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NOVEL WASHING STUDY OF STAINED WOOLEN FABRIC (HAVING STAINS OF BOOT POLISH AND HAIR COLOR DYE) WITH BUTANOL DRIVEN AMYLASE LOADED BSANPS AS BIO-ACTIVE NANO-WOOL SHAMPOO ADDITIVES

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ABSTRACT: Amylase has been exploited in textile, leather, paper, and detergent industries for washing and desizing of fabrics. It was reported to immobilize on to various compatible matrices by adopting various methods to increase its thermal and storage stability. Its immobilization onto bovine serum albumin (BSA) was observed to be very significant to synthesis its non-toxic and low-cost BSA loaded nanoparticles (BSANPs). In this designed washing study, *Cicer aritenium* amylase loaded butanol driven BSA nanoparticles (BSANPs) were used which were synthesized by using the desolvation method. These synthesized BSANPs were made bio-active with standardized 35U of alkaline protease for their biodegradation to allow the controlled release bound amylase. Then, this bio-active amylase loaded BSANPs were used as nano-wool shampoo additives with chosen woolen shampoo named, Perwoll Shampoo to test the stain removal efficacy from stained woolen fabric without affecting the delicacy and softness of the chosen fabric. In this study, chosen stains were comprised of daily routine stains of boot polish and hair color dye cream named, kiwi leather extra shine black and garnier nutrisse nourishing color crème black respectively. Sometimes, these stains are very difficult to wash off from the woolen/cashmere fabric or required couple of pre-washing practices. So, keeping this domestic or industrial washing problem, chosen stains are selected very thoughtfully. And, from this washing study, effective washing observations were carried out to wash off the selected stains form woolen fabric when washed with chosen wool shampoo along with bio-active prepared butanol driven amylase bound BSANPs solution as compared their washing with chosen wool shampoo alone.

Keywords: Kiwi leather extra shine black, Garnier nutrisse nourishing color crème black, BSANPs, Bovine serum albumin nanoparticles, Butanol, Desolvation, Wool shampoo, Cashmere fabric

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INTRODUCTION: Amylases were used significantly in food, fermentation, textile, paper, detergent, pharmaceutical, leather, and chemical industries. They have a significant role in brewing, liquefaction, saccharification, bio-fuel production, fabric designing, and starch processing [1, 2, 3]. In textile, rubber, and paper industries, amylases have a key role in starch processing to fabricate or desized the fibers as per the requirement of the garments designing and formulation [3, 4, 5, 6].

Amylase was also found to be a very safe enzyme in fabric designing, and washing as compared to other chemicals such as persulphate and alkali or bromide which lead to damage of fibers during the

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opted various fibers processing strategies [6, 7, 8]. Previously, it has been reported that 20-30% of industrially produced enzymes are exploited in the textile and detergent industries worldwide due to having good thermal stability, low requirement of water and energy and labor during the fibers processing [9, 10, 11, 12]. It has also been reported that amylase immobilization onto various eco-friendly biocompatible, non-toxic and non-corrosive supports made it more industrially viable to widen the application of immobilized amylase as compared to free enzyme [12, 13, 14]. Immobilization of amylase was found to be a more low-cost method to increase the storage stability and thermal stability as compared to its native form [15, 16, 17, 18]. Immobilization has been used to enhance its stability, easy recovery, easy separation of reactant and product, repeated or continuous use to reduce labor and overhead costs. Immobilized amylase has improved storage, pH operational, thermal and conformational stabilities after immobilization [19-20].

In this proposed washing practice, bio-active butanol driven *Cicer aritenium* amylase loaded BSANPs were used to wash the stained woolen/cashmere fabric pieces with chosen wool shampoo named Perwoll to compare the washing results of chosen wool shampoo alone.

MATERIALS AND METHODS: Butanol drove chemically modified *Cicer aritenium* amylase BSANPs were used for this study that was prepared by Rani, K., & Chauhan, C., 2015 [18]. This bio-active amylase bound BSA nano-wool shampoo additives with 35U of alkaline protease was used in the washing of stained fabric pieces with selected woolen shampoo named, Perwoll which is internationally popular wool shampoo brand name that proposed to use in many textiles and detergent industries for washing of expensive woolen and cashmere fabrics. Chosen stains were of kiwi leather extra shine black and garnier nutrisse nourishing color crème black that are very popular boot polish and hair color dye crèmes brands worldwide respectively **Fig 1**.

These selected stains were used to stain the woolen fabric pieces. Then, strained woolen fabric pieces were soaked in the reaction mixture of 1-2 mg of prepared butanol amylase loaded BSANPS with 350U of alkaline protease solution and 2-3 ml of selected wool shampoo in Petri plates [13, 16, 17, 18, 19]. Each sample of stained woolen fabric pieces was washed with only chosen woolen shampoo with the combination of the above-mentioned reaction mixture of alkaline protease-mediated olive oil-driven amylase loaded BSANPs. Then, their washing analysis was carried out to study its comparative washing results to know the washing efficacy of propped prepared BSANPs as bio-active amylase bound BSA nano-wool shampoo additives.

A: Chosen Woolen Shampoo **B: Chosen Stain of Shoe Polish** **C: Chosen Stain of Hair Colour**

FIG. 1: A: CHOSEN WOOL SHAMPOO, PERWOLL WHICH WAS USED FOR WASHING OF STAINED WOOLEN FABRIC; B: CHOSEN STAIN OF SHOE POLISH NAMED, KIWI LEATHER EXTRA SHINE BLACK (SAMPLE A); C: CHOSEN STAIN OF HAIR COLOR DYE CRÈME NAMED, GARNIER NUTRISSE NOURISHING COLOR CRÈME BLACK (SAMPLE B) WHICH WERE USED FOR STAINING THE WOOLEN FABRIC PIECES TO CARRY OUT THE WASHING STUDY

RESULTS AND DISCUSSION: Butanol driven *Cicer aritenium* amylase BSANPs were subjected to carry out the washing study with chosen wool shampoo named, Perwoll to remove the stains of chosen stains of boot polish and hair color dye crème. These stains are very tough to remove in single wash or required many tedious pre-treatment practices such as a long hour of soaking period in warm water and some time need the use of stain dissolving agents like potash alum or vinegar, *etc.*

FIG. 2: WASHING RESULTS OF STAINED WOOLEN FABRIC PIECES HAVING CHOSEN STAIN SAMPLE A OF BOOT POLISH (KIWI LEATHER EXTRA SHINE BLACK) WITH CHOSEN WOOL SHAMPOO NAMED, PERWOLL AND PREPARED BIO-ACTIVE BUTANOL DRIVEN AMYLASE LOADED BSANPS [18]

FIG. 3: WASHING RESULTS OF STAINED WOOLEN FABRIC PIECES HAVING CHOSEN STAIN SAMPLE B OF HAIR COLOR DYE CRÈME (GARNIER NUTRISSE NOURISHING COLOR CRÈME BLACK) WITH CHOSEN WOOL SHAMPOO NAMED, PERWOLL AND PREPARED BIO-ACTIVE BUTANOL DRIVEN AMYLASE LOADED BSANPS [18]

These prewashing practices were lead to harm the texture of woolen/cashmere fabric, especially smoothness, delicacy, and softness of expensive woolen and cashmere fabrics. Moreover, butanol driven amylase loaded BSANPs were made bio-active by using standardized 35U alkaline protease to carry out the controlled release of bound amylase from BSANPs in reaction mixture [13, 16, 17, 18, 19]. Then, this prepared bio-active butanol driven amylase loaded BSANPs reaction mixture was used with selected wool shampoo for washing of stained woolen fabric pieces whose fibers became strained due to increase in their weight and size by absorbing the chemical/biochemical ingredients of chosen stains with the time. These strained woolen fabric pieces are needed to subjecting them to good washing practices to remove the stains without affecting the delicacy and softness of woolen fabric before they become so tough and hard to be removed from the expensive woolen and cashmere fabrics. And, this designed washing study was found to be more effective to enhance the washing efficiency of chosen wool shampoo when used with prepared bio-active butanol driven amylase BSANPs as compared to washing observations of chosen wool shampoo alone to wash off the chosen stains **Fig. 2** and **3**.

In this designed washing study, that popular chosen wool shampoo named, Perwoll was used to wash the selected stained woolen fabric pieces with 35U alkaline protease derived butanol driven amylase loaded BSANPs. And, it was found that bio-active butanol driven amylase loaded BSANPs act as excellent bio-active amylase bound BSA nano-wool shampoo additive when used with selected wool shampoo to wash off the chosen stains of boot polish **Fig. 2** and hair color dye crème **Fig. 3** from stained woolen fabric pieces. Very clear, visible and noticeable observations were confirmed that these prepared bio-active butanol driven amylase bound BSANPs were lead to enhance the washing efficiency of chosen wool shampoo as nano-wool shampoo additives as compared to results of chosen

wool shampoo alone **Fig. 2** and **3**. As well as, it was also observed that there was no effect on the delicacy and softness of woolen fabric upon touching after using this designed washing practice. And, these washing observations of bio-active butanol driven amylase bound BSA-nano-wool shampoo additives were also found to be very similar and comparable with previous findings [16-20].

CONCLUSION: Form this designed washing study, it was concluded that use of *Cicer aritenium* amylase loaded butanol driven BSANPs with standard 35U of alkaline protease with selected wool shampoo, Perwoll, was found to be cost-effective and time-saving practice. And, it was lead to improved washing efficiency as compared to normal washing practices without harming the delicacy and softness of fibers of woolen and cashmere fabric pieces. These prepared bio-active butanol driven amylase loaded BSANPs washing mixture was found an eco-friendly and low-cost bio-active nano-wool shampoo additives.

It was also confirmed that this designed washing practice showed the zero requirements of other required washing labor practices, minimizing the water and energy consumption. And, the proposed study was proved quite helpful to maintain mild condition for expensive woolen and cashmere fabric as well as for skin of hands without causing any hassles during the designed washing practices. In many Indo-Asian countries, *e.g.* Indonesia, Malaysia, Bangladesh, Vietnam, Thailand, Asia, Cambodia, Srilanka, Bhutan, Nepal, Taiwan, etc., where textiles, wood, rubber, leather, and detergent industries are most prevailing industries for national economic growth and mostly endorsed for international trading productivity globally. So, this designed washing practice of woolen/cashmere fabric may prove helpful to cut down the cost of various washing procedures of expensive woolen fabrics as well as it can be used in paper and leather processing/desizing processing strategies to save time and energy.

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