ABSTRACT OF THE THESIS entitled "***Development of Non-edible Vegetable Oil-based Polymers and their Applications***" submitted to The Maharaja Sayajirao University of Baroda for the degree of Doctor of Philosophy in Applied Chemistry by **Vikashkumar Manojbhai Ganvit** under the supervision of **Dr. Rakesh K. Sharma**

Vegetable oil-based polymers have emerged as a promising class of materials, attracting the attention of scientists, engineers, and researchers across diverse fields. These polymers, derived from renewable vegetable oils (VOs), exhibit properties that significantly differ from their petroleum-based counterparts, making them an eco-friendly alternative for sustainable development. The inherent chemical structure of VOs, comprising triglycerides with varying fatty acid chains, provides a versatile platform for creating polymers with tailored functionalities. VO-based polymers offer several advantages, including biodegradability, renewability, and reduced environmental impact. Their unique chemical properties, such as the presence of double bonds, hydroxyl groups, and ester linkages, allow for extensive chemical modifications to suit specific applications. However, challenges like limited thermal stability and mechanical strength necessitate careful optimization during synthesis and application. There are many modifications possible in VO-based polymers which lead to superior performance of VO-based polymers in the applications ranging from coatings and adhesives to biomedical materials as well as environmentally friendly packaging.

This thesis work focuses on the development of sustainable polyurethane (PU) polymers synthesized from non-edible vegetable oils (NEVOs), specifically castor oil (CO) and mahua oil (MO). These renewable resources (CO and MO), known for their unique chemical properties and abundant availability, were utilized to create various PU and waterborne polyurethane (WPU) materials with tailored functionalities for diverse applications. The research addresses the urgent need to replace petroleum-based polymers with eco-friendly alternatives, contributing to sustainable development and environmental conservation.

CO, rich in ricinoleic acid, was directly employed as a polyol for PU synthesis, while MO underwent chemical modification to produce polyols with enhanced properties. The

synthesized polymers were rigorously characterized using ATR-FTIR, NMR, DSC, and TGA to evaluate their structural, thermal, mechanical, and chemical properties. The results demonstrated that the innovative PU materials derived from these VOs exhibited excellent thermal stability, chemical resistance, and mechanical strength. Key findings include the development of urethane-modified polyesteramide (UmPEA) resins, which displayed a glass transition temperature (Tg) ranging from 56.1°C to 69.1°C and two-stage thermal degradation, indicating high thermal stability. For waterborne PU coatings (WPUCs) with curcumin, antibacterial activity increased significantly, achieving bacterial reduction rates of up to 99.99%. These coatings also enhanced the washing and rubbing fastness of textile fabrics while improving tensile strength and abrasion resistance. Similarly, waterborne polyurethane-urea dispersions (WPUUs) exhibited Tg values increasing from 36.8°C to 57.4°C with higher chain extender (OA) content, along with high chemical resistance and smooth morphologies, making them ideal for protective coatings. PU composite films incorporating silica nanoparticles (SiO_2NPs) and curcumin demonstrated enhanced thermal and mechanical properties. The films exhibited low swelling in organic solvents, with the PUSC composite achieving a Tg of 62°C, indicating higher thermal stability compared to conventional PU. Antibacterial tests showed over 99% bacterial growth reduction, attributed to curcumin's inherent antibacterial properties. The composites also demonstrated improved wettability, with a contact angle decrease from 78° for PU to 68° for PUSC, reflecting increased hydrophilicity.

These results underscore the potential of VO-based PU and WPU polymers as sustainable alternatives for coatings, packaging, and antimicrobial applications.

Overall, this research work highlights the development of newer VO-based PU polymers using the renewable resources and their versatility in the coating applications.