

## WASHING STUDY OF STAINED WOOLEN FABRIC WITH MUSTARD OIL DRIVEN AMYLASE LOADED BSANPS AS BIO-ACTIVE NANO-WOOL SHAMPOO ADDITIVES

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### ABSTRACT

Amylase is exploited in textile, leather, wood, paper and detergent industries for washing and desizing of fabrics. Previously, it has been immobilized on to various compatible matrices by several methods to increase its thermal and storage stability. Its immobilization onto bovine serum albumin (BSA) was found to be very significant to prepare its non-toxic BSA loaded nanoparticles (BSANPs). In present study, *Pearl millet* amylase loaded mustard oil driven BSA nanoparticles (BSANPs) were used and made bio-active with 35U of alkaline protease for their biodegradation to release bound amylase. Then, these bio-active enzyme-BSANPs were used as nano-woolen shampoo additives with chosen wool shampoo named, Woolite Shampoo to test their stain removal efficiency 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 shoe polish and hair color dye cream named, Cherry Blossom shoe polish Black and Garnier Nutrisse Nourishing color crème Black respectively. Sometimes, these stains are very difficult to wash off from the woolen fabric or required couple of pre-washing practices. So, keeping this domestic or industrial washing issue, chosen stains are selected very thoughtfully. And, from this study, an effective washing analysis was carried out to remove the chosen stains form woolen fabric when washed with chosen woolen shampoo along with bio-active prepared mustard oil driven amylase bound BSANPs solution as compared their washing with chosen wool shampoo alone.

**KEYWORDS:** Cherry Blossom Shoe Polish Black; Garnier Nutrisse Nourishing Color Crème Black; BSANPs; Bovine serum albumin nanoparticles; Mustard oil; Wool shampoo

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## INTRODUCTION

Amylases were used in food, fermentation, textile, paper, detergent, pharmaceutical, leather and chemical industries. They have significant role in brewing, liquefaction, sacchrification, bio-fuel production, fabric desizing and processing of starch [1-4]. In textile, rubber and paper industries, amylases were found to be reported to have key role in starch processing to fabricate or desized the fibers as per the requirement of the garments designing and formulation [5-9]. Amylase was also found to be very excellent enzyme in fabric desizing and washing as compared to other chemicals such as persulphate and alkali or bromide which lead to damage of fibers during followed processing industries [9,10]. It has been reported that 20-30% of industrially prepared 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 processing [11-13]. It has been also reported that amylase immobilization into various eco-friendly biocompatible, non-toxic and non-corrosive supports made it more industrially viable to widen the application of bound amylase as compared to its free form [13-15]. Immobilization of amylase was found to be more low-cost method to increase the storage stability and thermal stability as compared to its native form [16-18]. Immobilization was lead to increase its stability, easy recovery, easy separation of reactant and product, repeated or continuous use to reduce labor and overhead costs. Immobilized enzyme has improved storage, pH operational,

thermal and conformational stabilities after immobilization [19-21]. In this designed work, bio-active mustard oil driven *Pearl millet* amylase loaded BSANPs were used to wash the stained woolen fabric pieces with chosen wool shampoo named, Woolite shampoo to compare the washing results of chosen woolen shampoo alone.

## MATERIALS AND METHODS

The Mustard oil driven chemically modified *Pearl millet* amylase BSANPs were used for this study that was prepared by Rani, K., *et al*, 2015 [14]. These bio-active amylyse bound BSA nano-wool shampoo additives with 35U of alkaline protease were used in washing of stained fabric pieces with selected wool shampoo named, Woolite Shampoo which is very much internationally popular in many textiles and detergent industries for washing of expensive woolen and cashmere fabrics. Chosen stains on the woolen fabric pieces were of Cherry Blossom Shoe Polish Black and Garnier Nutrisse Nourishing Color Crème Loreal Black that are very popular shoe polish and hair color dye crèmes brands worldwide respectively [Fig 1]. Then, strained woolen fabric pieces were soaked in reaction mixture of 1-2 mg of prepared mustard oil driven amylase loaded BSANPS with 350U of alkaline protease solution and 2-3ml of selected wool shampoo solution in petri plates [13,16-18, 20-21]. Each sample of stained woolen fabric pieces was washed with only chosen wool shampoo with the combination of above mentioned reaction mixture of alkaline protease

mediated mustard oil driven amylase loaded BSANPs. Then, their washing 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 wool shampoo B: Chosen stain of Shoe Polish C: Chosen stain of Hair colour

**Figure 1: A: Chosen wool shampoo, Woolite Shampoo which was used for washing of stained woolen fabric; B: Chosen stain of shoe polish named, Cherry Blossom Shoe Polish 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

Mustard oil driven Pearl millet (*Pennisetum glaucum*) amylase BSANPs were subjected to proposed washing study with chosen wool shampoo named, Woolite Shampoo to remove the stains of chosen stains of shoe 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 long hour of soaking period in warm water and sometime, need the use of stain dissolving agents like potash alum or vinegar etc. These prewashing practices are lead to harm the texture of woolen fabric especially smoothness, delicacy and softness of fibers. Moreover, mustard oil driven amylase loaded BSANPs were made bio-active by using standardized 35U alkaline protease to carry out the controlled and sustained release of bound amylase from BSANPs in reaction mixture. And, alkaline

protease was also good chosen and previously standardized proteolytic enzyme and found to be an efficient enzyme which can resist in harsh condition of fabric washing or desizing [13,16-18, 20-21]. Then, this prepared bio-active amylase loaded BSANPs reaction mixture was used with selected wool shampoo for washing of strained 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 subject them to good desizing or 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 practice was found to be more

effective to enhance the washing efficacy of chosen woolen shampoo when used with prepared mustard oil driven amylase BSANPs as compared to washing observations of chosen woolen shampoo alone used for washing of strained woolen fabric pieces (Fig 2 & 3). In this washing experiments, that most popular wool shampoo named, Woolite shampoo was used to wash the selected strained woolen fabric pieces with 35U alkaline protease derived mustard oil driven amylase loaded BSANPs. And, it was found that mustard oil driven amylase loaded BSANPs act as excellent bio-active nano-wool shampoo additive

when used with selected wool shampoo to wash off the chosen stains of shoe polish (Fig 2) and hair color dye crème (Fig 3) from the woolen fabric with very clear, visible and noticeable observations (Fig 2 & 3). As well as, it was also found that there was no affect on the delicacy and softness of woolen fabric upon touching after the designed washing practice. And, these washing observations of bio-active amylase bound BSA-nano-wool shampoo additives were also found to be comparable with previous findings (16-21).



**Table 2: Washing results of stained woolen fabric pieces having chosen stain sample A of shoe polish (Cherry Blossom Shoe polish Black) with chosen wool shampoo named, Woolite shampoo and prepared bio-active mustard driven amylase loaded BSANPs[14]**



**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, Woolite Shampoo and prepared bio-active mustard oil driven amylase loaded BSANPs[14]**

## CONCLUSION

From this designed washing study, it was concluded that use of *Pearl millet* amylase loaded mustard oil driven BSANPs with standard 35U of alkaline protease with selected wool shampoo, Woolite, 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 mustard oil driven amylase loaded BSANPs washing mixture was found an eco-friendly and low-cost bio-active nano-woolen shampoo additives. This practice was showed the zero requirements of other required washing labor practices, minimizing the water consumption and energy which was

quite helpful to maintain mild condition for fabric as well as for skin without causing hassles during the washing of chosen stains of shoe polish and hair color dye crème. 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 usually endorsed for international trading productivity worldwide. Hence, the new designed washing practice of woolen fabric may prove helpful to cut down the cost of fabric processing as well as can be used in paper and leather processing/desizing processing/washing or leaching methods to save time and energy.

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