ANTIMICROBIAL ACTIVITY OF SAGU STARCH FILLED WITH POLY (N-VINYL CARBAZOLE) PVK NANOPARTICLES

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ABSTRACT

The effects of PVK as fillers on the characteristics and properties of sagu starch solution and films, the antimicrobial, water vapour permeability and UV-VIS transmission of the sagu stach were investigated in this work. The sagu starch filled with PVK was homogenized and incorporated into sagu starch solutions at different concentrations. Introduction of PVK fillers to sagu starch solutions significant increased the viscosity of the solution and significantly decreased the permeability of the films to water vapour. Solubility to different solvents, moisture content was decreased. The sagu starch solutions filled with PVK nanoparticles had 30% UV transmittance. The sago starch films filled with PVK exhibited excellent antimicrobial activities against *S.aureus* and *E. coli*. These properties suggest that the prepared biocomposites has the potential as filler in starch based products for use as active materials in packaging and in pharmaceutical and textile industries.

Keywords: sagu starch, PVK, antimicrobial, biocomposite

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INTRODUCTION

The great importance of exploiting underutilized and non-utilized plant resources has been stressed by learned person at every opportunity. Some of them have focused their special attention to sago palm as invaluable resources of starchy food, having deep concern about the possible food shortage in the world in future. Some others have emphasized the incomparable usefulness of this plant for the agricultural development of low-lying swampy areas of the tropics, since sago palm has high adaptability to such a condition, under which very limited economic plants can only grows.

The general understanding on sago palm and its utilization has so far been very limited: at most, this plant grows wild in low-lying wetlands in the tropics, and the starch produced in its stem is a staple food upon which local people in these areas live. In recent years, however, considerable progress has been made in researches on sago palm itself and relevant environmental and socioeconomic conditions. In addition, there has been some progress in the area development programs which recognized that much remains unexplored regarding this underutilized plant resource.

Sago palm starch is an interesting substrate for the production of cyclodextrin, an important polysaccharide due to its unique hydrophobic interior cavity and hydrophilic surface. It can encapsulate hydrophobic organic substances and aid its solubilization in water. This property is useful in food, pharmaceutical, cosmetic and agricultural application because of its economic potential. Modification is usually carried out to overcome the unstable properties of native sago starch and improve its physical properties during processing. Sago starch shows a breakdown in viscosity during heating and shearing, and this breakdown further increased under acidic conditions. Incorporation of PVK into composite materials has attracted a great deal of attention due to its ability to enhance polymer properties such as thermal and mechanical properties. The combination of the unique properties of sagu starch and organic polymers like poly (N-vinylcarbazole) (PVK) make it an interesting material for the development of practical applications with antimicrobial properties.

MATERIALS AND METHODS

Preparation of Materials

Sagu starch was gathered from different study sites in Northern Samar. All the reagents were prepared using analytical grade reagents and distilled water. For the antimicrobial assay, *S. aureus* and *E. coli* was used in this work.

Sagu Starch Isolation

Sagu palm available in the study area are studied. Fresh tubers were washed thoroughly with tap water and grated into a pulp. The pulp was suspended in excess distilled water (1:25 w/v) and homogenized in a blender (Osterizer) at medium speed for 20 minutes at room temperature. The homogenized slurry was strained and filtered through a whatman filter paper.

The waste residue was washed washed with 20 mL of distilled water. The resulting milky filtrate was centrifuged for 10 minutes. The starch was dried at 50⁰C for 24 hours. The isolated starch was ground in a mortar, sieved through a mesh sieve and stored at room temperature.

Preparation of sagu starch filled with PVK biocomposites films

PVK was dispersed in suitable solvent and stirred for 2 hours. The solution was used to prepare the starch dispersion at 10% (w/w). A mixture of sorbitol and glycerol of total solid was added as plasticizer. Starch and PVK biocomposites were heated to 85⁰C and held for 1 hour to allow gelatinization. Upon completion of starch gelatinization, the solution was cooled to room temperature. A portion of the dispersion was cast on a plates to produce 20 x 20 cm^2. The prepared films were dried under controlled conditions (at room temperature) and was kept in a dessicator prior to analysis. Control films were also prepared similarly but without the addition of PVK. Dried films were peeled and stored in a dessicator at room temperature until experimentation. The thickness of each film was measured using vernier caliper. All films were prepared in triplicate.

Antimicrobial Testing (Paper Disc Method) for the sagu starch and sagu starch filled with PVK biocomposite solution

Each microorganism was streak on a petri dish with culture media in such a manner that the entire surface of the media was streaked. Two petri dishes were prepared for each microorganism, one labelled as standard drug and the other labeled as extract. On the dish labelled standard drug, three (3) disc of antibiotic (Penicillin for S. aureus and Ciprofloxacin for E. coli) for specific microorganism was equally placed in a circular arrangement and was incubated for 24 hours. On the dish labeled sagu starch and sagu starch films filled with PVK, 3 blank disc dipped in the samples were placed in the same manner as of the standard drug and was incubated for 24 hours. The zone of inhibition in millimetre was measured on the following day using a ruler.

Statistical analysis

Analysis of variance (ANOVA) was used to compare the means of the physical and antimicrobial properties of sagu starch and sagu starch filled with PVK at 5% significance level.

RESULTS AND DISCUSSION

Starch is one of the natural occuring polymers which is biocompatible, biodegradable and shows bio-adhesion property. It is a polysaccharide that contains amylose and amylopectin. Due to its biodegradability, abundance and low cost, starch has been widely used in various practical applications. Polymer biocomposites have attracted much attention due to their unique properties that are different significantly from their bulk materials. Various synthesis methods have been attempted to prepare starch biocomposites.

Sagu starch was isolated from fresh sagu palm. The percentage yield 80.78 % might be an indication of appreciable accumulation of starch in the young palm for conversion of energy during the physiological development of palm. Sagu starch is perhaps the only starch derived from the stem of palm (sagu palm). Sagu palm contains a large amount of starch in its trunk. Normally, during germination arrays of enzymes including amylases developed and remain in an active form. Since no preservatives were used during isolation of starch, there could be a possibility of some amount of starch getting hydrolyzed which might affect the starch yield. Sagu starch yield in this work, after isolation and washing process, relative to other sources of starch like corn and potato as presented in other studies showed a marked loss of starch suggested that the starches had been solubilized by during the treatment.

During treatment, starch can undergo changes in the structure and

physicochemical properties. These changes could be attributed and depend on the type of treatment, concentration used and the type of starch. Compared to other starch modifications, such as enzyme and acid treatments, very few studies on the introduction of polymers have been conducted.**Antimicrobial assay of bulk materials**Effects of sago starch film reinforced with PVK on the growth of *S. aureus* and *E. coli* were investigated. The inhibition zone of sagu starch with PVK on textiles was significantly increasing suggesting that sago starch film incorporated with PVK can act as an active film against microorganisms. Excellent antimicrobial activities of PVK fillers against *S. aureus* and *E. coli* on textiles showed antimicrobial activity and the corresponding mechanisms of action have also been demonstrated by other researchers. Mechanisms of the antibacterial behaviour of PVK have been detailed in previous works and they have categorized this behaviour as chemical and/or physical interaction between PVK particles and the cell envelope of microorganism. The PVK could penetrate through the cell wall of microorganism and react with interior components that finally effects on viability of the cells. In this study, the PVK particles could act as needle and easily penetrated through cell wall.

Microorganism	ZONE OF INHIBITION		
	Sagu starch	Sagu starch filled with PVK	Sagu starch and PVK biocomposites on textiles
S. aureus	23 mm	6 mm	6 mm
E. coli	20 mm	3 mm	3 mm

Table1. Antimicrobial testing of bulk materials in test organisms.

CONCLUSION

Effects of sagu starch reinforced with PVK on the growth of S. aureus and E. coli were investigated in this present study. The inhibition zone of the biocomposite was significantly increased by increasing the PVK contents. The results show that the sagu starch incorporated with PVK filler can act as an active component against the said microorganisms. Excellent antimicrobial activity of the biocomposites against microorganisms and its corresponding mechanism of action have been demonstrated by other researchers.

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