To Promote the Progress of Science and Useful Arts

The Director

of the United States Patent and Trademark Office has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this United States

Patent

grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b). See the Maintenance Fee Notice on the inside of the cover.

Katherine Kelly Vidal

Director of the United States Patent and Trademark Office

Maintenance Fee Notice

If the application for this patent was filed on or after December 12, 1980, maintenance fees are due three years and six months, seven years and six months, and eleven years and six months after the date of this grant, or within a grace period of six months thereafter upon payment of a surcharge as provided by law. The amount, number and timing of the maintenance fees required may be changed by law or regulation. Unless payment of the applicable maintenance fee is received in the United States Patent and Trademark Office on or before the date the fee is due or within a grace period of six months thereafter, the patent will expire as of the end of such grace period.

Patent Term Notice

If the application for this patent was filed on or after June 8, 1995, the term of this patent begins on the date on which this patent issues and ends twenty years from the filing date of the application or, if the application contains a specific reference to an earlier filed application or applications under 35 U.S.C. 120, 121, 365(c), or 386(c), twenty years from the filing date of the earliest such application ("the twenty-year term"), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b), and any extension as provided by 35 U.S.C. 154(b) or 156 or any disclaimer under 35 U.S.C. 253.

If this application was filed prior to June 8, 1995, the term of this patent begins on the date on which this patent issues and ends on the later of seventeen years from the date of the grant of this patent or the twenty-year term set forth above for patents resulting from applications filed on or after June 8, 1995, subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b) and any extension as provided by 35 U.S.C. 156 or any disclaimer under 35 U.S.C. 253.

US011760962B1

(12) **United States Patent**
Sun et al.

(10) **Patent No.: US 11,760,962 B1**
(45) **Date of Patent: Sep. 19, 2023**

(54) **ENVIRONMENTAL FRIENDLY DETERGENT TABLET, AND PREPARATION METHOD AND TABLETING EQUIPMENT THEREOF**

(71) Applicant: **Guangzhou Joyson Cleaning Products Co., Ltd.**, Guangdong (CN)

(72) Inventors: **Jianfeng Sun**, Guangzhou (CN); **Fenglei Li**, Guangzhou (CN); **Min Sun**, Guangzhou (CN); **Haixiang Zeng**, Guangzhou (CN)

(73) Assignee: **Guangzhou Joyson Cleaning Products Co., Ltd.**, Guangdong (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/946,220**

(22) Filed: **Sep. 16, 2022**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2022/104547, filed on Jul. 8, 2022.

(51) **Int. Cl.**

C11D 17/00	(2006.01)
C11D 1/37	(2006.01)
C11D 3/20	(2006.01)
C11D 3/33	(2006.01)
C11D 11/00	(2006.01)
C11D 3/37	(2006.01)
C11D 3/22	(2006.01)
C11D 3/386	(2006.01)

(Continued)

(52) **U.S. Cl.**
CPC ***C11D 17/0086*** (2013.01); ***B29C 43/003*** (2013.01); ***B29C 43/02*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC C11D 17/0086; C11D 1/146
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,792,675 A * 2/1931 Chamberlain B42C 9/0043 100/237
3,225,713 A * 12/1965 Kruse B30B 15/302 425/449

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1152334 A 6/1997
CN 106367222 A 2/2017

(Continued)

OTHER PUBLICATIONS

International Search Report to Corresponding Application No. PCT/CN2022/104547; dated Apr. 4, 2023, 4 Pgs.

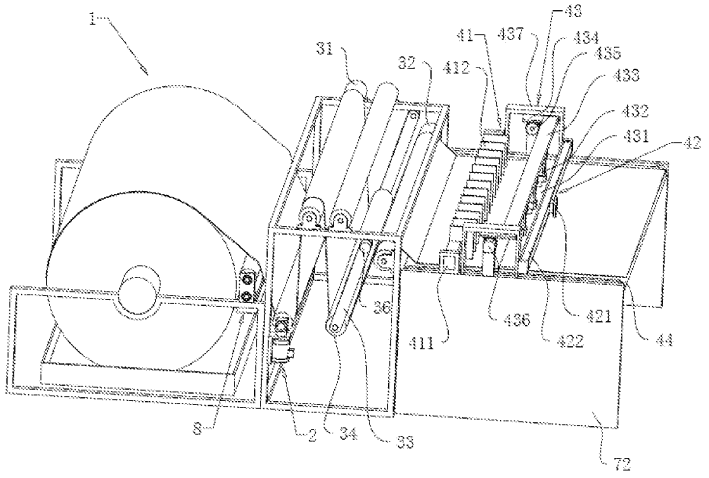
(Continued)

Primary Examiner — Liam J Heincer
Assistant Examiner — M. Reza Asdjodi
(74) *Attorney, Agent, or Firm* — COOPER LEGAL GROUP, LLC

(57) **ABSTRACT**

The present application discloses an environmental friendly detergent tablet, and a preparation method and an tableting equipment thereof, belonging to the field of washing products. An environmental friendly detergent tablet is made of the following raw materials by weight percentage: polyvinyl alcohol, film-forming agent, surfactant, plant starch, co-solvent, bio-enzyme formulation, water softener, and other additives; the preparation method includes the following steps: mixing water, polyvinyl alcohol and film-forming agent under stirring, heating to 80° C-90° C., and continuing stirring to obtain an initial mixed slurry; adding a co-solvent into the initial mixed slurry, then adding a surfactant, then adding a plant starch, under stirring, to obtain a mixed materials; drying the mixed materials, coating with the bio-enzyme formulation, molding, and slicing to obtain the environmental friendly detergent tablet.

3 Claims, 5 Drawing Sheets



(51) **Int. Cl.**

B29C 43/02	(2006.01)
B29C 43/40	(2006.01)
B29C 43/00	(2006.01)
C11D 1/14	(2006.01)
C11D 1/28	(2006.01)

(52) **U.S. Cl.**

CPC ***B29C 43/40*** (2013.01); ***C11D 1/37*** (2013.01); ***C11D 3/2086*** (2013.01); ***C11D 3/222*** (2013.01); ***C11D 3/33*** (2013.01); ***C11D 3/3753*** (2013.01); ***C11D 3/38609*** (2013.01); ***C11D 3/38645*** (2013.01); ***C11D 11/0017*** (2013.01); ***C11D 11/0082*** (2013.01); *B29K 2003/00* (2013.01); *C11D 1/146* (2013.01); *C11D 1/28* (2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0148488	A1 *	7/2005	Jekel	C11D 3/2086 510/447
2005/0225003	A1 *	10/2005	Holderbaum	C11D 17/0078 264/109
2006/0073263	A1 *	4/2006	Binder	A23L 29/219 426/658
2011/0136719	A1	6/2011	Jalbert et al.	
2016/0053027	A1 *	2/2016	Essers	C08L 3/02 127/71

FOREIGN PATENT DOCUMENTS

CN	106381236	A	2/2017
CN	206337243	U	7/2017
CN	107022425	A	8/2017
CN	111333738	A *	6/2020
WO	2022126232	A1	6/2022

OTHER PUBLICATIONS

Canadian Intellectual Property Office; Office Action dated Feb. 8, 2023; 8 Pgs.

* cited by examiner

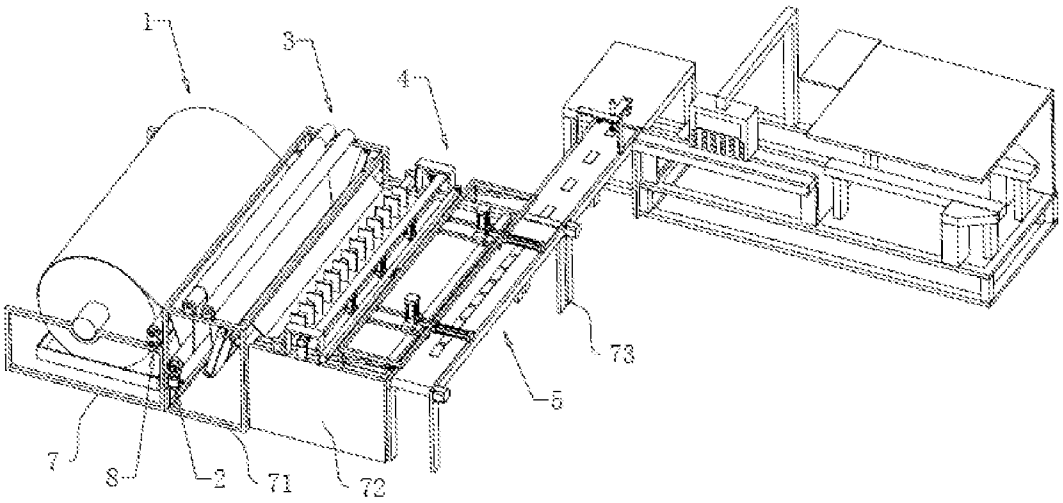


FIG. 1

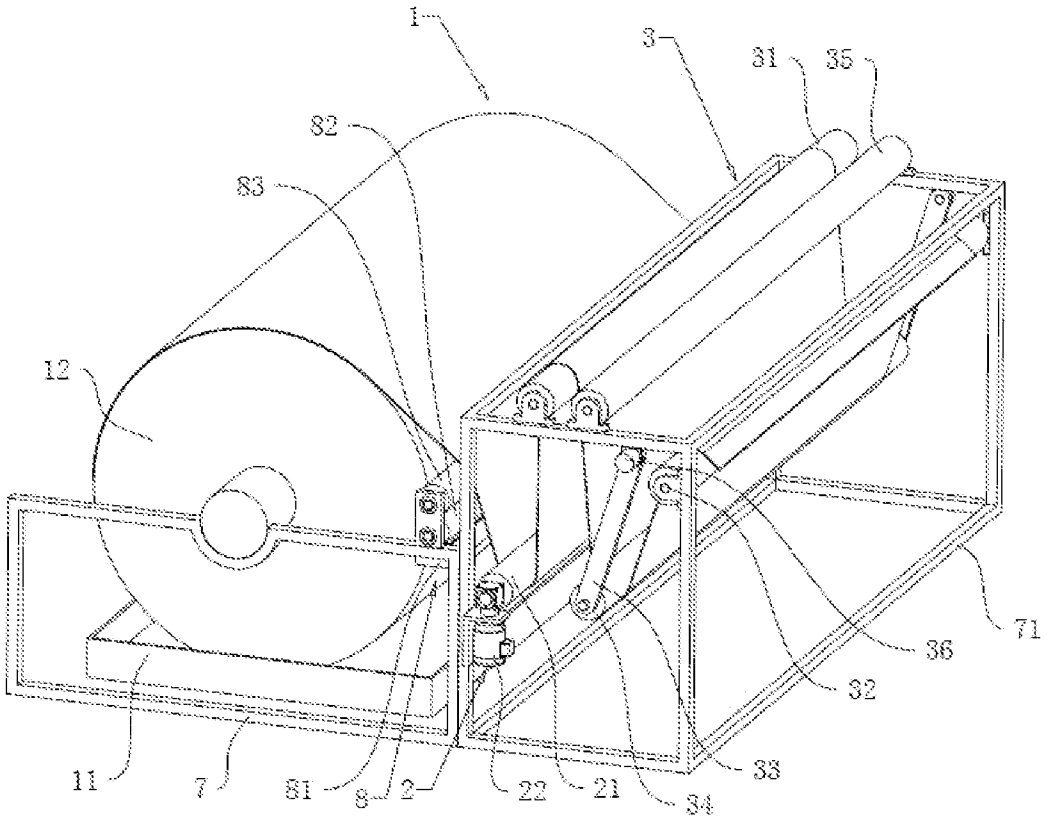


FIG. 2

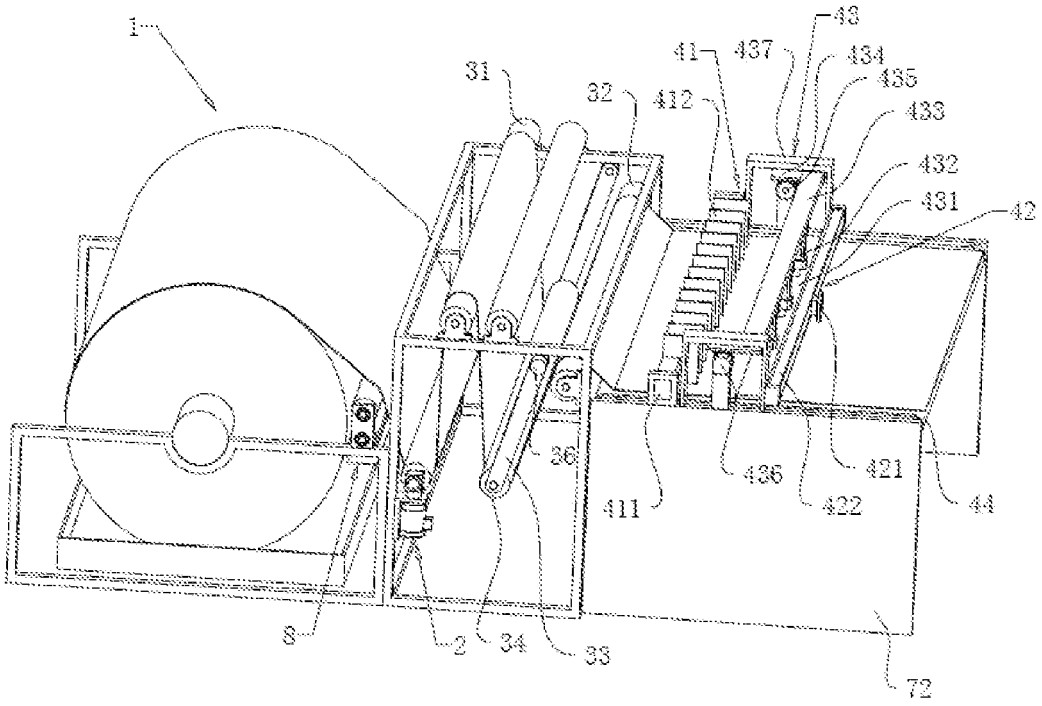

1
31
32
41
437
43
434
435
433
412
432
431
42
36
411
436
421
422
44
8
2
34
33
72

FIG. 3

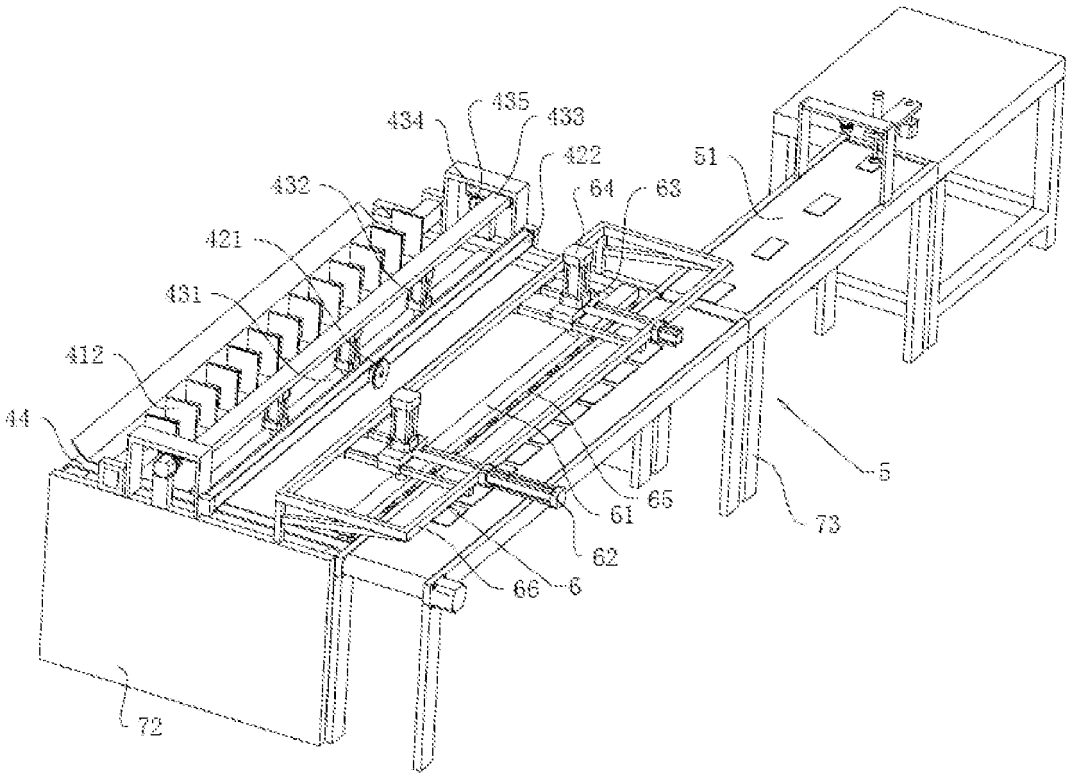


FIG. 4

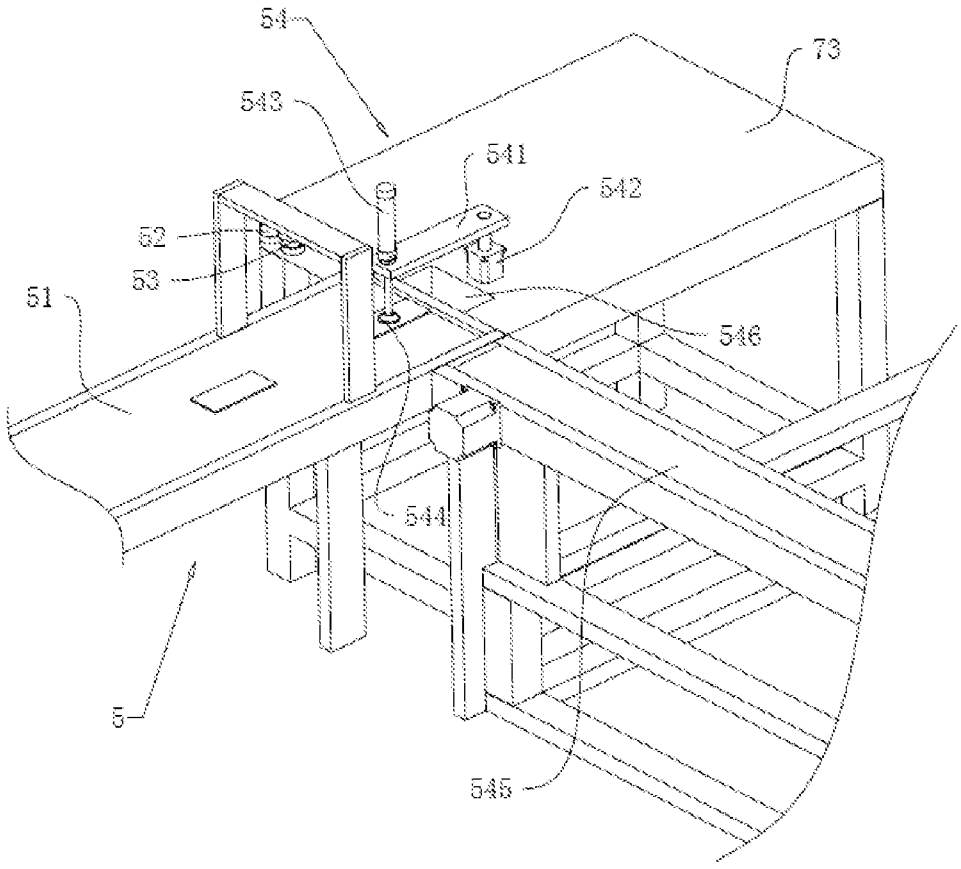


FIG. 5

ENVIRONMENTAL FRIENDLY DETERGENT TABLET, AND PREPARATION METHOD AND TABLETING EQUIPMENT THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of international PCT application serial no. PCT/CN2022/104547, filed on Jul. 8, 2022. The entirety of international PCT application serial no. PCT/CN2022/104547 is hereby incorporated by reference herein and made a part of this specification.

TECHNICAL FIELD

The present application relates to the technical field of washing products, and particularly to an environmental friendly detergent tablet, and preparation method and tableting equipment thereof.

BACKGROUND ART

Detergent is an indispensable household washing product in people's daily life. In recent years, great changes have taken place in the dosage form. The concentration of detergent is more and more favored by the industry and the consumers, such as concentrated liquid and concentrated laundry pods. In particular, in recent years, the solid sheet-shaped detergent tablet have gradually attracted the attention of domestic and foreign consumers due to its portability. Most of the detergent tablet are solid sheets prepared by using polyvinyl alcohol as film-forming agent, melting and mixing polyvinyl alcohol, water and surfactant, and then drying.

Due to the increasing environmental protection requirements in various countries to adapt sustainable development in the future, some foreign countries and regions require that the biodegradation rate of detergent products should reach 60% or more within 28 days. Because polyvinyl alcohol has lower degradability and longer biodegradation time, and usually begins to decompose slowly after one year, adding too much polyvinyl alcohol into the detergent tablet will impair the biodegradability of the product itself, such that the product would not meet the requirements of biodegradation within 28 days.

However, when the amount of polyvinyl alcohol added is too small, there will exist problem that the detergent tablet cannot be formed as tablet and are unstable. For example, the detergent tablets are easy to break in winter and are easy to stick together in summer, resulting in product quality problems.

SUMMARY

In order to shorten the degradation period of the detergent tablet, and meanwhile ensure the quality of the detergent tablet, the present application provides an environmental friendly detergent tablet, and a preparation method and a tableting equipment thereof.

In a first aspect, the present application provides an environmental friendly detergent tablet, which adopts the following technical solution:

an environmental friendly detergent tablet including the following raw materials by weight percentage:

polyvinyl alcohol 4%-17%;

film-forming agent 1%-5%;

surfactant 20%-50%;

plant starch 20%-50%;

cosolvent 1%-12%;

enzyme 0.1%-1%;

water softener 1%-7%; and

other additives 0-1%;

the polyvinyl alcohol has an average polymerization degree of 1700-2700 and an average molecular weight of 84000-130000.

In some embodiments, the polyvinyl alcohol has an average polymerization degree of 2300-2500 and an average molecular weight of 111000-124000.

In the above technical solution, high molecular weight polyvinyl alcohol and plant starch are used to cooperate with each other, so as to obtain an detergent tablet with good stability, good biodegradability and high detergency.

Taking advantage of the high molecular weight characteristics of polyvinyl alcohol, the viscosity of the detergent tablet is increased, which helps the degradable surfactant be stably exist in the detergent tablet. Moreover, the exist of high molecular weight polyvinyl alcohol obviously improves the compatibility of the plant starch in the detergent tablet system, so more plant starch can be added to the detergent tablet system. Further, the plant starch can rub the stains on the clothes, and help peel off the stains, thereby assisting washing. Therefore, the addition of plant starch can not only improve the washing ability of the detergent tablet, but also replace part of polyvinyl alcohol, thereby reducing the amount of polyvinyl alcohol. In addition, the plant starch itself is easy to degrade, so the biodegradability of the detergent tablet is greatly improved.

In the present application, the bio-enzyme formulation is added by normal temperature process, so that the activity of the bio-enzyme formulation is not affected by the high temperature, and the decontamination effect is maximized. The bio-enzyme formulation can make the protein and other high molecular compounds in the dirt of the fabric decompose into small molecular substances such as soluble amino acids to improve the decontamination ability.

In addition, the addition of plant starch can reduce the moisture content of the detergent tablet after drying. The bio-enzyme formulation contains solvent, and the plant starch can reduce the impact of moisture caused by the addition of bio-enzyme formulation after the drying of the detergent tablet. Therefore, the detergent tablet can be packed in plastic free cartons, which is more accord with the concept of low-carbon environmental protection.

In some embodiments, a weight ratio of the polyvinyl alcohol to the plant starch is 1:(1.5-3).

In the above technical solution, the polyvinyl alcohol and the plant starch are mixed according to the above ratio range, and a good improvement effect is obtained in terms of degradation rate and detergency.

In some embodiments, the plant starch has a whiteness value of 84-93% and a moisture content of 7-15%, in which the moisture content is calculated by weight.

In the above technical solution, the plant starch with whiteness value in the above range has good detergency, and the plant starch with moisture content in the above range is not easy to impair the stability of the detergent tablet, so that the detergent tablet has better comprehensive performance.

In some embodiments, the plant starch is one or more selected from a group consisting of mung bean starch, potato starch, sweet potato starch, corn starch, tapioca starch and pea starch.

In some embodiments, the plant starch is selected from a group consisting of pea starch, potato starch and corn starch; a weight percentage of the pea starch in the raw materials is

10%-20%, a weight percentage of the corn starch in the raw materials is 10%-20%, and a weight percentage of the potato starch in the raw materials is 0-10%.

In some embodiments, the plant starch is selected from pea starch and corn starch, a weight percentage of the pea starch in the raw materials is 10%-20%, and a weight percentage of the corn starch in the raw materials is 10%-20%.

In the above technical solution, pea starch, corn starch and potato starch have high biodegradability. Moreover, the combination of different starches can help to improve the detergency of the detergent tablet and replace more polyvinyl alcohol, so as to improve the biodegradability of the detergent tablet.

In some embodiments, the pea starch has a whiteness value of 89%-92.5% and a moisture content of 7%-9.3%; the potato starch has a whiteness value of 89.5%-93% and a moisture content of 11.5%-15%; and the corn starch has a whiteness value of 86%-90% and a moisture content of 9%-10.5%.

In the above technical solution, pea starch, corn starch and potato starch have respective whiteness values and moisture contents, and the their costs are different. By considering the whiteness values and moisture contents of different types of starches, and balancing the effects of whiteness values and moisture contents on the detergent tablet, the detergency of the detergent tablet is ensured. In addition, the stability of detergent tablet having different types of starch mixed is improved by combining the composition and performance differences among different types of plant starches.

In some embodiments, the film-forming agent is maltodextrin, and a DE value of the maltodextrin is 10%-20%.

In the above technical solution, maltodextrin is derived from plants and has good biodegradability. Maltodextrin has strong viscosity after being dissolved, and may further replace part of polyvinyl alcohol taking advantage of its viscosity, which is conducive to accelerating the biodegradation of detergent tablet.

In some embodiments, the surfactant is one or more selected from a group consisting of sodium alkenyl sulfonate, coco-sulfate, fatty acid methyl ester sulfonate, fatty acid methyl ester ethoxy sulfonate, laureth polyether sulfate, alkyl polyglycoside, fatty alcohol polyoxyethylene ether, isomeric alcohol polyoxyethylene ether, modified oil ethoxylate, rhamnolipid, sophorolipid and sorbitan fatty acid ester.

In the above technical solution, the surfactant not only has high washing ability, but also has good biodegradability, which helps to obtain detergent tablet with good biodegradability and high detergency.

In some embodiments, the surfactant includes one or more selected from a group consisting of coco-sulfate and fatty acid methyl ester ethoxy sulfonate in a weight ratio of (3-4):1, modified oil ethoxylate and fatty alcohol polyoxyethylene ether in a weight ratio of (1.5-2.5):1, rhamnolipid and sophorolipid in a weight ratio of (1-2):1, and alkyl polyglycoside.

In the above technical solution, the combination of coco-sulfate and fatty acid methyl ester ethoxy sulfonate is conducive to improving the emulsifying ability of anionic surfactant in the detergent tablet system, thereby improving the washing ability of the detergent tablet.

Moreover, the combination of the two is conducive to improving the biodegradability of coco-sulfate and the biodegradability of the detergent tablet system.

Modified oil ethoxylate is selected from modified coconut oil ethoxylate (SOE-C), modified palm oil ethoxylate (SOE-P), modified palm kernel oil ethoxylate (SOE-N), preferably, modified coconut oil ethoxylate (SOE-C). The combination of modified oil ethoxylate and fatty alcohol polyoxyethylene ether not only has high biodegradation rate, but also reduces the cloud point of fatty alcohol polyoxyethylene ether. The wettability and permeability of the raw material components in the detergent tablet system are improved, and at the same time, the washing performance of the detergent tablet in cold water is improved, which is conducive to better wetting and dissolution of the detergent tablet in water, and is conducive to improving the washing ability. In addition, the combination of modified oil ethoxylate and fatty alcohol polyoxyethylene ether is conducive to dispersing a large amount of plant starch during washing, better assisting washing, and achieving the effect of no residue of detergent tablet in the fast washing mode.

The combination of rhamnolipid and sophorolipid not only has the detergency of surfactant, but also helps to accelerate the decomposition rate of polyvinyl alcohol molecules and improve the biodegradation rate.

Alkyl polyglycoside has low surface tension, no cloud point, strong wetting ability, strong detergency, rich and delicate foam, strong compatibility, no irritation to skin, rapid and complete biodegradation, and is non-toxic and harmless, so it can be combination with various types of surfactants.

In some embodiments, the co-solvent is one or more selected from a group consisting of glycerol, propylene glycol, sorbitol and butanediol.

In the above technical solution, the co-solvent can dissolve a plurality of organic and inorganic substances, has a certain dissolving effect on common stains, and can cooperate with surfactants to quickly remove stains.

In some embodiments, the co-solvent includes glycerol and propylene glycol in a weight ratio of (1-2):1.

In the above technical solution, the above combination is helpful to improve the biodegradation rate of the co-solvent.

In some embodiments, the bio-enzyme formulation is one or more selected from a group consisting of protease, cellulase, amylase, pectinase, mannanase and lipase.

In the above technical solution, the above-mentioned bio-enzyme formulation has strong decomposition ability and has good washing effect on stains such as bloodstains, sweat stains, milk stains, grease and starch that are difficult to clean in daily life.

In some embodiments, the water softener is one or more selected from a group consisting of tetrasodium glutamate acid diacetate, sodium citrate, citric acid, sodium iminodisuccinate, polyaspartic acid and sodium polyepoxysuccinate.

In the above technical solution, the water softener can chelate the divalent metal ions in tap-water, such as calcium ions and magnesium ions, and has good effect on assisting the detergency of the detergent.

In some embodiments, the environmental friendly detergent tablet is made of the following raw materials by weight percentage: 4%-17% of polyvinyl alcohol, 1-5% of dextrin, 10%-20% of pea starch, 10%-20% of corn starch, 0.05%-0.5% of protease, 0.05%-0.5% of cellulase, 0-0.3% of amylase, 0-0.3% of pectinase, 0.5%-3% of sodium citrate, 0.1-2% of citric acid, 0-2% of tetrasodium glutamate acid diacetate, 3.2%-6% of glycerol, 3.2%-6% of propylene glycol, 0-1% of butanediol, 24.5-36% of sodium coco-sulfate, 0-3.6% of modified oil ethoxylate, 1.5%-3.6% of fatty alcohol polyoxyethylene ether, 4.5%-8.1% of fatty acid methyl ester ethoxy sulfonate, 1.5-2% of alkyl polyglycoside, 1.1%-2.2% of sophorolipid and 2.2%-3.4% of rhamnolipid.

In some embodiments, the raw materials of the environmental friendly detergent tablet also include plant essence.

Plant essence is one or more selected from a group consisting of jasmine essence, lemon essence, citrus essence, lavender essence and grapefruit essence.

In the above technical solution, plant essence is added to make the washed fabric have a fresh and pleasant feeling.

In a second aspect, the present application provides a preparation method for an environmental friendly detergent tablet, which adopts the following technical solution:

a preparation method for an environmental friendly detergent tablet including the following steps:

mixing water, polyvinyl alcohol and a film-forming agent under stirring, heating to 80° C-90° C., and continuing stirring to obtain an initial mixed slurry;

adding a co-solvent into the initial mixed slurry under stirring, then adding a surfactant under stirring, then adding a plant starch under stirring, to obtain a mixed materials;

drying the mixed materials, coating with the bio-enzyme formulation, molding, and slicing to obtain the environmental friendly detergent tablet.

In the above technical solution, a stable initial mixed slurry is formed first, so that the system of detergent tablet is initially formed, then the co-solvent and surfactant are added, and finally the plant starch is added, to avoid a gelatinization of the plant starch due to long reaction time under high temperature environment, resulting in instability of the mixed materials.

The bio-enzyme formulation is attached to the surface of the detergent tablet by coating. The amount of the bio-enzyme formulation is small, which further reduces the impact on the detergent tablet without plastic packaging, and also improves the detergency of the detergent tablet.

In a third aspect, the present application provides a tableting equipment for the environmental friendly detergent tablet, which adopts the following technical solution:

a tableting equipment for the environmental friendly detergent tablet including a frame, the frame is provided with a molding device configured for drying the mixed materials into a solid semi-finished product, a coating device configured for coating with the bio-enzyme formulation, an advancing device configured for moving the solid semi-finished product forward, an adjusting device configured for controlling the conveying state of the solid semi-finished product, and a slicing device configured for cutting the solid semi-finished product to obtain a finished product; the slicing device includes a transverse cutting mechanism, a vertical cutting mechanism, a feeding conveyor belt rotationally installed on the frame and configured to support the solid semi-finished product, and a downward pressing and feeding mechanism configured for pressing the solid semi-finished product and moving the solid semi-finished product.

In the above technical solution, the mixed materials is formed into solid semi-finished product under the action of the molding device, the advancing device and the adjusting device;

then the solid semi-finished product are cut into finished products by the slicing device. The solid semi-finished product are conveyed forward under the pressing action of the feeding conveyor belt and the downward pressing and feeding mechanism. The adjusting device controls the change of the conveying state to realize the intermittent advance of the solid semi-finished product, so that the transverse cutting of the solid semi-finished product is not disturbed by the conveying state of the solid semi-finished product, and the quality of the detergent tablet is ensured and the efficiency is improved.

In some embodiments, the adjusting device includes a first guide roller and a second guide roller rotatably installed on the frame, an adjusting rod rotatably installed on the frame, and an adjusting roller rotatably installed on the adjusting rod. The solid semi-finished product is wound around the first guide roller, the adjusting roller, and the second guide roller in sequence in the conveying direction; the frame is provided with an angle sensor configured for obtaining a rotation angle of the adjusting rod, and the angle sensor is connected in communication with a controller for controlling the operation of the downward pressing and feeding mechanism.

In the above technical solution, with the continuous advancing of the solid semi-finished product passing through the advancing device, there are more solid semi-finished product in the adjusting device; the tension force applied by the solid semi-finished product to the adjusting roller is reduced, and the adjusting roller swings downward under its gravity; at the same time, the adjusting rod is rotated; when the adjusting rod is rotated to a predetermined angle, the angle sensor is triggered and the downward pressing and feeding mechanism is controlled by the controller to operate; the downward pressing and feeding mechanism drives the solid semi-finished product to move forward. At this time, there are fewer solid semi-finished product in the regulating device, the tension force applied by the solid semi-finished product to the adjusting roller is increased, and the adjusting roller is tensioned and swings upward. At the same time, the regulating rod is rotated to a predetermined angle, and the angle sensor is again triggered to stop the operation of the downward pressing and feeding mechanism, so as to realize the intermittent advance of the solid semi-finished product.

In some embodiments, the frame is provided with an embossing roller, and the embossing roller and the first guide roller jointly extrude the solid semi-finished product.

In some embodiments, the downward pressing and feeding mechanism includes a pressing plate, a lifting assembly for driving the pressing plate to be close to or away from the solid semi-finished product, and a translation assembly for driving the pressing plate to move forward or backward in the conveying direction of the solid semi-finished product. The controller is configured to control the operation of the lifting assembly and the translation assembly.

In the above technical solution, the rise and fall of the pressing plate can realize the pressing state of the solid semi-finished product. Under the pressing state, the horizontal movement of the pressing plate can realize the advancing of the solid semi-finished product.

In some embodiments, the lifting assembly includes a lifting cylinder connected to the frame, and an output end of the lifting cylinder is connected to the pressing plate.

In some embodiments, the translation assembly includes a mounting plate configured to be connected to the pressing plate, a rack connected to the mounting plate, a moving motor installed on the rack, and a gear provided on an output shaft of the moving motor; the gear meshes with the rack.

In some embodiments, the translation assembly includes a mounting plate configured to be connected to the pressing plate, and a moving cylinder installed on the frame; and an output end of the moving cylinder is connected to the mounting plate.

In some embodiments, the molding device includes a trough configured for containing the mixed materials, a drying-forming roller rotatably installed on the frame and provided above the trough, and a forming driver for driving

the drying-forming roller to rotate; the mixed materials is attached to the drying-forming roller and forms a solid semi-finished product.

In the above technical solution, the mixed materials is attached to the drying-forming roller, and the heat of the drying-forming roller volatilizes the moisture of the mixed materials and dries it into solid semi-finished product.

In some embodiments, the advancing device includes an advancing roller rotatably installed on the frame and an advancing driver for driving the advancing roller to rotate; the solid semi-finished product is wound around the advancing roller after leaving the drying-forming roller.

In the above technical solution, the advancing roller rotates to drive the solid semi-finished product to move forward, leave the drying-forming roller and go to the next device.

In some embodiments, the vertical cutting mechanism includes a fixed base installed on the frame and vertical cutting blades connected to the fixed base; and the vertical cutting blades are arranged at intervals in a direction perpendicular to the conveying direction of the solid semi-finished product.

In some embodiments, the transverse cutting mechanism includes a cutting saw and a moving component configured for driving the cutting saw to move in a direction perpendicular to the conveying direction of the solid semi-finished product.

In some embodiments, the tableting equipment is also provided with an discharging device, and the discharging device is arranged at a delivery side of the slicing device. The discharging device includes a discharging conveyor belt for receiving and conveying the finished products out, an detection photoelectric switch configured for sensing the position of the finished products, a visual detector configured for detecting products, and a sorting mechanism configured for sorting good and bad products; the detection photoelectric switch is connected in communication with the visual detector; and the visual detector is connected in communication with a controller configured for controlling the sorting mechanism.

In some embodiments, the sorting mechanism includes a sorting plate, a sorting motor configured for driving the rotation of the sorting plate, a sorting cylinder installed on the sorting plate, a sorting sucker connected to the sorting cylinder, and a good product conveyor belt arranged at an end of the discharging conveyor belt. The sorting motor, the sorting cylinder, and the sorting sucker are connected in communication with the visual detector.

In the above technical solution, the discharging device can transport the finished products to the next process, visually inspect the finished products, sort out the good and bad products according to the appearance of the finished products, and make the good products flow into the next process.

In some embodiments, a transfer mechanism is provided between the slicing device and the discharging device, and the transfer mechanism includes a transfer plate moving between the slicing device and the discharging device, a first transfer cylinder arranged on the frame, a transfer base arranged on an output end of the first transfer cylinder, and a second transfer cylinder arranged on the transfer base; an output end of the second transfer cylinder is connected to the transfer plate; the output directions of the first transfer cylinder and the second transfer cylinder are perpendicular to each other; and the transfer plate is provided with a transfer sucker.

In the above technical solution, the transfer sucker sucks up the finished products, and the first transfer cylinder and the second transfer cylinder drive the finished products to leave the slicing device and enter the discharging device, so as to realize the transfer of the finished products.

To sum up, the present application has the following beneficial effects:

1. In the present application, high molecular weight polyvinyl alcohol and plant starch are combined to obtain a detergent tablet with good biodegradability and high detergency; taking advantage of the high molecular weight characteristics of polyvinyl alcohol, the viscosity of the detergent tablet is increased, which helps the degradable surfactant be stably exist in the detergent tablet. Moreover, the exist of high molecular weight polyvinyl alcohol obviously improves the compatibility of the plant starch in the detergent tablet system, so more plant starch with assisting washing function can be added to the detergent tablet system. Therefore, the plant starch can not only improve the detergency of the detergent tablet, but also replace part of polyvinyl alcohol, thereby reducing the amount of polyvinyl alcohol. In addition, the plant starch itself is easy to degrade, so the biodegradability of the detergent tablet is greatly improved.

2. In the present application, plant starch with specific whiteness value and moisture content is used, and different kinds of plant starch are combined, so that the detergent tablet with not only good detergency, but also good stability is obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a tri-dimensional structural diagram according to Example 1 of the present application.

FIG. **2** is a tri-dimensional structural diagram of the molding device, the advancing device and the adjusting device according to Example 1 of the present application.

FIG. **3** is a tri-dimensional structural diagram of the molding device, the advancing device, the adjusting device and the slicing device according to Example 1 of the present application.

FIG. **4** is a tri-dimensional structural diagram of a slicing device and an discharging device according to Example 1 of the present application.

FIG. **5** is a tri-dimensional structural diagram of an discharging device according to Example 1 of the present application.

DETAILED DESCRIPTION

The present application is further described in detail below in combination with the Examples.

EXAMPLES

Example 1

An environmental friendly detergent tablet included the following raw materials by weight percentage: polyvinyl alcohol 4 kg; film-forming agent 3 kg; surfactant 41.5 kg; plant starch 38 kg; co-solvent 12 kg; bio-enzyme formulation 0.5 kg; and water softener 1 kg.

Specifically, the film-forming agent was maltodextrin; the surfactant was sodium coco-sulfate; the plant starch was pea starch; the co-solvent was glycerol and propylene glycol, in particular, glycerol 6 kg and propylene glycol 6 kg; the bio-enzyme formulation was protease and cellulase, in particular, protease 0.25 kg and cellulase 0.25 kg; and the water softener was tetrasodium glutamate acid diacetate, sodium

citrate and citric acid, in particular, tetrasodium glutamate acid diacetate 0.4 kg, sodium citrate 0.5 kg, citric acid 0.1 kg.

The polyvinyl alcohol had an average polymerization degree of 1700 and an average molecular weight of 84000.

A DE value of the maltodextrin was 10%.

The pea starch had a whiteness value of 89%, and a moisture content of pea starch of 7%.

The protease had an enzyme activity content of 100 PRMU-U/g; the cellulase had an enzyme activity content of 5000 ECU/g; and the protease and cellulase had a water content of 50%.

A preparation method for the environmental friendly detergent tablet includes the following steps:

adding 50 kg water, polyvinyl alcohol and a film-forming agent into a stirring tank, mixing for 5 min under stirring, then heating to 80 ° C., and continuing stirring for 30 min to obtain an initial mixed slurry;

adding a co-solvent into the initial mixed slurry under stirring for 10 min, then adding a surfactant under stirring for 10 min, then adding a plant starch under stirring for 10 min to obtain the mixed materials;

drying the mixed materials in a tableting equipment, coating with the bio-enzyme formulation, molding, and slicing to obtain the environmental friendly detergent tablet.

Example 2

An environmental friendly detergent tablet included the following raw materials by weight percentage:

polyvinyl alcohol 10 kg; film-forming agent 5 kg; surfactant 43 kg; plant starch 30 kg; co-solvent 6.4 kg; bio-enzyme formulation 0.6 kg; water softener 5 kg.

Specifically, the film-forming agent was maltodextrin; the surfactant was sodium coco-sulfate; fatty acid methyl ester ethoxy sodium sulfonate and alkyl polyglycoside, in particular, sodium coco-sulfate 36 kg, fatty acid methyl ester ethoxy sodium sulfonate 5 kg and alkyl polyglycoside 2 kg; the plant starch was corn starch; the co-solvent was glycerol and propylene glycol, in particular, glycerol 4.3 kg and propylene glycol 2.1 kg; the bio-enzyme formulation was amylase and pectinase, in particular, amylase 0.3 kg and pectinase 0.3 kg; and the water softener was sodium citrate and citric acid, in particular, sodium citrate 3 kg, citric acid 2 kg.

The polyvinyl alcohol had an average polymerization degree of 2700 and an average molecular weight of 130000.

A DE value of the maltodextrin was 20%.

The amylase had an enzyme activity content of 140000 u/mL, the pectinase had an enzyme activity content of 100 PTF/mg, and the pectinase had a water content of 50%.

The fatty acid methyl ester ethoxy sodium sulfonate had a carbon number of 16-18.

The alkyl glycoside had a carbon number of 8-14.

The corn starch had a whiteness value of 86%, and a moisture content of 9%.

a preparation method for the environmental friendly detergent tablet included the following steps:

adding 125 kg water, polyvinyl alcohol and a film-forming agent into a stirring tank, stirring for 2 min, then heating to 90° C., and continuing stirring for 20 min to obtain an initial mixed slurry;

adding a co-solvent into the initial mixed slurry under stirring for 5 min, then adding a surfactant under stirring for 5 min, then adding a plant starch under stirring for 5 min to obtain the mixed materials;

drying the mixed materials in a tableting equipment, coating with the bio-enzyme formulation, molding, and slicing to obtain the environmental friendly detergent tablet.

Example 3

The difference between this Example and Example 2 was that the composition and proportion of raw materials was different.

an environmental friendly detergent tablet included the following raw materials by weight percentage:

polyvinyl alcohol 17 kg; film-forming agent 4 kg; surfactant 50 kg; plant starch 20 kg; co-solvent 1 kg; bio-enzyme formulation 1 kg; water softener 7 kg.

Specifically, the film-forming agent was maltodextrin; the surfactant was sodium coco-sulfate, fatty alcohol polyoxyethylene ether and alkyl polyglycoside, in particular, sodium coco-sulfate 44 kg, fatty alcohol polyoxyethylene ether 4 kg and alkyl polyglycoside 2 kg; the plant starch was potato starch; the co-solvent was butanediol; the bio-enzyme formulation was protease and cellulase, in particular, protease 0.5 kg and cellulase 0.5 kg; and the water softener was tetrasodium glutamate acid diacetate, sodium citrate and citric acid, in particular, tetrasodium glutamate acid diacetate 2 kg, sodium citrate 3 kg, citric acid 2 kg.

The polyvinyl alcohol had an average polymerization degree of 2300 and an average molecular weight of 111000.

A DE value of the maltodextrin was 20%.

The protease had an enzyme activity content of 100 PRMU-U/g; the cellulase had an enzyme activity content of 5000 ECU/g; and the protease and cellulase had a water content of 50%.

The fatty alcohol polyoxyethylene ether had an EO value of 9.

The alkyl glycosides had a carbon number of 8-14.

The potato starch had a whiteness value of 89.5%, and a moisture content of 11.5%.

In the preparation method for the environmental friendly detergent tablet, 212 kg of water was added to the stirring tank.

Example 4

The difference between this Example and Example 2 was that the composition and proportion of raw materials were different.

An environmental friendly detergent tablet included the following raw materials by weight percentage:

polyvinyl alcohol 14 kg; film-forming agent 1 kg; surfactant 20 kg; plant starch 50 kg; co-solvent 8.9 kg; bio-enzyme formulation 0.1 kg; water softener 6 kg.

Specifically, the film-forming agent was maltodextrin; the surfactant was sodium coco-sulfate, rhamnolipid, sophorolipid and alkyl polyglycoside, in particular, sodium coco-sulfate 10 kg, rhamnolipid 4 kg, sophorolipid 4 kg and alkyl polyglycoside 2 kg; the plant starch was pea starch, corn starch and potato starch, in particular, pea starch 20 kg, corn starch 20 kg and potato starch 10 kg; the co-solvent was butanediol; the bio-enzyme formulation was protease and cellulase, in particular, protease 0.05 kg and cellulase 0.05 kg; and the water softener was tetrasodium glutamate acid diacetate, sodium citrate and citric acid, in particular, tetrasodium glutamate acid diacetate 1 kg, sodium citrate 3 kg, and citric acid 2 kg.

The polyvinyl alcohol had an average polymerization degree of 2300 and an average molecular weight of 111000.

A DE value of the maltodextrin was 20%.

The protease had an enzyme activity content of 100 PRMU-U/g; the cellulase had an enzyme activity content of 5000 ECU/g; and the protease and cellulase had a water content of 50%.

The alkyl glycoside had a carbon number of 8-14.

The pea starch had an whiteness value of 89% and a moisture content of 7%; the corn starch had a whiteness value of 86% and a moisture content of 9%; and the potato starch had a whiteness value of 93% and a moisture content of 15%.

In the preparation method for the environmental friendly detergent tablet, 140kg of water was added to the stirring tank.

Example 5

The difference between this Example and Example 2 was that the composition and proportion of raw materials were different.

An environmental friendly detergent tablet included the following raw materials by weight percentage:

polyvinyl alcohol 10 kg; film-forming agent 5 kg; surfactant 33 kg; plant starch 40 kg; co-solvent 6.4 kg; bio-enzyme formulation 0.6 kg; water softener 5 kg.

Specifically, the film-forming agent was maltodextrin; the surfactant was sodium coco-sulfate, fatty acid methyl ester ethoxy sodium sulfonate and alkyl polyglycoside, in particular, sodium coco-sulfate 27.5 kg, fatty acid methyl ester ethoxy sodium sulfonate 4 kg and alkyl polyglycoside 1.5 kg; the plant starch was pea starch and corn starch, in particular, pea starch 20 kg and corn starch 20 kg; the co-solvent was glycerol and propylene glycol, in particular, glycerol 3.2 kg and propylene glycol 3.2 kg; the bio-enzyme formulation was protease and cellulase, in particular, protease 0.3 kg and cellulase 0.3 kg; and the water softener was sodium citrate and citric acid, in particular, sodium citrate 3 kg, citric acid 2 kg.

The polyvinyl alcohol had an average polymerization degree of 2500 and an average molecular weight of 124000.

A DE value of the maltodextrin was 20%.

The protease had an enzyme activity content of 100 PRMU-U/g; the cellulase had an enzyme activity content of 5000 ECU/g; and the protease and cellulase had a water content of 50%.

The fatty acid methyl ester ethoxy sodium sulfonate had a carbon number of 16-18.

The alkyl glycoside had a carbon number of 8-14.

The pea starch had a whiteness value of 89% and a moisture content of 7%; and the corn starch had a whiteness value of 86% and a moisture content of 9%.

Example 6 to 7

The difference between Examples 6 to 7 and Example 5 was that the proportions of polyvinyl alcohol, surfactant, plant starch and sodium coco-sulfate are different, as shown in Table 1.

TABLE 1

	Surfactant (kg)					
	Polyvinyl alcohol (kg)	Sodium coco-sulfate	Fatty acid methyl ester sodium ethoxy sulfonate	Alkyl polyglycoside	Plant starch (kg) Pea starch	Plant starch (kg) Corn starch
Example 5	10	27.5	4	1.5	20	20
Example 6	10	36	5	2	20	10
Example 7	14	41	5	2	10	11

Example 8 to 14

The difference between Examples 8 to 14 and Example 6 was that the types of plant starch were different, as shown in Table 2.

TABLE 2

	Starch types	Starch dosage (kg)	Whiteness value (%)	Moisture content (%)
Example 6	Pea starch	20	89	7
	Corn starch	10	86	9
Example 8	Potato starch	30	93	15
Example 9	Sweet potato starch	30	84	11.4
Example 10	Pea starch	30	89	7
Example 11	Corn starch	30	86	9
Example 12	Sweet potato starch	20	84	11.4
	Corn starch	10	86	9
Example 13	Pea starch	20	89	7
	Potato starch	10	93	15
Example 14	Pea starch	20	92.5	9.3
	Corn starch	10	90	10.5

Examples 15 to 18

The differences between Examples 15 to 18 and Example 6 was that the composition and proportion of surfactants were different, as shown in Table 3.

TABLE 3

	Surfactant (kg)						
	Sodium coco-sulfate	Fatty acid methyl ester ethoxy sodium sulfonate	Modified oil ethoxylate	Fatty alcohol polyoxyethylene ether	Rhamnolipid	Sophorolipid	Alkyl polyglycoside
Example 6	36	5	0	0	0	0	2
Example 15	34	5	0	0	1	1	2
Example 16	24.5	4.5	3.6	3.6	3.4	1.4	2
Example 17	24.5	6.1	3.6	2.4	2.2	2.2	2
Example 18	24.5	8.1	3.6	1.5	2.2	1.1	2

The fatty acid methyl ester ethoxy sodium sulfonate had a carbon number of 16-18.

The fatty alcohol polyoxyethylene ether had an EO value of 9.

The modified oil ethoxylate was SOE-C-60;

The alkyl glycoside had a carbon number of 8-14.

Examples 19

This Example was different from Example 17 in that the raw material also contains other additives.

Specifically, an environmental friendly detergent tablet included the following raw materials by weight percentage: polyvinyl alcohol 10 kg; film-forming agent 5 kg; surfactant 43 kg; plant starch 30 kg; co-solvent 6.4 kg; bio-enzyme formulation 0.6 kg; water softener 5 kg; and other additives 1 kg.

Specifically, other additives were lemon essence. In the preparation method, lemon essence and plant starch were added at the same time.

Examples 20

This Example was different from Example 19 in that the addition amount of other additives was 0.1 kg.

Comparative Example 1

This Comparative example was different from Example 5 in that the plant starch was replaced by same amount of polyvinyl alcohol. That is, the amount of polyvinyl alcohol was 40 kg, and the amount of plant starch was 0.

Comparative Example 2

This Comparative example was different from Example 5 in that part of the plant starch was replaced by same amount of polyvinyl alcohol. Specifically, the amount of polyvinyl alcohol was 2 kg, and the amount of plant starch was 38 kg.

Comparative Example 3

This Comparative example was different from Example 5 in that the polyvinyl alcohol had an average polymerization degree of 1200 and an average molecular weight of 64000.

Comparative Example 4

This Comparative example was different from Example 5 in that the polyvinyl alcohol had an average polymerization degree of 3000 and an average molecular weight of 146000.

Comparative Example 5

This Comparative example was different from Example 5 in that the film-forming agent was replaced by same amount of polyvinyl alcohol. That is, the amount of polyvinyl alcohol was 15 kg, and the amount of film-forming agent was 0.

Performance Test

The detergent tablet of each Example and Comparative example of the present application were tested according to the following test methods and standards.

The whiteness value was determined by "Starch-Determination of whiteness" (GB/T 22427.6-2008).

Biodegradation test was performed according to OECD 301B, then the 28 day degradation rate of the detergent tablet was obtained.

Forming stability: the detergent tablet was placed in a test environment with a temperature of (25±2)° C. and a humidity of (40±5)% for 48 h, then the detergent tablet was bended by hand to align and overlap the two sides, and whether the detergent tablet breaks was observed.

Moisture resistance stability: two detergent tablet were stacked together and were put in a test environment with temperature of (25±2)° C. and humidity of (85±5)% for 24 h. Then two detergent tablet were separated and observed whether there was adhesion between the detergent tablets. The adhesion phenomenon was divided into no adhesion, slight adhesion and obvious adhesion.

Moisture resistance stability: two detergent tablet were stacked together and were put in a test environment with temperature of (25±2)° C. and humidity of (85±5)% for 48 h. Then two detergent tablet were separated and observed whether there was adhesion between the detergent tablets. The adhesion phenomenon was divided into no adhesion, slight adhesion and obvious adhesion.

Detergency test: the test was performed according to GB/T 13174-2021 "determination of detergency and cyclic of washing property for laundry detergents"; the test pieces were JB-01 dirty cloth, JB-02 dirty cloth and JB-03 dirty cloth, and the decontamination ratio Pi of the detergent tablet was obtained. When Pi≥1.0, it was qualified, and <1.0, it was unqualified.

TABLE 4

	Degradation rate	Forming stability	24h moisture resistance stability	48h moisture resistance stability
Example 1	64.2	Unbroken	Slight adhesion	Obvious adhesion
Example 2	63.3	Unbroken	Slight adhesion	Slight adhesion
Example 3	60.5	Unbroken	No adhesion	Slight adhesion
Example 4	62	Unbroken	No adhesion	Slight adhesion
Example 5	63.5	Unbroken	Slight adhesion	Slight adhesion
Example 6	63.2	Unbroken	No adhesion	No adhesion
Example 7	61.5	Unbroken	No adhesion	No adhesion
Example 8	63.3	Unbroken	Slight adhesion	Slight adhesion
Example 9	64	Unbroken	No adhesion	Slight adhesion
Example 10	61.5	Unbroken	Slight adhesion	Obvious adhesion
Example 11	62.6	Unbroken	Slight adhesion	Slight adhesion
Example 12	62.3	Unbroken	Slight adhesion	Slight adhesion
Example 13	62.6	Unbroken	Slight adhesion	Obvious adhesion
Example 14	63.6	Unbroken	No adhesion	No adhesion
Example 15	65.3	Unbroken	No adhesion	No adhesion
Example 16	63.9	Unbroken	No adhesion	No adhesion
Example 17	65.8	Unbroken	No adhesion	No adhesion
Example 18	65.5	Unbroken	No adhesion	No adhesion
Example 19	65.7	Unbroken	No adhesion	No adhesion
Example 20	65.8	Unbroken	No adhesion	No adhesion
Comparative example 1	24	Unbroken	No adhesion	No adhesion
Comparative example 2	64.3	Broken	Obvious adhesion	Obvious adhesion
Comparative example 3	61.7	Broken	Slight adhesion	Obvious adhesion
Comparative example 4	56.6	Unbroken	No adhesion	No adhesion
Comparative example 5	60.9	Broken	Obvious adhesion	Obvious adhesion

TABLE 5

	Decontamination ratio		
	JB-01 dirty cloth	JB-02 dirty cloth	JB-03 dirtycloth
Example 1	1.10	3.75	1.45
Example 2	1.21	4.02	1.50
Example 3	1.12	3.78	1.45
Example 4	1.15	3.78	1.48
Example 5	1.14	4.03	1.47
Example 6	1.18	4.12	1.51
Example 7	1.20	4.15	1.53
Example 8	1.23	4.22	1.54
Example 9	1.04	3.72	1.43
Example 10	1.14	4.00	1.45
Example 11	1.11	3.88	1.42
Example 12	1.17	4.00	1.47
Example 13	1.15	3.90	1.46
Example 14	1.20	4.05	1.55

TABLE 5-continued

	Decontamination ratio		
	JB-01 dirty cloth	JB-02 dirty cloth	JB-03 dirtycloth
Example 15	1.24	4.17	1.56
Example 16	1.27	4.29	1.59
Example 17	1.34	4.68	1.71
Example 18	1.37	4.71	1.73
Example 19	1.36	4.71	1.71
Example 20	1.37	4.74	1.74
Comparative example 1	0.93	3.24	1.13
Comparative example 2	1.05	3.75	1.46
Comparative example 3	1.02	3.30	1.19
Comparative example 4	0.98	3.30	1.15
Comparative example 5	1.07	3.75	1.44

From Table 4 and Table 5, in Comparative example 1, a large amount of polyvinyl alcohol was used as the film-forming material without adding plant starch. It can be seen from the test results that the biodegradation rate of the detergent tablet is only 41%, which is much lower than the standard requirement of 60%, and it is difficult to meet the requirements of environmental protection. In Comparative example 2, a small amount of polyvinyl alcohol was used as the film-forming material and plant starch was added. It can be seen from the test results that the biodegradation rate of the detergent tablet reaches the standard, but the overall stability of the detergent tablet is low and the practicability is affected. In Example 6, an appropriate amount of polyvinyl alcohol was mixed with plant starch. It can be seen from the test results that not only the biodegradation rate of the detergent tablet exceeds 60%, but also the overall stability is better and the detergency is improved. In addition, by adjusting the proportion of the raw materials of the detergent tablet within the range of Examples 1 to 7, detergent tablets with good comprehensive performance are still obtained.

Compared with Comparative examples 3 to 4, in Example 6, polyvinyl alcohol with appropriate polymerization degree and molecular weight was selected, the biodegradation rate and overall stability of the detergent tablet are balanced better. In addition, it was also found that when the polymerization degree and molecular weight of polyvinyl alcohol is too large, the dissolution rate of the detergent tablet is low, and there is residue after washing. Compared with

Comparative example 5, in Example 6, the addition of maltodextrin as a film-forming agent significantly improved the overall stability of the detergent tablet.

Compared with Example 5, in Example 6 and Example 7, the weight ratio of the polyvinyl alcohol to the plant starch was controlled as 1:(1.5-3), so that the detergent tablet had better detergency and moisture resistance stability.

Compared with Examples 8 to 13, in Examples 6 and 14, the plant starch was combination of pea starch and corn starch, so that the detergent tablet had better overall stability; the detergency and stability were well balanced; and the use effect of the detergent tablet was better.

Compared with Example 6, in Example 15, rhamnolipid and sophorolipid were added, and the biodegradation rate and detergency of the detergent tablet were both improved; in examples 16 to 20, the composition and proportion of the surfactant were adjusted; it was found that the detergency of detergent tablet could be well improved and the biodegradation rate could be further improved by the combination of coco-sulfate and fatty acid methyl ester ethoxy sodium sulfonate, the combination of modified oil ethoxylate and fatty alcohol polyoxyethylene ether, and the combination of rhamnolipid and sophorolipid.

Example 1 of the present application also discloses a tableting equipment for an environmental friendly detergent tablet.

As shown in FIG. **1**, an tableting equipment for the environmental friendly detergent tablet includes a frame, a molding device **1**, a coating device **8**, an advancing device **2**, an adjusting device **3**, a slicing device **4**, and an discharging device **5**. The frame is configured to support and install the above devices. Specifically, the frame includes a first frame **7**, a second frame **71**, a third frame **72**, and a fourth frame **73**. The molding device **1** and the coating device **8** are installed on the first frame **7**; the advancing device **2** and the adjusting device **3** are installed on the second frame **71**; the slicing device **4** is installed on the third frame **72**; and the discharging device **5** is installed on the fourth frame **73**. The mixed materials passes through the molding device **1**, the coating device **8**, the advancing device **2**, the adjusting device **3**, the slicing device **4**, and the discharging device **5** in sequence to obtain the finished product of the tablet.

As shown in FIG. **2**, the molding device **1** includes a trough **11**, a drying-forming roller **12**, a feeding roller and a forming driver. The trough **11** is arranged in the first frame **7**. The trough **11** is configured to accommodate the mixed materials. The feeding roller is rotatably installed on the trough **11**, and the surface of the feeding roller is in contact with the mixed materials. The drying-forming roller **12** is rotatably installed to the first frame **7**, and the drying-forming roller **12** is arranged above the trough **11**. The drying-forming roller **12** and the feeding roller are coaxially arranged with a gap between them. A heating device is provided inside the drying-forming roller **12**, or a heating device is connected outside the drying-forming roller **12**. The heating device may be a device with heating function such as a heating rod or a steam heater, so that the surface of the drying-forming roller **12** has a certain temperature.

The forming driver is fixedly installed on the first frame **7**. The forming driver is in transmission connection with the drying-forming roller **12** and the feeding roller, and the forming driver is configured to drive the drying-forming roller **12** and the feeding roller to rotate.

In this example, the forming driver is a combination of motor and gearbox. During the rotation of the feeding roller, the mixed materials is driven to leave the trough **11** continuously. Meanwhile, the feeding roller drives the mixed materials to be coated on the surface of the drying-forming roller **12**. The heat on the surface of the drying-forming roller **12** makes the moisture of the mixed materials evaporate, forming a solid semi-finished product.

The coating device **8** includes an enzyme formulation tank **81**, a first coating roller **82**, a second coating roller **83**, and an coating driver. The enzyme formulation tank **81** is fixedly connected to the first frame **7**. The enzyme formulation tank **81** is a square box. The enzyme formulation tank **81** contains bio-enzyme formulation. The first coating roller **82** and the second coating roller **83** are both rotatably connected to the first frame **7**. The first coating roller **82** is arranged below the second coating roller **83**. The first coating roller **82** is in contact with the bio-enzyme formulation; the first coating roller **82** is close to the second coating roller **83**; and the second coating roller **83** is configured to coat the bio-enzyme formulation to the solid

semi-finished product. The addition amount of the bio-enzyme formulation is controlled by adjusting the degree to which the first coating roller **82** enters the bio-enzyme formulation tank **81** and the distance between the first coating roller **82** and the second coating roller **83**.

The coating device driver is in transmission connection with the first coating roller **82** and the second coating roller **83**. In this example, the coating device driver is a combination of a motor and a gearbox. The coating device driver drives the first coating roller **82** and the second coating roller **83** to rotate, thereby driving the bio-enzyme formulation to continuously leave the enzyme formulation tank **81** and be attached to the surface of the first coating roller **82**. The first coating roller **82** transfers the bio-enzyme formulation to the second coating roller **83**, and the second coating roller **83** then applies the bio-enzyme formulation to the solid semi-finished product, so that the bio-enzyme formulation is attached to the detergent tablet.

The advancing device **2** includes an advancing roller **21** and an advancing driver **22**. The advancing roller **21** is rotatably installed on the second frame **71**; the advancing driver **22** is fixedly installed on the second frame **71**; and the molding driver is in transmission connection with the advancing roller **21** and configured to drive the advancing roller **21** to rotate. In this example, the advancing driver **22** is a combination of a motor and a gearbox, and the advancing roller **21** rotates under the driving action of the advancing driving member **22**. The solid semi-finished product is wound around the advancing roller **21** after leaving the drying-forming roller **12**. The advancing roller **21** generates a force for the forward movement of the solid semi-finished product, so that the solid semi-finished product enters the adjusting device **3**.

The adjusting device **3** includes a first guide roller **31**, a second guide roller **32**, an adjusting rod **33**, and an adjusting roller **34**. The first guide roller **31**, the second guide roller **32**, and the adjusting rod **33** are all rotatably installed on the second frame **71**. Two adjusting rods **33** are provided. The adjusting roller **34** is rotatably installed between the two adjusting rods **33**. The adjusting roller **34** is arranged between the first guide roller **31** and the second guide roller **32**, and the installation height of the adjusting roller **34** is lower than the installation height of the first guide roller **31** and the second guide roller **32**. The solid semi-finished product is wound around the first guide roller **31**, the adjustment roller **34**, and the second guide roller **32** in sequence in the conveying direction, and then enters the slicing device **4**. An embossing roller **35** is rotatably installed on the second frame **71**. The embossing roller **35** is parallel to the first guide roller **31**. A pattern is provided on the surface of the embossing roller **35**. The embossing roller **35** and the first guide roller **31** jointly extrude the solid semi-finished product, and the pattern can be printed on the surface of the solid semi-finished product.

Specifically, the installation height of the second guide roller **32** is lower than the installation height of the first guide roller **31**. Additionally, the adjustment roller **34** can rotate freely relative to the adjusting rod **33**, and the adjusting rod **33** can rotate freely relative to the second frame **71**. Therefore, when the solid semi-finished product is tensioned, the adjusting rod **33** will deviate from the height direction and form an angle with the height direction.

In the present application, the slicing device **4** performs a cutting mode combining vertical cutting and transverse cutting on the solid semi-finished product. In particular, transverse cutting refers to cutting in the direction perpendicular to the conveying direction of the solid semi-finished product. In order to ensure that the forward conveying of the solid semi-finished product will not affect the transverse cutting, the solid semi-finished product of the present application advances intermittently in the slicing device **4**, and the transverse cutting is performed only when the solid semi-finished product stops advancing.

As shown in FIG. **2** and FIG. **3**, in order to realize the above cutting mode, the second frame **71** is provided with an angle sensor **36**. The angle sensor **36** may obtain the rotation angle of the adjusting rod **33**. The angle sensor **36** is connected in communication with a controller. In particular, the controller is a PLC controller, which can control the operation of the tableting equipment, including the operation of the slicing device **4**.

With the continuous advancing of the solid semi-finished product passing through the advancing device **2**, there are more solid semi-finished product in the adjusting device **3**; the tension force applied by the winding of the solid semi-finished product to the adjusting roller **34** is reduced, and the adjusting rod **33** swings downward under its gravity. When the adjusting rod **33** swings to a predetermined angle, the angle sensor **36** is triggered, and the slicing device **4** is controlled by the controller to operate, driving the solid semi-finished product to be transported to the slicing device **4**. At this time, there are fewer solid semi-finished product in the adjusting device **3**, the tension force applied by the winding of the solid semi-finished product to of the adjusting roller **34** is increased, the regulating roller **34** is tensioned and the regulating rod **33** swings upward; the regulating rod **33** returns to a predetermined angle; and the angle sensor **36** is triggered again to stop the operation of the slicing device **4**, to control the conveying state of the solid semi-finished product, so as to realize the intermittent advance of the solid semi-finished product, and facilitate the transverse cutting of the solid semi-finished product.

The slicing device **4** includes a transverse cutting mechanism **42**, a vertical cutting mechanism **41**, a feeding conveyor belt **44** and a downward pressing and feeding mechanism **43**. The feeding conveyor belt **44** is rotatably installed on the third frame **72**. The feeding conveyor belt **44** does not have an external driving source, that is, the feeding conveyor belt **44** cannot rotate itself and the feeding conveyor belt **44** is configured to support the solid semi-finished product.

The downward pressing and feeding mechanism **43** is configured to realize the intermittent advance of the solid semi-finished product. The downward pressing and feeding mechanism **43** includes a pressing plate **431**, a lifting assembly and a translation assembly. The lifting assembly is configured to drive the pressing plate **431** to be close to or away from the solid semi-finished product in the height direction, and the translation assembly is configured to drive the pressing plate **431** to move forward or backward in the conveying direction of the solid semi-finished product.

In this example, the lifting assembly includes a lifting cylinder **432**. An output end of the lifting cylinder **432** moves in the height direction, and the output end of the lifting cylinder **432** is fixedly connected to the pressing plate **431**. When the lifting cylinder **432** operates, the pressing plate **431** is pressed down, then the solid semi-finished product is pressed between the feeding conveyor belt **44** and the pressing plate **431**, so that the feeding conveyor belt **44** and the pressing plate **431** are relatively stationary. In other examples, the lifting assembly may also be an motor-driven push-rod, a gear **435** and rack **434** transmission structure, and a leading screw and slide block transmission structure.

In this example, the translation assembly includes a mounting plate **433**, a rack **434**, a gear **435** and a translation

motor **436**. The third frame **72** is fixedly arranged with a limit base **437**. The rack **434** is slidably connected to the limit base **437**. The sliding direction of the rack **434** is parallel to the conveying direction of the feeding conveyor belt **44**. The translation motor **436** is installed on the third frame **72**. In particular, the motor is a servo motor. The gear **435** is installed on the output shaft of the translation motor **436**. The gear **435** meshes with the rack **434**. The rack **434**, the gear **435** and the translation motor **436** are symmetrically arranged on both sides of the third frame **72**. Both ends of the mounting plate **433** are fixedly connected to the two racks **434**, respectively, and the lifting cylinder **432** is installed on the mounting plate **433**. When the translation motor **436** operates, the gear **435** cooperates with the rack **434** to drive the mounting plate **433** to translate and drive the pressing plate **431** to translate, and cooperates with the feeding conveyor belt **44** and the pressing plate **431** to press the solid semi-finished product, so that the feeding conveyor belt **44** rotates and drives the solid semi-finished product to be conveyed forward. In other examples, the translation assembly may also be a cylinder, an motor-driven push-rod and a leading screw and slide block transmission structure. For example, a translation cylinder is provided on the third frame **72**, the output end of the translation cylinder moves in the conveying direction of the solid semi-finished product, and the output end of the translation cylinder is connected to the mounting plate **433**.

Under the cooperation of the lifting assembly and the translation assembly, the pressing plate **431** drives the solid semi-finished product to move forward for a certain distance, and then the pressing plate **431** rises and is translated to the original position under the action of the lifting assembly and the translation assembly, so as to carry out the next pressing and feeding. The controller is connected in communication with the lifting cylinder **432** and the translation motor **436**. The lifting cylinder **432** and the translation motor **436** are started or stopped or change the output direction according to the signal of the angle sensor **36**, to realize the intermittent advance of the solid semi-finished product.

The vertical cutting mechanism **41** is arranged on a side of the downward pressing and feeding mechanism **43** close to the adjusting device **3**. The vertical cutting mechanism **41** includes a fixed base **411** and a vertical cutting blade **412**. Both ends of the fixed base **411** are fixedly connected to both sides of the third frame **72**, respectively. A plurality of vertical cutting blades **412** are provided. The vertical cutting blades **412** are fixed to the fixed base **411** at intervals in the direction perpendicular to the conveying direction of the solid semi-finished product. The solid semi-finished product are in contact with the vertical cutting blade **412** when being conveyed. The interaction between the vertical blades **412** and the solid semi-finished product realizes the vertical cutting of the solid semi-finished product.

The transverse cutting mechanism **42** is arranged on a side of the downward pressing and feeding mechanism **43** away from the adjusting device **3**. The transverse cutting mechanism **42** includes a cutting saw **421** and a moving component. The cutting saw **421** can rotate and cut solid semi-finished product during the rotation. The moving component is configured to drive the cutting saw **421** to move in a direction perpendicular to the conveying direction of the solid semi-finished product, to realize the transverse cutting of the solid semi-finished product, and make the solid semi-finished product into a square finished product after vertical cutting. In this example, the moving component is a linear module **422**. In other examples, the moving component may also be a rodless cylinder.

As shown in FIG. **4**, a transfer mechanism **6** is provided between the slicing device **4** and the discharging device **5**. The transfer mechanism **6** includes a transfer plate **61**, a first transfer cylinder **62**, a transfer base **63**, and a second transfer cylinder **64**. A positioning base **66** is fixedly installed on the fourth frame **73**. The positioning base **66** is provided with a sliding rail for sliding connection of the transfer base **63**. The first transfer cylinder **62** is installed on the positioning base **66**, and the output end of the first transfer cylinder **62** is connected to the transfer base **63**. The output end of the first transfer cylinder **62** moves in the conveying direction of the solid semi-finished product; the second transfer cylinder **64** is fixedly installed to the transfer seat **63**; the output end of the second transfer cylinder **64** is connected to the transfer plate **61**; and the output end of the second transfer cylinder **64** moves in the height direction. The output directions of the first transfer cylinder **62** and the second transfer cylinder **64** are perpendicular to each other. The transfer plate **61** is provided with a transfer sucker **65**, in particular, the transfer sucker **65** is a vacuum sucker. The transfer sucker **65** is activated to suck up the finished product. The first transfer cylinder **62** and the second transfer cylinder **64** drive the finished product to leave the slicing device **4** and enter the discharging device **5**.

The discharging device **5** includes a discharging conveyor belt **51**, an incoming material detection photoelectric switch **52**, a visual detector **53** and a sorting mechanism **54**. The discharging conveyor belt **51** is provided with an external drive source, and the discharging conveyor belt **51** can rotate. The discharging conveyor belt **51** supports the finished products and conveys them. The incoming material detection photoelectric switch **52** and the visual detector **53** are both arranged at one end of the discharging conveyor belt **51** and connected in communication. The incoming material detection photoelectric switch **52** is connected in communication with the visual detector **53**. When the finished product is transported to a position where the incoming material detection photoelectric switch **52** may be triggered, the visual detector **53** takes pictures of the finished product and detects whether the finished product is good or defective.

As shown in FIG. **5**, the sorting mechanism **54** includes a sorting plate **541**, a sorting motor **542**, a sorting cylinder **543**, a sorting sucker **544**, and a good product conveyor belt **545**. The fourth frame **73** is provided with a defective product placement port **546** for dropping of the defective products. In particular, the sorting motor **542** is a servo motor. The sorting driver is installed on the fourth frame **73**. The sorting plate **541** is connected to the output shaft of the sorting motor **542**. The sorting cylinder **543** is installed on the sorting plate **541**. The sorting sucker **544** is installed at the output end of the sorting cylinder **543**. In particular, the sorting sucker **544** is a vacuum sucker. The sorting motor **542**, the sorting cylinder **543**, and the sorting sucker **544** are all connected in communication with the visual detector **531**. The visual detector **53** is connected in communication with the controller. The good product conveyor belt **545** is arranged close to the end of the discharging conveyor belt **51** and has a conveying direction perpendicular to the conveying direction of the discharging conveyor belt **51**. When a defective product is detected, the defective product continues to be transported forward and falls into the defective product placement port **546**. When a good product is detected, the sorting motor **542**, the sorting cylinder **543** and the sorting sucker **544** are started; the sorting cylinder **543**

drives the sorting plate **541** to descend; the sorting sucker **544** sucks the good product; then the sorting cylinder **543** drives the sorting plate **541** to rise; the sorting motor **542** drives the sorting plate **541** to rotate, so that the good product leaves the discharging conveyor belt **51** and enters above the good product conveyor belt **545**; then the good product is put down; and the good product conveyor belt **545** supports the good product and conveys the good product to the next process.

Implementation principle of the tableting equipment:

The molding device **1** dries the mixed materials into solid semi-finished product; the advancing device **2** generates a force for moving the solid semi-finished product; and then the transverse cutting mechanism **42** and the vertical cutting mechanism **41** cut the solid semi-finished product into finished products. The regulating device **3** and the downward pressing and feeding mechanism **43** realize the intermittent advance of the solid semi-finished product to complete the tableting.

What is claimed is:

1. A detergent tablet made of the following raw materials by weight percentage:

4%-17% of polyvinyl alcohol,
1-5% of dextrin,
10%-20% of pea starch,
10%-20% of corn starch,
0.05%-0.5% of protease,
0.05%-0.5% of cellulase,
0-0.3% of amylase,
0-0.3% of pectinase,
0.5%-3% of sodium citrate,
0.1-2% of citric acid,
0-2% of tetrasodium glutamate acid diacetate,
3.2%-6% of glycerol,
3.2%-6% of propylene glycol,
0-1% of butanediol,
24.5-36% of sodium coco-sulfate,
0-3.6% of modified oil ethoxylate,
1.5%-3.6% of fatty alcohol polyoxyethylene ether,
4.5%-8.1% of fatty acid methyl ester ethoxy sulfonate,
1.5-2% of alkyl polyglycoside,
1.1%-2.2% of sophorolipid, and
2.2%-3.4% of rhamnolipid.

2. The detergent tablet according to claim **1**, wherein, the pea starch has a whiteness value of 89%-92.5% and a moisture content of 7%-9.3%; and the corn starch has a whiteness value of 86%-90% and a moisture content of 9%-10.5%.

3. A preparation method for the detergent tablet according to claim **1**, comprising the following steps:

mixing water, the polyvinyl alcohol and the dextrin film forming agent under stirring, heating to 80° C-90° C , and continuing stirring to obtain an initial mixed slurry;

adding the glycerol, the propylene glycol, and the butanediol into the initial mixed slurry under stirring, then adding the sodium coco-sulfate, the modified oil ethoxylate, the fatty alcohol polyoxyethylene ether, the fatty acid methyl ester ethoxy sulfonate, the alkyl polyglycoside, the sophorolipid, and the rhamnolipid-under stirring, then adding the pea starch and the corn starch under stirring to obtain a mixed material; and

drying the mixed material, coating with the protease, the cellulase, the amylase, and the pectinase, molding, and slicing to obtain the detergent tablet.

* * * * *