METHOD FOR PRODUCING MILK PROTEIN FIBRES

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The disclosure relates to milk protein micro and super-micro fibres (MPM) and polymer nano fibres (MPN) produced according to a spinning method, in which at least one protein, which is obtained from milk and which can be thermally plasticized, is plasticized using a plasticizing agent, such as for example, water or glycerol at temperatures between room temperature and 140°C. by means of mechanical stress in a spinning system and is spun using a spinneret to obtain the MPN- and MPM fibres.
METHOD FOR PRODUCING MILK PROTEIN FIBRES

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a National Stage of International Application No. PCT/EP2012/072422, filed on Nov. 12, 2012, and published in German as WO 2013/068596 A1 on May 16, 2013. This application claims the benefit and priority of German Application No. 10 2011 118 432,9, filed on Nov. 12, 2011. The entire disclosures of the above applications are incorporated herein by reference.

BACKGROUND

[0002] This section provides background information related to the present disclosure which is not necessarily prior art.

TECHNICAL FIELD

[0003] Methods for producing polymer nano fibers (MPN fibers) are described in literature and known to the man skilled in the art. Within the scope of the present application, this fiber group also comprises milk protein micro and super micro fibers (MPM fibers).

DISCUSSION

[0004] Electrospinning processes for producing protein fibers are for example described in the patents EP 091 56540.8 and EP 081 621 229. Centrefiuge spinning processes which are suitable for producing nano fibers are for example disclosed in EP 624 665 A, EP 081 362 2 and EP 1 088 918 A. In these centrifuge spinning processes, the polymer containing solution or dispersion is brought into a rotating container and discharged from the container in form of fibers by means of centrifugal forces.

[0005] The German Patent 09170024.5 (BASF) describes a method for producing coated protein fibers by means of a centrifriuge spinning technology, wherein it is essential with respect to the invention that the fibers are contacted with a 2-cyanocrylate acid ester during or after their production. These esters are inviscid or intentionally thickened esters of the cyanoacrylic acid which are placed on the market as monomers in 1K form and are converted into the real adhesive polymer in the joint gap by a polymerization reaction. From U.S. Pat. No. 3,215,725 (1) and DE-A 41 22 475, 2-cyanocrylate acid esters of monovalent and bivalent alcohols are known as light protection agents for synthetic materials and varnishes. These compounds however have the technical disadvantage of a relatively high volatility. Since they are only partially compatible with many organic materials, in particular polyolefins, they tend to migrate, over all when they are stored in warm condition, and to show exudation effects which are related thereto. 2-cyanocrylate acid esters polymerize spontaneously to polycyanocrylate under the effect of air humidity. They are thus used as reactive adhesives (super adhesives). Even if the patent application 95938395.1/0790980 (BASF) describes new 2-cyanocrylate acid esters which shall avoid the present problems, cyanoacrylate acid is known as wound closure, cyanoacrylates which can furthermore be mixed with epoxy resin, acrylates etc. are considered to be harmful to health due to the risk of quick hardening.

[0006] This can be especially a problem for medical applications, where the nano fibers shall enable the penetration of the skin and the reception of drugs, because then toxicologic substances are received by the skin. For improving the water and humidity resistance of polymer or protein fibers or fiber surface structures produced from these ones, diverse measures have been described in literature.

[0007] Herein it is a possible method to influence the properties of the polymers by cross linking reactions.

SUMMARY

[0010] It is an object of the invention to eliminate the above mentioned disadvantages and to give polymer fiber materials, preferably made of renewable raw materials (over all protein based), a required water or humidity resistance, preferably without addition of acrylates and fossil raw materials.

[0011] Herein, the invention shall in particular reduce the processing time and the use of chemicals and preferably, and to the greatest possible extend, produce the MPN and MPM fibers from renewable and biodegradable raw materials. Simultaneously, the water and energy consumption shall be decreased and the productivity be increased.

[0012] The aim is achieved by a method according to the teachings of the present disclosure.

[0013] The present invention aims at MPN and MPM fibers which are produced by a continuous or discontinuous process from a composition which comprises destructured milk proteins, biodegradable thermoplastic polymers and softening agents.

[0014] Herein, at least one protein obtained from milk or a protein produced from bacteria is plasticized, optionally together with a plasticizer, at temperatures comprised between room temperature and 140° C. under mechanical stress.

[0015] The invention is based upon the knowledge that the milk proteins and in particular casein and the derivates thereof can be plasticized and in this manner be polymerized. It is preferably provided that the plasticizing takes place at temperatures of preferably up to 140° C.

[0016] For achieving an even more gentle treatment, the protein is intensely mixed or kneaded with a plasticizer and simultaneously subjected to mechanical stress. Herein, the temperature which is required for the plasticizing is considerably reduced by means of the plasticizer.

[0017] The milk protein is preferably casein or lactalbumin or soy protein.

[0018] The protein obtained from milk can be produced in situ by precipitation from milk. According to a first procedure, the milk in form of a mixture with lab, other suitable enzymes or acid can be immediately introduced into the process as flocculated mixture or the presssed-off flocculated protein can be used in humid form. According to another
optional procedure, a previously separately obtained, if necessary prepared, pure or mixed protein, i.e. a protein fraction from milk, can be used, for example in the form of a dried powder.

[0019] The protein fraction can also be produced by ultrafiltration or by using cell cultures. Furthermore, the milk proteins can be modified in other process steps for example by additional salts such as sodium and potassium, such that a casein is produced.

[0020] The milk protein used according to the invention can be mixed with other proteins in a proportion of preferably up to 70% by mass with respect to the milk protein. For this, other albumins, such as ovalbumin and vegetable proteins, in particular lupine protein, soy protein or wheat proteins, in particular gluten can be used.

[0021] The mixture of solvent and protein is heated up, usually under pressure conditions and shear, in order to accelerate the cross linking process. Chemical and enzymatic agents can also be used, in order to destructurize and to crosslink, to oxidize and to derivatize, to etherify, to saponify and to esterify the milk proteins. Usually, the milk proteins are destructurized by dissolving them in water. The milk proteins are completely destructurized, if there are no clots which influence the fiber spinning process.

[0022] In the present invention, a plasticizer can be used in order to destructurize the milk proteins and to enable the milk proteins to flow, i.e. to produce thermoplastic milk proteins. The same plasticizer or other plasticizers can be used in order to increase the melting processability, or two separate plasticizers can be used. The plasticizers can also improve the flexibility of the final products, wherein it is assumed that this is due to the reduction of the glass transition temperature of the composition caused by the plasticizer. The plasticizers are essentially compatible with the polymer constituents of the present invention, such that the plasticizers can effectively modify the properties of the composition. As it is used here, the expression “essentially compatible” means that if the plasticizer is heated up to a higher temperature than the softening and/or melting temperature of the composition, the plasticizer will be able to form an essentially homogenous mixture with milk proteins.

[0023] The plasticizer is preferably water which is used in a proportion comprised between 20 and 80% with regard to the weight of the protein, preferably in a proportion comprised between approximately 40 and 50% by mass of the protein content.

[0024] Instead of water or mixed with this one, other plasticizers, in particular alcohols, poly alcohols, carbohydrates in aqueous solution and in particular aqueous polysaccharide solutions can be used.

[0025] In detail, the following plasticizers and associated proportions are preferred: hydrogen bridges forming organic compounds without hydroxyl group, for example urea—and derivates,—animal proteins, e.g. gelatin,—vegetable proteins such as for example cotton,—soy beans,—and sunflower proteins,—esters of producing acids which are biodegradable, e.g. citric acid, adipic acid, succinic acid, oleic acid,—hydrocarbon-based acids, e.g. ethylene acrylic acid, ethylene maleic acid, butadiene acrylic acid, butadiene maleic acid, propylene acrylic acid, propylene maleic acid,—sugars, for example maltose, lactose, sucrose, fructose, maltooltriose, glycogen, pentaerythrit and sugar alcohols, e.g. maltitol, mannitol, sorbitol, xylitol,—polys, e.g. hexanetritol, glycols and the like, also mixtures and polymers, sugar hydrides, e.g. sorbitan,—esters, such as for example glycerin acetate, (mono, -di, -triacetate) dimethyl and diethylene glycol succinate and related esters, glycine propionates, (mono, -di, -tripropionate) butanoates, stearates, phthalate esters. These are non limiting examples of hydroxyl softening agents. Important influencing factors are the affinity to the proteins, the quantity of proteins and the molecular weight. Glycerin and sugar alcohols belong to the most important softening agents. The percentages of the softening agents are for example comprised between 5% and 55%, but they can also be comprised between 2% and 75%. Any desired alcohols, polyols, esters and polymers can be preferably used in a percentage of up to 30% by weight in the polymer mixture.

[0026] The rheological features are of a particular importance for the polymer mixture, in order to achieve a good processing. The solidification under stretch flow is required for forming a stable polymer structure. The melting temperature is mostly in a temperature range comprised between 30° C. and 190° C. Temperatures above these values should be reduced by means of diluents and softening agents.

[0027] The biodegradability of the polymers, i.e. their decomposition by living creatures and their enzymes is an important feature of the polymeric MPN and MPM fibers.

[0028] Among the biodegradable thermoplastic polymers which are for example suitable for being used in the present invention, are lactic acid polymers, lactide polymers, glycolide polymers, including their homo- and co-polymers and mixtures thereof; aliphatic polyesters of dibasic acids/esters; aliphatic polistyrenes, aromatic polyesters, also of modified polyethylene terphthalates and polybutylene terephthalates; polyacrylates; aliphatic/aromatic copolymers; poly(3-hydroxyalkanoates), including their copolymers and/or other -valerates, -hexanoates and -alkanoates, polyesters and dialkylamyl polymers, polyanides and copolymers of polyethylene/vinyl alcohol.

[0029] These compounds are for example and preferably suitable as biodegradable thermoplastic polymer of this invention: polyvinyl alcohol and polyvinyl copolymers, aliphatic amide and ester copolymers which are formed by monomers such as for example dialcohols (1,4-butandiol, 1,3-propanediol, 1,6-hexandiol etc.) or ethylene glycol and diethylene glycol, aliphatic polystyrenes, (aliphatic esters are formed with aliphatic amides) or by means of other reactions, such as for example lactic acid with diamines and dicarboxylic acid dichlorides, diols with carboxylic acids, caprolacton and caprolactam, or ester prepolymer with disocyanates, dicarboxylic acids, especially succinic acid, oxalic acid and adipic acid and the esters thereof; hydroxy-carboxylic acids, lactones, amino alcohols (for example ethanolamine, propanolamine), cyclic lactams, aminocarboxylic acids (e.g. aminocaproic acid), dicarboxylic acids and diamines (e.g. salt mixtures of dicarboxylic acids) and mixtures thereof. Polysteres such as for example oligoesters can also be used.

[0030] Polybutylene succinate/adipate copolymer; polyalkylene succinates; polymethyl succinates; polyhexamethyl succinates; polyheptamethyl succinates; polyoctamethyl succinates; polyalkylene oxalates, such as polyethylene oxalate and polybutylene oxalate, polyalkylene succinate copolymers, such as polyethylene succinate/adipate copolymer and polyalkylene oxalate copolymers, such as polybutylene oxalate/succinate copolymer and polybutylene oxalate/adipate copolymer; polybutylene oxalate/succinate/adipate terpolymers; and mixtures thereof are non limiting examples of aliphatic polyesters of dibasic acids/esters which are for
example produced by polymerization of acids and alcohols or ring-opening reactions and are suitable for producing a polymer.

[0031] In the production of biodegradable polymers, aliphatic/aromatic copolymers can also be used. These copolymers are formed in a condensation reaction from dicarboxylic acids (and derivatives) such as malonic, succinic, glutaric, adipic, pimelic, azelaic, sebacic, furmaric, 2,2-dimethyl glutaric, suberic, 1,3-cyclohexanedicarboxylic, 1,4-cyclohexanedicarboxylic, 1,3-cyclohexane dicarboxylic, diglycolic, terephthalic, maleic, 2,5-norbornedicarboxylic, 1,4-terephthalic, 1,3-terephthalic, 2,6-naphthoic, 1,5 naphthoic acid, esters forming diesters and mixtures thereof and diols, for example ethylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, propylene glycol, 1,3-propylene glycol, 2,2 dimethyl-1, 3-propylene glycol, 1,3-butane diol, 1,4-butane diol, 1,5-pentane diol, 1,6 hexane diol, 2,2,4 trimethyl-1,6 hexane diol, thiodiethanol, 1,3-cyclohexane dimethanol, 1,4-cyclohexane dimethanol, 2,2,4,4 tetramethyl-1,3 cyclobutane diol and combinations thereof. Examples of such aliphatic/aromatic copolymers include mixtures of poly(tetramethylene glutarate co-terephthalate), poly(tetramethylene glutarate co-terephthalate), poly(tetramethylene glutarate co-terephthalate), poly(tetramethylene glutarate co-terephthalate), poly(ethylene glutarate co-terephthalate), poly(tetramethylene adipate co-terephthalate), a mixture having a ratio of 85/15 of poly(tetramethylene succinate co-terephthalate) and poly(tetramethylene co-ethylene glutarate co-terephthalate), poly(tetramethylene co-ethylene glutarate co-terephthalate).

[0032] The processability of the protein mass can be modified by other materials, in order to influence the physical and mechanical properties of the protein mass, but also those of the final product. Non limiting examples include thermoplastic polymers, crystallization accelerators or inhibitors, odor masking agents, cross linking agents, emulsifiers, salts, lubricants, surfactants, cyclodextrins, greasing agents, other optical brighteners, antioxidants, processing agents, flame retardants, dye stuffs, pigments, filler materials, proteins and their alkali salts, waxes, adhesive resins, extenders and mixtures thereof. These auxiliary agents are bound to the protein matrix and influence the properties of this one.

[0033] Salts can be added to the molten mass. Non limiting examples of salts include sodium chloride, potassium chloride, sodium sulfate, ammonium sulfate and mixtures thereof. Salts can influence the solubility of the protein in water, but also the mechanical properties. Salts can serve as binding agents between the protein molecules.

[0034] Lubricants can, on the other hand, influence the stability of the polymer. They can reduce the stickiness of the polymer and decrease the friction coefficient. Polyethylene is a non limiting example.

[0035] The physical properties of the polymer mass can be influenced by other proteins; these ones include, without limitation, for example vegetable proteins such as sunflower protein or animal proteins such as gelatine. Water soluble polysaccharides and water soluble synthetic polymers such as polyacrylic acids can also influence the mechanical properties.

[0036] Monoglycerides and diglycerides and phosphatides as well as other animal and vegetable fats can influence and favour the flow characteristics of the biopolymer.

[0037] Inorganic filler materials also belong to the optional additives and can be used as processing agents. Possible examples, which do not limit the use, are oxides, silicates, carbonates, lime, clay, limestone and kieselguhr and inorganic salts. Stearate based salts and colophony can be used for modifying the protein mixture.

[0038] Amino acids which are constituents of the proteins and peptides can be added to the polymer mass in order to enhance special pleated sheet structures or mechanical properties. Without limitation, glutamic acid, histidine, tryptophane etc. are mentioned as examples.

[0039] Enzymes, surfactants, acids, serpines as well as phenoil molecules are other additives which can contribute as cross linking agents to improve the mechanical properties and the resistance in water and the protease resistance.

[0040] Other additives can be desirable in dependence on the respective final use of the intended product. Wet strength is for example a required property of most of the products. Therefore, it is required to add resins comprising a wet strength as cross linking agents.

[0041] Other natural polymers can also be added as additives. Possible examples of natural polymers are, without limiting the selection, albumins, soy protein, zein protein, chitosan and cellulose, “polylactide” and “PLA”, which can be used in a percentage comprised between 0.1% and 80%.

[0042] Apart from natural polymers, other synthetic polymers such as inter alia polyvinyl alcohol as well as polyester or others such as polyethylene glycol, aldehydes such as glutaraldehyde and acrylic acids can be used.

[0043] These ones also include non-degradable polymers which are used in dependence on the final use of the MPN and MPM fibers. Thermoplastic synthetic materials which can be used for copolymerization are included, such as—for example—without having a limiting effect—for example polypropylene, polyethylene, polyamide, polyester and copolymers thereof. Other high molecular polymers are also possible.

[0044] Carbohydrates and polysaccharides as well as amyloses, oligosaccharides and chenodesoxicholic acids can be used as other auxiliary agents and additives.

[0045] Salts, carbonic acids, dicarboxylic acids and carbonates as well as their anhydrides, salts and esters can also be used as additional cross linking agents. Hydroxides, butyesters as well as aliphatic hydrocarbons present other possibilities to cross link the molecules to each other and to form macromolecules.

[0046] The addition of other agents is not excluded. Additives and auxiliary agents, such as lipophile, hydrophobic, hydrophile, hydrosopic additions, glossing agents and cross linking agents can be especially provided. The additives and auxiliary agents shall altogether not exceed a proportion of preferably maximum about 30% by mass with regard to the protein. Vegetable oils, alcohols, fats can be chosen as lipophile additions which slightly hydrophobize the fiber already during the plasticizing operation. Furthermore, waxes and fats can be used which additionally give the fiber stability. Preferred waxes are carnauba wax, beeswax, candellilla wax and other naturally obtained waxes.

[0047] After the MPN and MPM fiber has been formed, the fiber can be further processed or the bound substance can be treated. A hydrophile or hydrophobic surface treatment can be added, in order to adjust the surface energy and the chemical condition of the substance. Hydrophobic MPN and MPM fibers can for example treated with wetting agents, in order to facilitate the absorption of aqueous liquids. A bound sub-
stance can also be treated with a topic solution which contains surfactants, pigments, lubricants, salt, enzymes or other materials, in order to further adjust the surface properties of the MPN and MPM fiber.

For achieving that the MPN and MPM fiber or the surface structures thereof meet the stricter requirements by means of improved properties for a certain purpose, they are preferably produced, apart from the hitherto known and described production methods, by means of a nano centrifuge spinning unit in order to increase the productivity. For this the spinning mass, which is also called spinning solution or spinable solution, is produced with the viscosity required for the nano centrifuge spinning process. The spinning mass is produced by the continuous or discontinuous method which is known to the man skilled in the art and from literature, preferably by mixing or extruding a pre-mixture while adding additives or by preparing the spinning solution by dosing in the basic materials and additives during the mixing or extruding.

The production of the MPN fibers can be realized according to known methods, for example by means of an electro-spinning or a centrifuge spinning method, force spinning, melt-blow-spinning or a nano centrifuge spinning process.

The method in which water is used as solvent and plasticizer prevents any difficulties with respect to labour law, toxicology and product approval.

Thanks to the plasticizing operation, the spinning mass corresponds to a polymer in which the materials are transferred into a plastic state by heating them up and are deformed in this manner. Herein, the temperature exceeds the glass transition temperature of the protein such that this one is converted from the amorphous state into the rubber-like plastic state.

After the MPN and MPM fiber has left for example the spinning jet, this fiber can be immediately processed further, preferably for forming a fiber surface structure.

Immediately after the formed MPN and MPM fiber has left the jet or in at least one subsequent processing step, the fiber can alternatively be further processed to a plied yarn, can be in particular twisted, be loosely coiled up to a cotton wool or be further processed to a fleece.

In order to improve the properties of the described fibers, bio-components can be used before and after the spinning mass gets out of the jet.

As a further development of the invention, the MPN and MPM fiber can also pass through a bath for a further treatment, wherein this process is not especially preferred and usually not required. Alternatively, the fiber can be subjected to a spraying treatment after having left the jet. Herein, for example smoothing agents, waxes, lipophiles or cross linking agents can be applied to the surface of the fiber. In the case of cross linking agents, the above mentioned ones are preferred: generally different salt solutions, preferably a calcium chloride solution, a dialdehyde starch solution or an aqueous lactic acid. Alternatively, the fiber can be subjected to a gas treatment or an ice treatment or a drying and blowing treatment or a sonic treatment or a UV treatment or an enzymatic treatment as well as to a rejuvenation by means of salts or esterification, etherification, saponification or another cross linking process as well as to a needling and hydro entangling process and to calendaring etc.

The obtained MPN and MPM fibers and the products which are made of these ones can be used for all imaginable purposes. Thus, they can be processed to form all types of textile fabrics, woven fabrics, knitted fabrics, crocheted textile fabrics, yarns, ropes, fleecees, felts etc. and also be processed further accordingly, e.g. be coated. The MPN and MPM fibers and fiber surface structures according to the invention can be used in numerous fields of application and be completely or partially composed of the fiber surface structures, for example as coating and/or constituent. They can be used as non-woven fabrics or fleecees, in particular in the field of cosmetics, textiles, medical products, hygienic and cleaning products, cell culture and catalyst carriers as well as bubbles, filter and membrane parts, coalescers etc. Furthermore, cotton wools, wound dressings, implants, loose fiber insulating materials, light-weight building materials and sclera-like fiber surface structures can be made of the MPN and MPM fibers according to the invention.

The fibers of the present invention which are composed of several constituents can be present in many different configurations. Constituent, such as used here, means, according to definition, the chemical substance or the material. Fibers can comprise mono component or multiple component configurations. Component, such as used here, is defined as a separate part of the fiber which is in a spatial relationship with another part of the fiber.

The advantages obtained by the invention are inter alia that, in the production of MPN and MPM fibers according to the invention, it becomes possible to reduce the substances which present a health risk and are environmentally harmful during the process and in the fiber itself. Besides, the fiber is biodegradable.

Furthermore, considerable resources of energy, water, time and manpower can be saved, which enhances the environmental protection and improves the economic efficiency. The particularly advantageous properties of the MPN and MPM fibers are attributed to solidifying structural changes (tertiary structure) during the plasticizing operation.

The MPN fibers in the nano range, preferably comprising a diameter of 80-500 nanometers, including filaments, fiber surface structures or bio-components, are preferably produced by means of a nano centrifuge spinning unit in order to enable a highest possible productivity. All production methods of the described nano fibers and micro fibers, in particular the MPM fibers which are finer than 1.0 den and micro superfibers which are finer than 0.3 den, which production methods are known to the man skilled in the art and from literature, can be used without any exception. It is essential with respect to the invention that a homogeneously plasticized polymer, preferably a biogen biopolymer, can be produced that is biodegradable. Unfortunately, it has not been possible so far to develop fibers on this base which are water resistant and sufficiently resistant to proteases, acids and alkalis. Preferably, the use of petroleum-based raw materials and/or organic solvents, in particular for fibers having skin contact or which are even used as wound dressing, as hygiene or childcare articles, just to mention a few examples, shall be reduced or even excluded.

For MPN and MPM fibers which are preferably produced from renewable raw materials with a proportion of milk proteins and are characterized by features such as water resistance, high protease resistance, sufficient mechanical properties such as tensile strength and tear resistance, and are elastic, antiallergic, antibacterial and biodegradable, it is furthermore possible to influence the properties of the protein
fiber according to the requirements of the intended purpose by changing the additions of raw materials.

EXAMPLES

[0062] In the following, the invention will be described in detail by means of an exemplary embodiment. The exemplary embodiment only serves to illustrating purposes and shall not limit the invention. On the base of this exemplary embodiment and his know-how, the man skilled in the art can find other possible embodiments by varying the parameters.

[0063] Example 1: Production of a milk protein spinning mass. The extrusion is realized by a twin-screw extruder type 30 E of the company Dr. Collin having a diameter of 30 mm. The MPN fiber is produced by means of nano centrifuge spinning technology of the equipment engineering Fa. Dienes.

[0064] The heating is realized by four cylinder heating zones with the following temperature development: 65° C., 74° C., 75° C., 60° C.:

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<th>Temperature</th>
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[0065] The casein powder is supplied via a vibrating conveyor. Water is added by means of a peristaltic pump. The additives are added by means of other dosing devices. The fiber thickness is defined by the jet strength. The fiber can for example have a thickness of 80 nm.

BRIEF DESCRIPTION OF THE DRAWING

[0066] The drawing described herein is for illustrative purposes only of selected embodiments and not all possible implementations, and is not intended to limit the scope of the present disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0067] Example embodiments will now be described more fully with reference to the accompanying drawing.

[0068] The course of the extrusion process and the development of the MPN and MPN centrifuge spinning become additionally apparent in FIG. I. The raw materials are dosed into the extruder via a dosing device I and the polymer mass is mixed.

[0069] Afterwards, the extruded material is supplied to a spinning pump 3 and to a nano spinning centrifuge 4, wherein it passes afterwards through the post-treatment.

[0070] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

1. A method for the production of milk protein nano fibers and/or meso fibers (MPN fibers), preferably comprising a diameter comprised between 80 nm and 500 nm, characterized in that said fibers are produced from a homogenous polymer on the base of proteins obtained from milk by addition of heat and a plasticizer and by using an electro-spinning, centrifuge spinning, force spinning, melt-blown-spinning or a nano centrifuge spinning method.

2. A method according to claim 1, characterized in that the MPN fibers are produced from a homogenous polymer, preferably a bio-polymer of renewable raw materials, or are coated with this one.

3. A method for the production of milk protein micro fibers and milk protein micro-super fibers (MPM fibers), preferably comprising a diameter of less than 1 μm, characterized in that the MPM fibers are produced from a homogenous polymer, preferably a bio-polymer of renewable raw materials, or are coated with this one.

4. A method according to one of the preceding claims, characterized in that the production of the MPN and MPM fibers is a continuous or a discontinuous process.

5. A method according to one of the preceding claims, characterized in that the homogenous polymer that is composed of macromolecules is produced before the real spinning process of the MPN and MPM fibers by means of a continuous or discontinuous process under mechanical stress.

6. A method according to one of the preceding claims, characterized in that the plasticizer is a constituent of the macromolecules.

7. A method according to one of the preceding claims, characterized in that the plasticizing operation is carried out in a mixer, a kneading device, an extruder or an injection moulding machine.

8. A method according to one of the preceding claims, characterized in that other additives and auxiliary agents are added to the base material to be plasticized, optionally by admixing before or during the plasticizing operation.

9. A method according to one of the preceding claims, characterized in that at least one protein obtained from milk is plasticized together with a plasticizer under mechanical stress and is preferably spun to fibers through a jet.

10. A method according to one of the preceding claims, characterized in that the plasticizing takes place at temperatures of up to 140° C.

11. A method according to one of the preceding claims, characterized in that the protein obtained from milk is either produced in situ by precipitation from milk or is used in form of a protein that has been separately obtained before and, if required, been prepared or is used in form of a protein fraction.

12. A method according to one of the preceding claims, characterized in that the proteins obtained from milk are obtained from bacteria.

13. A method according to one of the preceding claims, characterized in that the proteins obtained from milk are obtained by gas treatment or filtration.

14. A method according to one of the preceding claims, characterized in that the proteins obtained from milk, in particular casein, lactalbumin or soy protein are obtained from goat's milk, sheep's milk, cow's milk or soy milk.

15. A method according to one of the preceding claims, characterized in that the plasticizer is selected from the group:
water, aqueous carbohydrate solution and in particular aqueous polysaccharides, oligosaccharides, proteins, alcohol, polyalcohol, fats, acids, amino acid, peptides, salts, cations, enzymes or mixtures thereof as well as their oxidation.

16. A method according to one of the preceding claims, characterized in that the MPN and MPM fibers are dried and post-treated, in that they pass through a bath and are subjected to a spraying treatment, a gas treatment, an ice treatment, a drying and blowing treatment, a ionic treatment, a UV treatment, an infrared treatment, an enzymatic treatment, a needling and hydro entangling process, as well as to a renaturation by means of salts or alcohols, esters and ethers, esterification, etherification or saponification or another cross linking or coating process or calendering process.

17. A method according to one of the preceding claims, characterized in that the polymer mass or the MPM or MPN fibers are destructured, oxidized, derivatized, etherified, esterified or saponified during or after the process by means of chemical or enzymatic substances.

18. A method according to one of the preceding claims, characterized in that amino acids are added to the polymer mass.

19. A method according to one of the preceding claims, characterized in that the polymer mass is mixed with or post-treated by protease inhibitors, preferably enzymes, surfactants, acids, serpines, phenolic molecules of plants and/or polysaccharides.

20. A method according to one of the preceding claims, characterized in that the MPN and MPM fibers are produced by copolymerization of mixtures of two or more different monomers and/or production of bi-component or multi-component fibers.

21. A milk protein fiber product which contains MPN and MPM fibers which contain a thermally mechanically plasticized milk protein, in particular produced by a method according to one of the claims 1 through 20.

22. A use of milk protein fiber products according to claim 21 as coating and/or constituent of non woven fabrics or fleeces, loose cotton wool or plied yarns, in particular in the field of cosmetics, textiles, medical products, hygiene and cleaning products, cell culture and catalyst carriers as well as filter and membrane parts.