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Preparation of Adhesive from Raw Potatoes and Evaluation of Its Physicochemical Properties

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Abstract: Adhesives are used in process industries for many binding purposes. The aim of the study is to produce adhesive from raw potatoes. The raw potatoes are first processes to extract starch. Then, the starch is used as one of the main raw materials to prepare adhesive using borax and hydrochloric acid. The produced adhesive has been analysed and tested to check its effectiveness and quality by measuring the physicochemical properties such as pH, density, and viscosity. Three samples of adhesives were prepared by mixing various proportions (S1: 5 g potato starch, 100 mL hydrochloric acid and 5 g borax; S2: 8 g potato starch, 100 mL hydrochloric acid and 5 g borax and S3: 14 g starch, 150 mL hydrochloric acid and 7 g borax). The physicochemical properties of prepared adhesives were compared with standard value and S2 was found to have closer properties. The results revealed that the adhesive from raw potatoes was found to be effective for various industrial applications.

Keywords: Adhesive, Raw potatoes, Starch, Borax, Physicochemical properties

Introduction:

Adhesive glue is any substance that could hold materials together in a functional manner by surface attachment that resists separation [1]. Adhesive as a general term includes cement, mucilage, glue, and paste and Portland cement. Natural adhesives have been known since antiquity. Egyptian carvings dating back 3,300 years depict the gluing of a thin piece of veneer to what appears to be a plank of sycamore. Papyrus, an early nonwoven fabric, contained fibers of reed like plants bonded together with flour paste. Bitumen, tree pitches, and beeswax were used as sealants and adhesives in ancient and medieval times [2].

The technology of animal and fish glues advanced during the 18th century, and in the 19th century rubber- and nitrocellulose-based cements were introduced. Decisive advances in adhesives technology, however, awaited the 20th century, during which time natural adhesives were improved and many synthetics came out of the laboratory to replace natural adhesives in the marketplace. The rapid growth of the aircraft and aerospace industries during the second half of the 20th century had a profound impact on adhesives technology [3, 4]. The demand for adhesives that had a high degree of structural strength and were resistant to both fatigue and severe environmental conditions led to the development of high-performance materials, which eventually found their way into many industrial and domestic applications [5-7].

Natural adhesives are primarily of animal or vegetable origin. Though the demand for natural products has declined since the mid-20th century, certain of them continue to be used with wood and paper products, particularly in corrugated board, envelopes, bottle labels, book bindings, cartons, furniture, and laminated film and foils. In addition, owing to various environmental regulations, natural adhesives derived from renewable resources are receiving renewed attention [8]. Two components of polyurethane adhesive are polyisocyanate prepolymer and polyol, a poly (alkaline oxide) polyamine containing two or more primary amine groups and having a molecular weight of from about 400 to about 10,000 and a polyurethane catalyst [9].

The present study aims to produce adhesive from raw potatoes and to determine its physicochemical properties such as density, viscosity, and pH.

Materials and Methods:

Materials:

Raw potatoes were purchased from local commercial market in Salalah. Borax and hydrochloric acid from VWR International were used without further processing. Double distilled water was used in this study unless otherwise specified.

Extraction of starch from raw potatoes:

Raw potatoes of 500 g were weighed and washed thoroughly with water to get rid of dirty particles. Then, the potatoes were peeled and mixed with 500 mL of water to proceed for grinding. After grinding, the slurry mixture was allowed to settle in 1 L measuring cylinder. After settling, the liquid was decanted to collect potato starch collected in the bottom. Finally, potato starch was dried at 105 °C to constant weight.

Preparation of adhesive from potato starch:

Potato starch of 5 g was dissolved in 1000 mL of 0.01 M hydrochloric acid and heated to 100 °C to reduce the viscosity of starch and for gelatinization. Then, the slurry was cooled to 75 °C and 5 g of borax was added with continuous stirring. The stirring was continued until the slurry becomes sticky.

Physicochemical properties of adhesives:

The prepared adhesive was evaluated for physicochemical properties such as pH, viscosity, and density. They were measured by pH meter, pycnometer, and rotational viscometer, respectively. The physicochemical properties were evaluated by preparing three samples in various proportions of potato starch, borax and hydrochloric acid as given in Table 1.

Table 1. Proportions of potato starch, borax, and hydrochloric acid for preparation of adhesives

Sample code	Mass of potato starch (g)	Mass of borax (g)	Volume of hydrochloric acid (mL)
S1	5	5	100
S2	8	5	100
S3	14	7	150

Results and Discussion:

Sample 1 (S1) contains equal proportion of starch and borax. Sample 2 (S2) contains more starch than borax in the mass ratio of 8:5. Sample 3 (S3) contains more starch than borax in the mass ratio of 2:1 with excess volume of hydrochloric acid.

Density of adhesives:

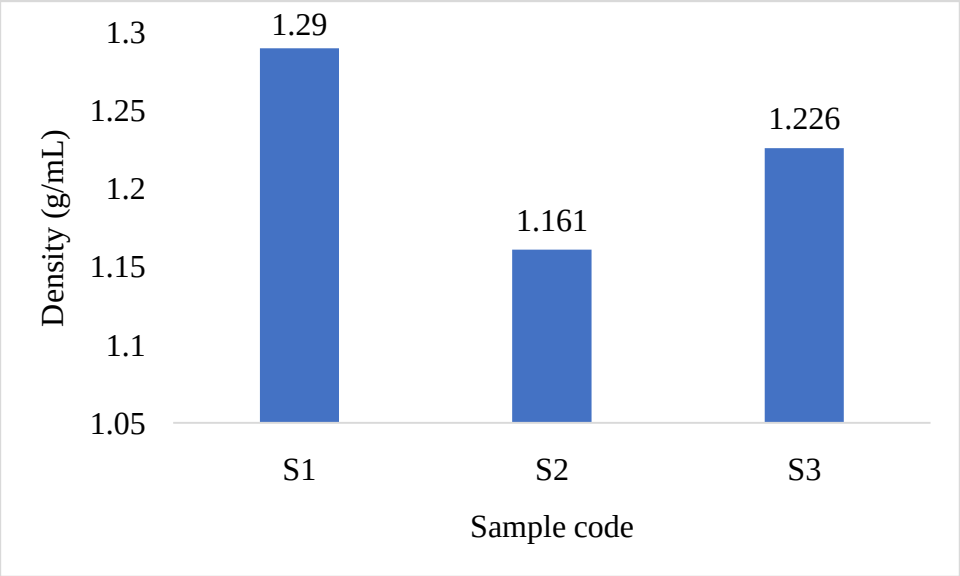

Figure 1. Effect of sample on density of adhesive prepared from potato

Figure 1 shows the effect of sample on density of the adhesive prepared from potato. A good adhesive has low density (1.08-1.10 g/mL). Density of S1, S2, and S3 were 1.29, 1.161, and 1.226, respectively. The density of sample S2 is closer to the standard value.

Viscosity of adhesives:

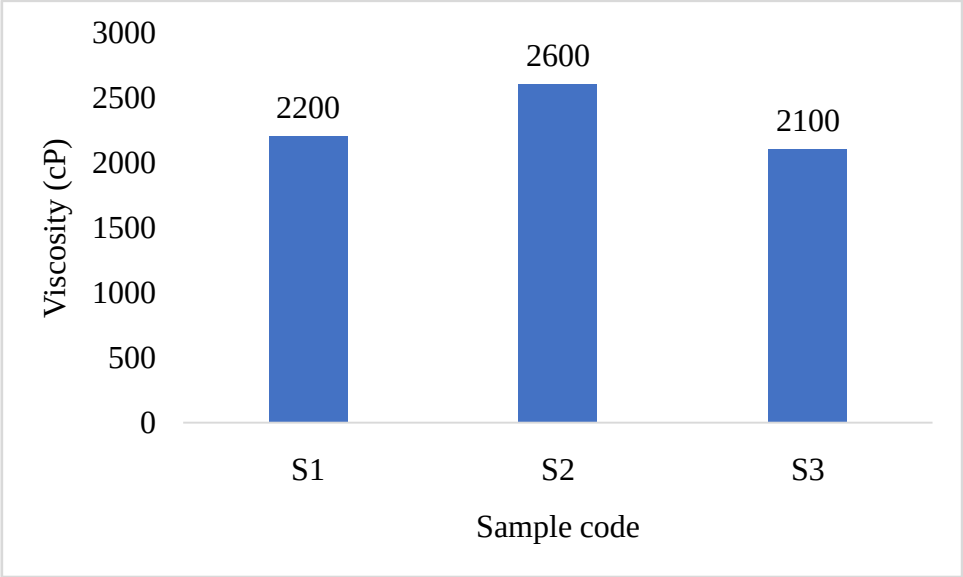

Figure 2. Effect of sample on viscosity of adhesive prepared from potato

Figure 2 shows the effect of sample on viscosity of the adhesiveprepared from potato. The viscosity of adhesive ranges from 200 to 1,500,000 cP, depending on the application. Viscosity of S1, S2, and S3 were 2200, 2600, and 2100 cP, respectively. The viscosity of sample S2 is closer to the standard value.

pH of adhesives:

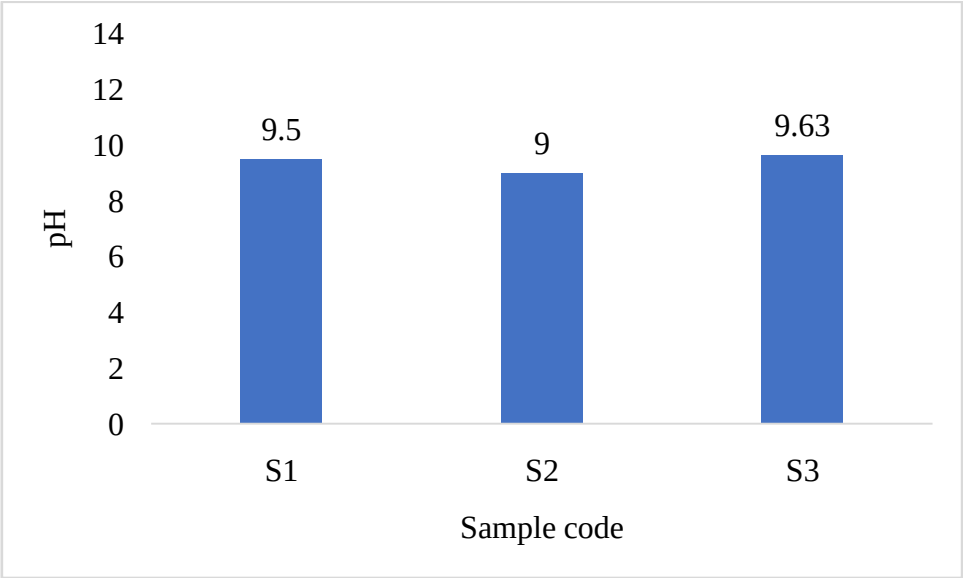

Figure 3. Effect of sample on pH of adhesive prepared from potato

Figure 3 shows the effect of sample on pH of the adhesiveprepared from potato. A good adhesive has a neutral pH of 7. pH of S1, S2, and S3 were 9.5, 9, and 9.63, respectively. The pH of sample S2 is closer to the standard value.

Conclusion:

The work focused on preparing an adhesive from raw potatoes and to evaluate its physicochemical properties such as density, viscosity, and pH. Three samples of adhesives were prepared by mixing various proportions (S1: 5 g potato starch, 100 mL hydrochloric acid and 5 g borax; S2: 8 g potato starch, 100 mL hydrochloric acid and 5 g borax and S3: 14 g starch, 150 mL hydrochloric acid and 7 g borax). The physicochemical properties of prepared adhesives were compared with standard value and S2 was found to have closer properties. Hence, it could be concluded that an increase in starch content by 60% could improve the properties of adhesives.

References:

[1]. Täljsten, B. (2005). The importance of bonding: an historic overview and future possibilities. In *International Symposium on Bond Behaviour of FRP in Structures: 07/12/2005-09/12/2005* (pp. 1-10). International Institute for FRP in Construction.

[2]. Skeist, I., &Miron, J. (1981). History of adhesives. *Journal of Macromolecular Science—Chemistry*, *15*(6), 1151-1163.

[3]. Keimel, F. A. (2003). Historical development of adhesives and adhesive bonding. *Handbook of Adhesive Technology*, 1-12.

[4]. Fay, P. A. (2021). A history of adhesive bonding. In *Adhesive Bonding* (pp. 3-40). Woodhead Publishing.

[5]. Marques, E. A. S., Da Silva, L. F., Banea, M. D., &Carbas, R. J. C. (2015). Adhesive joints for low-and high-temperature use: an overview. *The Journal of Adhesion*, *91*(7), 556-585.

[6]. Zhu, W., Bartos, P. J., &Porro, A. (2004). Application of nanotechnology in construction. *Materials and structures*, *37*(9), 649-658.

[7]. Hollaway, L. C., &Cadei, J. (2002). Progress in the technique of upgrading metallic structures with advanced polymer composites. *Progress in Structural Engineering and Materials*, *4*(2), 131-148.

[8]. Gwangwazo, I. U., Usman, A. H., & Abubakar, A. A. (2021). Production and properties of seven adhesives from gum arabic (Acacia senegal). *Fudma Journal of Sciences*, *5*(4), 100-107.

[9]. Janik, H., Sienkiewicz, M., &Kucinska-Lipka, J. (2014). Polyurethanes. In *Handbook of thermoset plastics* (pp. 253-295). William Andrew Publishing.