To overcome all the drawbacks from the known drying methods, the present invention provides a roller drying or drum drying method, which is simple, cost effective and scalable, for the drying of human milk oligosaccharides.

The method of roller or drum drying of the present invention for drying human milk oligosaccharides, represents a simpler, safer and more energy efficient method. And it is particularly relevant for the drying of HMOs which need a special care for drying due to their properties. This method does not need a heated air flow and there is no risk of dust explosions or electrical charge due to circulating material flow.

Summary

The present disclosure concerns a simple and economical process for drying HMOs. The drying of saccharides, oligo- and polysaccharides in particular, and above all the drying of HMOs is a very special undertaking in which many parameters must be taken into consideration. HMOs are very sensitive substances, which are intended for the pharmaceutical or food industry and are therefore heavily regulated and to which high quality demands are made.

It is an object of the present disclosure to provide a roller drying or a drum drying method to dry human milk oligosaccharides and make them available as a solid.

As an additional example, the present disclosure relates to vacuum roller drying or vacuum drum drying applied to HMOs.

It is yet another object of the present disclosure to provide a method of roller drying or drum drying for HMOs where the quality of such HMOs is obtained with maintained purity due to the mild drying conditions of such method. Where HMOs with a specific water content, a specific surface texture as well as a certain particle size is obtained, which gives such HMOs unique product properties for the pharmaceutical and food industry.

It is another object of the present disclosure to provide an industrial scale method of roller drying or drum drying for HMOs. Specifically, the method should be suitable for providing dried HMOs ranging from kg-scale to tons-scale.

In one aspect, the present disclosure refers to a method for drying human milk oligosaccharides and/or for obtaining human milk oligosaccharides in the form of a powder, the method comprises the steps of:

a) providing an aqueous solution containing a purified human milk oligosaccharide; and

b) applying the aqueous solution to a roller dryer or a drum dryer,

wherein the roller dryer or the drum dryer is a vacuum roller dryer or a vacuum drum dryer and wherein the aqueous solution contains the human milk oligosaccharide in a total purity of at least 50 % with respect to the weight of dry matter / solutes within such aqueous solution.

Brief description of the drawings

FIG. 1 shows a HILIC-CAD (Hydrophilic interaction liquid chromatography coupled to a charged aerosol detector) spectrum of the *N*-acteylneuraminic acid sodium salt used as starting material in examples 1 and 2.

FIG. 2 shows a HILIC-CAD (Hydrophilic interaction liquid chromatography coupled to a charged aerosol detector) spectrum of the *N*-acteylneuraminic acid sodium salt obtained as a product in example 1.

FIG. 3 shows a HILIC-CAD (Hydrophilic interaction liquid chromatography coupled to a charged aerosol detector) spectrum of the *N*-acteylneuraminic acid sodium salt obtained as a product in example 2.

FIG. 4 shows a HILIC-CAD (Hydrophilic interaction liquid chromatography coupled to a charged aerosol detector) spectrum of the *N*-acteylneuraminic acid used as a starting material in example 3.

FIG. 5 shows a HILIC-CAD (Hydrophilic interaction liquid chromatography coupled to a charged aerosol detector) spectrum of the *N*-acteylneuraminic acid obtained as a product in example 3.

FIG. 6 shows a HILIC-CAD (Hydrophilic interaction liquid chromatography coupled to a charged aerosol detector) spectrum of the 6'-sialyllactose sodium salt used as a starting material in example 5.

FIG. 7 shows a HILIC-CAD (Hydrophilic interaction liquid chromatography coupled to a charged aerosol detector) spectrum of the 6'-sialyllactose sodium salt obtained as a product in example 5.

CLAIMS

1. A method for drying human milk oligosaccharides and/or for obtaining human milk oligosaccharides in the form of a powder, the method comprises the steps of:

    a) providing an aqueous solution containing a purified human milk oligosaccharide; and
    b) applying the aqueous solution to a roller dryer or a drum dryer,

    wherein the roller dryer or the drum dryer is a vacuum roller dryer or a vacuum drum dryer and wherein the aqueous solution contains the human milk oligosaccharide in a total purity of at least 50 % with respect to the weight of dry matter / solutes within such aqueous solution.

2. The method according to claim 1, wherein the aqueous solution contains the purified human milk oligosaccharide in a concentration of ≥ 1 g/L, ≥ 10 g/L, ≥ 20 g/L, ≥ 25 g/L, ≥ 30 g/L, ≥ 40 g/L, ≥ 60 g/L, ≥ 100 g/L, ≥ 200 g/L, ≥ 300 g/L or even ≥ 400 g/L.

3. The method according to any one of the preceding claims, wherein the aqueous solution contains the human milk oligosaccharide in a total purity of at least 65 %, at least 80 %, at least 90 %, at least 95 % or at least 98 % with respect to the weight of dry matter/solutes within such aqueous solution.

4. The method according to any one of the preceding claims, wherein the roller dryer or the drum dryer is selected from a single drum dryer or a double drum dyer.

5. The method according to any one of the preceding claims, wherein the aqueous solution is dried at a drum cylinder wall temperature of at least 25 °C, preferably at least 30 °C, preferably at least 35 °C, preferably at least 40 °C, preferably at least 45 °C, preferably at least 50 °C, preferably at least 55 °C, preferably at least 60 °C, preferably at least 65 °C, preferably at least 70 °C, more preferably at least 75 °C, and less than 200 °C, less than 195 °C, less

than 190 °C, less than 185 °C, less than 180 °C, preferably less than 175 °C, less than 170 °C, less than 165 °C, less than 160 °C, less than 155 °C, and more preferably less than 150 °C.

6. The method according to any one of the preceding claims, wherein the aqueous solution is dried at a shell temperature of at least 25 °C, preferably at least 30 °C, preferably at least 35 °C, preferably at least 40 °C, preferably at least 45 °C, preferably at least 50 °C, and less than 150 °C, preferably less than 145 °C, preferably less than 140 °C, preferably less than 135 °C, preferably less than 130 °C, and more preferably less than 145 °C.

7. The method according to claim 6, wherein the aqueous solution is dried at a shell temperature of about 80 °C to about 90 °C.

8. The method according to any one of the preceding claims, wherein the aqueous solution is dried at a rotation speed of the drum cylinders of at least 0.1 rpm, preferably at least 1.0 rpm and less than 30 rpm, more preferably less than 20 rpm.

9. The method according to any one of the preceding claims, wherein the aqueous solution is dried at a gap between the drum cylinders of at least 0.02 mm, preferably at least 0.2 mm, and less than 20 mm, more preferably less than 10 mm.

10. The method according to any one of the preceding claims, wherein the aqueous solution is dried at a pressure of at least 0.55 mbar, preferably at least at 5.5 mbar, and less than 1013 mbar, more preferably less than 550 mbar.

11. The method according to any one of the preceding claims, wherein the aqueous solution is dried from a solution having an ethanol content of at least 0.1% (v/v), preferably at least of 1.0% (v/v), and less than 100% (v/v), more preferably less than 50% (v/v).

12. The method according to claim 11, wherein the aqueous solution is dried from a solution with a relative ethanol content determined by HPAEC-PAD (High performance anion exchange chromatography with pulsed amperometric detection) of at least 0.01 %, and less than 10 %.

13. The method according to any one of the preceding claims, wherein the human milk oligosaccharide is selected from the group consisting of *N*-acetyl-lactosamines, Lacto-N-biose I, sialylated oligosaccharides, and fucosylated oligosaccharides.

14. The method according to claim 13, wherein the *N*-acetyl-lactosamine or Lacto-N-biose I are selected from one or more of the group consisting of lacto-*N*-tetraose (L*N*T), lacto-*N*-*neo*tetraose (L*N*nT) and lacto-*N*-fucopentaose I (L*N*PFI).

15. The method according to claim 13, wherein the sialylated oligosaccharide is selected from one or more of the group consisting of 3'-sialyllactose (3'-SL), 6'-sialyllactose (6'-SL), sialyllacto-*N*-tetraose a (LST-a), sialyllacto-*N*-tetraose b (LST-b), sialyllacto-*N*-tetraose c (LST-c) and disialyllacto-N-tetraose (DSLNT).

16. The method according to claim 13, wherein the fucosylated oligosaccharide is selected from one or more of the group consisting of 2'-fucosyllactose (2'-FL), 3-fucosyllactose (3-FL), 2',3-difucosyllactose (DiFL) and lacto-*N*-fucopentaose I (L*N*PFI).