Chapter I. Introduction

1.1 Introduction

Beef consumption has been on an uptrend with data showing an average increase of 1.43% from the year 1990 to 2022, resulting in a total meat consumption of 333.8 million tons by 2022 (OECD, 2023) with meat contributing 21% of the world meat consumption, coming in third after poultry and pork. Unfortunately, food spoilage caused by poor storage conditions, lack of aseptic handling, and bad processing have caused losses for up to 21% of the annual meat production (Höll, et al., 2016). meat itself is considered as highly perishable food, shown by its characteristic of having high water activity, high nutrient content, availability of autolytic enzymes, and relatively high amount of fat and lipids which are easily oxidized (Pellissery, et al., 2020). Poor handling during processing, packaging, and storage provokes growth of unwanted microorganisms such as Brochotrix, Pseudomonas, Lactobacillus, and Leuconostoc, which can result in slime formation on surface, off-odor, and texture alteration (Erkmen & Bozoglu, 2016). The degradation of the meat quality in the meat industry has resulted in sizable amounts of economic losses and also deterioration on the amount of good quality food to be consumed. One of the approaches for increasing the shelf life of meat products is with the use of flexible packaging in the form of vacuum bags. Vacuum bags present a great extension of meat's shelf life in refrigerated conditions with claims of up to 120 days (Mazolla & Sarantopoulos, 2019) due to the lack of oxygen of which bacteria like Pseudomonas can't proliferate, therefore reducing the chances of spoilage during storage.

The vacuum bag itself, however, is made up of polyvinylidene chloride (PVC), a type of clear plastic with high durability (Rodrigues et al., 2016), which is a non-degradable and non-renewable material that will eventually end up in the landfill. In Europe alone, 130.9 million tons of packaging waste were produced in 2022 (Eurostat, 2023), therefore to offset the huge amount of waste caused by single used plastic, many have further researched into the viability of biodegradable films. Biodegradable films are made up of polymers sourced from plants, fungi, and animals such as insects and crustaceans (Scheller & Conrad, 2005; Elsabee & Abdou, 2013) in the form of cellulose, starch, pectin, or chitosan (Song et al., 2021) which were then used as the foundation for the creation of edible films and coatings. Edible films are viable to use as plastic food wrapper substitute as edible films exhibit similar important properties of a good food packaging such as good gas and water retention, non-toxic, and affordable (Umaraw & Verma, 2017).

Chitosan is one of the most common biopolymer commonly sourced from the shells of crustacean like shrimp that is used for the synthesis of edible films and coatings due to its film-forming abilities, good antimicrobial properties, carrier of active compound, abundance in nature, non-toxic, high industrial scalability and relatively low cost (Yilmaz, 2020). However, chitosan by itself is a poor water barrier due to its solubility in water (Cao, et al., 2020). To accommodate the lack of water retention ability, gelatin can be added into the mixture during the production process (Wang, et al., 2021). Gelatin is also commonly used as the foundation for edible film for its flexibility, transparency, and abundance from byproducts of animal and fish processing (Bonilla & Sobral, 2020; Gomez-Estaca, et al., 2011). Studies have also shown that the combination of these polymers is capable of extending the shelf life of meat (Zou, et al., 2022).

During the production process of the edible films, essential oils (EO) are usually incorporated into the film for their antimicrobial properties, reducing the chances of microbial contamination on meat (Anis, et al., 2021). Research from Khalaf et al. (2013) shows an incorporation of oregano and rosemary essential oils into pullulan film shows significant effect on inhibiting the growth of gram-positive bacteria. Another plant that has great potential as an antimicrobial essential oil is kesum plant. Kesum plant (*Polygonum minus Huds*) originated from West Borneo where the leaves are usually used as an ingredient for a dish due to their unique taste and aroma (Dewi, Asseggaf, Natalia, Mahyarudin, 2019). Kesum leaves extract have been studied to have good antimicrobial effects on *Escherichia coli* and *Staphylococcus aureus* (Imelda, et al., 2020), and has been shown effective as well as an addition to edible film (Lestari, et al., 2020).

The use of chitosan-gelatin on beef has been done before, however it was without the addition of kesum leaves extract. Therefore, this research aimed to evaluate the physicochemical and microbial properties of beef steak during storage, wrapped with chitosan-gelatin edible film incorporated with kesum leaves extract.

1.2 Research Objective

The aim of this research is to evaluate the physicochemical and microbial properties of beef steak during storage, wrapped with chitosan-gelatin edible film incorporated with kesum leaves extract by comparing beef steak without wrapper and beef steak wrapped with chitosan-gelatin film but without kesum leaves extract. Assays such as lipid oxidation using thiobarbituric acid (TBARS) and total volatile base - nitrogen (TVB-N) were done to determine the level of oxidation and protein degradation during storage. Other physicochemical analysis such as color analysis, and pH were also performed. Total plate count, *E. coli* count, and *S. aureus* count were also assessed to determine the antimicrobial activity of the film, with expectations that the film will significantly reduce the oxidation and bacterial contamination when compared to no film on beef.