-1147 Abstract; Figure 1	1-15
Y	HOU-PIN SU ET AL: "Development of low-fat mayonnaise containing polysaccharide gums as functional ingredients", JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE, 1 January 2010 (2010-01-01), pages n/a-n/a, XP055035900, ISSN: 0022-5142, DOI: 10.1002/jsfa.3888 the whole document	1-15
Y	PAPALAMPROU EVDOXIA M ET AL: "Effect of medium molecular weight xanthan gum in rheology and stability of oil-in-water emulsion stabilized with legume proteins", JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE, WILEY & SONS, CHICHESTER, GB, vol. 85, no. 12, 1 September 2005 (2005-09-01), pages 1967-1973, XP002681880, ISSN: 0022-5142 abstract	1-10, 12-15
A	MASKUS, Heather: "Pulse Processing, Functionality and Application Literature Review", , 27 January 2010 (2010-01-27), pages 1-146, XP002682064, Retrieved from the Internet: URL:www.pulsecanada.com/media/2010-pulse-processing-functionality.pdf [retrieved on 2012-08-20] page 4; tables 1,5	1-15
Y	Herbstreith & Fox: "Chances and Limits for the Use of Pectin as Emulsifier", , November 1998 (1998-11), pages 1-14, XP002692294, Retrieved from the Internet: URL:http://www.herbstreith-fox.de/fileadmin/tmpl/pdf/funde/FuE_Chances_and_Limits_01.pdf [retrieved on 2013-02-15] page 9; table 3	1-9, 11-15

1 -/--

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

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This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 10(completely); 1-9, 12-15(partially)

   An O/W emulsion of 5-60 wt.% dispersed oil and 40-95 wt.% of continuous aqueous phase with pH of 2.0 to 5.5, said emulsion containing by weight of the aqueous phase 0.5-8 wt.% of gelatinized starch, 0.1-3.5 wt.% of pulse seed albumin, and 0.03-3 wt wt.% of the polysaccharide thickener xanthan gum, or a combination with pectin having a degree of esterification above 40.

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2. claims: 11(completely); 1-9, 12-15(partially)

   An O/W emulsion of 5-60 wt.% dispersed oil and 40-95 wt.% of continuous aqueous phase with pH of 2.0 to 5.5, said emulsion containing by weight of the aqueous phase 0.5-8 wt.% of gelatinized starch, 0.1-3.5 wt.% of pulse seed albumin, and 0.03-3 wt wt.% of the polysaccharide thickener pectin having a degree of esterification above 40, or a combination with xanthan gum.
