

A xylan-based dual network nanocomposite hydrogel, preparation method thereof and use therefor

Technical field

The invention belongs to the technical field of composite materials, and particularly relates to a xylan-based dual network nanocomposite hydrogel, preparation thereof and use therefor.

Background

Hydrogel is a polymer network system that could absorb a large amount of water without dissolving and maintain a certain shape. Hydrogel has been widely used and studied in the field of drug sustained release, biomedicine and tissue engineering. However, some of the traditional chemically cross-linked hydrogels possess relatively weak mechanical properties, which greatly limits deeper and wider application of hydrogels. Especially for biomedicine and tissue engineering, the requirements for the mechanical properties of hydrogels are gradually emerging.

In recent years, a large amount of research has been devoted to improving the mechanical properties of hydrogels. Polymer composite hydrogels and dual network hydrogels have been considered as common ways to effectively improve the mechanical properties of gels. Polymer composite hydrogels which introduces reinforcing organic/inorganic fillers, such as montmorillonite, nanocellulose, carbon nanotubes, etc., to

the polymer network structure could improve the mechanical properties of the hydrogel. GO/PAM nanocomposite hydrogels have been reported (R. Liu, S. Liang, X.-Z. Tang, D. Yan, X. Li and ZZ Yu, *J. Mater. Chem* 2012, 22, 14160- 14167; N. Zhang, R. Li, L. Zhang, H. Chen, W. Wang, Y. Liu, T. Wu, X. Wang, W. Wang and Y. Li, *Soft Matter* 2011, 7, 7231-7239; H. Wei, L. Han, Y. Tang, J. Ren, Z. Zhao and L. Jia, *J. Mater. Chem. B* 2015, 3, 1646-1654), but limited enhancement of mechanical strength was obtained, and compressive strength thereof is generally below 1 MPa, which still has a lot of room for further improvement. The dual network hydrogel consists of two separate crosslinked networks which improve the mechanical properties of the hydrogel by introducing a new crosslinked network. However, most dual network hydrogels have the disadvantages of serious environmental pollution, poor biocompatibility and poor degradability. Therefore, how to prepare a high-strength and biocompatible dual network composite hydrogel has become a challenge.

Xylan possesses good biocompatibility, renewability and special physical and chemical features. It could inhibit cell mutation, and is available for detoxification, anti-inflammatory, anti-cancer effects, etc., which shows good prospects in application in medicine field. So far, no report has been found on nanocomposite hydrogels using xylan as a raw material, GO as a reinforcing filler, acrylamide as a monomer grafted to

the polymer network, and graphene oxide (GO) and Ca^{2+} crosslinked to form another network.

Summary of the invention

In order to overcome the shortcomings and deficiencies of the prior art, the primary object of the present invention is to provide a method for preparing a xylan-based dual network nanocomposite hydrogel.

Another object of the present invention is to provide a xylan-based dual network nanocomposite hydrogel prepared by the above method.

A further object of the present invention is to provide use of the above xylan-based dual network nanocomposite hydrogel. The composite hydrogel could be applied in the field of biomedicine, in particular, tissue engineering, drug sustained release, cell culture scaffold, and cartilage tissue.

The objects of the present invention are achieved by the following technical solutions:

A method for preparing a xylan-based dual network nanocomposite hydrogel comprises the following steps:

- (1) adding graphite oxide powder to deionized water and dispersing by ultrasonication to obtain an aqueous GO dispersion;
- (2) adding xylan to deionized water, heating and stirring to obtain a xylan solution;
- (3) adding water-soluble calcium salt, reaction monomer and the

xylan solution to the aqueous GO dispersion, stirring until it is dispersed uniformly under ice bath conditions, then adding initiator, cross-linking agent and accelerator, stirring and mixing uniformly to obtain a mixed solution; the reaction monomer is one or more of acrylamide, polyacrylamide, acrylic acid, N-isoacrylamide, and butyl acrylate, and acrylamide is preferred;

(4) drying the mixed solution in step (3) to obtain a xylan-based dual network nanocomposite hydrogel.

The mass ratio of Ca^{2+} in the water-soluble calcium salt in step (3) to the graphite oxide powder in the GO aqueous dispersion is (10-240) mg: (20-60) mg, the mass ratio of the reaction monomer to the xylan is (1-6) g: (0.5-1.5) g, and the mass ratio of the graphite oxide powder in the GO aqueous dispersion to the xylan is (20-60) mg: (0.5-1.5) g.

The water-soluble calcium salt in step (3) is CaCl_2 or calcium nitrate; the initiator is ammonium persulfate or potassium persulfate; the crosslinking agent is *N, N'*-methylenebisacrylamide; the accelerator is tetramethylethylenediamine or *N,N,N',N'*-tetramethylethylenediamine.

The drying in step (4) is carried out at 50 °C - 80 °C for 2 h - 6 h;

Said heating and stirring in step (2) refer to stirring at 75°C - 95 °C for 0.5 h - 1.5 h.

The concentration of the GO aqueous dispersion in step (1) is 0.4 mg/mL - 6 mg/mL, and the concentration of the xylan solution in step (2)

is 0.05 g/mL - 0.2 g/mL.

The mass ratio of the initiator to the reaction monomer in step (3) is (0.01 - 0.05) g: (1 - 6) g; the mass ratio of the crosslinking agent to the reaction monomer in step (3) is (0.0025-0.03) g: (1-6) g; the volume-mass ratio of the accelerator to the reaction monomer in step (3) is (10 - 50) μ L: (1 - 6) g.

Said dispersing by ultrasonication in step (1) is carried out at 20°C-40 °C for 2 h - 6 h; the power of the ultrasound is 100W - 300W, and the frequency is 25 kHz-80 kHz.

A xylan-based dual network nanocomposite hydrogel prepared by the above method is provided.

The compressive strength and the elongation of the xylan-based dual network nanocomposite hydrogel are 0.17MPa- 2.3 MPa and 629% - 3967%, respectively.

Use of the xylan-based dual network nanocomposite hydrogel in the field of biomedicine is also provided, especially in tissue engineering, drug sustained release, cell culture scaffolds and cartilage tissue.

The preparation method of the invention and the obtained product has the following advantages and beneficial effects:

(1) The present invention combines the preparation method of a nanocomposite hydrogel and a dual network hydrogel to prepare a high-strength hydrogel using as a solvent, xylan as a raw material, GO as a

reinforcing filler to form a network copolymerized and grafted with a reaction monomer (acrylamide as the monomer), and form another network by introduction of Ca^{2+} to cross-link with GO. The method not only improves the mechanical strength of the hydrogel, but also improves the biocompatibility and biodegradability of the hydrogel; (2) The preparation method of the invention uses a one-step synthesis method with simple operation, mild and easily controlled reaction condition;

(3) The composite hydrogel obtained by the invention has high mechanical properties, meanwhile, it is biodegradable, has good biocompatibility, and can be applied in biomedical fields, such as tissue engineering, drug sustained release, cell culture scaffold and cartilage tissue, etc.

Description of the drawings

Figure 1 shows compression stress-strain curves of hydrogels with different Ca^{2+} contents (Comparative Example 1 (1: $\text{Ca}^{2+}/\text{GO} = 0$), Example 1 (2: $\text{Ca}^{2+}/\text{GO} = 0.5$), Example 2 (4: $\text{Ca}^{2+}/\text{GO} = 2$), Example 6 (3: $\text{Ca}^{2+}/\text{GO} = 1$) and Example 7 (5: $\text{Ca}^{2+}/\text{GO} = 4$));

Figure 2 shows tensile stress-strain curves of hydrogels with different Ca^{2+} content (Comparative Example 1 (1: $\text{Ca}^{2+}/\text{GO} = 0$), Example 1 (2: $\text{Ca}^{2+}/\text{GO} = 0.5$), Example 2 (4: $\text{Ca}^{2+}/\text{GO} = 2$), Example 6 (3: $\text{Ca}^{2+}/\text{GO} = 1$) and Example 7 (5: $\text{Ca}^{2+}/\text{GO} = 4$));

Figure 3 is a cyclic compression stress-strain curve of the

GO/Ca²⁺/PAM/XH composite hydrogel of Example 2.

Detailed description of the embodiments

The present invention will be further described in detail below with reference to the embodiments and drawings, but the embodiments of the present invention are not limited thereto.

Comparative example 1

A method for preparing a GO/PAM/XH hydrogel comprises the following steps:

(1) adding 20 mg of graphite oxide powder (GO) to 10 mL of deionized water, and dispersing by ultrasonication (100 W, 25 kHz) at 20°C for 4 h to obtain a GO aqueous dispersion;

(2) weighing 1 g of xylan, dissolving in 10 mL of deionized water, and stirring at 85 °C for 1 h to form a uniform xylan solution;

(3) adding 4 g of monomer acrylamide (AM) and the xylan solution to the aqueous GO dispersion in step (1), stirring until the mixture is dispersed uniformly under ice bath; adding 0.01 g of initiator ammonium persulfate, 0.008 g cross-linking agent N, N'-methylenebisacrylamide and 40 uL accelerator tetramethylethylenediamine, and stirring uniformly to obtain a mixed solution;

(4) placing the mixed solution in step (3) in an oven to react at 50°C for 2 hours to obtain a composite hydrogel, that is, a GO/PAM/XH hydrogel. The performance curves of obtained composite hydrogel are

shown in Figures 1 and Figure 2.

The GO/PAM/XH composite hydrogel obtained in this comparative example had a maximum compressive strength of 0.17 MPa and an elongation of 629% when the compressive deformation reached 95%.

Example 1

A method for preparing a xylan-based dual network nanocomposite hydrogel (GO/Ca²⁺/PAM/XH hydrogel) comprises the following steps:

(1) adding 20 mg of graphite oxide powder (GO) to 10 mL of deionized water, and dispersing by ultrasonication (100 W, 40 kHz) at 20°C for 4 h to obtain a GO aqueous dispersion;

(2) weighing 1 g of xylan, dissolving in 10 mL of deionized water, and stirring at 85 °C for 1 h to form a uniform xylan solution;

(3) adding 27.75 mg of CaCl₂, 4 g of monomer acrylamide and the xylan solution to the aqueous GO dispersion in step (1), stirring until the mixture is dispersed uniformly under ice bath; adding 0.01 g of initiator ammonium persulfate, 0.01 g of crosslinking agent N, N'-methylenebisacrylamide and 50 uL of accelerator tetramethylethylenediamine, and stirring uniformly to obtain a mixed solution;

(4) placing the mixed solution in step (3) in an oven to react at 60°C for 4 h to obtain a xylan-based dual network nanocomposite hydrogel (GO/Ca²⁺/PAM/XH composite hydrogel). The performance curves of

obtained composite hydrogel are shown in Figures 1 and Figure 2.

The GO/Ca²⁺/PAM/XH composite hydrogel obtained in this example did not break when the compressive deformation reached 95%, and could recover rapidly after compression. The compressive strength of the hydrogel was 0.184 MPa, and the elongation thereof was 775%.

Example 2

A method for preparing a xylan-based dual network nanocomposite hydrogel (GO/Ca²⁺/PAM/XH hydrogel) comprises the following steps:

(1) adding 20 mg of graphite oxide powder (GO) to 10 mL of deionized water, and dispersing by ultrasonication (200 W, 40 kHz) at 30°C for 4 h to obtain a GO aqueous dispersion;

(2) weighing 1 g of xylan, dissolving in 10 mL of deionized water, and stirring at 85 °C for 1 h to form a uniform xylan solution;

(3) adding 111 mg of CaCl₂, 4 g of monomer acrylamide and the xylan solution to the aqueous GO dispersion in step (1), stirring until the mixture is dispersed uniformly under ice bath; adding 0.03 g of initiator ammonium persulfate, 0.01 g of crosslinking agent N, N'-methylenebisacrylamide and 50 uL of accelerator tetramethylethylenediamine, and stirring uniformly to obtain a mixed solution;

(4) placing the mixed solution in step (3) in an oven to react at 60°C for 4 h to obtain a xylan-based dual network nanocomposite hydrogel (GO/Ca²⁺/PAM/XH composite hydrogel). The performance curves of

obtained composite hydrogel are shown in Figures 1, 2 and 3.

The GO/Ca²⁺/PAM/XH composite hydrogel obtained in this example did not break when the compressive deformation reached 95%, and can recover rapidly after compression. The compressive strength of the hydrogel was 0.184 MPa, and the elongation thereof was 1918%.

Example 3

A method for preparing a xylan-based dual network nanocomposite hydrogel (GO/Ca²⁺/PAM/XH hydrogel) comprises the following steps:

(1) adding 4 mg of graphite oxide powder (GO) to 10 mL of deionized water, and dispersing by ultrasonication (200 W, 40 kHz) at 30°C for 2 h to obtain a GO aqueous dispersion;

(2) weighing 1 g of xylan, dissolving in 10 mL of deionized water, and stirring at 85 °C for 1 h to form a uniform xylan solution;

(3) adding 22.2 mg of CaCl₂, 4 g of monomer acrylamide and the xylan solution to the aqueous GO dispersion in step (1), stirring until the mixture is dispersed uniformly under ice bath; adding 0.03 g of initiator ammonium persulfate, 0.01 g of crosslinking agent N, N'-methylenebisacrylamide and 20 uL of accelerator tetramethylethylenediamine, and stirring uniformly to obtain a mixed solution;

(4) placing the mixed solution in step (3) in an oven to react at 60°C for 4 h to obtain a xylan-based dual network nanocomposite

hydrogel(GO/Ca²⁺/PAM/XH composite hydrogel).

The GO/Ca²⁺/PAM/XH composite hydrogel obtained in this example did not break when the compressive deformation reached 95%, and can recover rapidly after compression. The compressive strength of the hydrogel was 1.1MPa, and the elongation thereof was 1100%.

Example 4

A method for preparing a xylan-based dual network nanocomposite hydrogel (GO/Ca²⁺/PAM/XH hydrogel) comprises the following steps:

(1) adding 60 mg of graphite oxide powder (GO) to 10 mL of deionized water, and dispersing by ultrasonication (300 W, 80 kHz) at 40°C for 6 h to obtain a GO aqueous dispersion;

(2) weighing 1 g of xylan, dissolving in 10 mL of deionized water, and stirring at 85 °C for 1 h to form a uniform xylan solution;

(3) adding 166.5 mg of CaCl₂, 4 g of monomer acrylamide and the xylan solution to the aqueous GO dispersion in step (1), stirring until the mixture is dispersed uniformly under ice bath; adding 0.05 g of initiator ammonium persulfate, 0.01 g of crosslinking agent N, N'-methylenebisacrylamide and 50 uL of accelerator tetramethylethylenediamine, and stirring uniformly to obtain a mixed solution;

(4) placing the mixed solution in step (3) in an oven to react at 80°C for 6 h to obtain a xylan-based dual network nanocomposite

hydrogel(GO/Ca²⁺/PAM/XH composite hydrogel).

The GO/Ca²⁺/PAM/XH composite hydrogel obtained in this example did not break when the compressive deformation reached 95%, and can recover rapidly after compression. The compressive strength of the hydrogel was 2.3 MPa, and the elongation thereof was 3310%.

Example 5

A method for preparing a xylan-based dual network nanocomposite hydrogel (GO/Ca²⁺/PAM/XH hydrogel) comprises the following steps:

(1) adding 60 mg of graphite oxide powder (GO) to 10 mL of deionized water, and dispersing by ultrasonication (300 W, 80 kHz) at 30°C for 6 h to obtain a GO aqueous dispersion;

(2) weighing 1 g of xylan, dissolving in 10 mL of deionized water, and stirring at 85 °C for 1 h to form a uniform xylan solution;

(3) adding 166.5 mg of CaCl₂, 4 g of monomer acrylamide and the xylan solution to the aqueous GO dispersion in step (1), stirring until the mixture is dispersed uniformly under ice bath; adding 0.05 g of initiator ammonium persulfate, 0.005 g of crosslinking agent N, N'-methylenebisacrylamide and 50 uL of accelerator tetramethylethylenediamine, and stirring uniformly to obtain a mixed solution;

(4) placing the mixed solution in step (3) in an oven to react at 80°C for 6 h to obtain a xylan-based dual network nanocomposite

hydrogel(GO/Ca²⁺/PAM/XH composite hydrogel).

The GO/Ca²⁺/PAM/XH composite hydrogel obtained in this example did not break when the compressive deformation reached 95%, and can recover rapidly after compression. The compressive strength of the hydrogel was 1.63 MPa, and the elongation thereof was 3976%.

Example 6

A method for preparing a xylan-based dual network nanocomposite hydrogel (GO/Ca²⁺/PAM/XH hydrogel) comprises the following steps:

(1) adding 20 mg of graphite oxide powder (GO) to 10 mL of deionized water, and dispersing by ultrasonication (200 W, 40 kHz) at 30°C for 4 h to obtain a GO aqueous dispersion;

(2) weighing 1 g of xylan, dissolving in 10 mL of deionized water, and stirring at 85 °C for 1 h to form a uniform xylan solution;

(3) adding 55.5 mg of CaCl₂, 4 g of monomer acrylamide and the xylan solution to the aqueous GO dispersion in step (1), stirring until the mixture is dispersed uniformly under ice bath; adding 0.03 g of initiator ammonium persulfate, 0.01 g of crosslinking agent N, N'-methylenebisacrylamide and 50 uL of accelerator tetramethylethylenediamine, and stirring uniformly to obtain a mixed solution;

(4) placing the mixed solution in step (3) in an oven to react at 60°C for 4 h to obtain a xylan-based dual network nanocomposite

hydrogel(GO/Ca²⁺/PAM/XH composite hydrogel). The performance curves of obtained composite hydrogel are shown in Figures 1 and 2.

The GO/Ca²⁺/PAM/XH composite hydrogel obtained in this example did not break when the compressive deformation reached 95%, and can recover rapidly after compression. The compressive strength of the hydrogel was 0.757MPa, and the elongation thereof was 942%.

Example 7

A method for preparing a xylan-based dual network nanocomposite hydrogel (GO/Ca²⁺/PAM/XH hydrogel) comprises the following steps:

(1) adding 20 mg of graphite oxide powder (GO) to 10 mL of deionized water, and dispersing by ultrasonication (200 W, 40 kHz) at 30°C for 4 h to obtain a GO aqueous dispersion;

(2) weighing 1 g of xylan, dissolving in 10 mL of deionized water, and stirring at 85 °C for 1 h to form a uniform xylan solution;

(3) adding 222 mg of CaCl₂, 4 g of monomer acrylamide and the xylan solution to the aqueous GO dispersion in step (1), stirring until the mixture is dispersed uniformly under ice bath; adding 0.03 g of initiator ammonium persulfate, 0.01 g of crosslinking agent N, N'-methylenebisacrylamide and 50 uL of accelerator tetramethylethylenediamine, and stirring uniformly to obtain a mixed solution;

(4) placing the mixed solution in step (3) in an oven to react at 60°C for 4 h to obtain a xylan-based dual network nanocomposite hydrogel

(GO/Ca²⁺/PAM/XH composite hydrogel). The performance curves of obtained composite hydrogel are shown in Figure1 and Figure 2.

The GO/Ca²⁺/PAM/XH composite hydrogel obtained in this example did not break when the compressive deformation reached 95%, and can recover rapidly after compression. The compressive strength of the hydrogel was 0.175MPa, and the elongation thereof was 630%.

Figures 1 and 2 show compressive stress-strain curves and tensile stress-strain curves of hydrogels with different ratio of Ca²⁺/GO (Comparative Example 1, Examples 1, 2, 6, and 7), respectively. It can be seen that the content of Ca²⁺ has a great influence on the mechanical strength of the GO/PAM/XH composite hydrogel. When 20 mg of GO and 0.01 g of crosslinking agent are used without Ca²⁺, the maximum compressive strength is 0.17 MPa and the maximum elongation is 629% while compressive deformation reaches 95%. However, after a small amount of Ca²⁺ (Ca²⁺/GO=0.5-2) is introduced into the GO/PAM/XH hydrogel network to form a second network, the mechanical strength of the hydrogel is significantly improved. When the ratio of Ca²⁺/GO is increased from 0.5 to 2, and the compressive deformation reaches 95%. Under this condition, the hydrogel is not broken, and the compressive strength of the hydrogel increases from 0.184 MPa to 1.84 MPa, and the elongation increases from 775% to 1918%. When the amount of Ca²⁺ is twice that of GO, the compressive strength is increased by 10 times, and the elongation

is increased by nearly 3 times. This is because Ca^{2+} could cross-link with GO to form another network structure, while the XH and AM grafted and copolymerized cross-linking network and the Ca^{2+} and GO cross-linking network could be connected by covalent bonds, making GO/ Ca^{2+} /PAM/XH hydrogels exhibit excellent mechanical properties as well as high elasticity and toughness. However, when the amount of Ca^{2+} ($\text{Ca}^{2+}/\text{GO}=3-4$) continues to increase, the compressive strength and elongation of the hydrogel gradually decrease. When the ratio of Ca^{2+}/GO is increased from 2 to 4, and the compression deformation reaches 95%, the compressive strength of the hydrogel decreased from 1.84 MPa to 0.37 MPa and the elongation decreased from 1918% to 942%. This is because GO acts as new chemical crosslinking points, and forms another network with Ca^{2+} , so that with increase content of Ca^{2+} , the chemical crosslinking points decrease, resulting in certain decline in mechanical properties. It can be seen that the introduction of Ca^{2+} and GO network can effectively improve the mechanical strength of the hydrogel, and when the ratio of Ca^{2+}/GO is 2, the highest mechanical strength is obtained.

Figure 3 is a cyclic compressive stress-strain curve of the GO/ Ca^{2+} /PAM/XH composite hydrogel of Example 2. When the ratio of Ca^{2+}/GO is 2, the amount of GO is 20 mg, the amount of cross-linking agent is 0.01 g, and the compressive deformation reaches 70%, the hydrogel is not broken and maintains good elasticity. After releasing

pressure, it rapidly recovers to its original shape. And after 100 cycles of cyclic compression, the hydrogel has almost no plastic deformation and decrease in compressive strength. Such high-strength hydrogel is expected to be used in biomedical fields such as tissue engineering, drug sustained release, cell culture scaffolds, and cartilage tissue, etc.

The above embodiments are preferred embodiments of the present invention, but the embodiments of the present invention are not limited to the above embodiments, and any other changes, modifications, substitutions, combinations, modifications and simplifications made without departing from the spirit and scope of the invention should all be equivalent replacements and be included in the scope of the present invention.

1. A method for preparing a xylan-based dual network nanocomposite hydrogel, characterized in that, it comprises the following steps:

(1) adding graphite oxide powder to deionized water and dispersing by ultrasonication to obtain a GO aqueous dispersion;

(2) adding xylan to deionized water, heating and stirring to obtain a xylan solution;

(3) adding water-soluble calcium salt, reaction monomer and the xylan solution to the GO aqueous dispersion, stirring until it is dispersed uniformly under ice bath conditions, then adding initiator, cross-linking agent and accelerator, stirring and mixing uniformly to obtain a mixed solution, wherein the reaction monomer is one or more of acrylamide, polyacrylamide, acrylic acid, N-isoacrylamide, and butyl acrylate;

(4) drying the mixed solution in step (3) to obtain a xylan-based dual network nanocomposite hydrogel.

2. The method for preparing a xylan-based dual network nanocomposite hydrogel according to claim 1, characterized in that: the mass ratio of Ca^{2+} in the water-soluble calcium salt in step (3) to the graphite oxide powder in the GO aqueous dispersion is (10-240) mg: (20-60) mg, the mass ratio of the reaction monomer to the xylan is (1-6) g: (0.5-1.5) g, and the mass ratio of the graphite oxide powder in the GO aqueous dispersion to the xylan is (20-60) mg: (0.5-1.5) g.

3. The method for preparing a xylan-based dual network nanocomposite

hydrogel according to claim 1, characterized in that, the water-soluble calcium salt in step (3) is CaCl_2 or calcium nitrate; the initiator is ammonium persulfate or potassium persulfate; the crosslinking agent is N, N'-methylenebisacrylamide; the accelerator is tetramethylethylenediamine or N,N,N',N'-tetramethyleneethylenediamine.

4. The method for preparing a xylan-based dual network nanocomposite hydrogel according to claim 1, characterized in that, the drying in step (4) is carried out at 50 °C - 80 °C for 2 h - 6 h; said heating and stirring in step (2) refer to stirring at 75 °C - 95 °C for 0.5 h - 1.5 h.

5. The method for preparing a xylan-based dual network nanocomposite hydrogel according to claim 1, characterized in that, the concentration of the GO aqueous dispersion in step (1) is 0.4 mg/mL - 6 mg/mL, and the concentration of the xylan solution in step (2) is 0.05 g/mL - 0.2 g/mL.

6. The method for preparing a xylan-based dual network nanocomposite hydrogel according to claim 1, characterized in that, the mass ratio of the initiator to the reaction monomer in step (3) is (0.01 - 0.05) g: (1 - 6) g; the mass ratio of the crosslinking agent to the reaction monomer in step (3) is (0.0025-0.03) g: (1-6) g; the volume-mass ratio of the accelerator to the reaction monomer in step (3) is (10 - 50) μL : (1 - 6) g.

7. The method for preparing a xylan-based dual network nanocomposite hydrogel according to claim 1, characterized in that, said dispersing by

ultrasonication in step (1) is carried out at 20 °C - 40 °C for 2 h - 6 h; the power of the ultrasound is 100W - 300W, and the frequency is 25 kHz-80 kHz.

8. A xylan-based dual network nanocomposite hydrogel prepared by the method according to any one of claims 1 to 7.

9. Use of the xylan-based dual network nanocomposite hydrogel according to claim 8 in the field of biomedicine.

10. Use according to claim 9, characterized in that the xylan-based dual network nanocomposite hydrogel is used in the field of tissue engineering, drug sustained release, cell culture scaffolds and cartilage tissue.