Chapter 1

Introduction

1.1 Background

Human population has been on the rise for the past few decades. According to Henchion et al. (2017), by 2050 the world population has been projected to reach 9.5 billion people. Despite many people facing fertility issues all over the globe, the momentum of population growth, which is a force created by the existing age structure, would still increase the overall population size, albeit at a slower pace (Gu et al., 2021). Moreover, as the world's population rises, so does the demand for food. Not only food demand, Ritchie et al. (2018) also suggested the increase in population would also indirectly increase the emission of greenhouse gases. Their study further mentioned that livestock for meat and dairy production are also responsible for around 14.5% global greenhouse gas emissions. Greenhouse gases produced by livestock cattle include nitrous oxide, carbon dioxide, and methane; methane having the highest impact on climate change (Thavamani et al., 2020). Overall, a study published by Mc Carthy et al. (2018) concluded that the surge in food demands and climate change would negatively impact food security as resources were spread thinner than ever before.

Hence, managing food resources correctly would be one of the crucial steps to ensure a sustainable food reserve for the people (Mc Carthy et al., 2018). A study done by Tyczewska et al. (2018) believed that allocating larger areas for agricultural purposes is not a realistic solution to the food security issue, as not all land is suitable for agriculture and most countries are currently focusing more on advancing their industrial rather than agriculture capabilities; by 2015, only around 35% of land are available for agriculture. On the other hand, they believed that selecting the right variant of crops would be a better approach to ensure that the crops would yield a product of high quality, which may include disease resistance, yield, and also nutritional value. Some crops that could provide good nutrition include cereals, algal biomass, and pulses (Cole et al., 2018).

Nutrition is especially an important factor to consider when managing food security. Dukhi. (2020) reported that many countries around the world were suffering from unbalanced nutrition uptake, where around 462 million adults worldwide have been reported to be underweight. As a result, this trend has led to a public health concern known as the protein energy malnutrition (PEM) (Bessada et al., 2019). Batool et al. (2014) predicted that PEM was the cause of at least 50% of childhood mortality in developing countries, as well as 50% of hospitalisation of old people. Fortunately, legumes, such as bean, lentils, and pea, are able to not only help alleviate protein deficiency problems, which are caused by food security issues, but also could help fix nitrogen in the soil, improving the overall soil quality in the environment (De Ron et al., 2017). Current trends also showed that worldwide, especially in Western countries, protein consumption trends have increased; demands for both animal and plant-based protein are on the rise (Juul et al., 2023). Furthermore, unlike conventional sources of proteins, such as beef, eggs, and dairy, legumes produce less greenhouse gas, which is responsible for climate change (Semba et al., 2021). Thavamani et al. (2020) claimed that legumes produce 250 times less greenhouse gas emissions when compared to cattle livestocks.

A commonly consumed legume product all over the world is pea (*Pisum sativum*) (Semba et al., 2021). According to Shanthakumar et al. (2022), pea is a sustainable, affordable, and widely available crop. Not only that, pea also has shown its significance as a source of protein, especially in its protein isolate form, for both foods and beverages (Lam et al., 2016). Furthermore, pea also contains high amounts of protein, dietary fiber, minerals and vitamins, while also having low levels of antinutrients (Tulbek et al., 2024).

However, pea and other legume products are infamous for their off-flavors due to the presence of many inherent compounds such as saponins and phenolic compounds; saponins are especially abundant in pea (Roland et al., 2016). Saponins are responsible for the presence of both bitterness and astringency in pea products (Cosson et al., 2022). Moreover, pea is susceptible to oxidation, which induces a beany off-flavor (Trindler et al., 2022). The oxidation process first starts when cell walls are damaged, which causes various enzymes, such as the lipoxygenase (LOX), to readily bind with various substrates (Liburdi et al., 2021). They further explained that LOX is an enzyme that oxidizes linoleic and linolenic acids into conjugated diene hydroperoxides, which is also known as the primary oxidation products. The primary products could undergo further degradation pathways to form volatile and non-volatile compounds as secondary oxidation products; products of the oxidation pathway usually owe to the formation of off flavor in many legume products (Yonny et al., 2018).

Off-flavor due to oxidative changes is not only caused by LOX activity, but processing procedures may also contribute to the formation of these off flavors; pea proteins are commonly utilized in the form of concentrate and isolate which exposed the peas to several processing stages (Trindler et al., 2022). Zhang et al. (2020) explained that pea protein concentrate was produced using dry processing technique, while pea protein isolate required a wet processing technique, where the protein from the pea would be extracted at its isoelectric point from the pea milk.

Fortunately, as humans started domesticating peas for thousands of years, there are currently plenty of variants of peas with their own unique characteristics, such as different taste or nutritional profile growing all over the world (Trindler et al., 2022). Thus, uncovering the characteristics of various pea variants would be beneficial for seed breeding companies, such as Nordic Seed, which is currently carrying out pea breeding programs with an end product catered towards pea protein products.

1.2 Objective

This research investigated the protein content, saponin content, and oxidative products in peas that will take part in a breeding program focusing on pea protein isolate production.

1.3 Hypothesis

Different pea variants will have significantly different protein content, saponins content, and lipid hydroperoxide. While, the null hypothesis will be that no significant difference in the aforementioned parameter is present between different pea variants.