CHAPTER TWO

LITERATURE REVIEW

2.1 Driving Forces for Utilisation of Sweet Potato Haulm

The loss of edible or inedible food from the food supply chain can cause environmental problems and long-term economic threats. Plant-based wastes are often discarded and disposed of using various methods, including dumping, incineration, and decomposing (Ayilara et al., 2020). It is encouraged to discard plant waste using an organic method such as anaerobic decomposition for a more extensive operation.

However, it may take 6 to 8 months to produce compost (FAO, 2003). Solutions for these problems are through prevention of the production and recovery of the wastes. Waste beneficiation or valorisation is another sustainable technique to convert waste into refined or advanced food products. Generated materials can be used in various sectors as biofertilisers, bioplastics, biofuels, or nutraceutical products (Mak et al., 2020).

Haulm also consists of nutritional compounds that can be further utilised as a functional food in future. Several fruits were extracted for the ascorbic acid. For instance, ascorbic acid in orange are used in the pharmaceutical and nutraceutical sectors. Therefore, a preliminary study on the nutrients from sweet potato haulm juice should be done.

2.2 Sweet Potato

Sweet potato, which belongs to the *Convolvulaceae* family, is one of the significant tuber crops that is originated from South America and has been planted mainly for its tubers (Jeng et al., 2015). As sweet potato plants grow well in various climates such as tropical, subtropical, and temperate region, it has been grown widely in African countries such as Nigeria and Uganda, Asian countries such as China, Indonesia, Malaysia, and certain European countries (Prakash et al., 2018). Known as storage root's plant, sweet potatoes are plants that yield starch from their roots. Sweet potato remains as one of the sources for main food consumption, animal feed, alcohol production, and others.

The types of sweet potato are characterised based on the tuber's shape or size, colour of the peel, and flesh (Šlosár et al., 2016). The colours range in varieties from white, yellow, orange to purple. Tubers are edible and usually have a sweet flavour and pleasant smell. Sweet potato consists of a high amount of carbohydrates of starch and simple sugars, proteins, fats, and fat-soluble vitamins. Ghasemzadeh et al. (2016) has studied the compatibility of sweet potato root extracts as a source of natural bioactive compounds, an effective antioxidant, and anticancer properties. Colourful flesh of sweet potato shows the high content of flavonoids such as anthocyanin, peonidin, and cyanidin (Mohamad Zahari et al., 2016). These constituents are antioxidative phytochemicals that provide various benefits to human health.

The top parts, which are the leaves and soft stems of the plants, are called haulm. Islam (2014) states that sweet potato leaves are believed to own a significant amount of additional nutrients such as vitamin B, β-carotene, calcium, zinc, and iron. Figure 2.1

below shows the sweet potato haulm, which consists of the leaves and soft stems of the sweet potato plant.

Figure 2.1: Sweet Potato Haulm

2.3 Sweet Potato Haulm

According to Ishida et al. (2000), the highest protein and dietary fibre content had been found in the leaf and stem compared to the stalk part. The proximate analysis had been done on the sweet potato leaves, which exhibited a great amount of carbohydrate and protein, which were 51.95 g/100 g dw and 24.85 g/100 g dw, respectively (Antia et al., 2006).

Carbohydrates contribute greatly to the energy requirement for human. Moisture content was also recorded high (82.21 g/100 g fw), yet this made the juicing technique possible. A high level of ash content (11.10% g/100 g dw) was reported, followed by crude fibre (7.20 g/100 g dw) and crude fat (4.90 g/100 g dw).

Hue et al. (2012) found that leaf extracts of sweet potato showed the presence of total phenolic and flavonoid content, along with scavenging free radicals' activity. Several phenolic acids have been analysed in sweet potato leaf, such as dicaffeoylquinic, caffeic, and chlorogenic acid. Other micronutrients such as iron, calcium, phosphorus, vitamin C, and magnesium are found at a notable level.

2.4 Chloroplast in Sweet Potato Leaf

Chloroplast is an organelle that converts light to chemical energy and can be found in almost all parts of the plants, such as stems and leaves. Due to its function, it contains a lot of micronutrients stored in the thylakoid and envelope membrane in the chloroplast (Wattanakul et al., 2020). The main component in the chloroplast is chlorophyll, which can be scharacterised as chlorophyll' *a*' and '*b*'. Pareek et al. (2018) report that chlorophyll '*a*' and '*b*' work together in photosynthesis by absorbing red light and blue light from the whole colour spectrum, respectively. Chloroplast is trusted to be high in antioxidant capabilities due to the existence of photosynthetic pigments such as chlorophyll and carotenoids (Pérez-gálvez et al., 2020; Wattanakul et al., 2019; Latowski et al., 2014).

A study has been done on the Chloroplast Rich Fraction (CRF) of spinach (Syamila, 2019; Gedi et al., 2017). The CRF gave better bioaccessibility of nutrients when added with oil (Gedi et al., 2017). The sweet potato leaf consisted of a significant amount of vitamin contents such as β-carotene (476.2 µg/100 g) and vitamin C (14.6 µg/100 g) (Chirwa-moonga, 2020).

2.5 Nutrient Content in Sweet Potato Leaf

Antioxidants serve excellent nutraceuticals benefit, shield against free radicals, and help to improve human health (Alam et al., 2016). Sweet potato leaf could be a potential source of various antioxidants that exhibit different -promoting effects, which can be influenced by the areas or regions grown. The leaves from sweet potatoes possess phytochemicals such as phenolic acid, flavonoids and carotenoids, and each has its own antioxidant activities. (Nguyen et al., 2021).

Suárez et al. (2020) studied the polyphenol content of sweet potato leaf, which are around 6.0 – 9.1 g chlorogenic acid/100 g dw in the presence of 3,4,5-tri-O-caffeoylquinic acid and caffeic acid, mainly contributed to the antioxidant activities of the leaf. Other natural antioxidants present in the leaf include 4,5-di-O-caffeoylquinic acid, vitamin C and E. However, these phenolic contents can be varied from one another of the leaf, possibly due to the processing methods, maturity, polyphenol oxidase activity, storage condition, or genotype (Sun et al., 2014).

2.6 Anti-Nutrient Content in Sweet Potato Leaf

Apart from the beneficial nutrients, sweet potato leaves also consisted various anti-nutrients such as oxalic acid, phytic acid, anthraquinone, tannin, saponin, cyanide and trypsin (Alam, 2021; Awol, 2014; Johnson & Pace, 2010). Anti-nutrient is another concern in consuming agricultural products, especially in green leafy vegetable and this could lessen the bioavailability of nutrients (Ekanayake, 2011). Oxalates may bind to the minerals such as calcium or magnesium (Ooko Abong’ et al., 2020), and could cause hypocalcemia, severe poisoning and in some instances, formation of calcium oxalate as kidney stones might cause renal failure (Banso & Adeyemo, 2007; Islam, 2006). Phytate had been studied to reduce the protein digestibility and interfere with the mineral bioavailability (Ekpo & Baridia, 2020; Francis et al., 2001).

2.7 Effect of Drying Methods, Heat Treatments and Light on Nutrients

To protect phytochemical efficiency in long-term storage, agriculture products were usually exposed to drying process (Mediani et al., 2014). Conventional drying methods such as hot air-drying might damage dried products in terms of colour, nutrients and flavour (Yang et al., 2010). A study conducted by Jiang (2021) showed no significant effect on flavonoids of sweet potato leaves after being oven-treated at 75˚C for 90 min. However, oven-dried sweet potato chips had discoloration, while freeze-dried chips did not significantly cause changes to the colour, probably due to the absence of oxygen and oxidation process on the samples (Zaizuliana et al., 2019).

Effective and rapid drying mechanism is required to minimize the quality loss in plant products. Vacuum freeze-drying preserved the highest content of protein, fat, dietary fibre, and various vitamins along with antioxidant compounds compared to microwave and hot-air drying (Sui et al., 2019). Heat processing such as pasteurisation, which is conducted at below 100˚C and known as mild heat treatment, aimed to extend shelf-life of the food products (food preservation method). Pasteurisation will inactivate enzymes, destroy vegetative and non-spore-forming pathogenic microorganisms, however, this thermal process also may generate quality loss either physical or chemical characteristics of food products. Pasteurisation (90˚C) had reduced 22% red colour in pomegranate juice (Vegara et al., 2013) but did not affect total phenolic content in tomato juice upon storage (Odriozola-Serrano et al. 2008).

Peroxidase (POD) enzyme-catalysed oxidation of phenolics that cause browning and affected colour in juice (Peng et al., 2017). Inactivation of POD also helped to avoid degradation of phenolic concentration. β-carotene, lutein, and α-tocopherol in CRF of pea vine degraded significantly when exposed to light, explaining photo-oxidation occurred (Wattanakul et al., 2020). Similar results obtained where 52% degradation of flavonoids and 24% of antioxidant activity due to the light exposure (Jiang, 2021).