CHAPTER I
INTRODUCTION

1.1 General Background

With the world's population increasing and various activities that human being must rely on natural resources more than in the past, natural resources are decrease rapidly. Therefore, humans have invented and developed thing that will replace natural resources, which is "plastic", durable materials lasted for hundreds of years. However, the overutilization of plastic gives rise to a multitude of issues. A portion of plastic rapidly becomes waste. Conventional plastic, which is non-biodegradable, can contaminate our environment for many decades if not disposed of correctly. Currently, enormous amounts of plastic are accumulating in landfills and in the environment. With rising consumption, there is a pressing need for innovation and comprehensive solutions to address this issue. Plastic which are biodegradable or made from renewable resources including poly(lactic acid) (PLA), polybutylene adipate terephthalate (PBAT) and polybutylene succinate (PBS) represent an alternative potential in the improvement of materials for utilization in environmental preservation. The discovery of biodegradable plastics has made it possible for humans to find a substitute for traditional petrochemical plastics because there are features in use that are comparable.

Thailand, a country mostly reliant on agriculture, exhibits a significant amount of agricultural production. The abundance of soils and favorable terrain, along with sufficient water resources and a tropical climate, enable multiple crop cycles per year. Consequently, amount of plastic waste from agricultural sector has been increased. One of them is plastic films such as seedling bags and mulch films. When seedlings are planted, plastic films cannot be quickly decomposed in the soil. The seedlings may not grow as well as they should. Waste plastic from films is also a problem for the environment. The residual plastic is a stubborn waste with the potential to contaminate the atmosphere when burned. Therefore, focusing on the ecosystem by using biodegradable films is a proactive strategy for reducing plastic waste, decrease waste disposal costs, and avoid diverse environmental issues. It can also biodegrade naturally within a reasonable period of environmental conditions.

Films for agricultural applications generally made from polyethylene plastic, are used worldwide because they are inexpensive and lightweight (Haase et al., 2021). Such films often have a short service life, resulting in massive amounts of plastic waste. Therefore, it has presented numerous problems. Despite its non-biodegradable nature, polyethylene can transform into microplastics in the environment. This can have substantial adverse effects on the health of organisms, as well as on the entire food chain (Da Costa et al., 2018). Therefore, it is crucial to substitute conventional polymers with biodegradable and compostable alternatives to decrease the quantity of post-consumer plastics that are hard and costly to recycle and pose risks to the environment.

Poly(lactic acid) (PLA) is a biodegradable polymer that is especially suitable for use in agricultural film. Renewable sources such as corn, wheat, potato starch, or sugarcane produce this biodegradable polyester. This thermoplastic biopolymer is highly promising due to its biocompatibility and excellent mechanical characteristics (Zhou and Butchosa, 2016). Nevertheless, PLA has certain disadvantages, such as low toughness, slower decomposition rate, hydrophobic nature, and absence of reactivity side-chain groups. In addition to having mechanical properties that are either superior to or equivalent to those of conventional plastics, PLA must also have undergone bulk modification, primarily to increase its toughness and degradation rate, for it to be successfully used in consumer commercial applications (Ren, 2011). For example, Garcia-Garcia et al. (2020) applied epoxidized karanja oil (EKO) to PLA to increase its flexibility. They discovered that the compositions, including EKO, produced an increase in elongation at break and, as the EKO content increased, reduced the glass transition temperature. The PLA composition, including 5 wt.% EKO, demonstrated the best possible balance between increasing the material's strength and increasing its elongation at break to 77%. Furthermore, under composting conditions, all of it decomposed. In addition, Arrieta et al. (2020) discovered that oligomeric lactic acid (OLA) enhanced the rate of crystallisation in PLA. The PLA composite containing 15 wt.% of OLA exhibited superior structural and mechanical capabilities, along with suitable degradation in compost. These findings suggest that this composite could be used as an agricultural mulch film.

This research specifically emphasizes developing sustainable and biodegradable agricultural films to solve the above-mentioned problems. PLA was the polymer base chosen for this purpose, with natural rubber and rice straw as additional components.

Blending PLA with NR without various modification is a good choice to improve toughness and elongation at break and enhance degradation rate of PLA (Buys, Aznan and Anuar, 2017). Natural rubber, derived from the latex found in the sap of certain plants, is a renewable resource that can effectively enhance the flexibility of PLA, as well as its low cost (Bitinis, Verdejoa, Cassagnau, and Lopez-Manchadoa, 2011). However, the different polarity and molecular weights of PLA and NR cause the blends to be immiscible, leading to phase separation and poor mechanical properties. A study conducted by Jaratrotkamjorn, Khaokong, and Tanrattanakul (2012) discovered that the polarity, viscosity, and molecular weight of NR can be improved through NR mastication using a two-roll mill. This results in improved compatibility as well as an increase in impact strength and elongation at break in the PLA/NR blend. Furthermore, NR has been observed to disrupt the crystalline structure of PLA (Huang et al., 2013). It will have a positive effect on the degradability of PLA. The hydrolysis of PLA is partially regulated by the water diffusion rate in the amorphous areas of the polymer. The diffusion of water through crystalline areas is limited (Kale et al., 2007). Incorporating NR resulted in an augmentation of the amorphous region within the matrix, thereby resulting in an elevation in the rate of water absorption. This phenomenon arises because of the amorphous area's inherent flexibility, which allows for rapid water diffusion (Rosli, Ahmad, Anuar, and Abdullah, 2018). One of basic parameters controlling control the hydrolytic degradation of a PLA is quantity of absorbed water (Zaaba and Jaafar, 2020).

In Thailand, rice serves as both the predominant staple crop and the key agricultural export of the country (Suebpongsang, Ekasingh and Cramb, 2020). To serve the growing demands, rice is grown yearly; as a result, the product of rice increased by around 30% in 2022 compared to 2021 (Thai Rice Exporters Association, 2022). Rice harvesting leaves behind a waste called rice straw. Rice straw is either stacked or spread over the field, depending on the harvesting methods employed. Removing the remaining rice straw from the field is a difficult task. Burning is the simple method. Remaining rice straw burning influences greenhouse gas emissions and a direct effect on the environment, ultimately leading to climate change (Singh et al, 2021). And with these problems that have spread throughout several global regions. There are many researchers who understand its importance. To encourage the sustainable disposal of this agricultural waste and increase the value of rice straw for farmers, rice straw has been studied for a variety of purposes, including its possible use as a reinforcing ingredient in polymer composites. The research conducted by Xu et al. (2022) provides a practical approach to optimize the utilization of rice straw waste. Green wall insulation based on PLA offer the benefits of environmental preservation and renewability. However, their limited usage is attributed to their poor efficiency. To solve this issue, the researchers employed the azodicarbonamide (AC) as the foaming agent and utilized the molded foaming method to manufacture PLA/rice straw (RS) biocomposite foams. To enhance the performance of foams, degradable polycaprolactone (PCL) was added. This study found that foams exhibited enhanced impact strength, compression strength, and water resistance following the addition of 40 wt.% PCL. Therefore, all the foams demonstrated exceptional insulating capabilities. Xie et al. (2022) proposes strong proof in support of the development and production of green composites reinforced with rice straw. The researchers found that the stalk consists of a central core and an outer sheath. The epidermal tissue within the outer layer of the core is thicker compared to that of the sheath, and its thickness plays a significant role in determining composite mechanical characteristics.

The information above suggests that PLA, NR, and RS biocomposite could potentially produce low-cost, biodegradable, flexible, and strong agricultural films.

1.2 Research objectives

(i) To study the effect of mastication time of natural rubber on the melt flow index and tensile properties of PLA/NR blends.

(ii) To study the preparation method of biocomposite films from PLA/NR/RS.

(iii) To study the effect of an amount of rice straw on tensile, thermal, morphological, and biodegradable properties of PLA/NR/RS biocomposites films.

(iv) To study the agricultural application of PLA/NR/RS biocomposites films.

1.3 Scope and limitation of the study

This study initially investigated the influence of different mastication times (10, 20, and 30 minutes) in a two-roll mill on the tensile characteristics of a blend of PLA and NR, with a blend ratio of 60/40 wt.%. The blend that shows optimum tensile properties was chosen and used as a matrix for PLA/NR/Rice straw biocomposites. A ground RS with a diameter of about 53 μm was applied. An internal mixer was used to prepare the biocomposites with 3, 5, and 10% RS based on the amount of PLA/NR blend matrix. Biocomposite films were produced by cast film extrusion. Mechanical, thermal, morphological, and biodegradable properties of biocomposite films were characterized. In addition, the potential applications of PLA, NR, and RS biocomposite films as agricultural films, including seedling bags and mulch films, were investigated. The plant's growth efficiency and degradation during the planting period were examined.