(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 748 065 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
19.02.2025 Bulletin 2025/08

(21) Application number: **19178847.0**

(22) Date of filing: **06.06.2019**

(51) International Patent Classification (IPC):
D06L 4/10 *(2017.01)* ***D06L 4/12*** *(2017.01)*
D06L 4/40 *(2017.01)*

(52) Cooperative Patent Classification (CPC):
D06L 4/10; D06L 4/12; D06L 4/40

(54) PROCESS FOR FABRIC BLEACHING, PRODUCTS AND USES THEREOF

VERFAHREN ZUR GEWEBEBLEICHE, PRODUKTE UND VERWENDUNGEN DAVON

PROCÉDÉ DE BLANCHIMENT DE TEXTILES, PRODUITS ET UTILISATIONS ASSOCIÉS

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **03.06.2019 PT 2019115560**

(43) Date of publication of application:
09.12.2020 Bulletin 2020/50

(73) Proprietor: **AQUITEX ACABAMENTOS QUÍMICOS TÊXTEIS, SA**
4425-626 Maia (PT)

(72) Inventor: **ABREU FARIA, Jorge João**
4455-125 Lavra (PT)

(74) Representative: **Patentree**
Edificio Net
Rua de Salazares, 842
4149-002 Porto (PT)

(56) References cited:
WO-A1-03/002810
WO-A1-2007/093677
US-A1- 2012 015 860

EP 3 748 065 B1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to the field of textile industry and chemistry, namely textile dyeing and a process for fabric bleaching, products and uses thereof.

[0002] The present disclosure describes a process for fabric bleaching using a novel enzyme blend combined with a specifically designed chemical system, which reduces the use of caustic soda and hydrogen peroxide in the conventional oxidative bleaching process, replacing the manipulation of these chemicals.

BACKGROUND

[0003] The Textile Industry (TI) is one of the biggest industries in the world with a current worth of nearly 1.5 trillion USD. Nevertheless, it is also one of the world's top polluting industries, partaking a heavy environmental impact in terms of resource consumption, effluents contamination and textile elimination.

[0004] It has long been known that the TI processes are characterized, not only by the large volume of water required, but also by the high temperatures and the variety of chemicals used. There is a long sequence of wet processing stages requiring inputs of water, chemical and energy, generating waste at each stage.

[0005] Water is a finite resource that is quickly becoming scarce and is used at every step of the process both to convey the chemicals used during that step and to wash them out before beginning the next step. The water becomes full of chemical additives and is then expelled as wastewater; which in turn pollutes the environment. The liquid effluents of the TI have usually a high Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD), high conductivity and colouring.

[0006] Along with the direct contamination and consumption of water, this industry's processes are usually carried out at high temperatures, also representing a very high energy consumption level. Most energy used in the TI is still obtained from coal and fossil fuels, meaning this energy use is an important source of greenhouse gases emission.

[0007] The minimization of the above-mentioned issues means all processing steps need to be optimized in such a way that their environmental impact is reduced and they become more sustainable, resulting in reduced effluents charge and energy and water consumption. There are different variables that can be addressed for the optimization of textile processes, such as process temperature, water requirement and chemical system used. It is mandatory to find alternative processes that work at a lower temperature, require less water or where harsh chemicals can be replaced for eco-friendly and more sustainable and safe products.

[0008] Focusing on the particular case of cotton, it remains one of the more prominent textile fibres and it has regained importance due to the heavy environmental impact of synthetic fibres. Among the different steps of cotton pre-treatment (before dyeing) we can have desizing, mercerizing, alkaline scouring and bleaching, some of them requiring severe chemical treatment and the need to perform multiple washing steps between them.

[0009] Naturally occurring fibres, such as cotton, still contain colouring materials even after scouring processes and the cause of this colour may be the naturally occurring pigments present in the fibre structure. This colour can come from different contaminations occurring during the processing of natural fibres like for example, oils and greases coming from the processing equipment.

[0010] The bleaching process aims to eliminate all coloured contaminants that are on the fibres, as well as the remaining of other contaminants that have resisted to previous pre-treating processes (desizing, scouring, etc.) such as bark remnants of the cotton plant.

[0011] Nowadays, the major process used for cotton whitening is the oxidative bleaching with hydrogen peroxide.

[0012] Considering a typical oxidative bleaching process by exhaustion, it usually consists in the steps depicted in figure 1.

[0013] The conventional bleaching of cotton gives an article with a white level adequate to the subsequent dyeing steps and free of additional contaminants. Nevertheless, it is important to have in mind that this step is performed at a very high temperature, requiring a considerable amount of time and high energy to reach. It also includes several water baths that represent a big water consumption, with the disposed water becoming contaminated with harsh chemicals, such as NaOH.

[0014] This chemical is used in substantial quantities in the bleaching process and it is an important contributor to the pollution load in bleaching effluents. A high concentration of NaOH in water will result in toxic effects for the wildlife. Likewise, highly concentrated solutions of NaOH (which is the case of the solutions used for textile bleaching) are also corrosive and irritating to the skin, eyes and mucous membranes, increasing the risk of harmful accidents among textile workers.

[0015] On the perspective of textile workers safety, it is also important noting that fifty-percent-concentration hydrogen peroxide solutions can also represent major safety hazards, such as skin burns; eye injuries; potential for rapid pressurization within tanks, pipes, pumps, and/ or storage vessels, etc. Therefore, being able to replace the handling

of this chemical would also be advantageous.

[0016] There are other traditional bleaching processes that can be applied, nonetheless they are even more damaging than the oxidative bleaching with hydrogen peroxide. Chlorine is known to be extremely toxic to the environment and to consumers, while sodium hypochlorite is very hazardous to human health due to the etching effect that may cause skin and lungs damage. In its compound form, sodium hypochlorite is also very toxic to aquatic organisms and bacteria.

[0017] The TI has been exploring the potential of enzymes for several years. Enzymes are protein catalysts produced by living cells that catalyse specific reactions. The use of enzymes in textile processes has gained increased interest due to the fact that enzymes are non-toxic, biodegradable and environmentally friendly.

[0018] Many processes, such as desizing, scouring, anti-pilling, can be accomplished with the help of these products. Nevertheless, an industrially viable enzyme that is capable of directly bleaching cotton fabric has still not been developed. Also, it has not been possible to include enzymes in the conventional bleaching processes as they are usually not stable to the severe pH, temperature and oxidative conditions of these processes.

[0019] Document WO0200823386 relates to novel compositions for biobleaching coupled with stone washing of indigo dyed denims comprising a blend of glucose oxidase, catalases and cellulases in the ratio of 1.0:10.0:1.0 along with sugar base, peroxide source and optional adjuvants, wherein the process is carried out at optimized conditions of neutral pH (6.5 - 7.0) and a temperature of 55 °C.

[0020] Document CN103266495 discloses a method for pre-treating a cotton-polyester blended fabric with a biological enzyme. The method comprises the steps of scouring and bleaching, washing and drying and is characterized in that the scouring and bleaching step comprises the sub-step of adding the cotton-polyester blended fabric to a scouring and bleaching solution to be scoured and bleached, wherein the mass ratio of the cotton-polyester blended fabric to the scouring and bleaching solution is (1:10)-(1:20); the temperature is controlled to be 50-60 °C; the treatment time is 30-90 minutes; and the scouring and bleaching solution comprises the following components by weight percent: 2.5-3.5% of compound biological enzyme, 5-10% of hydrogen peroxide, 1-2% of tetra acetyl ethylene diamine, 0.1-0.3% of sodium cocoamphoacetate, 0.1-0.3% of ferrous sulfate and the balance of water. The method has the advantages of desizing and bleaching in one bath, mild treatment conditions, small damage to the fabric and short treatment time.

Further bleaching processes are disclosed in WO-A-03/002810, US-A-2012/015860 and WO-A-2017/093677.

[0021] These facts are disclosed in order to illustrate the technical problem addressed by the present disclosure.

GENERAL DESCRIPTION

[0022] In order to optimize and minimize the environmental impact of one of the most universal cotton processing steps, the oxidative bleaching, we have come up with an alternative pre-treatment process that accomplishes fabric whitening using less water, less energy and less harsh chemicals.

[0023] The process of the present disclosure is a simplified treatment that results in a fabric that retains the characteristics of cotton and shows a better handle and hydrophilicity and a cleaner and smoother surface than the conventionally bleached cotton.

[0024] It was developed a bleaching process to spare some resources and increase the quality of the treated fabric, water and energy consumption.

[0025] Additionally, the process of the present disclosure decreases the chemical load used, namely it eliminates the use of NaOH and includes more sustainable versions of the auxiliary chemicals used.

[0026] The chemical intervenients were as follows:

Wetting agent - It is based on ethoxylated alcohols of natural origin. It does not contain silicone and complies with GOTS 5.0:2017 standards.

Enzyme blend - It is a specific enzyme blend, specially developed for the process of the present invention that allows to obtain a final article with good hydrophilicity and a soft touch. It is a blend containing at least 3 of the following enzymes: alpha-amylase, endoglucanase, beta-amylase, pectate lyase, cellulase, lipase.

Peroxide donor - It is a solid compound that, boosted by a combination of products, acts as a peroxide donor. The peroxide donor is selected from the following

list: sodium percarbonate, sodium perborate or a mixture thereof.

Bleaching activator - it is a combination of salts that works as a specific activator for bleaching at lower temperatures.

Sequestering and dispersing agent - It is a biodegradable sequestering and dispersing agent, based on a mixture of hydrocarboxylic acids. It is free from APEOs and GOTS 5.0 :2017 approved.

Catalase - It is a commonly used enzyme for elimination of the residual hydrogen peroxide after bleaching.

[0027] An aspect of the present disclosure relates to a process for fabric bleaching comprising the following steps:

preparing a first water bath with a wetting agent and the fabric,

wherein the bath is warmed to a first temperature up to a maximum of 40-60°C,
and the pH of the bath is at a maximum of pH 5.5-8;
adding an enzyme blend to the bath, wherein the enzyme blend comprises at least 3 of the following enzymes: alpha-amylase, beta-amylase, pectate lyase, cellulase, endoglucanase, lipase;
maintaining the first temperature of the bath during the enzymatic reaction;
adding a peroxide donor and a bleaching activator to the bath;
warming the bath to a second temperature of a minimum of 75 °C for the peroxidation reaction, wherein the peroxide donor is from 10 to 15 g/l,

wherein the bleaching activator concentration is from 1 to 3g/l;
wherein the peroxide donor is sodium percarbonate, sodium perborate or a mixture thereof.

[0028] In an embodiment for better results, the process may further comprise the following steps:

discharging the water bath;
removing chemical residues from the fabric.

[0029] In an embodiment for better results, the process may further comprise the following steps:

submitting the fabric to a second bath at a minimum of 60 °C to improve the residue removal;
discharging the bath water.

[0030] In an embodiment for better results, the process may further comprise the following steps:

preparing a further water bath with a sequestering and dispersing agent, and the fabric,
wherein the bath is warmed to a temperature up to a maximum of 60 °C,
and the pH of the bath is at a maximum of pH 8;
maintaining the first temperature of the bath during the reaction of the component.

[0031] In an embodiment for better results, the process may further comprise the following steps:
adding a catalase solution to the third bath maintaining the first temperature of the bath during the catalase reaction.
[0032] In an embodiment for better results, the duration of the enzymatic reaction is at least 30 minutes, preferably from 30 minutes to 1 hour, more preferably 45 minutes.
[0033] In an embodiment for better results, the second temperature of the first bath is from 75-90 °C, preferably 80 °C.
[0034] In an embodiment for better results, the duration of the peroxidation reaction is at least 5 minutes, preferably from 5-20 minutes, more preferably 10 minutes.
[0035] In an embodiment for better results, the temperature of the second bath is from 60-90 °C, preferably 70 °C.
[0036] In an embodiment for better results, the duration of the washing is at least 5 minutes, preferably from 5-20 minutes, more preferably 10 minutes.
[0037] In an embodiment for better results, the temperature of the third bath is from 25-60 °C, preferably 40 °C.
[0038] In an embodiment for better results, the duration of the washing with the sequestering and dispersing agent is at least 5 minutes, preferably from 5-15 minutes.
[0039] In an embodiment for better results, the duration of the catalase reaction is at least 10 minutes, preferably from 10-30 minutes.
[0040] In an embodiment for better results, the blend of enzymes is:

alpha-amylase, endoglucanase, cellulase;
alpha-amylase, endoglucanase, pectate lyase;
alpha-amylase, endoglucanase, lipase;
endoglucanase, beta-amylase, pectate lyase;
endoglucanase, beta-amylase, cellulase;
endoglucanase, beta-amylase, lipase;
beta-amylase, pectate lyase, cellulase;
beta-amylase, pectate lyase, lipase;
beta-amylase, cellulase, lipase;
pectate lyase, cellulase, lipase.

[0041] In an embodiment for better results, the blend of enzymes further comprises oxidoreductase.

[0042] In an embodiment for better results, the liquor ratio between fabric: water is from 1:5 -1:40; preferably 1:10 -1:20.

[0043] In an embodiment for better results, the wetting agent concentration is from 0,5 - 5 % (wt/wt), preferably 1 - 2 % (wt/wt).

[0044] In an embodiment for better results, the enzyme blend concentration is from 0,5 - 5 % (wt/wt), preferably 1 - 2 % (wt/wt).

[0045] In an embodiment for better results, the sequestering and dispersing agent concentration is from 0.5 - 3 g/l, preferably 0.5 -1 g/l.

[0046] In an embodiment for better results, the catalase concentration is from 0.2 - 2 g/l.

[0047] In an embodiment for better results, the wetting agent is ethoxylated isotridecanol.

[0048] In an embodiment for better results, the bleaching activator is a manganese salt.

[0049] In an embodiment for better results, the sequestering and dispersing agent is 3-hydroxy-3-carboxy-1,5-pentanedioic acid.

[0050] Another aspect of the present disclosure relates to a bleached fabric obtainable by the process described in the present disclosure wherein the weight loss is inferior to the standard process, being less than 4.5%.

[0051] In an embodiment for better results, the fabric is a natural yarn fabric, preferably a cotton fabric.

[0052] Another aspect of the present disclosure also relates to an article comprising the fabric described in the present disclosure.

[0053] Among the advantages of the process of the present invention, are the significant savings in terms of resources consumption, namely:

- In an embodiment for better results, the maximum temperature attained was 80°C, sparing the need to heat the system an additional 20 °C.
- By accomplishing the process to be performed at the optimum temperature for each phase, what means using different temperatures, all below 100 °C, there is no need to maintain the system at 100 °C during the entire process.
- The process of the present invention allows to obtain a white article with three water baths. Comparing to the example shown in figure 1, it is possible to save two water baths, considering the middle washing and the anti-pilling treatment baths. If we consider the bleaching of 1 ton of cotton fabric in liquor ratio of 1:10, the fact that two baths are eliminated means a 20 000-liter saving in water consumption, i.e. 20 l water per 1 kg of cotton.
- The chemical system used has been conceived to present more sustainable products and to avoid the need for harsh chemicals like caustic soda, thus diminishing the effluent charge in polluting species.
- The process of the present invention is also advantageous in terms of productivity as the total time of process can be decreased.

BRIEF DESCRIPTION OF THE DRAWINGS

[0054] The following figures provide preferred embodiments for illustrating the invention and should not be seen as limiting the scope of invention.

Figure 1: Schematic representation of an embodiment of a common process for oxidative bleaching of cotton.

Figure 2: Schematic representation of an embodiment of one of the processes of the present subject matter.

Figure 3: Schematic representation of an embodiment of one of the processes of the present subject matter: Hydrophilicity: a) Spread of the drop in a fabric treated with the common process for oxidative bleaching of cotton; b) Spread of the drop in a fabric treated with the process of the present subject matter, the drop is wider and more regular, meaning the fabric has higher hydrophilicity.

Figure 4: Schematic representation of an embodiment of one of the processes of the present subject matter: a) Noticeable protuberant fibres in the fabric treated with the common process for oxidative bleaching of cotton; b) Cleaner and smoother surface of the fabric treated with the process of the present subject matter.

Figure 5: Schematic representation of an embodiment of one of the possible processes of the present invention: Colour yield for a Light Pink dyeing. Comparison of same dyeing in a fabric treated with the common process for oxidative bleaching of cotton (A) and a fabric treated with the process of the present subject matter (B); spectrophotometric reading of both samples (C) and result for colour difference (DE).

Figure 6: Schematic representation of an embodiment of one of the possible processes of the present invention: for a Salmon dyeing. Comparison of same dyeing in a fabric treated with the common process for oxidative bleaching of

cotton (A) and a fabric treated with the process of the present subject matter (B); spectrophotometric reading of both samples (C) and result for colour difference (DE).

Figure 7: Schematic representation of an embodiment of one of the possible processes of the present invention: Brown dyeing. Comparison of same dyeing in a fabric treated with the common process for oxidative bleaching of cotton (A) and a fabric treated with the process of the present subject matter (B); spectrophotometric reading of both samples (C) and result for colour difference (DE).

DETAILED DESCRIPTION

[0055] The process of the present disclosure is an alternative pre-treatment process that accomplishes fabric whitening using less water, less energy and less harsh chemicals. It minimizes environmental impact of one of the most universal cotton processing steps, the oxidative bleaching.

[0056] The process of the present disclosure is a simplified treatment that results in a fabric that retains the characteristics of cotton and shows a better handle and hydrophilicity and a cleaner and smoother surface than the conventionally bleached cotton.

[0057] In an embodiment, the present disclosure is used to bleach all 100% cotton articles used as starting material for the Textile Industry.

[0058] In an embodiment the conventional process described in figure 1 consists in the following steps:

first water bath adding a detergent, a stabilizer and sequestering agent, an anti-creasing agent, 3 g/l of NaOH at 50% and 3 g/l of H_2O_2 200 vol;
temperature increase up to 100 °C, the fabric being treated for at least 30 minutes; water discharge;
water washing with addition of a sequestering agent, at a temperature of 70°C, for 10 minutes;
water discharge;
new washing step with water at 60°C for 10 minutes;
water discharge;
new water bath at 40°C with addition of acetic acid for neutralization;
run for 5 minutes and check pH, if necessary, adjust to the interval of 6.5 - 7;
add a catalase solution (enzyme that will degrade the hydrogen peroxide to avoid its interference in dyeing) and run for additional 15 minutes;
water discharge;
If an anti-pilling treatment is required (for a cleaner surface and to reduce the tendency of fabric to pill) an additional water bath in necessary. It is usually run at 50 - 60 °C, pH 5 - 8, 30 - 90 minutes, depending on the cellulase-based product (neutral or acid cellulase) used. For inactivation of the enzyme it is then mandatory to increase the temperature up to 80 °C for 10 minutes or add Na_2CO_3 for pH increase.

[0059] In an embodiment, the process of the present disclosure may comprise the following steps:

Obtaining a bath with the fabric to bleach comprising water in a liquor ratio from 1:5 and 1:40, 0.5 - 5 % of a wetting agent and set the temperature to 40 - 60°C;
When temperature is close to the set point, check that pH is in the interval 5.5 - 8, add an enzyme blend 0.5 - 5% and run the process for 30- 60 min;
add 10-15 g/l of a peroxide donor and 1-3 g/l of a bleaching activator;
set the temperature to 75 - 90 °C and run the process for 5 -20 minutes;
discharge the water;
water wash at 60 - 90 °C for 5-20 minutes;
discharge the water;
new water bath at 25 - 60 °C with addition of 0.5 - 3 g/l of a sequestering and dispersing agent;
Run for 5 -15 min and check that pH is 5 - 8;
add a catalase solution and run for 10 - 30 minutes;
discharge the water.

[0060] In an embodiment, considering an initial water temperature of 30 °C, a machine with a heating and cooling rate of 4°C/min, a machine that takes 5 minutes to fill in and 5 minutes to drain the water and the optimized process conditions, the bleaching process is reduced from 148 min with the conventional procedure to 135 min with the process of the present disclosure, meaning a reduction of approximately 9% in process time.

Table 1: Comparison between 100% cotton knitted fabric bleached according to the conventional method and to the process of the present disclosure

	Bleaching process of figure 1 (30 min at 100°C)	Process of the present disclosure as described in figure 2
HANDLE	Slightly harsh handle	Softer and smoother handle
WHITE LEVEL (WI-BERG)	74.97	67.73
WEIGHT LOSS (%)	5.1%	4.5%

Table 2: Results of effluent analysis after conventional bleaching and process of the present disclosure by exhaustion.

Effluent parameters	Bleaching process of figure 1 (30 min at 100°C)	Process of the present disclosure as described in figure 2
Total nitrogen (mg/L N)	75	70
Biochemical oxygen demand (5 days) (g/L O_2)	1.5	0.79
Chemical Oxygen Demand (g/L O_2)	4.2	3.3
Total phosphorus (mg/L P)	26	8.4
pH final	11.7	9.9
Total suspended solids (g/L)	57	22

Table 3: Results of effluent analysis after conventional bleaching and process of the present disclosure by continuous application (pad-steam).

Effluent parameters	Bleaching process of figure 1 (30 min at 100°C)	Process of the present disclosure as described in figure 2
Total nitrogen (mg/L N)	40	30
Biochemical oxygen demand (5 days) (g/L O2)	15	1.5
Chemical Oxygen Demand (g/L O2)	21	13
Total phosphorus (mg/L P)	25	2.9
pH final	11.7	10.9
Total suspended solids (g/L)	0.2	0.4

[0061] In addition to the decrease of environmental impact due to resource savings, which has already been described, the effluents generated by the process of the present disclosure show decreased values for practically all parameters of effluent analysis, namely on BOD and COD, as shown in Tables 2 and 3.

[0062] The overall difference of colour can be calculated by spectrophotometric reading and it is expressed by the DE value, obtained based on the comparison between samples that went through the conventional bleaching and samples treated by the process of the present disclosure. Standard values for colour tolerance accepted amongst the industry players are usually ≤ 0.5.

[0063] The spectrophotometric analysis of the dyed samples shows DE values between 0.52 and 0.84, which can be attributed to the slight differences in whiteness level obtained in the samples post-bleaching. This means the colour yield of samples subjected to the process of the present disclosure is not exactly the same but it is close enough to the conventionally bleached samples and, therefore, it is expected to be easy to adjust the dyeing recipes. In some cases, this colour difference will possibly mean the need to use less dyestuff.

[0064] In conclusion, in terms of final article characteristics, the process of the present disclosure is a perfectly viable option to replace the conventional bleaching process as the final article is softer, smoother, with cleaner surface, better hydrophilicity and lower weigh loss. Even though there seems to be some variation in the colour yield, dyeing recipes are expected to be easily adjusted. When assessing the variation of colour yield against all the benefits and advantages of the process of the present disclosure, it can be deemed a manageable adaptation.

[0065] Moreover, on an environmental perspective, the process of the present disclosure allows meaningful savings in

terms of water, energy and time consumption and originates less polluted effluents.

[0066] The term "comprising" whenever used in this document is intended to indicate the presence of stated features, integers, steps, components, but not to preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

[0067] It will be appreciated by those of ordinary skill in the art that unless otherwise indicated herein, the particular sequence of steps described is illustrative only and can be varied without departing from the disclosure. Thus, unless otherwise stated the steps described are so unordered meaning that, when possible, the steps can be performed in any convenient or desirable order.

[0068] Furthermore, it is to be understood that the disclosure encompasses all variations, combinations, and permutations in which one or more limitations, elements, clauses, descriptive terms, etc., from one or more of the claims or from relevant portions of the description is introduced into another claim. For example, any claim that is dependent on another claim can be modified to include one or more limitations found in any other claim that is dependent on the same base claim.

[0069] Furthermore, where the claims recite a composition, it is to be understood that methods of using the composition for any of the purposes disclosed herein are included, and methods of making the composition according to any of the methods of making disclosed herein or other methods known in the art are included, unless otherwise indicated or unless it would be evident to one of ordinary skill in the art that a contradiction or inconsistency would arise.

[0070] Where ranges are given, endpoints are included. Furthermore, it is to be understood that unless otherwise indicated or otherwise evident from the context and/or the understanding of one of ordinary skill in the art, values that are expressed as ranges can assume any specific value within the stated ranges in different embodiments of the invention, to the tenth of the unit of the lower limit of the range, unless the context clearly dictates otherwise. It is also to be understood that unless otherwise indicated or otherwise evident from the context and/or the understanding of one of ordinary skill in the art, values expressed as ranges can assume any subrange within the given range, wherein the endpoints of the subrange are expressed to the same degree of accuracy as the tenth of the unit of the lower limit of the range.

[0071] The above described embodiments are combinable.

[0072] The following claims further set out particular embodiments of the disclosure.

Claims

1. A process for fabric bleaching comprising the following steps:

preparing a first water bath with a wetting agent and the fabric;
wherein the first water bath is warmed to a first temperature up to a maximum of 40-60 °C and the pH of the bath is at a maximum of pH 5.5 - 8;
adding an enzyme blend to the bath, wherein the enzyme blend comprises at least 3 of the following enzymes: alpha-amylase, beta-amylase, pectate lyase, cellulase, endoglucanase, lipase;
maintaining the first temperature of the bath during the enzymatic reaction;
adding a peroxide donor and a bleaching activator to the bath;
warming the bath to a second temperature of a minimum of 75 °C for the peroxidation reaction;
wherein the peroxide donor concentration is from 10 to 15 g/l,
wherein the bleaching activator concentration is from 1 to 3 g/l;
wherein the peroxide donor is sodium percarbonate, sodium perborate or a mixture thereof.

2. The process according to the previous claim further comprising the following steps:

discharging the first water bath;
removing chemical residues from the fabric;
optionally submitting the fabric to a second water bath of a minimum of 60 °C to improve the residue removal;
optionally discharging the bath water;
optionally preparing a further water bath, with a sequestering and dispersing agent, and the fabric, wherein the bath is warmed to a temperature up to a maximum of 60 °C, preferably 40 °C - 50 °C, and the pH of the bath is at a maximum of pH 8, maintaining the first temperature of the bath during the reaction time;
optionally adding a catalase solution to the third bath, maintaining the first temperature of the bath during the catalase reaction.

3. The process according to any of the previous claims wherein the first temperature of the first bath is preferably 60 °C and the pH of the first bath is preferably 6.0 - 6.5; and wherein the second temperature of the first bath is from 75 to 90 °C, preferably 80 °C and wherein the temperature of the second water bath is from 60 to 90 °C, preferably 70 °C and

wherein the temperature of the third bath is from 25 to 60 °C, preferably 40 °C.

4. The process according to any of the previous claims wherein the duration of the enzymatic reaction is of at least 30 minutes, preferably from 30 minutes to 1 hour, more preferably 45 minutes.

5. The process according to any of the previous claims wherein the duration of the peroxidation reaction is at least 5 minutes, preferably from 5 to 20 minutes, more preferably 10 minutes.

6. The process according to any of the previous claims wherein the duration of the washing is at least 5 minutes, preferably from 5 to 20 minutes, more preferably 10 minutes.

7. The process according to any of the previous claims wherein the duration of the washing with the sequestering and dispersing agent is at least 5 minutes, preferably from 5 to 15 minutes.

8. The process according to any of the previous claims wherein the duration of the catalase reaction is at least 10 minutes, preferably from 10 to 30 minutes.

9. The process according to any of the previous claims wherein the blend of enzymes is:

alpha-amylase, endoglucanase, cellulase;
alpha-amylase, endoglucanase, pectate lyase;
alpha-amylase, endoglucanase, lipase;
endoglucanase, beta-amylase, pectate lyase;
endoglucanase, beta-amylase, cellulase;
endoglucanase, beta-amylase, lipase;
beta-amylase, pectate lyase, cellulase;
beta-amylase, pectate lyase, lipase;
beta-amylase, cellulase, lipase;
pectate lyase, cellulase, lipase;
optionally comprising oxidoreductase.

10. The process according to any of the previous claims wherein the liquor ratio between fabric: water is from 1:5 to 1:40; preferably from 1:10 to 1:20.

11. The process according to any of the previous claims wherein

the wetting agent concentration is from 0.5 to 5 % (wt/wt), preferably from 1 to 2 % (wt/wt),
optionally, the sequestering and dispersing agent concentrations are from 0.5 to 3 g/l, preferably from 0.5 to 1 g/l.

12. The process according to any of the previous claims wherein the enzyme blend concentration is from 0.5 to 5 % (wt/wt), preferably from 1 to 2 % (wt/wt) and/or the catalase concentration is from 0.2 to 2 g/l, preferably from 0.5 to 1 g/l.

13. The process according to any of the previous claims wherein

the wetting agent is
ethoxylated isotridecanol, the bleaching activator is a manganese salt, the sequestering and the dispersing agent is 3-hydroxy-3-carboxy-1,5-pentanedioic acid.

Patentansprüche

1. Ein Verfahren zur Gewebebleiche, umfassend die folgenden Schritte:

Herstellen eines ersten Wasserbades mit einem Netzmittel und dem Gewebe;
wobei das erste Wasserbad auf eine erste Temperatur von maximal 40 - 60 °C erwärmt wird und der pH-Wert des Bades bei maximal pH 5,5 - 8 liegt;
Zugeben einer Enzymmischung zu dem Bad, wobei die Enzymmischung mindestens 3 der folgenden Enzyme umfasst:

Alpha-Amylase, Beta-Amylase, Pektatlyase, Cellulase, Endoglucanase, Lipase;
Aufrechterhalten der ersten Temperatur des Bades während der enzymatischen Reaktion; Zugeben eines Peroxidspenders und eines Bleichaktivators zu dem Bad;
Erwärmen des Bades auf eine zweite Temperatur von mindestens 75 °C für die Peroxidationsreaktion;
wobei die Konzentration des Peroxidspenders 10 bis 15 g/l beträgt,
wobei die Konzentration des Bleichaktivators 1 bis 3 g/l beträgt;
wobei der Peroxidspender Natriumpercarbonat, Natriumperborat oder eine Mischung davon ist.

2. Das Verfahren nach dem vorangehenden Anspruch ferner die folgenden Schritte umfassend:

Ablassen des ersten Wasserbads;
Entfernen chemischer Rückstände aus dem Gewebe;
gegebenenfalls Einbringen des Gewebes in ein zweites Wasserbad mit mindestens 60 °C, um das Entfernen von Rückständen zu verbessern;
gegebenenfalls Ablassen des Badewassers;
gegebenenfalls Herstellen eines weiteren Wasserbades mit einem Sequestrier- und Dispergiermittel und dem Gewebe, wobei das Bad auf eine Temperatur von maximal 60 °C, bevorzugt 40 °C - 50 °C, erwärmt wird und der pH-Wert des Bades bei maximal pH 8 liegt, wobei die erste Temperatur des Bades während der Reaktionszeit aufrechterhalten wird;
gegebenenfalls Zugaben einer Katalaselösung in das dritte Bad, wobei die erste Temperatur des Bades während der Katalasereaktion aufrechterhalten wird.

3. Das Verfahren nach einem der vorangehenden Ansprüche, wobei die erste Temperatur des ersten Bades bevorzugt 60 °C und der pH-Wert des ersten Bades bevorzugt 6,0 - 6,5 beträgt; und wobei die zweite Temperatur des ersten Bades 75 bis 90 °C, bevorzugt 80 °C beträgt, und wobei die Temperatur des zweiten Wasserbades 60 bis 90 °C, bevorzugt 70 °C beträgt, und wobei die Temperatur des dritten Bades 25 bis 60 °C, bevorzugt 40 °C beträgt.

4. Das Verfahren nach einem der vorangehenden Ansprüche, wobei die Dauer der enzymatischen Reaktion mindestens 30 Minuten, bevorzugt 30 Minuten bis 1 Stunde, besonders bevorzugt 45 Minuten beträgt.

5. Das Verfahren nach einem der vorangehenden Ansprüche, wobei die Dauer der Peroxidationsreaktion mindestens 5 Minuten, bevorzugt 5 bis 20 Minuten, besonders bevorzugt 10 Minuten beträgt.

6. Das Verfahren nach einem der vorangehenden Ansprüche, wobei die Dauer des Waschens mindestens 5 Minuten, bevorzugt 5 bis 20 Minuten, besonders bevorzugt 10 Minuten beträgt.

7. Das Verfahren nach einem der vorangehenden Ansprüche, wobei die Dauer des Waschens mit dem Sequestrier- und Dispergiermittel mindestens 5 Minuten, bevorzugt 5 bis 15 Minuten, beträgt.

8. Das Verfahren nach einem der vorangehenden Ansprüche, wobei die Dauer der Katalasereaktion mindestens 10 Minuten, bevorzugt 10 bis 30 Minuten, beträgt.

9. Das Verfahren nach einem der vorangehenden Ansprüche, wobei die Enzymmischung ist:

Alpha-Amylase, Endoglucanase, Cellulase;
Alpha-Amylase, Endoglucanase, Pektatlyase;
Alpha-Amylase, Endoglucanase, Lipase;
Endoglucanase, Beta-Amylase, Pektatlyase;
Endoglucanase, Beta-Amylase, Cellulase;
Endoglucanase, Beta-Amylase, Lipase;
Beta-Amylase, Pektatlyase, Cellulase;
Beta-Amylase, Pektatlyase, Lipase;
Beta-Amylase, Cellulase, Lipase;
Pektatlyase, Cellulase, Lipase;

gegebenenfalls umfassend Oxidoreduktase.

10. Das Verfahren nach einem der vorangehenden Ansprüche, wobei das Flottenverhältnis zwischen Gewebe: Wasser

1:5 bis 1:40, bevorzugt 1:10 bis 1:20 beträgt.

11. Das Verfahren nach einem der vorangehenden Ansprüche, wobei die Netzmittelkonzentration 0,5 bis 5 % (Gew./Gew.), bevorzugt 1 bis 2 % (Gew./Gew.) beträgt,

gegebenenfalls,
die Konzentrationen des Sequestrier- und des Dispergiermittels zwischen 0,5 und 3 g/l, bevorzugt zwischen 0,5 und 1 g/l liegen.

12. Das Verfahren nach einem der vorangehenden Ansprüche, wobei die Konzentration der Enzymmischung 0,5 bis 5 % (Gew./Gew.), bevorzugt 1 bis 2 % (Gew./Gew.) und/oder die Katalasekonzentration 0,2 bis 2 g/l, bevorzugt 0,5 bis 1 g/l beträgt.

13. Das Verfahren nach einem der vorangehenden Ansprüche, wobei das Netzmittel ethoxyliertes Isotridecanol ist, der Bleichaktivator ein Mangansalz ist, das Sequestrier- und Dispergiermittel 3-Hydroxy-3-carboxy-1,5-pentandisäure ist.

Revendications

1. Un procédé de blanchiment de textiles comprenant les étapes suivantes :

préparer un premier bain d'eau avec un agent mouillant et le textile ;
dans lequel le premier bain d'eau est chauffé à une première température pouvant aller jusqu'à un maximum de 40-60 °C et le pH du bain est à un pH maximum de 5,5 - 8 ;
ajouter un mélange d'enzymes au bain, dans lequel le mélange d'enzymes comprend au moins 3 des enzymes suivantes :
alpha-amylase, bêta-amylase, pectate lyase, cellulase, endoglucanase, lipase ;
maintenir la première température du bain durant la réaction enzymatique ;
ajouter un donneur de peroxyde et un activateur de blanchiment au bain ;
chauffer le bain à une seconde température d'un minimum de 75 °C pour la réaction de peroxydation ;
dans lequel la concentration de donneur de peroxyde est de 10 à 15 g/l, dans lequel la concentration d'activateur de blanchiment est de 1 à 3 g/l;
dans lequel le donneur de peroxyde est du percarbonate de sodium, du perborate de sodium ou un mélange de ceux-ci.

2. Le procédé selon la revendication précédente comprenant également les étapes suivantes :

déverser le premier bain d'eau ;
éliminer les résidus chimiques du textile ;
facultativement, soumettre le textile à un second bain d'eau d'un minimum de 60 °C pour améliorer l'élimination des résidus ;
facultativement, déverser l'eau du bain ;
facultativement, préparer un autre bain d'eau, avec un agent séquestrant et dispersant, et le textile, dans lequel le bain est chauffé à une température pouvant aller jusqu'à un maximum de 60 °C, préférablement 40 °C - 50 °C, et le pH du bain est à un maximum de 8, maintenant la première température du bain durant le temps de réaction;
facultativement, ajouter une solution de catalase au troisième bain, maintenant la première température du bain durant la réaction de catalase.

3. Le procédé selon l'une quelconque des revendications précédentes dans lequel la première température du premier bain est préférablement de 60 °C et le pH du premier bain est préférablement 6,0 - 6,5 ; et dans lequel la seconde température du premier bain est de 75 à 90 °C, préférablement 80 °C et dans lequel la température du second bain est de 60 à 90 °C, préférablement 70 °C et dans lequel la température du troisième bain est de 25 à 60 °C, préférablement 40 °C.

4. Le procédé selon l'une quelconque des revendications précédentes dans lequel la durée de la réaction enzymatique est d'au moins 30 minutes, préférablement de 30 minutes à 1 heure, plus préférablement de 45 minutes.

5. Le procédé selon l'une quelconque des revendications précédentes dans lequel la durée de la réaction de peroxydation est d'au moins 5 minutes, préférablement de 5 à 20 minutes, plus préférablement de 10 minutes.

6. Le procédé selon l'une quelconque des revendications précédentes dans lequel la durée du lavage est d'au moins 5 minutes, préférablement de 5 à 20 minutes, plus préférablement de 10 minutes.

7. Le procédé selon l'une quelconque des revendications précédentes dans lequel la durée du lavage avec l'agent séquestrant et dispersant est d'au moins 5 minutes, préférablement de 5 à 15 minutes.

8. Le procédé selon l'une quelconque des revendications précédentes dans lequel la durée de la réaction de catalase est d'au moins 10 minutes, préférablement de 10 à 30 minutes.

9. Le procédé selon l'une quelconque des revendications précédentes, dans lequel le mélange d'enzymes est :

alpha-amylase, endoglucanase, cellulase ;
alpha-amylase, endoglucanase, pectate lyase ;
alpha-amylase, endoglucanase, lipase ;
endoglucanase, bêta-amylase, pectate lyase ;
endoglucanase, bêta-amylase, cellulase ;
endoglucanase, bêta-amylase, lipase ;
bêta-amylase, pectate lyase, cellulase ;
bêta-amylase, pectate lyase, lipase ;
bêta-amylase, cellulase, lipase ;
pectate lyase, cellulase, lipase ;

comprenant facultativement de l'oxydoréductase.

10. Le procédé selon l'une quelconque des revendications précédentes dans lequel le rapport de bain textile:eau est de 1:5 à 1:40 ; préférablement de 1:10 à 1:20.

11. Le procédé selon l'une quelconque des revendications précédentes dans lequel

la concentration d'agent mouillant est de 0,5 à 5% (poids/poids), préférablement de 1 à 2% (poids/poids), facultativement, les concentrations des agents séquestrant et dispersant sont de 0,5 à 3 g/l, préférablement de 0,5 à 1 g/l.

12. Le procédé selon l'une quelconque des revendications précédentes dans lequel la concentration du mélange d'enzymes est de 0,5 à 5% (poids/poids), préférablement de 1 à 2% (poids/poids) et/ou la concentration de catalase est de 0,2 à 2 g/l, préférablement de 0,5 à 1 g/l.

13. Le procédé selon l'une quelconque des revendications précédentes dans lequel l'agent mouillant est de l'isotridécanol éthoxylé, l'activateur de blanchiment est un sel de manganèse, les agents séquestrant et dispersant sont de l'acide 3-hydroxy-3-carboxy-1,5-pentanedioïque.

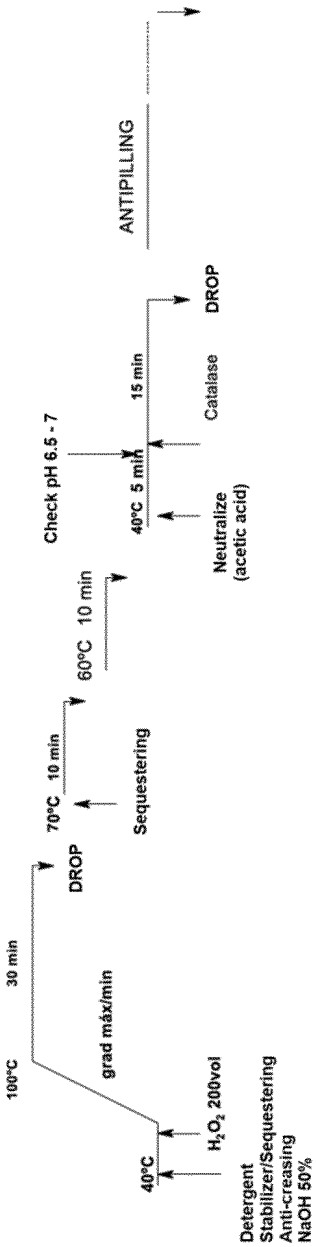

Detergent
Stabilizer/Sequestering
Anti-creasing
NaOH 50%
40°C
H_2O_2 200vol
grad máx/min
100°C
30 min
DROP
70°C 10 min
Sequestering
60°C 10 min
Neutralize
(acetic acid)
40°C 5 min
Catalase
15 min
DROP
Check pH 6.5 - 7
ANTIPILLING

Fig. 1

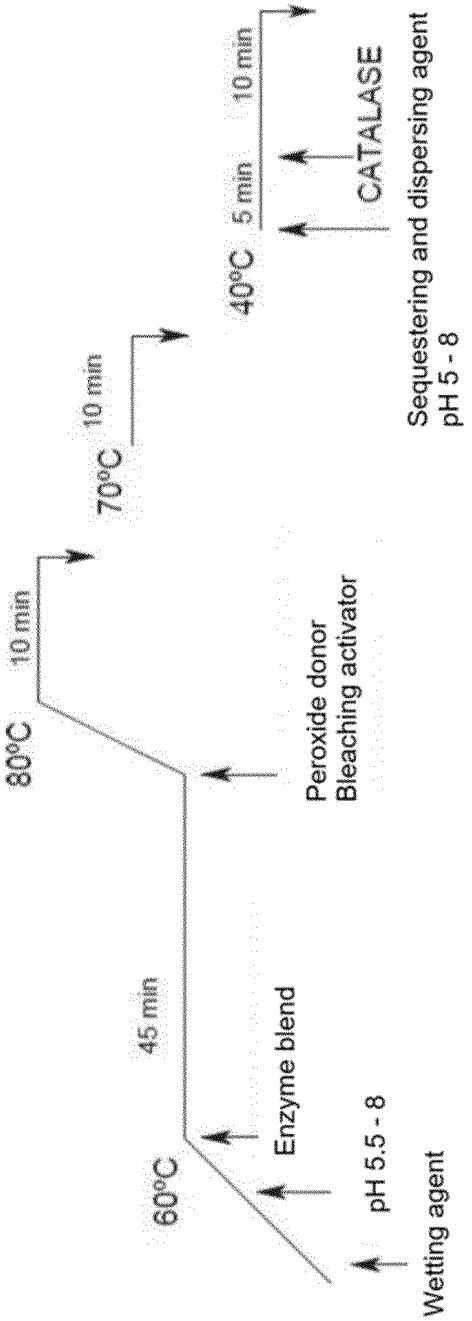
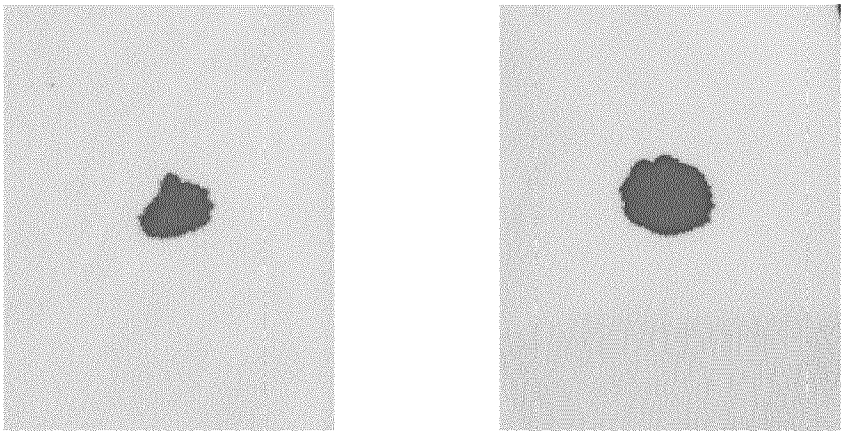
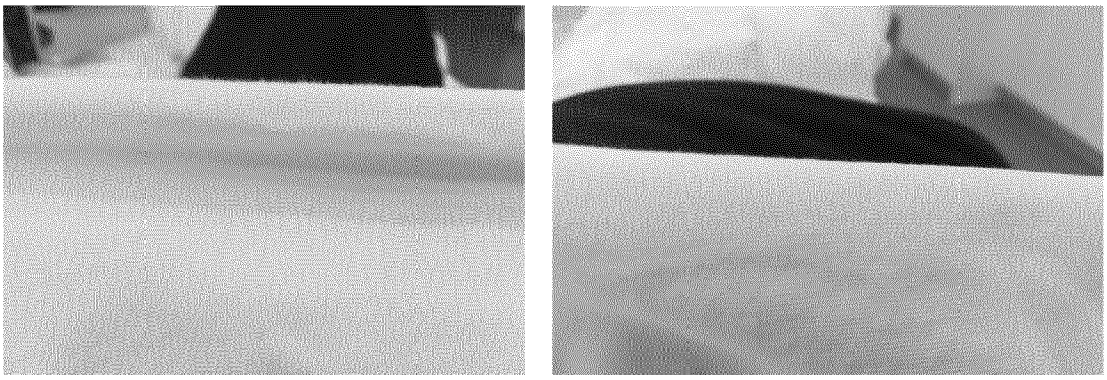

60°C
45 min
80°C
10 min
70°C
10 min
40°C
5 min
10 min
Wetting agent
pH 5.5 - 8
Enzyme blend
Peroxide donor
Bleaching activator
CATALASE
Sequestering and dispersing agent
pH 5 - 8

Fig. 2



a) b)

Fig. 3



a) b)

Fig. 4

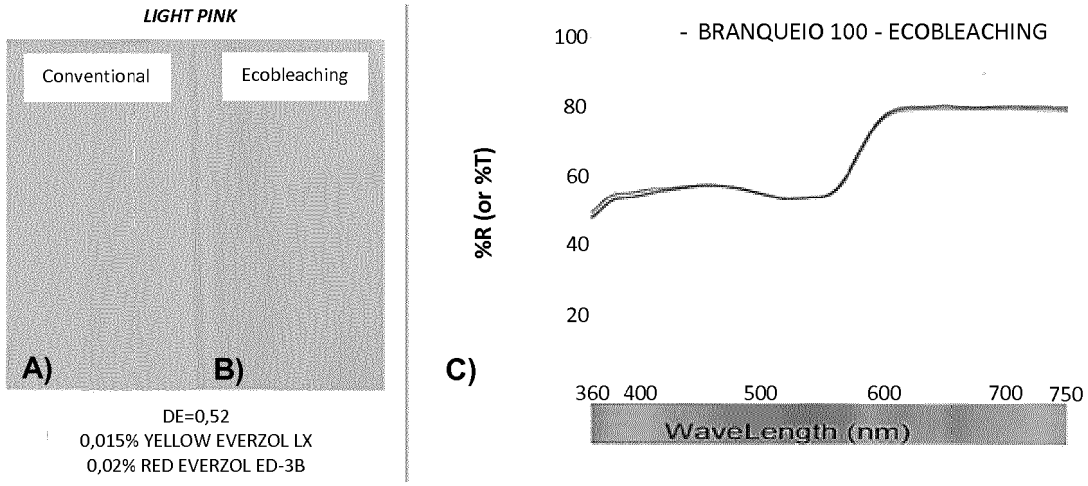

LIGHT PINK
Conventional
Ecobleaching
A)
B)
DE=0,52
0,015% YELLOW EVERZOL LX
0,02% RED EVERZOL ED-3B
C)
- BRANQUEIO 100 - ECOBLEACHING
%R (or %T)
100
80
60
40
20
360
400
500
600
700
750
WaveLength (nm)

Fig 5.

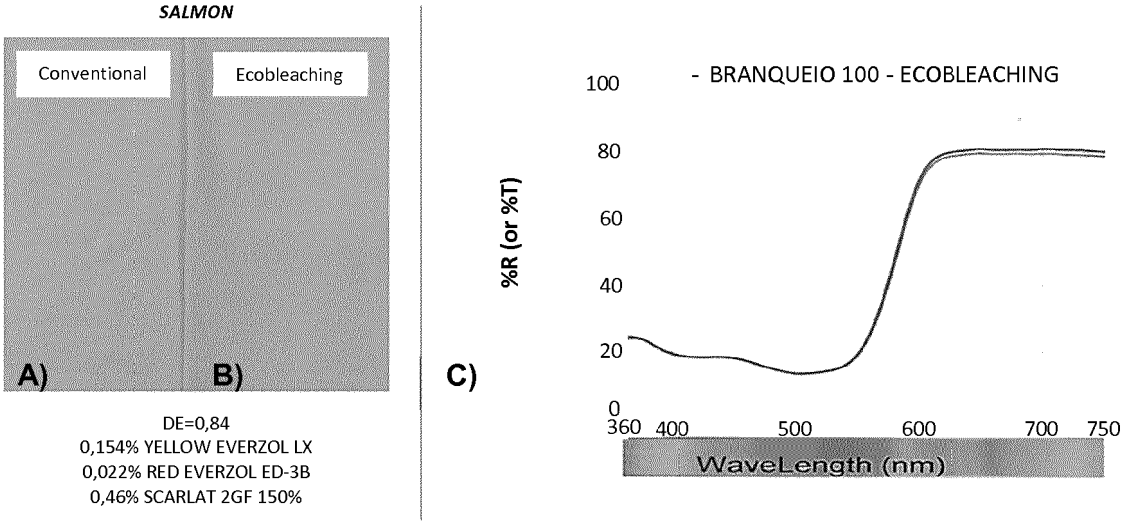

SALMON
Conventional
Ecobleaching
A)
B)
DE=0,84
0,154% YELLOW EVERZOL LX
0,022% RED EVERZOL ED-3B
0,46% SCARLAT 2GF 150%
C)
- BRANQUEIO 100 - ECOBLEACHING
%R (or %T)
100
80
60
40
20
0
360
400
500
600
700
750
WaveLength (nm)

Fig 6.

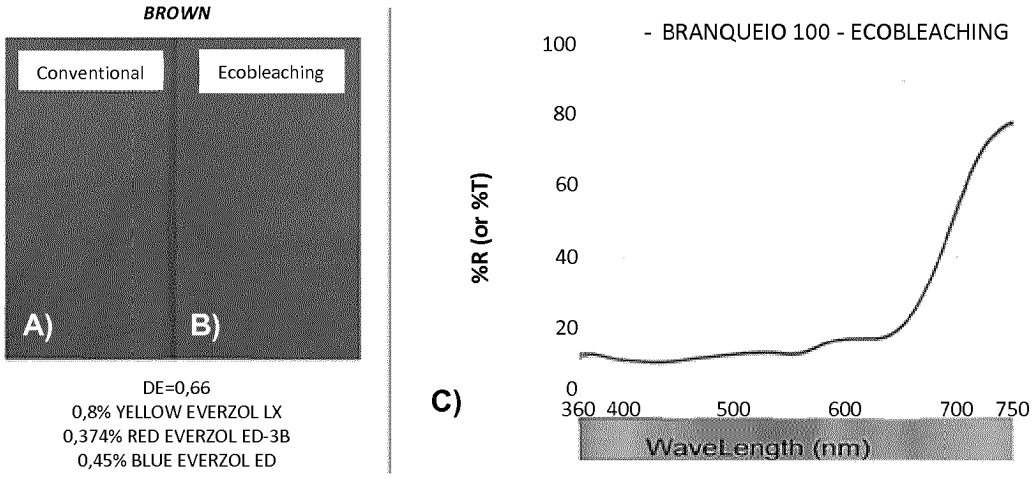

BROWN
Conventional
Ecobleaching
A)
B)
DE=0,66
0,8% YELLOW EVERZOL LX
0,374% RED EVERZOL ED-3B
0,45% BLUE EVERZOL ED
C)
- BRANQUEIO 100 - ECOBLEACHING
%R (or %T)
100
80
60
40
20
0
360 400 500 600 700 750
WaveLength (nm)

Fig 7.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 0200823386 A **[0019]**
- CN 103266495 **[0020]**
- WO 03002810 A **[0020]**
- US 2012015860 A **[0020]**
- WO 2017093677 A **[0020]**