

# Cost-Effective Washing Study of Acryl paint, Oil paint, Grease, Ink, Rust Stained fabric with Bio-active Emulsified *Pearl millet* Amylase loaded BSA nanoparticles as Laundry additives

<sup>1</sup>Kirti Rani, <sup>2</sup>Sunidhi Kant, <sup>3</sup>Sherya Goyal, <sup>4</sup>Chandrika Gupta

<sup>1</sup>Assistant Professor (II)

<sup>1,2,3,4</sup> Amity Institute of Biotechnology, Amity University Uttar Pradesh, Noida, Sec-125, Noida-201303 (UP), India

---

**Abstract:** Amylase has been exploited in textile and detergent industries for desizing and stain removal due to having its hydrolytic features lead to breakdown of glycosidic linkages in starch into low molecular weight products such as glucose, maltose, maltotriose units, limit dextrans. Amylase immobilization is also lead to increase thermal and storage stability when it was bound onto bovine serum albumin (BSA) to prepare n enzyme bound nanoparticles. In present work, we were extracted amylase form *Pearl millet* seedlings and bound in BSA nanoparticles with four Almond Oil, Jasmine Oil, Mustard Oil, and Olive Oil as naturally occurring emulsifier. These fabricated nanoparticles were used as bio-active laundry additives with different detergents named, Ariel matic, Surf excel liquid, Active wheel and Tide plus to test their stain removal competency. Selected strains in this study were comprised of industrial/domestic routine strains, namely, Acryl paint, Oil paint, Grease, Ink, Rust strains. These industrial/common domestic stains are tough to vanish from clothes and often require lethargic pre-washing practices. Hence, from this study, fruitful comparative analysis was carried out from this study and all strains are very well wash off if when washed with chosen detergents with the prepared amylase bound nanoparticles solution as compared to when washing was done with chosen detergents only. Among them, Ariel matic detergent with enzyme loaded bovine serum albumin nanoparticles was found to be have best washing results as bio-active system compared to other chosen detergent samples, followed by Surf excel liquid, Tide plus and the least effective was found to be Active wheel. Among the prepared enzyme bound BSA nanoparticles, Almond and Olive oil driven nanoparticles was showed excellent washing competency when mixed with Ariel matic while mustard oil nanoparticles with Ariel matic also showed comparable good washing effects. Furthermore, very good results were also found to be observed when stained cloth was washed with Almond and Olive Oil driven nanoparticles with Surf Excel liquid. While, fairly good results were shown by Jasmine oil driven and Mustard Oil driven nanoparticles followed by Almond and Olive Mustard Oil driven nanoparticles with Active wheel and tide plus. As well as, least washing efficiency was found to be for Jasmine oil driven BSA nanoparticles.

**Keywords:** Acryl paint; Oil paint; Grease; Ink; Rust strains; Almond oil; Olive oil; Jasmine Oil; mustard oil; BSA nanoparticles; Detergents.

---

## 1. INTRODUCTION

Amylases have been extensively utilized in food, fermentation, textile paper, detergent, pharmaceutical and fine-chemical industries [1,2,3]. The application of the enzyme was found to be reported very well significantly in brewing, fructose syrup, liquefaction, sacchrification, bio-fuel production, fiber desizing [4,5,6,7]. Textile industry can never be complete without amylase and use of amylase was found in starch processing of starch [8,9]. Use of amylase was found to be very excellent enzyme that does not damage the fabric while desizing unlike other chemicals such as persulphate and alkali or

bromide [10,11]. Most recently the demand for amylase in textile, paper and detergent industries has also been increased as detergent additive [12]. Mostly 30% of the enzymes is produced industrially and successfully used in the detergent due to having good thermal stability, required less amount of water and energy during processing and reduce labor cost when bound onto eco-friendly biocompatible, non-toxic, non-allergic and non-corrosive supports [13,14,15,16]. Immobilization of enzyme is found to be cost effective method to increase the storage stability life and thermal stability of an enzyme for the longer of periods as compared to native form [17, 18, 19]. Advantage of enzyme after the immobilization was lead to increased its stability, easy recovery, easy separation of reactant and product, repeated or continuous use to reduce labor and overhead costs. As well as, It also have improved storage, pH operational, thermal and conformational stabilities. [20, 21, 22, 23]. In our study, we have used the *Pearl millet* amylase loaded BSA nanoparticles to wash the stained fabric pieces with 40U of alkaline protease solution and chosen detergents samples and compared their washing results with detergent washing powder only. Chosen stains were subjected to washing to test for the washing efficiency with bio-active laundry additive nanopreparation. Chosen strains were grouped into traditional or festive cosmetic stains of Acryl paint, Oil paint, Grease, Ink, Rust strains. These strains are very tough due to having its starch containing lipo-chemical preparation. Selected detergents used for stain removal were *Active Wheel*, by Hindustan Unilever Ltd. (HUL) containing less than 10% active ingredient sodium alkyl benzenesulphonate. *Ariel Matic*, by Procter and Gamble containing approximately 16% active ingredient and 63, 95 detergency. *Surf Excel Liquid* by Hindustan Unilever ltd and *Tide Plus* manufactured by Procter and Gamble having 9.90% detergency and alkalinity at 22% [24].

## 2. MATERIALS AND METHODS

The Almond, Jasmine, Mustard and Olive oil driven chemically modified *Pearl millet* amylase bovine serum albumin were used for this study prepared by Rani K, *et al*, 2015 [16, 25, 28]. These bio-active laundry additives with proteolytic enzyme, alkaline protease was used in leaching of dry tough cosmetic stained cloth pieces with selected detergents such as Active wheel, Ariel matic, Surf excel liquid and Tide plus. Selected strains were of traditional and festive cosmetic strains of Acryl paint, Oil paint, Grease, Ink, Rust strains to strain the cloth pieces. These strained cloth pieces were soaked in reaction mixture of 2 mg of prepared enzyme loaded BSA nanoparticles with 1ml of selected detergent solution in petri plates. Each sample of stained cloth piece was tested with their washing with chosen detergents only and with the combination of above mentioned reaction mixture of Almond, Jasmine, Mustard and Olive oil driven amylase loaded BSA nanoparticles. Then, their washing was carried out its comparative washing study to get washing efficacy of our prepared nanoparticles as bio-active detergent additives.



**Figure 1: Chosen industrial strains namely, Acryl paint, Oil paint, Grease, Ink, Rust strains for staining the fabric pieces to be tested for washing study.**

## 3. RESULTS AND DISCUSSION

Almond, jasmine, mustard and olive oil driven emulsified bovine serum albumin nanoparticles of encapsulated *Pearl millet* (*Pennisetum glaucum*) amylase were subjected to study with four detergent solutions of Active wheel, Ariel matic, Surf excel liquid and Tide plus to remove stained cloth pieces of Acryl paint, Oil paint, Grease, Ink, Rust strains. Generally, these kinds of tough strains are usually not removed in one wash and require tedious pre-treatment practices e.g. rigorous wash-brushing, long hour of soaking in warm water and use of any stain dissolving agents like potash alum or vinegar etc. Therefore, amylase loaded bio-active bovine serum albumin nanoparticles with selected detergents were used for washing to remove the chosen dry tough strains from stained cloths. That was lead to enhance the effectiveness

of detergents for washing. When, stained cloth were washed with the chosen detergent and prepared nanoparticles with effective units of 40 U of alkaline protease solution (proteolytic enzyme) to release of bound amylase from nanoparticles for their sustained and consistent release in reaction mixture. Previously, the washing application of nanoparticles of encapsulated amylase was reported which were prepared by coconut oil as emulsifier [8,15,18]. Washing was done with chosen samples of detergent solutions of Ariel, Surf excel, Wheel and Tide to remove rust, gel ink pen, grease, chocolate, coffee, tea, pomegranate and turmeric stains for clothes [8,14,15,16,18]. Presently, more extensive study have been carried out on advanced detergents solutions like Ariel matic, Surf excel liquid, Active wheel and Tide plus were used along with amylase encapsulated nanoparticles using four different emulsifier Almond, jasmine, mustard and olive oil to remove various cosmetic stains along with 40U of alkaline protease solution for their sustained and controlled biodegradation. Because, alkaline protease was also reported efficient enzyme which can resist in harsh condition of washing [27]. Among the four samples of detergent solution, Ariel matic detergent with bio-active amylase loaded BSA nanoparticles was found to be the effective washing bio-active laundry system as compared to other used detergent (Table 1). Previously, Ariel matic with immobilized enzyme based BSA nanoparticles has shown better washing results as compared to other detergents which are similar to our washing results [15,25,27,28]. It was followed by Ariel matic detergent, Surf excel liquid with enzyme loaded bovine serum albumin having good results [22, 23, 24, 27, 28] (Fig 2,3,4,5). Therefore, on comparing the four different samples of prepared different emulsifiers derived bovine serum albumin nanoparticles, Almond and Olive oil driven emulsified nanoparticles along with Ariel matic detergent and Surf excel liquid had gave excellent results as compared to Jasmine and Mustard driven emulsified nanoparticles. Also, Almond and Olive oil driven emulsified nanoparticles were shown good results with Surf excel liquid and tide plus followed by fairly good washing observations with Active wheel. As compared to Mustard oil driven emulsified nanoparticles, Jasmine oil driven emulsified nanoparticles was found to be least efficient bio-active system with Tide plus and Active wheel detergent [22,24,26,28] (Fig 2, 3, 4 & 5).

**Table 1: Washing results of stained clothes having Acryl paint, Oil paint, Grease, Ink, Rust strains) with chosen detergents and different samples of prepared emulsifiers driven bovine serum albumin nanoparticles by Rani K, et al, 2015 [16, 25, 28]**

Emulsifier \ Detergent	Almond	Jasmine	Mustard	Olive
Ariel matic	Excellent	Very good	Very good	Excellent
Surf excel liquid	Excellent	Good	Fairly good	Excellent
Tide plus	Excellent	Good	Fairly good	Excellent
Active Wheel	Fairly good	Good	Good	Fairly good

#### 4. CONCLUSION

Form the present study, it was conformed that use of *Pearl millet* extracted amylase loaded BSA with alkaline protease solution and different selected detergents was reported to be cost-effective and time saving practice with improved washing efficacy as compared to normal washing practice. The prepared bio-active enzyme loaded BSA nanoparticles mixture solution was excellent eco-friendly bio-active detergent additives. It was contributed the decreased washing labor and water consumption which was quite helpful to maintain mild condition for fabric as well as without causing any skin irritation during the washing. This washing study might be new landmark for textiles, wood, rubber and detergent industries of low-income countries e.g. Indonesia, Malaysia, Bangladesh, Vietnam, Thailand, Asia, Cambodia, Shrilanka, Bhutan, Nepal, Taiwan etc. for desizing of fabrics to cut down the cost of industrial processing procedures to save time and energy.

#### REFERENCES

- [1] Rani K. Extraction and study of kinetic parameters of variety of sprouted pulses  $\beta$ -amylases. *Int J Pharm and Life Sci*, 2012, 3(8): 1895-1898.
- [2] Valls C, Rojas C, Pujadas G, Gracia-Vallav S, Mulero M. Characterization of the Activity and Stability of Amylase from Saliva and Detergent. *Biochem Mol Biol Edu*, 2013; 40(4); 254–265.
- [3] Mojsov K, Application of enzymes in the textiles industry : A review, II International Congress “Engineering, Ecology and Materials in the Processing Industry. *Appl Tech & Innov*, 2011, 2(2): 40-46.

- [4] Horvathova V, Janecek S, Sturdik E. Amylolytic enzymes: their specificities, origins and properties. *Biol, Bratislava*, 2000; 55(6): 605-615.
- [5] De souza PM, Magalhaes P deO. Application of microbial  $\alpha$ -amylase – A review. *Braz J Microbol*, 2010; 41(4): 850-861.
- [6] Reddy NS, Nimmagada A, Rao KRSS. An overview of the microbial  $\alpha$ -amylase family. *Afr. J. Biotechnol*, 2003; 2(12): 645-648.
- [7] Rani K, Kant S, Goyal S, Saini A, Gupta C. A novel comparative assessment of extracted amylase activity in germinating and germinated seeds of *Cicer arietinum*, *Ceci neri* and *Pisum sativum*. *Int J Pure & Appl Sci*, 2014; 2(2):191-193.
- [8] Rani K. Applicative biodegradation study of egg albumin nanospheres by alkaline protease for release of encapsulated *cicer arietinum* amylase in washing as bio-active detergent additive. *World J Pharmaceutical Res*, 2015, 4(1): 1-13.
- [9] Kirti R. Comparative study of kinetic parameters of bacterial and fungal amylases. *J Bio-Innovation*, (2012), 3: 48-57.
- [10] Aiyer PV. Amylases and their applications. *Afri J of Biotechnol*, 2005; 4(13): 1525-1529.
- [11] Shukla SR, Jajpura L. Immobilization of amylase by various techniques. *Ind J Fibre Text .Res*, 2005, 29: 79-81.
- [12] Olsen HS, Felholt P. The role of enzymes in modern detergency. *J Surfact Detergents*, 1998; 1(4): 555-567.
- [13] Kumar G C, Malik R K, Tiwari M P, Novel Enzyme based detergents- An Indian perspective, *Curr Sci*, 1998, 75(12) :1312-1318.
- [14] Rani K. Emulsified Entrapment of Glycine Max B-amylase into Chemically Modified Bovine Serum Albumin and Study its Applications in Detergents. *Int J Adv Biotechnol and Res*, 2012, 3(2): 591-595.
- [15] Rani K, Chauhan C, Biodegradation of *Cicer Arietinum* Amylase loaded Coconut oil driven Emulsified Bovine Serum Albumin Nanoparticles and their application in Washing Detergents as Eco-Friendly Bio-Active Addictive, *World J Pharm and Pharmaceutical Sci*. 2014, 3(12): 924-936.
- [16] Rani K, Goyal S and Chauhan C, Novel approach of alkaline protease mediated biodegradation analysis of mustard oil driven emulsified bovine serum albumin nanospheres for controlled release of entrapped *Pennisetum glaucum* (Pearl Millet) amylase. *American J Advn Drug Delivery*. 2015, 3(2): 135-148.
- [17] Rani K. Immobilization of Glycine max amylase onto variety of chlorinated and Nitrated fabrics (silk, nylon and cotton). *GSTF Int J Biosci*. 2013, 2(2): 8-12.
- [18] Kirti R, Vartika M, Preparation, Biodegradation of Coconut Oil Driven Chemically Modified Bovine Serum Albumin Microparticles of Encapsulated *Cicer arietinum* Amylase and Study of Their Application in Washing Detergents, *Int. J. Pharm. Sci. Drug Res*. 2014, 6(4): 351-355.
- [19] Arica, Y., Bayramogflu, G. and Yilmaz, M., Immobilization of a thermostable  $\alpha$ -amylase onto reactive membranes: kinetics characterization and application to continuous starch hydrolysis. *Food Chem*, 2004, 84: 591-599.
- [20] Arica, Y., Bayramogflu, G. and Yilmaz, M., Immobilization of a thermostable  $\alpha$ -amylase onto reactive membranes: kinetics characterization and application to continuous starch hydrolysis. *Food Chem*, 2004, 84: 591-599.
- [21] Rani K, Immobilization of *Vigna radiate*, *Vigna mungo*, *Cicer arietinum* (white) and *Cicer arietinum* (Black) amylases onto variety of activated fabrics, *Int J Life Sci and Pharma Res*. 2012, 1(3): 124-133.
- [22] Rani K. Immobilization of *Vigna mungo*  $\beta$ -amylase onto NaCl and NaNO<sub>3</sub> treated woven *Bombyx mori* silk fabrics. *Asian J Biol & Life Sci*, 2012; 1(2): 96-100
- [23] Sharma KR, Preparation of emulsified encapsulated nanoparticles of bovine serum albumin of bound glucose oxidase and their application in soft drinks/non-alcoholic beverages, *Biotechnol & Biomaterials*, (2012); 2(2): 1-5

- [24] Khetrapal M, Comparative Study of Detergents in India-A Step towards More Sustainable Laundry, *DU J Undergraduate Res and Innov*, 2015, 163-172.
- [25] Rani K, Gupta C and Chauhan C, Biodegradation of almond oil driven bovine serum albumin nanoparticles for controlled release of encapsulated Pearl millet amylase. *American J Phytomedicine Clin Therapeutics*. 2015, 3(3): 222-230.
- [26] Rani K, Chauhan C, Preparation of Cicer Artienium Amylase Loaded BSA Nanoparticles and Their Bioproteolysis to be used as Detergent Additive. *Bioengg and Biosci*, 2015; 3(5): 72-82.
- [27] Rani K, Production of amylase and alkaline phosphatase, Verlag:Lambert Academic Publishing GmbH & Co. KG, 2012,Germany
- [28] Rani K, Kant S, Alkaline Protease Mediated Bioproteolysis of Jasmine Oil Activated Pennisetum glaucum Amylase Loaded BSA Nanoparticles for Release of Encapsulated Amylase, *Int J Chem Sci and Appl*, 2015, 6(2): 56-63.

### APPENDIX - A



(A) Washing results with Almond Oil driven nanoparticles



(B) Washing results with Jasmine Oil driven nanoparticles



(C) Washing results with Mustard Oil driven nanoparticles



(D) Washing results with Olive Oil driven nanoparticles

Figure 2 : Washing results of Acryl paint, Oil paint, Grease, Ink, Rust stained cloth with Ariel matic alone and Ariel matic with amylase loaded nanoparticles prepared with different emulsifiers- Almond Oil, Jasmine Oil,



(A) Washing results with Almond Oil driven nanoparticles



(B) Washing results with Jasmine Oil driven nanoparticles



(C) Washing results with Mustard Oil driven nanoparticles

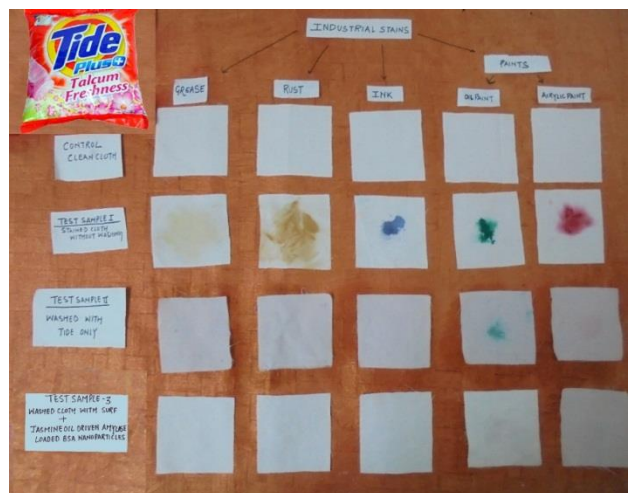


(D) Washing results with Olive Oil driven nanoparticles

Figure 3: Washing results of Acryl paint, Oil paint, Grease, Ink, Rust stained cloth with Surf Excel alone and Surf Excel with amyilase loaded nanoparticles prepared with different emulsifiers- Almond Oil, Jasmine Oil, Mustard Oil and Olive Oil



(A) Washing results with Almond Oil driven nanoparticles



(B) Washing results with Jasmine Oil driven Nanoparticles



(C) Washing results with Mustard Oil driven nanoparticles



(D) Washing results with Olive Oil driven nanoparticles

Figure 4 : Washing results of Acryl paint, Oil paint, Grease, Ink, Rust stained cloth with Tide Plus alone and Tide Plus with amylase loaded nanoparticles prepared with different emulsifiers- Almond oil, Jasmine Oil, Mustard Oil and Olive Oil



(A) Washing results with Almond Oil driven nanoparticles



(B) Washing results with Jasmine Oil driven nanoparticles



(C) Washing results with Mustard Oil driven nanoparticles



(D) Washing results with Olive Oil driven nanoparticles

Figure 5: Washing results of Acryl paint, Oil paint, Grease, Ink, Rust strained cloth with Active Wheel Alone and Active Wheel with amylase loaded nanoparticles prepared with different emulsifiers- Almond oil, Jasmine Oil, Mustard Oil and Olive Oil