

## Research Article (Open access)

## Washing Study of Stained Woolen fabric with Bio-active Jasmine Oil Driven Amylase Loaded BSANPs-Wool Shampoo Additives

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**ABSTRACT-** Amylase is exploited in textile, leather, wood, paper and detergent industries for de-sizing and washing of fabrics. Previously, it has been immobilized on various compatible, supports 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 BSA loaded nanoparticles (BSANPs). In this study, Pearl millet amylase loaded jasmine oil-driven BSA nanoparticles (BSANPs) were used and made bio-active with 35U of alkaline protease for their biodegradation. Then, these bio-active enzyme-BSANPs were used as nano-wool shampoo additives with chosen wool shampoo named, Wool & Cashmere Shampoo to test their 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 Liquid boot polish Black and Loreal Paris Casting Crème Gloss Black respectively. Sometimes, these stains are very difficult to remove from the woolen fabric or required a couple of pre-washing practices. So, keeping this domestic or industrial washing problem, selected stains are chosen very thoughtfully. And, from this study, an effective washing data was carried out to wash off the selected stains from woolen/cashmere/merino/mohair fabric when washed with chosen wool shampoo along with with bio-active prepared jasmine oil-driven amylase bound BSANPs solution as compared their washing with chosen wool shampoo alone.

**Key-Words:** Kiwi Liquid boot polish Black, Loreal Paris Casting Crème Gloss hair color Black, BSANPs, Bovine serum albumin nanoparticles, Jasmine oil, Wool shampoo

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### INTRODUCTION

Amylases were used in food, fermentation, textile, paper, detergent, pharmaceutical, leather and chemical industries [1-3]. Amylase has a significant role in brewing, liquefaction,

sacchrification, bio-fuel production, fabric desizing and processing of starch [3-5]. In textile and paper industries, amylases were found to be reported to have key role in starch processing to fabricate the fibers as per the requirement of the garments designing and formulation [6-9]. 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 processing [9-11]. Mostly 30% of industrially prepared enzymes are used in the 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

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viable to widen the application of bound amylase [13-15]. Immobilization of amylase was found to be a more cost effective 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 study, bio-active Pearl millet amylase loaded BSANPs were used to wash the stained woolen fabric pieces with chosen wool shampoo named, Wool & Cashmere Shampoo to compare the washing results of chosen wool shampoo alone.

**MATERIALS AND METHODS**

The Jasmine oil driven chemically modified Pearl millet amylase BSANPs were used for this study that was prepared by earlier reported method [13]. These bio-active nano-woolen shampoo additives with 35U of alkaline protease were used in washing of stained fabric pieces with selected wool shampoo named, Wool & Cashmere Shampoo which is very much internationally popular in many textiles and detergent industries for washing of woolen fabrics. Selected stains on the woolen fabric pieces are on Kiwi leather Extra Shine Black Boot Polish and Loreal Paris Casting Crème Gloss Black that is very popular boot 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 jasmine oil driven amylase loaded BSANPS with 35U of alkaline protease solution and 2–3 ml of selected wool shampoo 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 jasmine 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 nano-wool shampoo additives.



**A** Chosen wool shampoo **B** Chosen stain of Boot Polish **C** Chosen stain of Hair colour

**Fig. 1:** A: Chosen wool shampoo, Wool & Cashmere Shampoo which was used for washing of stained woolen fabric  
 B: Chosen stain of Boot polish named, Kiwi Leather Black (Sample A)  
 C: Chosen stain of Hair color dye crème named, Loreal Paris Casting Crème Gloss Black (Sample B) which were used for staining the woolen fabric pieces to carry out the washing study

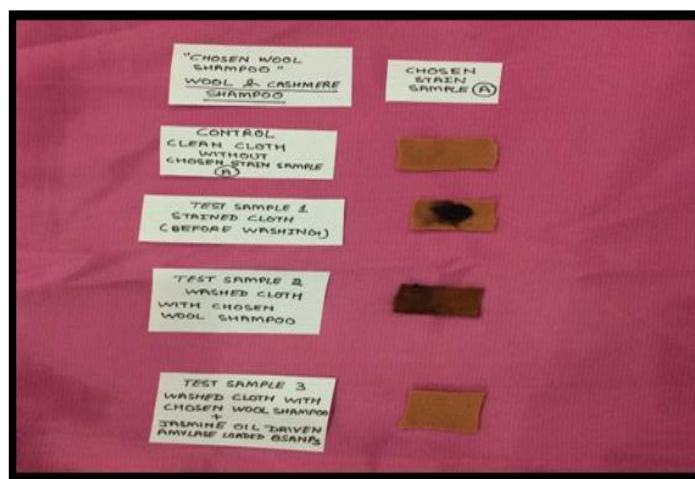
**RESULTS AND DISCUSSION**

Jasmine oil driven Pearl millet (*Pennisetum glaucum*) amylase BSANPs were subjected to designed washing study with chosen woolen shampoo named, wool & Cashmere Shampoo to remove the stains of chosen stains of boot polish and hair color dye crème. These stains are very tough to be removed in one wash or required many tedious pre-treatment practices, such as long hour of soaking period in warm water and use of stain dissolving agents like potash alum or vinegar etc. These pre-washing practices are lead to harm the texture of woolen fabric, especially smoothness, delicacy and softness of fibers. Moreover, jasmine oil driven amylase loaded BSANPs were made bio-active by using 35U alkaline protease to carry out the controlled release of bound enzyme from BSANPs in the reaction mixture. And, alkaline protease was also well 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 the 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 desizing practices to wash off 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 fabrics such as cashmere/merino/mohair fabrics. And, this designed washing practice was found to be more effective to enhance the washing efficacy of chosen wool shampoo when used with prepared jasmine oil driven enzyme bound BSANPs as compared to washing observations of chosen wool shampoo alone used for washing of strained woolen fabric pieces (Fig. 2 & 3). In this washing experiment that most popular wool shampoo named, Wool & Cashmere Shampoo was used to wash the selected strained woolen fabric pieces with 35U alkaline protease derived jasmine oil driven amylase loaded BSANPs. And, it was found that jasmine oil driven amylase loaded BSANPs act as excellent bio-active nano-wool shampoo additive when used with selected wool shampoo to wash the chosen stains of boot polish (Fig. 2) and hair color dye crème (Fig. 3) from the fabric (Table 1). The improved noticeable calculated washing interpretations were also obtained for combined washing analysis by chosen wool shampoo with bio-active jasmine oil driven amylase loaded BSANPs to wash off both of chosen stain samples (Table 1 and Fig. 4). As well as, it was also observed that there was no effect on the delicacy and softness of woolen fabric upon touching after the designed washing practice and these washing observations were also found to be comparable with previous findings [16-21].

**Table 1:** Washing results of stained woolen fabric have stains of boot polish, Kiwi Leather Extra Shine (Sample A) and hair color dye crème, Loreal Paris Casting Crème Gloss (Sample B) with chosen wool shampoo named, Wool and Cashmere shampoo and bio-active jasmine oil driven amylase loaded BSANPs prepared by earlier method [13]

Chosen stains	Washing with Chosen shampoo	Washing with washing mixture of chosen shampoo with bio-active jasmine oil driven BSANPs
Boot Polish Stain: Kiwi Leather Extra Shine Black (Sample A)	Good	Excellent
Hair color dye crème Stain: Loreal Paris Casting Crème Gloss (Sample B)	Good	Very Good



**Fig. 2:** Washing results of stained woolen fabric pieces having chosen stain sample A of boot polish (Kiwi Leather Black) with chosen woolen shampoo named, Wool & Cashmere Shampoo and prepared bio-active jasmine driven BSANPs [13]



**Fig. 3:** Washing results of stained woolen fabric pieces having chosen stain sample B of hair colour dye crème (Loreal Paris Casting Crème Gloss Black) with chosen woolen shampoo named, Wool & Cashmere Shampoo and prepared bio-active jasmine oil driven BSANPs<sup>[13]</sup>

**Sample A: Stain of chosen Boot Polish**  
**Sample B: Stain of chosen Hair Color Dye Creme**



**Fig. 4:** Observed combined interpretations of comparative washing efficacy of chosen woolen shampoo named, Wool & Cashmere Shampoo and prepared bio-active jasmine oil driven BSANPs<sup>[13]</sup> to wash off the chosen stain sample A (Kiwi Leather Extra Shine Black) and sample B (Loreal Paris Casting Crème Gloss) as per designed experiments

### CONCLUSIONS

From this designed washing study, it was concluded that use of Pearl millet amylase loaded jasmine oil driven BSANPs with standard alkaline protease units with selected wool shampoo 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 expensive woolen fabric pieces such as cashmere/merino/mohair fabrics. The prepared jasmine oil driven bio-active amylase loaded BSANPs washing mixture was found an eco-friendly and low-cost bio-active nano-wool shampoo additives. It was showed the zero requirements of other required washing labor practices, minimizing the water consumption and energy which was quite helpful to maintain mild conditions for fabric as well as for skin without causing hassles during the washing of chosen stains of boot polish and hair color dye crème. In many Indo-Asian countries e.g. Indonesia, Malaysia, Bangladesh, Vietnam, Thailand, Asia, Cambodia, Sri Lanka, Bhutan, Nepal, Taiwan etc., where textiles, wood, rubber, leather and detergent industries are prevailing industries for national economic growth and very popular for international trading productivity worldwide. Hence, the new proposed washing practice of woolen fabric may prove helpful to cut down the cost of various procedures of fabric, paper and leather processing/desizing processing to save time and energy.

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