MEDICO RESEARCH CHRONICLES
ISSN NO. 2394-3971
DOI No. 10.26838/MEDRECH.2023.10.1.675
Contents available at www.medrech.com

PREPARATION AND CHARACTERIZATION OF BINARY BLENDS OF NR AND OXIDIZED NR WITH PVAc

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ARTICLE INFO

Article History
Received: November 2022
Accepted: January 2023
Key Words: Natural rubber (NR); Polyvinyl acetate (PVAc); Viscometric.

ABSTRACT

ORIGINAL RESEARCH ARTICLE

Background: Studies had been performed on blends of natural rubber (NR) and poly vinyl acetate (PVAc). The two polymers had been characterized based totally on their physicochemical properties and used in paint production. Results received confirmed that viscometric measurement and density of the polymers did now not fluctuate much. Five paints of distinctive compositions labeled; Paint 1 (100% PVAc), Paint 2 (100% NR), Paint 3 (75% NR: 25% PVAc), Paint 4 (50% PVAc: 50% NR), and Paint 5 (25% NR: 75% PVAc) the usage of popular emulsion paint formula and approach of manufacturing have been employed. NR and PVAc are well-matched as binders in emulsion paint production. Therefore, NR/PVAc blends may want to be used as a binder in the coating industry as a choice to PVAc binder-based emulsion paint.
Objectives: This study aims to assess the Preparation and characterization of binary blends of NR and oxidized NR with PVAc.
Methods: This is an observational study. The study used to be carried out with the samples in the Department of Applied Chemistry and Chemical Engineering, Islamic University, Kushtia-7003, Bangladesh. The duration of the period from Data was entered in MS Excel and Statistical analysis was done using SPSS trial version.
Results: This study shows that the according to Constituent, Cellulose was 43.4822%, Alpha-Cellulose was 34.8427% and Cellulose was 8.6395%. And according to Source, Rice Straw was 32.15% %, Sugarcane was 41-43%, Rye Straw was 31.8-42.64%, Corn Stalks were 29.80% and Wheat Straw was 34-40%.
Conclusion: The residences of opacity, wash ability resistance, and putting contact drying time of emulsion paint with modified NRL binder and modified NRL combination with PVAc can be multiplied using in addition editing natural rubber latex (NRL) molecules.

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Modifications are needed to rise the adhesion of natural rubber latex (NRL). The adhesive characteristics of natural rubber latex (NRL) can match the characteristics of general adhesives such as PVAc.

2023, www.medrech.com

INTRODUCTION

Polymer blends are being increasingly used in many functions such as; coating, the paint industry, automobile and aircraft industry, etc. Research in blends has emerged as one of the largest areas of polymer research, both in the industrial and educational world [1]. Blending two or more polymers may give an increase to new polymeric structures with new, interesting and "adhoc" properties, exclusive from those of the two components, therefore removing the lengthy and highly-priced route of synthesizing new polymers [2]. Hence, the goal of polymer blending is to enhance products with special residences that can't be attained from personal ingredients [3]. Polymer blends additionally think about the use of polymers from non-renewable sources. Polymers from non-renewable sources have attracted a growing quantity of interest over the ultimate two decades, predominantly due to two predominant reasons: firstly, environmental concerns, and secondly, the recognition that our petroleum sources are finite [4].

Polyvinyl acetate is a rubbery artificial polymer with the formulation (C4H6O2) from a non-renewable source. It has a molar mass of 86.09g/mol/unit. It belongs to the polyvinyl ester family with the regularly occurring formula: RCOOCHCH2 [5]. It is produced for use as a binder in emulsion paints, adhesives, and several textile-finishing operations [6].

Natural rubber (NR), on the different hand is an instance of polymer from a renewable supply that consists of cis-1,4-polyisoprene as the primary component, which well-known shows remarkable elasticity, resistance to tearing, and applicable dynamic properties. NR additionally includes non-rubber aspects such as phospholipids and proteins, which have a strong influence on material properties [7]. However, the utility of natural rubber is restrained due to the fact it can be effortlessly degraded by way of ozonolysis, publicity to light, and oxidation owing to the presence of double bonds in its chain. As a result of the barriers posed through NR, a focal point used to be given on the utilization of liquid natural rubber.

Liquid natural rubber (LNR) is an NR precursor or modified NR [8]. This differs from different liquid elastomers in the approach of preparation. It is commonly got through the partial depolymerization of NR, and exhibits some enhancement before being discovered to be higher than NR primarily based on natural aspects that produce the color, appearance, and overall performance of NR [9]. For the instruction of LNR, two routes are commonly

adopted, one beginning from dry rubber and the different from latex [10].

Today, the important benefits of blended structures are simplicity of practice and ease of management of physical residences using compositional adjustments [11]. The fact that the binders (LNR and PVAc) can be received in emulsion shape and use at once in a paints system mainly water (emulsion) primarily based paints promotes a higher homogenous system [12].

Paints and coatings can be categorized into the following essential categories; architectural coatings, product coatings for unique equipment producers and different motive coatings [13], of these three categories, emulsion paints as the paint of interest fall under the first category.

Emulsion paints are environmentally benign and exhibit some characteristics even related to oil-based paints [14] as it evaporates water to the surroundings on application. The manufacturing satisfaction of emulsion paints

and overall performance relies upon generally on the properties of its ingredients which include; pigments, solvents, extenders, binders and components [15].

The binder (PVAc) typically takes between 17–33% complete rate of manufacturing relying on paint category and this raw material is no longer handy regionally in Nigeria and is consequently imported. Hence, there is an excessive rate of this raw material (binder) and hence the excessive value of production [16].

In this current work, we report on the utilization of binder blends of PVAc and LNR in emulsion paint formula which to the exceptional of our knowledge has not been in the past studied.

METHODS

The rapeseed plant straws used as raw material were collected from a farmer of Pabna district. Natural rubber latex was collected from Cox's bazar (Ramu). Vinyl acetate monomer and other chemicals used in this paper as listed were purchased from Nafi-nano Science and some required chemicals were also provided from the department of Applied Chemistry and Chemical Engineering, Islamic University, Kushtia, Bangladesh.

Various efficient methods have been developed by researchers to isolate cellulose from lingo-cellulosic materials. Cellulose is isolated by the removal of other substances such as hemicelluloses and lignin from straws.

For this investigation, the rapeseed plant straw was collected from Pabna district region. When rapeseed seed got matured then the seeds were collected from the field and the plant straw was rejected as agro waste. The straws were dried in the air exposing sunlight. These straws were used for the extraction of cellulose.

RESULTS

Table 1: Average compositions of Brassica napus (Rapeseed plant) plant straw

Constituent	Weight (%)
Cellulose	43.4822
Alpha-Cellulose	34.8427
Cellulose	8.6395

Table 1 demonstrated and distribution of the Average compositions of Brassica napus (Rapeseed plant) plant straw. Here according to Constituent, Cellulose was 43.4822%, Alpha-Cellulose was 34.8427% and Cellulose was 8.6395%.

Table 2: Cellulose content in other plant straws

Source	Cellulose
Rice Straw	32.15% [Shawky et al.2011]
Sugarcane	41-43% [Mokhena et al.2018]
Rye Straw	31.8-42.64% [Kraszkiewicz et al.2015]
Corn Stalks	29.80% [Shawky et al.2011]
Wheat Straw	34-40% [Kapoor et al.2016]

Table 2 demonstrated and distribution of the Cellulose content in other plant straws. Here according to Source, Rice Straw was 32.15% %, Sugarcane was 41-43%, Rye Straw was 31.8-42.64%, Corn Stalks was 29.80% and Wheat Straw was 34-40%.

Table 3. FTIR spectrum analysis of NR

Band intensity wavenumber	Wave number cm-1	Absorption	Assignment
Strong	2957	C-H	Stretching vibration

Strong	2929	CH	Stretching vibration
Medium	1644	C=C	Stretching vibration
Strong	1457, 1364	C-H	CH_2 and CH_3 deformation
Strong	834	C=C	C=C bending

Table 3 demonstrated and distribution of the FTIR spectrum analysis of NR. When Absorption was C-H, Band intensity wavenumber was Strong, Wave number was 2957 and Assignment was Stretching vibration. When Absorption was CH, Band intensity wavenumber was Strong, Wave number was 2929 and Assignment was Stretching vibration. When Absorption was C=C, Band intensity wavenumber was Medium, Wave number was 1644 and Assignment was Stretching vibration.

Table 4. FTIR spectrum analysis of oxidized natural rubber.

Band intensity wavenumber	Wavenumber cm-1	Absorption	Assignment
Strong	3200	O-H	Stretching vibration
Strong	2907	C-H	Stretching vibration
Medium	2343	O=C=O	Stretching vibration
Strong	1715	C=O	Stretching vibration
Strong	1616	C=C	Stretching vibration
Medium	1447	C-H	C-H bending
Medium	1390	O-H	O-H bending
Medium	1172	C-O	C-O stretching

Table 4 demonstrated and distribution of the FTIR spectrum analysis of oxidized natural rubber. When Absorption was O-H, Band intensity wavenumber was Strong, Wave number was 3200 and Assignment was Stretching vibration. When Absorption was O=C=O, Band intensity wavenumber was Medium, Wave number was 2343 and the Assignment was Stretching vibration.

When Absorption was C=O, Band intensity wavenumber was Strong, the Wave number was 1715 and the Assignment was Stretching vibration. When Absorption was C-H, Band intensity wavenumber was Medium, Wave number was 1447 and Assignment was C-H bending.

Table 5. **FTIR spectrum analysis of PVAc.**

Band intensity wavenumber	Wavenumber cm-1	Absorption	Assignment
Weak	2930	C-H	Stretching vibration
Weak	2343	O=C=O	Stretching vibration
Strong	1725	C=O	Stretching vibration
Medium	1365	C-H	Bending vibration
Strong	1226	C-O	Stretching vibration
Strong	1023	C-C	Stretching vibration
Medium	625	C-H	Rocking vibration

Table 5 demonstrated and distribution of the FTIR spectrum analysis of PVAc. When Absorption was O=C=O, Band intensity wavenumber was weak, Wave number was 2343 and Assignment was Stretching vibration.When Absorption was C-H, Band intensity wavenumber was Medium, Wave number was 1365 and Assignment was Bending vibration. When Absorption was C-C, Band intensity wavenumber was strong, Wave number was 1023 and Assignment was Stretching vibration.

Table 6. Tensile strength and elongation (%) of natural rubber (NR), polyvinyl acetate (PVAc), NR/PVAc blend, ONR/PVAc blend, NR60/PVAc40 blend-based nano-cellulose (5%) composite and ONR60/PVVc40 blend-based nano-cellulose (5%) composite.

Materials	Tensile strength (N/mm^2)	Elongation (%)
Natural rubber	0.27	67.96
NR60/PVAc40	3.31	42.2
NR40/PVAc60	7.76	11.77
ONR60/PVAc40	1.71	71
ONR40/PVAc60	3.52	8.2
NR60/PVAc40/NC	0.92	12.3
ONR60/PVAc40/NC	5.69	5
PVAc	13.23	3.55

Table 6 demonstrated and distribution of the Tensile strength and elongation (%) of natural rubber (NR), polyvinyl acetate (PVAc), NR/PVAc blend, ONR/PVAc blend, NR60/PVAc40 blend-based nano-cellulose (5%) composite and ONR60/PVVc40 blend-based nano-cellulose (5%) composite. Tensile strength of Natural rubber, NR60/PVAc40, ONR60/PVAc40, ONR40/PVAc60, NR60/PVAc40/NC, ONR60/PVAc40/NC, PVAc was 0.27, 3.31, 7.76, 1.71, 3.52, 0.92, 5.69, 13.23 and Elongation was 67.96, 42.2, 11.77, 71, 8.2, 12.3, 5, 3.55 respectively.

DISCUSSION

Washability is the stage of resistance of emulsion paint to water. This parameter is one of the feasibility and superiority parameters of emulsion paint. The higher the washability resistance, the higher the fantastic of the emulsion paint. [17] The binder with a combination of modified NRL has higher washability resistance properties than NRL barring modification. It is considered that the greater the LNR content material in the emulsion paint binder, the decreased the washability resistance properties. This suggests that growing the LNR content material of the emulsion paint binder combination can limit the adhesive electricity of the paint. However, NRL modified to LNR resulted in higher adhesion of emulsion paint than NRL except for modification. LNR has a shorter carbon chain and decrease molecular weight, so it normally has pretty strong adhesion. [18]

LNR additionally suggests accurate compatibility with PVAc, producing binders with greater adhesion. The pattern with the lowest washability resistance used to be located in emulsion paint with an LNR content material of 100%, besides PVAc. The adhesion property of LNR is nevertheless decreased than that of PVAc. In our study, according to Constituent, Cellulose was 43.4822%, Alpha-Cellulose was 34.8427% and Cellulose was 8.6395%. And according to Cellulose content in other plant straws, Rice Straw was 32.15%, Sugarcane was 41-43%, Rye Straw was 31.8-42.64%, Corn Stalks was 29.80% and Wheat Straw was 34-40%.

NRL-g- (MMA-co-St) had higher adhesion properties than both unmodified

NRL or LNR. The washability resistance of LNR is much lower than that of NRL-g-(MMA-co-St) at the identical composition of binder mixture and binder content material of emulsion paint. This is due to the fact NRL-g-(MMA-co-St) has a higher affinity between particles and water resistance than LNR. [19]

The low adhesion property of NRL-g-(MMA-co-St) in contrast to PVAc is due to the fact NRL-g-(MMA-co-St), which coats emulsion paints, oxidizes quicker than PVAc. The oxidation procedure in the emulsion paint layer will no longer give up till the binder layer dries. [20] An appropriate emulsion paint binder needs to additionally pay interest to the material's oxidation ability, chemical resistance, and mechanical properties. [21] Emulsion paint with a binder NRL-g-(MMA-co-St) has resistance to extra severe temperatures. This is due to grafted styrene and MMA monomers in the rubber polymer chain. Styrene and MMA monomers bonded to rubber elements can extend the rubber latex's elasticity, tensile strength, and durability. [22]

In this present study, according to FTIR spectrum analysis of NR, Absorption was C-H, Band intensity wavenumber was Strong, Wave number was 2957 and Assignment was Stretching vibration. When Absorption was CH, Band intensity wavenumber was Strong, Wave number was 2929 and Assignment was Stretching vibration. When Absorption was C=C, Band intensity wavenumber was Medium, Wave number was 1644 and Assignment was Stretching vibration. And according to FTIR spectrum analysis of oxidized natural rubber, Absorption was O-H, Band intensity wavenumber was Strong, wave number was 3200 and Assignment Was Stretching vibration. When Absorption was O=C=O, Band intensity wavenumber was Medium, Wave number was 2343 and Assignment was Stretching vibration. When Absorption was C=O, Band intensity wavenumber was Strong, Wave number was 1715 and Assignment was Stretching vibration. When Absorption were C-H, Band intensity wavenumber was Medium, Wave number was 1447 and Assignment was C-H bending.

The washability resistance of emulsion paint decreases with growing NRL-g-(MMAco-St) stages in the binder, up to 40%. Sample A15 confirmed the quality properties, specifically, the ratio of NRL to the monomer of 80:20 and the ratio of the combination of NRL-g-(MMAco-St)/PVAc of 15:85. This suggests that the greater MMA and St bonded to the NRL, will minimize the elasticity and adhesion of the NRL. Materials combined with NRL-g-(MMA-co-St) at the appropriate composition will decrease the surface tension, thereby growing the adhesion residences of the combination. [23]

The lowered washability resistance due to the expansion in the LNR-g-(MMA-co-St) stage in PVAc can be prompted by the viscosity and water content. LNR-g-(MMA-co-St) has a decreased viscosity than NRL at room temperature. PVAc, regularly used as a commercial emulsion paint binder, has a greater viscosity than LNR-g-(MMA-co-St). Therefore, the high-water content material of LNR-g-(MMA-co-St) and its decreased viscosity reasons the emulsion paint to erode greater effortlessly and dissolve effortlessly in water. [24]

CONCLUSION

Polyvinyl acetate (PVAc) binder possessed higher viscosity and adhesion than Natural rubber (NR). Since the value of NR is much less than of PVAc, combination each binder will sincerely lead to cost discount for the manufacturing of emulsion paint. However, emulsion paint produced with 25%NR: 75% PVAc binder blends confirmed best physical and chemical properties. Therefore, besides compromising standard, effective and reasonable emulsion paint can be produced the usage of binder in PVAc to NR ratios of 75:25%. In addition, the findings of

this study can be utilized in the scale-up emulsion paint production.

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