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(54) **BIODEGRADABLE DETERGENT COMPOSITION BASED ON MALIC ACID AND SUCROSE FOR THE REGENERATION OF COTTON CELLULOSE FIBER STRUCTURE AND PREVENTION OF WRINKLES**

(57) The invention relates to a laundry washing composition comprising sucrose and 2-Hydroxybutanedioic acid, wherein said composition may be a formulation selected from a solution, a paste, a gel, a powder, a granulate, and wherein said formulation is preferably a powder formulation. Said composition may be used for cotton fiber microdamage repair, cotton fiber regeneration, cotton fiber elasticity regulation, including increasing of elasticity of said cotton fibers, wherein preferably said microdamage and/or elasticity loss is caused by previous washing treatments, mechanical stress, tension, heat and sunlight exposure of said cotton fabric fibers. Said composition can be further used for brightness care of colored fabrics, removal and/or preventing creases on said fabrics comprising cotton fibers after washing of said fabrics.

Microscopic assessment of the surface of cotton fabrics of different density after exposure to two systems (sucrose acid; sucrose+malic acid)

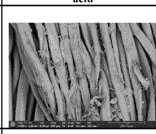
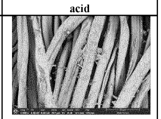
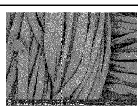
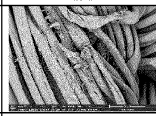
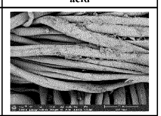
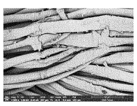
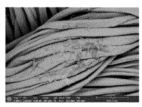
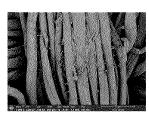
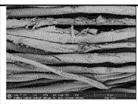
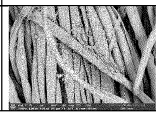
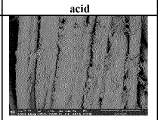
Fabric sample	High density cotton reference sample	After 5 washes with the addition of 0.1 wt.% sucrose acid	After 10 washes with the addition of 0.1 wt.% sucrose acid
Suiting and dress cotton Crimson red TRC H10/7/C50 23042360 Density ~ 260 g/m²			
Fabric sample	High density cotton reference sample	After 5 washes with the addition of 0.1 wt.% sucrose acid	After 10 washes with the addition of 0.1 wt.% sucrose acid
Max Mara mercerized cotton Blue SVM H4/C40 8022303 Density~130 g/m²			
Fabric sample	Medium density cotton reference sample	After 5 washes with the addition of 0.1 wt.% sucrose acid and 0.25 wt.% malic acid	After 10 washes with the addition of 0.1 wt.% sucrose acid and 0.25 wt.% malic acid
Max Mara mercerized cotton Blue SVM H4/C40 8022303 Density~130 g/m²			
Fabric sample	High density cotton reference sample	After 5 washes with the addition of 0.1 wt.% sucrose acid and 0.25 wt.% malic acid	After 10 washes with the addition of 0.1 wt.% sucrose acid and 0.25 wt.% malic acid
Suiting and dress cotton Crimson red TRC H10/7/C50 23042360 Density ~ 260 g/m²			

Fig. 1

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Description

PERTINENT ART

[0001] The invention relates to a biodegradable detergent composition based on malic acid and sucrose for the regeneration of cellulose cotton thread structure, elimination of damage caused by previous washes and exposure to sunlight, and for the prevention of formation of wrinkles on fabric after washing and wearing. The composition is intended for inclusion in household chemicals for the care of cotton and mixed fabrics, the use of which can increase effectiveness of cotton fiber protection from microdamage due to improper use of synthetic detergents in home washing, regulate color fastness, ensure smoothness of fabrics and prevent formation of wrinkles on clothing items. The composition is biodegradable, it has a safe effect on the skin and can be used for preparation of household chemicals for sensitive skin, such as dry, liquid, concentrated laundry detergents, while maintaining long-term cleanliness of fabrics. The use of the composition can help reduce the damaging effect on the skin of a consumer with allergic diseases, while maintaining skin hydration and elasticity during hand washing.

BACKGROUND

[0002] Every day we use a large number of detergents for washing various fabrics, such as powders for washing white and colored laundry, gels and capsules for washing, conditioners, stain removers and bleaches. Development of household chemicals with improved properties for consumers remains one of the promising areas in the category of home care products. According to analysts, consumers have begun to more often pay attention to the composition of laundry detergents and carefully study the ingredients for human and environment safety. In addition, consumers are looking for more natural products free of harmful chemical additives [Kantar Profiles/Mintel; A year of innovation in fabric and dish care, 2021, Mintel; KuRunData/Mintel; A year of innovation in fabric and dish care, 2021, Mintel]. This creates a demand for more environmentally friendly products and changes in the formulation of household chemicals towards natural ingredients. Thus, by 2025, a trend towards sustainable products with a high content of natural ingredients is expected.

[0003] A modern detergent must combine a large number of functions to remove general dirt and specific stains, prevent appearance of pilling and wrinkles, maintain the bright color of products, prevent re-deposition of dirt during the washing cycle, and influence the aesthetic perception of clothes. The demand for new laundry solutions is driven by frequent use of short washing cycles and low-temperature washes, and the growing need for liquid laundry detergents with natural and environmentally friendly ingredients. Consumers want clothes that look new longer and can be worn longer [https://www.savers.com/sites/default/files/reuse_report_2017_sav.pdf]. 55% of consumers worldwide are willing to pay more for products that improve the quality of clothing and extend the service life, which is directly related to the regeneration of the cotton cellulose fiber structure, drying and ironing. After prolonged washing cotton items begin to look dull and gray, lose their softness and appearance of newness, become damaged, pills and other undesirable defects appear, such as microdamage, invisible to the eye. In a study of European consumers conducted by Efficiency, 54% of respondents said they considered clothes to be "worn out" after just 20 washes. Consumers may be tempted to replace damaged clothing with new ones, however frequent replacement is harmful to the environment and budget. In this regard, a detergent with new properties can significantly extend the life of clothing. Although, even with rare and delicate washing, cotton fabric can be damaged during wear as a result of mechanical stress, tension, exposure to heat and sunlight, and dye instability. The most attractive claim for consumers is care for fabrics, in particular, noticeable and visible care for fabric [Novozymes/-Conjointly consumer survey Europe 2019, N=1902]. One of the latest fashion trends, wrinkle-free cotton clothing, combines the advantages of easy care after washing (does not require ironing), practicality, comfort and low cost. However, wrinkles appear after each wash on clothes made from pure cotton fabrics, and it takes a lot of time to remove wrinkles by ironing and restore original appearance of the fabrics. Various coatings are currently being developed and used for cotton fabrics that can prevent wrinkles. In particular, there are examples of the use of formaldehyde-based products, which are not environmentally friendly, or polycarboxylic acids, which were proposed as an environmentally friendly substitute, although they significantly increase the cost of the product, impair biodegradability of the finished product and are not suitable for industrial use [Omidian, H., Hashemi, S. A., Samadikhah, E., & Akbari Javar, H. (2018). A review on biodegradable polymeric materials in drug delivery applications. Journal of Polymer Research, 25(5), 107.; Lv, S., Tang, Z., Li, M., Lin, S., Song, W., Chen, X., ... & Huang, W. (2018). Recent advances in the development of biodegradable polyesters derived from renewable resources. Frontiers in microbiology, 9, 20.; Zhang, J., Liu, Q., Yan, X., Ding, M., & Chen, X. (2016). Biodegradable polymeric materials: present advances and future prospects. Materials Science and Engineering: C, 61, 965-978.; Lutze, L. H., & Chappell, M. A. (1981). Environmental degradation of polymeric materials. Progress in Polymer Science, 7(4), 283-368]. Accordingly, there is a need to develop an environmentally friendly, inexpensive and industrially usable coating and/or composition for treating cotton fabrics to prevent wrinkles. At the same time, in view of consumer demands for multifunctionality, such composition should not only restore and care, but also cope with stains. One of these solutions is the use of biotechnological or natural components, which, if included in cleaning compositions, can ensure not only delicate care and removal of contaminants, but also restoration of clothing items, thereby extending their service life.

[0004] Cotton fabric is a natural fiber of vegetable origin. The main element of vegetable fiber is cellulose, a solid, poorly soluble substance (β-D-glucopyranose, with units in the polysaccharide chain linked by β(1→4)-glycosidic bonds). Cotton fibers contain 82% to 96% cellulose and a small amount of non-cellulose components (hemicellulose, lignin, pectin). Cotton fiber is relatively strong, however, disadvantages of the fiber include low elasticity. The proportion of elastic deformation in total elongation is 50%; due to the small amount of elastic deformation cotton fiber fabrics are easily wrinkled. Cotton has relatively low abrasion resistance, therefore cotton items have low wearability and quickly lose their consumer properties. The process of cellulose oxidation by atmospheric oxygen is activated by exposure to sunlight and weather, which results in a decrease in mechanical properties (strength, elongation), and an increase in fiber rigidity and fragility [TAPPI Monograph series - Light-Induced Degradation of Cellulose and Paper (2008); TAPPI Journal, vol. 96(11), pp. 51-56 - Examining the role of radiation in the yellowing of paper (2013); Polymer Degradation and Stability, vol. 94(3), pp. 371-378 - The role of oxygen in the light-induced degradation of cellulose (2009)]. As a result of exposure to sunlight for 940 hours, the strength of cotton is reduced by 50% [Journal of Photochemistry and Photobiology B: Biology, vol. 86(2), pp. 169-174 - Photodegradation of cellulose in paper: A fluorescence study (2007)]. Cotton fiber is resistant to alkalis and reducing agents, but unstable to aggressive strong acids and oxidizing agents. Also, cotton items are susceptible to wrinkles during wear and after washing, which is associated with the fiber elasticity, strength and deformation parameters. Weak hydrogen bonds arise between the hydroxyl groups connecting the elementary units in cellulose molecules. These groups are easily deformed during washing or other external impact during wear, causing wrinkles to appear on the fabrics [Patil, N.V., Netravali, A.N. Multifunctional sucrose acid as a 'green' crosslinker for wrinkle-free cotton fabrics. Cellulose 27, 5407-5420 (2020)].

[0005] Thus, one of the priorities for companies involved in the development of laundry detergents is introduction of new components or compositions that preserve, restore the original properties of cotton fabrics, effectively remove stains and are environmentally friendly. One of the solutions is the use of biogenic components, such as natural carbohydrates, organic acids and their esters. This paper will discuss malic acid and sucrose and their synergistic effect in regeneration of fiber microdamage and reduction of wrinkling.

[0006] Malic or apple acid (Malic Acid, CAS 97-67-6, EC Number 202-601-5) has the chemical formula HOOCCH(OH)CH_2COOH. This acid is found in all living organisms as an intermediate in the citric acid metabolic cycle. It is found in relatively large quantities in many fruits and vegetables. Malic acid has two stereoisomeric forms (L- and D-enantiomers). Malic acid is considered an alpha hydroxy acid (AHA), a class of naturally occurring acids commonly used in skin care products (https://pubmed.ncbi.nlm.nih.gov/?term=AHA%20acid%20malic%20acid). It is highly soluble in water within the range from 10 to 55°C. The scientific article "Thermal degradation of malic acid under microwave irradiation in the presence of hydrogen peroxide" (https://www.sciencedirect.com/science/article/abs/pii/S0040603104008836) states that malic acid decomposes at high temperatures, especially when using a microwave oven or when adding hydrogen peroxide. The scientific article "Compatibility of detergents with acid cleaners: influence of concentration and temperature" (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3210117/) shows that malic acid is incompatible with active oxygen, surfactants and chelates. They can cause sediment to form or change the pH, which reduces the effectiveness of malic acid. The scientific article "Comparison of the effect of pH and acid type on cotton fabric damage" (https://doi.org/10.1016/j.jclepro.2018.06.249) states that malic acid itself can damage cotton fiber, increasing porosity and reducing the mechanical strength of the material. Therefore, the use of malic acid may be ineffective, since it decomposes at high temperatures, is incompatible with household chemicals, and can damage materials. It is necessary to select another component that will be more suitable for a particular process.

[0007] Sucrose (saccharose or a-D-glucopyranosyl-b-D-fructofuranoside; CAS 57-50-1) is a chemical compound that is a natural disaccharide consisting of α-glucose and β-fructose. Sucrose is highly soluble in water and insoluble in alcohol. Sucrose serves as a chemical intermediate for the synthesis of emulsifiers and nonionic surfactants with sugar residues. (https://byjus.com/chemistry/sucrose/#:~:text=Sucrose%20is%20a%20molecule%20compose d,connected%20via%20a%20glycosidic%20bond). Data on the instability of sucrose can be found in scientific articles devoted to the chemical properties of sucrose or its degradation processes. For example, the scientific article "Thermal degradation of sucrose: reaction kinetics and formation of degradation products" (https://www.sciencedirect.com/science/article/abs/pii/50021967300003695) studies the kinetics of the decomposition reaction of sucrose at high temperatures and the decomposition products, such as aldehydes, which have an adverse effect on the consumer properties of the product, inactivate enzymes and reduce the effect of using the products. Data on incompatibility with components of household chemicals can be found in articles devoted to the chemical properties and interactions of various chemicals. For example, the scientific article "Incompatibilities of Chemicals: A Comprehensive Guide to the Hazardous Properties of Chemical Substances" (https://www.sciencedirect.com/book/9780444594530/incompatibilities-of-chemicals) provides information about individual substances, their chemical properties and incompatibility with other substances. Therefore, if a component is unstable and/or incompatible with other substances, its use may have negative consequences, such as loss of product properties or even dangerous reactions. Thus, the use of unstable sucrose or components that are incompatible with household chemicals may be ineffective and dangerous for consumers.

[0008] The authors proposed the use of a composition based on malic acid and sucrose for a synergistic effect in relation to the regeneration of cotton cellulose microfibers and removal of wrinkles. The authors have shown that malic acid and sucrose alone have little effect on wrinkles on cotton fabric and do not regenerate fabric microfibers. It is sometimes proposed to use a catalyst to activate malic acid, but the authors have found that sucrose acts as a natural catalyst for malic acid and an additional cross-linking agent for microfibers of cotton fabric.

[0009] Several patent documents or commercial products implement both components together or separately, but a new technical result is not mentioned there, and their use together or separately is aimed at solving other technical problems.

GB1335959A dated September 14, 1971 mentions the use of malic acid with addition of sucrose, and inclusion of other components is also possible. However, in this document the components used by the authors are proposed as a food preservative. Thus, the authors of the document did not use or consider the properties associated with the effect on fabrics, washing and inclusion in household chemicals, as well as the specific effect of regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles.

US2020138021 dated July 12, 2018 describes a detergent composition containing malic and citric acids, as well as metals. Sucrose is not included in the composition. The purpose of the given composition is the antibacterial and antiviral activity of the detergent for hard porous surfaces, while data on surface restoration is not provided. This patent differs in the scope of application and does not claim the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles.

US8759269 dated July 2, 2007 describes a curing matrix based on straight chain saturated mono-, di-, or tricarboxylic acid salts and other components. The straight chain saturated mono-, di- or tricarboxylic acid is selected from a group consisting of salts of acetic acid, gluconic acid, malic acid, succinic acid, glutaric acid, adipic acid, tartaric acid and citric acid. However, in this document, malic acid, more specifically its derivative salt, is considered only as a structure-forming component. The authors did not take into account the active properties of malic and other fruit acids separately and together with sucrose. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

WO2014105296A1 dated December 28, 2012 describes a detergent composition/sorbent composition to be included in antiperspirants containing malic acid or other organic acids. The reason for inclusion is described as follows: acidic components may be selected to support the surfactant action of the detergent and eliminate water hardness in the wash environment. Despite the potential for inclusion of the composition in detergents, this document has a different scope and does not claim the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles. Antiperspirants are proposed as products for introducing a detergent composition. This document also has a specific feature, namely, all components of the composition have pH of 1-4, highly acid to be used in personal care products and detergents, which has a negative result on the microstructure of cotton fiber and poses technical difficulties for implementation in alkaline household chemicals. [Effects of Low-pH on the Tensile Properties of Wet-cotton Fabric Treated with Hydroxylamine at Room Temperature", by H. Wang, K. Xu, X. Shen, S. Li, and H. Liu. Fibers and Polymers, 2017. DOI: 10.1007/s12221-017-7153-3; The Effect of pH and Temperature on the Tensile Properties of Cotton Fiber", by Y. Roberts, S. M. Morris, A. C. Long, and K. R. Rowland. Journal of Natural Fibers, 2020. DOI: 10.1080/15440478.2020.1777286.].

US6391842 dated December 18, 1997 mentions the use of malic acid in a detergent. However, malic acid serves therein to trap and stabilize the EDTA chelating agent and also serves as a pH adjuster. It is worth noting that malic acid in this case serves to stabilize the composition and structure of the detergent. The authors did not take into account the active properties of malic acid. This document mentions the use of chelating agents, however chelating agents such as DTPA and EDTA have been banned for use in green household products in some countries, such as Sweden and Norway, due to the chemicals' devastating effects on aquatic life and pollution wastewater (Bajpai, 2014). As a consequence, this composition cannot be environmentally safe and prevents environmentally friendly voluntary certification of a product with the composition. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

WO2012101149 dated January 26, 2011 mentions malic acid as a component for stabilizing the shell of granules for storing enzymes and bleaching agents. Despite a similar scope of application, detergents, the authors do not consider the properties of malic acid as an active component. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

US4247408 dated June 5, 1978 mentions malic acid and other organic acids as an ingredient for an acidic or mildly acidic detergent mostly intended for hard surface and bathroom cleaning. Similar to the documents mentioned above, malic acid is used as a pH stabilizer, its active properties are not used. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

WO2022134891 dated December 23, 2020 mentions inclusion of malic acid in laundry formulations intended to remove microorganisms. The authors indicated that the complex, which includes one of the organic acids, including malic acid, and a surfactant, copes with the removal of microorganisms during washing and prevents their deposition on the fabric after washing. However, the specified preferred pH values 1.6 to 4.5, preferably 1.7 to 4.0, more preferably 1.8 to 3.5, most preferably 1.9 to 3.1, present a quite narrow range, which is not suitable for inclusion in all types of detergents, in particular washing powders with pH 10-12. Moreover, the authors do not consider the active components of the composition and the fiber restoration effects, while the highly acid composition worsens the condition of cotton fiber, since it was previously indicated that cotton is unstable to acids, which can result in degradation of the fibers during the washing process. For example, in the article "Effect of pH on the mechanical properties of cotton fibers," the authors examined the effect of different pH levels on the mechanical properties of cotton fibers. They found that at low pH levels, fiber strength decreased and fiber fragility increased [Zhang, L., & Wang, X. (2017). Effect of pH on the mechanical properties of cotton fibers. Journal of Engineered Fibers and Fabrics, 12(1), 1558925016684727. https://doi.org/10.1177/1558925016684727]. Another study published in the Textile Research Journal also confirms that cotton fibers can be degraded during washing due to the action of acidic substances such as monochloroacetic acid [Miao, M., & Wang, X. G. (2014). Degradation of cotton fabrics in acidic solutions. Textile Research Journal, 84(6), 563-571. https://doi.org/10.1177/0040517513494805]. Thus, when washing cotton products, it is necessary to take into account the effect of acidic substances on their fibers and use appropriate means to protect the fabric. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

WO2020191161 dated March 19, 2019 mentions the use of malic acid or other organic acids for inclusion in a fabric washing composition. The authors do not consider the effects of fabric regeneration and prevention of wrinkling, so the purpose and scope of application of the component differs from that proposed by the authors of this application.

Document US11359168 dated April 3, 2020 provides a composition for a solid anhydrous form of laundry detergent containing malic or citric acids as an acidic cleaning component. The authors of the document did not mention the interaction of malic acid and sucrose with fabrics in order to restore the fiber structure and prevent wrinkles, and also presented a composition with only citric acid in the form of an experimentally obtained sample, therefore, experimental confirmation of the functionality of the product with malic acid was not obtained or given by the authors. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

RU2110630 dated March 30, 1993 mentions the use of sucrose or other mono- and disaccharides in laundry detergent compositions for the purpose of eliminating inorganic crusts on fabrics. If multiple wash cycles are used, washing performance is significantly reduced due to inorganic build-up on fabrics and washing machine parts. This build-up of inorganic crusts on fabrics reduces the elasticity of the fibers and, accordingly, reduces the service life of the fabrics, and also gives the fabric a gray color. The authors did not consider the main points of activity, including restoration of the fiber structure and prevention of wrinkles in fabrics. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

Document WO02083999 dated April 12, 2001 mentions the use of sucrose as a component of a wool detergent. Sucrose is mentioned in the context of washing, but the scope of application concerns wool and fat removal from wool only. This is important from the point of view of the differences between animal and vegetable fibers, since a composition suitable for washing wool is not suitable for washing cotton fabric. The effects associated with restoring fiber structure and preventing wrinkles are not considered. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

GB1409416 dated September 28, 1971**,** GB890204 dated April 11, 1958 **and** WO2019035840 dated August 18, 2017 propose a laundry composition for softening fabrics containing sucrose esters with fatty acids. The papers do not address the effects of using malic acid in combination with sucrose for the restoration of cotton fiber structure and prevention of wrinkling. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

US8888924 dated August 24, 2012 describes a detergent composition for washing products and laundry containing sucrose. The composition is intended for effective cleaning and, in particular, to prevent the deposition of metals and their salts on products or fabrics, which represents a different area of application and purpose of use of the component in comparison with those presented by the authors of the application. This document does not mention malic acid and the possibility of combination with sucrose. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

US10030217 dated November 16, 2006 presents a laundry composition for softening fabrics with addition of sucrose. However, sucrose does not act as a softening component and the authors did not consider the effects associated with the restoration of cotton fiber and the prevention of wrinkles, therefore the document differs in the scope and intended use of the component. This document does not mention malic acid and the possibility of combination with sucrose. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

WO2011131585 dated April 20, 2010 discusses a composition for washing and cleaning fabrics using sucrose as a matrix component for an enzyme detergent. The active properties of sucrose and, in particular, its use in preventing wrinkles and restoring cotton fiber have not been considered. This document does not mention malic acid and the possibility of combination with sucrose. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

WO1997011151 dated September 18, 1995 discusses a composition containing scaffold particles for the delivery and release of active components, with sucrose acting as a component for the scaffold that forms the particle. The active properties of sucrose and, in particular, its use in preventing wrinkles and restoring cotton fiber have not been considered. This document does not mention malic acid and the possibility of combination with sucrose. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

WO2007070378 dated December 12, 2005 discloses a composition for removing soil from textiles during washing by including at least one multi-branched (hydrophobic/hydrophilic) soil release/wetting agent containing oxygen based on a polyfunctional compound. Sucrose acts as a multifunctional compound due to the presence of several functional binding sites. Thus, the purpose is indicated as a matrix for including active components in it. The active properties of sucrose and, in particular, its use in preventing wrinkles and restoring cotton fiber have not been considered. This document does not mention malic acid and the possibility of combination with sucrose. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

CA2865682 dated September 30, 2013 discusses an antimicrobial composition containing carboxylic acids, an example of which may be malic acid and sucrose octaacetate as a peracid catalyst. The active properties of malic acid and sucrose and, in particular, their use in preventing wrinkles and restoring cotton fiber have not been considered. This document does not mention malic acid and the possibility of combination with sucrose. Therefore, the scope of application is different and the use of the composition for regenerating the structure of cellulose threads of cotton fiber and preventing the formation of wrinkles is not claimed.

DETAILED DESCRIPTION OF THE INVENTION

[0010] In the first aspect, the invention relates to a composition intended for use in household chemicals for washing clothes, active at pH 8.0-12.0 and water hardness 0-15 °dH, consisting of:

(A) Malic acid obtained by a synthetic or biotechnological process, wherein the specified malic acid is D-Malic acid, L-Malic acid or the racemate of DL-Malic acid;
(B) Sucrose obtained by a synthetic or biotechnological process;

where the mass ratio of components A and B is (0.1-0.5):(0.1-0.5), respectively.

[0011] In the second aspect, the invention relates to a composition intended for use in household cleaning products to regenerate the structure of cellulose threads of cotton and prevent the formation of wrinkles, where the said composition is used

[0012] In the third aspect, the invention relates to the use of a composition according to the present invention in a household laundry detergent. The household chemical product according to the present invention may contain 0.1-1.0% wt. compositions according to the present invention.

[0013] The mass content of malic acid in household chemicals can be 0.1, 0.2, 0.3, 0.4, or 0.5 or any values between those specified.

[0014] Malic acid may differ in that malic acid is an organic acid obtained synthetically or biotechnologically from microorganisms, in particular fungi or bacteria. Malic acid may be a substance or commercially available product with CAS registration number 617-48-1.

[0015] The composition may differ in that it additionally contains sucrose.

[0016] The mass content of sucrose in household chemicals can be 0.1, 0.2, 0.3, 0.4, or 0.5 or any values between those specified.

[0017] The present invention also relates to the use of malic acid and sucrose according to the present invention in household chemicals.

[0018] The present invention also relates to a powdered detergent for white cotton fabrics containing 0.1-1.0% wt. compositions according to the present invention.

[0019] The present invention also relates to a powdered detergent for washing colored laundry, a powdered detergent for washing children's laundry containing 0.1-1.0% wt. compositions according to the present invention.

[0020] The product according to the present invention may contain, wt. %:

Malic Acid	*0.1-0.5 wt. %.*
Sucrose	*0.1-0.5 wt . %*

[0021] The present invention also relates to the use of malic acid and sucrose according to the invention to regenerate the structure of cellulose threads of cotton fiber and prevent the formation of wrinkles caused by previous chemical treatments of cotton fabrics.

[0022] Household chemicals preferably do not contain any other active and/or auxiliary substances, such as detergent active agents and/or acceptable auxiliary substances, but may contain them. Such substances may be, or are, agents conventionally used in the art and well known to those skilled in the art. Addition of these agents to the complex according to the present invention does not negate achievement of the claimed technical results, but can improve them.

[0023] The invention also covers household chemicals, such as a detergent for washing white cotton laundry, a detergent for washing colored cotton laundry, a detergent for washing children's underwear, and a powdered detergent for washing clothes.

[0024] All weight fractions, parts by weight, weight percentages, as well as volume fractions, parts by volume, volume percentages are given in this disclosure in relation to the means, agent, composition or product to which they refer in the specified context.

[0025] In the household cleaning product according to the present invention, suitable auxiliary substances can be selected from the following categories of components.

[0026] Anionic surfactants:

Salts of higher carboxylic acids with the general formula R1-CO2X1, where R1 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, and X1 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium, a basic amino acid;

Alkyl polyethylene glycol sulfate with the general formula R2-O(-CH2-CH2-O) n1S03X2, where n1 can take on values from 1 to 10 and denotes the number of polyethylene glycol groups, R2 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 6 up to 22 carbon atoms, and X2 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Alkyl sulfate with the general formula R3-OSO3X3, where R3 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 6 to 22 carbon atoms, and X3 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Amide salt of a higher fatty acid and methylglycine with the general formula R4-C(O)-N(-CH3)-CH2-CO2X4, where R4 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, and X4 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Alkyl polyethylene glycol carboxylate with the general formula R5-O(-CH2-CH2-O-)n2CH2-CO2X5, where n2 can take on values from 1 to 15 and denotes the number of polyethylene glycol groups, R5 is an alkyl and/or alkenyl group with a long hydrocarbon chains from 6 to 22 carbon atoms, and X5 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

A disubstituted salt of 2-sulfocarboxylic acid with the general formula R6-CH(-SO3X6)-CO2X6, where R6 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 4 to 20 carbon atoms, and X6 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Mono or disubstituted amide salt a higher carboxylic acid and glutamic acid with the general formula R7-C(O)-NH-CH(-CH2-CH2-CO2X7)-CO2X7, where R7 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, and X7 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium or hydrogen;

Amide salt of a higher fatty acid and glycine with the general formula R8-C(O)-NH-CH2-CO2X8, where R8 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, and X8 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Amide salt of a higher fatty acid and alanine with the general formula R9-C(O)-NH-CH(-CH3)-CO2X9, where R9 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, and X9 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Amide salt of a higher fatty acid and 2-aminomethylethanesulfonic acid with the general formula R10-C(0)-N(-CH3)-CH2-CH2-S03X10, where R10 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, and X10 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Alkyl polyglucoside hydroxypropyl sulfonate with the general formula R11-O-[G]p1-O-CH2-CH(-OH)-CH2-S03X11, where R11 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 6 to 22 carbon atoms, G is a saccharide fragment containing 5 or 6 carbon atoms, p1 can take on values from 1 to 4, and X11 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Alkyl polyglucoside carboxylate with the general formula R12-O-[G]p2-O-CH2-CO2X12, where R12 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 6 to 22 carbon atoms, G is a saccharide fragment containing 5 or 6 carbon atoms, p2 can take on values from 1 to 4, and X12 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Amide salt of a higher fatty acid and threonine with the general formula R13-C(0)-NH-CH(-CH(-OH)-CH3)-CO2X13, where R13 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, and X13 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Amide salt of a higher fatty acid and amino acid obtained by hydrolysis of proteins from vegetable raw materials, with the general formula R14-C(O)-AAX14, where R14 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, AA is an amino acid or peptide obtained by hydrolysis of vegetable protein (possible sources of protein are apple, soybean, wheat, cotton, etc.), and X14 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium.

[0027] Amphoteric surfactants:

A disubstituted acylamphodiacetate salt with the general formula R15-C(O)-NH-CH2-CH2-N(-CH2-CO2X15)-CH2-CH2-O-CH2-CO2X15, where R15 is an alkyl and/or alkenyl group with a long hydrocarbon chain chains from 5 to 21 carbon atoms, and X15 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Acylamphoacetate salt with the general formula R16-C(O)-NH-CH2-CH2-N(-CH2-CO2X16)-CH2-CH2-OH, where R16 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, and X16 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Alkylamphoacetate salt with the general formula R17-C(=N-CH2-CH2-N((-CH2-CH2-OH)-CH2-CO2X17)-), where R17 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 up to 21 carbon atoms, and X17 is a cation of an alkali and/or alkaline earth metal, ammonium, alkylammonium, alkanolammonium, glucoammonium;

Acylamidoalkylbetaine with the general formula R18-C(O)-NH-R19-N(-CH3)2)-CH2-CO2, where R18 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, and R19 is an alkyl group with a long hydrocarbon chain of 1 to 4 carbon atoms;

Acylamidoalkylhydroxysultaine with the general formula R20-C(O)-NH-R21-N(-CH3)2-CH2-CH(-OH)-CH2-SO3, where R20 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 up to 21 carbon atoms, and R21 is alkyl group with a long hydrocarbon chain of 1 to 4 carbon atoms;

Acylamidoalkylamine oxide with the general formula R22-C(O)-NH-R23-N(-CH3)2-O, where R22 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, and R23 is an alkyl group with a long hydrocarbon chain of 1 to 4 carbon atoms;

Alkylbetaine with the general formula R24-N(-CH3)2)-CH2-CO2, where R24 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms;

Alkylhydroxysultaine with the general formula R25-N(-CH3)2-CH2-CH(-OH)-CH2-SO3, where R25 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 6 to 22 carbon atoms;

Alkylsultaine with the general formula R26-N(-CH3)2-CH2-CH2-CH2-SO3, where R26 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 6 to 22 carbon atoms;

Alkylamine oxide with the general formula R27-N(-CH3)2-O, where R26 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 6 to 22 carbon atoms.

[0028] Nonionic surfactants:

Alkyl glucoside with the general formula R28-O-[G]p3, where R28 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 4 to 22 carbon atoms, G is a saccharide fragment containing 5 or 6 carbon atoms, and p3 can take on values from 1 to 4;

Alkylpolyethylene glycol with the general formula R29-O(-CH2-CH2-O-)n3H, where n3 can take on values from 2 to 20 and denotes the number of polyethylene glycol groups, and R29 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 6 to 22 carbon atoms;
Alkylpolyethylene/propylene glycol with the general formula R30-O(-CH2-CH2-O-)n4(-CH(-CH3)-CH2-O-)n5H, where n4 can take on values from 2 to 20 and denotes the number of polyethylene glycol groups, n5 can take on values from 2 to 20 and denotes the number of polypropylene glycol groups, and R30 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 6 to 22 carbon atoms;
Dialkylpolyethylene glycol with the general formula R31-O(-CH2-CH2-O-)n6R32, where n6 can take on values from 2 to 20 and denotes the number of polyethylene glycol groups, R31 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 6 to 22 carbon atoms, and R32 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 1 to 12 carbon atoms;
Dialkylpolyethylene/propylene glycol with the general formula R33-O(-CH2-CH2-O-)n7(-CH(-CH3)-CH2-O-)n8-R34, where n7 can take on values from 2 to 20 and denotes the amount polyethylene glycol groups, n8 can take on values from 2 to 20 and denotes the number of polypropylene glycol groups, R33 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 6 to 22 carbon atoms, and R34 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 1 to 12 carbon atoms.

[0029] Dispersed medium for polysaccharide/solvent:

Organic alcohol with the general formula R35(-OH)s1, where R35 is an alkyl group with a long hydrocarbon chain of 3 to 12 carbon atoms, S1 can take on values from 1 to 12 and denotes the number of hydroxyl groups located in the hydrocarbon radical in random order relative to each other;
Alkylpolypropylene glycol with the general formula H(-CH(-CH3)-CH2-O-)n9R36, where n9 can take on values from 2 to 10 and denotes the number of polypropylene glycol groups, and R36 is an alkyl group with a long hydrocarbon chain of 1 to 10 atoms carbon.
Organic acid activator: sodium phosphite, sodium hypophosphite or other derivative of hypophosphorous acid; laccase in combination with an organic compound (TEMPO, vanillin alcohol, syringaldehyde, etc.).

[0030] pH regulators:

Organic acids with the general formula R37(-OH)s2(-COOH)m1, where R37 is an alkyl group with a long hydrocarbon chain of 1 to 12 carbon atoms, S2 can take on values from 1 to 12 and denotes the number of hydroxyl groups located in the hydrocarbon radical in random order relative to each other, and M1 can take on values from 1 to 4 and denotes the number of carboxyl groups located in the hydrocarbon radical in random order relative to each other;
Solutions of hydroxides of alkali or alkaline earth metals, ammonia, primary and tertiary alkylamines, primary and tertiary alkanolamines, primary and tertiary glucamines, basic amino acids, disodium citric acid, trisodium citric acid.

[0031] Chelating agent:

Trisodium salt of methylglycine diacetic acid, tetrasodium salt of glutamine diacetic acid, trisodium salt of ethylenediamine-(N,N)-disuccinate;
Esters of phosphonic acids with the general formula $RP(O)(OR'_1)n(OH)_{2-n}$, where R, R' are organic radicals, in particular alkyl, alkenyl or aryl radicals, and can be primary (n=1, acid phosphonates) and secondary (n=2, complete phosphonates) depending on the hydroxyl groups;
Organic acids, as well as salts of alkali metals, ammonium, alkylammonium, alkanolammonium, glucoammonium, corresponding to the following acids: citric acid, tartaric acid, glutaric acid, adipic acid, glucuronic acid, galacturonic acid, galactaric acid, gluconic acid, phytic acid, polytaconic acid, polyacrylic acid, polymethacrylic acid, copolymer of acrylic and maleic acids, as well as organic acids with the general formula R38(-OH)s3(-COOH)m2, where R38 is an alkyl group with a long hydrocarbon chain of 1 to 12 carbon atoms, S3 can take on values from 1 to 12 and denotes the number of hydroxyl groups located in a hydrocarbon radical in an arbitrary order relative to each other, and M2 can take on values from 1 to 4 and denotes the number of carboxyl groups located in a hydrocarbon radical in an arbitrary order relative to each other.

[0032] Contaminant redeposition inhibitors:

Polysaccharide derivatives: sodium salt of carboxymethyl polysaccharide, hydroxyalkyl polysaccharide, alkyl polysaccharide;
Polyvinylpyrrolidone and its derivatives, copolymers of polyvinylpyrrolidone and vinylimidazole;

Water-soluble salts of polyacrylic acid, polymethacrylic acid, copolymer of acrylic/methacrylic and maleic acid.

[0033] Defoamers:

Higher carboxylic acids with the general formula R39-CO2H, where R39 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms;
Higher carboxylic alcohols with the general formula R40-COH, where R40 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms;
Simple ethers of higher carboxylic alcohols with the general formula R41-O-R42, where R41, R42 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 4 to 22 carbon atoms;
Bisamides of alkyldiamines and higher carboxylic acids with the general formula R43-C(O)-NH-R44-NH-C(O)-R45, where R43, R45 is an alkyl and/or alkenyl group with a long hydrocarbon chain of 5 to 21 carbon atoms, and R44 is an alkyl radical with a hydrocarbon chain length from 1 to 12 carbon atoms.

[0034] Preservatives:

Organic acids and salts of alkali and alkaline earth metals, ammonium, alkylammonium, alkanolammonium, glucoammonium, corresponding to the following acids: benzoic acid, sorbic acid, 4-methoxybenzoic acid, salicylic acid, undecylenic acid;
Organic alcohols and phenols: phenoxyethanol, benzyl alcohol, caprylyl glycol, ethylhexyl glycerin, phenethyl alcohol, 3-methyl-4-isopropylphenol, 2,4-dichlorobenzyl alcohol;
Broad-spectrum biocides: benzisothiazolinone, dodecyldipropylene triamine, methylisothiazolinone.

[0035] Fungicides: sodium pyrithione, climbazole.

[0036] Enzymes: protease, lipase, transglutaminase, pectate lyase, mannanase, mannosidase, cellulase, amino oxidase, ferruloyl esterase, beta-glucanase, tannase, alpha-glucosidase, beta-glucosidase, alpha-galactosidase, beta-galactosidase, manganese peroxidase, lycheninase, xylanase and other commercially available enzymes that are used in laundry detergents.

[0037] Fragrances with essential oils or essential oils in pure form or in the form of mixtures in different proportions: orange, bergamot, lemon, lime, tangerine, grapefruit, neroli, rosewood, yuzu, lemongrass, lavender, sage, rosemary, thyme, lemon balm, various mint species, tea tree, eucalyptus, cypress, pine, cedar, sandalwood, vetiver, black pepper, pink pepper, cinnamon, cardamom, coriander, jasmine, rose, peony, blue chamomile, ylang-ylang, monoi, palmarosa and others commercially available essential oils.

[0038] In another aspect, the invention relates to the use of malic acid and sucrose according to the present invention to regenerate micro-damage to the cellulosic threads of cotton and prevent wrinkling caused by previous chemical treatments of cotton. The application may differ in that the specified cotton fabric is selected from cotton, linen, tencel or cotton blends with synthetic additives in the composition.

EXPERIMENTAL PART

[0039] The examples included in this description are not limiting of the claimed invention and are provided for the purpose of illustration and confirmation of the achievement of the expected technical results only. These examples are among many experimental data obtained by the inventors that confirm the effectiveness of the agents within the scope of the present invention.

Example 1.

[0040] Components for formulation into the composition according to the present invention were studied in the composition of detergents for washing clothes. A powdered detergent, in particular a dry concentrated powdered detergent for washing colored items, was prepared within the framework of the present invention (Table 1).

Table 1. Composition of a powdered detergent base for washing colored fabrics

Item No.	Component	Content, wt. %
1	Sodium salt of fatty palmitic acid, such as sodium palmitate	0.5-3.5
2	Water softener, such as sodium silicate	0.1-1.5
3	Anti-resorbent, such as carboxymethylcellulose sodium salt	0.5-3.5

(continued)

Item No.	Component	Content, wt. %
4	Emulsifier, nonionic surfactant, such as laureth-7	3.5-7.0
5	Zeolites	10.0-16.0
6	Excipient, such as sodium sulfate	17.0-21.0
7	Filler, such as sodium carbonate	22.0-26.0
8	Nonionic surfactant, such as laureth-3	0.1-2.0
9	Anionic surfactant, such as sodium coco-sulfate	2.5-6.5
10	Anti-resorbent, such as cellulose derivative	0.1-1.5
11	Enzyme mixture (amylase, protease, mannanase)	0.05-1.5
12	Lipase	0.01-1.0
13	Whitening activator, such as TAED	0.05-1.0
14	Cotton seed extract	0.005-0.50
15	Sodium aluminum silicate	0.5-3.5

[0041] The prepared dry powdered detergent for colored laundry washing and stain removal ensures high regeneration of microdamage to cellulose threads of cotton fiber, increasing the elasticity of colored fabrics, and enhances removal of tightly fixed stains at any tap water hardness 0-15° dH and at any washing temperature from +20°C to +60°C. The average pH range of the product is 10.0-12.5. Malic acid and sucrose should be added to the product base in quantities of 0.1-0.5 and 0.1-0.5 wt.%, respectively. The product does not change the color of the fabric or wash out the dye, it retains the original appearance of the items, does not leave streaks, it can be washed off completely from the surface of the fabric, and it is shelf stable for 24-36 months (observation time).

Example 2.

[0042] Components for formulation into the composition according to the invention were studied in the composition of detergents for washing clothes. A dry detergent, in particular a dry powdered concentrated detergent for washing white fabrics, was prepared within the framework of the present invention (Table 2).

Table 2. Composition of a powdered detergent base for washing white fabrics

Item No.	Component	Content, wt. %
1	Sodium salt of fatty palmitic acid, such as sodium palmitate	0.5-3.5
2	Water softener, specifically sodium silicate	0.1-1.5
3	Anti-resorbent, such as carboxymethylcellulose sodium salt	0.5-3.5
4	Emulsifier, nonionic surfactant, such as laureth-7	3.5-7.0
5	Zeolites	12.0-16.0
6	Excipient, such as sodium sulfate	17.0-21.0
7	Filler, such as sodium carbonate	18.0-22.0
8	Nonionic surfactant, such as laureth-3	0.1-2.0
9	Anionic surfactant, such as sodium coco-sulfate	2.5-6.5
10	Anti-resorbent, such as cellulose derivative	0.1-2.0
11	Enzyme mixture (amylase, protease, mannanase, cellulase)	0.005-2.0
12	Lipase	0.01-1.0
13	Whitening activator, such as TAED	1.5-5.5
14	Cotton seed extract	0.005-0.50

(continued)

Item No.	Component	Content, wt. %
15	Sodium aluminum silicate	0.5-3.5
16	Oxygen bleach, such as sodium percarbonate	10.0-18.0

[0043] The prepared dry powdered detergent for washing white laundry and stain removal ensures high regeneration of microdamage to cellulose threads of cotton fiber, increasing the elasticity of white fabrics, and enhanced removal of tightly fixed stains at any tap water hardness 0-15° dH and at any washing temperature from +20°C to +60°C. The average pH range of the product is 10.0-12.5. Malic acid and sucrose should be added to the product base in quantities of 0.1-0.5 and 0.1-0.5 wt.%, respectively. The product does not cause changes in the whiteness of fabrics, it retains the original appearance of the items, does not leave streaks, it can be washed off completely from the surface of the fabric, and it is shelf stable for 24-36 months (observation time).

Example 3.

[0044] Components for formulation into the composition according to the present invention were studied in the composition of detergents for washing clothes. A dry detergent, in particular a dry universal powdered concentrated detergent for washing white and colored items, was prepared within the framework of the invention (Table 3).

Table 3. Composition of a universal powdered detergent base for washing white and colored fabrics

Item No.	Component	Content, wt. %
1	Sodium chloride	25.5-35.5
2	Sodium carbonate	17.0-27.0
3	Sodium carbonate peroxide	5.0-15.0
4	Sodium sulfate	2.75-12.75
5	Laureth-7	2.0-12.0
6	Sodium bicarbonate	0.9-10.0
7	Sodium palmate	0.8-9.0
8	Citric acid anhydrous	0.76-8.6
9	Silica	0.7-8.0
10	Corn starch	0.5-7.0
11	TAED	0.45-6.5
12	3Na MGDA	0.4-6.0
13	Sodium polyacrylate copolymer	0.4-6.0
14	Enzyme complex (granulate): protease, cellulase, lipase, amylase, pectate lyase, mannanase	0.01-1.0
15	Botamical cotton Extract	0.01-0.5
16	Aqueous solution of citric acid and silver citrate	0.01-0.05

[0045] The prepared dry universal powdered detergent for washing white and colored laundry ensures high regeneration of microdamage to cellulose threads of cotton fiber, increased elasticity of white fabrics, and enhanced removal of tightly fixed stains at any tap water hardness 0-15° dH and at any washing temperature from +20°C up to +60°C. The average pH range of the product is 10.0-12.5. Malic acid and sucrose should be added to the product base in quantities of 0.1-0.5 and 0.1-0.5 wt.%, respectively. The product does not cause changes in the whiteness of fabrics, it retains the original appearance of the items, does not leave streaks, it can be washed off completely from the surface of the fabric, and it is shelf stable for 24-36 months (observation time).

Example 4.

[0046] An electron microscope imaging study was conducted for fibers of fabrics of different density (high-density cotton, medium-density cotton) to assess the damage/repair of fabrics after washing with a dry concentrated detergent for washing colored fabrics using the composition according to the present invention. The powdered concentrated detergent for washing colored items specified in Table 1 was used as a base for introducing the components.

[0047] The test method is based on studying samples of cotton fabrics of different density before and after washing (5, 10) with different systems (sucrose acid obtained by synthesis from sucrose and malic acid; sucrose and malic acid) to determine the effectiveness of regeneration of microdamage in fabric fibers. An assessment was carried out using high-resolution imaging of various areas of the samples, damaged fabric fibers were searched for using topographic and/or compositional contrast. The study examined the effects of two systems (sucrose acid obtained by synthesis from sucrose and malic acid; sucrose and malic acid) on the fiber structures of two fabric samples of different density (high-density cotton, medium-density cotton).

[0048] At the first stage of the study, samples of selected delicate fabrics (100% cotton of different density) were treated with a two-component system (sucrose + malic acid) and synthesized sucrose acid to assess the mutual effect on the structure of the fabrics. Then, the fabric samples were sent to the laboratory to study the surface and structure under an electron microscope in order to visualize damage/recovery after washing with two systems (sucrose acid, obtained by synthesis from sucrose and malic acid; sucrose and malic acid). Three pieces of fabric measuring 1x1 cm^2 each were cut out from the original fabric sample provided for the analysis, placed on carbon tape mounted on an aluminum table, and fixed with adhesive tape along the sample edges. Then, a thin layer of gold was sputtered onto the surface of the samples to remove the electrostatic charge, and the sample was placed in an electron microscope chamber. A preliminary search for the most damaged/restored areas was carried out for subsequent high-resolution imaging using the SEM method (FEI Teneo raster electron microscope). Visualization of the fabric surface was carried out using FEI Helios NanoLab 660 electron-ion microscope (double-beam scanning electron microscope), the most damaged/regenerated areas were detected. The microscope chamber was evacuated to a pressure of ≤10-3 Pa in a high vacuum mode. A general optical image of the samples placed in the camera was captured using a navigation camera, for ease of positioning during the test. The accelerating voltage and current of the electron beam, the detector and its operating mode were selected to obtain images that allow would the best visualization of the sample distinctive objects. To assess the uniformity of the distinctive object distribution on the sample surface and determine the area of interest, a preview of the sample was carried out at low magnification (x100-x200). The choice of the area of interest was determined by the need to display the areas detected at the previous stage of the study.

Test parameters are given in Table 4.

Table 4. Test parameters

Accelerating voltage of the primary electron beam	1-10 kV
Primary electron beam current	0.40 nA
Type of detector used	T1, CBS
2D Image Pixel Size	22.5 nm - 1.70 μm
Horizontal field of view in 2D projection	34.5 μm - 2.76 m
Sample inclination angle	0°

[0049] Following the study results the images obtained were compared and analyzed, and defects in fabric samples were assessed: contamination/presence of particles; damage to fiber/fiber integrity; fluffing after exposure to selected active agents: sucrose and malic acid; sucrose acid.

[0050] The samples were washed once in a Miele washing machine. The following conditions were chosen as testing conditions: temperature 45°C, water hardness 10.9 °dH, and cotton washing mode (100% cotton fabrics of different density). The concentration of the dry concentrated detergent for washing cotton items was 5.0 g/l for a standard washing machine load of 2-4 kg. At the end of the study, the best system for the active agents to influence the fiber structure was selected. The washing results were assessed by visualization on a 5-point scale in comparison with the original:

5 - the fiber structure has been completely restored;
4 - minimum number of fiber defects;
3 - significant cross-linking of the fiber structure can be seen;

2 - fabric delamination can be seen;
1 - large number of fabric defects.

Results.

[0051] It was established based on the results of assessing the effectiveness of regeneration of microdamage in cotton fiber, that the composition under study according to the present invention, formulated into a powdered concentrated detergent for washing colored cotton laundry (Table 1), has an apparent effect. After the first wash the item retains its original shape and does not show microdamage, which appears as small stretch marks or damage to the texture, compared to fabrics washed with the comparison product containing sucrose acid. Visually, a decrease in the number of microdefects was noted, in the form of tears, micro-breaks in fibers invisible to the eye, thanks to visualization using a focused ion beam (22.5 nm) (Figure 1 and Table 5).

[0052] Repeated washing of cotton fabric samples of different density with the addition of the sucrose+malic acid system to a powdered concentrated detergent for washing colored laundry for 2 hours 40 minutes (time for one wash) made it possible to eliminate fabric damage by more than 90%, which means an apparent regeneration of microdamage to cellulose threads of cotton fiber (Figure 1). Repeated washing of fabrics with synthesized sucrose acid did not allow achieving such efficiency and could not cross-link the structure of cotton fibers, which indicates the negative impact of this acid on the structure of the fabric.

Table 5. Evaluation of the effectiveness of restoration of the structure of cotton of different density after treatment with sucrose acid and sucrose + malic acid in 10 washes

Test sample	**Structure restoration**			
	0.1 wt.% sucrose acid		**0.1 wt.% sucrose + 0.25 wt.% malic acid**	
	Before washing	**After washing**	**Before washing**	**After washing**
Sample No. 1 **Max Mara mercerized cotton Blue SVM H4/C40 8022303 Density~130 g/m^2**	2.5	3.5	3.0	4.5*
Sample No. 2 **Suiting and dress cotton Crimson red TRC H10/7/C50 23042360 Density ~ 260 g/m^2**	3.0	3.5	3.0	4.5*
*statistically significant result ($p<0.05$)				

[0053] At the end of the laboratory study, apparent changes were observed in the assessed indicator of regeneration of microdamage to the fibers of cotton fabrics. The fibrous layer of cotton fiber is partially damaged after treatment with sucrose acid, exposing bundles of fibrils consisting of p-D-glucose residues linked by glucosidic bonds. According to the electron microscopy results, the addition of a highly effective system of sucrose and malic acid reduced the amount of microdamage to cotton fibers due to restoration of the damaged fibrous layer, self-regeneration of the fiber and strengthening of its structure. A composition with 0.1 wt.% sucrose and 0.25 wt.% malic acid made it possible to reduce the area of damage to fabric fibers after repeated washing by 90%. The use of sucrose acid showed a greater number of fiber fluffs, delamination and micro-tears of fibers, which shows the need to use pure malic acid in combination with sucrose to level out this effect and regenerate microdamage in the fibers of delicate fabrics.

Example 5.

[0054] An electron microscope imaging study was conducted for fibers of fabrics of different density (high-density cotton, medium-density cotton) to assess the damage/repair of fabrics after washing with a dry concentrated detergent for washing colored fabrics using various concentrations of sucrose and malic acid and without using the system. The purpose of the study was to confirm the regeneration of microdamage to fibers during repeated washing of cotton items and to determine the range of effective concentrations of the selected sucrose and malic acid system according to the present invention to ensure the targeted effect on the cross-linking of p-D-glucose residues linked by glucosidic bonds. A powdered concentrated detergent for washing colored items specified in Table 1 was used as a base for introducing the components. The study was carried out according to the method described in Example 4, under the same conditions. Sucrose and malic acid were added to laundry detergent formulations (pH 10.0-10.5) at concentrations of 0.05%, 0.1%, and 0.2% for sucrose and 0.1%, 0.25%, 0.5% for malic acid. The exposure cycle time was 2 hours 40 minutes, which corresponds to the cotton washing cycle and the recommended washing time for an automatic washing machine. The cycle temperature was 45 degrees. The study tested the effectiveness of sucrose and malic acid at selected concentrations after multiple washes (up to 5 washes).

[0055] The washing results were assessed by visualization on a 5-point scale in comparison with the original:

5 - the fiber structure has been completely restored;
4 - minimum number of fiber defects;
3 - significant cross-linking of the fiber structure can be seen;
2 - fabric delamination can be seen;
1 - large number of fabric defects.

Results.

[0056] It was established based on the results of assessing the effectiveness of regeneration of microdamage in cotton fiber, that the composition under study based on sucrose and malic acid formulated into a dry concentrated detergent for washing cotton laundry has an apparent self-regeneration effect. The cellulose item does not lose its original shape after repeated use, microdamage and tears that look like small stretch marks or damage to the structure are eliminated. Based on the results of assessing the regeneration of microdamage in cotton fibers, it was found that the optimal concentration of sucrose and malic acid ranges within 0.25-0.50 wt.%, since it is these contents of the system components that result in self-regeneration of damaged cellulose fibers without the use of additional agents. At a minimum concentration of 0.05 wt.% sucrose and 0.1 wt.% malic acid in the composition, minimally noticeable restoration of cellulose fibers occurs in the cotton fabrics. Visual assessment using a focused ion beam (22.5 nm) shows a reduction in the number of defects in the form of tears and fiber breaks in proportion to the concentration of the composition, the optimal concentration of sucrose and malic acid being 0.1% to 0.5%, more particular, in the optimal range within 0.25% to 0.5% (Figure 2).

[0057] The ability of sucrose and malic acid to form cross-links between cellulose fibers significantly expands the scope of potential application of the system in household chemicals for self-regeneration of microdamage in cotton fabrics. The fibrous layer of cotton fiber is partially damaged after washing, exposing active hydroxyl groups that interact with various substances. The hydroxyl groups of the amorphous region may be free or weakly bound, as a result of which they are available for sorption. Such hydroxyl groups behave as active sorption centers capable of attracting water. The use of the sucrose and malic acid system as a cross-linking component allows formation of multiple covalent bonds between fabric fibers in everyday conditions, while preserving the structure, appearance, color and increasing the light resistance of items. 5 washes of the cotton fabric samples with the addition of sucrose and malic acid according to the present invention at a concentration of 0.1 wt.% sucrose and 0.25 wt.% malic acid for 2 hours 40 minutes eliminated fabric damage by more than 80% compared to the original appearance, which means an apparent regeneration of microdamage and an increase in strength due to cross-linking of the fiber structure (Table 6).

Table 6. Evaluation of the effectiveness of restoring the structure of cellulose-based fibers after washing with sucrose + malic acid

Test sample	**Fabric structure restoration, score**			
	Effect after 5 washes			
	Product base sucrose and malic acid	**Composition with 0.05 wt.% sucrose and 0.1 wt.% malic acid**	**Composition with 0.1 wt.% sucrose and 0.25 wt.% malic acid**	**Composition with 0.2 wt.% sucrose and 0.5 wt.% malic acid**
Sample No. 1 **Max Mara mercerized cotton Blue SVM H4/C40 8022303 Density~130 g/m^2**	2,0	3,0	4,5*	4,5*

(continued)

Test sample	Fabric structure restoration, score			
	Effect after 5 washes			
	Product base sucrose and malic acid	Composition with 0.05 wt.% sucrose and 0.1 wt.% malic acid	Composition with 0.1 wt.% sucrose and 0.25 wt.% malic acid	Composition with 0.2 wt.% sucrose and 0.5 wt.% malic acid
Sample No. 2 **Suiting and dress cotton Crimson red TRC H10/7/C50 23042360 Density ~ 260 g/m^2**	2,5	3,0	4,5*	4,5*
*statistically significant result ($p<0.05$)				

[0058] At the end of the laboratory study, apparent changes in the assessed parameters were observed, namely, elimination of microdamage in the form of tears and fiber breaks. According to the electron microscopy results, the addition of highly effective sucrose and malic acid to 0.1% sucrose and 0.25% malic acid ensured self-regeneration of fibers of selected cotton fabrics of different density after 5 washes. The composition with a total content of 0.35% sucrose and malic acid in a ratio of 1:2.5 effectively restored damaged fibers of cotton fabrics after repeated washing and did not deteriorate the appearance of the items. The samples of concentrated laundry powder that did not contain sucrose and malic acid showed a greater amount of fluffing, delamination and fiber breaks, which indicates lack of the fabric restoration effect and damage during the washing process of cotton fabrics. Repeated use of the composition based on sucrose and malic acid at a concentration of 0.1% and 0.25 wt.% demonstrates a positive cumulative effect, allowing the restoration of up to 90% of microdamage to cotton fibers in 5 washes. Repeated use of a concentrated detergent for washing cotton items has an aggressive effect on the fiber structure at the microscopic and macroscopic levels, worsening their condition and causing greater fabric defects than a product with sucrose and malic acid.

Example 6.

[0059] A laboratory study was carried out to determine changes in the strength characteristics of samples of selected cotton fabrics after washing with sucrose acid, sucrose and malic acid. The study was necessary to test the hypothesis about improvement of strength characteristics when washing cotton fabrics with sucrose and malic acid. The powdered concentrated detergent for washing colored items specified in Table 1 was used as the basis for the study.

[0060] During wear, textiles experience multiple loads such as stretching, compression, bending and friction. Durability of the fabric and preservation of consumer properties depend on the ability of the material to withstand such exposure. The mechanical properties of textiles are understood as resistance to those factors that deteriorate the structure as a result of prolonged use. The ability of a textile to withstand breaking loads is its tensile strength.

[0061] The test procedure is based on physical and chemical methods, determination of the breaking load and elongation of fabrics. The tests were carried out at an air temperature of 21.6°C, humidity 60%, pressure 97.3 kPa. This procedure enables evaluation of the effect on the structure of fabric fibers, strength and elasticity of items after one wash with a concentrated detergent for washing cotton items with the addition of a system according to the present invention. The testing principle is based on the steel ball method, where a fabric sample of a certain area is clamped in a circle of a fixed base, and a round spherical upper rod is pressed vertically against the sample at a constant movement speed, so that the sample is deformed until it breaks, and tensile strength is measured. The commonly used steel ball tester is an electronic bullet type fabric strength tester or a tensile tester equipped with a steel ball fixture. This is the use of steel spherical surfaces to tear fabric.

[0062] 8 samples of fabrics measuring 50x100 mm each were taken for the test, washed with a concentrated detergent for washing colored items without sucrose, with sucrose, with sucrose and malic acid according to the present invention. The samples were washed once in a Miele washing machine. The following requirements were set as testing conditions: temperature mode 45°C, water hardness 10.9° dH and "cotton items" mode. The concentration of powdered concentrated detergent for washing cotton items was 5.0 g/l for a standard washing machine load of 2-4 kg. Washed fabric samples were tested on Shimadzu AG 10kNX universal testing machine in the longitudinal and transverse directions. Strips of fabricweare fixed on a universal tensile machine and stretched under the influence of a force stop. Data on the weft and warp was recorded, and the arithmetic average was determined, i.e. tensile strength. The tensile strength and elongation of the fabric are determined at the same time. Graphs of changes in the strength characteristics of paired samples are presented in the "force (N) - elongation (mm)" coordinates. The average test results with data on how the strength characteristics of each pair of samples changed relative to the baseline fabric (samples 1-2) for each type of fabric (cotton of different density) are presented in Table 7.

[0063] Breaking load and elongation were determined using Shimadzu AG 10kNX universal testing machine with the help of wedge clamps. Cotton of different density was tested at a speed of 50 mm/min. Breaking load and elongation values were determined for the fabric samples. The sizes and average values of the test series of fabric samples are presented in the table below.

Results.

[0064] Concentrated dry detergent for washing colored items with sucrose and malic acid allows for an increase in the strength and elasticity of the fibers of selected cotton fabrics, which indicates regulation of the elasticity of cellulose fibers and, accordingly, regeneration of microdamage. Exposure to a concentrated powder for washing colored items containing 0.1 wt.% sucrose and 0.25 wt.% malic acid gives better results in terms of strength characteristics for cotton of different density than the effect of concentrated powder for washing colored items containing 0.25 wt.% sucrose acid on the structure of fabrics (Table 7).

Table 7. Evaluation of the strength characteristics of cotton of different density after washing with sucrose and malic acid and with sucrose acid

<table>
<tr><th>Composition</th><th>Fabric</th><th>Breaking load, N</th><th>Elongation, mm</th><th>Difference, % Strength</th><th>Difference, % Elasticity</th></tr>
<tr><td>5 washes with 0.25 wt.% sucrose acid</td><td rowspan="4">Max Mara mercerized cotton Blue SVM H4/C40 8022303 Density -130 g/m²</td><td>62.94*</td><td>16.38</td><td rowspan="2">-50.55</td><td rowspan="2">+36.63* fabric strengthening</td></tr>
<tr><td>10 washes with 0.25 wt.% sucrose acid</td><td>31.12</td><td>10.38*</td></tr>
<tr><td>5 washes with 0.1 wt.% sucrose и 0,25 wt.% malic acid</td><td>34.03</td><td>9.70*</td><td rowspan="2">+34.37* fabric strengthening</td><td rowspan="2">-34.46</td></tr>
<tr><td>10 washes with 0.1 wt.% sucrose and 0.25 wt.% malic acid</td><td>51.85*</td><td>14.80</td></tr>
<tr><td>5 washes with 0.25 wt.% sucrose acid</td><td rowspan="4">Suiting and dress cotton Crimson red TRC H10/7/C50 23042360 Density ~ 260 g/m²</td><td>110.53*</td><td>15.62*</td><td rowspan="2">-46.75</td><td rowspan="2">-8.7</td></tr>
<tr><td>10 washes with 0.25 wt.% sucrose acid</td><td>58.85</td><td>17.11</td></tr>
<tr><td>5 washes with 0.1 wt.% sucrose and 0.25 wt.% malic acid</td><td>67.47*</td><td>16.43</td><td rowspan="2">-34.51</td><td rowspan="2">+1.64* fabric strengthening</td></tr>
<tr><td>10 washes with 0.1 wt.% sucrose and 0.25 wt.% malic acid</td><td>44.18</td><td>16.16*</td></tr>
<tr><td colspan="6">*significant result</td></tr>
</table>

[0065] Samples of cotton fabrics of different density, washed with laundry detergent with 0.1 wt.% sucrose and 0.25 wt.% malic acid, showed an increase in the breaking load in Newtons by 34.37% and a decrease in the elongation of the fabric in mm by 1.64%, which indicates an improvement in the strength and elasticity of the item fibers and regeneration of microdamage with sucrose and malic acid. Cotton fabric samples of different density washed with laundry detergent containing 0.25 wt% sucrose acid demonstrated a -50.55% reduction in breaking load and a +36.63% increase in elongation. This means a decrease in strength, but an increase in elasticity of the fabric fibers and proves that sucrose acid does not have an effective impact on the structure of the fabric.

Example 7.

[0066] Changes in the strength characteristics of samples of selected cellulose fabrics were studied after repeated washing with sucrose and malic acid formulated into the composition. The study was necessary to test the hypothesis about improvement in strength characteristics during repeated washing of cotton fabrics with the composition according to the present invention. The powdered concentrated detergent for washing colored items specified in Table 1 was used for the study.

[0067] The study was carried out according to the method described in Example 6 under the same conditions to confirm the effectiveness of sucrose and malic acid for repeated use in washing cotton items. Sucrose and malic acid were used in concentrations of 0.05%, 0.1% and 0.2% for sucrose and 0.1%, 0.25%, 0.5% for malic acid, respectively. The cycle time for the fabric structure exposure was 2 hours 40 minutes (for 1 wash), which corresponds to the "cotton fabrics" automatic washing mode.

[0068] At the end of the tensile strength, elongation at break and load at constant elongation tests, the selected concentrations of sucrose and malic acid were assessed for repeated use in detergent for colored items (up to 5 washes).

Results.

[0069] It was established based on the assessment results of the strength and elasticity of the structure of cotton fabrics of different density, that the composition under study with the addition of an optimal concentration of 0.05 wt.% to 0.2 wt.% sucrose and 0.1 wt.% to 0.5 wt.% malic acid, respectively, formulated into a powdered concentrated detergent for washing colored laundry has an apparent effect. After repeated use the cellulose item does not lose its original shape due to deformation or microdamage to the fibers. An increase in breaking load in Newtons and elongation in mm was experimentally observed using Shimadzu AG 10kNX with the optimal concentration of sucrose and malic acid established within the range from 0.05%, 0.1% and 0.2% for sucrose and 0.1%, 0.25%, 0.5% for malic acid (Table 8).

Table 8. Evaluation of the strength characteristics of the surface of cotton fabrics of different density during repeated washing with sucrose and malic acid

<table>
<tr><th>Composition</th><th>Fabric</th><th colspan="2">Breaking load, N</th><th colspan="2">Elongation, mm</th><th colspan="2">Stress, N/mm</th></tr>
<tr><td colspan="8">Medium density cotton</td></tr>
<tr><td>Reference</td><td>Max Mara mercerized cotton Blue SVM H4/C40 8022303</td><td colspan="2">58.00</td><td colspan="2">20.93</td><td colspan="2">2.77</td></tr>
<tr><td>After 5 washes with 0.05 wt.% sucrose and 0.1 wt.% malic acid</td><td></td><td>87.01*</td><td>+50.02%</td><td>26.21</td><td>+25.22%</td><td>3.32*</td><td>+19.85%</td></tr>
<tr><td>After 5 washes with 0.1 wt.% sucrose and 0.25 wt.% malic acid</td><td></td><td>94.06*</td><td>+62.17%</td><td>25.35*</td><td>+21.11%</td><td>3.71*</td><td>+33.93%</td></tr>
<tr><td></td><td>Density ~130 g/m^2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">High density cotton</td></tr>
</table>

(continued)

	Density ~130 g/m^2						
Reference	**Suiting and dress cotton Crimson red TRC H10/7/C50 23042360** **Density ~ 260 g/m^2**	60.15		22.45		2.67	
After 5 washes with 0.05 wt.% sucrose and 0.1 wt.% malic acid		**78.52***	+30.54%	**26.34**	+17.33%	**2.98***	+11.61%
After 5 washes with 0.1 wt.% sucrose and 0.25 wt.% malic acid		**67.47***	+12.17%	**16.43***	-26.81%	**4.1 ***	+53.55%
After 5 washes with 0.2 wt.% sucrose and 0.5 wt.% malic acid		**84.38***	+40.28%	**24.89***	+10.86%	**3.4***	+27.34%

[0070] The data obtained from the tensile test can determine the elastic limit, elongation, modulus of elasticity, proportional limit, area reduction, tensile at break, tensile strength test and other indicators of the material tensile strength. This helps accurately determine the structural and mechanical properties of cotton fabrics mediated by the regeneration of microdamage.

[0071] The force required to tear cotton fabrics increases with the addition of sucrose and malic acid according to the present invention. For medium density cotton, the breaking force, measured in Newtons, increases from 58 N to 87.0 N at a sucrose concentration of 0.05 wt.% and malic acid 0.1 wt.% and to 94.06 N at a sucrose concentration of 0.1 wt. % and malic acid 0.25 wt.% after 5 washes, which means an apparent restoration and strengthening of cotton fibers. The breaking force depends on the thickness of the fibers and yarn, therefore, for high density cotton fibers the breaking load increases from 60.15 N to 78.52 N (+30.54% of the value) at a concentration of sucrose of 0.05 wt.% and malic acid 0.1 wt.% and up to 84.38 N (+40.28% to the value) at a concentration of sucrose 0.2 wt.% and malic acid 0.5 wt.% after 5 washes, which indicates an apparent restoration of microdamage and strengthening high density cotton fibers.

[0072] The tensile elongation before breaking is called elongation at break, and it indicates the ability of a textile material to resist deformation when stretched. With the addition of sucrose and malic acid according to the present invention, the elongation at break increases. For medium density cotton, the percentage of elongation relative to the baseline length increased from 20.93 mm to 26.21 mm (+25.22% of the value) at a concentration of sucrose of 0.05 wt.% and malic acid of 0.1 wt.% and up to 25.35 mm (+21.11% to the indicator) at a concentration of 0.2 wt.% and malic acid 0.5 wt.% after 5 washes. For high-density cotton, fiber elongation increased from 22.45 mm to 26.34 (+11.61% of the value) at a concentration of 0.1 wt.% each component of sucrose and malic acid and to 24.89 mm (+27.34 % to the indicator) at a concentration of 0.5 wt.% each component of sucrose and malic acid after 5 washes. With an increase in the tensile elongation value, the value of the force increases, since the fabric becomes more elastic and more difficult to tear, which has a positive effect on the structural and mechanical characteristics of the fiber and its wear resistance.

[0073] The relative strength of a fabric is characterized by the maximum tension force per unit fineness of fiber or yarn. The addition of sucrose and malic acid according to the invention helps to increase the tension of fabrics made from cellulose fibers. For medium-density cotton, the stress increases from 2.77 N/mm to 3.32 N/mm (+19.85% of the value) at a concentration of sucrose of 0.05 wt.% and malic acid of 0.1 wt.% and up to 3 .71 N/mm (+33.93% to the value) at a concentration of sucrose of 0.2 wt.% and malic acid of 0.5 wt.%. For high-density cotton, the stress increases from 2.67 N/mm to 2.98 N/mm (+11.61% of the value) at a concentration of sucrose of 0.05 wt.% and malic acid of 0.1 wt.% and up to 3 .4 N/mm (+27.34% to the value) at a concentration of sucrose of 0.2 wt.% and malic acid of 0.5 wt.%.

[0074] The properties of a material in terms of deformation and damage under tensile forces can be measured from a stress-strain curve, which is one of the most fundamental and important concepts in mechanics of materials. The horizontal coordinate of the curve is the strain, and the vertical coordinate is the stress. The shape of the curve reflects various deformation processes occurring in the material under the influence of external forces. The curves representing the relationship between load and tensile elongation of a textile material (Figures 3a-f) show that a composition based on sucrose and malic acid reduces a significant increase in elongation at a significant increase in the resistance to the load applied, which proves strengthening and increase in strength of cotton fabrics after its use.

[0075] Changes in the dimensions of textile materials under prolonged exposure to a load significantly less than the tensile load (i.e., creep and stress relaxation) upon termination of deformation, as well as strain relaxation (during rest) are important characteristics of mechanical properties that are of great importance in the use of items. Relaxation characteristics depend on the fibrous composition and structure of the material and largely determine properties of the materials.

[0076] Elastic deformation occurs, because under the influence of an external force small changes appear in the average distances between adjacent links and atoms in the macromolecules of the fibers that make up delicate fabrics. Elastic deformation cannot be great, when particles are removed over long distances, the connection between them is disrupted, cracks and breaks appear.

[0077] σe means the tensile yield point of the material and represents the maximum stress at which the material remains elastically deformed. In the elastic phase there is a special linear segment with a linear relationship between σ and ε. This is called the proportional phase, also known as the linear elastic phase.

[0078] After the load exceeds σe to a certain value, the linear relationship between stress and strain is broken, the strain increases significantly, and uniform plastic deformation occurs. This phenomenon of increasing resistance to plastic deformation as plastic strain increases is known as work hardening or strain hardening.

[0079] The uniform deformation phase of the sample ends when the stress reaches σb. This maximum stress σb is called the tensile strength or ultimate tensile strength of the material and shows the material resistance to maximum uniform plastic strain, that is, the maximum stress that the material can withstand before tensile failure. (Table 9). After reaching the stress value σb, the sample begins to deform unevenly and form a shrinkage neck, the stress drops, and finally the sample collapses (breaks) when the stress reaches σc. σc is the fracture strength of a material, which represents the ultimate resistance of the material to plasticity. In general, indicators of the plastic properties of a material are elongation and reduction in area.

Table 9. Evaluation of the tensile strength index σb of cotton fabrics of different density after washing with different concentrations of the composition of sucrose and malic acid

Composition	**After 5 washes with 0.05 wt.% sucrose and 0.1 wt.% malic acid**		**After 5 washes with 0.1 wt.% sucrose and 0.25 wt.% malic acid**		**After 5 washes with 0.2 wt.% sucrose and 0.5 wt.% malic acid**	
Test sample	**Tensile strength index, σb**		**Tensile strength index, σb**		**Tensile strength index, σb**	
	Force, N	**Elongation, mm**	**Force, N**	**Elongation, mm**	**Force, N**	**Elongation, mm**
Max Mara mercerized cotton Blue SVM H4/C40 8022303 Density~130 g/m²	86.10	24.72	36.7	9.78	90.34	26.36
Suiting and dress cotton Crimson red TRC H10/7/C50 23042360 Density ~ 260 g/m²	79.7	26.22	65.8	16.6	82.66	25.14

[0080] The addition of sucrose and malic acid to the composition according to the present invention in concentrations of 0.1% sucrose and 0.25% malic acid gives the most optimal values of the tensile strength index σb for both cotton fabrics. The applied force for the maximum tensile stress 36.7 N for medium density cotton and 65.8 N for high density cotton at sucrose and malic acid concentrations ranging from 0.1 wt.% to 0.2 wt. % for sucrose and from 0.25 wt.% to 0.5 wt. % for malic acid elongates the fabric by 9.78 mm for medium density cotton and 16.6 mm for high density cotton. Addition of sucrose and malic acid in concentrations from 0.1 wt.% to 0.2 wt. % for sucrose and from 0.25 wt.% to 0.5 wt. % for malic acid into concentrated colored laundry detergent powder increases the applied force for maximum tensile stress to 90.34 N for medium density cotton and 82.66 N for high density cotton and elongates the fabric by 26.36 mm for medium density cotton and by 25.14 mm for high density cotton. Higher concentrations of sucrose and malic acid have a greater effect on tensile strength, which indicates strengthening of the cotton fabrics, increasing their elasticity and strength at the same time.

Example 8.

[0081] A study was conducted to determine the measurement of color differences between samples of selected fabrics (cotton of different density) after repeated washing with sucrose acid and sucrose+malic acid according to the present invention. The study serves to test the hypothesis about improving the color retention of products when cotton fabrics are repeatedly washed with the composition according to the present invention: sucrose and malic acid. The powdered concentrated detergent for washing colored items specified in Table 1 was used as a research product.

[0082] Discoloration or changing color of dyed fabrics can be assessed using a color fastness test. The transfer of some of the dye from the originally attached fibers to other adjacent fabrics is called dyeing or dye transfer. Dyeing depends on how much of the sample color was applied to the standard adjacent fabric or how much the adjacent fabric was discolored.

[0083] The test procedure is based on the generally accepted recommendations of the international standard ISO 7724-3:1984 "Paints and varnishes - Colorimetry - Part 3: Calculation of color differences", to determine the differences between samples in color coordinates. The International Commission has recommended two calculation formulas for general use. One of them in the color coordinate system L*, a*, b*, V (CI ELAB system) is recommended for determining color differences. The possibility of its use for colorimetric assessment of color differences has been proven in practice.

[0084] This test hepls evaluate the effectiveness of the composition by the degree of color retention of cellulose materials, after actual washing conditions. Washing was carried out in a Bosch WAB 24272 CE washing machine. The following recommendations were chosen as testing conditions: temperature 45°C, water hardness 10.9° dH, and automatic washing mode (cotton fabrics, 2 hours 40 minutes). The concentration of the dry concentrated detergent for washing colored laundry was 4.5 g/l for a standard washing machine load of 2-4 kg. After washing selected fabric samples with a product containing a composition with sucrose and malic acid, and with sucrose acid, the differences in color, lightness, color tone and color purity of the test fabric sample and the comparison sample (reference) were determined by their color coordinates (L *, a *, b*) using a Konica Minolta Chroma Meters colorimeter model CR-400 with a measuring area of 8 mm. Three repetitions were performed (n=3), the error was no more than 0.1% for each sample. Measurement time, the minimum interval between measurements was 1-3 seconds. The values are based on the total color difference ΔE^*_{ab} between two colors, i.e. the geometric distance between two points of color space (L*, a*, b*), which are calculated by the formula: $\Delta E^*_{ab} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$. The method has many advantages, such as, high accuracy, reproducibility, and low error (less than 5%). Effective and statically significant is a difference of 2 or more units of ΔE^*_{ab}.

Results.

[0085] Based on the results of assessing the color preservation of fabrics, it was found that the studied composition based on sucrose and malic acid formulated into a dry concentrated detergent for washing cotton items has an apparent effect in terms of preserving color tone, saturation, color purity, and the complete color difference of the fabric compared to the comparison detergent containing sucrose acid (Table 10)

Table 10. Evaluation of the color retention of cellulose fabrics after repeated washing with sucrose + malic acid and with sucrose acid

Composition	Reference sample		Experiment No. 1 5 washes with 0.1 wt.% sucrose and 0.25 wt.% malic acid		Experiment No. 2 5 washes with 0.25 wt.% sucrose acid	
Parameters	Medium density cotton	High density cotton	Medium density cotton	High density cotton	Medium density cotton	High density cotton
L_{mean}[1]	42.62	42.73	43.86	40.59	44.68	39.70
a_{mean}	-3.56	49.52	-3.81	49.32	-4.42	44.36
b_{mean}	-40.21	-5.04	-38.48	-5.74	-38.39	-3.01
h	84.94	-4.84	84.34	-6.64	83.43	-3.89
C	40.36	59.74	38.66	49.65	38.64	44.46
ΔC[3]	-	-	**-1.70**	**-0.13**	**-1.72**	**-5.39**
Δh[4]	-	-	**-0.60**	**-0.82**	**-1.51**	**1.92**
ΔL_{mean}[2]	-49.63	-48.91	**1.23**	**-2.14**	**2.05**	**-3.04**

(continued)

Composition / Parameters	Reference sample		Experiment No. 1 5 washes with 0.1 wt.% sucrose and 0.25 wt.% malic acid		Experiment No. 2 5 washes with 0.25 wt.% sucrose acid	
	Medium density cotton	High density cotton	Medium density cotton	High density cotton	Medium density cotton	High density cotton
ΔE_{mean}[5]	65.83	76.29	**2.18**	**2.30**	**3.08**	**6.42**

[1]$L_{sample\ mean}$ and $L_{st.sample\ mean}$ are saturation values for the test sample and the reference sample.
[2]If "ΔL" has a "+", the sample under study is lighter than the reference one, if "-", it is darker (more intensely colored).
[3]ΔC is color purity. If "+", the sample is more saturated than the reference one, if "-", the sample is less saturated, the color is dirtier.
[4]Δh-difference in color tone compared to the reference sample color is determined depending on the sign.
The color tone of the silk is blue, the sign is "-", the sample is greener compared to the reference one.
The color tone of the wool is red, the sign is "+", the sample is yellower compared to the reference one.
[5]ΔE is a complete color difference. If the value is greater than 2, then the color difference is significant.

[0086] Washing cotton fabrics with colored washing powder with sucrose and malic acid promotes more intense coloring of high density cotton fabric. For medium density cotton, a smaller ΔL value was observed, for high density cotton a larger ΔL value was observed.

[0087] Washing cotton fabrics with a concentrated powder for washing colored items with a composition based on sucrose and malic acid helps partially preserve the purity of the color. The color of cotton samples of different density is slightly more saturated than that of the reference sample, since the ΔC value is negative, with a "-" sign. The ΔC values obtained for selected cellulose fibers in experiment No. 1 showed the best results. A smaller negative ΔC value was observed for both medium density and high density cottons.

[0088] Washing cotton fabrics with concentrated powder for washing colored items contributes to a smaller difference in the color tone of the baseline fabric sample; the shade of the reference color is preserved, since the Δh values obtained in experiment No. 1 for cottons of different density are closer in value to zero. The use of a composition based on sucrose and malic acid facilitates regeneration of microdamage to the fibers of cotton fabrics and, consequently, maintains the brightness and purity of color.

[0089] The differences in total color tone ΔE for the selected cellulose fabrics, less significant in magnitude, were observed in experiment No. 1, which confirms the hypothesis that addition of the sucrose and malic acid system to the composition of a concentrated powder for washing colored fabrics contributes not only to the regeneration of microdamage to fibers, but also contributes to less color leaching from the cotton fabrics. Sucrose in combination with malic acid contributes to fixation of the dye and its less leaching due to the restoration of fibers, formation of a protective layer on the cotton fiber surface without the use of additional agents.

Example 9.

[0090] A study was conducted to measure the color difference between samples of selected cellulose-based fabrics after repeated washing with a sucrose+malic acid system. The study was necessary to test the hypothesis about preservation of the color of products during repeated washing of cotton fabrics with a new composition based on sucrose and malic acid. The powder used for the study was a powdered concentrated detergent for washing colored items, specified in Table 1.

[0091] The study was conducted according to the procedure described in Example 8 under the same conditions to confirm the effectiveness of the sucrose and malic acid system when used repeatedly during washing of cotton items. Sucrose and malic acid were added at a concentration of 0.1 wt.% for sucrose and 0.25 wt.% for malic acid. The exposure cycle time for the fabric structure was 2 hours 40 minutes, which corresponds to the automatic "cotton fabrics" mode.

[0092] At the end of the study, the color difference was measured using a spectrophotometer in color coordinates L, a, b on three different areas of the fabric sample treated with a composition of sucrose and malic acid formulated into the detergent for repeated use (up to 5 washes).

Results.

[0093] Based on the results of assessing the differences in color, lightness, color tone and color purity of the pigments, it was established that the studied composition based on 0.1 wt.% sucrose and 0.25 wt.% malic acid formulated into a powdered concentrated detergent for washing colored laundry has an apparent effect. It has been established that after repeated use the product does not lose its original color due to the effect of the composition according to the invention on the structure of the fibers. ΔE^*_{ab} convergence is within 0.6.

[0094] Preservation of the color characteristics of cotton fabrics of different density was experimentally and visually noted with the help of a stand-alone portable device Konica Minolta Chroma Meters model CR-400 using 0.1 wt.% sucrose and 0.25 wt.% malic acid (Table 11).

Table 11. Evaluation of the preservation of the color characteristics of cellulose fabrics after repeated washing with sucrose and malic acid

Parameters	**Standard sample for testing with product base**		**After 1 wash with 0.1 wt.% sucrose and 0.25 wt.% malic acid**		**After 5 washes with 0.1 wt.% sucrose and 0.25 wt.% malic acid**		**After 5 washed with the product base** without the composition according to the present invention	
	Medium density cotton	**High density cotton**	**Medium density cotton**	**High density cotton**	**Medium density cotton**	**High density cotton**	**Medium density cotton**	**High density cotton**
L_{mean}[1]	42.62	42.73	43.24	41.62	43.86	40.59	45.18	41.61
a_{mean}	-3.56	49.52	-3.98	48.13	-3.81	49.32	-4.59	43.79
b_{mean}	-40.21	-5.04	-38.19	-3.90	-38.48	-5.74	-38.35	-3.29
h	84.94	-4.84	84.05	-4.63	84.34	-6.64	83.17	-4.30
C	40.36	59.74	38.40	48.29	38.66	49.65	38.62	43.92
ΔC	-	-	-1.97	-1.49	**-1.70**	**-0.13**	-1.74	-5.86
Δ h	-	-	-0.89	1.18	**-0.60**	**-0.82**	-1.77	1.51
ΔL_{mean}	-49.63	-48.91	0.62	-1.11	**1.23**	**-2.14**	2.56	-1.12
ΔE_{mean}	65.83	76.29	2.25	2.20	**2.18**	**2.30**	3.56	6.16

[0095] According to the study results, there was a cumulative effect of increasing the brightness, saturation, and overall color tone of the tested cotton fabrics after repeated use of the composition according to the present invention, which indicated preservation of the original color of the clothing (Table 12).

Table 12. Evaluation of the preservation of the color characteristics of cellulose fabrics after repeated washing with a composition of sucrose and malic acid

Composition	**Effects of multiple washes with sucrose and malic acid, %**		**Effects of multiple washes with the base without the composition, %**	
Parameters	**Medium density cotton**	**High density cotton**	**Medium density cotton**	**High density cotton**
ΔC	15%	32%	15%	75%
Δ h	48%	43%	50%	22%
ΔL_{mean}	50%	48%	75%	1%
ΔE_{mean}	**3%**	**4%**	37%	65%

[0096] At the end of the laboratory study, apparent changes in the assessed parameters were observed in terms of the preservation of color characteristics. According to the changes in measures, the addition of a highly effective composition based on sucrose and malic acid to the composition of a concentrated powder for washing colored items made it possible to preserve the color of cotton fabrics and inhibit the transfer of dyes. A composition based on 0.1 wt.% sucrose and 0.25 wt.% malic acid made it possible to preserve color from fading by 97% for medium density cotton and 96% for high density cotton after 5-fold washing, which is a statistically significant result in maintaining the color of laundry after repeated washing ($p<0.05$). A sample of the base without the composition according to the present invention showed poor fiber fading prevention, indicating that the surfactants and other ingredients are not effective enough for creating a protective layer around clothing and preventing fading.

Claims

1. A concentrate laundry washing composition comprising the following components:

   A) sucrose; and
   B) 2-Hydroxybutanedioic acid.

2. Use of a concentrate composition for laundry washing, said composition comprising the following components:

   A) sucrose; and
   B) 2-Hydroxybutanedioic acid.

3. The concentrate laundry washing composition of claim 1 or the use of claim 2, wherein the mass ratio of said components is the following:

A	:	B
0.05-0.5, preferably 0.1-0.5		0.1-0.5

4. The concentrate laundry washing composition or use of any of the preceding claims, wherein said concentrate composition is assembled as

   i) a single composition comprising both components A) and B), or
   ii) as a kit-of-parts, wherein said kit-of-parts separates components A) and B).

5. The concentrate laundry washing composition or use of any of the preceding claims, wherein said component A) is further defined by at least one of the following:

   i) is naturally occurring or is produced produced synthetically or biotechnologically from microorganisms, including fungi or bacteria;
   ii) has the CAS number 57-50-1.

6. The concentrate laundry washing composition or use of any of the preceding claims, wherein said component B) is further defined by at least one of the following:

   i) is the naturally occurring form or is produced synthetically or biotechnologically from microorganisms, including fungi or bacteria;
   ii) is D-Hydroxybutanedioic acid, L-Hydroxybutanedioic acid or a racemate of D/L-Hydroxybutanedioic acid;
   iii) has one of the CAS numbers selected from the group consisting of 636-61-3, 97-67-6, 617-48-1 and 6915-15-7.

7. The concentrate laundry washing composition or use of any of the preceding claims, wherein said concentrate composition comprises

   - component A) as per the following wt.% or ranges defined by the following wt.%: 0.1, 0.2, 0.3, 0.4, 0.5, and combinations thereof, including 0.1-0.4 wt.%, 0.1-0.3 wt.%, 0.1-0.2 wt.%, 0.2-0.5 wt.%, 0.2-0.4 wt.%, 0.2-0.3 wt.%, 0.3-0.5 wt.%, 0.3-0.4 wt.%, 0.4-0.5 wt.%;
   and/or
   - component B) as per the following wt.% or ranges defined by the following wt.%: 0.1, 0.2, 0.3, 0.4, 0.5, and combinations thereof, including 0.1-0.4 wt.%, 0.1-0.3 wt.%, 0.1-0.2 wt.%, 0.2-0.5 wt.%, 0.2-0.4 wt.%, 0.2-0.3 wt.%, 0.3-0.5 wt.%, 0.3-0.4 wt.%, 0.4-0.5 wt.%.

8. The concentrate laundry washing composition or use of any of the preceding claims, wherein said concentrate composition comprises components A) and B) as per the following options

Option	A [wt.%]	B [wt.%]
1	0.1-0.5	0.1-0.5

(continued)

Option	A [wt.%]	B [wt.%]
2	0.25-0.50	0.25-0.50
3	0.05	0.1
4	0.1	0.25
5	0.2	0.5

9. An application laundry washing composition comprising 0.05-1.0 wt.%, preferably 0.1-1.0 wt.%, further preferably 0.35 wt.% of said concentrate laundry washing composition of any of the preceding claims.

10. The concentrate or application laundry washing composition or use of any of the preceding claims, said composition not comprising at least one of the following:

- hydrogen peroxide or active oxygen,
- surfactants,
- chelates.

11. The concentrate or application laundry washing composition or use of any of the preceding claims, wherein said composition is a formulation selected from the following: solution, paste, gel, powder, granulate, wherein said formulation is preferably a powder formulation.

12. Use of the concentrate or application laundry washing composition of any of the preceding claims for hand and/or machine laundry washing, preferably of fabrics comprising cotton fibers.

13. The use of claim 12, wherein said uses comprises at least one of the following:

i) cotton fiber microdamage repair;
ii) cotton fiber regeneration;
iii) cotton fiber elasticity regulation, including increasing of elasticity of said cotton fibers,
wherein preferably said microdamage and/or elasticity loss is caused by previous washing treatments, mechanical stress, tension, heat and sunlight exposure of said cotton fabric fibers;
iv) brightness care of colored fabrics;
v) removal and/or preventing creases on said fabrics comprising cotton fibers after washing of said fabrics.

14. The concentrate or application laundry washing composition or use of any of the preceding claims, wherein

i) said composition has a pH of 8.0 to 12.5, preferably selected from the following pH sub-ranges: 8.5-12.0, 9.0-11.5, 9.5-11.0, 10.0-10.5, and combinations thereof;
and/or
ii) said use of the composition is for use at

- a pH of 8.0 to 12.5, preferably selected from the following pH sub-ranges: 8.5-12.0, 9.0-11.5, 9.5-11.0, 10.0-10.5, and combinations thereof;
and/or
- a temperature range of +15 °C to +60 °C, preferably selected from the following temperature sub-ranges: +20 °C to +60 °C, +20 °C to +55 °C, +30 °C to +55 °C, +40 °C to +55 °C, and combinations thereof.

15. A method for cleaning fabrics and/or for fabric care, preferably of fabrics comprising cotton fibers, said method comprising:

a) solving the concentrate or application laundry washing composition of any of the preceding claims in water for obtaining an aqueous solution;
b) optionally, adjusting

- the pH of said aqueous solution to a pH of a pH of 8.0 to 12.5, preferably selected from the following pH sub-

ranges: 8.5-12.0, 9.0-11.5, 9.5-11.0, 10.0-10.5, and combinations thereof; and
- a water hardness of 0-15 °dH; and

c) applying said aqueous solution to said fabric, preferably at a temperature range of 15 °C to 60 °C, further preferably selected from the following temperature sub-ranges: +20 °C to +60 °C, +20 °C to +55 °C, +30 °C to +55 °C, +40 °C to +55 °C, and combinations thereof.

Microscopic assessment of the surface of cotton fabrics of different density after exposure to two systems (sucrose acid; sucrose+malic acid)

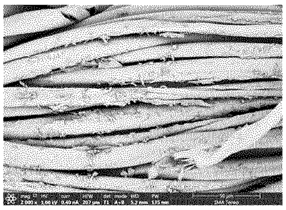
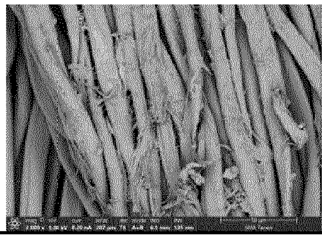
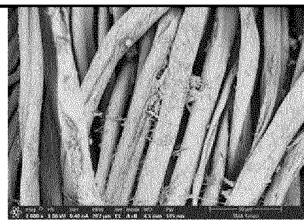
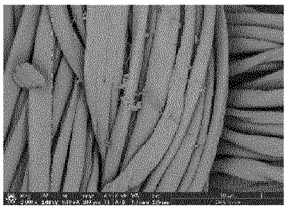
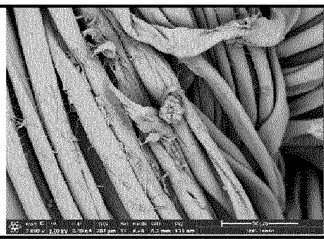
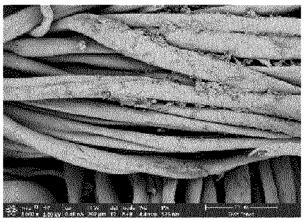
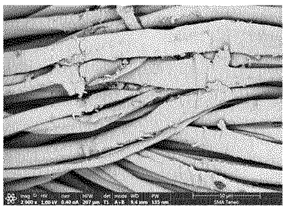
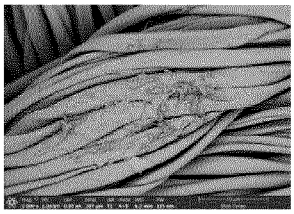
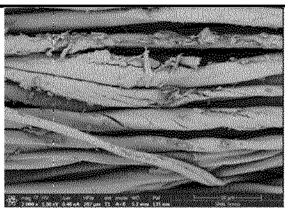
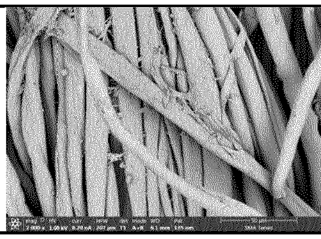
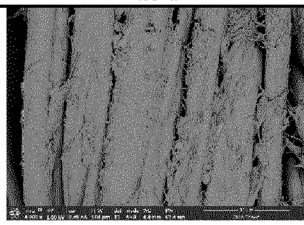
Fabric sample	High density cotton reference sample	After 5 washes with the addition of 0.1 wt.% sucrose acid	After 10 washes with the addition of 0.1 wt.% sucrose acid
Suiting and dress cotton Crimson red TRC H10/7/C50 23042360 Density ~ 260 g/m^2			
Fabric sample	**High density cotton reference sample**	**After 5 washes with the addition of 0.1 wt.% sucrose acid**	**After 10 washes with the addition of 0.1 wt.% sucrose acid**
Max Mara mercerized cotton Blue SVM H4/C40 8022303 Density~130 g/m^2			
Fabric sample	**Medium density cotton reference sample**	**After 5 washes with the addition of 0.1 wt.% sucrose acid and 0.25 wt.% malic acid**	**After 10 washes with the addition of 0.1 wt.% sucrose acid and 0.25 wt.% malic acid**
Max Mara mercerized cotton Blue SVM H4/C40 8022303 Density~130 g/m^2			
Fabric sample	**High density cotton reference sample**	**After 5 washes with the addition of 0.1 wt.% sucrose acid and 0.25 wt.% malic acid**	**After 10 washes with the addition of 0.1 wt.% sucrose acid and 0.25 wt.% malic acid**
Suiting and dress cotton Crimson red TRC H10/7/C50 23042360 Density ~ 260 g/m^2			

Fig. 1

Microscopic evaluation of the surface of cotton fabrics after treatment with different concentrations of sucrose and malic acid in 5 washes

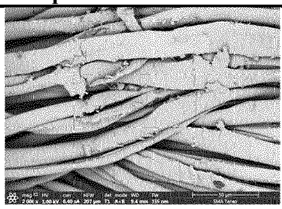
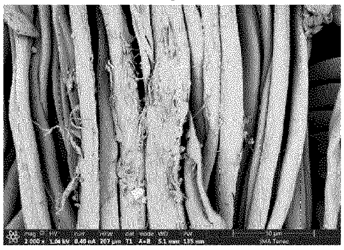
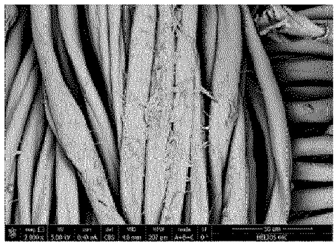
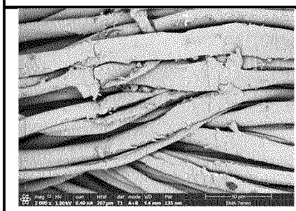
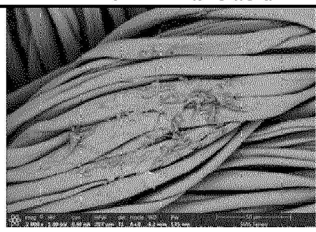
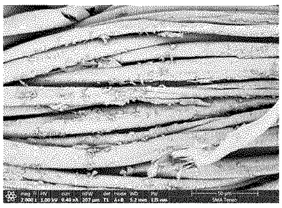
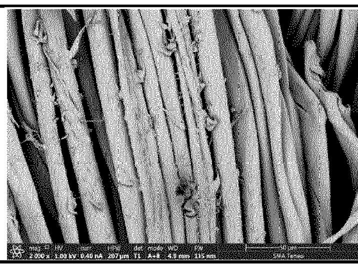
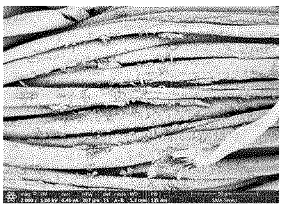
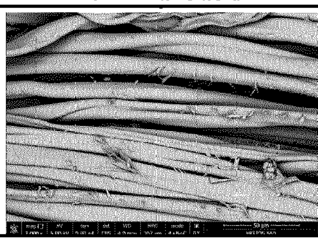
Fabric sample	Before washing with a composition according to the present invention	After 5 washes with the product base	After 5 washes with the composition of 0.05% sucrose and 0.1% malic acid
Max Mara mercerized cotton Blue SVM H4/C40 8022303 Density ~130 g/m^2			
	До стирки с композицией по изобретению	After 5 washes with the composition of 0.1% sucrose and 0.25% malic acid	After 5 washes with the composition of 0.2% sucrose and 0.5% malic acid
			
Fabric sample	Before washing with a composition according to the present invention	After 5 washes with the product base	After 5 washes with the composition of 0.05% sucrose and 0.1% malic acid
Suiting and dress cotton Crimson red TRC H10/7/C50 23042360 Density ~ 260 g/m^2			
	Before washing with a composition according to the present invention	After 5 washes with the composition of 0.1% sucrose and 0.25% malic acid	After 5 washes with the composition of 0.2% sucrose and 0.5% malic acid
			

Fig. 2

Stress-strain curve after 5 washes with 0.05 wt.% sucrose and 0.1 wt.% malic acid for medium density cotton

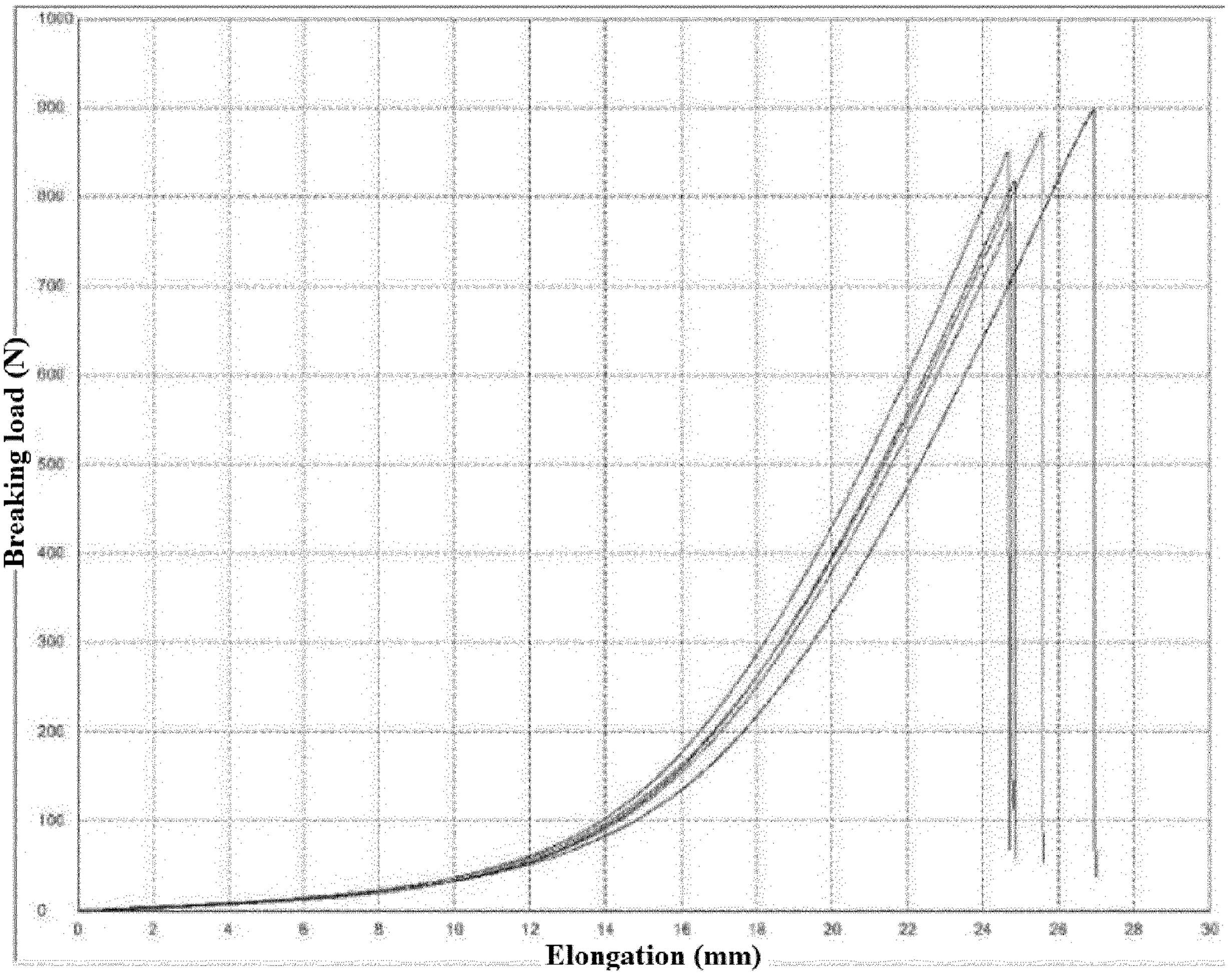


Fig. 3a

Stress-strain curve after 5 washes with 0.05 wt.% sucrose and 0.1 wt.% malic acid for high density cotton

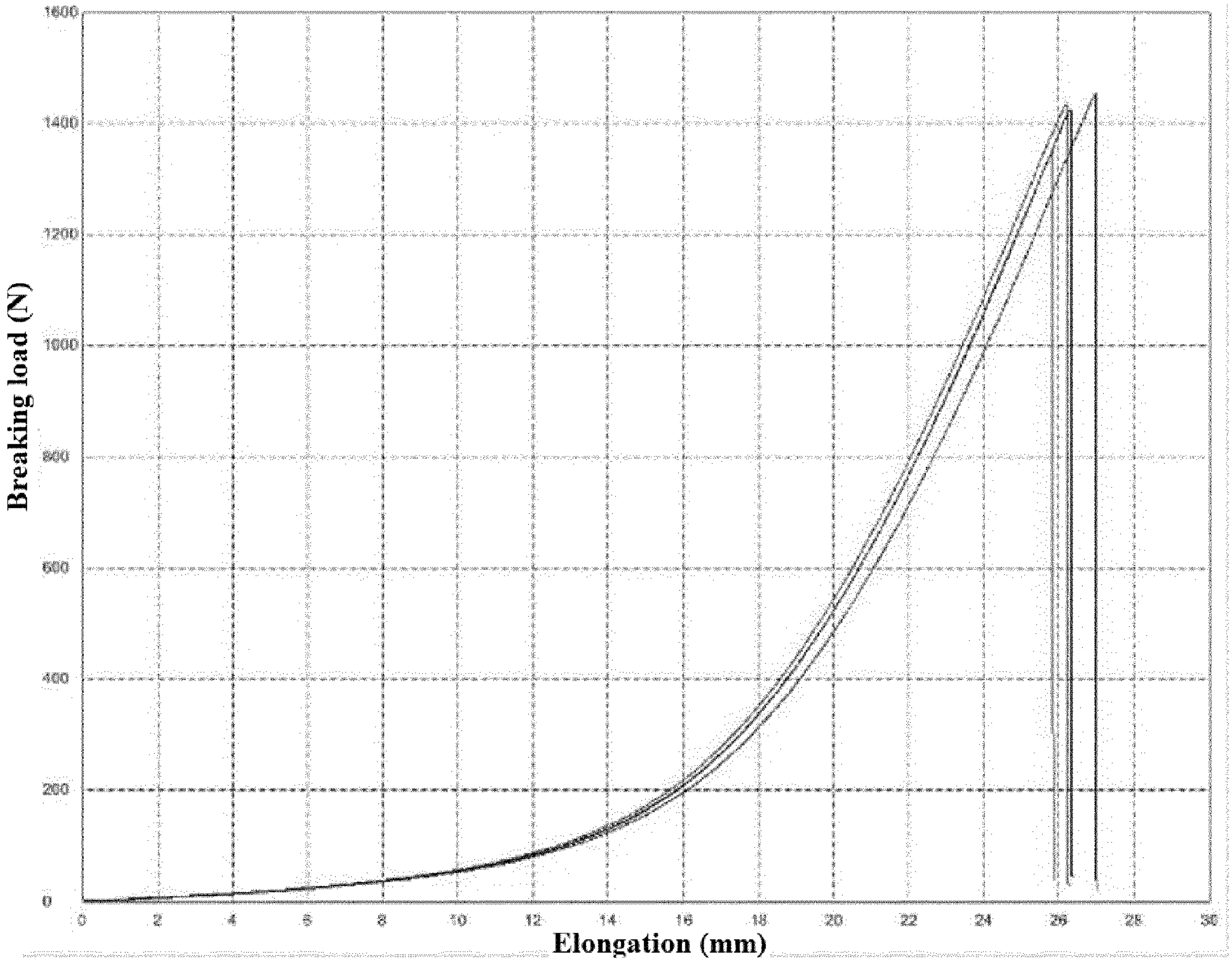


Fig. 3b

Stress-strain curve after 5 washes with 0.1 wt.% sucrose and 0.25 wt.% malic acid for medium density cotton

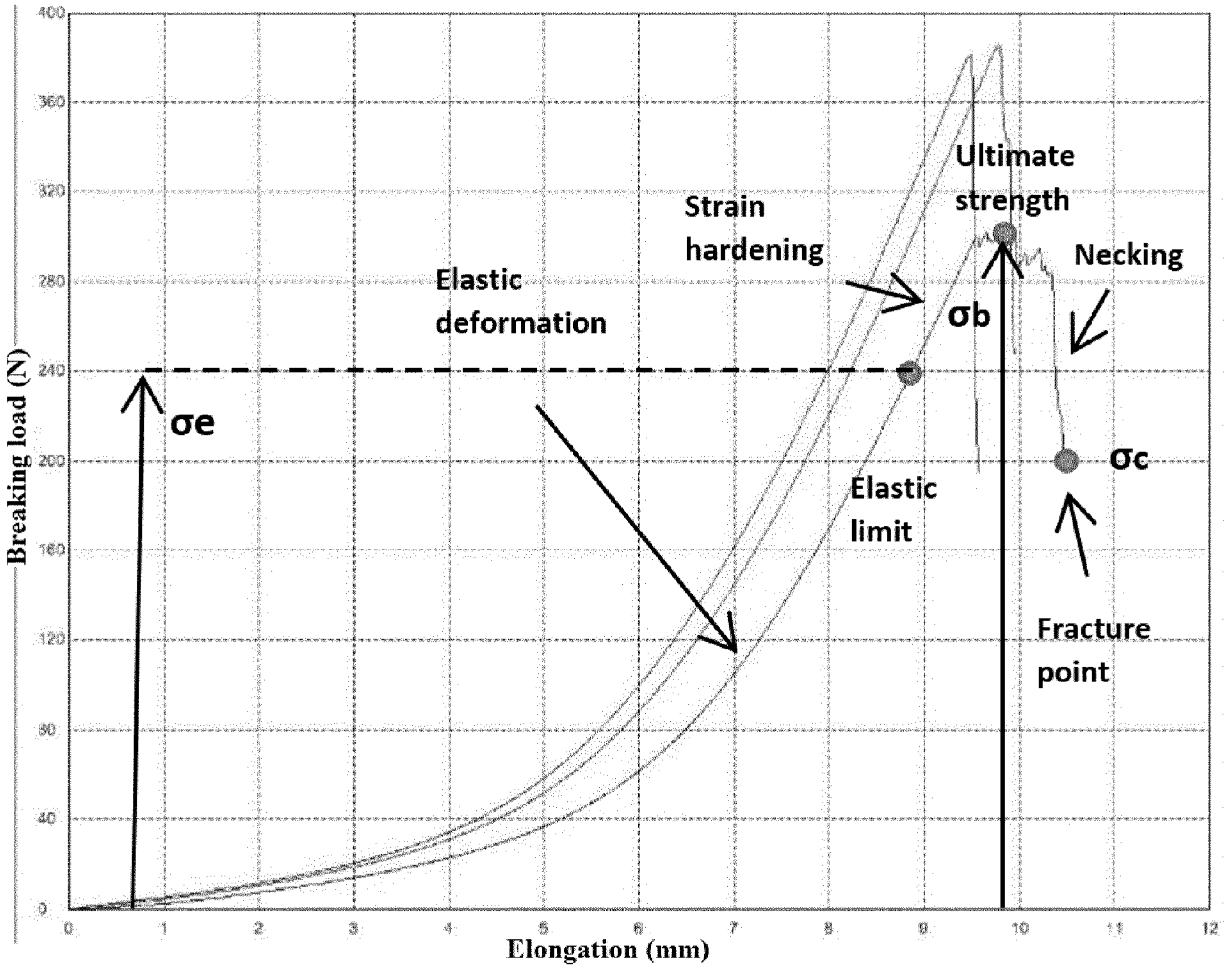


Fig. 3c

Stress-strain curve after 5 washes with 0.1 wt.% sucrose and 0.25 wt.% malic acid for high density cotton

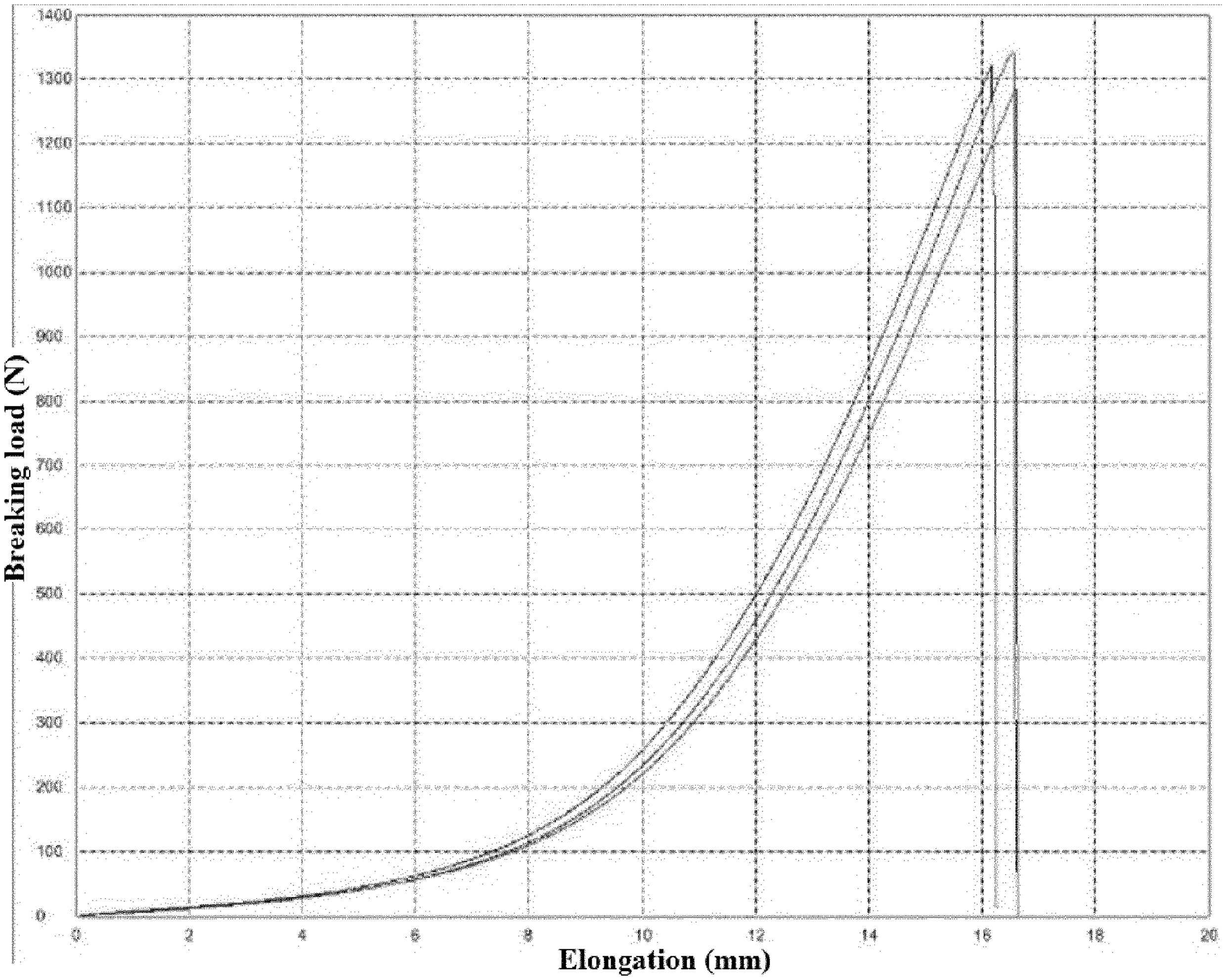


Fig. 3d

Stress-strain curve after 5 washes with 0.2 wt.% sucrose and 0.5 wt.% malic acid for medium density cotton

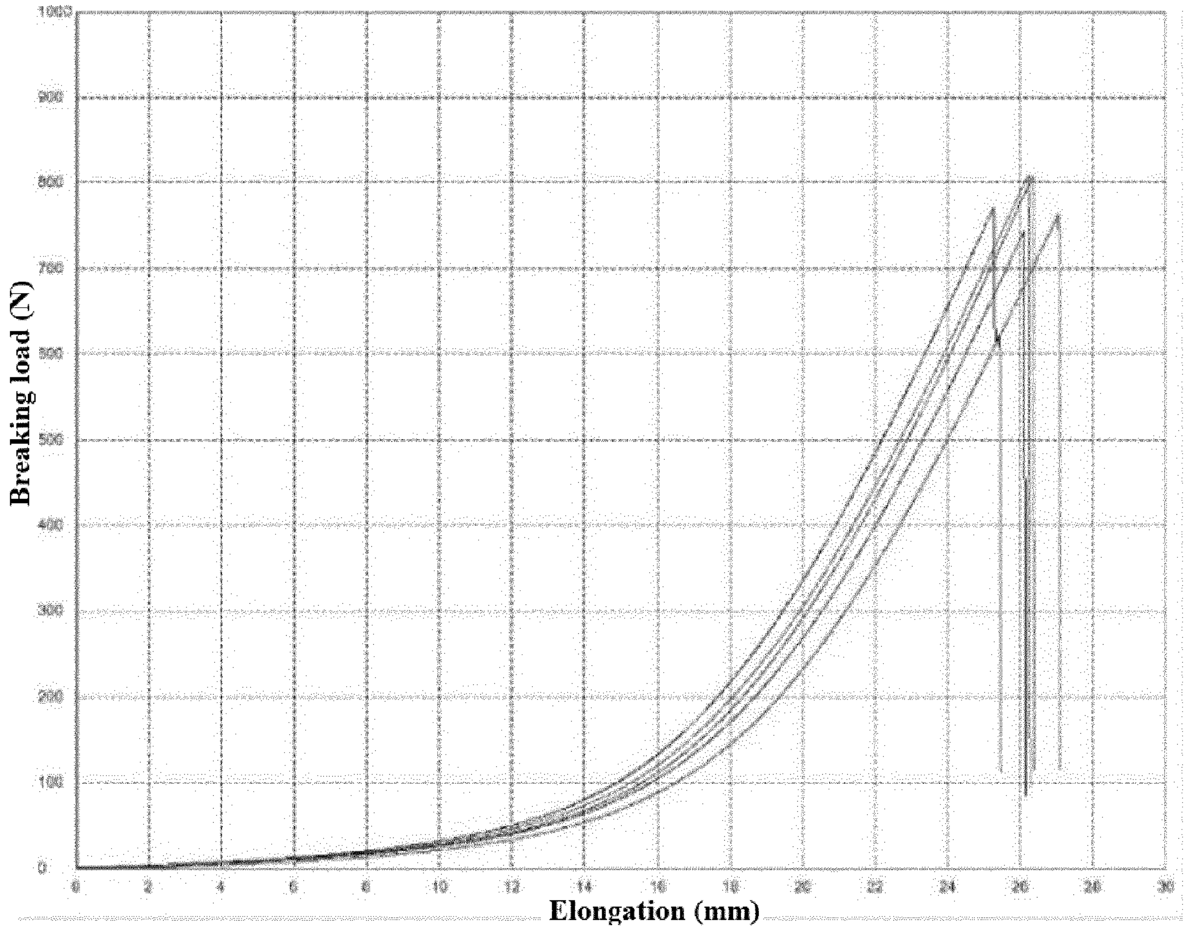


Fig. 3e

Stress-strain curve after 5 washes with 0.2 wt.% sucrose and 0.5 wt.% malic acid for high density cotton

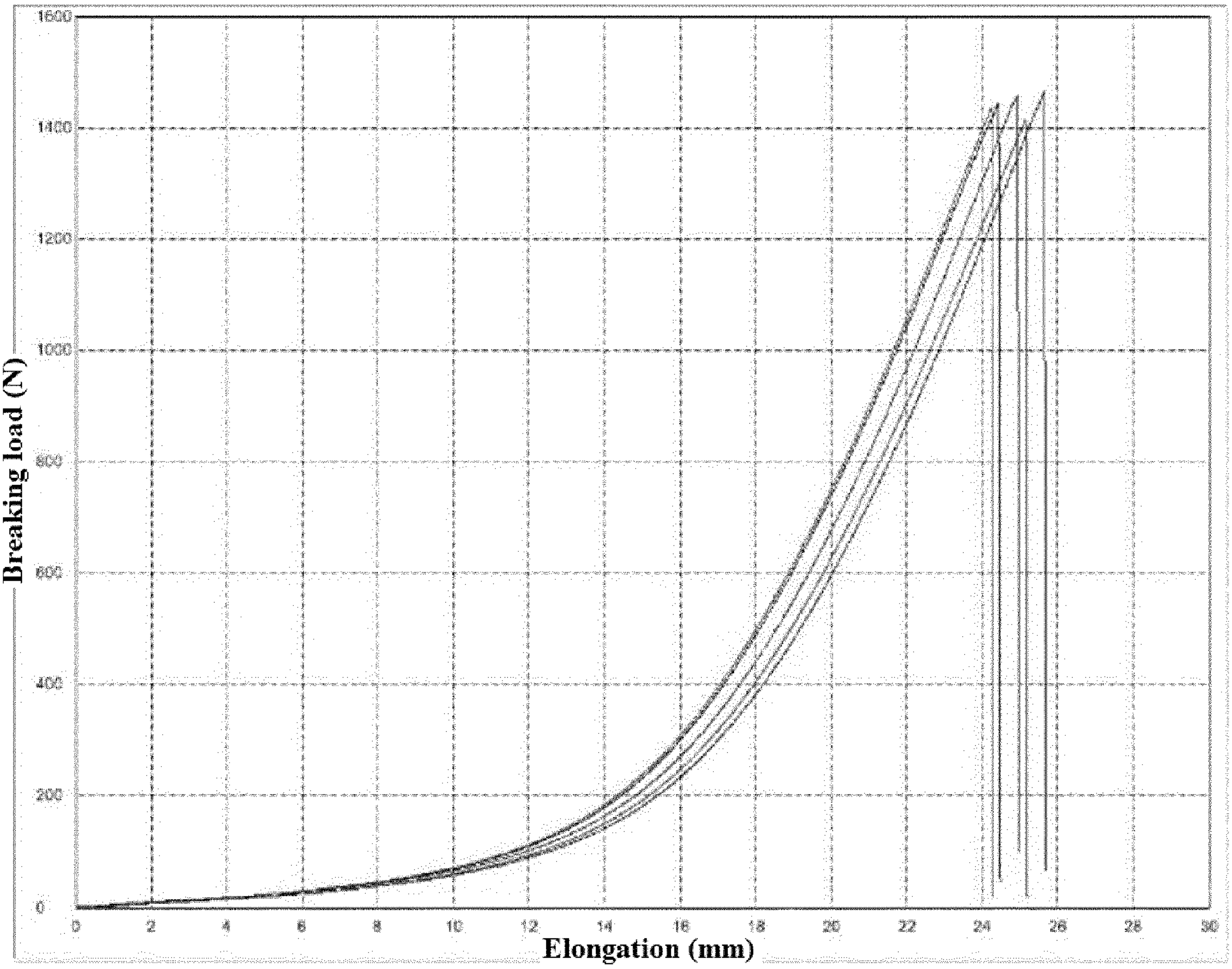


Fig. 3f

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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 9327

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2016/010037 A1 (WAINMAN PETER NELSON [TH] ET AL) 14 January 2016 (2016-01-14) * paragraphs [0010], [0020], [0084] - [0087], [0094], [0095], [0098], [0131]; examples 64-86 * -----	1-12,14, 15 13	INV. C11D3/20 C11D3/22 D06M15/03
Y A	PATIL NAMRATA V ET AL: "Multifunctional sucrose acid as a 'green' crosslinker for wrinkle-free cotton fabrics", CELLULOSE, SPRINGER NETHERLANDS, NETHERLANDS, vol. 27, no. 9, 7 April 2020 (2020-04-07), pages 5407-5420, XP037126435, ISSN: 0969-0239, DOI: 10.1007/S10570-020-03130-9 [retrieved on 2020-04-07] * abstract * -----	13 1,2	
A	US 2001/006938 A1 (GRAINGER DAVID STEPHEN [GB] ET AL) 5 July 2001 (2001-07-05) * paragraph [0018]; examples 1-3 * -----	1-15	TECHNICAL FIELDS SEARCHED (IPC)
A	US 2004/043915 A1 (WHILTON NICOLA [GB]) 4 March 2004 (2004-03-04) * paragraphs [0013], [0068]; examples 1,2 * -----	1-15	C11D D06Q D06M

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	10 April 2024	Goodman, Marco

CATEGORY OF CITED DOCUMENTS

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10-04-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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