(REFEREED RESEARCH)

ROLE OF AUXILIARIES IN COTTON ABSORBENCY VARIATIONS

YARDIMCI MADDELERİN PAMUĞUN SU EMİCİLİK DEĞİŞİMLERİNDEKİ ROLÜ

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ABSTRACT

In this study, the effect of various auxiliaries on the variation of water absorbency of cotton depending on the drying temperature and the possibility of providing homogenous and stable absorbency values were investigated as well. Alkaline pectinase scouring, conventional alkaline scouring and bleaching and different drying temperatures were applied and the best absorbency values were obtained under the drying conditions at room temperatures. Absorbency decrease was detected after high temperature dryings in some cases depending on the process conditions, wetting and complexing agent kind. Use of wetting, complexing and washing agents were found to be effective to obtain satisfying, homogenous and consistent absorbency through better cleaning effect in fibers. Nonionic wetting agent, acrylate and polycarboxylic acid based complexing agent ensured the most satisfying results. Washing agent also supported absorbency due to its wetting and emulsifying effect. Better emulsification in a proper way improved the absorbency values and prevented from absorbency decrease through heat treatment.

Key Words: Absorbency, Alkaline pectinase, Enzymatic scouring, Alkaline scouring, Auxiliary, Complexing agent, Wetting agent.

ÖZET

Bu çalışmada, yardımcı maddelerin kurutma sıcaklığına bağlı olarak pamuğun su emicilik değerlerinin değişimine etkisinin yanı sıra, kararlı ve yeknesak su emicilik değerleri sağlanması olanağı incelenmiştir. Alkali pektinaz ile hidrofilleştirme, klasik bazik işlem, klasik ağartma işlemi ve farklı kurutma sıcaklıkları uygulanarak en iyi su emicilik değerleri oda sıcaklığında kurutmada elde edilmiştir. İşlem koşullarına, ıslatıcı ve kompleks oluşturucu cinsine bağlı olarak bazı durumlarda, yüksek sıcaklıklarda kurutma sonrasında su emicilik değerinde azalma olduğu belirlenmiştir. Islatıcı, kompleks oluşturucu ve yıkama maddesi kullanımının liflerde daha iyi temizleme etkisi yaratması nedeni ile, tatmin edici, yeknesak ve kararlı bir su emicilik elde edilmesinde etkili olduğu görülmüştür. Nonionik ıslatıcı, akrilik ve polikarboksilik asit esaslı kompleks oluşturucu en tatmin edici sonuçları vermiştir. Yıkama maddesi de ıslatıcı ve emülsiye edici etkisi sayesinde su emiciliği desteklemiştir. Uygun bir şekilde daha iyi emülsifikasyon su emicilik değerlerini iyileştirmiş ve ısıl işlem nedeniyle gerilemeyi önlemiştir.

Anahtar Kelimeler: Su emicilik, Alkali pektinaz, Enzimatik hidrofilleştirme, Bazik işlem, Yardımcı madde, Kompleks oluşturucu, Islatıcı madde.

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1. INTRODUCTION

Absorbency of cotton can be enhanced by various chemical and biotechnological methods. Greige cotton fabrics show a hydrophobic character due to the presence of the cuticle around the fibers. The hydrophobic character of the fabric interferes with sufficient processing of the cloth in common water based dyeing and finishing processes. Additionally the comfort of such hydrophobic fabrics is inferior to that of hydrophilic fabrics (1). The noncellulosic impurities (waxes, pectins, proteins, noncellulosic polysaccharides, inorganics, lignin-containing impurities, coloring materials,etc.) in raw cotton represent approximately 10 % of the total weight (2). The aim of cotton scouring is to remove noncellulosic materials from the surface of the fiber. Scouring results in much more water absorptive fiber that is ready for wet processing. Cleaning property is influenced by many factors including surfactants, auxiliaries, process contitions, substrates and impurities.

The use of surfactant is important for ensuring good contact between the enzyme and the cotton fabric (3). Boiling in sodium hydroxide is the conventional scouring process used by the textile industry to improve the wetting and penetration of aqueous dyeing and finishing solutions. Uniform wetting strongly depends on the scouring conditions and the structure of the cotton products, i.e., yarns and fabrics (4). Oils and fats are removed by saponification with hot sodium hydroxide solution. This process breaks the compounds down into water soluble glycerol and soaps and is the same process traditionally used in the home to make soaps from animal fat. Unsaponifiable materials such as waxes and dirt are removed by emulsification (5). One of the main constituents of a scouring bath is a surfactant that helps keep the impurities in suspension and helps remove oil and other hydrophobic substances by emulsifying them (6).

Surface active agents are often present during dyeing and finishing. They influence the interfacial energy between a solid surface, such as textile material, and a reaction solution (7). Surfactants function by lowering the surface tension of water at boundaries between water and air or oily substances (8). Nonionic surfactants are generally preferred over anionics because they are excellent emulsifiers (5). They reduce the surface energy of cotton allow enzymes to penetrate micropores or cracks, and help enzymes maintain the proper orientation for catalysis to occur (9). Surfactant absorption influences the wettability of a cotton fabric without any removal of hydrophobic cuticle material (1). Nonionic surfactants have many advantages such as wetting, cleaning and emulsifying owing to non-ionizing property in aqueous systems. Thanks to being excellent wetting, emulsifying and washing agent they are able to emulsify and disperse waxes, pectins etc. and inhibit their redeposition (10). Complexing agents are used in textile processing to avoid the disturbing influences of multivalent cations. Depending on the nature of their molecular action, they are designated in different ways e.g chelating agents, sequestering agents, dispersing agents. They should have both complexing as well as dispersing action for use in processing (11). Complexing agents prevent the precipitation of ions by forming stable and water soluble complexes with these ions. Phosphonate and acrylate based complexing agents are the most prevalent classes. They have high complexing and dispersing power (12). A complexing agent which is proper for a process could not be for another (13). Process conditions and properties of complexing agent should be considered. They have different level of sensitivitity for various pH and chemical agents. Washing process is also as important as scouring process itself. It is clear that insufficient washing off noncellulosic impurities would have undesirable influences. The hydrophobic cuticle substances have to be removed from fibers to achieve a homogenous, satisfying and consistent absorbency over the fabric after scouring. It is possible to enhance the effect of pre-treatment by using washing and complexing agents by increasing removal of impurities.

Further improvement of rinsing procedure may be achieved by incorporating a surfactant. Additionally, incorporating a chelator in the rinsing medium may also facilitate the removal of pectin and wax. It is known that the pectin structure in cotton fibers is stabilized by calcium. By extracting this calcium, the pectin structure is destabilized and solubilization of pectin/wax by the surfactant may therefore facilitated (1). Generally speaking, a wetting time of 1 second in the AATCC method means that the absorption of water by the fabric is sufficient for practical dyeing, finishing and printing (14). The fabric should wet in less than 5 seconds and preferably less than 3 seconds. If the wetting time for all the drops is greater than five seconds, the fabric has not been adequately scoured (5). Textile materials are subject to high temperature dryings/fixations during finishing processes at the mill production. Therefore it can be suggested that the matter of how the absorbency is influenced by heat treatment is a descriptive phenomenon. Any instable and/or nonuniform absorbency reveals some defects during dying/printing and finishing processes as well as decreased comfort and performance properties. Various cotton enzymatic scourings were investigated in comparision to alkaline scouring in terms of wax and pectin content and absorbency behaviour through heat treatments (15). Significant differences were detected among trials depending on enzyme kind and heat treatment. Emulsification and removal of waxy substances played a key role in improving and getting a stable and homogenous absorbency. In this study, it was focused on the effect of various auxiliaries to achieve a consistent and satisfactory absorbency.

2. BACKGROUND

Absorbency reduction was observed in bioscoured woven fabric subsequent heat treatment. Greige 100 % cotton with a weight of 126 g/m^2, starch sized plain woven fabric was bioscoured with various enzyme combinations including 0.5 g/L wetting agent without using complexing agent in a Linitest machine at a liquor ratio of 22.5:1. Enzymatic scourings were performed at 60 °C for 20 minutes then the process continued for 20 minutes once the temperature reached 80 °C. Alkaline scouring was conducted in a bath containing 2 % sodium hyroxide, 2 % sodium bicarbonate and 0.5 g/L wetting agent at 90 °C for one hour. Fabrics were washed and their absorbency values were measured after air drying and kept at 100°C for 15 minutes by DIN 53924 strip method (Figure 1). Acceptance value was 3 cm/60 seconds. Significant absorbency differences were seen between samples depending on enzyme combinations and various proportions of absorbency decreases were experienced through heat treatment. However, no remarkable absorbency differences were found between variously bioscoured knitted fabrics after room drying and some differences revealed after heat treatment as expected (15). In com-

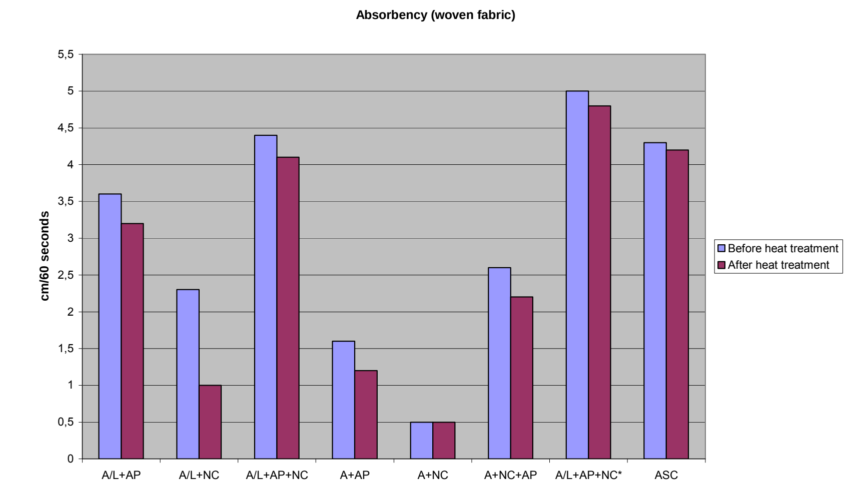

Figure 1. Absorbency values of woven fabric after air drying and heat treatment

A/L+AP: (0.25 %) Amylase/Lipase and (0.05 %) alkaline pectinase combination
A/L+NC: (0.25 %) Amylase/Lipase and (0.5 %) neutral cellulase combination
A/L+AP+NC: (0.25 %) Amylase/Lipase, (0.05 %) alkaline pectinase and (0.5 %) neutral cellulase combination
A+AP: (0.25 %) Amylase and (0.05 %) alkaline pectinase combination
A+NC: (0.25 %) Amylase and (0.5 %) neutral cellulase combination
A+AP+NC: (0.25 %) Amylase, (0.05 %) alkaline pectinase and (0.5 %) neutral cellulase combination
A/L+AP+NC*: Two-bath bioscouring. First bath; (0.25 %) Amylase/lipase, Second bath; (0.025 %) alkaline pectinase and (0.5 %) neutral cellulase
nventional alkaline scouring after enzymatic desizing with amylase

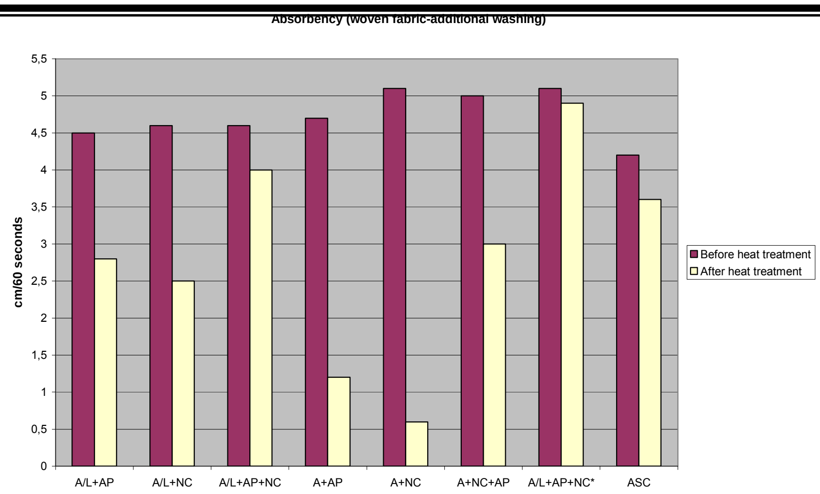

Figure 2. Absorbency values of additionally washed woven fabric after air drying and heat treatment

Table 1. Auxiliaries in alkaline scouring

		ASC*	ASST**	AS1	AS2	AS3
Wetting agent	Nonionic	1	-	-	-	1
	Nonionic/anionic	-	1	1	1	-
Complexing agent	Acrylate based	-	-	0.5	0.5	0.5
	Organic acids and polymers combination based	-	0.5	-	-	-
Washing agent	Nonionic wetting and emulsification agent	-	-	-	0.5	-

* ASC: Control sample for alkaline scouring
** ASST: Standart recipe for alkaline scouring

Table 2. Auxiliaries in alkaline pectinase scourings (Effect of various washing agents)

		AP1-A	AP1-B	AP1-C	AP1-D
Wetting agent	Nonionic	1	1	1	1
Complexing agent	Acrylate based	0.5	0.5	0.5	0.5
Washing agent	Nonionic wetting agent and oil remover (A)	0.5	-	-	-
	Nonionic wetting and emulsification agent (B)	-	0.5	-	-
	Etoxile substances and complexing agent (C)	-	-	0.5	-
	Detergent containing esther combination (D)	-	-	-	0.5

parision to woven fabric, it could be stemmed from use of complexing agent and higher wetting agent concentration. Author observed that excessive use of wetting agent and washing cycles prevented from perceiving obviously the absorbency differences between various enzymatic scourings. Bioscoured samples were washed additionally at 80 °C for 15 minutes to see the improving effect of more washing and absorbency values were determined after room drying and heat treatment (Figure 2). Additional washing enhanced the values extremely. However, different rates of absorbency reductions were observed after heat treatment depending on enzyme combinations. Best absorbency values were achieved with amylase/lipase+alkaline pectinase combination, amylase/lipase+alkaline pectinase+neutral cellulase combination and two-bath bioscouring in all cases. All these findings point out the effect of auxiliaries and enzyme combinations on absorbency.

3. MATERIALS AND METHODS

Fabric

100 % cotton knitted single jersey fabric (30/1 Ne) with a weight of 135 g/m^2 was used at the experiments.

Methods

First stage trials were applied in a Termal HT laboratory dyeing machine at a liquor ratio of 10:1. Greige knitted fabric was subjected to conventional alkaline scourings, enzymatic scourings, peroxide bleachings and and control (blank) treatments. Second stage trials were applied in an Eliar TBB 6000 Ataç Lab Dye HT10 overflow machine with 1.5 kg capacity and automatic control system at a liquor ratio of 10:1. Experiments were repeated two times.

Alkaline scouring

Alkaline scouring was performed in a bath containing 1 g/L wetting agent, 0.5 g/L complexing agent, 3 g/L NaOH (38 Baumé) at 95 °C for 45 minutes. It was followed by washing at 80 °C for 10 minutes, neutralization with 1 g/L acetic acid at 60 °C for 10 minutes and rinsing at ambient temperature for 5 minutes respectively. Nonionic and nonionic/anionic wetting agents were used. Two kinds of complexing agents; acrylate based and organic acids-polymers combination based and a nonionic washing agent with wetting and emulsification effect were applied. Control sample was prepared with the same process conditions without using complexing agent. Table 1 shows the auxiliaries of alkaline scouring trials.

Enzymatic scouring

Enzymatic scouring was performed in a bath containing 0.5 % (o.w.f) alkaline pectinase produced from a Bacillus microorganism with 360 APSU/g activity which is kindly supplied by Rudolf Duraner, 1 g/L nonionic wetting agent, pH 9 at 55 °C for 20 minutes; 0.5 g/L complexing agent was added, then the process continued for 15 minutes once the temperature reached 80 °C. Fabric was subsequently washed at 90 °C for 20 minutes and rinsed at room temperature for 5 minutes. Four kinds of complexing and washing agents were used during enzymatic or washing step. Complexing agents were acrylate, polycarboxylic acid, phosphonate and organic acids-polymers combinations based. Washing agents were nonionic wetting agent and oil remover (A), nonionic wetting and emulsification agent (B), etoxile substances and

Table 3. Auxiliaries in alkaline pectinase scourings (Effect of various complexing agents)

		APC	APS	AP1	AP2	AP3	AP4	AP5	AP6	AP7
Wetting agent	Nonionic	1	1	1	1	1	1	1	1	1
Complexing agent	Acrylate based	-		0.5[a]	-	-	0.5[b]	-	-	
	Policarboxylic acid based				0.5[a]			0.5[b]		
	Phosphonate based					0.5[a]			0.5[b]	
	Organic acids and polymers combination based	-	0.5[a]	-	-	-	-	-	-	0.5[b]

a: It was used during enzymatic treatment
b: It was used during washing step
* APC: Control sample for alkaline pectinase scouring
** APS: Standart recipe for alkaline pectinase scouring

Table 4. Auxiliaries in alkaline pectinase scourings (Effect of various complexing and washing agents)

		AP8*	AP9*	AP10	AP11	AP12	AP13	AP14	AP15
Wetting agent	Nonionic	1	1	1	1	1	1	1	1
Complexing agent	Acrylate based	1	1	0.5[a]	0.5[a]	0.5[b]	-	-	-
	Policarboxylic acid based	-	-	-	-	-	0.5[a]	0.5[a]	0.5[b]
	Phosphonate based	-	-	-	-	-	-	-	-
	Organic acids and polymers combination based	-	-	-	-	-	-		-
Washing agent	Nonionic wetting agent and emulsification	-	1	0.5[a]	0.5[b]	0.5[b]	0.5[a]	0.5[b]	0.5[b]

a: It was used during enzymatic treatment
b: It was used during washing step
* Excess washing at 90 C for 20 minutes, 80 C for 10 minutes and cold washing for 5 minutes.

Table 5. Auxiliaries in hydrogen peroxide bleaching

		PBC*	PBS**	PB1	PB 2	PB3	PB4
Wetting agent	Nonionic	1	-	1	-	1	-
	Nonionic/anionic	-	1	-	1	-	1
Complexing agent	Acrylate based	-	-	-	0.5	0.5	0.5
	Organic acids and polymers combination based	-	0.5	0.5	-	-	-
Washing agent	Nonionic wetting and emulsification agent	-	-	-	-	-	0.5

* PBC: Control sample for hydrogen peroxide bleaching
** PBS: Standart recipe for hydrogen peroxide bleaching

Table 6. Auxiliaries in trials at the mill condition

		C	AS	AP	PB
Wetting agent	Nonionic	1	1	1	1
Complexing agent	Acrylate based	0.5	0.5	0.5	0.5

complexing agent (C) and detergent containing esther combination (D).

Control trial was also carried out by using the same process conditions of enzymatic scouring without using complexing agent addition (APC). Table 2, 3 and 4 show the auxiliaries for alkaline pectinase scourings. However, control trial for enzmatic scouring at the mill condition contains wetting and complexing agent without using enzyme.

Hydrogen peroxide bleaching

Fabric was treated in a bath containing 1 g/L wetting agent, 0.5 g/L complexing agent, 0.5 g/L peroxide stabilizer, 2.5 g/L NaOH (38 Baumé), 2 g/L hydrogen peroxide (50 %), at 95 °C for 30 minutes. Then washing at 80 °C for 10 minutes, neutralization with 1 g/L acetic acid at 60 °C for 10 minutes, rinsing with catalase enzyme at 50 °C for 15 minutes and rinsing at room temperature for 5 minutes were carried out respectively. Acrylate based and organic acids-polymers combination based complexing agents, nonionic and nonionic/anionic wetting agents and nonionic washing agent with wetting and emulsification property were used. Control trial was also applied with the same process conditions without using complexing agent. Table 5 and Table 6 show the auxiliaries for hydrogen peroxide bleaching trials and mill trials respectively.

Drying conditions

Wet fabrics were squezeed with a 70 % pick-up and dried in four different ways; at room temperature, at 120 °C for 3 minutes in a stenter, at 140 °C for 2 minutes in stenter and contact drying at 200 °C for 1 minute.

Testing procedure

Fabrics dried in different ways were tested after conditioning for one day at 20 °C and 65 % relative humidity. Water absorbency for knitted fabric was determined according to AATCC 79-1972 water drop method.

4. RESULTS AND DISCUSSION

Alkaline scouring

The absorbency results of alkaline scoured samples are shown in Figure 3. The satisfactory results were achieved at room temperature. Although absorbency of control sample was acceptable it was worse than that of the others. Control sample proves that complexing and wetting agent were effective to obtain a consistent absorbency. Washing agent usage did not generate a significant difference in practice. A stable and satisfactory absorbency without a washing agent can be obtained if an appropriate wetting and complexing agent combination is used. However, by comparing AS1 and AS2, use of washing agent resulted in a remarkable improvement in absorbency reduction. Wetting and complexing agent kind played an important role in absorbency reduction.

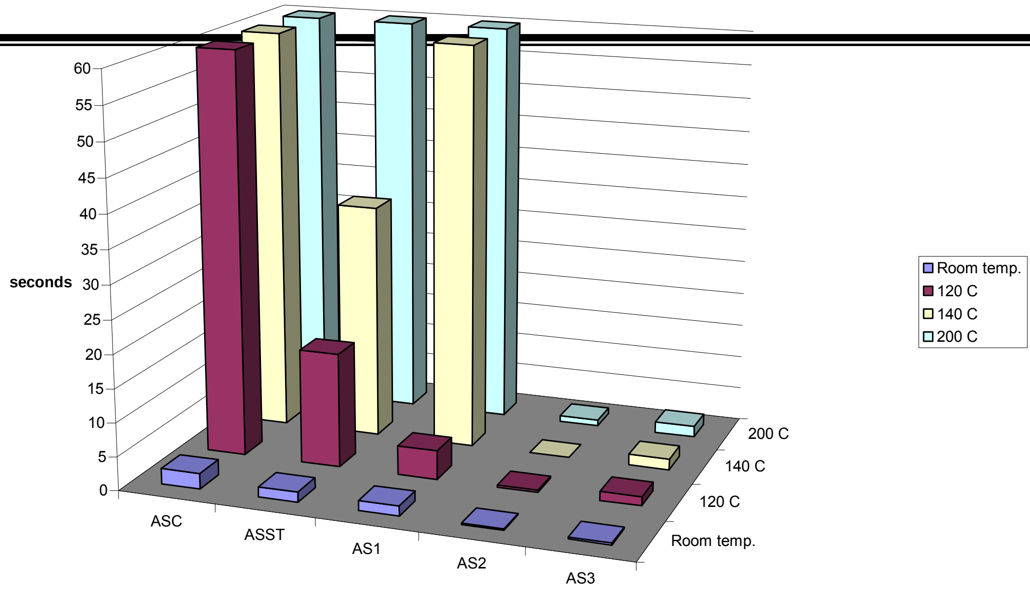

Figure 3. Absorbency of the alkaline scoured samples

ASC: Control sample, nonionic wetting agent, no complexing agent
ASST: Standart recipe, nonionic/anionic wetting agent, organic acids and polymers combination based complexing agent.
AS1: Nonionic/anionic wetting agent, acrylate based complexing agent.
AS2: Nonionic/anionic wetting agent, acrylate based complexing agent, washing agent.
AS3: Nonionic wetting agent, acrylate based complexing agent

Alkaline pectinase scouring

Washing agent was used together with complexing agent in enzymatic treatment. Washing agents A and B gave satisfactory results. (Figure 4) It seems that the kind of washing agent led to a difference in absorbency especially subsequent drying at higher temperatures. The use of washing agent with wetting and wax removing property can be recommended.

The kind of complexing agent resulted in different proportions of absorbency reduction while the difference was not significant at room temperature drying (Figure 5). Control sample proves that complexing agent contributes to get more consistent absorbency especially followed by a high temperature drying process. Control sample exhibited variance in water absorbency measurements. Trials containing polycarboxylic acid and acrylate based complexing agents resulted in the best absorbency values. Application step of complexing agent is also efficient. Use of complexing agent during enzymatic scouring was more advantageous over washing step application (AP1-AP4, AP2-AP5, AP3-AP6, AP5-AP7). Excellent absorbency values of the trials with severe process conditions; higher auxiliary concentration, additional washing agent and washing cycle, emphasize importance of noncellulosic impurities removal to obtain a stable and homogenous absorbency. Complexing and washing agents were incorporated in different steps, (I) simultaneous use of complexing and washing agent during ezymatic scouring, (II) use of complexing agent during enzymatic scouring and use of washing agent during washing step, (III) simultaneous use of complexing and washing agent during washing step. Simultaneous use of complexing and washing agents during enzymatic scouring ensured the best absorbency values. Although the observation of this tendency, application step of complexing and washing agents did not create a significant difference and all of the values were within acceptable limits. Better emulsification as well as utilization and saving of rinsing cycle can be achieved by incorporating washing agent at the beginning of the process. The more stable absorbency the more efficient cleaning effect in pretreatment. The findings of trials are in line with the the explanations of Peters' and other study (15,16). The existence of sufficient area covered with wax to present a hydrophobic surface is emphasized. Absorbency is altered by washing with hot water and air drying or by drying at a higher temperature. High temperature drying causes the melting wax to spread back over the fiber by forming a hydrophobic surface and the wax returnes to its original distribution (16). It could be considered that wax distribution is essential over the fiber surface as much as the wax content.

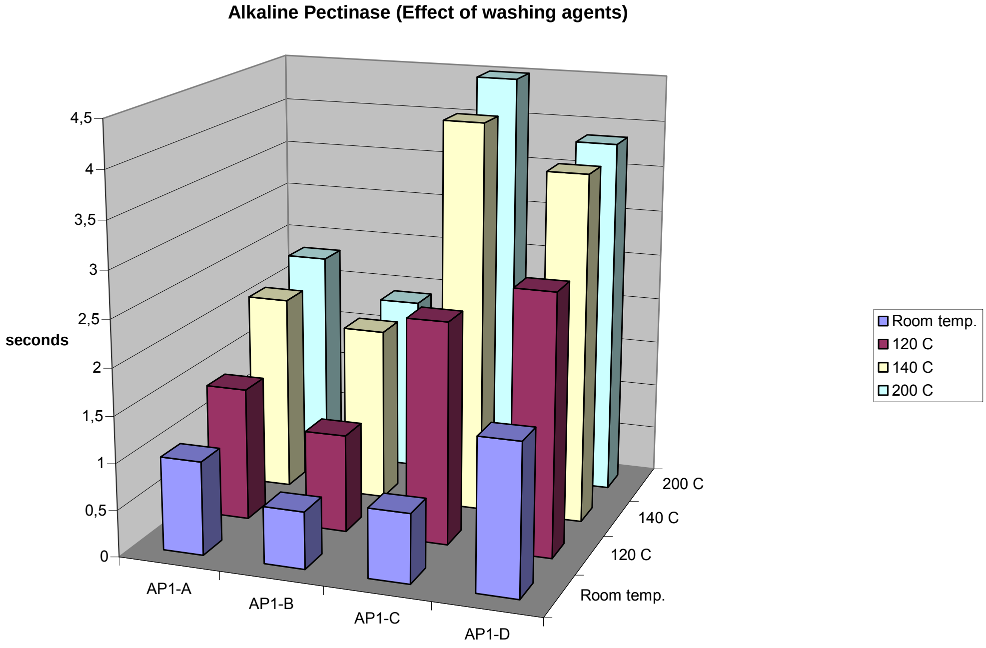

Figure 4. Absorbency of alkaline pectinase scouring with various washing agents

AP1-A: Nonionic wetting agent, acrylate based complexing agent, washing agent (nonionic wetting and oil remover agent)
AP1-B: Nonionic wetting agent, acrylate based complexing agent, washing agent (nonionic wetting and emulsification agent)
AP1-C: Nonionic wetting agent, acrylate based complexing agent, washing agent (etoxile substances and complexing agent)
AP1-D: Nonionic wetting agent, acrylate based complexing agent, washing agent (detergent containing esther combination)

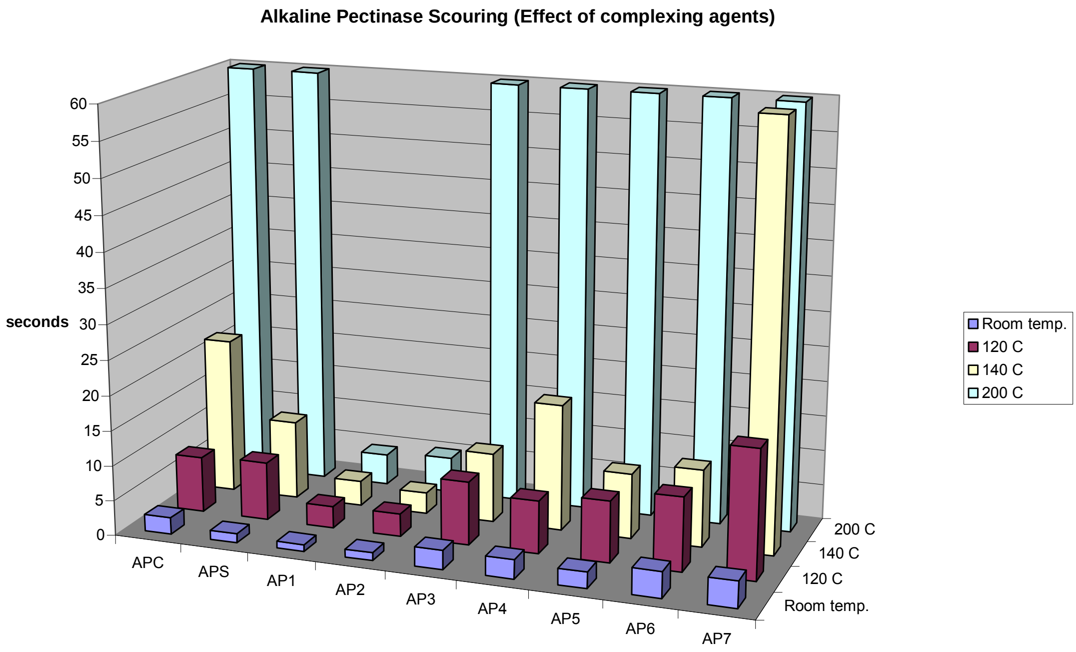

Figure 5. Absorbency of alkaline pectinase scouring with various complexing agents

* Control trial of enzymatic scouring contains enzyme and wetting agent except for complexing agent (APC).
APC: Control sample, nonionic wetting agent, no complexing agent
APS: Standart recipe, nonionic wetting agent, organic acids and polymers combination based complexing agent. (Complexing agent was used during enzymatic treatment)
AP1: Nonionic wetting agent, acrylate based complexing agent. (Complexing agent was used during enzymatic treatment)
AP2: Nonionic wetting agent, polycarboxylic acid based complexing agent. (Complexing agent was used during enzymatic treatment)
AP3: Nonionic wetting agent, phosphonate based complexing agent. (Complexing agent was used during enzymatic treatment)
AP4: Nonionic wetting agent, acrylate based complexing agent. (Complexing agent was used during washing step)
AP5: Nonionic wetting agent, polycarboxylic acid based complexing agent. (Complexing agent was used during washing step)
AP6: Nonionic wetting agent, phosphonate based complexing agent. (Complexing agent was used during washing step)
AP7: Nonionic wetting agent, organic acids and polymers combination based complexing agent. (Complexing agent was used during washing step)

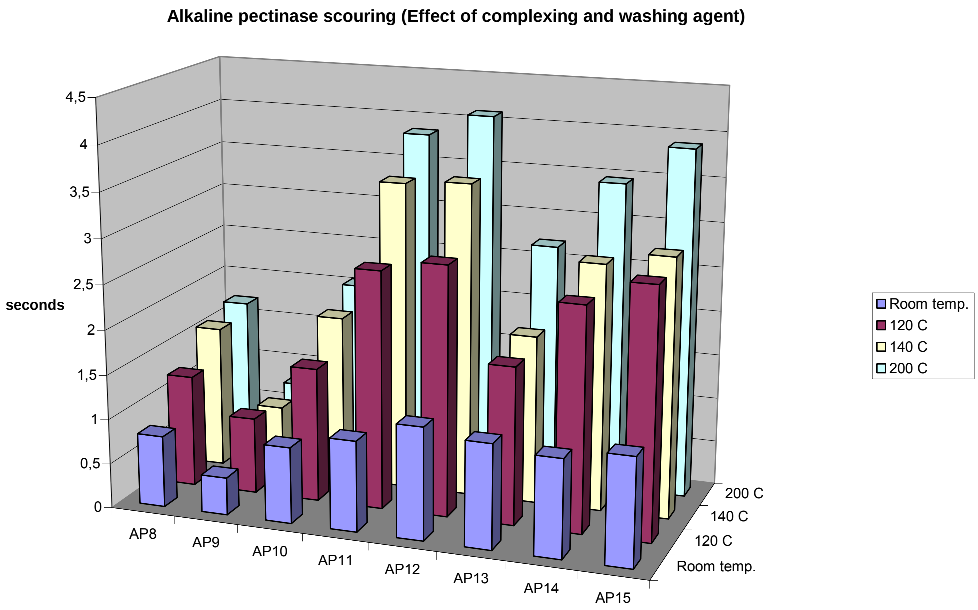

Figure 6. Absorbency of alkaline pectinase scouring with complexing and washing agents

AP8: Nonionic wetting agent, acrylate based complexing agent. (higher complexing agent concentration and excessive washing)
AP9: Nonionic wetting agent, acrylate based complexing agent, washing agent. (higher complexing agent concentration and excessive washing)
AP10: Nonionic wetting agent, acrylate based complexing agent, washing agent. (Complexing and washing agent were used during enzymatic treatment.)
AP11: Nonionic wetting agent, acrylate based complexing agent, washing agent (Complexing agent was used during enzymatic treatment and washing agent were used during washing step.)
AP12: Nonionic wetting agent, acrylate based complexing agent, washing agent (Complexing and washing agent were used during washing step.)
AP13: Nonionic wetting agent, polycarboxylic acid based complexing agent, washing agent (Complexing and washing agent were used during enzymatic treatment.)
AP14: Nonionic wetting agent, polycarboxylic acid based complexing agent, washing agent (Complexing agent was used during enzymatic treatment and washing agent were used during washing step.)
AP15: Nonionic wetting agent, polycarboxylic acid based complexing agent, washing agent (Complexing and washing agent were used during washing step.)

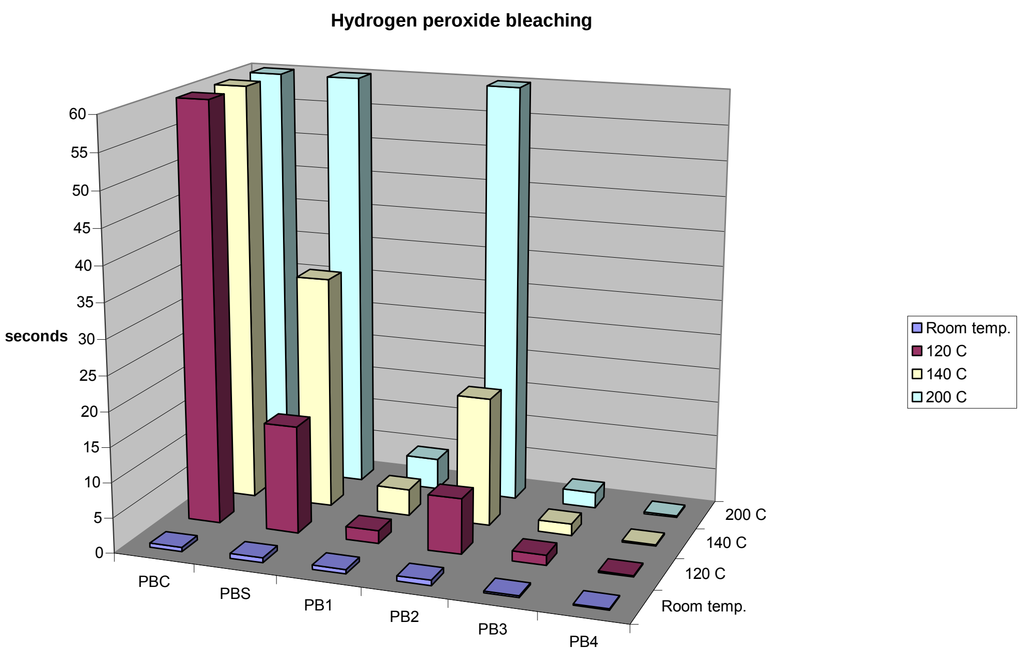

Figure 7. Absorbency of hydrogen peroxide bleaching

PBC: Control sample, nonionic wetting agent, no complexing agent
PBS: Standart recipe, nonionic/anionic wetting agent, organic acids and polymers combination based complexing agent.
PB1: Nonionic wetting agent, organic acids and polymers combination based complexing agent.
PB2: Nonionic/anionic wetting agent, acrylate based complexing agent.
PB3: Nonionic wetting agent, acrylate based complexing agent
PB4: Nonionic/anionic wetting agent, acrylate based complexing agent, washing agent

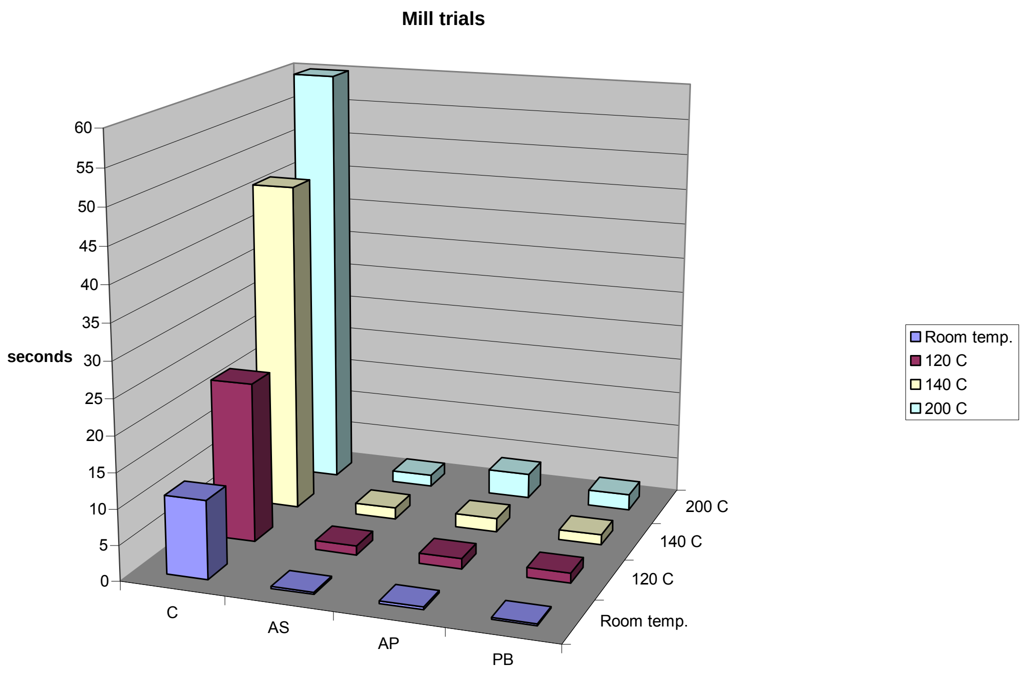

Figure 8. Absorbency of the trials performed at the mill conditions

C: Control
AS: Alkaline scouring
AP: Alkaline pectinase
PB: Hydrogen peroxide bleaching
* Control trial for enzmatic scouring at the mill condition contains wetting and complexing agent except for enzyme.

Hydrogen peroxide bleaching

Result of control sample is in line with the alkaline scouring (Figure 7) and shows the effect of complexing agent. Wetting and complexing agents prevented from absorbency reduction by supporting noncellulosic subsrates removal. These auxiliaries played a key role in bleaching similar to alkaline and enzymatic scourings. Nonionic wetting agent and acrylate based complexing agent resulted in better absorbency than that of the nonionic/anionic wetting agent and organic acid-polymers combination based complexing agent. An outstanding difference between two kinds of complexing agents was obviously observed. Nonionic wetting agent and acrylate based complexing agent combination gave the most promising absorbency values. Use of washing agent generated an improvement in absorbency according to trials containing nonionic/anionic wetting agent, organic acids-polymers combination based complexing agent except for the trial containing nonionic wetting agent and acrylate based complexing agent. A homogenous and stable absorbency could be obtained without washing agent in case of appropriate auxiliaries use.

Trials at the mill conditions

All absorbency values except for control sample were acceptable with nonionic wetting agent and acrylate based complexing agent (Figure 8). Control sample proves that only use of auxiliaries is not sufficient. This finding also points out the removal noncellulosic impurities through a proper pretreatment.

5. CONCLUSION

Absorbency values can vary in various extents after heat processes depending on the content of pretreatment baths and washing conditions. The best absorbency values were obtained after room temperature dryings. However, absorbency decrease with higher temperatures in some cases points out the residuals of noncellulosic impurities especially fats and waxes that get back their original position over fiber surface. Emulsification and removal of waxy substances from the fiber play a key role in improving and getting a consistent absorbency. Wetting, complexing and washing agents can also ensure water absorbency themselves. However it must be considered the homogenity and stability of the absorbency over the fibre surface. Auxiliaries have an improving and crucial effect on getting a homogenous and consistent absorbency together with scouring/bleaching agents such as sodium hydroxide, enzymes, hydrogen peroxide etc. Nonionic wetting agent, acrylate and polycarboxylic acid based complexing agent ensured the most satisfying results. Washing agent also supported absorbency through its wetting and emulsifying effect. The use of washing agent can be eliminated with a proper selection of wetting and complexing agent combination. However production cost, water-chemical-energy saving and and ecological criteria should also be considered carefully in terms of the determination of process conditions and recipes. Monitoring the absorbency variation and homogenity depending on subsequent heat processes can be proposed as an evaluation way for the accuracy of the pretreatment.

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