Introduction

CHAPTER I

INTRODUCTION

India is a tropical country, and summers here can be very health excruciating. With over 45ºC outside, one needs to be well hydrated and take precautions to stay energised to beat the heat. The best way to do that and cool your taste buds is to be a seasonal fruit and vegetable lover. Seasonal fruits and vegetables consist of rich ingredients and essential nutrients that are required to stay healthy. Alongside water content, these also provide the body with lot of vitamins and minerals, keeping several health hazards at bay.

Jackfruit (*Artocarpus heterophyllus Lam*.) is one of the largest tree-borne spiky seasonal fruits, characterized by strong, sweet scents and aroma and distinctive taste. In 2022, global jackfruit production was estimated at approximately 3.7 million tonnes, with India contributing over 1.4 million tonnes, making it the largest producer worldwide (Pathak *et al.,* 2022). Jackfruit is a fruit packed with minerals such as sodium, potassium, calcium, phosphorous, and iron (Amadi *et al.,* 2018). Fruit provides essential dietary fiber, vitamins, and sugars to the diet. Studies showed that phytochemicals such as carotenoids, polyphenols, and flavonoids have different levels in jackfruit according to different stages of development (Chandra and Bharati, 2020). The high-profile phytochemicals found in jackfruit may contribute to its health-promoting properties. It is eaten fresh or made into cakes, juices, ice creams, and crisps when ripe. It was officially declared the state fruit by the Government of Kerala in 2018 (Anon., 2018). This announcement comes at a time when the Kerala Government is looking into the possibility of branding ‘Kerala Jackfruit’ as a brand to bring attention to its organic and nutrient-dense qualities throughout the country and abroad. By positioning the Kerala Jackfruit as a brand, the state government can leverage its unique characteristics and capture the interest of consumers both domestically and internationally. The jackfruit was once considered a humble crop without any commercial status before it was declared the official fruit of Kerala. Despite its composition and texture, the fruit is perishable and cannot be stored for a long time. There were rotten yellow puddles under every tree in rural homesteads, since this fruit has no market value. Due to insufficient postharvest knowledge during harvest, transportation, and storage, a considerable amount of jackfruit in particular is wasted

throughout the glut season every year. The major constraint to the marketability of jackfruit is its limited shelf-life due to rapid microbial growth and colour loss. A standardised process protocol for the minimally processed jackfruit can reduce post-harvest losses and boost the production sector. This will provide better returns to the farmers, various stakeholders of the supply chain, and ultimately improving the self-sufficiency of the country.

The fruit and vegetable processing market are expected to experience significant growth in the coming years. According to the data, the market is estimated to have reached approximately INR 714 million in 2022. Furthermore, it is projected to expand at a compound annual growth rate (CAGR) of 6.4% from 2022 to reach a value of nearly INR 96,85,14,500 by 2027 (Markets and Markets, n.d). The processed fruit and vegetables market is specifically driven by the ever-increasing needs of busy consumers due to the fast pace of modern life. As people's incomes increase, they have more discretionary income to spend on convenience foods that require minimal preparation. This has led to an increase in the demand for ready-to-eat and on-the-go foods such as pre-packaged snacks, and beverages. As a result of the high growth in the industry, the outlook for the fruit and vegetable processing market appears positive. This is due to the increasing demand for processed fruits and vegetables from consumers, the technological advancements in the processing industry, and the growing number of food processing companies that are entering the market.

Processing of fruits and vegetables will check microbial growth, improve their preservability and enhance sensorial characteristics. Nowadays, consumers are increasingly looking for food products that are as close to their natural taste and flavour as possible, with minimal processing and few added ingredients or minimum preservatives and there is, therefore, a strong tendency towards consumption of premium quality products. The conventional practice of inactivating microbial population by thermal processing helps to extend the product storability and inactivate heat-stable enzymes. In spite of its advantages, thermal processes do have some downsides, such as slow convection and conduction heat transfer. It is also possible to overcook food, resulting of desirable taste, texture, aroma, or appearance, while also being deficient in essential nutrients (Petruzzi *et al*., 2017). It means that the food not only fails to provide adequate nourishment but also fails to meet the expectations of

sensory enjoyment. According to Chen *et al.* (2013), thermal treatments' efficacy can also be affected by several factors, such as the complexity of the product and the microorganisms that reside in it. In the case of minimally processed fruits and vegetables, many methods have been tested and successfully proposed, but thermal processing remains the most cost-effective solution. Contrary to thermal processing, non-thermal processing can preserve quality characteristics in minimally processed fruits and vegetables. Non-thermal preservation techniques such as high pressure and pulsed light processing are believed to be more effective at preserving the original nutrients and flavour of the food, while also reducing the risk of contamination from pathogens. Additionally, these techniques are more energy-efficient than traditional thermal processing methods.

High-pressure processing (HPP) is a non-thermal way to produce high-quality food that maintains the freshness of the product and extends its shelf life. HPP works by applying a high level of hydrostatic pressure to food products, which kills microorganisms and other spoilage agents responsible for food spoilage without the need for high temperatures. This makes it ideal for preserving freshness and extending shelf life without compromising the quality and nutritional value of the food. The process includes using high levels of pressure on packaged or bulk food products. This pressure can range from 100 to 600 megapascals (MPa) and lasts for a specific amount of time (Abera, 2019). The high pressure is evenly distributed all over the product package or container. Contrary to thermal processing, HPP primarily affects the non-covalent bonds. This ensures the highest product quality while minimizing changes in taste and nutrition. Previous studies have already reported the potential ability of HPP in retaining the bioactive compounds, enzyme inactivation, and microbial destruction in fruits and vegetables. HPP processed mango pulp was shown to retain up to 129% of ascorbic acid (AA) after a single 600 MPa pulse (Kaushik *et al*., 2014). As the world population is becoming increasingly urbanized, there is an increase in the number of young people and changes in lifestyles. Increasing disposable incomes and more nuclear families create demand for HPP foods. It is estimated that HPP is worth USD 15,523.36 million in 2019, indicating its economic significance and growth potential in the food industry, since it offers a safe and longer-lasting alternative to preserving perishable food (Anon, 2020).

Pulsed light (PL) technology is another environmentally friendly short-time non-thermal decontamination technique for fruit juices. In PL an intense pulse of light with 100-1100 nm wavelengths is used on the target within a short time. The pulse covers ultraviolet, visible, and near-infrared wavelengths. The major application of PL is in surface decontamination of food and packaging materials. Upon absorption of the high intensity PL by the microbial DNA, genetic information is impaired. This process is also known as photodamage or photochemical damage, which is caused by the absorption of light energy within the microbial cells. This energy is then converted into heat, resulting in the denaturation of proteins and nucleic acid molecules, and ultimately cell death (Chen *et al*., 2013). Pataro *et al*. (2011) found that membrane damage played a crucial role in bacterial inactivation by PL in apple and orange juice. In addition to the photochemical effect, the photothermal effect can also play a significant role in the destruction of microbes during PL processing. A number of fruit juices have been studied using PL technology to kill food microbes and inactivate enzymes over the course of the past year. The effects of PL treatment on the microbial load of lactic acid fermented Mulberry juice have been reported to be acceptable without affecting the biochemical properties (Kwaw *et al*., 2018). Food and Drug Administration, 2015, approved PL applications for food processing and handling with a UV dosage of 12 J/cm^2 and pulse duration ≤ 2 ms. Food treatment with PL has been attempted on a small scale, but there is no evidence that it is useful on a large scale.

In a few studies, temperature control was demonstrated to be an effective method for safely storing ripe jackfruit. However, nonthermal methods such as HPP and PL have yet to be investigated. This study attempted to standardise thermal and non-thermal processing of ripe jackfruit and evaluate the quality and storage of ripe jackfruit processed with retort pouches, high pressure, and PL techniques. The major objective of the study consists of:-

- Standardisation of thermal process protocols for ripe jackfruit and its pulp using retort pouch packaging
- Standardization of non-thermal processing protocols for ripe jackfruit and its pulp using HPP, and for pulp using PL technology
- Safety and quality evaluation of thermal and non- thermal processed ripe jackfruit